

Long-Term Strategic Research Programme for a Specific RIS3 SK Area of Specialisation from the Point of View of Available Scientific and Research Capacities

1. Name of the RIS3 SK area of specialisation from the point of view of scientific and research capacities:

Sustainable energy sector and energy

2. Specific subtopics of the areas of research specialisation:

- I. Power plants of the future and renewable energy sources
- II. Electricity system
- III. Effective use of energy sources
- IV. Smart grid

la. Power plants of the future and renewable energy sources

lb. The subtopic covers research activities focusing on the use of two types of nuclear reactions: fission of heavy nuclei and fusion of hydrogen isotopes, and research on renewable energy sources.

lc. Key words – nuclear power plants, 4th generation nuclear reactors, nuclear fusion, renewable energy sources

Subtitle: Research of physical and technical problems related to the tokamak type fusion reactor for the purposes of the development of technology investment units, mainly in the field of energy and industrial equipment, while taking into account the internationalisation of activities and the development of emerging countries:

- Research of the physical problems in the fusion of deuterium and tritium nuclei;
- Research of high-temperature plasma reactions with materials of reactor walls, including divertor and Li-blanket;
- Research of the systems of creating strong magnetic fields and plasma heating and stabilisation.

Subtitle: Research of physical and technical problems and of the work cycle of the 4th generation fast reactor for the purposes of the development of technology investment units, mainly in the field of energy and industrial equipment:

- Research of the kinetics of fission reaction at higher temperatures, and of the dynamics and fuel cycle of fast high-temperature nuclear reactors;
- Research of passive systems for heat removal;
- Research using experimental helium loop focusing mainly on heat transfer modes;
- Research of the properties of materials for high-temperature systems;
- Research and development of new construction materials for 4th generation reactors;
- Research and development of diagnostic elements for 4th generation reactors;
- Research and development of ceramic materials for the fuel elements of 4th generation reactors;
- Research of the transformation of fission and activation products, including metrology and radiochemical analysis methods;
- Research of the radiation damage to materials;
- Research focusing on the safety of treatment of radioactive waste, waste reduction and transmutation of long-living nuclides.

Subtitle: Research of the physical and technical problems in renewable energy sources

(RES) for the purposes of increasing energy efficiency and renewable energy sources:

- Research of photovoltaic materials with increased conversion efficiency;
- Research of wind turbine components;
- Research of geothermal systems;
- Research of the systems of use of energy from biomass;
- Research of effective production of alternative fuels using renewable energy sources;
- Development of technologies for the use of alternative fuels as coal substitution in industrial processes.

IIa. Electricity system

IIb. This subtopic integrates research activities aimed to increase the safety and effectiveness of Slovakia's electricity system using modern ICT and new technologies enabling data transfer, processing and storage, including technologies for intelligent management of consumption, intelligent production systems and transport.

IIc. Key words – electricity system, safety, advanced control system, renewable energy sources, intelligent management.

Subtitle: Research of the possibilities of increasing the transfer capacities and safety of Slovakia's electricity system for the purposes of increasing energy effectiveness:

- Research of new methods and control features of the electricity system;
- Research and development of the electricity system model of Slovakia and neighbouring countries for the simulation of conditions and situations;
- Research and development of re-dispatching alternatives in Slovakia's electricity system;
- Research of advanced systems for the simulation of effects in the electricity system;
- Research and development of the life-cycle, reliability and safety of the transmission electricity system;
- Analysis of an effective integration of local distribution systems with own sources into crisis management in the event of local or national blackouts.

Subtitle: Research of intelligent systems for the purposes of intelligent management of consumption and intelligent manufacturing systems:

- Research of advanced systems for analysis, control and dynamic regulation of distribution and low-voltage systems;
- Research of control of HV/LV distribution systems and its importance in terms of higher accommodation of volatile sources/consumption and preservation of the quality of electric energy in the HV/LV system;
- Research of systems for safe and environment-friendly power transmission and storage;
- Research of the systems of conversion of direct current into alternating one and vice versa, with high performance and efficiency;
- Research of the systems for effective diversification of the use of local (regional) renewable sources and non-renewable energy sources;
- Research of the use of alternative power sources for hydrogen production with subsequent production of stable power supplies using fuel elements.

IIIa. Effective use of energy sources

IIIb. This topic covers research activities aimed to increase the effectiveness of the use of energy sources

IIIc. Key words – energy efficiency, new materials, industrial technologies.

Subtitle: Research of new materials for the purposes of energy effectiveness

- Research of construction materials with improved heat and mechanic properties;
- Research of materials for the purposes of innovation in the energy sector;
- Use of the residues of the combustion of energy coal for building applications, development of technological processes, and the legislative framework.

Subtitle: Research of industrial technologies for the purposes of development of manufacturing processes in industry for better use of available sources, more recycling and the use of environment-friendly materials on the basis of scientific and technological development and innovation:

- Research of new manufacturing processes with reduced energy demands;
- Research of systems of combined power and heat production and use of low-potential heat generated in manufacturing processes;
- Research of surface treatment methods, monitoring of properties, and detection of defects in industrial production;
- Research aimed to increase the added value of manufactured energy equipment;
- Research of the methods for reduction of greenhouse gas emissions;
- Research of the methods for increasing the energy efficiency of thermic disposal of hazardous, municipal and other waste.

IVa. Smart grid

IVb. This subtopic covers research activities focused on information and communication products and services, as well as consumer electronics products and electrical appliances used in the electricity system in the field of development of technology investment units in the energy management of smart grids, and research activities targeting economic, social and environmental sustainability of the energy sector with regard to renewable sources.

IVc. Key words – electricity system, smart grid, smart macro-grid, renewable energy source, innovation, energy efficiency, smart building/household, predictive maintenance, virtual power plant, sustainable energy sector, energy poverty.

Subtitle: Research on micro-grids for the purposes of technologies for intelligent management of consumption:

- Research and development of new algorithms for information and communication products and services in the electricity system;
- Research and development of models of renewable sources, accumulation devices and appliances for the testing of stable and temporary features of the micro-grid;
- Research and development of model designs of a comprehensive information and communication system for the management of the energy control of buildings to ensure energy self-sufficiency through the integration of renewable sources and accumulation;
- Research and development of automated systems to promote the position of end customers on the electricity market through energy counselling and the choice of suitable renewable sources and their integration in the electricity system;
- Research and design of a national reference architecture for smart grids and micro-grids, including requirements for ensuring data safety and privacy protection;
- Research and development of models and services ensuring intelligent and effective power consumption control and management of the energy efficiency of micro-grid elements.

Subtitle: Research of the physical and technical problems in electromobility for the purposes of the automotive industry and machinery

- Research on the possibilities of short-term accumulation of energy at the level of end users;
- Research of systems for the management of the charging cycle in smart chargers;
- Research of wireless transmission of electricity;
- Research on the possibilities of interconnecting smart transport systems with future systems of smart cities; control and planning of routes with regard to the location of charging stations and the calculated vehicle electric range.

Subtitle: Consumer electronics products, electrical machines and devices in the electricity system for the purposes of technologies for intelligent management of consumption:

- Research and development of communication modules equipped with broadband or narrowband PLC technology and functional units ensuring high reliability and communication safety;
- Development of smart data concentrators ensuring operative consumption management and power accumulation on the basis of the results of optimisation algorithms;
- Research of modular solutions for the monitoring of energy parameters in LV and HV grids;
- Research and development of smart energy systems for households;
- Research of highly efficient electric machines with improved dynamic features.

Subtitle: Research targeting the economic, social and environmental sustainability of the energy sector with regard to renewable energy sources

- Research of the links between the energy sector and economic growth for the purposes of energy efficiency and renewable energy sources;
- Research of the environmental sustainability of the energy sector for energy efficiency and renewable energy sources;
- Research of the social sustainability of the energy sector with regard to employment and poverty for the purposes of developing solutions in the context of adaptation to climate change and enhancing internal security.

3. Links/relationships between the long-term strategic research programme and the addressing of some/several development trends on the basis of available R&I capacities (short description of the links, if such exist with respect to the specific area):

Available R&I capacities in the field of energy can be used in the following development trends:

- R&I in new materials and their components, polymer composites and their practical use;
- R&I of technologies for obtaining electricity and heat from renewable sources and mixed municipal waste;
- Research in nuclear energy with a focus on safety, burnt fuel storage, research of 4th generation reactors and nuclear fusion, Slovakia's participation in global projects;
- Development i improving the efficiency of transmission systems and energy conversion;
- Design of solutions in the context of adaptation to climate changes and enhanced internal security.

The mutual relationships and links between the long-term strategic research programme from the point of view of available R&I capacities and the development trends of economic specialisation and prospective areas of specialisation are shown in the table below.

	Power plants of the future and renewable energy sources	Electricity system	Effective use of energy sources	Smart grid
Development trends for the areas of economic specialisation of the economy				
Increasing domestic value-added products, particularly through the effective transfer of technology and R&D results into the production process			P	P
Development of production processes in industry focusing on better use of available resources, greater use of recycling materials and environment-friendly materials through scientific and technological development and innovation	P		Y	Y
The use, placement and replacement of previously used materials for advanced materials with a new and more complex performance, including technological processing (machining, forming, joining)			Y	
Development of technological investment units, particularly in the field of metallurgy, engineering, energy and integrated industrial equipment, with respect to the application and use of light metals and advanced materials in the manufacture of transport and construction facility to reduce overall weight and contribute to the green economy, development and application usage of composite materials)	P	Y	Y	P
Development of technological investment units, particularly in the energy and industrial facilities, with respect to internationalisation activities and the development of "emerging countries"	Y	Y		
Increasing the effectiveness of production and logistics processes	Y	P	P	Y
Use of ICT and robotics in production processes			P	Y
Involvement in supply chains and internationalisation - "the purchase of cooperation is a purchase, too"	Y	Y		

	Know-how transfer from large to small subjects and vice versa in the framework of cooperation		P		Y
	Energy efficiency and renewable energy	Y	Y	Y	Y

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Areas of economic specialisation					
	Automotive and mechanical engineering industries	Y	Y	Y	Y
	Consumer electronics and electrical equipment	P	P	Y	Y
	ICT products and services	P	P	P	Y
	Production and processing of iron and steel	Y	Y	Y	P
Prospective areas of specialisation					
	Automation, robotics and digital technology	P	P	Y	Y
	Processing and increasing the value of light metals and their alloys	Y	Y		
	Production and processing of polymers and progressive chemical substances	P	P	Y	P
	Creative industry	P		P	
	Increasing the value of domestic raw material base	Y	P	Y	Y
	Supporting smart technologies in the processing of raw materials and waste in the region of their occurrence	Y		Y	Y

Explanatory notes:

Y – yes

P – partially

4. Expected outputs and the potential of their application and use in economic and social practice

(examples of outputs in indents)

- Enhanced safety, reliability and effectiveness of the energy infrastructure operation;
- Smaller energy dependency of the state and of its regions;
- Reduction of greenhouse gas emissions;
- Increased share of renewable sources in Slovakia's energy mix;
- New knowledge of basic and applied research measured by the quantity and quality of scientific publications, patents and draft legislative changes;
- Improved conditions for involvement in international R&D projects;
- Involvement of Slovak organisations in the programme of development of alternative fuels in transport;
- Involvement of Slovak organisations in the research and development of 4th generation reactors;
- Reduced energy demands of buildings, operation facilities and production technologies;
- Innovated energy equipment with better or new utility features;
- Increased stability and security of fuel supply from domestic sources;
- More effective use of domestic sources of raw materials and increased added value;
- Development of economic activities, mainly in rural areas;
- Reduced energy demands in the disposal of hazardous and other waste and their transformation into inert materials.

5. Quality objectives to which the support of long-term strategic programme

is expected to contribute under the RIS3 SK objectives, including the addressing of issues of nationwide concern identified in the RIS3 SK – short description of the objectives and of the ways of achieving them: Safety, stability and effectiveness of Slovakia's energy infrastructure are the key prerequisites for a sustainable functioning and development of the state's economy and the satisfaction of the population's demands for ensuring better quality of life. The implementation of the long-term strategic programme in the area of specialisation Sustainable energy sector and energy addresses the current and prospective themes of the Slovak energy sector which create the conditions for achieving the long-term objectives in enhancing the safety and stability of the electricity system, energy efficiency, reduction of emissions and protection of the environment. Another positive impact will be the maintenance and dissemination of knowledge and technologies in the field of nuclear energy with possible applications in different industrial sectors. The conditions for significant reduction of consumption and greater use of renewable energy sources will be created for energy demanding industrial sectors, such as production and processing of metals or automotive industry and machinery, which would lead to the reduction of emissions and costs of adaptation to climate changes. The support of smart technologies in the framework of the long-term strategic programme creates the potential for the development and manufacture of new consumer electronics devices and equipment based on digital technologies supporting the job creation mainly for young people across Slovakia. The research of a socially sustainable energy sector will lead to the reduction of energy poverty of a part of elderly people and marginalised population groups.

6. Links to research trends within the EU:

Out of the seven basic parts of Horizon2020 (Excellent Science, Industrial leadership, Societal Challenges, Spreading Excellence, Science with and for Society, EIT, Euratom), the proposed topics are directly linked to Secure, Clean and Efficient Energy under Societal Challenges, and to Euratom Research and Training Activities. They also relate to Industrial Leadership, which defines

topics such as Advanced Materials and Advanced Manufacturing and Processing, as well as Access to risk finance.