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LATVIA'S SMART SPECIALISATION STRATEGY (RIS3)
SPECIALISATION AREA

# Smart Energy

RESEARCH ECOSYSTEM REPORT
(2014–2018)

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Ministry of Education and Science

THE NATIONAL DEVELOPMENT PLAN 2014-2020

EUROPEAN UNION
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# Content

# Summary

Research and innovation investments in the RIS3 specialisation area "Smart energy" are made to advance the energy sector and to achieve the national goals of energy efficiency, decarbonisation, and energy security. The research ecosystem report on Smart Energy provides quantitative information and analysis on the trends of research competencies and capacity development in Latvia over the period 2014–2018.

The investments of 34.3 million euros in the research and innovation of the RIS3 specialisation area "Smart energy" has contributed to the development of new materials, engineering and digital solutions to improve energy efficiency in buildings and construction, smart grids, power system efficiency improvements, the development of alternative fuels for transport, and research on renewable energy sources.

In the publicly funded sector, the research competence and capacity is concentrated at several research institutes at Riga Technical University (the Institute of Power Engineering, the Institute of Industrial Electronics and Electrical Engineering, the Institute of Energy Systems and Environment, the Institute of Applied Chemistry), the Institute of Solid State Physics of the University of Latvia, and the Institute of Numerical Modelling of the University of Latvia. In addition, the Institute of Physical Energetics and Latvia University of Life Sciences and Technologies (especially the Institute of Energetics and the Research Laboratory of Alternative Fuels of the Institute of Motor Vehicles) are active in the field of energy research.

Internationally research cooperation is well developed with the neighbouring countries – Estonia, Russia, Ukraine, Germany, and increasingly with the other European Union countries and the USA.

For further developments of the research and innovation landscape of the Smart Energy in Latvia, much closer collaboration between industry and scientific institutions and among various research disciplines is needed, particularly for developing innovation for integration and digitalisation of energy systems, solutions for energy storage and user-centered energy services.

# Introduction

Latvia's Research *and Innovation* Strategy *for Smart Specialisation* (*RIS3*) is a national-level research and innovation strategy for economic transformation that seeks to identify new competitive advantages, select strategic priorities, and to design policy tools that maximise the country's knowledge-based socioeconomic development potential. RIS3 objectives in Latvia are pursued within the framework of science and innovation policy.

Taking into account the prospective directions and priorities of economic transformation, 5 smart specialisation areas (biomedicine, bioeconomy, smart materials, smart energy, information and communication technologies (ICT)) have been defined in Latvia together with Social sciences and humanities and their horizontal impact for the achievement of the RIS3 objectives.

The analytical review of the research ecosystem of the RIS3 specialisation area "Smart energy" has been developed within the framework of RIS3 monitoring and provides an in-depth insight into the changes in research capacity and competence development over the period 2014–2018 and in international comparison.

Data sources used in the report:

- National Research Information System (NRIS);
- Scientific publications database / repository *Web of Science* and analytical tool *InCites*;
- Statistics on higher education of the Ministry of Education and Science;
- Cohesion Policy Fund Management Information Systems for 2014–2020 (CP FMS);
- Latvian Council of Science data on the Fundamental and Applied Research Programme and National Research Programmes;
- European Commission *CORDIS* database on "Horizon 2020" projects;
- The European Patent Office Database *Espacenet*.

# 1 Development of research and innovation in the RIS3 specialisation area "Smart energy" in Latvia

Research and development in the RIS3 specialisation area "Smart energy" is carried out in accordance with the priorities of the Energy Union and the EU Strategic Energy Technology (SET) Plan and will be closely integrated with the priorities of the Latvia's National Energy and Climate Plan (NECP) 2030.

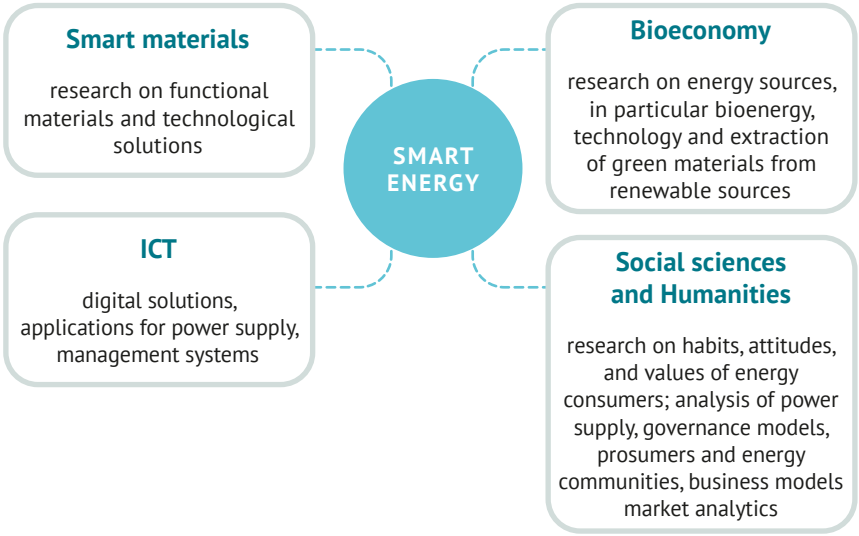



**Figure 1.1.** Linkages between the RIS3 specialisation area "Smart energy" and other RIS3 specialisation areas

The RIS3 specialisation area "Smart energy" contributes to the development of the energy sector and to the achievement of the objectives of the NECP through the development of research and innovation in three priority areas of energy efficiency, decarbonisation, and energy security. This means developing new materials, engineering and digital solutions for the sustainable production, storage and integration of renewable energy systems, improving energy efficiency in construction, and the automatisation and optimisation of production processes, as well as developing alternative fuels for transport.

Research and Innovation in the RIS3 area "Smart energy" is closely related to the transport, construction, industrial, and circular economy industries, creating a close link with research activities in other specialisation areas of the RIS3 (**Figure 1.1**).

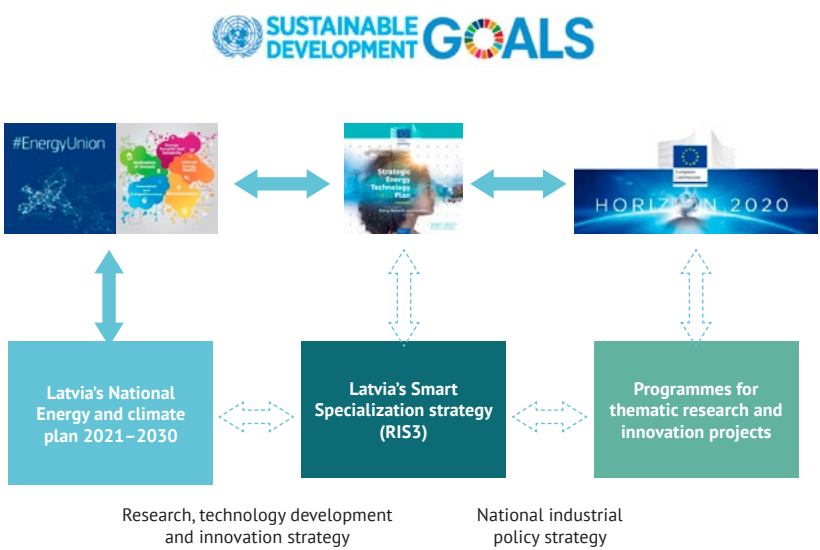



**Figure 1.2.** The global context of the development of research and innovation in the RIS3 specialisation area "Smart energy" in Latvia and linkage to EU and national activities

# 2 Funding landscape of the RIS3 specialisation area "Smart energy"

In 2014–2018, **34.3 million euros** were invested and attracted for the development of research and innovation in the RIS3 specialisation area "Smart energy". It constitutes 19.3% of the total research and innovation funding for RIS3 specialisation areas in Latvia. The most important sources of funding are state budget funding, investments of EU structural funds, and the funding attracted in the EU research and innovation programme Horizon 2020 (**Figure 2.1**). The implementation of the State research programme "Energy" since 2018 should be especially noted.

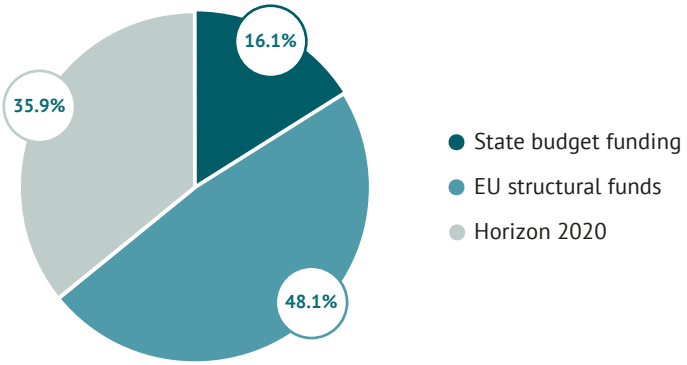



**Figure 2.1.** The amount of funding for research and innovation in the RIS3 specialisation area "Smart energy" by the source of funding

The main thematic niches of the RIS3 specialisation area "Smart energy" according to the priorities of the SET Plan where Latvia has developed research competence and implements research and innovation projects are:

- **improving energy efficiency in buildings and energy supply systems** (materials, near-zero energy buildings, automation, technology integration);
- **power system automation, efficiency and smart grid development** (power conversion and storage technologies, digital solutions);
- **development of renewable energy technologies** (biofuels – biomass sources and technologies; solar energy materials and technologies, wave energy research);
- **sustainable energy for transport** (biofuels – bioethanol, biogas, hydrogen production technology, electric drive technology).

By funding distribution (**Figure 2.2**), most funding has been invested in the development of smart energy systems and energy-efficient buildings and systems and relatively less in the development of alternative fuels and renewable energy sources and technologies.

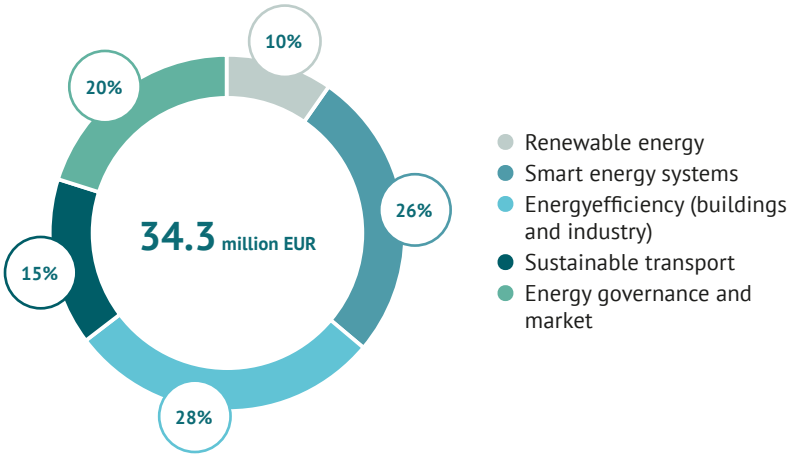



**Figure 2.2.** Proportion of energy research and innovation funding by thematic niches

In the public sector (public universities and research institutes) and in the private sector, the research priorities and investment in the RIS3 specialisation area "Smart energy" are relatively similar (**Figure 2.3**). At the same time, most of the thematic niches require better linkages between fundamental research, technological development, and commercialisation, in particular in the research and innovation of renewable energy sources and technologies, which is one of the most promising energy areas in the coming decades.

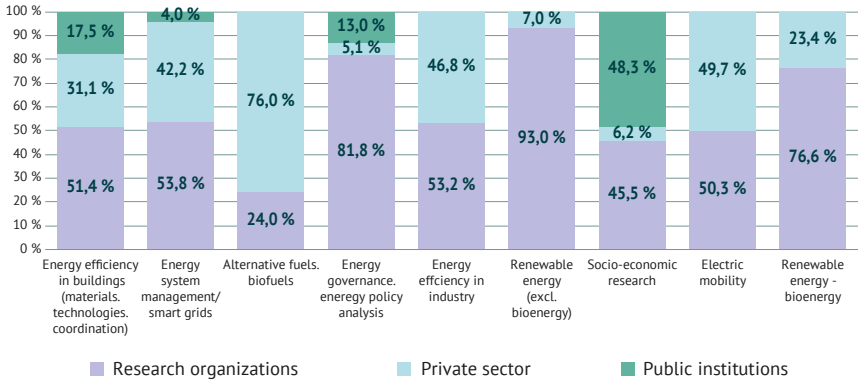



**Figure 2.3.** Public investments in research and innovation by thematic niches by the type of funding receiver, 2014–2018

# 3 Latvian research and innovation competencies in the RIS3 specialisation area "Smart energy"

Evaluation of research and innovation capacity, competencies and potential in the RIS3 specialisation area "Smart energy", identification and mapping of thematic niches was carried out according to the *technology readiness level* (*TRL*) to see the degree of coherence and complementarity of financial instruments (**Table 3.1.**).

The key findings suggest that:

- Major investments have been made and most R&D activities are focused on developing solutions for improving energy efficiency in buildings to advance the integration and management of power systems. These research areas the link between fundamental research and commercial applications is the closest one.
- There is a growing trend in the research and development in renewable energy and alternative fuel technologies.
- A relatively small share of public funding is invested into research and innovation to improve energy efficiency in industry, but this should be seen in the context of private funding in the field.
- Overall, the investments of EU structural funds for the current period have fostered the development of research, technology and innovation in the thematic areas of smart energy.
- Several research areas are becoming increasingly more topical in Latvia such as energy storage systems of different sizes, carbon accumulation and storage, industrial energy efficiency and heat recovery technologies, urban mobility and multimodal transport solutions, and socioeconomic aspects of energy circulation.

**Table 3.1.** Thematic niches developed in Latvia in the RIS3 specialisation area "Smart energy" by funding programmes and funding share

| | | | TRL 1-2<br>**Fundamental and Applied Research Programme (SB)** | TRL 1-3<br>**National Research Programme (SB)** |
|---|---|---|---|---|
| **ENERGY EFFICIENCY** | | | | |
| **Energy consumption** | Energy efficiency in buildings | energy efficiency in building materials, automation, nearly-zero energy buildings | 4.7% | 4.6% |
| | | nearly-zero energy buildings | | |
| | Energy efficiency in industry | energy efficiency in industry | | |
| **Energy transmission, distribution, storage** | Power system integration and management efficiency, smart grids | power system management efficiency/ smart grids, energy storage and conversion | 4.6% | 7.3% |
| | | centralised heat supply | | |
| | | LED luminaires | | |
| | | hybrid generation, local power systems | | |
| **Energy management and market** | Energy management and market | energy policy and management evaluations, financing schemes and market research | 0.3% | 52.0% |
| **DECARBONISATION** | | | | |
| **Energy production: thermal and electric energy** | RES technologies | bioenergy – biofuels (sources and technologies) | 4.6% | 13.9% |
| | | solar energy | 5.9% | |
| | | wind energy | | |
| | | wave energy | | |
| | | waste gasification | | |
| **Sustainable energy for transport** | Alternative fuels, incl. electromobility | biofuels (biomethane, biodiesel) | | |
| | | hydrogen | | |
| | | electric drive technology | | |
| | | electromobility services | | |

**0–5%** **5–10%** **10–25%** **25–50%** **>50%** **submitted, not funded projects**

SB – state budget financing. ES – financing of EU structural funds

| TRL 1-2 | TRL 2-3 | TRL 3-5 | TRL 4-6 | TRL 4-8 | |
|---|---|---|---|---|---|
| **1.1.1.2. Postdoctoral grants (ES)** | **1.1.1.1. Applied research programme (ES)** | **1.2.1.2. Research commercialisation (ES)** | **1.2.1.1. Competency centres (ES)** | **Horizon2020** | **Total funding, EUR** |
| | | | | | |
| 1.8% | 32.0% | | 15.2% | 42.7% | 7 632 848 € |
| | 8% | | | | |
| 5.1% | 85.2% | 0.9% | 6.9% | 1.9% | 2 637 625 € |
| 4.1% | 2.9% | 0.7% | 25.3% | 12.9% | 6 487 192 € |
| 6% | | | | 2% | |
| | | | 3.0% | | |
| 2.1% | 19.2% | | | 9.7% | |
| 4.0% | | | | 41.1% | 6 759 411 € |
| | | | | | |
| 8.0% | 17.9% | | 7.9% | | 3 353 346 € |
| | 15.6% | | | 4.6% | |
| | | | | | |
| | | | 1.4% | | |
| | 19.3% | | | | |
| 3.6% | 16.5% | | | | 7 382 246 € |
| | | | | 38.2% | |
| 1.8% | 9.3% | | | | |
| | | | 1.9% | | |
| | | | | **Total** | **34 252 668 €** |

**Financial instruments of the Ministry of Education and Science**
**European Union Research and Innovation Programme**
**Financial instruments of the Ministry of Economics**

# 4 Research and innovation capacity and human capital

Key indicators of research capacity and sustainability are:

- human resources in science and technology or the number of scientific personnel;
- renewal of research human capital or the number of students.

## 4.1. Scientific personnel

About 1/5 of the total scientific personnel in Latvia is employed in public research institutions in the research areas related to the RIS3 specialisation area "Smart energy". The most represented fields of science are electrical engineering, electronics, and information and communication technologies, as well as construction, transport, and chemical engineering fields (**Figure 4.1**).

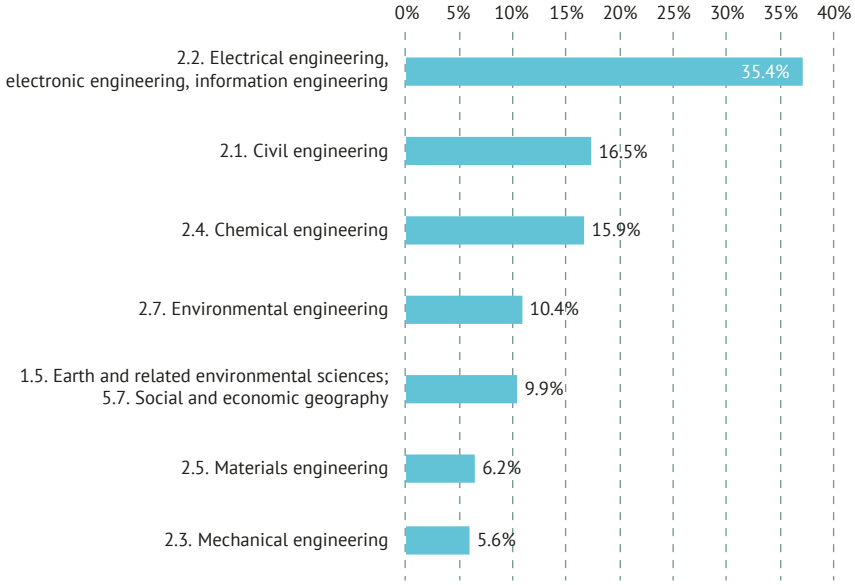



**Figure 4.1.** Scientific personnel by fields of science, 2019.

In terms of research institutions (**Figure 4.2**), the highest proportion of research personnel – 64% – is represented at Riga Technical University, especially in electrical, electronics, construction, and transport engineering, while the University of Latvia has the highest concentration of researchers in earth and environmental sciences and physical, social and economic geography. The highest number of researchers in the field of chemical engineering is at Riga Technical University and the Latvian State Institute of Wood Chemistry.

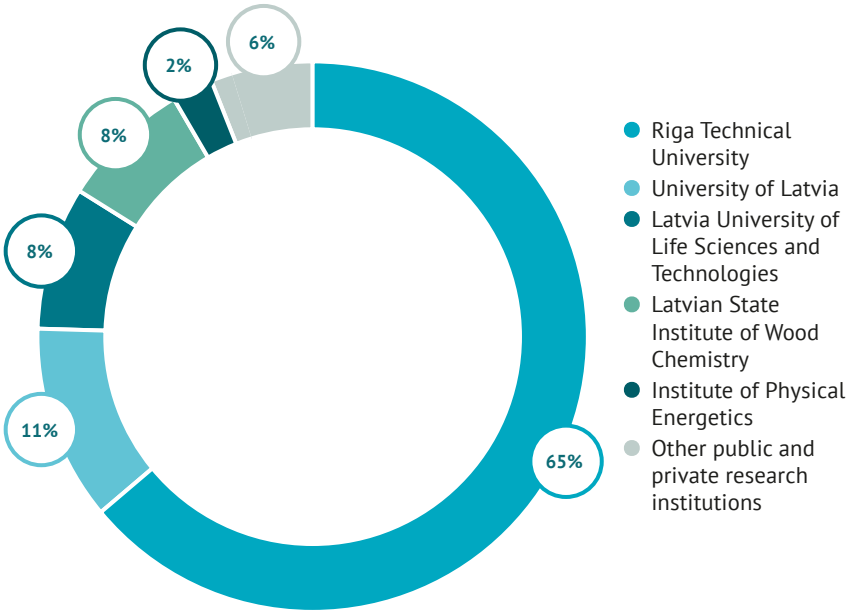



**Figure 4.2.** Scientific personnel by research institution, 2019 (source: NRIS)

Most of the researchers are of middle age (25–44 years) and a gradual renewal of the scientific personnel is taking place during the last 5–10 years (**Figure 4.3**).

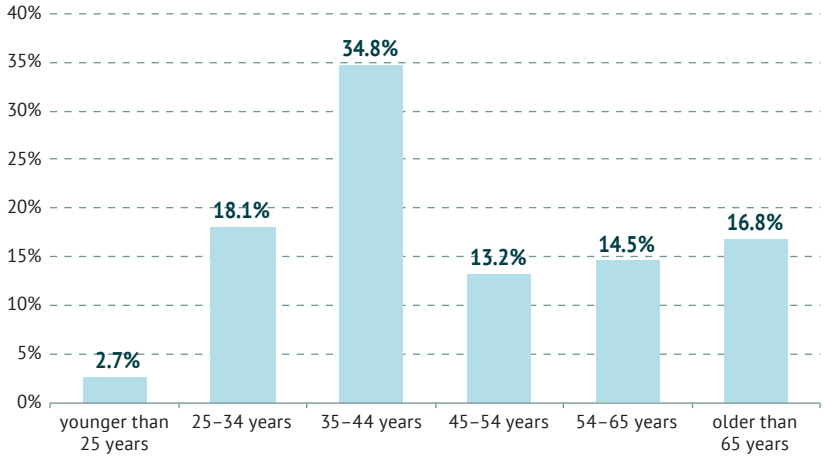



**Figure 4.3.** Scientific personnel by age group, 2019 (source: NRIS)

In terms of gender equality – 62% are male scientists, 37% are female scientists and there is a difference of gender representation between scientific positions (**Figure 4.4**).

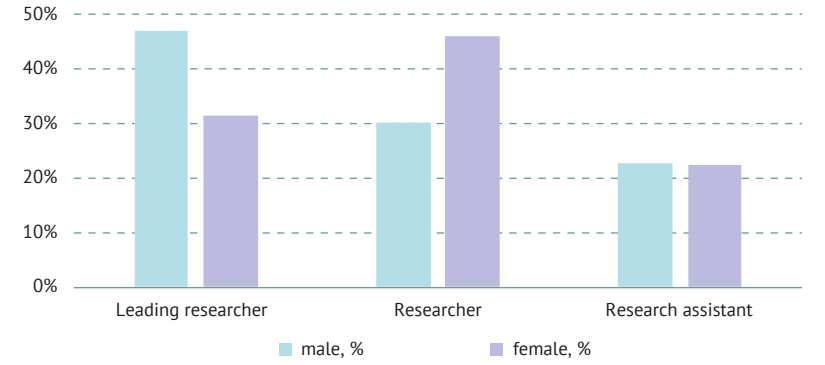



**Figure 4.4.** Scientific personnel by gender and research position, 2019 (source: NRIS)

## 4.2. Students

On average, each year 4.5% of students study in Bachelor's and Master's study programmes related to the RIS3 specialisation area "Smart energy".

(**Figure 4.5**). The leading institution of higher education providing the respective education is Riga Technical University with about 75% of students; as well as the University of Latvia, with about 13% of Latvian students.

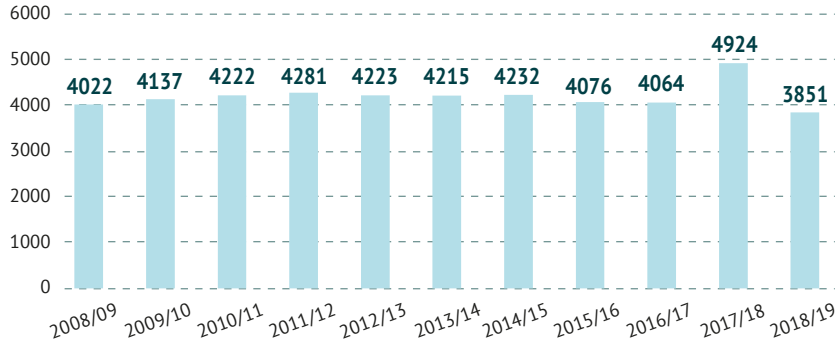



**Figure 4.5.** The dynamics of bachelor's and master's degree programme students in the programmes related to the RIS3 specialisation area "Smart energy" in 2008–2018

In recent years, the number of doctoral students in the RIS3 specialisation area "Smart energy" has increased and on average accounts for 13% of the total number of doctoral students in Latvia (**Figure 4.6**).

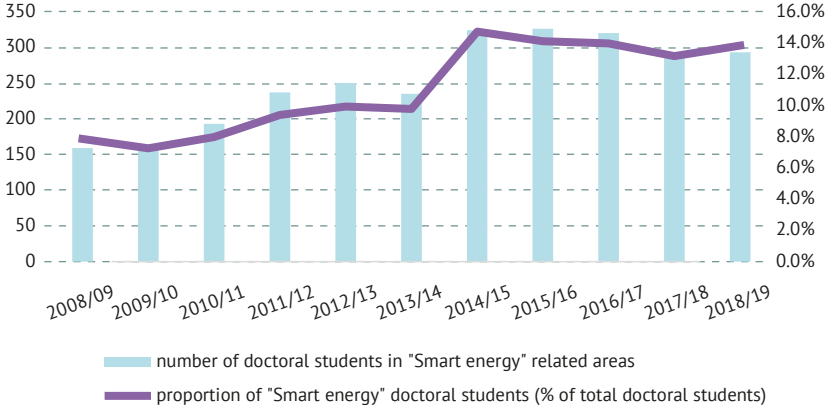



**Figure 4.6.** The dynamics of the doctoral students in the doctoral programmes related to the RIS3 specialisation area "Smart energy", 2008–2018

# 5 Research excellence and publicity

Quantitative and qualitative evaluation of research capacity and excellence, visibility of research results, and international cooperation, as part of the RIS3 monitoring, is carried out using a number of measurable indicators that have been adopted in international practice:

- **number of publications** – shows the volume and regularity of publication by scientists and scientific institutions;
- **citations of publications** – visibility of publications and recognition of research results in the field of science and at the international level;
- **quality of scientific journals** (measured by the *Journal Impact Factor*) – demonstrates the quality, international recognition, and competitiveness of publications.

In 2014–2018, **1,307** publications, or **12.5%** on average of the total number of Latvian publications, were published in the topics of the RIS3 specialisation area "Smart energy". On average, 200–300 publications are published annually. The leading scientific institutions by the amount of publications are Riga Technical University and the University of Latvia (including the Institute of Solid State Physics of the University of Latvia), which together account for 85% of Latvia's publications in energy related areas (**Figure 5.1**).

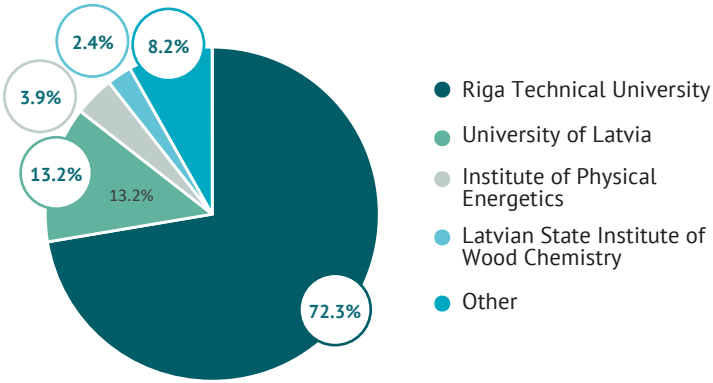



**Figure 5.1.** Publications in the RIS3 specialisation area "Smart energy" by scientific institutions, 2014–2018 (source: *Web of Science*)

Latvia ranks second among the EU-28 by the share of publications in the topics of "Smart energy" area (**Figure 5.2**) but regarding the results of the Top 10% most cited publications in the field, Latvia's performance is equivalent to the European Union average.

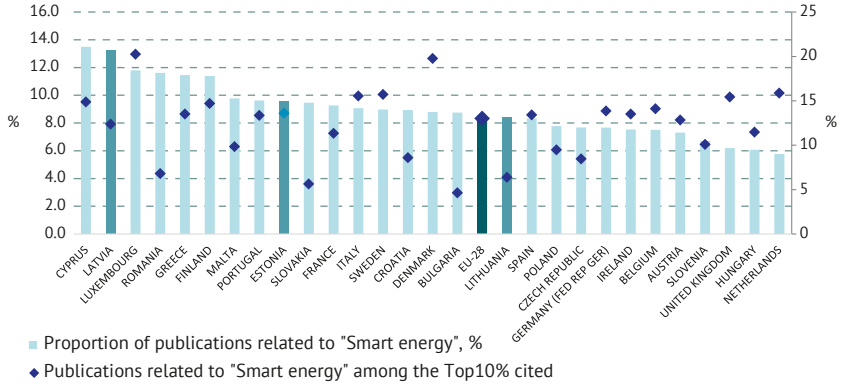



**Figure 5.2.** Scientific quality of Latvian publications in comparison with EU-28 countries. Share of publications in the topics related to "Smart energy" (% of all Latvia's publications) and among the Top 10% most cited publications in the field, 2014–2018

By international comparison, Latvia has the highest share of publications in the top 25% of journals among the Baltic countries, and the share of publications among the top 10% most cited is equivalent to the average EU-28 (**Figure 5.3**).

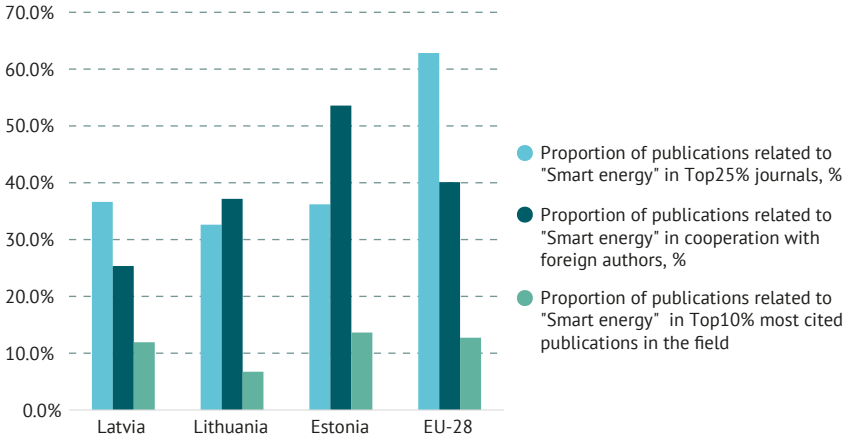



**Figure 5.3.** International comparison of publication indicators in the RIS3 specialisation area" Smart energy" in 2014–2018

Thematically scientific excellence is evaluated by the four main thematic groups of publications in the *Web of Science* database – Energy and Fuels, Electrical Engineering and Electronics, Green and Sustainable Science and

Technology, and Environmental Engineering. Latvia performs excellently in the thematic group Energy and Fuels where approximately 35% of the total number of publications is produced and has a well-balanced quality/quantity ratio (**Figure 5.4**). In the thematic group Environmental Engineering, more than half of the publications are published in the Top 25% of the field-relevant journals although the total number of publications is relatively small. The thematic group Engineering and Electronics has a high share of publications – 64% but the ambition to publish in higher quality journals should be increased.

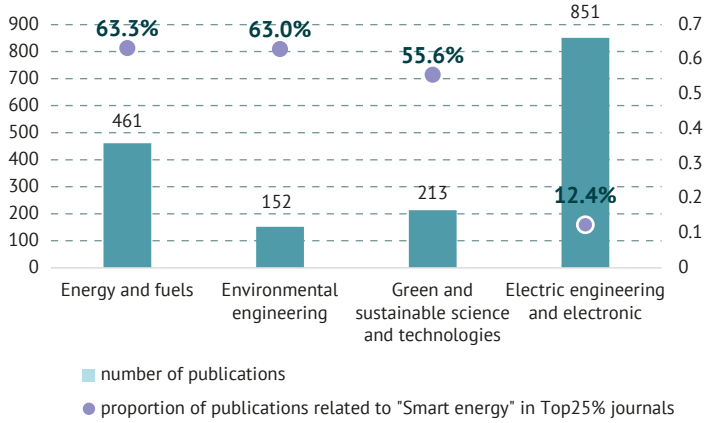



**Figure 5.4.** Publications of the "Smart energy" in the Top 25% Journals by the thematic groups of *Web of Science* database, 2014–2018

# 6 International cooperation

International cooperation through co-publications is one of the main ways towards creation of a wider research impact. The total number of Latvian international co-publications in 2014–2018 is **334 co-publications**[1] or 25% of all Latvia's publications in the field of RIS3 specialisation area "Smart energy" (**Figure 6.1**). Co-publications are of various kinds – co-publications with foreign scientific institutions, co-publications with scientific institutions in Latvia, and co-publications with foreign and Latvian scientific institutions. Of the total number of co-publications, 84% are in co-operation with foreign authors and 38% in co-operation with another Latvian research institution, resulting in 22% of co-publications being developed with representatives of at least two Latvian research institutions and foreign partner institutions.

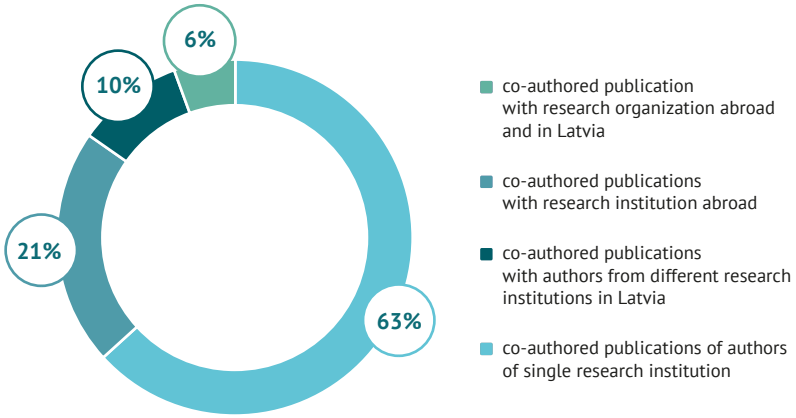



**Figure 6.1.** Publications in the RIS3 specialisation area "Smart Energy" by authors' representation

According to the number of co-publications by scientific institutions (**Figure 6.2**), Riga Technical University and the University of Latvia (including the Institute of Solid State Physics of the University of Latvia) have the most developed international co-operation, demonstrating a greater capacity for the implementation of research projects and a wider range of international contacts.

Co-publications are attributed to the scientific institution of each author; therefore, the total number of publications and the amount produced by the scientific institutions differ in number.

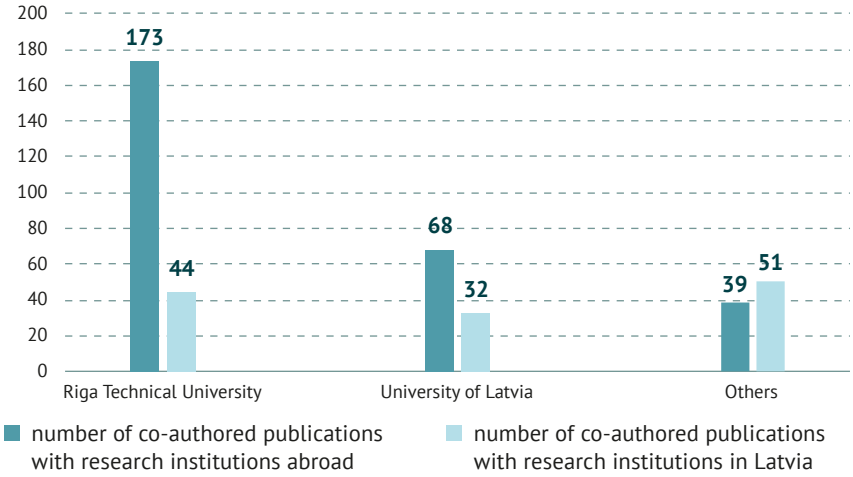
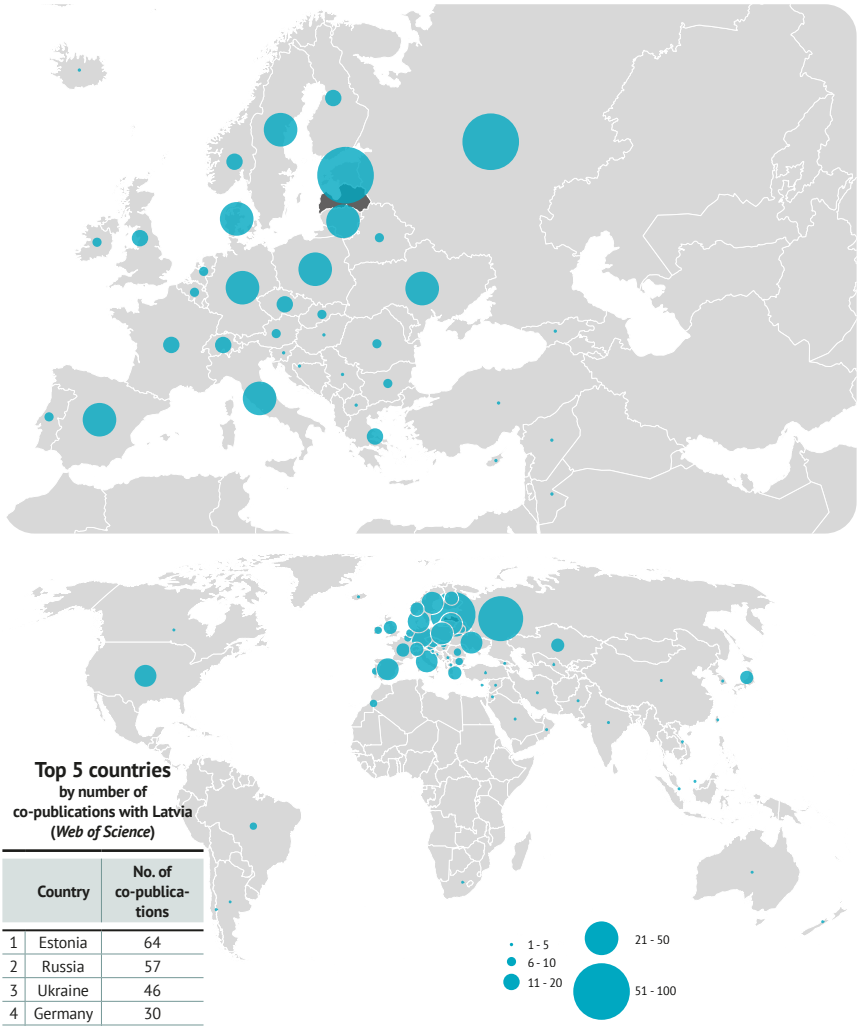



**Figure 6.2.** Number of co-publications with Latvian and foreign research institutions in the topics of the RIS3 specialisation area "Smart Energy"

Latvia has the closest international co-operation in terms of co-publications with the scientific institutions in the neighbouring countries – Estonia, Lithuania, Russia, Ukraine (**Figure 6.3**).

At the same time, cooperation with the countries of the European Research Area – Germany, Sweden, Spain, Poland, as well with the USA – is also developing.




**Top 5 countries**
**by number of co-publications with Latvia (*Web of Science*)**

| | Country | No. of co-publications |
|---|---|---|
| 1 | Estonia | 64 |
| 2 | Russia | 57 |
| 3 | Ukraine | 46 |
| 4 | Germany | 30 |
| 5 | Lithuania | 30 |

**Figure 6.3.** International cooperation with foreign countries in the RIS3 specialisation area "Smart energy" by the number of co-publications in 2014–2018 (source: *Web of Science*)

Leading research institutions in the RIS3 specialisation area "Smart energy" in Latvia have a broad range of foreign co-operation partners that vary by the thematic scope and geographical distribution (**Figure 6.4**).

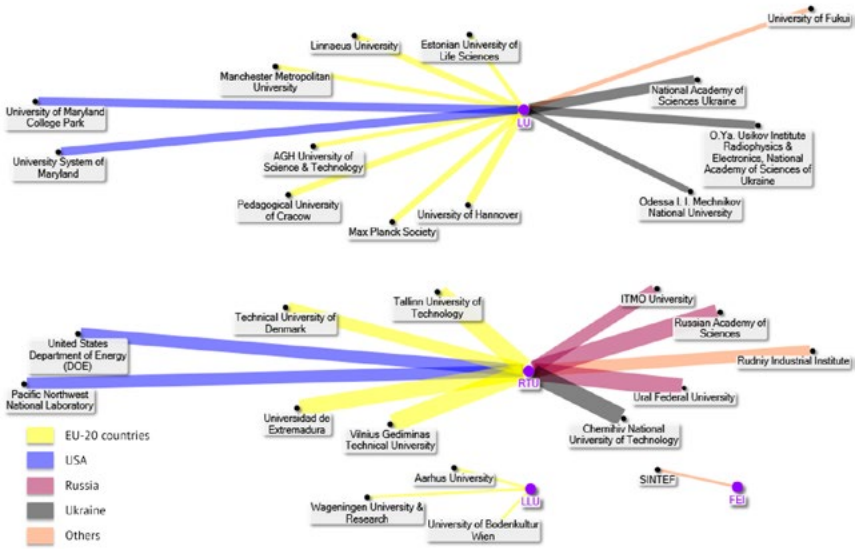



**Figure 6.4.** International cooperation with foreign scientific institutions by number of publications in 2014–2018 (showing for each Latvian scientific institution, the first ten foreign scientific institutions with which more than 1 co-publication has been published)

The most internationally oriented public research institutions are Riga Technical University and University of Latvia (including Institute of Solid Physics). Riga Technical University and has equally well established collaboration with countries within the European Union, as well with Russia and Ukraine. Whereas University of Latvia (including Institute of Solid Physics) has established more diverse collaborations with institutions in the European Union countries.

## 6.1. Performance in "Horizon 2020"

Projects funded (*Societal Challenge 3 – Secure, clean and efficient energy*) – **35**

Funding received – **EUR 7.65 million**

Success rate of projects submitted by Latvia (number of funded projects in relation to the number of project applications) – **15.6%**

Latvia's participation in the "Horizon 2020" thematic activity "Secure, Clean and Efficient Energy", which is directly related to the "Smart energy" area, has been remarkably successful (Table 6.1). Although the number of project applications is similar for all Baltic countries, the amount of funding obtained varies considerably.

**Table 6.1.** Comparison of the Baltic states by project performance in "Horizon 2020"

| | Number of project applications | Number of projects above-threshold | Funded projects | Success rate | Funding received |
|---|---|---|---|---|---|
| **Latvia** | 224 | 72 | 35 | 15.6% | 7 642 430 € |
| **Lithuania** | 214 | 78 | 32 | 15.0% | 4 541 546 € |
| **Estonia** | 232 | 91 | 33 | 14.2% | 18 372 596 € |

In 2014–2018, Riga Technical University and the Institute of Physical Energetics were the most successful among the scientific institutions, attracting 27% of the total Latvian funding in the thematic priority *SC3 – Secure, clean and efficient energy* (Table 6.2). Given the importance of energy as a social service area, public and local authorities and their affiliates are also widely represented as applicants and participants of the projects (**Figure 6.2**) and are among the key innovators, attracting an equivalent amount of funding. In most cases, successful projects are those in which Latvia's membership in the project consortium consists of a partnership between a scientific institution and a public or private organisation.

**Table 6.2.** Funding attracted by Latvia in the "Horizon 2020" programme by type of organisation, number of projects, and share of attracted funding

| Type | Number of project applicants | Number of projects | Funding, EUR | Share of attracted funding, % |
|---|---|---|---|---|
| **Scientific institutions** | 2 | 10 | 2078403 | 27.2% |
| **State and municipal authorities** | 14 | 19 | 1909751 | 25.0% |
| **Commercial organisations** | 6 | 13 | 2177565 | 28.5% |
| **Other** | 8 | 13 | 1487647 | 19.4% |

The results of the participation indicate the high level of activity, the potential and the need for closer thematic and territorial cooperation between scientific institutions, municipalities, non-governmental organisations, and enterprises active in the fields of energy, construction, information and communication technologies.

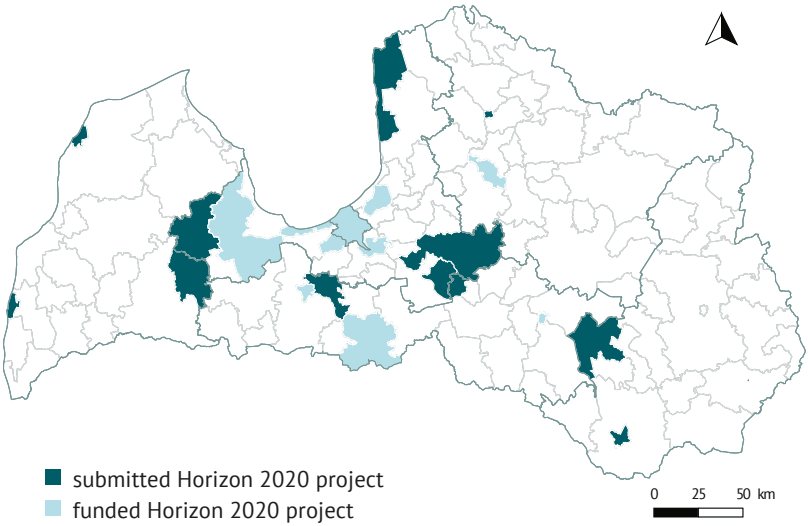



**Figure 6.5.** Territorial distribution of the project participants from Latvia for the "Horizon 2020" programme in the RIS3 specialisation area "Smart energy" by submitted and funded projects, 2014–2018

# 7 Potential development directions of the RIS3 specialisation area "Smart energy"

Regarding Latvia's research and innovation competencies and capacity in the RIS3 specialisation area "Smart energy" and global and EU-wide priorities, Latvia could potentially develop 3 thematic directions that include the development of both technological and non-technological solutions for **smart and efficient energy systems and sustainable mobility** in the following sub-areas:

**Generation of renewable electricity and heat:**

- materials and engineering technology research on renewable energy (in particular solar and hydrogen) generation and storage;
- research and solutions for bioenergy (biomass, biogas) sources and technologies and their development possibilities.

**Smart grids, energy storage and recovery, and integration of renewable energy into the grid:**

- automation of power systems (electricity and heat) management;
- energy conversion, integration, and storage technologies, incl. battery technologies for power self-generation and electric mobility.

**Energy efficiency in buildings:**

- construction, thermal insulation materials;
- technology, building structures, and design for energy efficiency improvement;
- power system management automation and power consumption monitoring.

**Smart mobility:**

- alternative fuels and biofuels – hydrogen, biogas
- electric drive and energy recovery technologies; battery technology;
- intelligent transport and intelligent transport systems;
- technologies for planning of transport, logistics, and mobility systems.

**Smart cities and communities**

New, efficient, and user-friendly technologies and services, in particular in the areas of energy, transport, and ICT, are fundamental to sustainable development (including urban areas), which is one of the major challenges in the world and Europe. The functioning of cities and communities is based on the spatial integration of housing, mobility, and energy systems. ICT and digital technologies are a means to make urban functionality more efficient, accessible and usable, while moving towards a low-carbon economy and adapting to climate change.

Development of smart cities combines both **1) smart energy systems** – smart grids, solutions for efficient energy supply (electricity, heating and cooling) and self-generation, research on alternative energy sources and development of technological solutions, material and digital solutions for improving the energy efficiency of buildings, etc. and **2) smart mobility** – automated mobility and intelligent transport systems, green transport and alternative fuels,; innovative mobility services, etc. In

addition, research should be developed in the planning and integration of transport and mobility systems, the development of multimodal solutions that have a potentially significant impact on the achievement of energy efficiency and decarbonisation goals, besides the introduction of technological innovations in transport.

At the same time, given the important role of societal, economic, and political processes in the energy transition, it is also necessary to develop non-technological research on socioeconomic aspects, identifying and analysing end user habits, attitudes, values, existing and potential forms of cooperation and sharing, coordination mechanisms, management and business models, etc.

# 8 Leading research institutions in the RIS3 specialisation area "Smart energy" in Latvia


**Riga Technical University**

**Research platform: Energy and Environment**
Contacts: Prof. Oskars Krievs, e-mail: oskars.krievs@rtu.lv; assoc.prof. Diāna Žalostība, e-mail: diana.zalostiba@rtu.lv

**Institute of Power Engineering**
Head of the Institute: Prof. Antans Sauļus Sauhats, e-mail: sauhatas@eef.rtu.lv

- Smart grids (incl. renewables, storages, electrical vehicles and energy efficiency; modelling and simulation of power systems and their elements; imitation and analysis of various operational modes).
- Energy security.
- Energy market (incl. demand side respond, flexibility and aggregation services; forecasting of electricity prices, demand, river water inflow and other random processes).
- Digitalisation of energy systems (incl., control, optimisation and automation of electricity generation, transmission and distribution; techno-economic assessment; development of methodologies and guidelines).
- Microprocessor-based protective relaying and automation systems (incl., synthesis and testing of algorithms and software).

**Institute of Industrial Electronics and Electrical Engineering**
Contacts: Prof. Leonīds Ribickis, e-mail: leonids.ribickis@rtu.lv

- Power electronics for electrical drives and renewable energy systems.
- Industrial automation and robotics.
- Electronics and electrical technologies.
- Advanced lighting systems.
- Motion control.

**Institute of Energy Systems and Environment**
Contacts: Prof. Dagnija Blumberga, e-mail: dagnija.blumberga@rtu.lv

- Energy efficient district heating and distributed energy systems, micro-cogeneration.
- Methodologies and technologies for energy audits.
- Renovation and insulation of historical buildings.
- Sustainable planning of energy and transport systems.
- Solar energy technologies.
- Energy accumulation.
- Circular economy and systems.
- Waste management technologies.
- Third generation biofuels, bio-hydrogen technologies.

**Institute of Heating, Gas and Water technologies**
Head of the institute Prof. Egils Dzelzītis, e-mail: egils.dzelzitis@rtu.lv

- Development of near zero-energy buildings.

- Integration and automation of energy systems in buildings – heating, cooling and ventilation system optimisation.
- Moisture transfer in building envelopes.
- Renewable energy sources for buildings.
- Fourth generation biofuels – biogas from agricultural residues.
- Regional planning for heating and gas supply systems.
- Microgrids of renewable energy sources for engineering systems of buildings and district heating systems.

**Institute of Applied chemistry**
Contacts: Head of the institute Prof. Valdis Kampars, e-mail: kampars@ktf.rtu.lv; valdis.kampars@rtu.lv

- Second generation biofuels.

**Research Laboratory of Functional Materials Technologies**
Contacts: Assoc.prof. Andris Šutka, e-mail: andris.sutka@rtu.lv

- Triboelectric nanogenerators for mechanical energy harvesting from ambient vibrations and human motions.
- Infrared modulating smart windows based on hybrid electro-photochromic materials.

**Research platform: Cities and development**
Contacts: Prof. Sandra Treija, e-mail: sandra.treija@rtu.lv

- Urban design and planning.
- Urban infrastructure planning and urban economics.
- Urban cultural heritage.

**Research platform: Transport**
Contacts: Prof. Olga Kononova, e-mail: olga.kononova@rtu.lv

- Energy efficient and safe road and railway transport systems.
- Safe and cost-efficient aerial transport, air traffic control and drone technologies.
- Diagnostics for vehicles and transport infrastructure.

**University of Latvia**

**Institute of Numerical Modelling**
Contacts: Chairman of the Scientific Council, Andris Jakovičs, e-mail: andris.jakovics@lu.lv

- Smart solutions for nearly zero energy buildings (nZEB).
- Calculation and measurements for estimation of the energy efficiency of buildings.
- Modelling of thermal comfort conditions in buildings.
- System optimisation and energy efficiency in industrial technologies.
- Simulations on energy efficient lighting systems and illumination.
- Modelling of combustion and chemical endothermic processes, e.g. for biomass gasification.

**Institute of Solid State Physics of University of Latvia**

Contacts: Deputy Director for Scientific Work, Andris Šternbergs, e-mail: andris.sternbergs@cfi.lu.lv

- Materials for energy harvesting and storage – covers major subjects such as fuel cells, organic, inorganic and hybrid photovoltaics, thin film batteries, lithium ion, sodium ion and metallic lithium coating batteries, supercapacitors, piezoelectric energy harvesters, lead free ferroelectric perovskites with high-value electrocaloric effect for refrigerators, ferroelectric composition ceramics

for electromechanical actuators and energy harvesting.
- Hydrogen generation, hydrogen and sustainable energy storage technologies with a lower environmental footprint, thermoelectric, advanced functional and constructive materials for thermonuclear fusion.

**Institute of Physical Energetics**

Contacts: Gaidis Klāvs,
e-mail: energy@edi.lv

- Smart energy in smart cities and communities, smart energy infrastructure and development of smart grids, including grid flexibility, integration of renewable energy sources, electricity market, demand response.
- Energy – environmental system modelling and assessment of economic, environmental and social impacts.
- Analysis of energy and transport infrastructure development scenarios involving air pollution and climate change mitigation policy and energy security.
- Renewable energy sources (wind, solar, biomass) and their application.
- Energy performance of buildings and application of energy efficiency monitoring IT systems.
- Advanced materials and technologies for the energy sector from industrial and agricultural by-products and waste.

**Latvia University of Life Sciences and Technologies**

**Institute of Energetics**
Contacts: Head of the Institute Liene Kanceviča, e-mail: liene.kancevica@llu.lv

- Technologies for alternative energy harvesting.
- Biomass conversion, biogas production and purification.
- Modelling of thermal process and heating technologies.
- Sensor development and monitoring systems.
- Energy efficiency and energy saving technologies.
- Modelling and automatisation of technological and industrial processes.
- Smart technologies and robots for biosystems.
- Operational safety of electric propulsion, control and protection of electric motors.
- Small HES automation and integration for the smart electricity market.
- Solar energy use and monitoring for technological processes.

**Motor Vehicle Institute's Alternative fuels research laboratory**
Contacts: Prof. Gints Birzietis,
e-mail: Gints.Birzietis@llu.lv

- First and second generation biofuels for transport.
- Biogas and hydrogen for transport vehicles.
- Electric vehicles and electric drive for mobile machinery.


**Latvian State Institute of Wood Chemistry**

Contacts: Director: Dr.sc.ing. Uģis Cābulis, e-mail: cabulis@edi.lv

Chairman of the Scientific Council: Dr.sc.ing. Jānis Rižikovs, e-mail: j.rizikovs@edi.lv

- Thermal insulation materials from renewable sources for energy efficiency in buildings (bio foam plastics, polyurethane, loose fill, cellulose containing plant fibres, mycelium-based composites).
- Advancement of physical properties (impregnation, renovation and modification) of wood and formaldehyde-free adhesive systems of wood-based panels for sustainable buildings. Thermally modified and thermosetting polymer impregnated wood products with improved physical and durability properties.
- Biorefinery approach for developing second-generation biofuel technologies (torrefied wood, steam explosion, hydrolysis, pretreatment, fast pyrolysis, wood pellets, biotechnology) from wood, its waste, recyclable materials and other types of biomass.

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Ministry of Education and Science

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