



LITHUANIAN  
ENERGY  
INSTITUTE

# ANNUAL REPORT 2020



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# FOREWORD

## MESSAGE FROM THE DIRECTOR

2020 was a challenging period for all of us. In such times it is possible to check the concentration, maturity and support of the team. Quarantine has affected not only our mode and nature of work, but also our lives. Despite all the difficulties, these changes have strengthened us. Perhaps this was even the beginning of a new qualitative leap.

The institute extended activities in the metrology field – besides four standards of gas and liquid volume and flow rate under maintenance of the institute in 2020 the fifth national pressure unit standard was transferred to the institute. It shows not only trust in us, but also in our competence. Three new “Horizon 2020” projects (one of which – TWIN-PEAKS – is coordinated by researchers of the Institute), two INTERREG, four Nordic Energy Research Programme (NERP), three IAEA, two COST and four other international projects have been launched. In addition, we have implemented over 60 projects with Lithuanian business. The Institute is the third in Lithuania with 26 projects and almost 3.8 million EUR of “Horizon 2020” grant. We were also pleased with the success rate of the projects – over 20% and projects financial success rate of almost 16%. These indicators were better than the general averages of Lithuania or even the European Union.

We are also pleased with the achievements of our young generation: in 2020, four doctoral dissertations were defended, Dr. Vidas Lekavičius was elected a member of the Lithuanian Academy of Sciences' Young Academy. Dr. Audrius Graževičius won the second place in the European Technical Safety Organisations Network ETSON AWARD 2020 competition for young researchers.

We actively cooperated in the format of the Association of Research and Technology Organizations RTO.Lithuania: Center for Physical Sciences and Technology, Lithuanian Research Center for Agriculture and Forestry and Lithuanian Energy Institute jointly implemented two inter-institutional projects; presented proposals on R&D&I policy and the Green Deal implementation in Lithuania. We also cooperated in Santaka Valley – we jointly implemented two inter-institutional projects – one together with Kaunas University of Technology, the other – with Vytautas Magnus University and Lithuanian University of Health Sciences.

For the five years in a row, the Institute shows an increase in revenue, which demonstrates the scientific achievements and competencies of our staff in implementing both international and business partnership projects.

The activities of the Institute were also presented to the public. As example could be four science popularisation broadcastings “Mokslo sriuba” (Science Soup) on national TV channel about the research of Institute scientists on the topics of fusion energy and hydrogen technologies.

Indeed, a lot of efforts have been made to prepare and present the vision of the Green Town of the Lithuanian Energy Institute – a pilot infrastructure of energy systems for Green Deal R&D&I projects. This infrastructure would be used for the production and utilisation of green hydrogen for transport and buildings, as well as for the development, integration and testing of energy storage technologies. We hope that this idea, which is relevant and widely supported in the science and innovation, energy, environment and transport sectors, will be implemented.

**Director of Lithuanian Energy Institute**  
**SIGITAS RIMKEVIČIUS**





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# ABOUT LEI

## MISSION

To perform energy, thermal, metrology, material engineering and social sciences (energy economy) research; to create innovative technologies; to perform fundamental and applied research, to participate in study processes; to transfer applied research results to industry and business; to consult governmental, public and private institutions and enterprises on the issues related with Lithuanian sustainable energy development; to actively participate (together with Higher Education institutions) in preparing specialists for Lithuanian Science and Industry.

**THE INSTITUTE IS INTERNATIONALLY RECOGNIZED  
ENERGY-RELATED RESEARCH, DEVELOPMENT  
AND INNOVATION (R&D&I) COMPETENCE CENTER.**

## STRATEGIC OBJECTIVES

- To perform long-term international level fundamental and applied R&D&I activities, which are necessary for sustainable development of Lithuanian Energy Sector and other Lithuanian economy branches as well as integration into the European energy system and European Research Area.
- To cooperate with business, governmental and public entities, to transfer knowledge to technically and commercially beneficial processes and facilities, ensuring development of innovative energy technologies, economy and security of energy sites and systems, efficient usage and energy sources, environmental pollution reduction and climate warming moderation.
- To spread scientific knowledge in society, to promote innovation and knowledge based Lithuanian economy development.
- To actively participate in EU R&D&I programmes and international projects, expand cooperation with internationally recognised research centers.

## AREAS OF ACTIVITY OF THE INSTITUTE

research and development activities in the fields of technology and social sciences.

### LEI STRATEGIC R&D TOPICS



Energy and biofuels from biomass and waste; Research in development and upgrade of associated technologies.



Energy storage technologies.



Nuclear energy (safety analysis, Decommissioning, Radioactive waste management, New generation nuclear reactors, Fusion energy).



Smart energy grids.



Environmental engineering and climate change influence on water resources.



Metrology research related with development and maintenance of national liquid and gas standards.



Energy economy research (Energy policy, Energy strategy, Social and macroeconomic impact assessment, Energy market research, Energy efficiency energy).



Materials science for energy generation technologies.

### INSTITUTE'S RESEARCH AND DEVELOPMENT DIRECTIONS:

- 1 Thermal physics, gas and liquid dynamics and metrology research;
- 2 Research of materials, processes and technologies, devoted to use renewable energy sources, to develop hydrogen energy, to efficiently use energy sources and reduce environmental pollution;
- 3 Safety and reliability research of nuclear and thermal nuclear power engineering and other industrial objects;
- 4 Methods of nuclear waste management, also terminating the operation of Ignalina nuclear power plant;
- 5 Simulation and management of power systems, energy economy.

## LEI IN NUMBERS

230+	EMPLOYEES
130+	RESEARCHERS
30+	PHD STUDENTS
10	RESEARCH LABORATORIES
10 mln. Eur	R&D INFRASTRUCTURE
8+ mln. Eur	ANNUAL INCOME
60+	ANNUAL R&D CONTRACTS

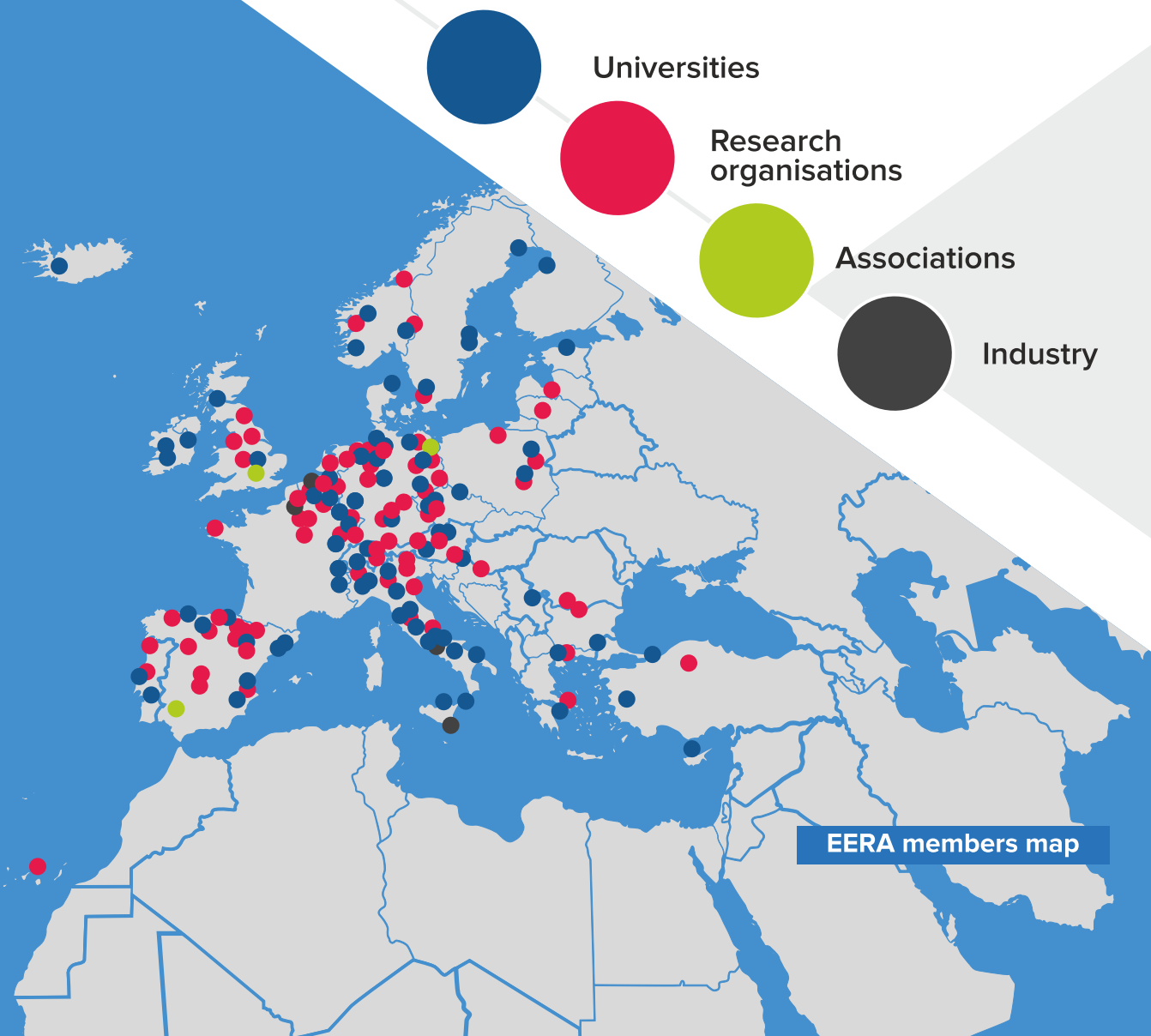
## LONG-TERM RESEARCH AND DEVELOPMENT PROGRAMMES (FOR THE PERIOD OF 2017 – 2021):

- Development of future energy technologies, their safety and reliability research.  
Manager – Dr. Habil. Eugenijus Ušpuras /  
Dr. Raimondas Pabarčius
- Study on the effects of ionising radiation and other issues related to the decommissioning of nuclear power plants.  
Manager – Dr. Artūras Šmaižys
- Modelling and management of sustainable energy development  
Manager – Dr. Dalia Štreimikienė
- Research of the regularities of thermal and hydrodynamic processes taking place in innovative technological systems.  
Manager – Dr. Robertas Poškas
- Forecasts for the development of renewable energy sources, a study of efficient use and social impact.  
Manager – Dr. Mantas Marčiukaitis



## MEMBERSHIP IN INTERNATIONAL ORGANISATIONS

- European Energy Research Alliance (EERA)
- World Bioenergy Association (WBA)
- European Safety, Reliability & Data Association (ESReDA)
- European Network of Freshwater Research Organisations (EurAqua)
- The European Association of National Metrology Institutes (EURAMET)
- Euro-Asian cooperation of national metrological institutions (COOMET)
- International Energy Agency Hydrogen Implementation Agreement (IEA HIA)
- Sustainable Nuclear Energy Technology Platform (SNETP)
- Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP)
- Nuclear Generation II & III Association (NUGENIA)
- European Technical Support Organisations Network (ETSON)



## ACHIEVEMENTS OF LEI EMPLOYEES



### DR. VIDAS LEKAVIČIUS ELECTED A MEMBER OF THE YOUNG ACADEMY OF LITHUANIAN ACADEMY OF SCIENCES (LAS)

On 8 December 2020, the Presidium of the Lithuanian Academy of Sciences (LAS) announced the results of the election of members to the LAS's Young Academy. Based on the nominations made by the commissions formed in the LAS science divisions and the

submissions of the latter, the principal researcher of the Laboratory of Energy Systems Research of the Lithuanian Energy Institute Dr. Vidas Lekavičius was elected a member of the LAS Young Academy for a term of four years.

### DR. AUDRIUS GRAŽEVIČIUS CAME SECOND AT THE ETSON AWARD 2020

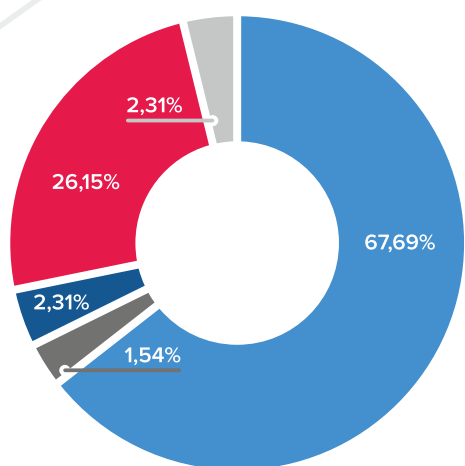
On 3 November 2020, Audrius Graževičius (Lithuania), a junior researcher at LEI's Laboratory of Nuclear Installation Safety, together with Anis Bousbia-Salah from BeIV (Belgium) came in second place at the European Technical Safety Organisations Network (ETSON)

Award Science Slam 2020. The awards are held to recognise young experts in technical safety institutions in different countries for their scientific articles and reports, as well as other scientific output.



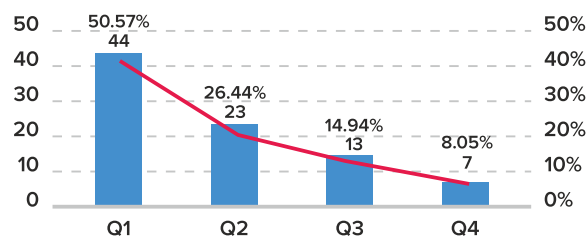
# PUBLICATION OF RESEARCH RESULTS

## STRUCTURE OF PUBLICATIONS OF THE INSTITUTE IN 2020, PCS.



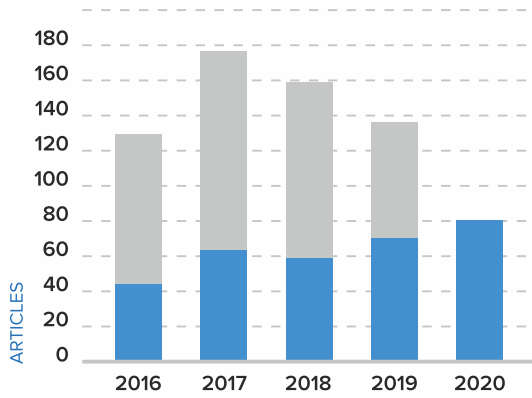
- Articles referenced in international databases
- Other peer-reviewed articles
- Monographs and book chapters
- Proceedings of conferences held abroad
- Proceedings of conferences held in Lithuania

## Publication of research results by quartiles



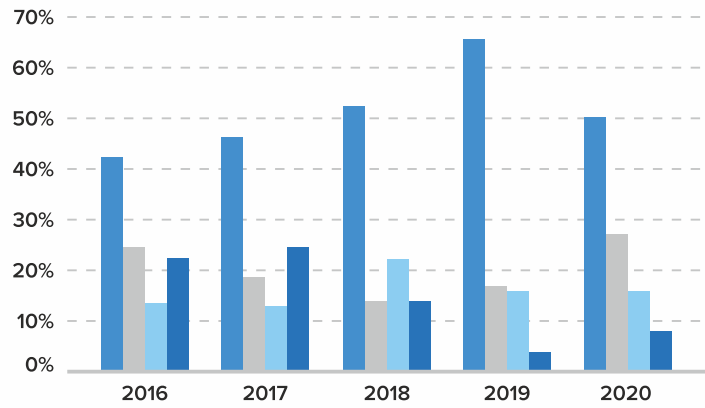


Dynamics of articles referred in the Clarivate Analytics WoS database



LEI Authors  
LEI Authors as JET Contributors

Dynamics of articles referred in the Clarivate Analytics WoS database by quartiles

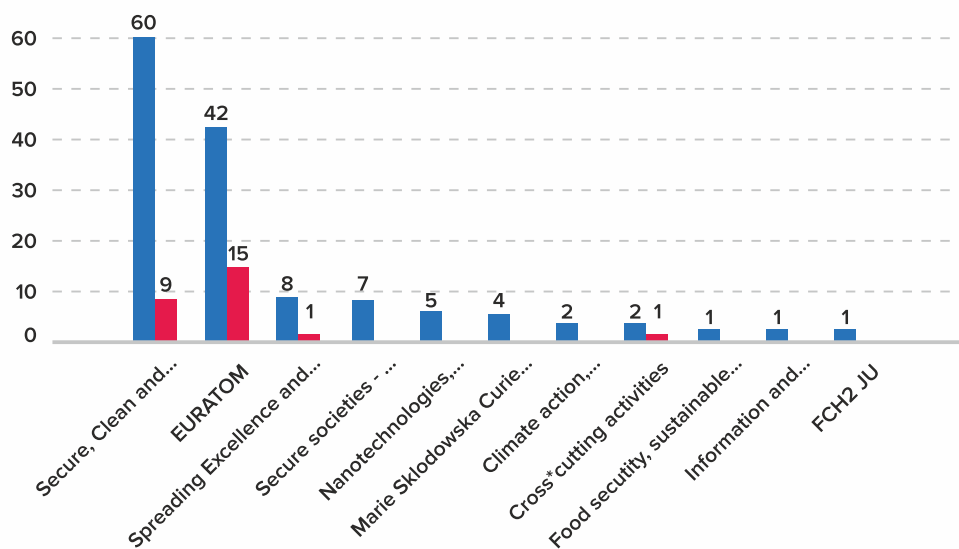


Q1 Q2 Q3 Q4

Full list of LEI Scientific Publications:  
[www.lei.it/en/publications](http://www.lei.it/en/publications)

Institute's H2020 success rates

Submitted (blue) Funded (red)



## LEI PROJECTS

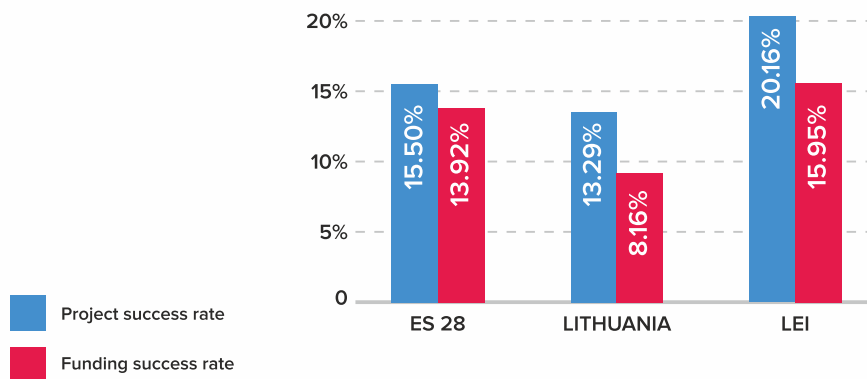
### INTERNATIONAL PROGRAMMES' PROJECTS IMPLEMENTED IN 2020

PROJEKTAI	17	Horizon 2020
	1	7th Framework
	4	Nordic Energy Research Programme (NERP)
	7	International Atomic Energy Agency (IAEA)
	4	International Partnerships
	6	COST Programme
	4	INTERREG Programmes

### INSTITUTE IN INTERNATIONAL PROGRAMMES (PROJECTS PORTFOLIO)

PROJEKTAI	26	Horizon 2020
	24	7th Framework
	14	6th Framework
	11	5th Framework
	31	Intelligent Energy Europe
	14	INTERREG Programmes
	6	Nordic Energy Research Programme (NERP)
	19	International Atomic Energy Agency (IAEA)
	4	International Partnerships
	27	COST Programme
	4	EUREKA Programme

Success rate of Lithuanian Energy Institute (LEI) in the Horizon 2020 programme (data as of 25/01/2021)



## INTERNATIONAL PROJECTS STARTED IN 2020

### **HORIZON 2020:**

- Twinning for Promoting Excellence, Ability and Knowledge to develop advanced waste gasification Solutions (TWIN-PEAKS) (coordinated by LEI)
- Innovative Water Recovery Solutions through recycling of heat, materials and water across multiple sectors (iWAYS)
- INNOvative tools FOR dismantling of GRAPHite moderated nuclear reactors (INNO4GRAPH)

### **INTERREG Programmes:**

- Joint management of Latvian – Lithuanian transboundary river and lake water bodies (TRANSWAT)
- Training on Low Temperature District Heating in the Baltic Sea Region (LowTEMP 2.0)

### **Nordic Energy Research Programme (NERP):**

- Techno-economic performance and feasibility study of the 5GDHC technology using agent based modelling and GIS (Agent-GIS-5GDHC)
- Integrating energy sufficiency into modelling of sustainable energy scenarios
- Fast, flexible and secure decarbonisation of the Baltic states – possible progress in the next Ten years (FasTen)
- Establishment of Nordic-Baltic PhD and researcher mobility network in the field of the bioenergy (REMONET-Bioenergy)

### **International Atomic Energy Agency (IAEA):**

- Pathways to Energy from Inertial Fusion: Materials Research and Technology Development (IAEA Nr. F13020)
- Spent Fuel Characterization (IAEA Nr. T13018)
- Developing a Phenomena Identification and Ranking Table (PIRT) and a Validation Matrix, and Performing a Benchmark for In-Vessel Melt Retention (IAEA Nr. J46002)

### **COST Programme:**

- Process-based models for climate impact attribution across sectors (CA19139)
- Positive Energy Districts European Network (CA19126)

### **Other international projects:**

- Consolidating ambitious climate targets with end-use sufficiency (CACTUS) (European Climate Initiative, EUKI)
- Development of a framework to assess resilience of energy systems by quantitative indicators (Joint Research Centre, EC)
- Benchmarking on Assessment of Radiological Consequences (BARCO)
- Consultancy services for the implementation of a remediation project in Turkey

Full list of LEI Projects: [www.lei.it/en/projects](http://www.lei.it/en/projects)





# DOCTORAL STUDIES

## LEI IN COOPERATION WITH LITHUANIAN UNIVERSITIES IMPLEMENTS JOINT DOCTORAL STUDIES IN THE FOLLOWING SCIENCE FIELDS:

  Energetics and Power Engineering (T 006)

   Environmental Engineering (T 004)

   Economics (S 004)

● **TECHNOLOGICAL SCIENCES**, two programmes in cooperation with Kaunas University of Technology and Vytautas Magnus University.

● **SOCIAL SCIENCES**, one programme in cooperation with Kaunas University of Technology and Klaipėda University.

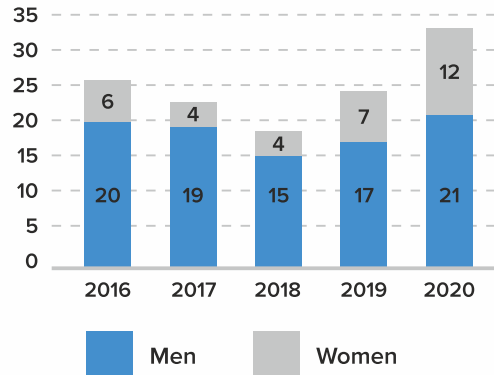
## PHD STUDIES IN NUMBERS

During 1992–2020, **82 doctoral theses** have been defended at the Lithuanian Energy Institute

In 2020, **12 doctoral students** have been admitted

By the end of 2020, **33 PhD students** have been carrying out their studies

## PHD STUDENTS DYNAMICS



## DOCTORAL THESES DEFENDED IN 2020:

### PAULIUS VILKINIS

Thesis – “Investigation of flow dynamics and structure in channels with structured surfaces” (Energetics and Power Engineering). Scientific Supervisor – Dr. Nerijus Pedišius.

### AUDRIUS GRAŽEVIČIUS

Thesis – “Numerical investigation of two-component two-phase natural convection and thermal stratification phenomena” (Energetics and Power Engineering). Scientific Supervisor – Dr. habil. Algirdas Kaliatka.

### REMIGIJUS JANULIONIS

Thesis – “Numerical Research of Fracture of Nuclear Energy Objects Construction Elements with Hydrides under Thermal Impact” (Energetics and Power Engineering). Scientific Supervisor – Dr. Gintautas Dundulis.

### DOVILĖ GIMŽAUSKAITĖ

Thesis – “Research of the Conversion of Liquid and Solid Wastes Using Thermal Plasma Technology” (Energetics and Power Engineering). Scientific Supervisor – Dr. Vitas Valinčius.

## CYSENI CONFERENCE

### SINCE 2003 LEI ORGANISES ANNUAL INTERNATIONAL CONFERENCE OF YOUNG SCIENTISTS ON ENERGY ISSUES (CYSENI).

The main goal of the Conference is to discuss issues and perspectives of energy sector worldwide; as well as to allow young scientists to develop their skills and networking.

PhD students, postdocs, master students and all other young scientists doing research on energy issues are welcome to the Conference as speakers and participants.



Dalyvavimas konferencijoje nemokamas.



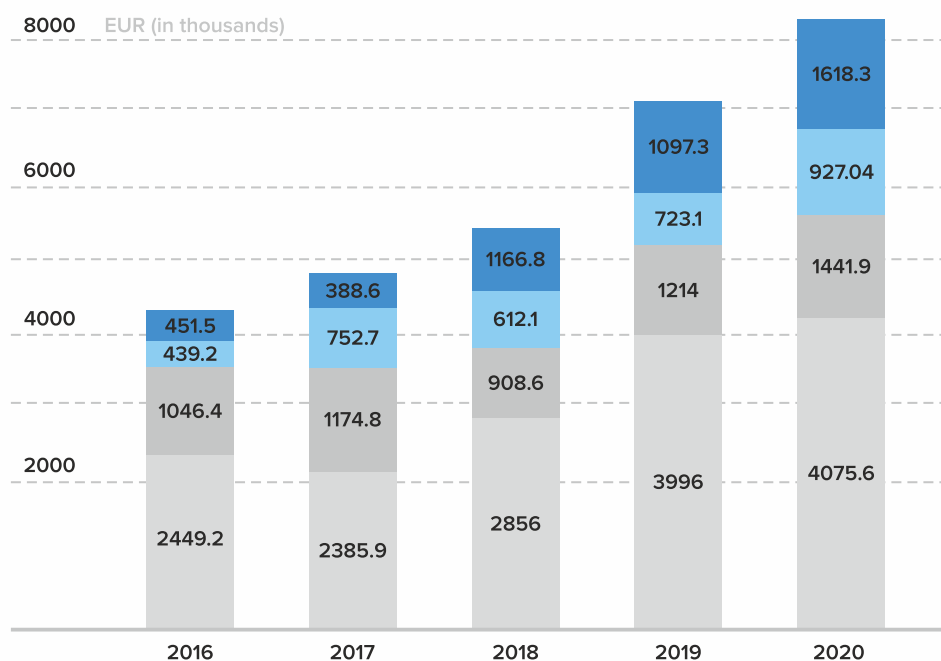
More information at [www.cyseni.com](http://www.cyseni.com)



# FINANCIAL ACTIVITY RESULTS

## FINANCIAL DYNAMICS 2016-2020

Both, State budget subsidies and funding from other sources, increased considerably in last three years. It was achieved due to the good evaluation of Institute's results by international experts and active participation of LEI researchers in national and international projects. In total, the Institute income had increased by 70 % in last three years.



**Budget subsidies** – funding from the budget of the Republic of Lithuania according to the achieved results.

**Industry contracts** – funds received for the services and works performed for companies and institutions.

**International programmes funding** – funds received during the reporting year for the results of implemented projects of international programmes (H2020, INTERREG, International Partnerships, IAEA).

**Research Council of Lithuania, Agency for Science, Innovation and Technology, EU Structural Funds and other procurement funding** – the funds received for the projects financed by state institutions.

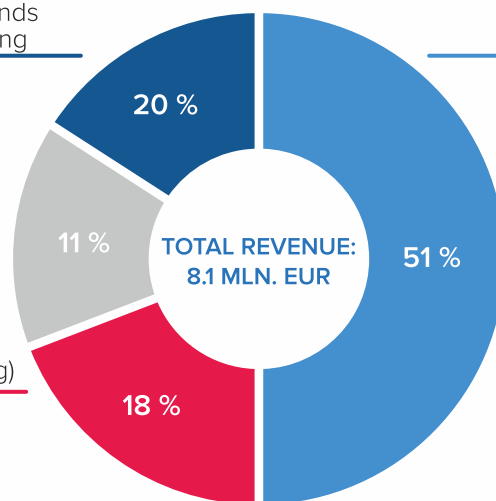
## REVENUE STRUCTURE IN 2020 (EXCL. VAT AND SUBCONTRACTING)

Research Council of Lithuania,  
Agency for Science, Innovation and  
Technology, EU Structural Funds  
and other procurement funding

International programmes'  
funds

Industry contracts  
(excl. VAT and subcontracting)

Budget subsidies



## Distribution of costs in 2020

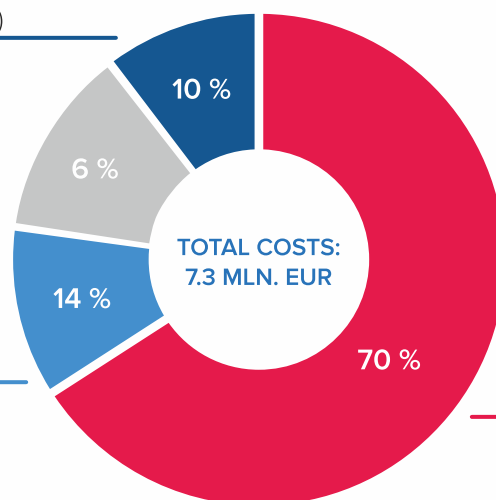
Research divisions account for about 84% of all costs and some indirect ones (e.g. operational costs).

General divisions  
(payroll+business trips+other)

Operational costs

Research divisions  
(consumables, services,  
business trips, etc.)

Research division payroll,  
PhD and Science  
Council reserves







## COLLABORATION WITH BUSINESSES

### PARTICIPATION IN THE NETWORKS OF LITHUANIAN INDUSTRIAL ORGANISATIONS

**Lithuanian Energy Institute is  
a member of:**

- Association LITBIOMA
- Biopower Plants Development Cluster
- Food Technologies Digitalization LT Cluster
- Smart Energy DIH
- Smart Technology Cluster (SMARTTA)
- Lithuanian Engineering Industries Association (LINPRA)
- Lithuanian Electricity Association (LEEA)
- National Lithuanian Energy Association
- National Defence Industries Association
- Liquefied Natural Gas Cluster
- International Energy Cluster
- Hydrogen Energy Association
- Hydrogen Platform



## PROJECTS LAUNCHED IN 2020 UNDER THE SCIENCE-BUSINESS COOPERATION PROGRAMMES:

- Investments in Research and Development of Very Large Tanks and Reactors with Cavitation Mixing (with "Astra LT" AB).
- Implementation of AXIS Tech R&D activities in developing innovative solutions for renewable energy technologies (with "Axis Tech" UAB).
- Creating and demonstrating an integrated smart ecosystem (with "Energy Ideas Group" UAB).
- Multifunctional biomass energy technologies MultiBET (with "Enerstena" UAB).



## RTO LITHUANIA

- In 2020, two interinstitutional FTMC-LAMMC-LEI projects were implemented:
  - Study of aerosol black carbon release from biofuel-fired plants and sedimentation on tree foliage, coordinated by Steigvilė Byčėnienė (FTMC), Valda Araminienė (LAMMC) and Eugenija Farida Dzenajavičienė (LEI).
  - Development of a database of specific parameters of plant pathogens for disease diagnosis by non-destructive methods, coordinated by Alma Valiuškaitė (LAMMC), Virginijus Bukauskas (FTMC) and Darius Milčius (LEI).
- Proposals were presented for interested parties on Research, Technology & Innovation (RTI) policy and the implementation of the Green Course in Lithuania.



LITHUANIAN  
ENERGY  
INSTITUTE



CENTER  
FOR PHYSICAL SCIENCES  
AND TECHNOLOGY



LITHUANIAN  
RESEARCH CENTRE  
FOR AGRICULTURE  
AND FORESTRY

## SANTAKA VALLEY

— In 2020, two interinstitutional SANTAKA projects were implemented:

- KTU-LEI: Modeling of energy efficiency of buildings using a digital model of the built environment (Energija\_3D), coordinated by Darius Pupeikis (KTU) ir Ramūnas Gatautis (LEI).
- VDU-LSMU-LEI: Innovative technologies to increase the production of biologically active plant metabolites (PlasmaMET), coordinated by Vida Mildažienė (VDU), Valdas Jakštas (LSMU) ir Darius Milčius (LEI).



VYTAUTAS  
MAGNUS  
UNIVERSITY  
MCMXXI



LITHUANIAN  
ENERGY  
INSTITUTE

## DIGITALISATION

The Institute participates in the consortium of digital innovation centre [EDIH4IAE.lt](https://www.edih4iae.lt) (Digital Transformation of Agricultural and Energy Sectors in Lithuania), which will seek to promote digital transformation of industrial, agricultural, food and energy sectors in Central and Western Lithuania and prepare an application for the future call of the European Commission eDIH. The project was co-launched by the Lithuanian Confederation of Industrialists, Lithuanian Innovation Centre, Vytautas Magnus University, Science and Technology Park of Institute of Physics, agro and food technology company ART21 and SMART IT Cluster, which coordinates AgriFood Lithuania DIH and Smart Energy DIH.



## ACHIEVEMENTS OF RESEARCH DIVISIONS

### RESEARCH DIVISIONS OF THE LITHUANIAN ENERGY INSTITUTE:

- Center for Hydrogen Energy Technologies
- Laboratory of Energy Systems Research
- Smart Grids and Renewable Energy Laboratory
- Laboratory of Combustion Processes
- Plasma Processing Laboratory
- Laboratory of Materials Research and Testing
- Laboratory of Heat Equipment Research and Testing
- Laboratory of Hydrology
- Laboratory of Nuclear Installation Safety
- Nuclear Engineering Laboratory

### **KEY ACHIEVEMENTS OF LITHUANIAN ENERGY INSTITUTE'S SCIENTIFIC DIVISIONS (LABORATORIES) FOR THE YEAR 2020 AND YEARS 2016-2020.**



# HYDROGEN RESEARCH AND NANOTECHNOLOGIES

Center for Hydrogen Energy  
Technologies

## MAIN RESEARCH AREAS OF THE CENTER

- Research in the field of hydrogen energy technologies: synthesis and properties analysis of hydrogen separation membranes; hydrogen production using direct reactions of water and plasma activated metals, storage of hydrogen in metal hydrides; synthesis of hydrogen fuel cells using physical evaporation technologies.
- Investigation of the properties of the materials forming the electrodes of nickel – metal hydride batteries.
- Synthesis and application of metal oxides and oxyhydrides for photocatalytic water treatment, photochromic devices, etc.
- Synthesis and analysis of properties of nano-clusters for biological objects (plant growth activation, destruction of pathogenic derivatives).



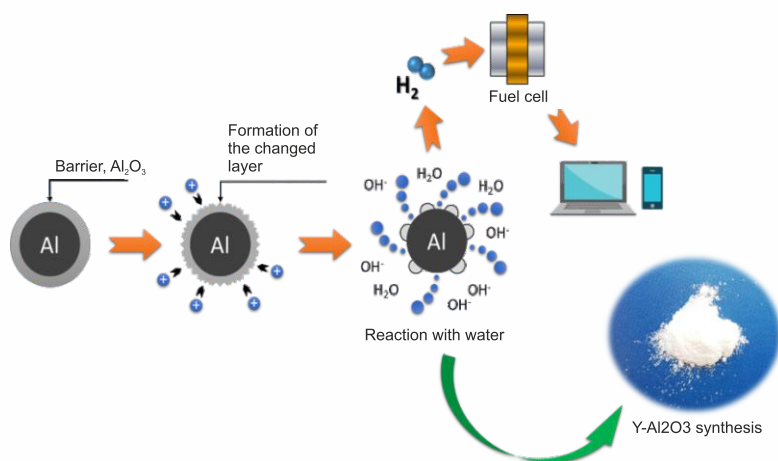
## KEY ACHIEVEMENT OF THE CENTER FOR THE YEAR 2020

### INVENTION: METHOD FOR HYDROGEN PRODUCTION AND SYNTHESIS OF GAMMA ALUMINA USING PLASMA-ACTIVATED ALUMINIUM AND WATER REACTIONS

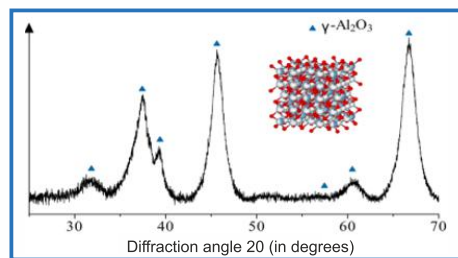
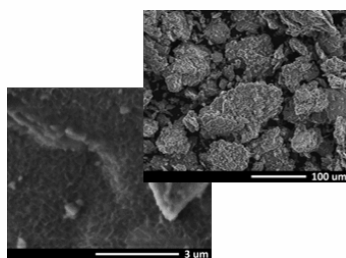
The technology is designed for the synthesis of high effective surface area alumina using direct plasma-activated aluminium reactions with water under conditions close to room temperature.

The method has 2 applications:

- **Synthesis** of pure **gamma alumina**, which due to its high surface area and porosity can be **used as a catalyst base** (e.g. in the petrochemical industry) for water purification, membranes or as an absorbent material.
- **Hydrogen production** from water that can be supplied to the fuel cell and **used for electricity generation** (e.g. an autonomous electricity system can be integrated into low-capacity installations).



- **PCT patent application of the present invention was filed in 2018 (WO2019186234)**
- **The application was made public in 2019**
- **The next patenting step was launched in 2020 to obtain an EPO patent**







# ENERGY SECTOR DEVELOPMENT ANALYSIS

Laboratory of Energy  
Systems Research

## MAIN RESEARCH AREAS OF THE LABORATORY

- Economic modeling at the micro and macro level. Analysis and solutions of economic and social problems. Development and application of various types of economic models (microsimulation, input-output, general equilibrium).
- Mathematical modelling and analysis of systems development and operation, systems integration and decarbonisation of the national economy. Formation and analysis of medium to long-term development scenarios and policy proposals.
- Analysis of optimal allocation of generation, reservation and balancing capacities in energy systems and interconnectors. Elaboration of optimal approaches for balancing intermittent energy generation from renewable energy sources.
- Transport decarbonisation research. Investigation of possibilities to balance intermittent electricity generation from renewable energy sources by means of smart charging of electric vehicles and alternative fuel production.



- Research on the impact of building renovation and long-term development of new energy-efficient buildings on the development of energy systems.
- Environmental impact analysis of the energy sector. Analysis and impact assessment of emission abatement technologies and environmental measures.
- Analysis and impact assessment of renewable energy integration and energy efficiency measures as well as preparation of recommendations based on the analysis.
- Research on climate change mitigation and promotion of behavioral changes in households. Assessment and integration of population preferences in this field by applying willingness to pay for climate change mitigation and other methods. Development of climate change mitigation policy provisions in this field.
- Research on modern management and marketing solutions for energy facilitating the creation of a welfare society.

## **KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2020**

- The possibilities of using Kruonis Hydro Pumped Storage Power Plant for balancing volatile generation of wind and solar power plants and provision of reserve services were investigated and the socio-economic consequences of such power plant development were assessed (Project funded by Ignitis Gamyba AB).
- Methods and mathematical models are being developed to assess the economic attractiveness of biofuel gasification and the integration of liquid fuel component production facilities into district heating systems (together with Laboratory of Combustion Processes). (H2020 FLEXCHX project);
- A system for monitoring energy poverty and evaluating policy measures in household sector is being developed. The limitations of the current energy poverty indicators have been revealed (for example, identified methodological problems, due to which the Lithuanian population's inability to heat their homes is one of the highest in the European Union) (project funded by the Research Council of Lithuania).
- An innovative general economic equilibrium model is being developed to assess the socio-economic effects of industry transformations (project funded by the Research Council of Lithuania).

- A system of mathematical models is being developed for the analysis of decarbonisation of the country's economy. Models enable an integrated analysis of the decarbonisation progress in the energy, transport, industry, household and agricultural sectors (project funded by the Research Council of Lithuania).
- Principles of integration of energy sufficiency measures into modern energy planning models have been developed; the possibilities of decarbonisation of the country in this decade are being examined (project of the joint Baltic-Nordic Energy Research programme).

## **KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2016-2020**

- Detailed research on the perspective development of the Lithuanian energy sector has been carried out, the macroeconomic consequences of the development of the energy sector have been analyzed and a draft update of the National Energy Independence Strategy has been prepared.
- The methodology of economic evaluation of the use of energy storage facilities, balancing intermittent generation and provision of reserve capacities in the electricity system has been developed, and modeling principles have been implemented in mathematical models. The socio-economic consequences of the development of the Kruonis hydro pumped storage power plant have been examined.
- Significant contribution was made to the preparation of the strategy for the development of social and affordable housing in Lithuania (project funded by the Council of Europe Development Bank).
- Through H2020, the Baltic-Nordic Joint Energy Research Program and other international projects, the collaboration of laboratory scientists with scientists from other countries in the fields of general economic equilibrium research, climate change analysis, energy sector development planning, renewable energy use and ecosystem sustainability and social protection research has significantly expanded. The results of the laboratory's research are increasingly used not only by the country's companies or ministries, but also by the European Commission, the Council of Europe Development Bank and other institutions.



# CONTROL OF ENERGY SYSTEMS

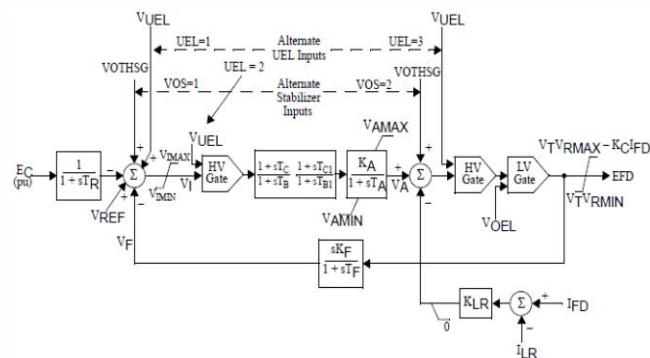
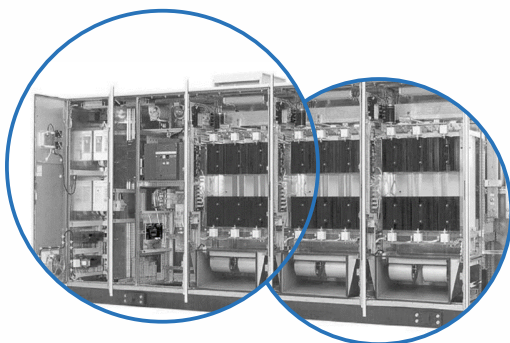
Smart Grids and Renewable Energy Laboratory

## MAIN RESEARCH AREAS OF THE LABORATORY

- Mathematical modelling of power systems and networks, investigation of their control issues;
- Modelling and optimisation of ICT-based control systems of power systems;
- Research of integration of renewable energy sources (wind, solar, etc.) and distributed generation into power systems.

## KEY ACHIEVEMENT OF THE LABORATORY FOR THE YEAR 2020

- The project "Update and verification of generators models for the isolated operational test" was completed in 2020. The main objective of the work was to carry out tests on Lithuanian power plant equipment (generators, exciters, turbines and their control systems), the results of which were used to update the mathematical model of the Baltic power system and to determine the appropriate damping parameters for the PSS (power system stabiliser). The project was carried out as preparational measure for the synchronous operation with Continental European Network in 2015
- The project was implemented in collaboration with the "Science and technology company ENPASELECTRO" Ltd.
- Project duration – 19 months, 28/09/2018 – 09/04/2020.
- The generator excitation system (UNITROL 5000) and its model

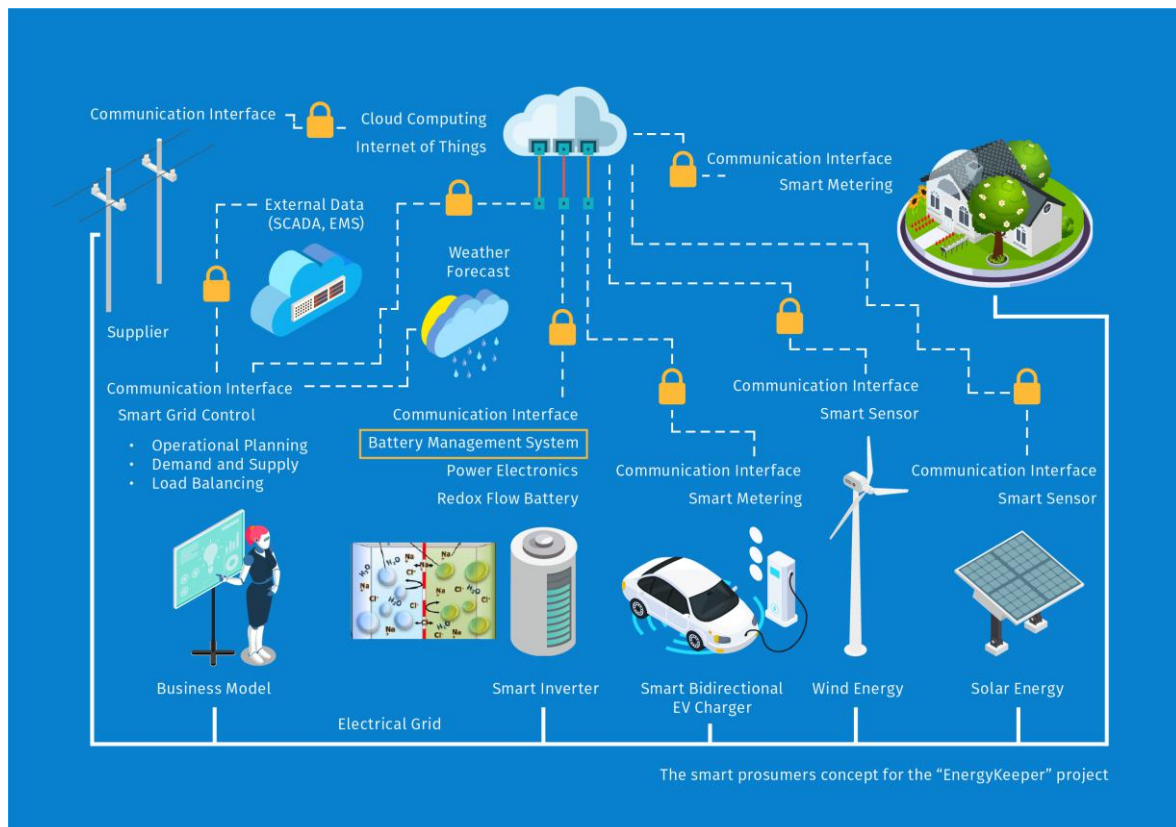


## KEY ACHIEVEMENT OF THE LABORATORY FOR THE YEAR 2016-2020

- Implementation of H2020 project EnergyKeeper. LEI scientists have contributed to the development of a redox-flow battery's smart control system and its algorithms for energy storage and provision of ancillary/system services (frequency and voltage control) that will enable optimisation of the income of the battery owners/consumers.
- Project consortium – 10 partners from 6 countries.
- Project duration – 36 months, 01/01/2017 – 31/12/2019.
- Project budget – EUR 4 million.



## THE SMART PROSUMER CONCEPT FOR THE “ENERGYKEEPER” PROJECT





# COMBUSTION RESEARCH

Laboratory of Combustion Processes

## MAIN RESEARCH AREAS OF THE LABORATORY

- Investigation of gaseous, liquid and solid fuels combustion processes;
- Development and optimization of industrial combustion devices;
- Thermochemical (gasification, pyrolysis, carbonization) processing of biomass and non-hazardous waste;
- Liquid and gaseous biofuel synthesis research.

Investigations of combustion and other thermochemical processes in order to valorize a biomass and waste usage for alternative biofuel and chemical production, reduce the environmental emissions and increase technology efficiency.

## KEY ACHIEVEMENT OF THE LABORATORY FOR THE YEAR 2020

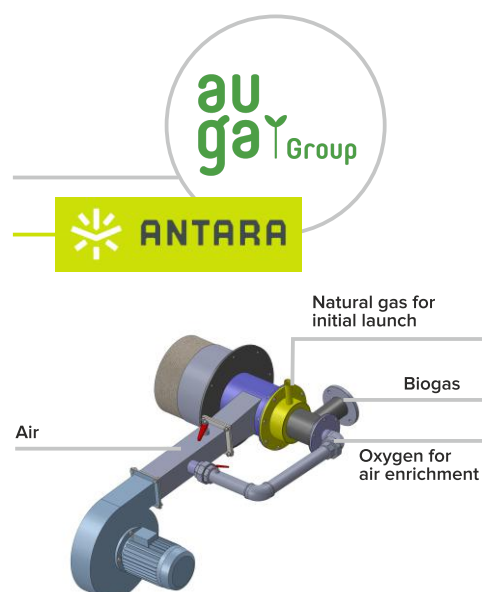
Developed burner prototype for clean combustion of low and unstable concentration methane gas using non-atmospheric composition air mixtures.



Client: "AUGA group" AB

Incinerator manufacturer: "ANTARA LT" UAB

A prototype of a 400kWth power combustion equipment, i.e. a burner with an incinerator, developed for tail biomethane gas ( $\text{CH}_4 < 15\text{-}25\%$ ,  $\text{CO}_2 > 72\text{-}82\%$ ,  $\text{O}_2 < 1.5\%$  and  $\text{N}_2 < 1.5\%$ ). The heat generated is used for the needs of the power plant to avoid methane and combustion pollutant emissions.



## KEY ACHIEVEMENT OF THE LABORATORY FOR THE YEAR 2016-2020

### THERMOCHEMICAL CONVERSION OF BIOMASS AND WASTE TOWARDS THE SYNTHESIS OF GREEN BIOFUELS





# PLASMA PROCESSING AND APPLICATION

Plasma Processing  
Laboratory

## MAIN RESEARCH AREAS OF THE LABORATORY

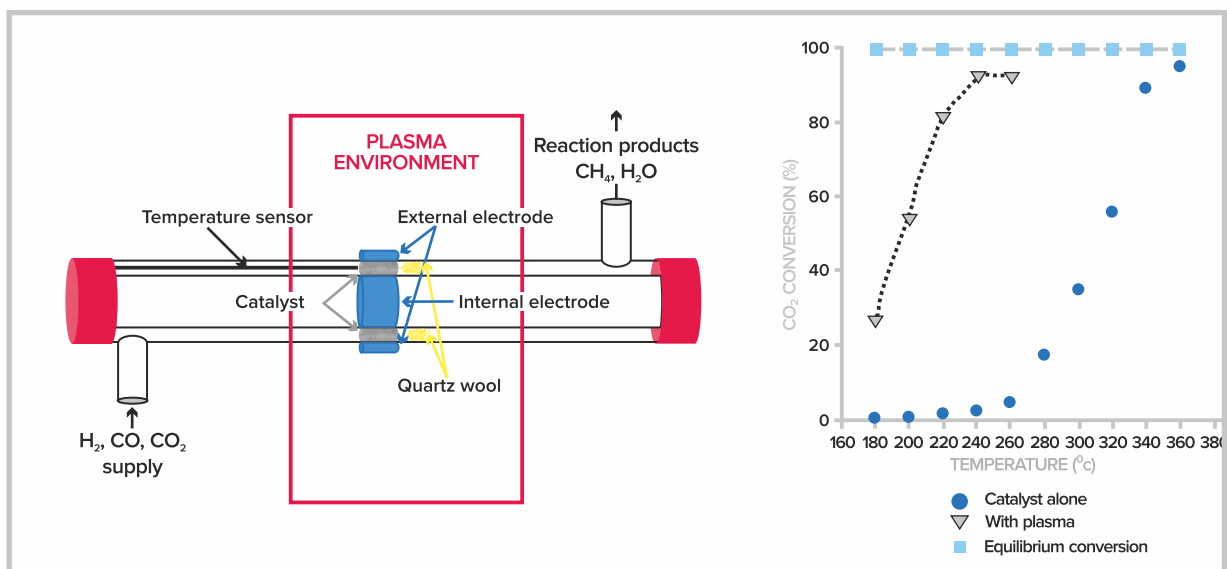
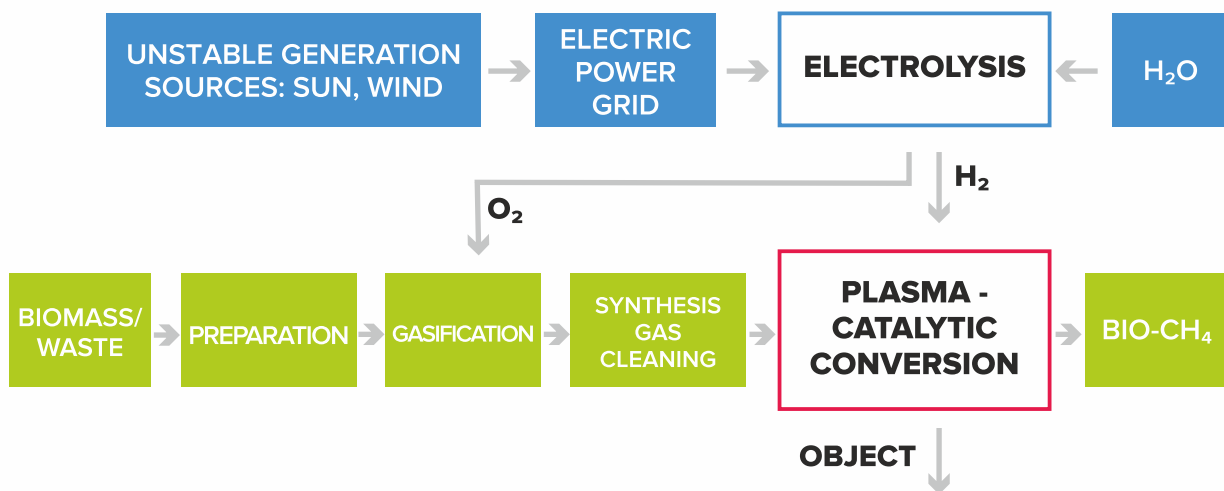
- development and research of DC plasma sources for wide range of applications
- research of processes and phenomena taking place in discharge channels, exhaust plasma jets and flows
- diagnostics of plasma and high-temperature flow and development of diagnostic measures
- research on interaction of plasma jets and substances in various plasma-technological processes
- generation of water vapor plasma and its application for fuel conversion and neutralization of hazardous waste
- research and implementation of plasma neutralization process of hazardous substances
- synthesis of catalytic and tribological coatings in plasma ambient and analysis of their properties
- research of thermal and heterogeneous processes for reacting product flowing around catalytic surface
- formation and modification of constructional material surfaces in plasma
- synthesis of micro- and nano- dispersed granules and mineral fiber from hardly meltable materials and analysis of their properties

## KEY ACHIEVEMENT OF THE LABORATORY FOR THE YEAR 2020

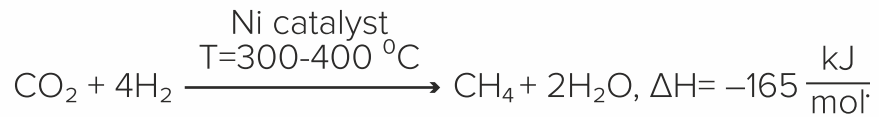
### PERFORMANCE OF R&D ACTIVITIES OF THE CENTRE OF EXCELLENCE IN DEVELOPING AND TESTING AN INNOVATIVE PROTOTYPE FOR THE PRODUCTION OF GASEOUS BIOFUELS

Part of the overall concept and benefits for the overall process:

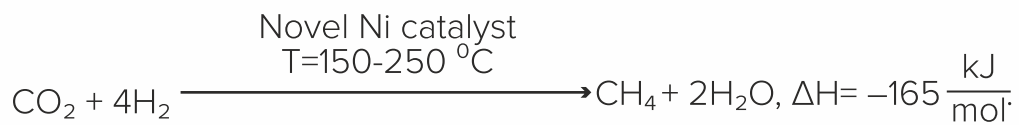
- Power to gas, producing the missing amount of hydrogen for the catalytic conversion of  $\text{CO}_2$  to bio-methane;
- Mains balancing / ensuring stability by using excess electricity produced by unstable generators;
- Avoidance of catalytic water vapour reaction (expensive catalysts for  $\text{H}_2/\text{CO}$  ratio control);
- The utilisation of excess oxygen by returning to the gasification process (synthesis gas of higher calorific value obtained).



### TYPICAL Ni CATALYST (SABATIER REACTION):



### THE PROJECT PROPOSES ITS IMPROVEMENT IN THE PLASMA ENVIRONMENT:



### ADVANTAGES OF AN IMPROVED PROCESS:

- Reaction proceeds at a lower temperature, thus fasters the process kinetics
- Reaction proceeds at atmospheric pressure
- Synergy between non-thermal plasma and catalyst

The above mentioned improvements allows to make the process closer to industrial applications, because in traditional thermo-catalytic  $\text{CO}_2$  conversion to methane, the reaction proceeds at around  $> 350\text{ }^\circ\text{C}$  and pressure up to 10 bars.





# MATERIALS RELIABILITY

## Laboratory of Materials Research and Testing

### MAIN RESEARCH AREAS OF THE LABORATORY

- Reliability of power plant facilities: research of metal aging processes and degradation of properties due to the impact of operational factors
- Development and research of multifunctional materials and composites
- Testing of materials, assessment and analysis of their qualitative indicators

### KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2016-2020

#### INCREASING SAFETY IN NPPS BY COVERING GAPS IN ENVIRONMENTAL FATIGUE ASSESSMENT (INCEFA PLUS)

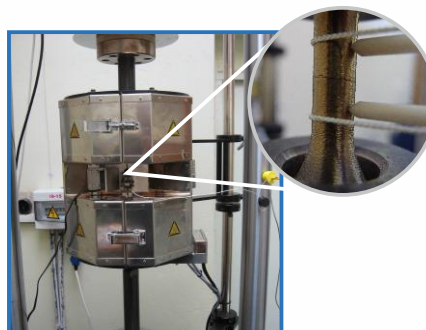
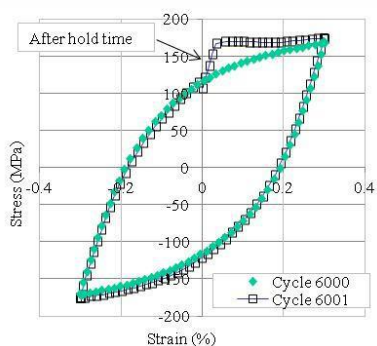
##### Experimental fatigue studies of 304L austenitic steel

Experimental test methods developed using Wave Matrix software to approximate the operating conditions of structural components in power plants.

Research results on long-term fatigue resistance:

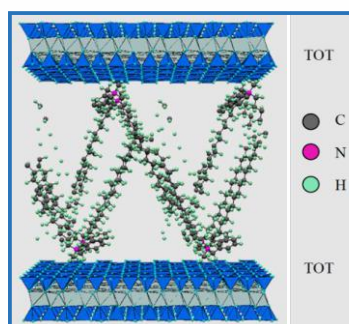
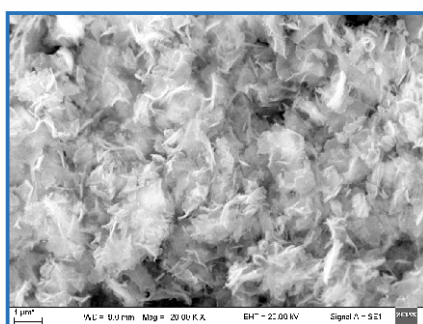
- Elastic and plastic strain components of fatigue cycle hysteresis curves;
- cyclic stress-strain curves depending on the number of cycles and effects of hold time on the number of cycles to failure;
- fractographic data and microstructural characterization of crack formation and growth in the material;
- data on the ‘recovery’ effect of steel properties at low strain amplitudes.

The experimental data has been peer-reviewed and included in the EC's Joint Research Centre (JRC) MatDB database.

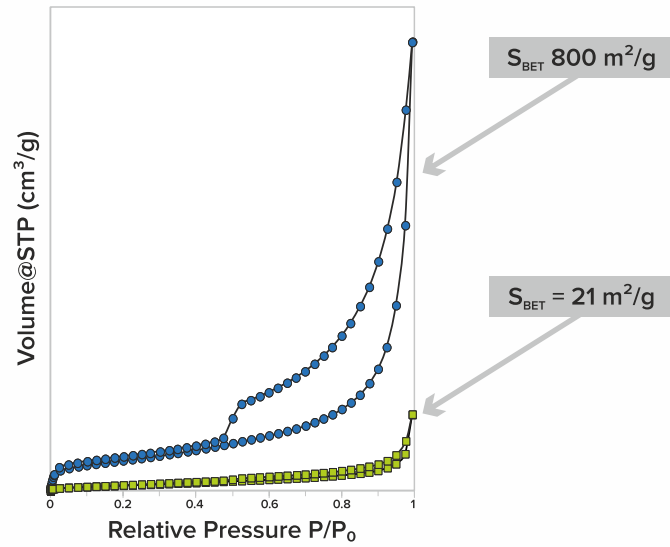
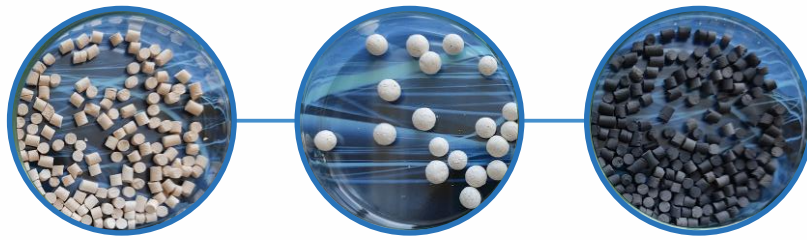


## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2020

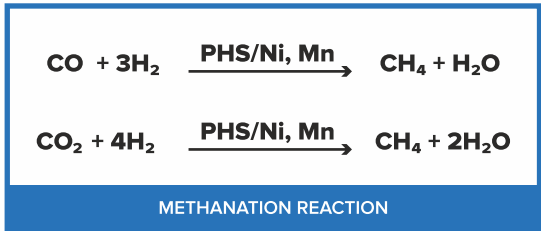
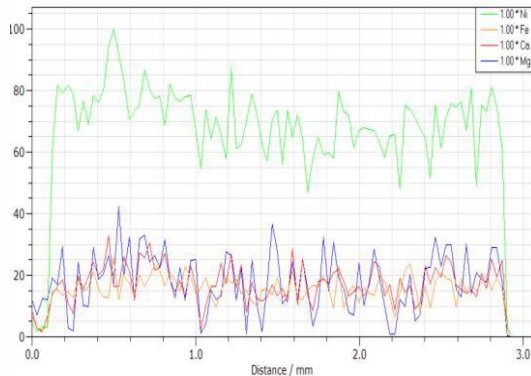
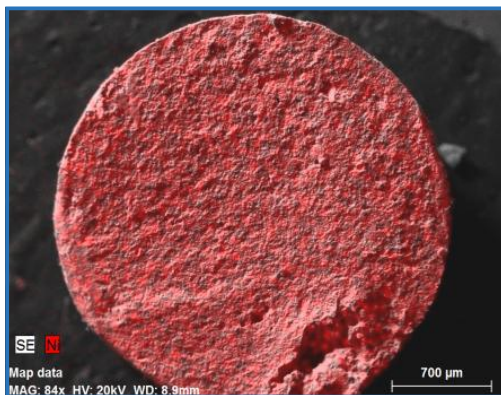
### SYNTHESIS AND STUDIES OF METHANATION REACTION CATALYST



Catalyst bead synthesis, microstructure and structure model

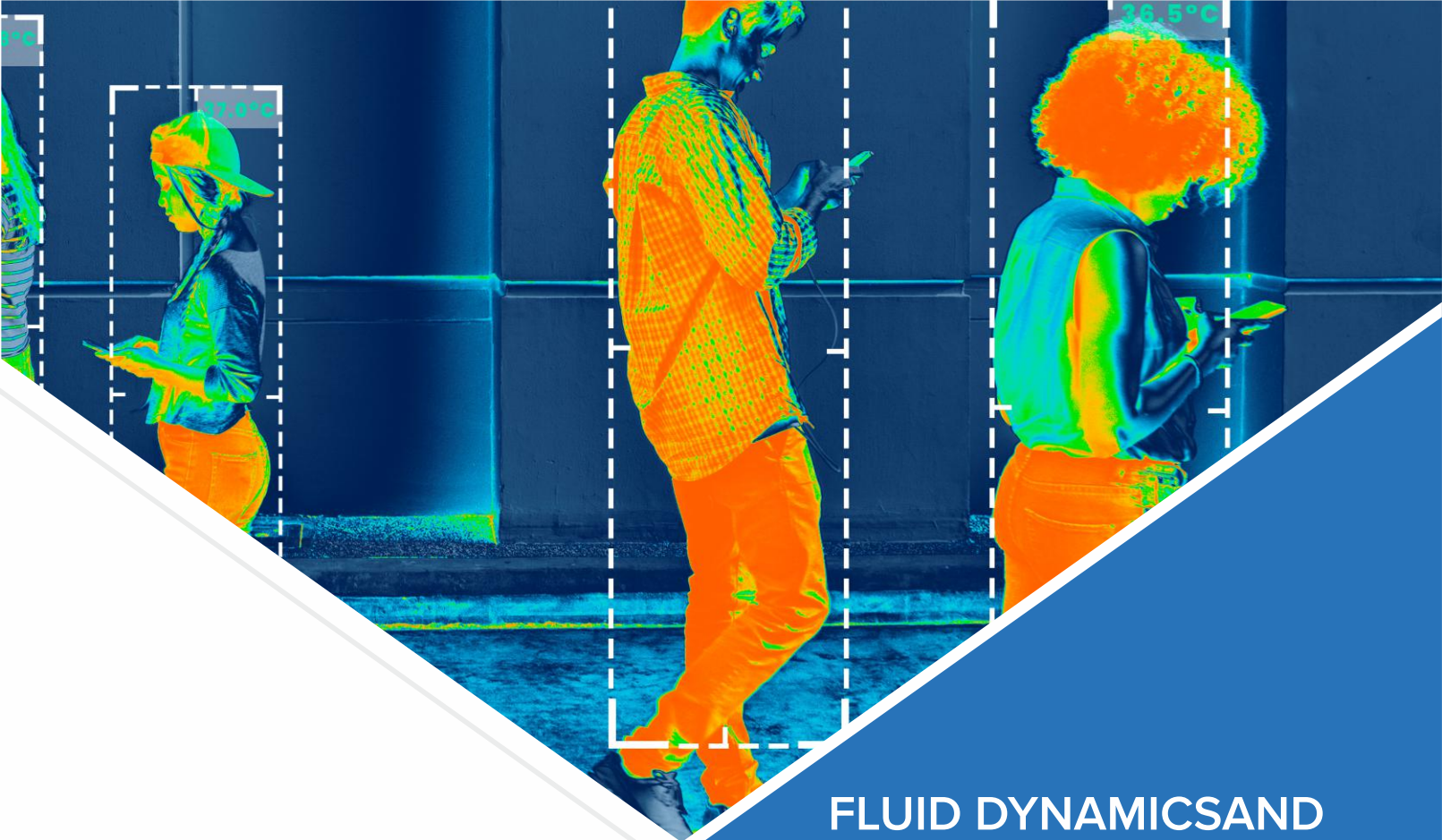


Porous Heterostructure (PHS) and high specific surface area Ni catalyst synthesis



Distribution of Ni in the catalyst bead





## FLUID DYNAMICS AND METROLOGY RESEARCH

Laboratory of Heat-Equipment Research and Testing

### MAIN RESEARCH AREAS OF THE LABORATORY

#### Processes and technologies for the efficient use of Renewable Energy Sources and reduction of environmental pollution:

- physical and thermal properties of solid biomass and recovered fuel
- fuel preparation methods and technologies
- thermal conversion processes (combustion, gasification) of solid fuel
- solid biofuel drying
- solid biofuel dynamics and thermal conversion on moving grate and in fluidized bed
- emission formation processes in heating appliances
- efficiency of low capacity boilers and heating appliances fired by solid fuel

#### Thermal physics, fluid mechanics and metrology:

- flows mixing in chambers of limited dimensions and various geometry
- permeability of gas mixtures through membranes
- particulate emission reduction
- flow dynamics in elastic channels
- ultrasound propagation in flows
- heat and mass transfer by molecular dynamics
- maintenance of five national flow and pressure standards and assurance of measurement traceability



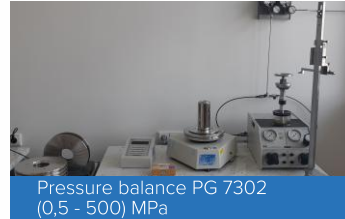
## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2020

### NATIONAL PRESSURE UNIT BENCHMARK 2020

- Equipment of the national pressure unit benchmark integrated
- The field of activity of the Benchmark assessed and accredited by the experts of the Lithuanian National Accreditation Bureau
- Uninterrupted services provided to Lithuanian economic and scientific entities



Pressure balance PG 7601 (8 kPa-7MPa)



Pressure balance PG 7302 (0,5 - 500) MPa

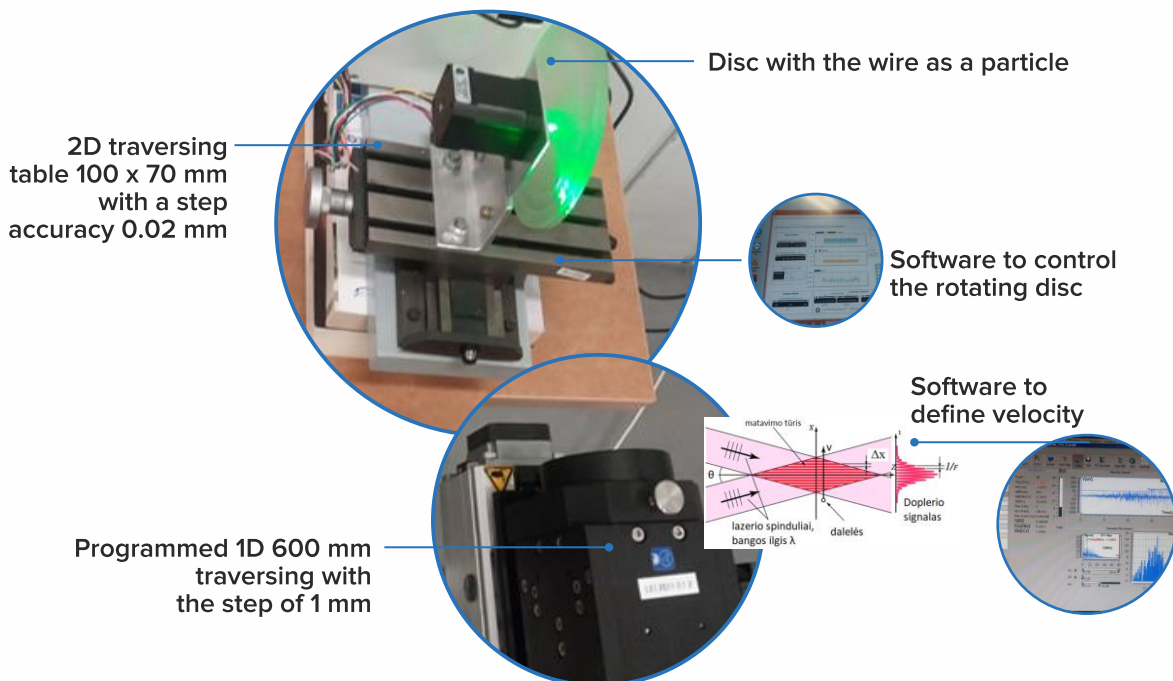


Pressure balance Vozduch-505 (5 Pa-25kPa)



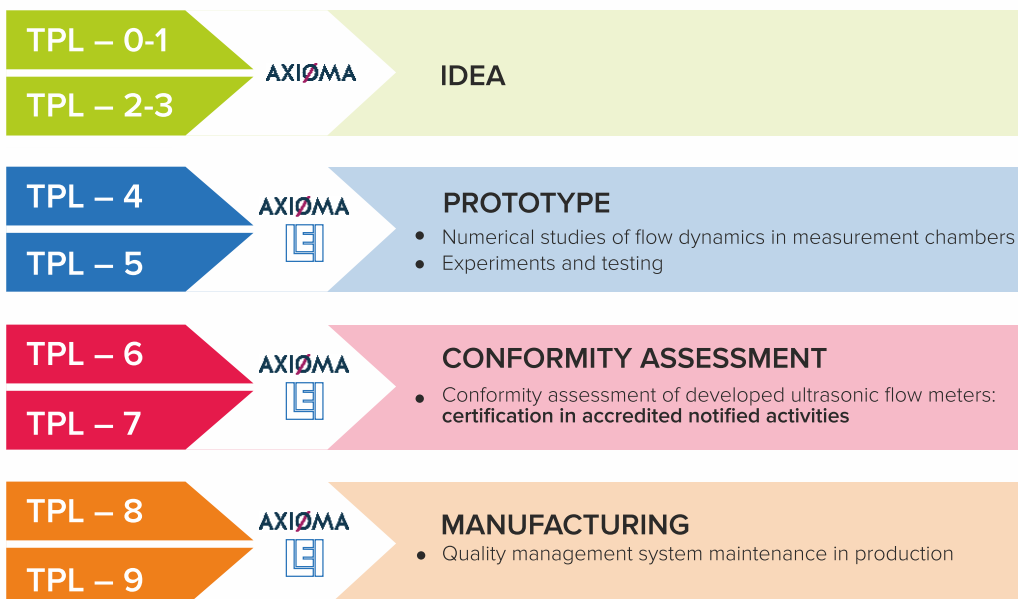
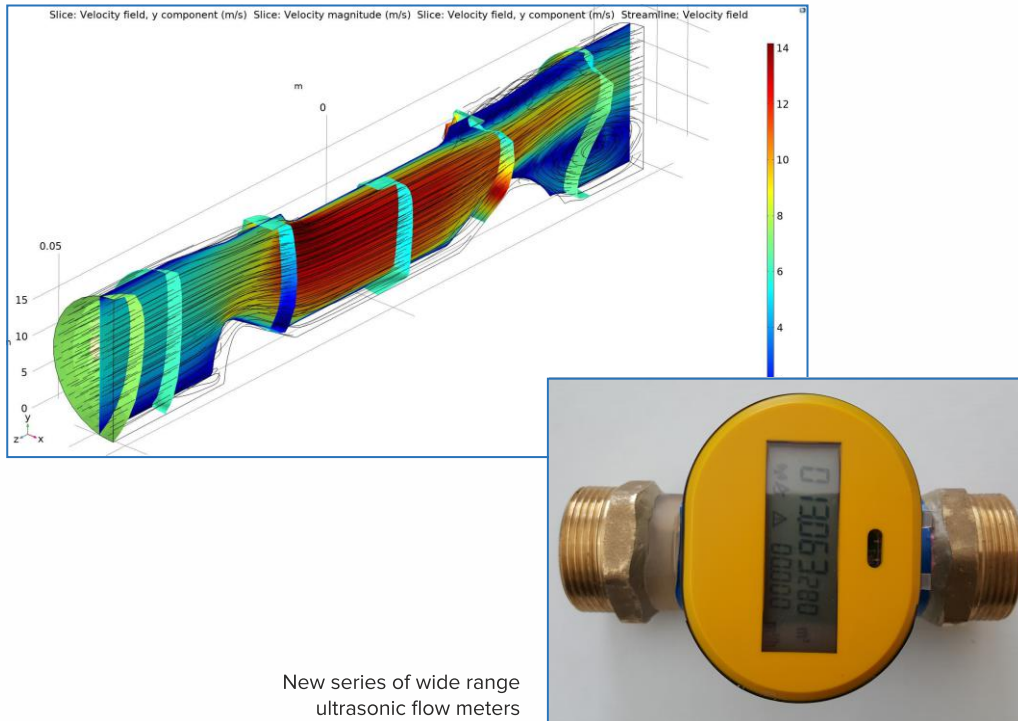
Pressure balance P3022-4-P (1,5 - 100) kPa / (-3 - -100) kPa

### CALIBRATION SYSTEM FOR THE LASER DOPPLER ANEMOMETER USING THE ROTATING DISC



## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2016-2020

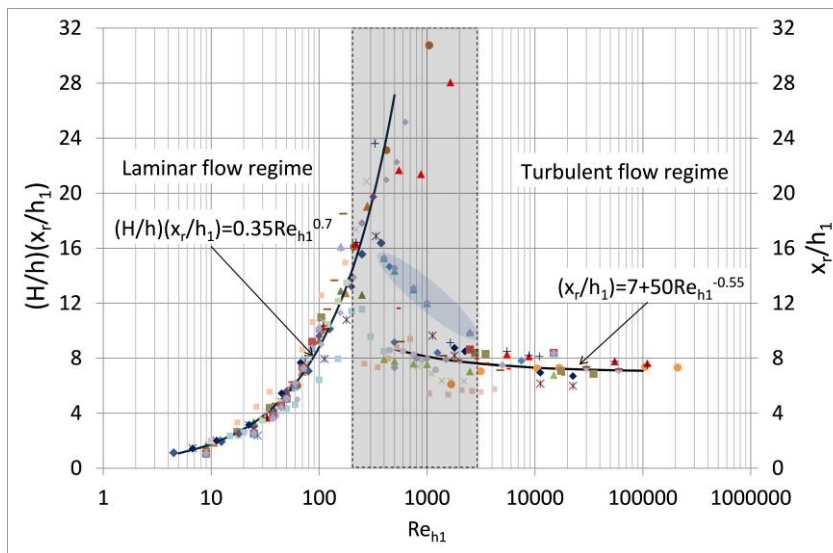
### LEI SCIENTISTS PROVIDE RESEARCH AND CERTIFICATION SERVICES TO AXIOMA METERING UAB IN DEVELOPING NEW SERIES OF WIDE RANGE ULTRASONIC FLOW METERS DN25 – DN40



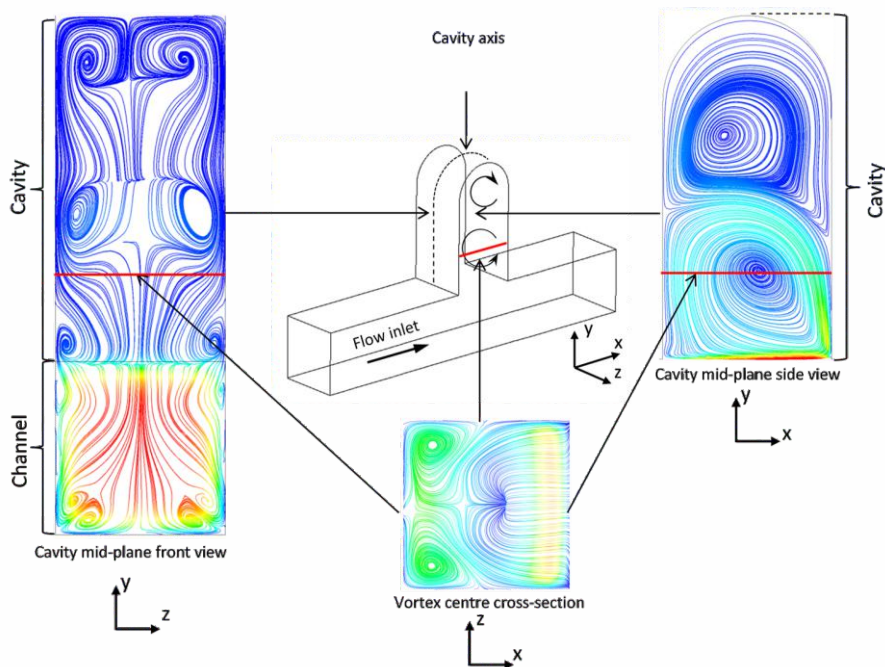
## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2016-2020

### R&D WORKS INVESTIGATING FLOW DYNAMICS IN CAVITIES AND MICROCHANNELS

Generalization of recirculation zone length dependence on  $Re$  in transitional and closed-type cavities



Flow structure in the open-type cavity investigated using CFD methods







# HYDROLOGY RESEARCH

Laboratory of Hydrology

## MAIN RESEARCH AREAS OF THE LABORATORY

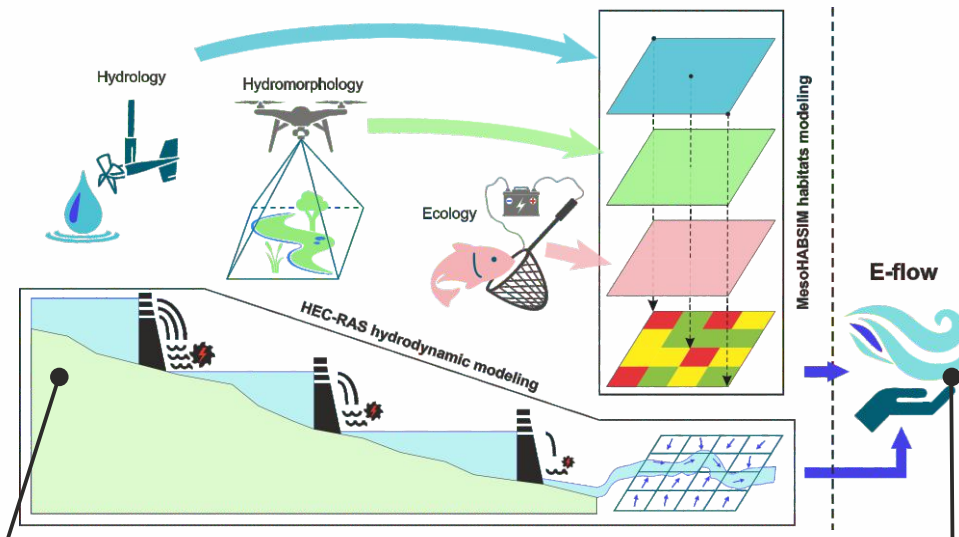
- Analysis of climate change and river runoff variation
- Research of extreme hydrological phenomena in the context of climate change
- Research of wave, hydrodynamic, and sediment processes in water bodies
- Research of environmental impact of energy and transport objects
- Collection and analysis of data on Lithuanian water bodies (rivers, ponds, the Curonian Lagoon, and the Baltic Sea)

## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2020

**Successful launch of Interreg Latvian–Lithuanian cross-border co-operation project Joint Management of Latvian–Lithuanian Transboundary River and Lake Water Bodies (TRANSWAT)**

- Duration: **01/10/2020 – 30/09/2022**
- Budget: **EUR 607,466.51**
- Funded by/under: **Latvian–Lithuanian cross-border cooperation programmes for 2014–2020.** <http://www.latlit.eu/>
- For more: <https://www.lei.lt/transwat/>





### Hydropower

The HEC-RAS hydrodynamic model will be used for investigation of activity of the HPP and the sustainable management of water bodies.

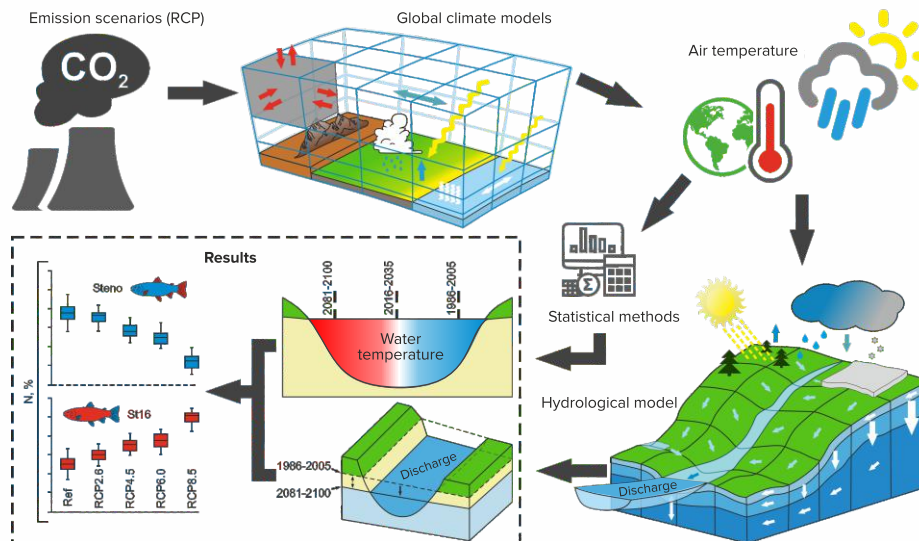
### E-flow

An ecologic discharge (E-flow) will be set in the rivers at the LT-LV border, Venta basin, regulated by HPP cascades; amendments to national water laws are proposed to mitigate the impact of regulation of such rivers.

## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2016-2020

Successful implementation of 'Impact Assessment of Climate Change and Other Abiotic Environmental Factors on Aquatic Ecosystems' (KLIM-EKO) project under the National Research Programme 'Sustainability of Agro-, Forest and Water Ecosystems' of the Research Council of Lithuania.

- Duration: **01/09/2015 – 30/11/2018**
- Budget: **EUR 315,001**
- Funded by/under: **Research Council of Lithuania**  
<http://www.lmt.lt/>



Kriaučiūnienė J. et al. Fish assemblages under climate change in Lithuanian rivers // Science of the Total Environment. Elsevier, 2019. Vol 661. p. 563-574. ISSN 0048-9697.



# SAFETY AND RELIABILITY STUDIES OF ENERGY AND INDUSTRIAL FACILITIES

Laboratory of Nuclear Installation Safety

## MAIN RESEARCH AREAS OF THE LABORATORY

- Safety, reliability and risk assessment of industrial facilities and energy systems
- Safety and reliability assessment of operating and new generation nuclear power plants
- Safety and reliability assessment of thermonuclear fusion installation
- Decommissioning safety and risk assessment of nuclear installations and radioactive waste disposal facilities
- Failure analysis and engineering assessment of complex technical systems
- Assessment of the strength of structures, piping and other systems components
- Reliability assessment of hydraulic supply networks (heat, water, gas, etc.)
- Assessment of security of energy supply
- Fundamental and applied research in thermal physics.

## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2020

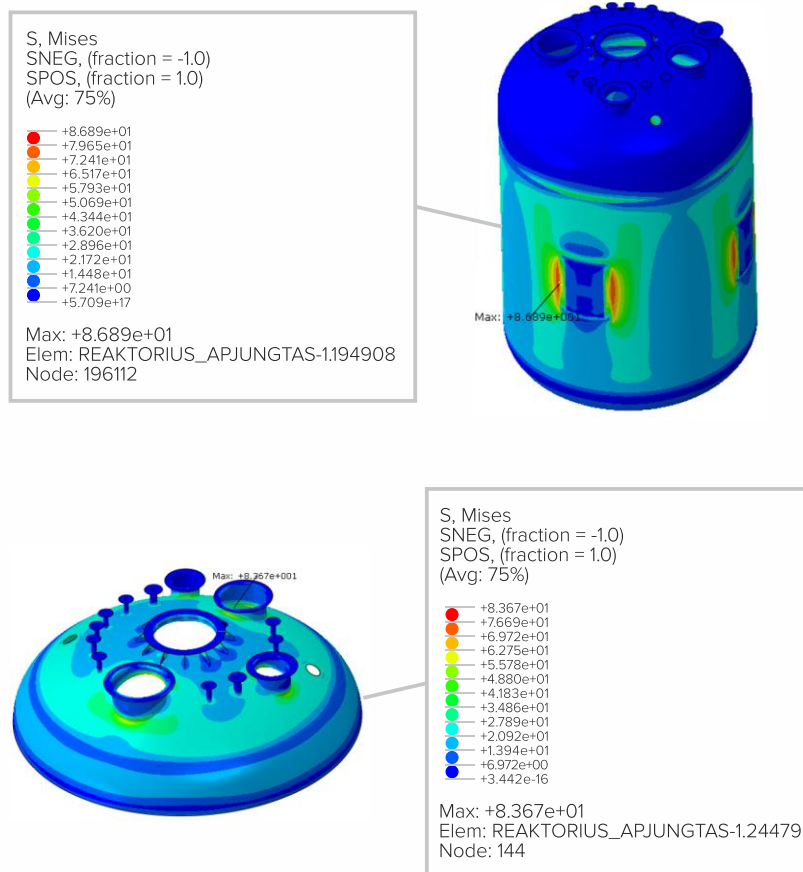
### APPLIED RESEARCH FOR INNOVATION AND PRODUCTS FOR THE EU MARKET

- Development and Placing on the EU Market of New DUPLEX Steel Semi-Trailer Road Tanker (No. J05-LVPA-K-04-0017), 2019–2021
- Investments in Research and Development of Very Large Tanks and Reactors with Cavitation Mixing (No. 01.2.1-LVPA-K-856-01-0099), 2020–2023

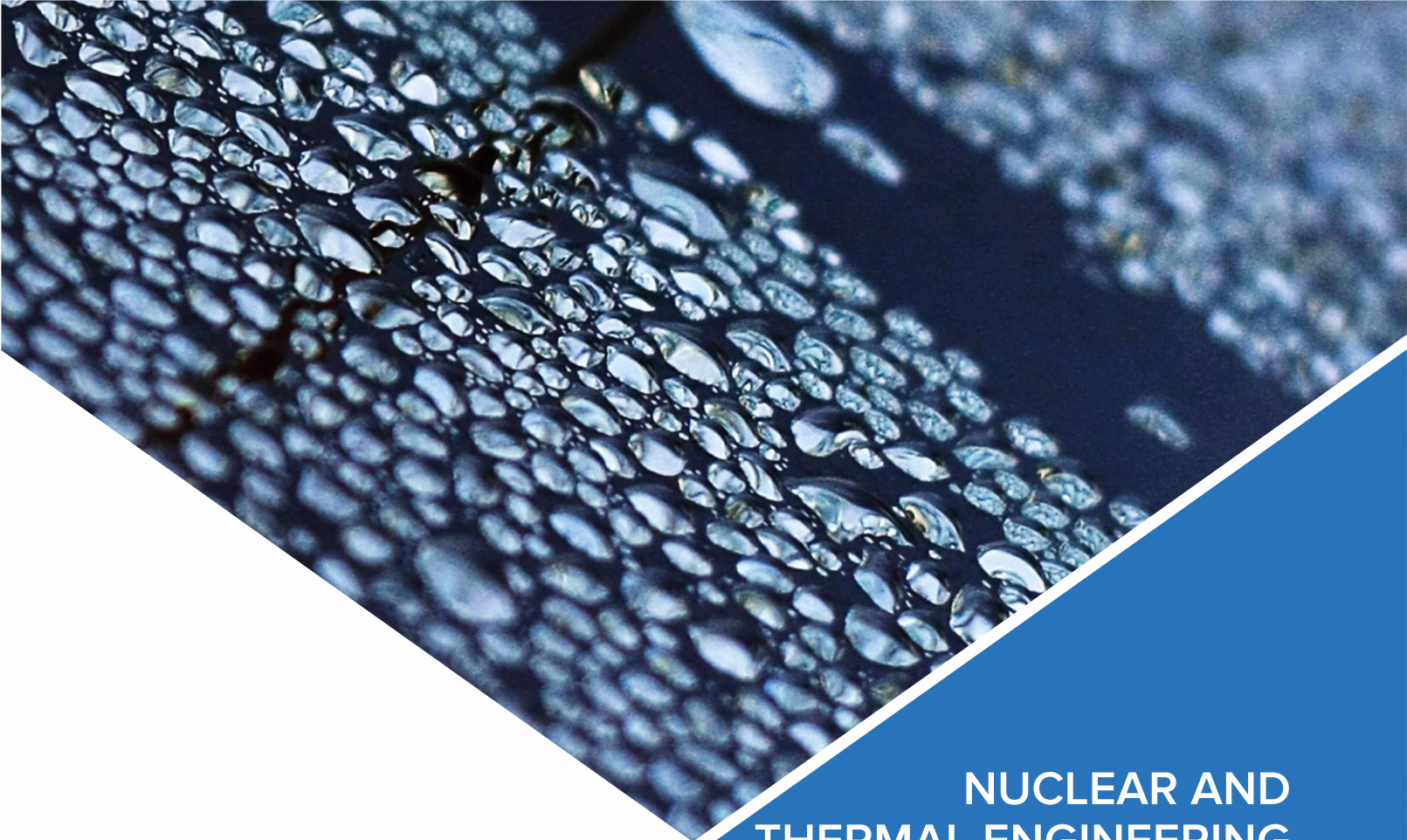
The scientists of the laboratory modelled and studied the heat and mass transfer processes in the tanks during natural convection or mixing, and performed the strength analysis of complex structures. Such research will allow Astra LT, AB:

- to produce and bring to the EU market a highly insulated, lighter semi-trailer road tanker made of new, sturdier DUPLEX steels, allowing to increase the cargo volume and carry distance;
- to develop and bring to market the innovations, i.e. very large tanks and reactors with cavitation mixing.

The projects are funded from the European Regional Development Fund under the agreement with Astra LT, AB in accordance with the measures for the implementation of Priority Axis 1 'Strengthening research and development and innovation' of the Operational Programme for EU Structural Funds Investments for 2014-2020 'Intelligence. Joint Science-Business Projects' and 'Experiment'.







# NUCLEAR AND THERMAL ENGINEERING

Nuclear Engineering  
Laboratory

## MAIN RESEARCH AREAS OF THE LABORATORY

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### Safety of spent nuclear fuel management

- Interim storage
- Disposal in deep geological repositories

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### Safety of radioactive waste management

- Treatment
- Temporal and interim storage
- Disposal in near-surface repositories

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### Assessment of different factors related to decommissioning of nuclear facilities using DECRAD (LEI) software

- Strategy selection
- Safety assessment
- Assessment of dose rates to workers and residents
- Evaluation of radwaste qualities, labor cost, dismantling duration, etc.

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### Waste heat recovery from flue gases during biofuel combustion and reduction of the amount of emissions from the exhaust

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### Investigation of heat transfer and hydrodynamic processes in various systems and their components

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### Fire safety investigation



## KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2020

### IMPLEMENTING THE IGNALINA NPP DECOMMISSIONING PROGRAMME FINANCIALLY ASSISTED BY THE EUROPEAN UNION, THE FOLLOWING PROJECTS HAVE BEEN CARRIED OUT

- Environmental impact assessment and safety assessment of the reconstruction of the INPP bitumen radioactive waste storage facility and its reorganization into a repository;
- Services of preparation of the Maišiagala radioactive waste storage facility decommissioning Project description, other documentation necessary to obtain a decommissioning licence, and Maišiagala radioactive waste storage facility demolition Project.

A large H2020 project "Innovative water recovery solutions through recycling of heat, materials and water" (iWAYS) was selected for funding in 2020 under the call "Preserving fresh water: recycling industrial waters industry" (CE-SPIRE-07-2020).



- Cost of the Project: **EUR 10,596,775.**
- Contribution of the Nuclear Engineering Laboratory: **EUR 454,375**
- Participants: **19 organisations from 9 countries**

#### This is a circular economy project, which envisages:

- Installation of special heat exchangers in 3 plants to recover heat and useful materials from highly polluted flue gas / gas.
- Development of various technologies to be used for improving water quality (steam condensate and wastewater treatment) and reducing primary energy consumption.
- Development of technologies for the recovery of substances accumulated in technological processes in order to turn them into an end product to be sold on the market.

The Nuclear Engineering Laboratory will carry out research on condensation processes in prototypes of these innovative corrosion-resistant heat exchangers using the existing equipment as well as new equipment / devices purchased from the project funds.



## **KEY ACHIEVEMENTS OF THE LABORATORY FOR THE YEAR 2016-2020**

### **IMPLEMENTING THE IGNALINA NPP DECOMMISSIONING PROGRAMME FUNDED BY THE EUROPEAN UNION, THE FOLLOWING MAJOR PROJECTS WERE COMPLETED:**

- Safety assessment of spent nuclear fuel interim storage facility
- Safety assessment of new solid radioactive waste management and storage facilities
- Safety assessment of near surface repository for low and intermediate level short-lived radioactive waste

### **IMPLEMENTING EU DIRECTIVE 2011/70 EURATOM AND THE DEVELOPMENT PROGRAMME FOR RADIOACTIVE WASTE MANAGEMENT OF THE REPUBLIC OF LITHUANIA, RESEARCH HAS BEEN CARRIED OUT IN FIVE H2020 PROJECTS:**

PROJECTS	2017-2020	<b>THERAMIN</b>
	2017-2022	<b>BEACON</b>
	2019-2021	<b>SHARE</b>
	2019-2024	<b>EURAD</b>
	2020-2023	<b>INNO4GRAPH</b>



- Participants: **50 organisations from 21 EU countries and 2 countries that are not members of the EU**
- Cost of the Project: **EUR 59 922 246,61**

The Project aims to start activities of common interest between EU Member States. Joint Programming will complement National RD&D Programmes implementing geological repositories. Research priorities were identified in 2018 based on preparatory work of the recent EC JOPRAD (Towards a Joint Programming on Radioactive Waste Disposal) project. The Joint Programme will generate and manage knowledge to support EU Member States with their implementation of the Directive 2011/70/Euratom that establishes a Community framework for the responsible and safe management of spent nuclear fuel and radioactive waste. Scientists of Nuclear Engineering Laboratory participate in five research work packages and two strategic studies:

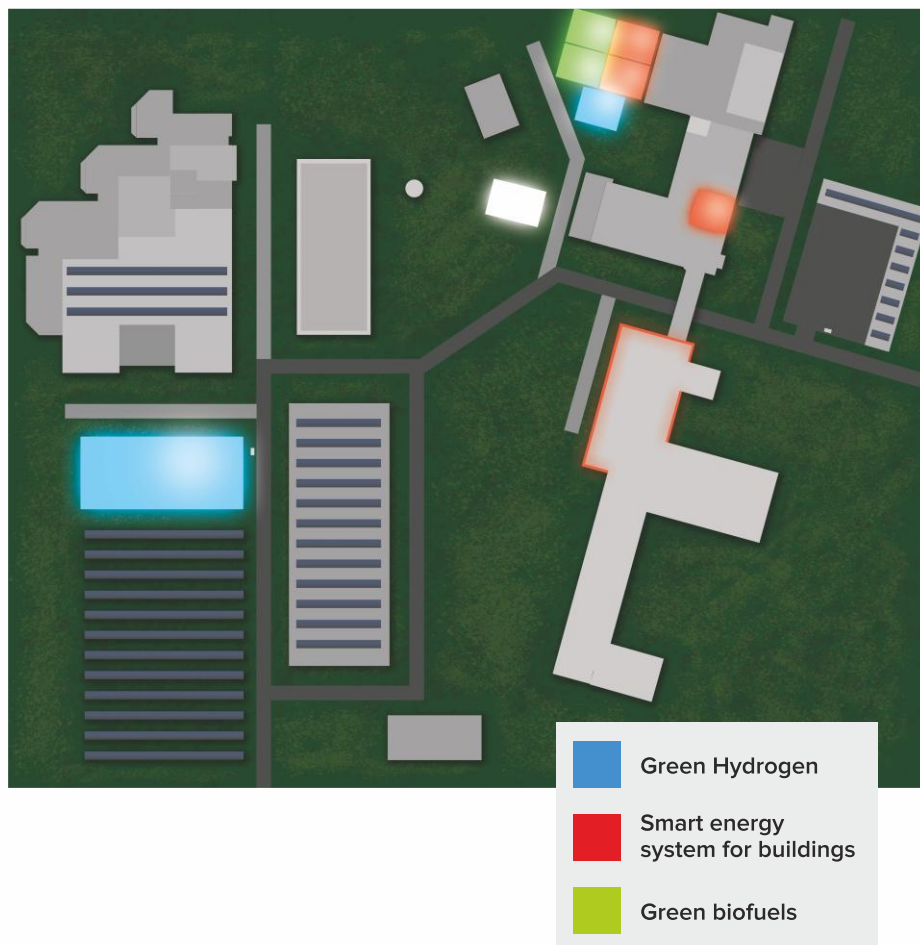
- WP2 Assessment of Chemical Evolution of ILW and HLW Disposal Cells (ACED)
- WP4 Development and Improvement Of NUmerical methods and Tools for modelling coupled processes (DONUT)
- WP6 Mechanistic understanding of gas transport in clay materials (GAS)
- WP7 Influence of temperature on clay-based material behaviour (HITEC)
- WP8 Spent Fuel Characterization and Evolution Until Disposal (SNF)
- WP9 Waste management routes in Europe from cradle to grave (ROUTES)
- WP10 Uncertainty Management multi-Actor Network (UMAN)

# LEI CAMPUS VISION – THE MODEL OF THE SMART GREEN TOWN

The Green town model is a model of an ecological establishment planned in the Campus of the Lithuanian Energy Institute. It covers and integrates systems for the supply of renewable energy for the modernized of buildings and green fuels for transport.

This infrastructure would be used for the development, integration and testing of green hydrogen production and use for transport and buildings as well as other energy storage technologies.

## INFRASTRUCTURE CONSISTS OF THREE INTEGRATED ENERGY ECOSYSTEMS:





# 1956 - 2021 – 65<sup>TH</sup> ANNIVERSARY OF THE LITHUANIAN ENERGY INSTITUTE

Lithuanian Energy Institute, internationally recognized energy-related research, development and innovation (R&D&I) competence center, today is among the top research institutions in Lithuania.

The history of the Lithuanian Energy Institute began in 1956, when LSSR Physics and Technology Institute was reorganized into separate institutes of Physics and Mathematics, Construction and Architecture, and Energy and Electrical Engineering.

In 1967 the institute was reorganized into LSSR Physical-Technical Energy Problems Institute (FTEPI).



1956 m.



1967 m.



2020 m.

The current name of the Institute was given in 1992 by the Government of the Republic of Lithuania, after Lithuania regained its independence.

## Illustration authorship attribution

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## **LITHUANIAN ENERGY INSTITUTE**

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