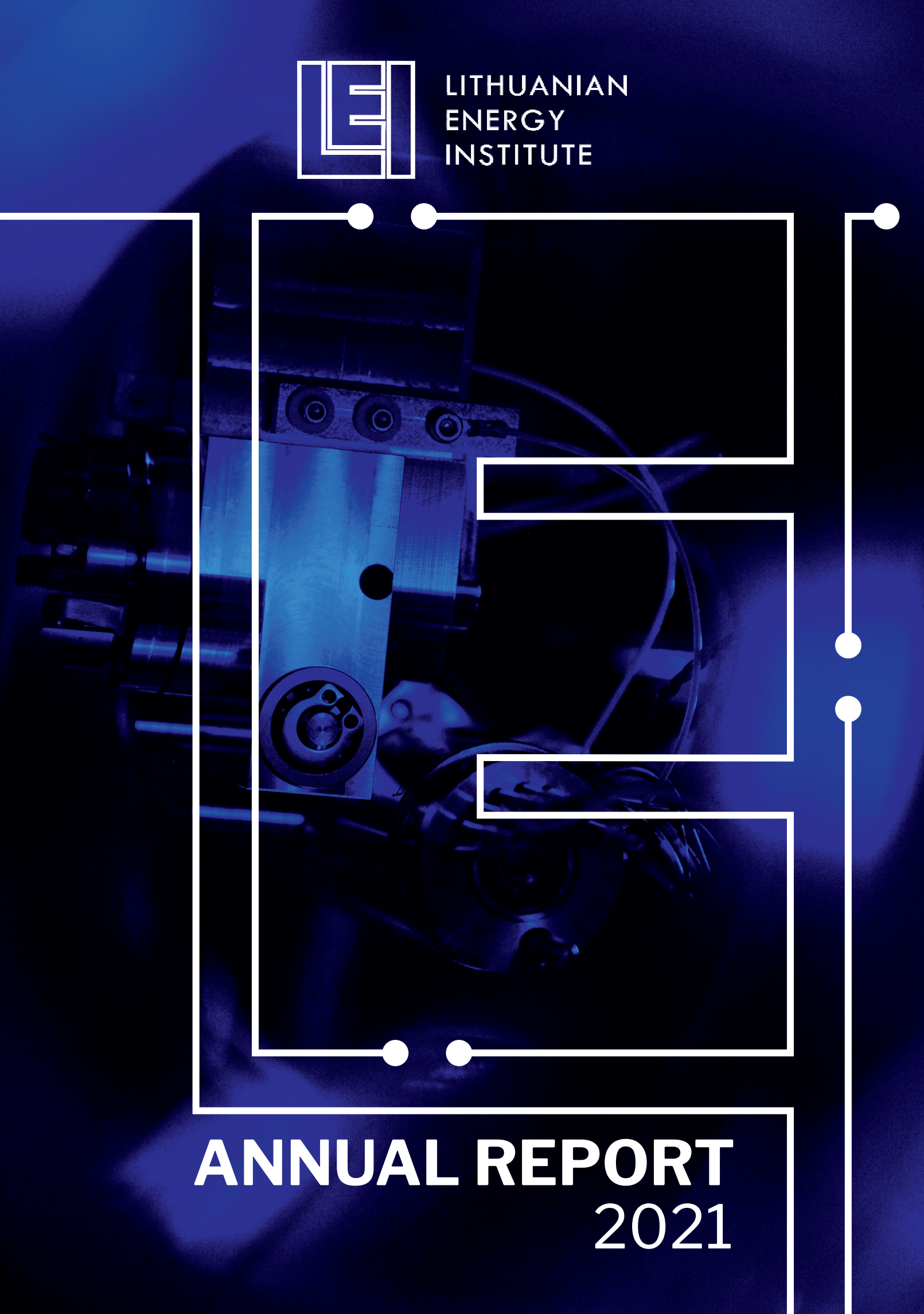
LITHUANIAN
ENERGY
INSTITUTE



ANNUAL REPORT
2021

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FOREWORD

MESSAGE FROM THE DIRECTOR

The year 2021 was full of important events and challenges. In October 2021, the Institute completed procedures for the reorganisation from a budget institution into a public institution. The new legal status has given the organisation greater flexibility in financial and asset management areas as well as wider opportunities for establishing start-ups and the development and use of the intellectual property.

The Institute is expanding collaboration with businesses and research institutions in both Lithuania and abroad. In 2021, LEI returned to the Lithuanian Confederation of Industrialists (LPK). This was not just a formality but the result of growing cooperation with LPK, in particular in the area of discussions on the vision of the LEI's demonstration pilot project on the Green Campus and hydrogen technologies as well as the presentation of the project to businesses and authorities. As regards cooperation with research institutions in Lithuania, I would like to point out LEI's collaboration with other institutes within the framework of RTO Lithuania (an association of non-university research and technology organisations), as well as with universities in the city of Kaunas (Kaunas University of Technology, Vytautas Magnus University and Lithuanian University of Health Sciences) within the framework of Santaka Valley. In both associations, joint projects are initiated and financed by own funds. This initiative is continued in 2022 as such projects provide an opportunity for building competencies by joining capacities of academic institutions and for preparing for the submission of competitive project proposals, both national and international. We have taken a further step in strengthening collaboration with foreign research institutions. In November, LEI was admitted to EARTO, the European Association of Research and Technology Organisations. Representing over 350 leading non-university research institutes and centres in Europe, membership in this association increases our opportunities for working in the space of international research.

A number of projects were continued or initiated under national and international research programmes in 2021. The Institute is among the three most successful Lithuanian institutions in terms of attracting funding for projects under Horizon 2020, an EU research and innovation programme. LEI is implementing, jointly with partners, 26 projects under this programme and acts in the capacity of a coordinator in three of these projects. The Institute intends to take an active part in the new EU research and innovation programme, Horizon Europe, approved for a new period (2021-2027). In 2021, LEI submitted 12 project proposals in response to calls under this programme; in two cases, LEI is a coordinator. One of the projects under the Horizon Europe programme is already underway: jointly with partners, we are implementing one of EU priority projects ***EUROfusion*** intended for research in the fusion energy area.

It is also worthy to mention the importance of attracting youth to LEI. In recent years we succeeded in increasing the number of PhD students and at present have 38 people pursuing doctoral studies at LEI. Still, attracting youth and doctoral students remains a challenge. Therefore, we are inviting young people to come to LEI for employment and doctoral studies.

In 2021, the Institute marked 65 years since its establishment. On this occasion, I express my gratitude to all current and previous employees, partners of the Institute and the authorities for their contribution to LEI's activities, achievements and discoveries. Our institute has a long and remarkable history, and its achievements are known all over the world.

Speaking about 2022, I would like to note that, along with research activities, we will focus on the implementation of projects on infrastructure development and improvement. A 500 kW solar plant will be installed in the LEI territory. Furthermore, energy efficiency and upgrading projects will be implemented in two buildings of the Institute to reduce energy consumption. We will also seek to upgrade and develop the research infrastructure so that it is suitable for the launching of demonstration pilot projects, which will further assist us in our participation in international research and development programmes.

Director of Lithuanian Energy Institute
SIGITAS RIMKEVIČIUS

CONTENTS

MISSION

To perform energy, thermal, measurement, material engineering and social sciences (energy economy) research; to create innovative technologies; to perform scientific 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 Economy.

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

OBJECTIVES OF THE INSTITUTE'S ACTIVITIES

- Develop international-level competencies in the fields of technological and social sciences; conduct long-term fundamental and applied R&D of international level that are required for sustainable development of Lithuania's energy system and other areas of Lithuania's economy as well as for their integration into the European energy systems and the European Research Area;
- In collaboration with business, governmental and public entities, transfer scientific knowledge and innovation to processes and installations that are beneficial technically and commercially to ensure advances in energy technologies, sustainable development of energy systems, security and reliability of energy supply, efficient use of energy resources, environmental protection and mitigation of climate change;
- Promote scientific knowledge in society, contribute to the development of the innovation and knowledge-based economy of Lithuania;
- Initiate and actively participate in projects of national and international programmes, broaden cooperation with academic institutions and scientists in both Lithuania and abroad;
- Perform functions of the designated organisation in accordance with the Republic of Lithuania Law on Metrology;
- Train, jointly with universities, scientists with the highest level of competencies in the fields of economics, energy, and environmental protection; attract PhD students and ensure their career development.

AREAS OF ACTIVITY OF THE INSTITUTE

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

LEI STRATEGIC R&D TOPICS

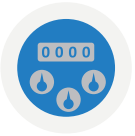
Energy and biofuels from biomass and waste; Research in development and upgrade of associated

Hydrogen energy and 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.



Measurement research related to the development and maintenance of national liquid and gas flow standards (etalons).

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

- Renewable energy and technologies enabling it;
- Environmental impact of climate change and anthropogenic activities;
- Economic development research towards climate-friendly economy;
- Modelling of energy systems and research of their control systems;
- Safety and reliability of industrial and energy facilities;
- Thermal physics, gas and fluid dynamics and metrology;
- Decommissioning of nuclear facilities and radioactive waste management.

LEI IN NUMBERS

220+	EMPLOYEES
130+	RESEARCHERS
35+	PhD STUDENTS
10	RESEARCH LABORATORIES
10+ mln. Eur	R&D INFRASTRUCTURE
8+ mln. Eur	ANNUAL INCOME
60+	ANNUAL R&D CONTRACTS

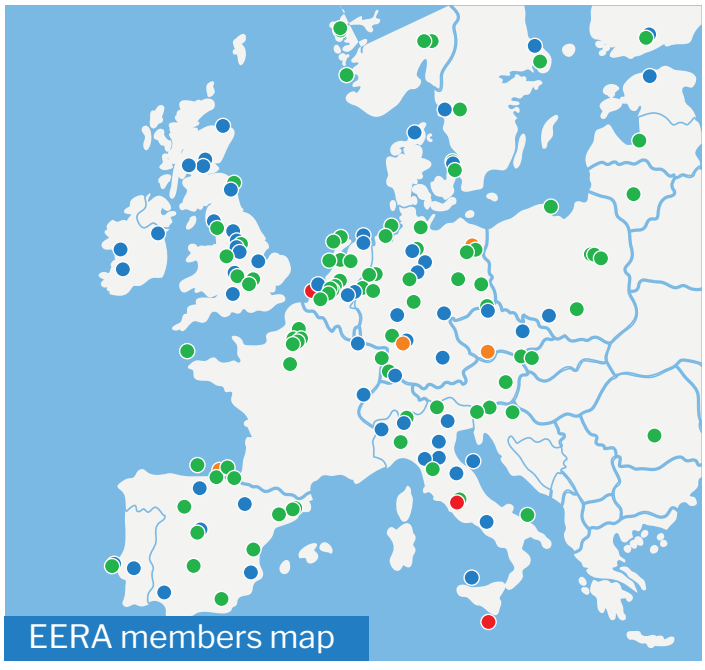
FINISHED LONG-TERM RESEARCH AND EXPERIMENTAL DEVELOPMENT PROGRAMMES (FOR THE PERIOD OF 2017 – 2021):

- 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

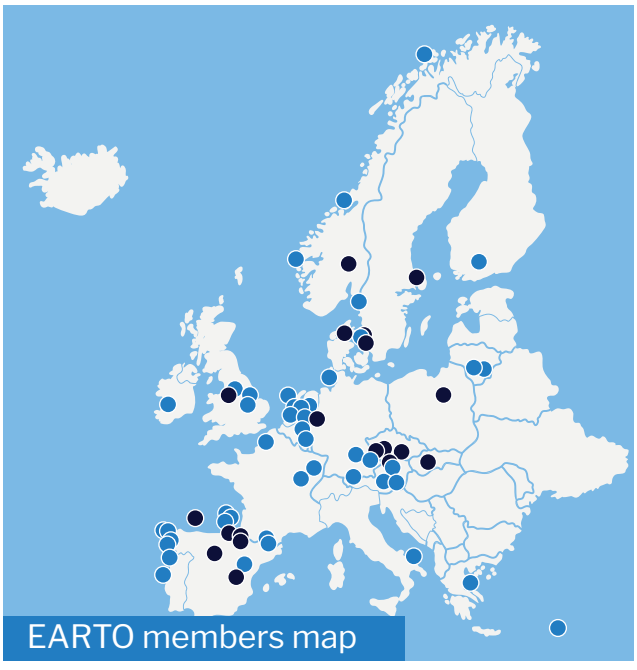
MEMBERSHIP IN INTERNATIONAL ORGANISATIONS

- European Association of Research and Technology Organisations (EARTO)
- European Energy Research Alliance (EERA)
- European Safety, Reliability & Data Association (ESReDA)
- European Network of Freshwater Research Organisations (EurAqua)
- The European Association of National Metrology Institutes (EURAMET)

- 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)



EERA members map



EARTO members map

MAIN LEI EVENTS

- LEI celebrated its 65th anniversary in **2021**.
- **On 24-28 May 2021**, annual international conference CYSENI was held. The range of its organisers was increased for the first time, including LEI, LAMMC, FTMC, and RTO.LT.
- **In June 2021**, a model under the title Hydrogen technologies in the **LEI Green Campus vision** was presented at the Green Ideas Festival curated by President of the Republic of Lithuania Gitanas Nausėda.
- **On 31 August 2021**, LEI was admitted to the Confederation of Lithuanian Industrialists as a non-associated member.
- **On 1 October 2021**, LEI's status was changed from an budget institution into a public institution.
- **On 24 November 2021**, LEI colleagues D. Milčius, M. Lelis and M. Urbonavičius were issued an EPO patent 'Method for synthesis of gamma-aluminium oxide using plasma – modified aluminium and water reaction'.
- **In November 2021**, LEI joined the European Association of Research and Technology Organisations (EARTO) representing over 350 leading non-university research institutes and centres in Europe.

ACHIEVEMENTS OF OUR EMPLOYEES

- **Dr. Algis Džiugys**, Senior Researcher at LEI's Laboratory of Heat-Equipment Research and Testing , was elected as a full member of the Lithuanian Academy of Sciences (Department of Technical Sciences – Energy);

- **Dr. Mantas Povilaitis**, Senior Researcher at LEI's Laboratory of Nuclear Installation Safety, was elected as a member of the Young Academy under the Lithuanian Academy of Sciences;

- **Noura Elsalamouny**, pursuing doctoral studies at LEI's Laboratory of Nuclear Installation Safety was ranked first for the **best team project** presented at a summer school 'Holistic Innovation: Integrating Methods, Experiments and People to Advance Nuclear Technology' organised by Argonne National Laboratory;

- **Dr. Darius Milčius,** Head of the Centre for Hydrogen Energy Technologies at LEI, received a Letter of Acknowledgement from the Government of Lithuania for his active involvement in the education of pupils of Lithuanian schools by preparing them for international competitions. Dr. D. Milčius assisted pupils in preparing for and participating in a EU Contest for Young Scientists (title of the project: 'Improving the functionality of fabrics used in medical masks through employment of metal/metal oxide nanoclusters').


LIETUVOS RESPUBLIKOS VYRIAUSYBĖ

PADĖKA

Gerbiamajam dr. Dariui Milčiui

Nuoširdžiai sveikinu ir dėkoju, kad savo žiniomis, gyvenimo išmintimi padėjote mokiniams siekti gražių pergalių. Dažnai mes nesugebame įvertinti tikrosios tokios pagalbos svarbos.

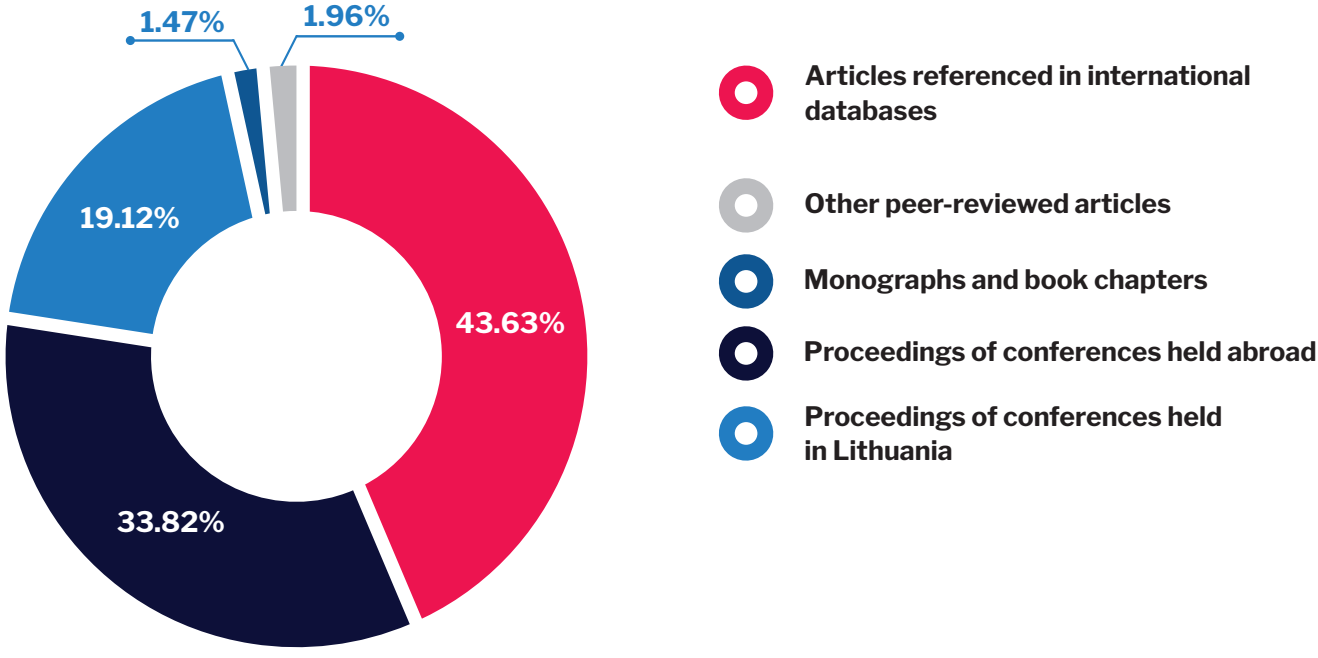
Džiaugiuosi, kad įkvėpėte jaunus žmones trokšti pažinti pasaulį, padėjote atskleisti talentus, mokėte kantrybės ir atkaklaus darbo. Linkiu neblėstančios stiprybės ir išminties, leidžiančios nesėkmes paversti kopėčiomis į ateities pergales.

Ministrė Pirmininkė
Ingrida Šimonytė

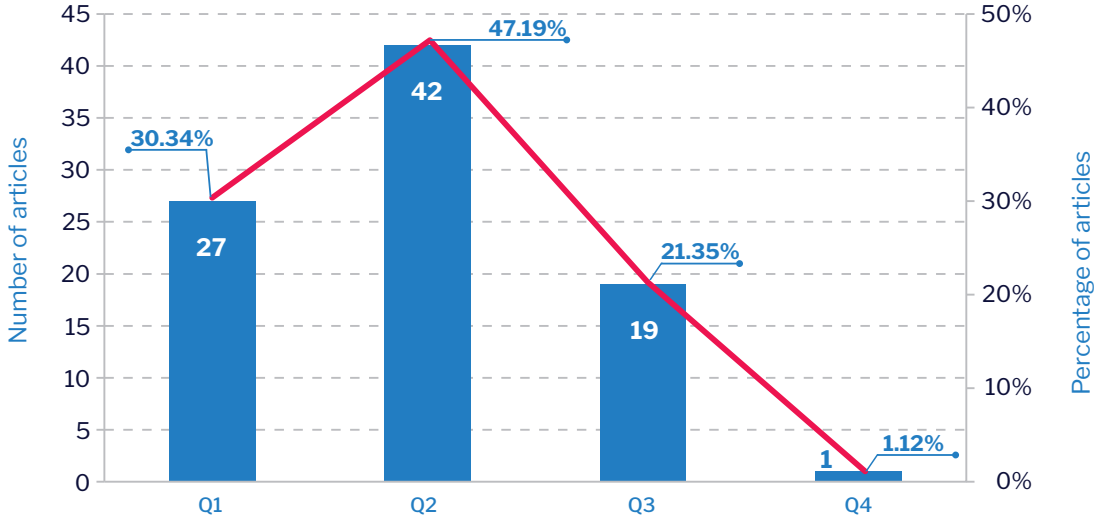
2021 m.

PUBLICATION OF RESEARCH RESULTS

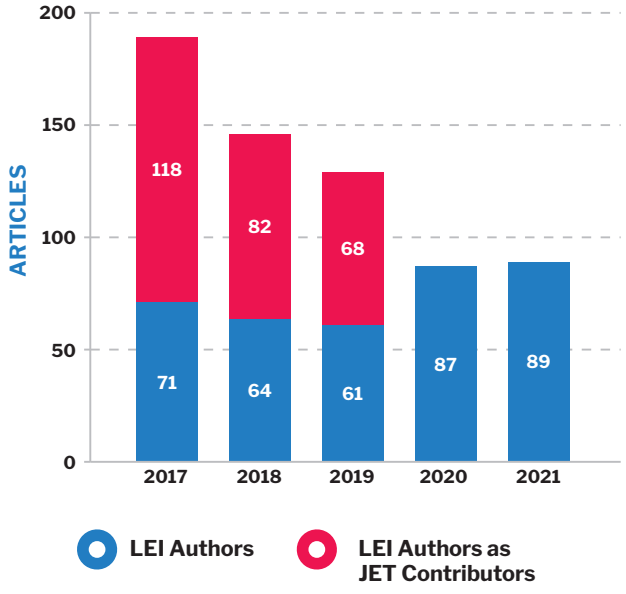
STRUCTURE OF PUBLICATIONS OF THE INSTITUTE IN 2021, PCS.



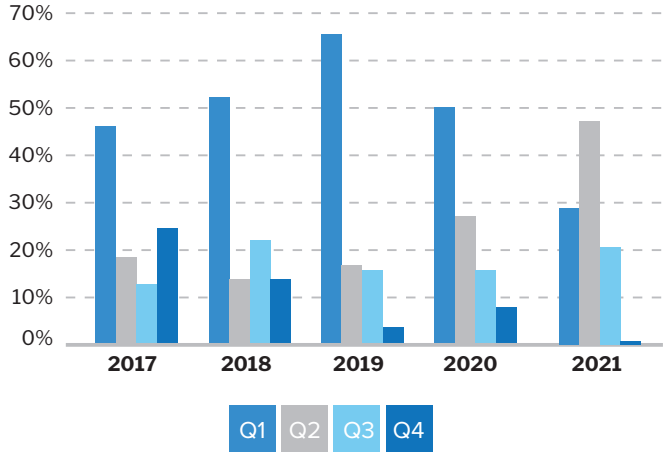
PUBLICATION OF RESEARCH RESULTS BY QUARTILES



Dynamics of articles referred in the Clarivate Analytics WoS database

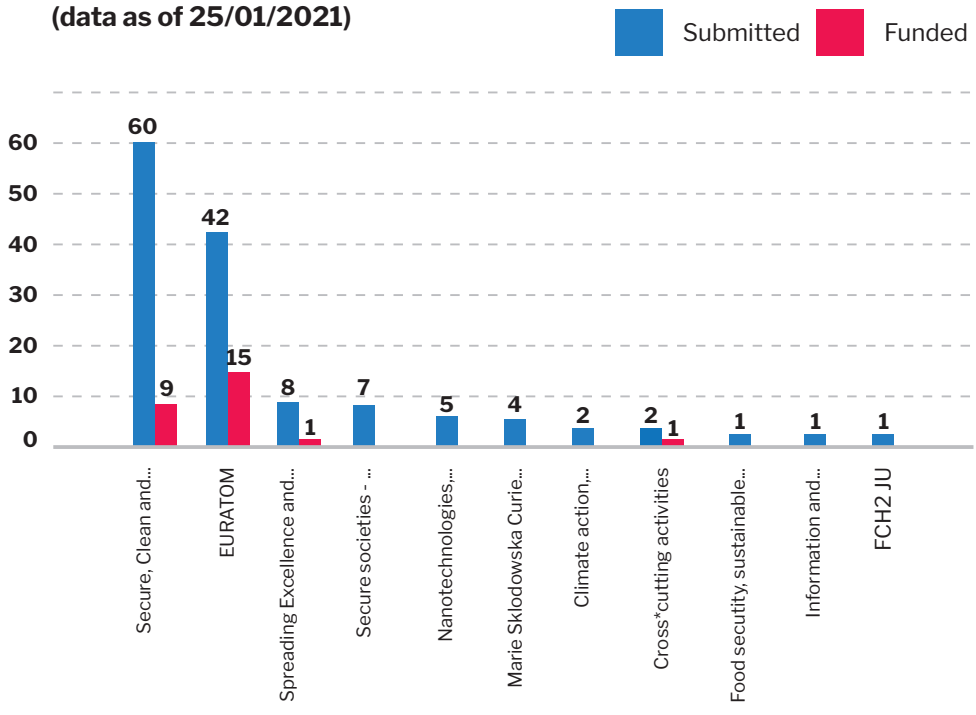


Dynamics of articles referred in the Clarivate Analytics WoS database by quartiles



Institute‘s H2020 success rates

(data as of 25/01/2021)



LEI PROJECTS

International programmes' projects implemented in 2021

Horizon Europe	1 project
Horizon 2020	14 projects
Nordic Energy Research Programme (NERP)	4 projects
Baltic Research Programme	2 projects
LIFE	1 project
INTERREG programme	3 projects
International Atomic Energy Agency (IAEA)	6 projects
COST programme	5 projects
International partnerships (EuropeAid)	2 projects
Other international projects	3 projects

Institute in International programmes (projects portfolio)

Horizon Europe	1 project
Horizon 2020	26 projects
7 Framework programme	24 projects
6 Framework programme	14 projects
5 Framework programme	11 projects
LIFE	1 project
Intelligent Energy Europe	31 projects
INTERREG programme	14 projects
Nordic Energy Research Programme (NERP)	6 projects
Baltic Research Programme	2 projects
International Atomic Energy Agency (IAEA)	19 projects
International partnerships (EuropeAid)	4 projects
COST programme	27 projects
EUREKA	4 projects

INTERNATIONAL PROJECTS STARTED IN 2021

Horizon Europe:

1. Implementation of activities described in the Roadmap to Fusion during Horizon Europe through a Joint Programme of the members of the EUROfusion consortium under Horizon Europe (EUROfusion)

Baltic Research Programme:

1. Innovation in concrete design for hazardous waste management applications (ICONDE)
2. Aluminum in circle economy – from waste through hydrogen energy to alumina (AliCE-Why)

LIFE programme:

1. Improving energy efficiency in Lithuania (LIFE IP EnerLIT)

Other international projects:

1. Understanding hygroscopic properties of wood through multiscale modelling (HYGRO-WOOD)

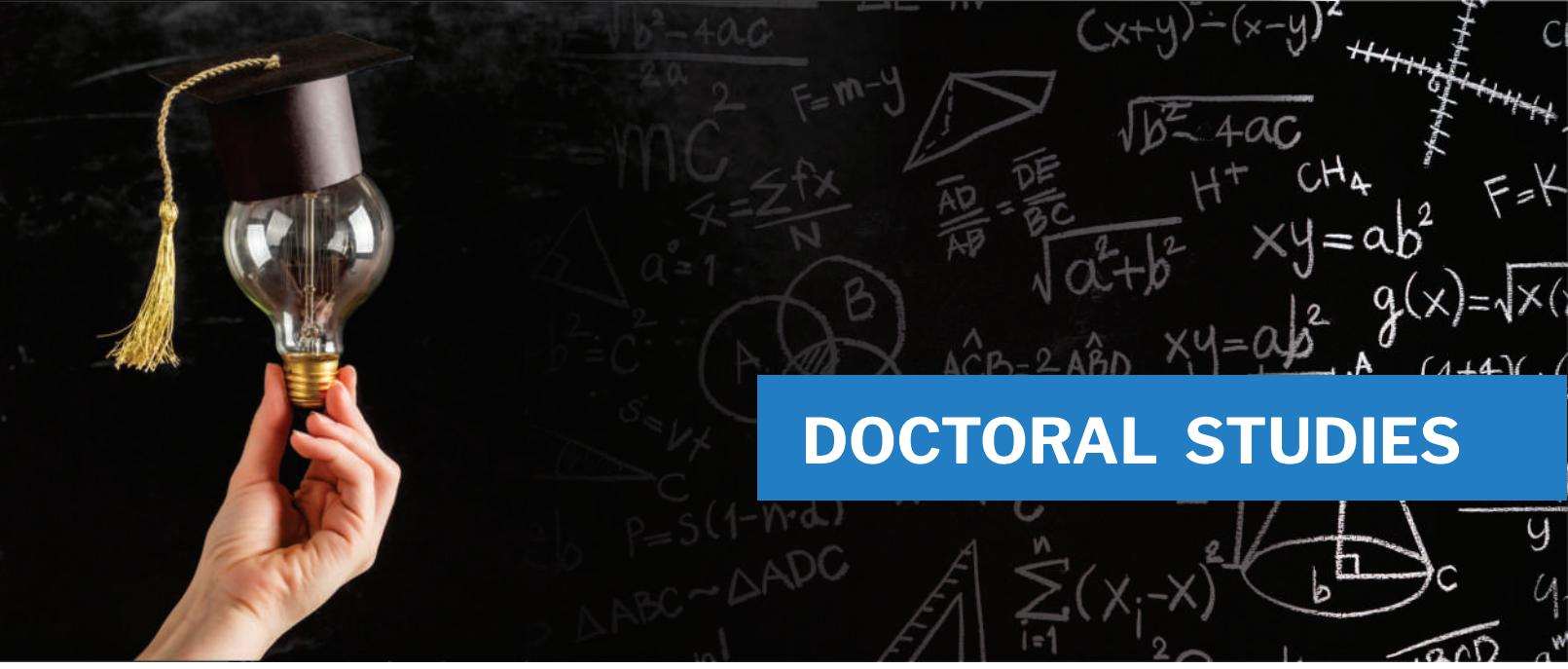
NATIONAL PROJECTS STARTED IN 2021

Research Council of Lithuania

1. Research group project "Particle and flow behavior in micro and nano structures" (group of young researchers)

Central Project Management Agency

1. Measure 01.2.2-CPVA-K-703 "Promotion of the Activities of Competence Centers and Innovation and Technology Transfer Centers" project "Promotion of Entrepreneurship Activities of the LEI Research, Experimental Development and Innovation Transfer Center (MTEPIPC)"



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.

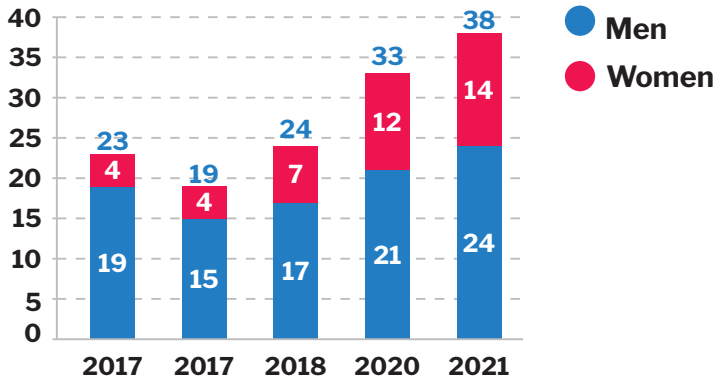
PhD STUDIES IN NUMBERS

During 1992-2021, 83 doctoral theses have been defended at the Lithuanian Energy Institute

In 2021, 7 doctoral students have been admitted

By the end of 2021, 38 doctoral students have been carrying out their studies

PhD STUDENTS DYNAMICS



Doctoral theses defended in 2021

POVILAS MAČIULIS

Thesis - "Assessment of the measures promoting the use of renewable energy sources in the transport sector" (Economics). Scientific Supervisor - Dr. Inga Konstantinavičiūtė.

ADOLFAS JANČIAUSKAS

Thesis - "Reduction of nitrogen and sulfur compound emissions in biofuel boilers using combined methods" (Energetics and Power Engineering). Scientific Supervisor - Dr. Kęstutis Buinevičius.

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.

Novelty in 2021 – LAMMC and FTMC, LEI's partners in RTO Lithuania association, were included in the conference organisers team in 2021. In cooperation with MDPI publishing house, selected conference presentations were published in a special edition of Energies journal referred to in Clarivate Analytics WoS database.

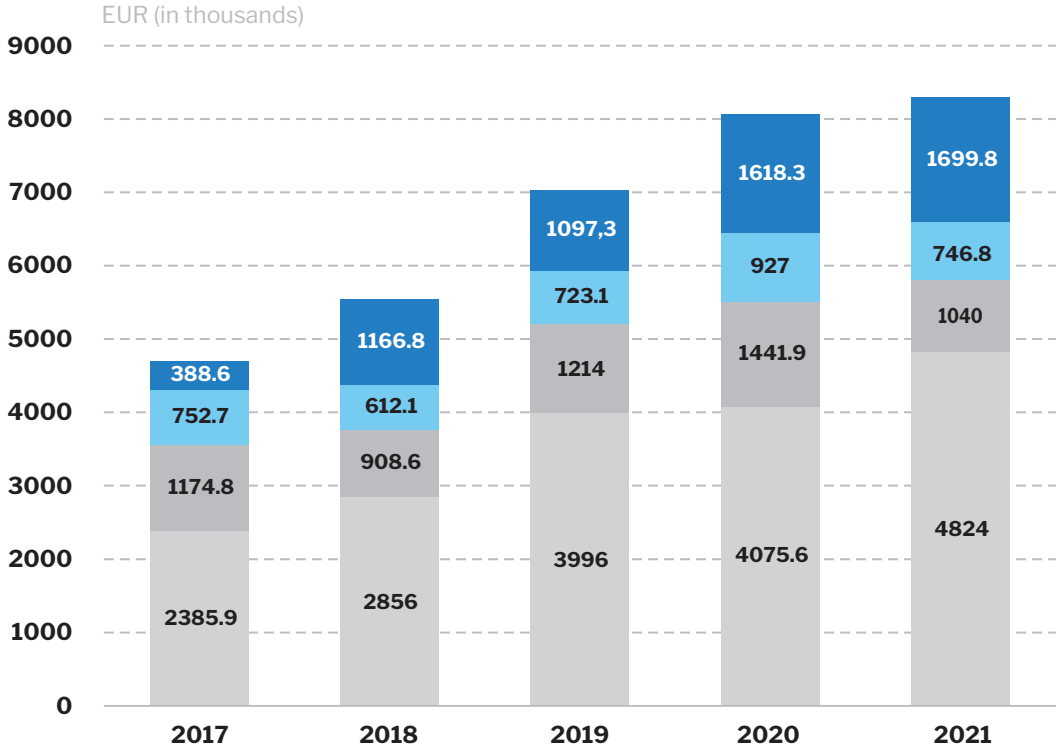
Participation in the Conference is free of charge

More information at
www.cyseni.com

FINANCIAL ACTIVITY RESULTS

FINANCIAL DYNAMICS 2017-2021

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 75 % in the last five years.



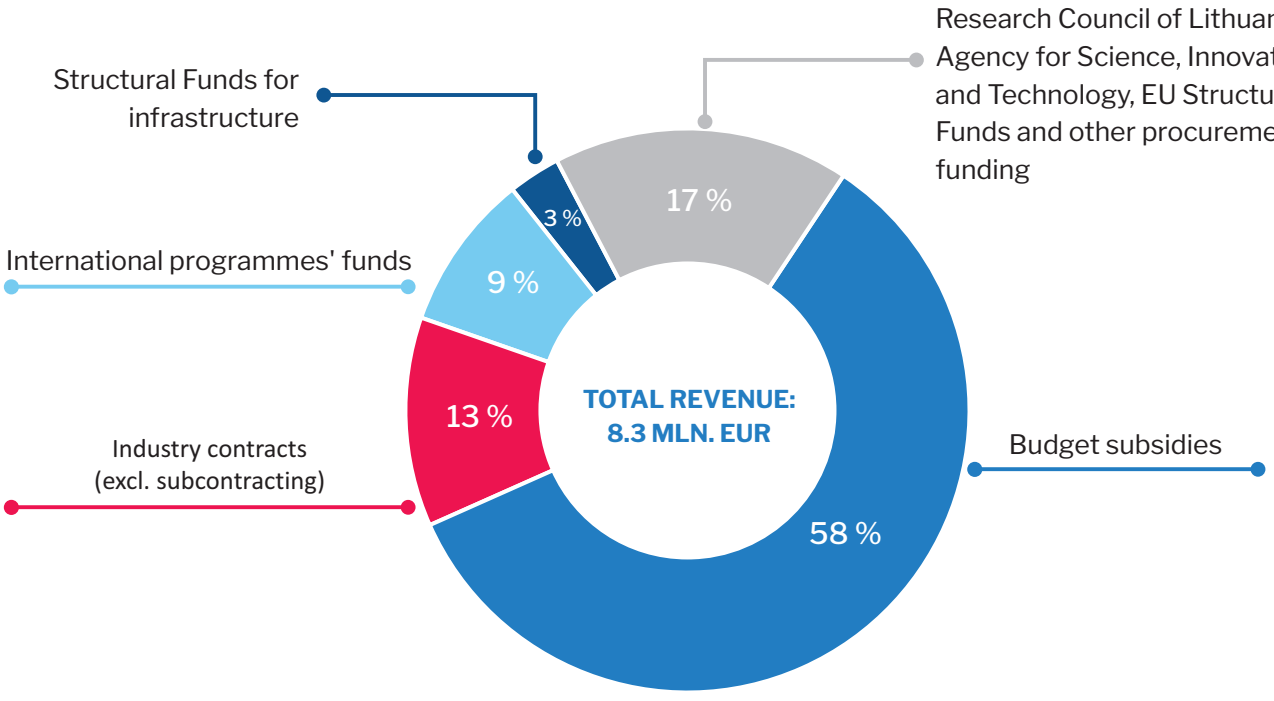
Budget subsidies – funding from the budget of the Republic of Lithuania according to the achieved results.

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, LIFE).

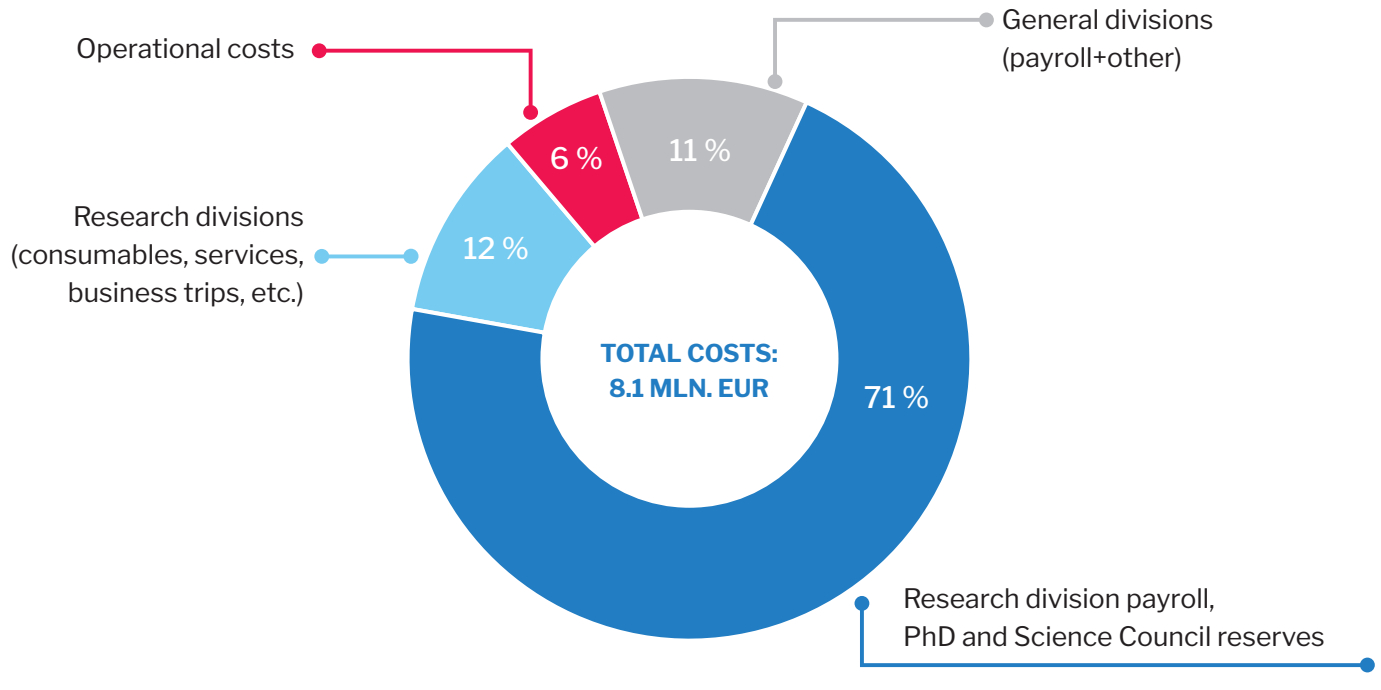
Research Council of Lithuania, Agency for Science, Innovation and Technology, EU Structural Funds and other procurement funding – the funds received for the projects financed by state institutions.

REVENUE STRUCTURE IN 2021



DISTRIBUTION OF COSTS IN 2021

Research divisions account for about 83% of all costs and some indirect ones (e.g. operational costs).



COLABORATION WITH BUSINESSES

PARTICIPATION IN THE NETWORKS OF LITHUANIAN INDUSTRIAL ORGANISATIONS

Lithuanian Energy Institute is a member of:

- Lithuanian Confederation of Industrialists (LPK),
- 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.

RTO
LITHUANIA

In 2021 three interinstitutional FTMC-LAMMC-LEI projects were implemented:

- Development of biodegradable biofuel cells (BioDegra), coordinated by Arūnas Ramanavičius (FTMC), dr. Žilvinas Kryževičius (LAMMC) and Nerijus Striūgas (LEI).
- New extraction approaches of valuables compounds from algae grown in integrated multitrophic aquaculture (ExtraIMTA), coordinated by Arūnas Stirkė (FTMC), Eugenija Bakšienė (LAMMC) and Liutauras Marcinauskas (LEI).
- Plant nutrients recovery using secondary raw materials (NUTREC), coordinated by Karolina Barčauskaitė (LAMMC), Marius Urbonavičius (LEI) and Ilja Ignatjev (FTMC).

LITHUANIAN ENERGY INSTITUTE
CENTER FOR PHYSICAL SCIENCES AND TECHNOLOGY
LAMMC LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

In 2021 two interinstitutional SANTAKA VALLEY projects were implemented:

- LEI-KTU-VMU: Model of Recovery and Sustainability of Energy Resources from Landfills (ISLAND), coordinated by Gintaras Denafas (LEI), Jolita Kruopienė (KTU) and Algirdas Jasinskas (VMU).
- LEI-KTU: Assessment of the possibilities of sustainable modernization and energy supply of the quarter using the digital twin (E-modernization), coordinated by Darius Milčius (LEI) and Vytautas Bocullo (KTU).

ktu 1922 kaunas university of technology
VYTAUTAS MAGNUS UNIVERSITY MCMXXII
LITHUANIAN ENERGY INSTITUTE

OBJECTIVES AND TASKS OF LEI. PERFORMANCE EVALUATION CRITERIA

The strategic objectives of LEI activities are as follows:

- Conduct both fundamental and applied research and development work at the international level;
- Train specialists of the highest qualifications for the development of research in the energy field.

For the attainment of these objectives, two tasks for continued activities have been set. The tasks and measures planned under them are as follows:

1. Create high level knowledge that increases the country's competitiveness.

Measure 1.1 – Conduct R&D in the areas of energy, thermal engineering, environmental engineering, and energy economy;

2. Increase the efficiency of doctoral studies.

Measure 2.1 – Ensure preparation and completion of doctoral theses.

LEI has implemented a Quality and Environmental Management System that meets the requirements of the international standards ISO 9001:2015 and ISO 14001:2015. A key performance indicator's (KPI) system is used for monitoring progress in the attainment of the LEI's objectives and tasks and for controlling the efficiency of activities. The system comprises key indicators focussed on the final result and included in LEI's Strategic Plan of Activities (SVP), as well as additional indicators the monitoring of which contributes to the improvement in activity planning and a smoother process of attainment of the objectives, tasks and key indicators. The indicators are focused on the development of the international dimension, creating new scientific knowledge, commercialisation of research results, and attracting new talented researchers to the Institute. The application of the KPIs covers all research divisions of LEI, and they are planned and monitored according to the Institute's Quality Management System.

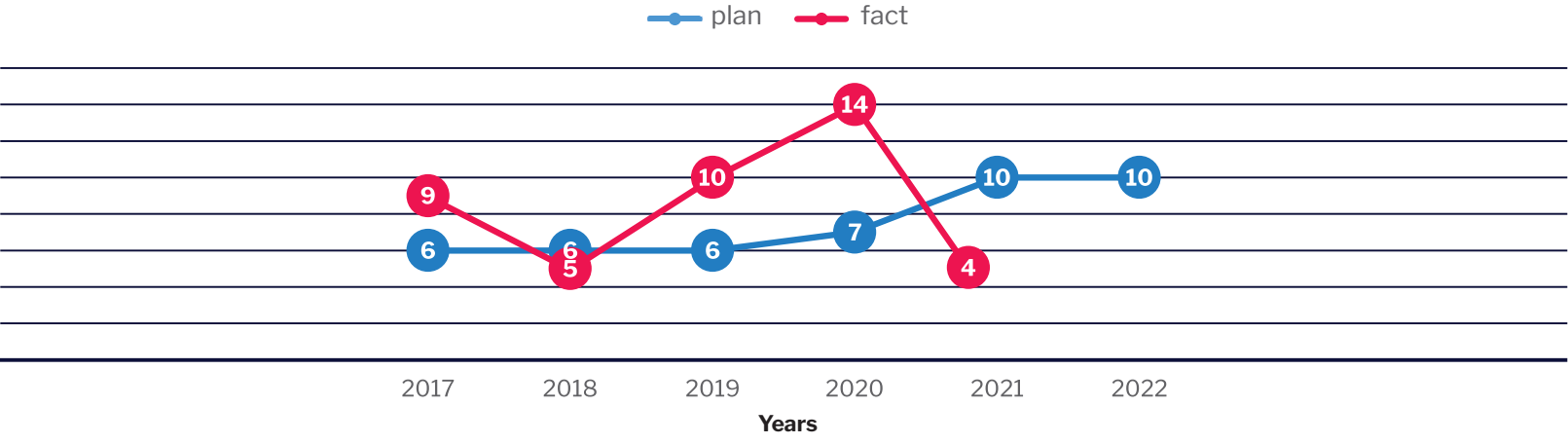
LEI tasks, measures and key performance indicators for 2017-2022

(SVP indicators – on blue background)

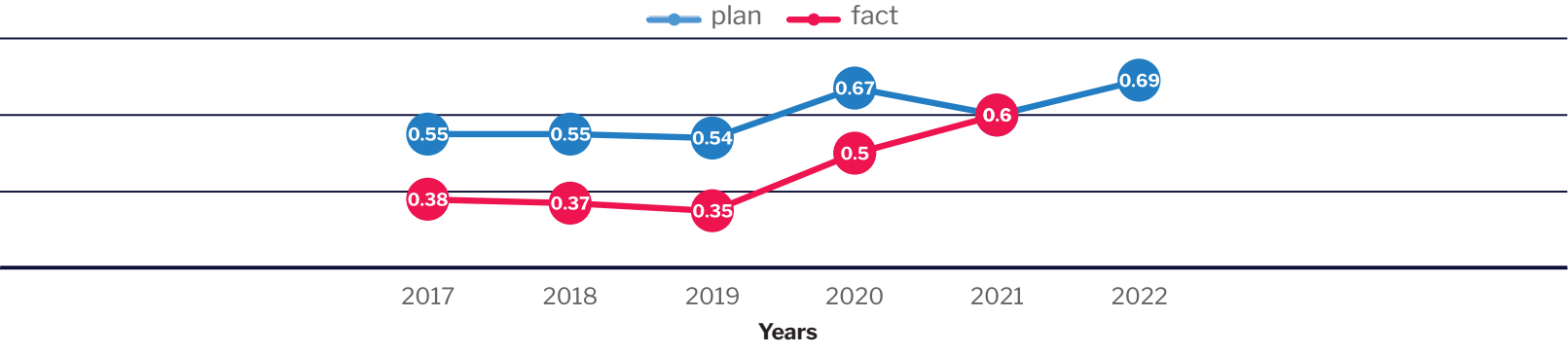
LEI tasks & measures	Key performance indicators (KPI)	2017	2018	2019	2020	*2021 target*	2021	*2022 target*
Task 1. Create high level scientific knowledge that increases the country's competitiveness.	New projects under international research programmes launched in the current year, number	16	8	10	11	*10*	4	*10*
	Additional indicator: Number of project proposals submitted to international research programmes	23	38	25	31	*17*	23	*20*
Measure 1.1 – Conduct R&D in the areas of energy, thermal engineering, environmental engineering,	Number of articles in journals referred to in Clarivate Analytics WoS list (IF>0.25 AIF) per scientist	0.38	0.37	0.35	0.5	*0.60*	0.60	*0.69*
	% share of articles in journals referred to in Clarivate Analytics WoS, in quartiles Q1 and Q2 (from 2019)			79.7	79	*75*	77.5	*70*
	Additional indicators:							
	Number of articles submitted to journals referred to in Clarivate Analytics WoS list (IF>0.25 AIF) per scientist	0.61	0.52	0.74	0.65	*0.73*	0.93	*1.02*
	Number of scores assigned to articles in journals referred to in Clarivate Analytics WoS list (IF>0.25 AIF) per scientist (from 2018)		3.5	3.76	4.92	*4.4*	5.23	*4.45*
	Number of publications co-authored with foreign scientists	40	53	106	35	*23*	35	*23*
	Funds from contracts, EUR '000	2290	2687	2830	3843	*2405*	2920	*2285*
	Funds for the improvement of research infrastructure, EUR '000	118	102	129	210	*113*	251	*142*
	Number of papers at international scientific conferences, per scientist	0.71	0.63	0.72	0.31	*0.5*	0.76	*0.53*
Task 2: Increase the efficiency of PhD studies	Successful completion of PhD studies, %	33	67	44	57	*60*	33	*60*
Measure 2.1: Ensure preparation and completion of PhD theses	Number of PhD students	23	19	24	33	*32*	38	*34*
	Number of PhD theses defended during the year	1	4	4	4	*1*	1	*2*
	Additional indicator: Number of PhD students admitted	4	5	10	12	*13*	7	*11*

Selected LEI planned and achieved key performance indicators for 2017–2022

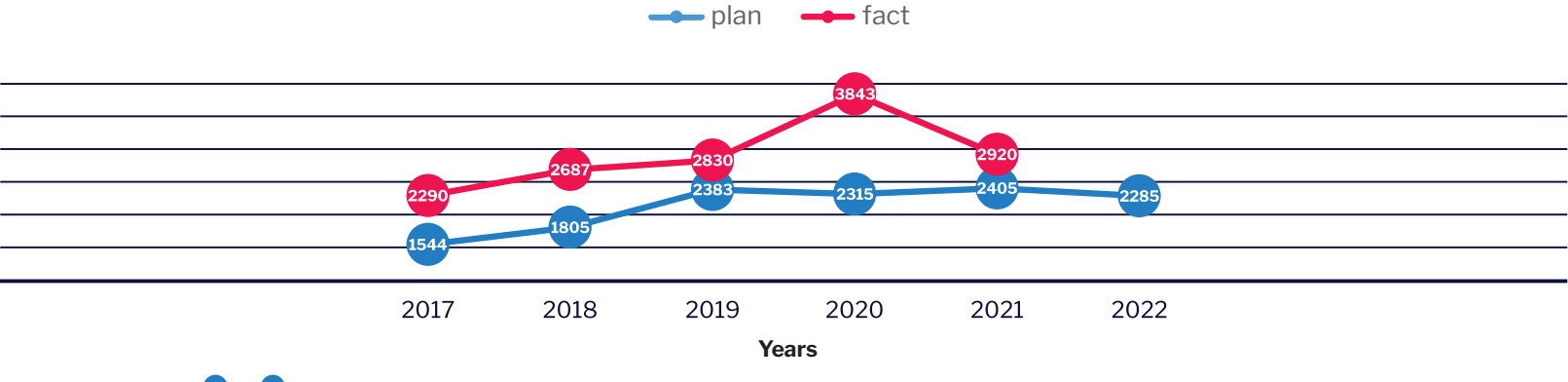
New projects under International research programmes



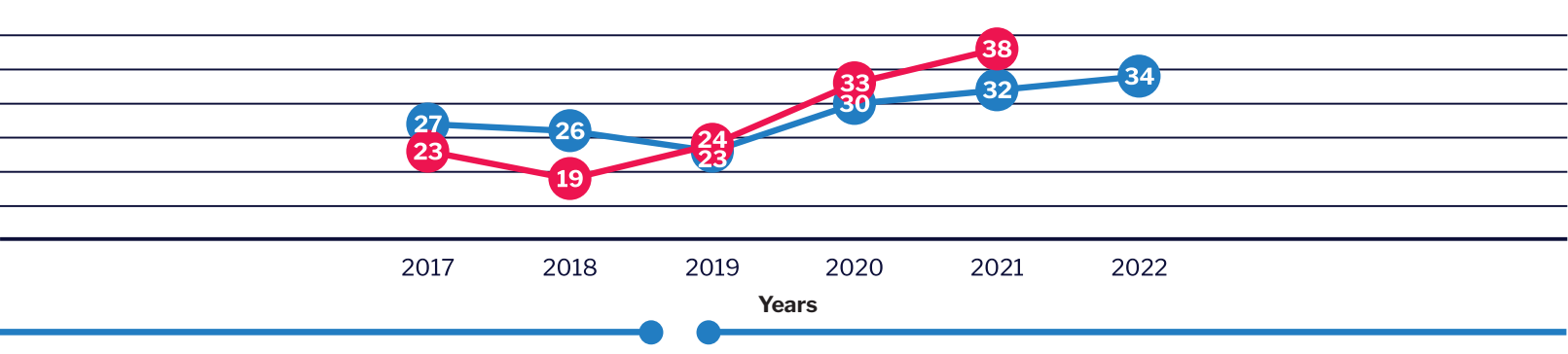
Number of articles in journals referred in Clarivate Analytics WoS list (IF>0.25 AIF) per scientist



Contracts, thous. EUR



Number of PhD students



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

h2

HYDROGEN RESEARCH AND NANOTECHNOLOGIES

CENTER FOR HYDROGEN ENERGY TECHNOLOGIES

MAIN RESEARCH AREAS OF THE CENTER

- Research in the field of hydrogen energy technologies.
- Synthesis of hydrogen separation membranes and analysis of their properties.
- Hydrogen production using water reactions with metals and nanoparticles of their alloys.
- Synthesis of metals and their alloy hydrides designed for hydrogen storage: analysis of their properties.
- Synthesis of hydrogen fuel cell components (anodes/electrolytes/cathodes) applying physical vapour deposition methods.
- Analysis of battery material properties.
- Synthesis and analysis of photocatalytic materials.
- Application of physical vapor deposition methods for thin films formation and surface modification.
- Surface modification of various materials by application of glow discharge plasma.

COMPLETED PROJECT “INVESTIGATION OF THE APPLICATION OF TiO_2 AND ZNO FOR THE VISIBLE LIGHT ASSISTED PHOTOCATALYTICAL DISINFECTION OF THE BIOLOGICALLY CONTAMINATED WATER, 09.3.3-LMT-K-712-01-0175"

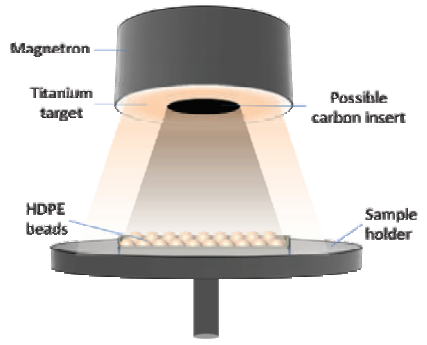
- One of the project “Investigation of the application of TiO_2 and ZnO for the visible light assisted photocatalytical disinfection of the biologically contaminated water, 09.3.3-LMT-K-712-01-0175" activities was the formation of photocatalytical active (TiO_2-based and ZnO-based) thin films on floating substrate, which would be capable to decompose various pollutants from wastewater under day-light irradiation. Several types of films were deposited using magnetron sputtering technique: a) anatase-phase TiO_2 films; b) carbon-doped TiO_2 films; c) carbon-doped TiO_2 films with metallic underlayers; d) ZnO-based films with or without metallic underlayers. The films were deposited onto high-density polyethylene (HDPE) beads, which can be successfully applied as substrate for floating photocatalysts.

- The obtained results revealed: a) the application of floating photocatalysts for wastewater disinfection is a promising technology in the terms of efficiency of various pollutants decomposition as well as their durability; b) anatase-phase TiO_2 films were successfully applied for methylene blue (MB) and Salmonella Typhimurium bacteria decomposition in a cycling experiments with UV-B light irradiation; c) carbon impurities(i.e. carbon-doped TiO_2 film) creates favourable conditions for higher photocatalytical activity and during the photocatalysis process can affect the higher permeability of bacterial membranes (this leads to more efficient bacterial decomposition) ; d) The efficiency of carbon-doped TiO_2 films using metallic underlayers was investigated using UV-B and daylight irradiation. In both cases, high efficiency of bacterial decomposition was achieved in cycling experiments; e) exceptional results were obtained using ZnO-based films with metallic underlayers, where the effectiveness of these coatings was tested using mixtures of bacteria (Salmonella Typhimurium and Micrococcus luteus) and bacteriophages (PRD1 and T4). Results showed high photocatalytical efficiency by decomposing microorganisms using day-light irradiation, which is exclusive and favourable results in this field.

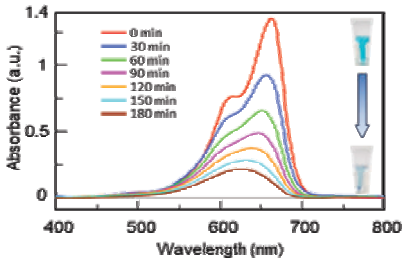
- These wastewater disinfection results using floating photocatalysts (TiO_2-based and ZnO-based) formed on high density polyethylene grains and activated by UV-B or day-light irradiation have been successfully published in four scientific publications.
https://doi.org/10.3390/catal11070794
https://doi.org/10.3390/ma14195681
https://doi.org/10.3390/catal11121454
https://doi.org/10.3390/ma15041318

One of the project activities was the formation of photocatalytical active (TiO_2-based and ZnO-based) thin films on floating substrate, which would be capable to decompose various pollutants from wastewater under day-light irradiation.

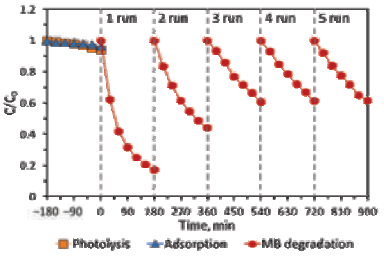
Formation of floating TiO_2 photocatalyst



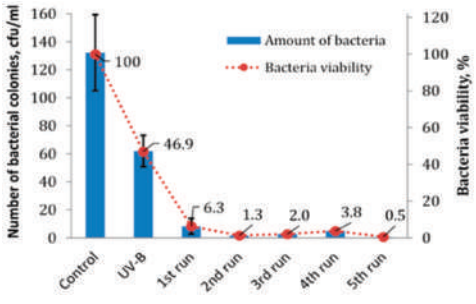
Absorbance spectra indicating the photocatalytic degradation of MB dye using HDPE-TiO_2 under UV-B irradiation



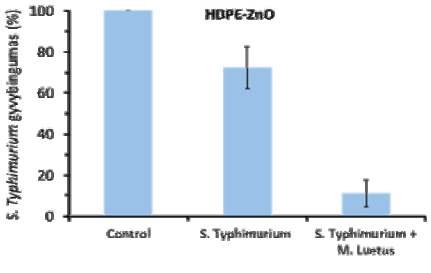
Effect of HDPE-TiO_2 on the photocatalytic degradation of MB dyes under UV-B irradiation



Bacterial viability results of cycling test using HDPE-TiO_2 photocatalyst under UV-B irradiation



Photocatalytic inactivation of bacteria mixture using HDPE-ZnO photocatalyst under visible-light irradiation



ENERGY SECTOR DEVELOPMENT ANALYSIS

LABORATORY OF ENERGY SYSTEMS RESEARCH

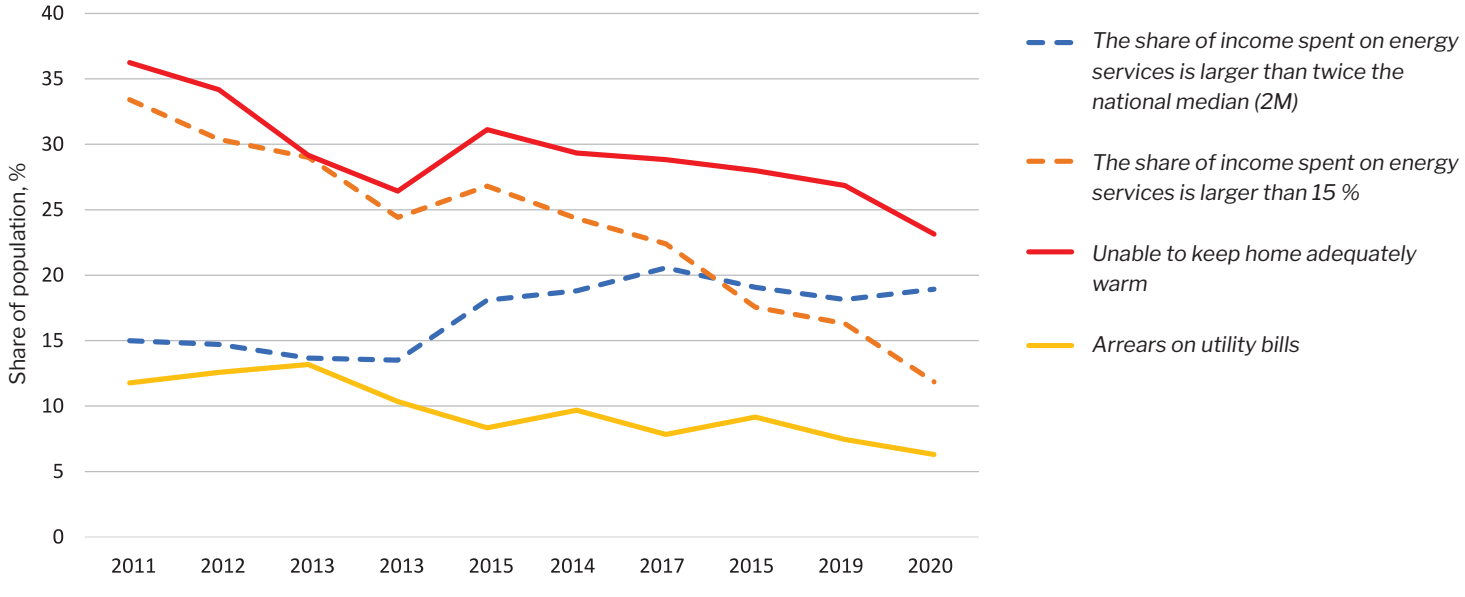
MAIN RESEARCH AREAS OF THE LABORATORY

- 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.

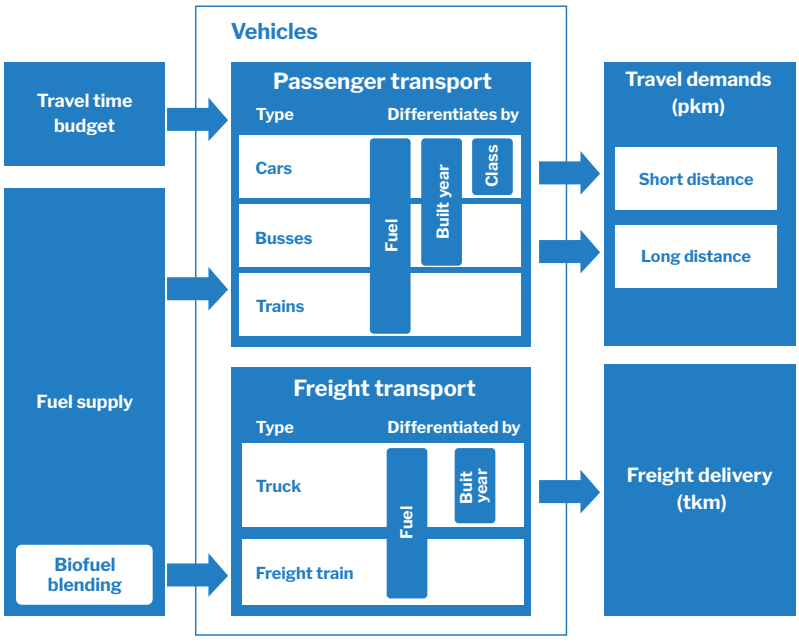
ON-DEMAND RESEARCH PROJECT "HOUSEHOLDS IN THE CONTEXT OF THE ENERGY TRANSITION" HAS BEEN COMPLETED

- *A framework for energy poverty monitoring and policy assessment has been created.*
- *The practical tool ENSPA for calculating energy poverty indicators and analysis of energy policy measures in households has been developed.*
- *Recommendations regarding energy poverty monitoring improvements and social aspects in energy policy measures have been prepared.*

Lithuanian energy poverty indicators in 2011-2020

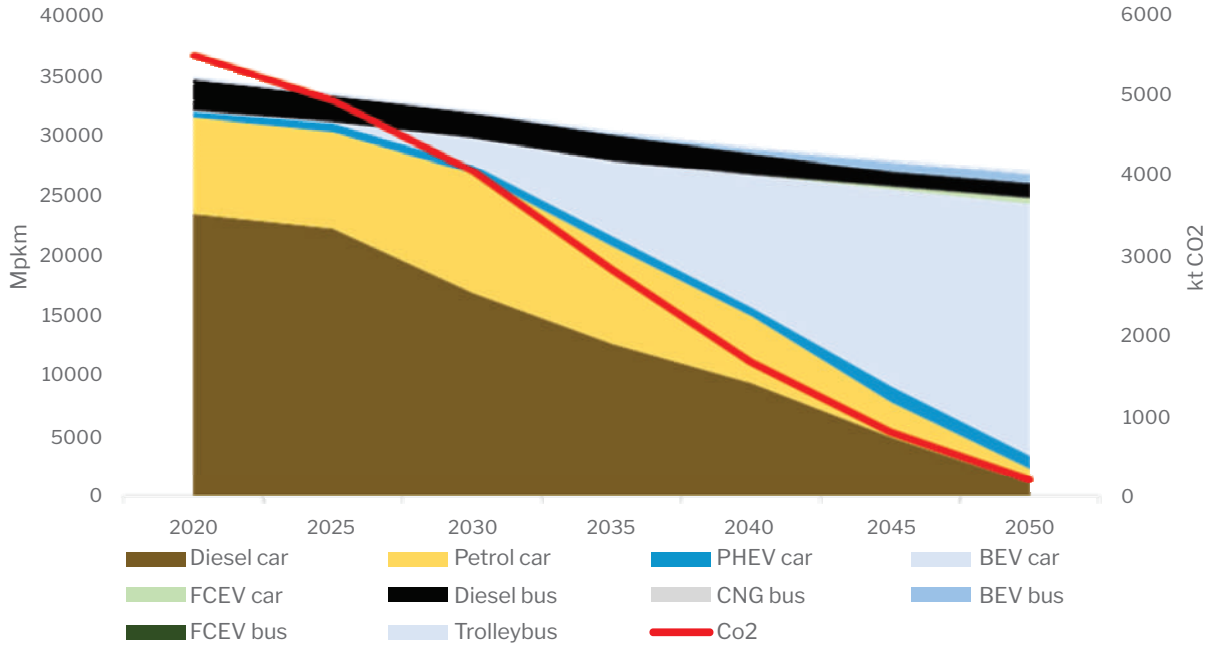


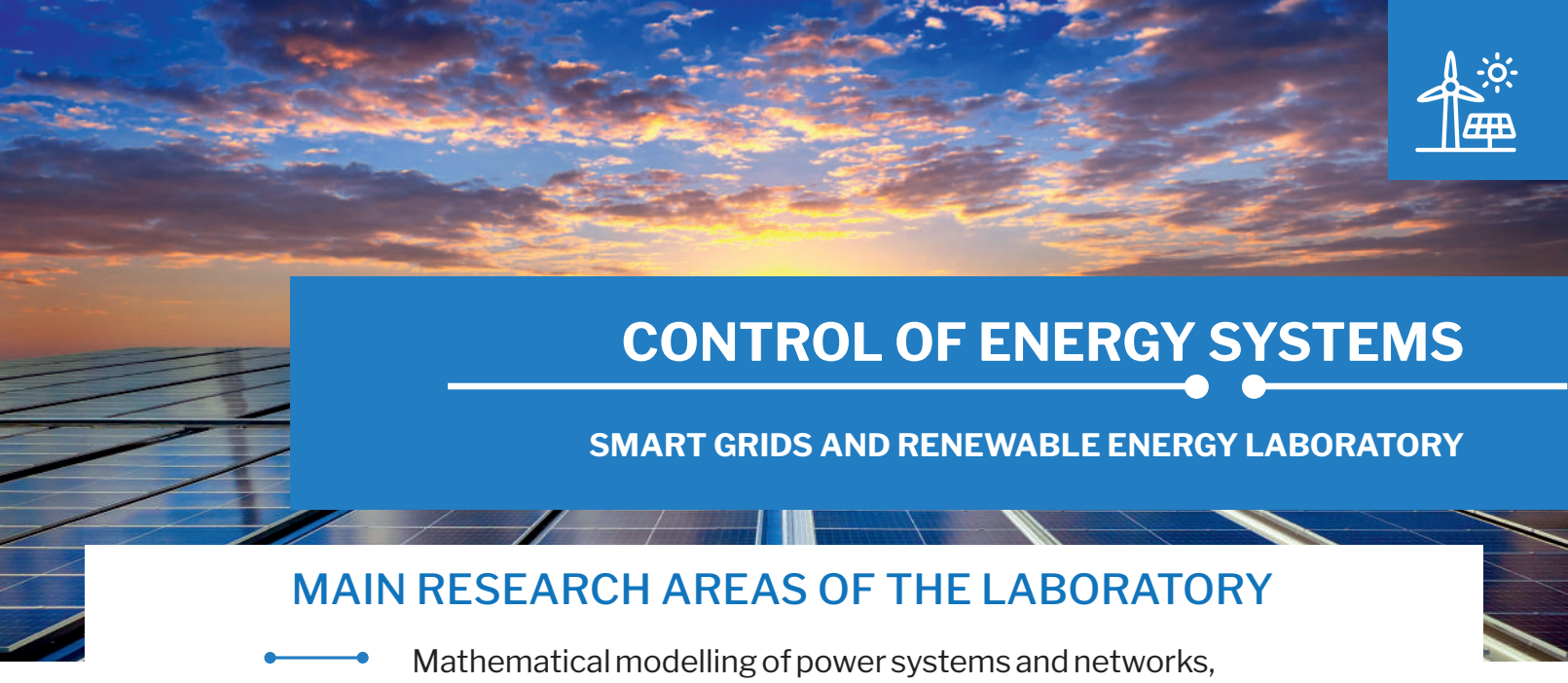
LITHUANIAN TRANSPORT DECARBONIZATION ANALYSIS WAS CARRIED OUT in order to determine how transport sector should develop in order to ensure emission reduction targets at the lowest costs.



- *A model was developed within the MESSAGE modelling suite, which is based on minimization of total discounted costs*
- *A unique methodology was developed to account for vehicle age distributions*
- *The model is adapted for the integration with the power sector model to perform integrated development analysis*

Lithuanian road transport CO_2 emissions and travel volumes by fuel in 2020-2050





CONTROL OF ENERGY SYSTEMS

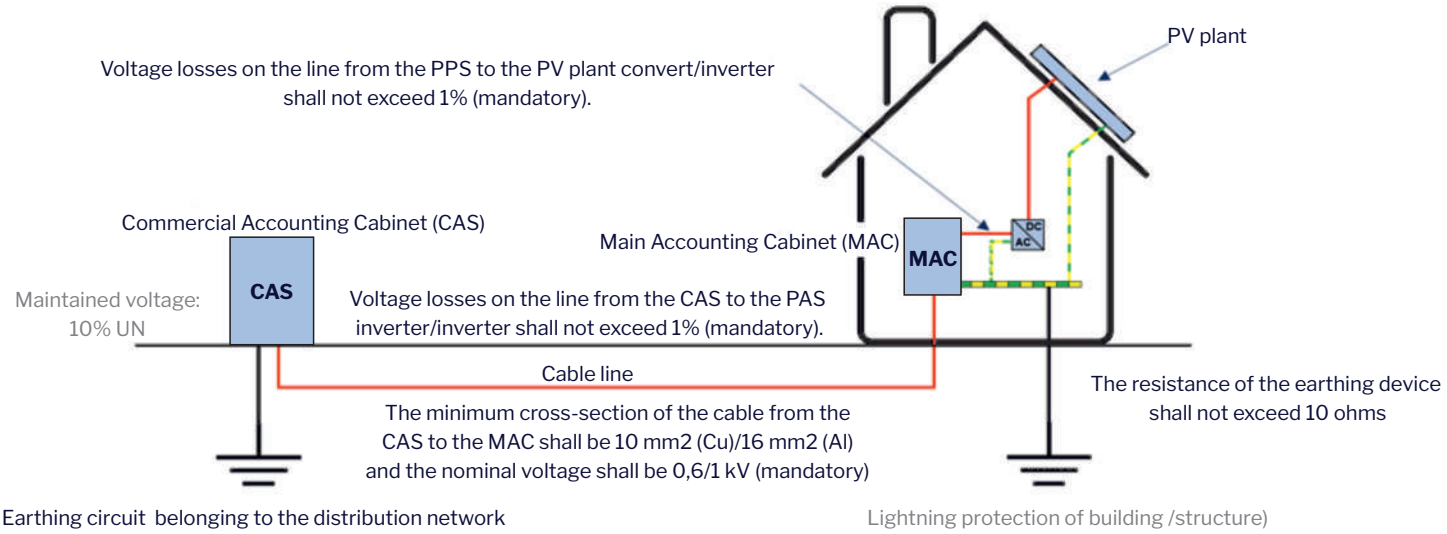
SMART GRIDS AND RENEWABLE ENERGY LABORATORY

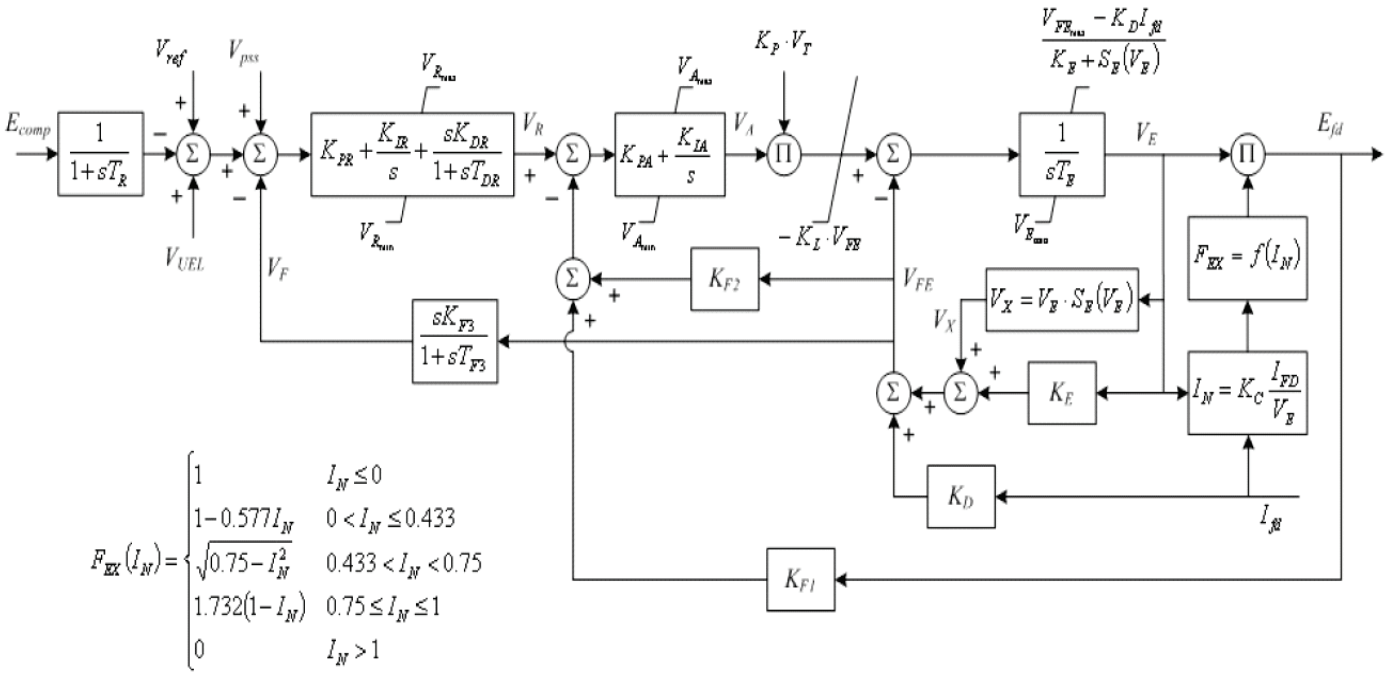
MAIN RESEARCH AREAS OF THE LABORATORY

- 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.

In 2021, as commissioned by UAB, ”Energijos skirstymo operatorius”, the Laboratory implemented a study on “Ensuring an optimal electrical equipment (internal wiring) scheme for a grid user (consumer, prosumer) by installing low power generation, storage and charging equipment".
Until now, there have been no codified requirements in Lithuania for the connection of power generation, storage and charging equipment to the electricity networks of household consumers.

It is recommended that the voltage losses on the line from the CAS to the PV plant converter/inverter should not exceed 1%.

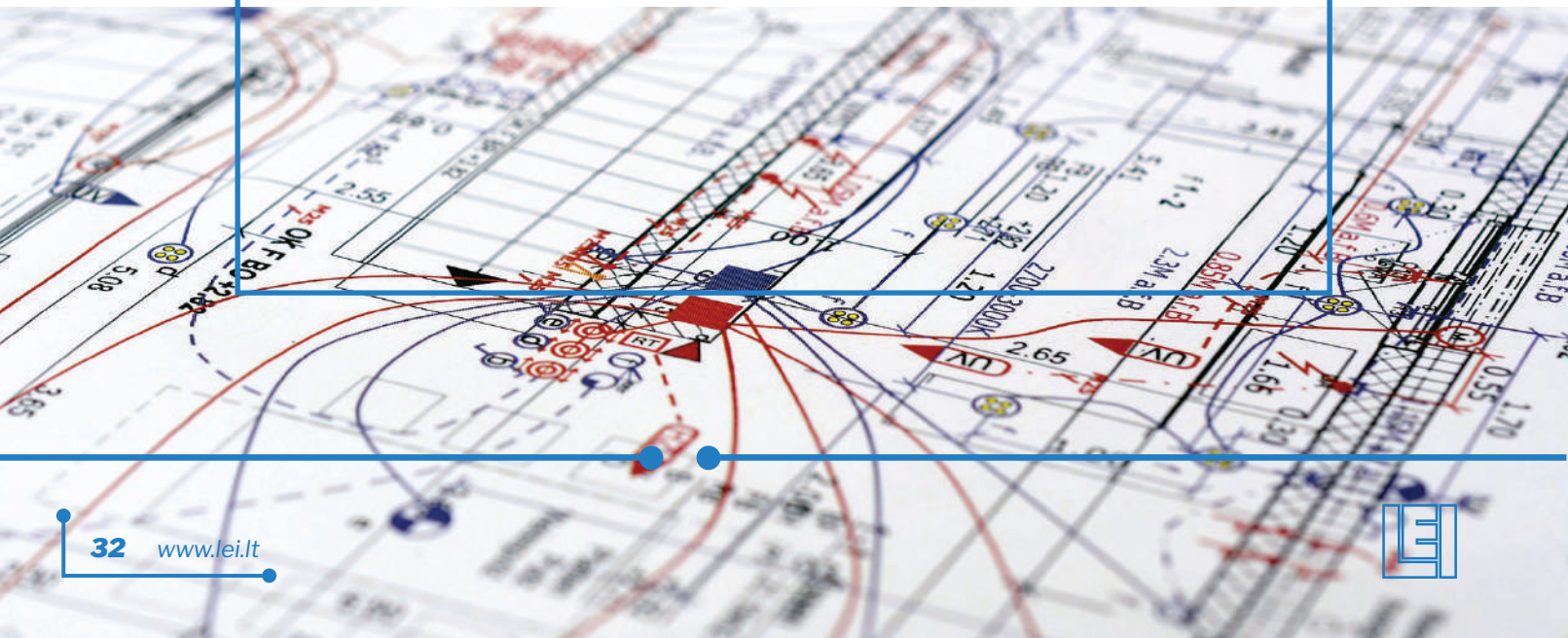




If K_p is zero, the factor K_p * V_t is ignored.

Structure of the generator excitation system's mathematical model AC7B (PSS®E software package)

The mathematical model of the power plant was commissioned by UAB "Kauno kogeneracinė elektrinė" in 2021.
The models were developed and their adequacy was verified by Laboratory for modeling and analysis of transient stability at the power plant.



COMBUSTION RESEARCH

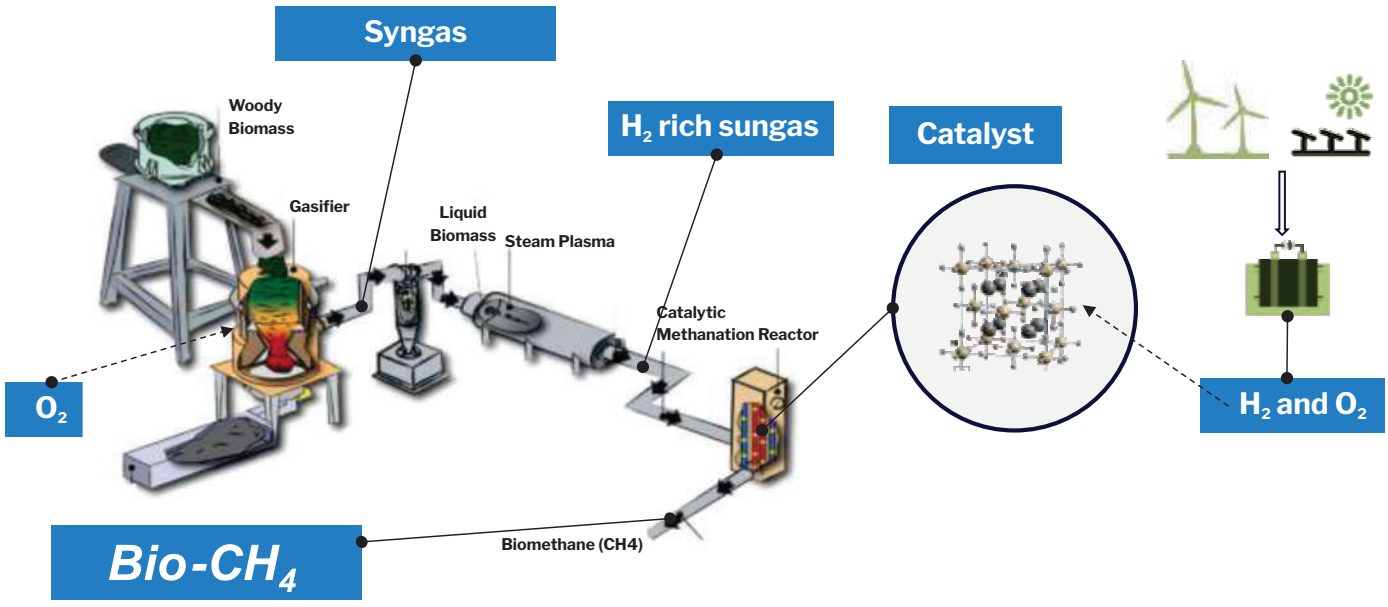
LABORATORY OF COMBUSTION PROCESSES

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 biofuels and production of chemicals, reduce the environmental emissions and increase technology efficiency.

DEVELOPMENT OF AN INNOVATIVE BIOMETHANE PRODUCTION TECHNOLOGY BY APPLYING A CATALYTIC THERMOCHEMICAL CONVERSION (NO. 01.2.2-LMT-K-718-01-0005)



COx conversion - 97%

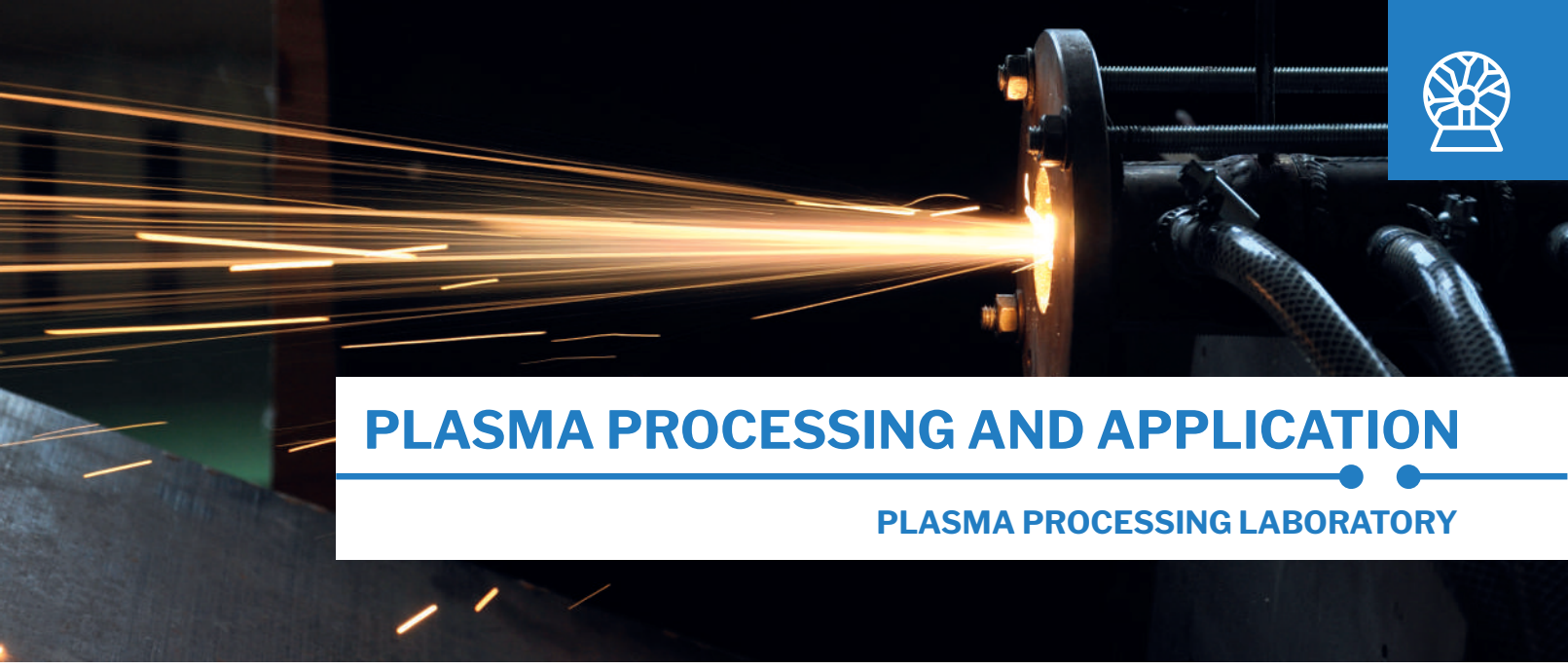
max bio-CH_4 purity - 86.4%

Developed and validated innovative biomethane production concept based on thermal-plasma gasification and conversion of synthetic gas to biomethane using metal hydride catalysts.

Kuriame Lietuvos ateitį
2014–2020 metų Europos Sąjungos fondų investicijų veiksmų programa

Lietuvos mokslo taryba

SMART BioMetanas



PLASMA PROCESSING AND APPLICATION

PLASMA PROCESSING LABORATORY

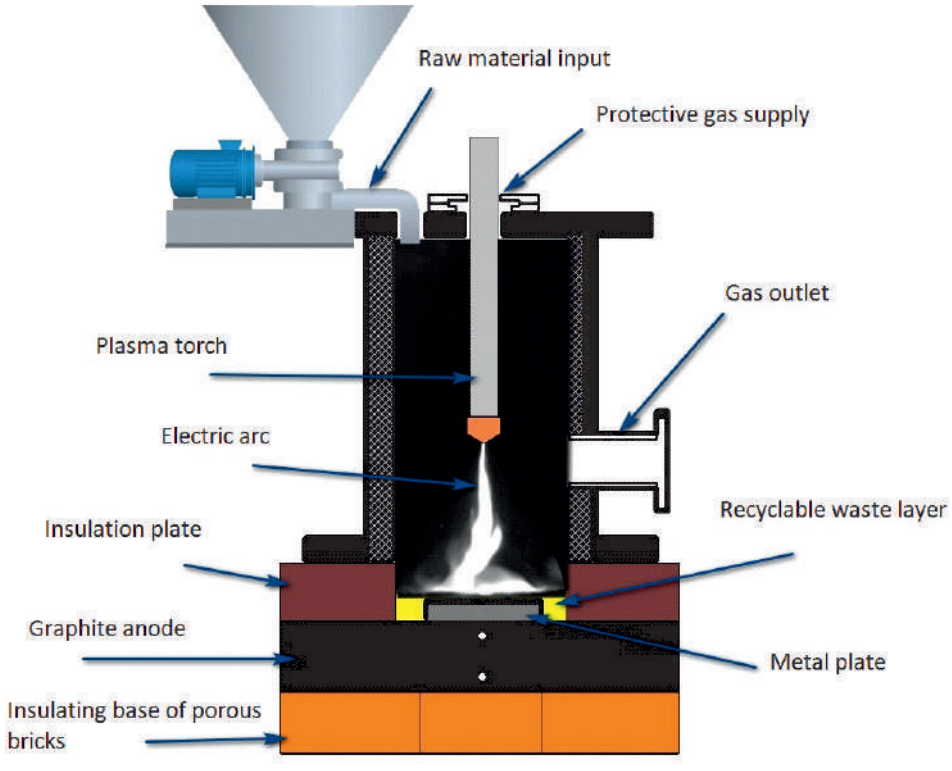
MAIN RESEARCH AREAS OF THE LABORATORY

- 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

A prototype of a plasma-chemical reactor (TRL7), suitable for the decomposition of waste in the air plasma environment was completed in 2021.

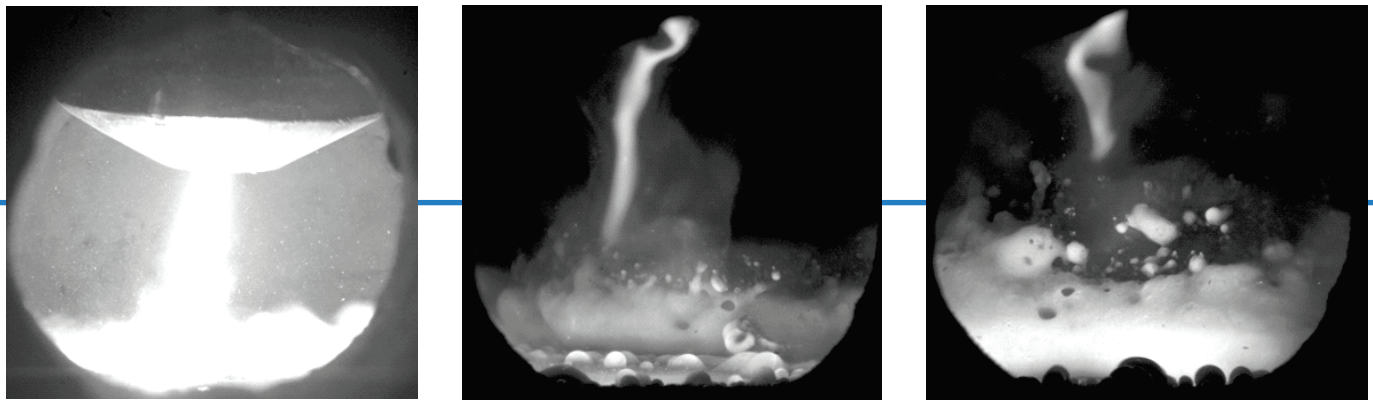
The plasma waste decomposition method is characterized by extremely high decontamination efficiency (99.99%), high temperatures (around 13,000 °C in the arc zone), high energy density, fast process control, and more environmentally friendly than traditional waste treatment methods.

Recycling phosphogypsum and hydroquinone waste in a plasma chemical reactor, valuable gaseous products (CO, H_2), and vitrified slag are produced that can be used in the energy and construction sectors.

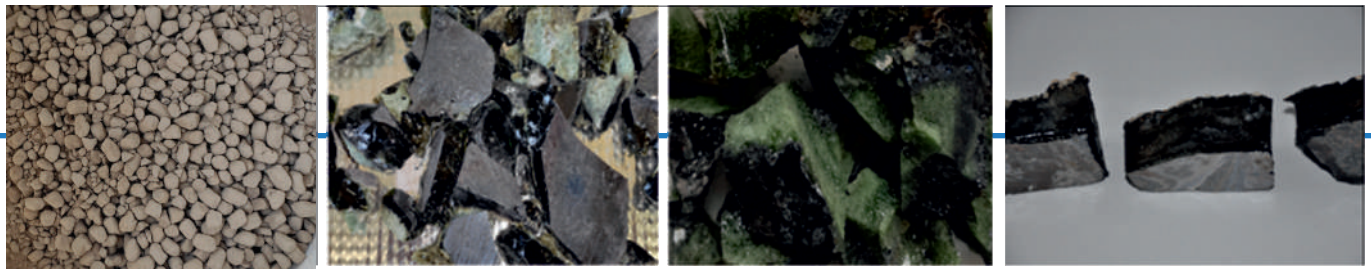


A volumetric plasma-chemical reactor for the neutralization of hazardous waste

This research was supported by European Regional Development Fund (project No. 01.2.2-LMT-K-718-01-0069) under a grant agreement with the Research Council of Lithuania (LMTLT).



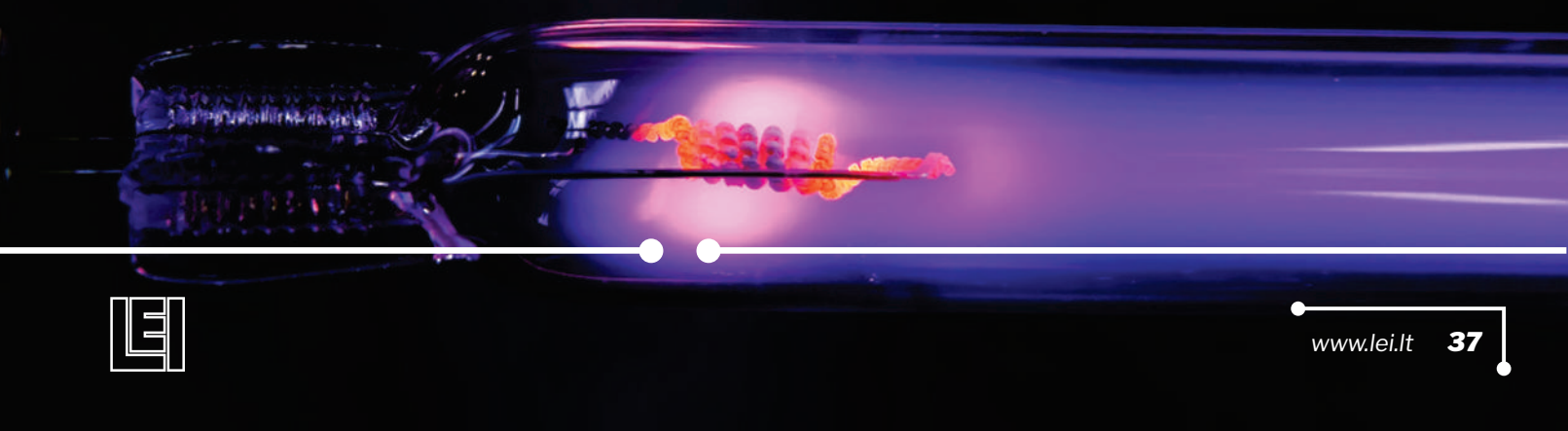
High-speed video camera images with a frame exposure time of 1 μs and frames per second rate of 5000 fps, captured during the decomposition of the waste in the chamber of the plasma-chemical reactor



Raw granules and vitrified slag from recycled waste

	O_2, %	CO_2, %	CO, %	H_2, %	NO, %	NO_2, %	SO_2, %	C_3H_8,%
Clay + phosphogypsum	17.52	3.51	0	0	0	0	0	0
Clay + hydroquinone	0.53	6.54	21.8	5.8	0	0	0	0

The composition of gas produced in a plasma-chemical reactor after waste conversion



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

A TECHNOLOGY FOR THE GRANULATION OF THE CATALYST BASE PCH POWDER

Within the framework of the Call 01.2.2-CPVA-K-703 project "Performing R&D activities of the Centre of Excellence by developing and testing an innovative prototype for the production of gaseous biofuels", a technology for the granulation of porous clay heterostructure (PCH) nickel catalyst support has been developed.

An innovative Ni catalyst with a high specific surface area PCH support is designed for the conversion of synthetic gases (H_2, CO and CO_2) from biomass/waste gasification (methanation or Sabatier reaction) to biomethane. The surface area of the catalyst support is a key factor in the methanation reaction, determining the dispersion of Ni particles on the support surface and the catalyst activity. The catalyst base powder needs to be granulated in order to achieve a uniform temperature distribution in the methanation reactor.

The granulation technology consists of several steps: mixing the PCH catalyst base powder with a binder and hardener, mixing at 120 rpm to a uniform viscous mass, forming the pellets using equipment developed in the laboratory, cutting, and annealing at a temperature of 550 °C. The formed pellets have a specific surface area S_{BET} of about 700 m^2/g, a pore size of approx. 2-5 nm and an estimated average pore volume of 0.86 cm^3/g. The proposed granulation technology of porous heterostructure powder produces pellets with a high specific surface area and pore volume, with potential use as an efficient carrier for catalysts in many chemical reactions.

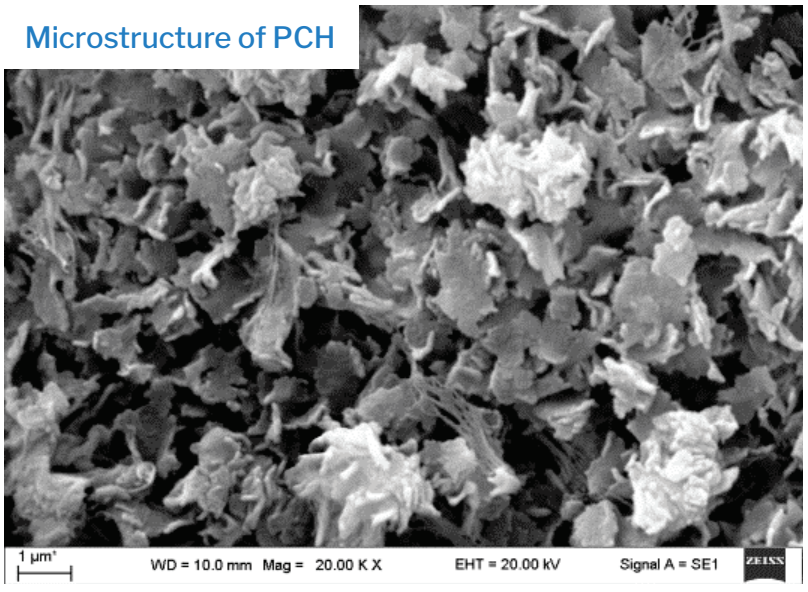
Powder of the catalyst support (PCH)

Binder + hardener

Formation

Cutting, calcination at 550 ^{0}C

Microstructure of PCH

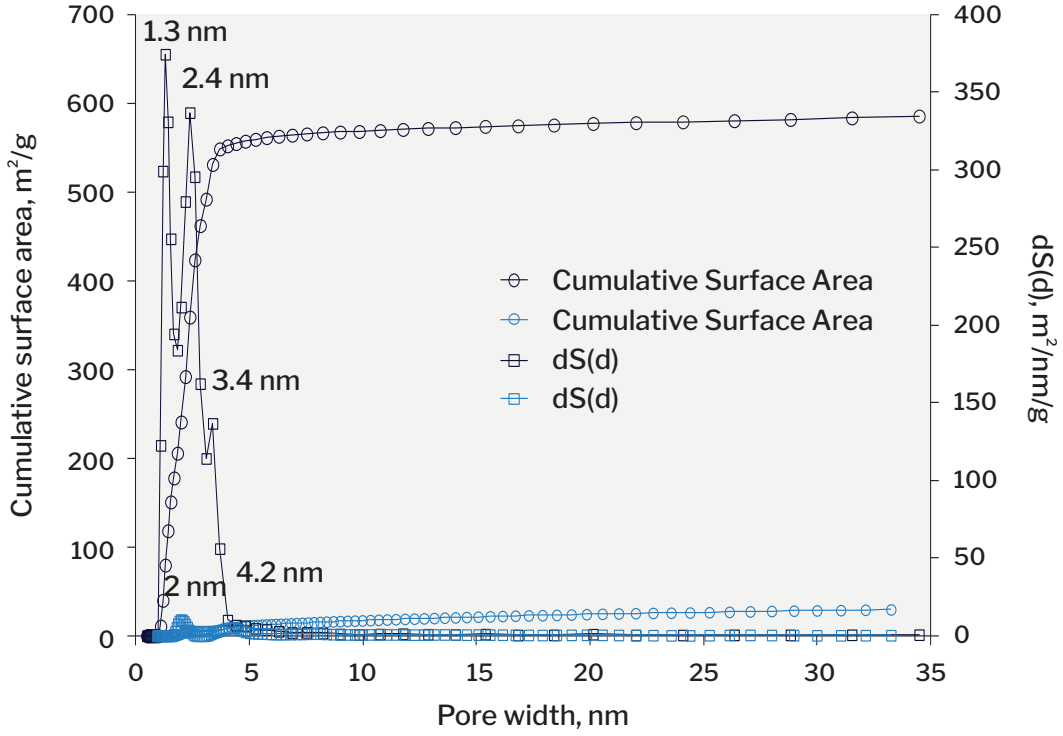


Properties of pellets

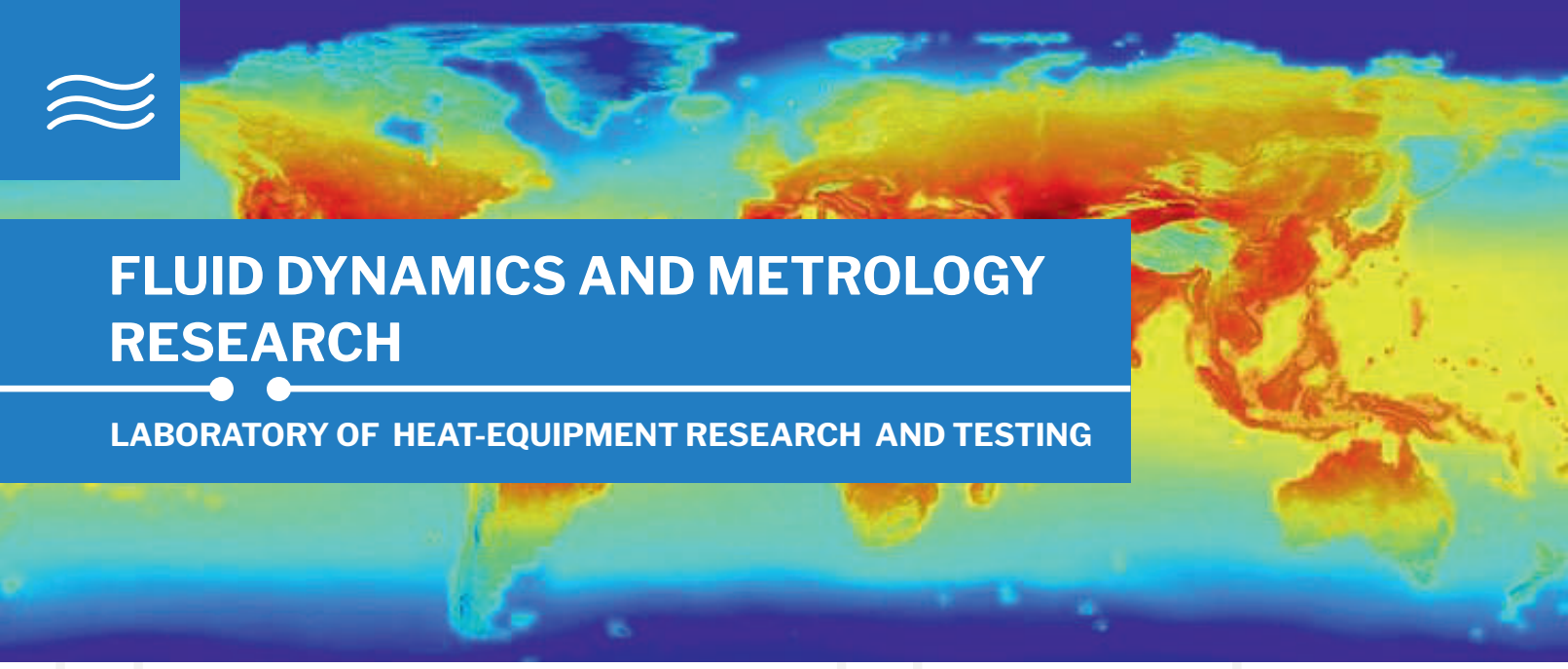
S_{BET} ~700 m^2/g

Pores size ~2-5 nm

Pores volume ~0.86 cm^3/g



Distribution of PCH pores



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 mechanicsand 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

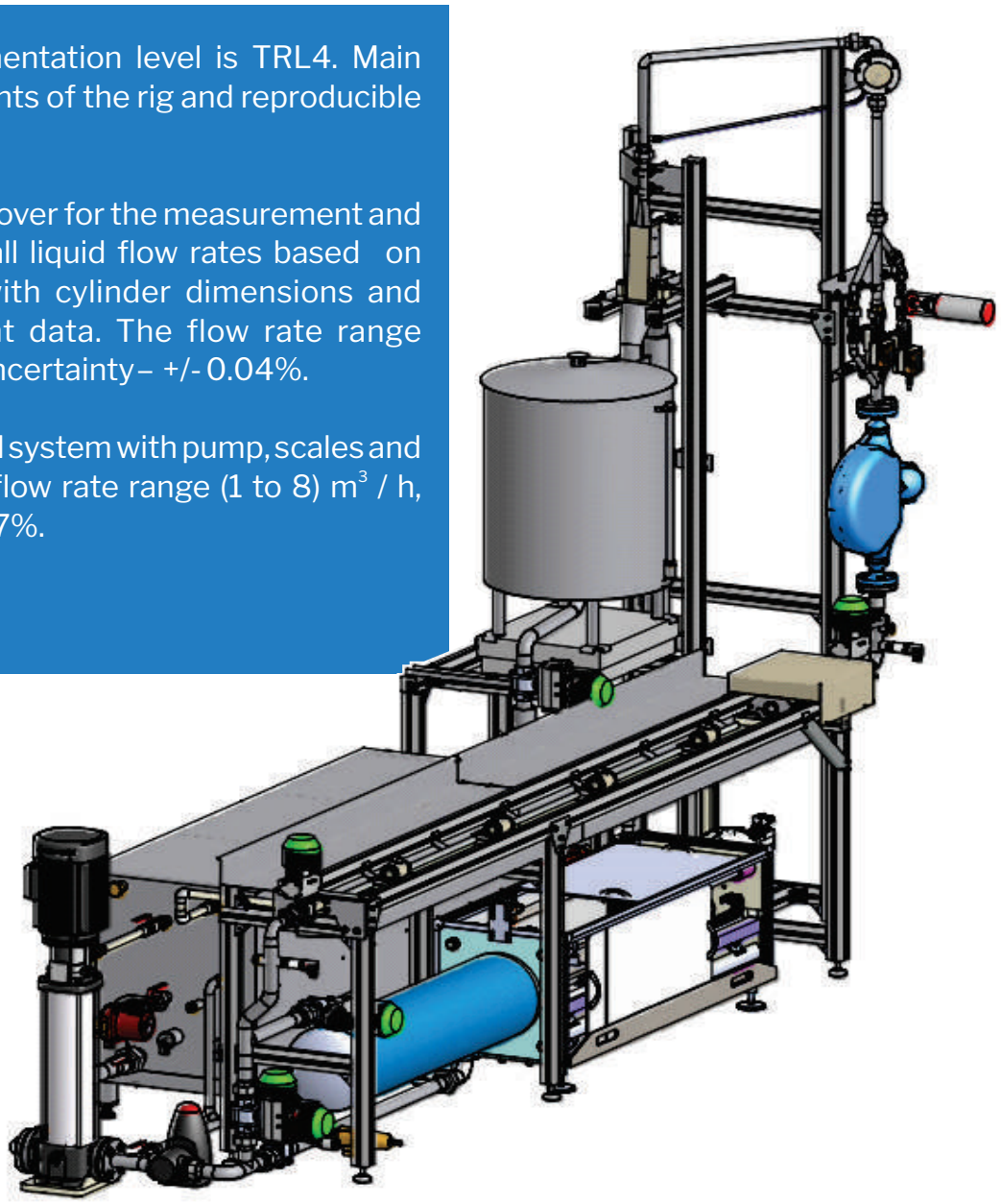
A RIG FOR INVESTIGATING AND MEASURING SMALL LIQUID FLOW RATES.

The production of a rig for the investigation and measurement of small fluid flow rates by using the set of the piston prover and conventional system with pump and scales as well as Coriolis meter is completed. This will allow to expand the measurement limits of the Lithuanian national water volume and flow standard and ensure its reliability and primary metrological level.

The current implementation level is TRL4. Main measuring instruments of the rig and reproducible measured values:

- 1 – A piston prover for the measurement and investigation of small liquid flow rates based on their relationship with cylinder dimensions and piston displacement data. The flow rate range (0.003 to 1) m^3/h, uncertainty – +/- 0.04%.

- 2 – Coventional system with pump, scales and Coriolis meter. The flow rate range (1 to 8) m^3 / h, uncertainty – +/- 0.07%.



HYDROLOGY RESEARCH

LABORATORY OF HYDROLOGY

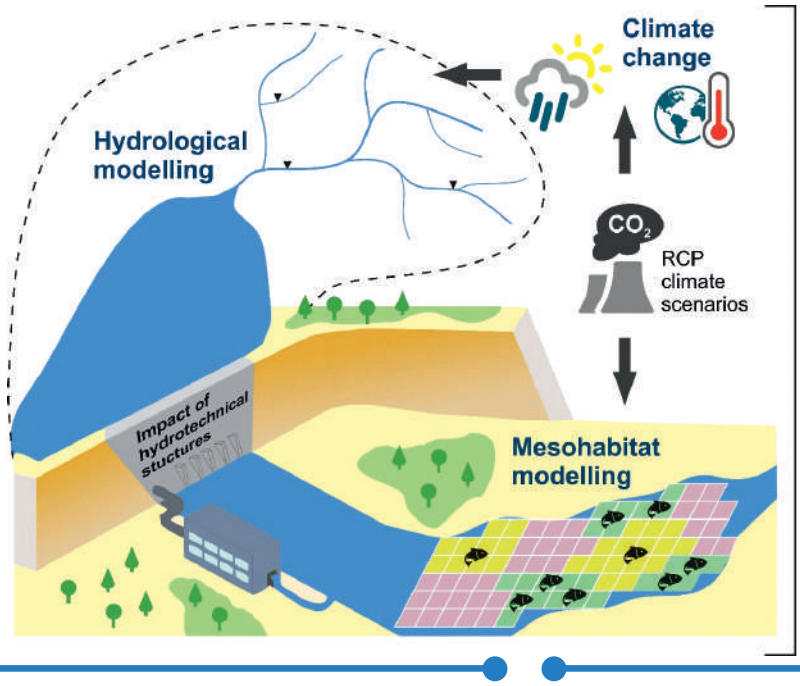
MAIN RESEARCH AREAS OF THE LABORATORY

- 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)

Successful implementation of the project **"Impact assessment of hydrotechnical structures on river runoff and sustainable water management for conservation and restoration of water ecosystems"** (ECODAM) of the National Science Programme "Sustainability of Agro-, Forest and Aquatic Ecosystems". LEI and GTC.

Project manager: **J. Kriaučiūnienė**
Project budget: **146 264 EUR**

Project period: **2020.02.03 – 2021.12.31**
Project funding: **Research Council of Lithuania.**
http://www.lmt.lt/



Period	2021-2040			2081-2100		
Scenario / Fish specie	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Bleak	▼	●	●	▲	▼	●
Chub	▼	●	●	▲	▼	●
Dace	●	●	●	●	●	●
Gudgeon	●	●	▲	●	●	●
Minnow	●	▲	●	▼	▼	▼
Roach	●	●	●	▼	●	●
Schneider	▼	●	●	▲	▼	●
Stone loach	●	●	●	▲	●	●
Bullhead	●	●	▲	●	●	●
Salmon (juv.)	●	▼	▼	●	●	●
Trout (juv.)	▼	●	●	▲	▼	●

Conditions
● Almost unchanged
▲ Improved
● Significantly improved
▼ Deteriorated
● Significantly deteriorated

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.

APPLIED RESEARCH IN COLLABORATION WITH BUSINESS AND CREATING INNOVATIONS

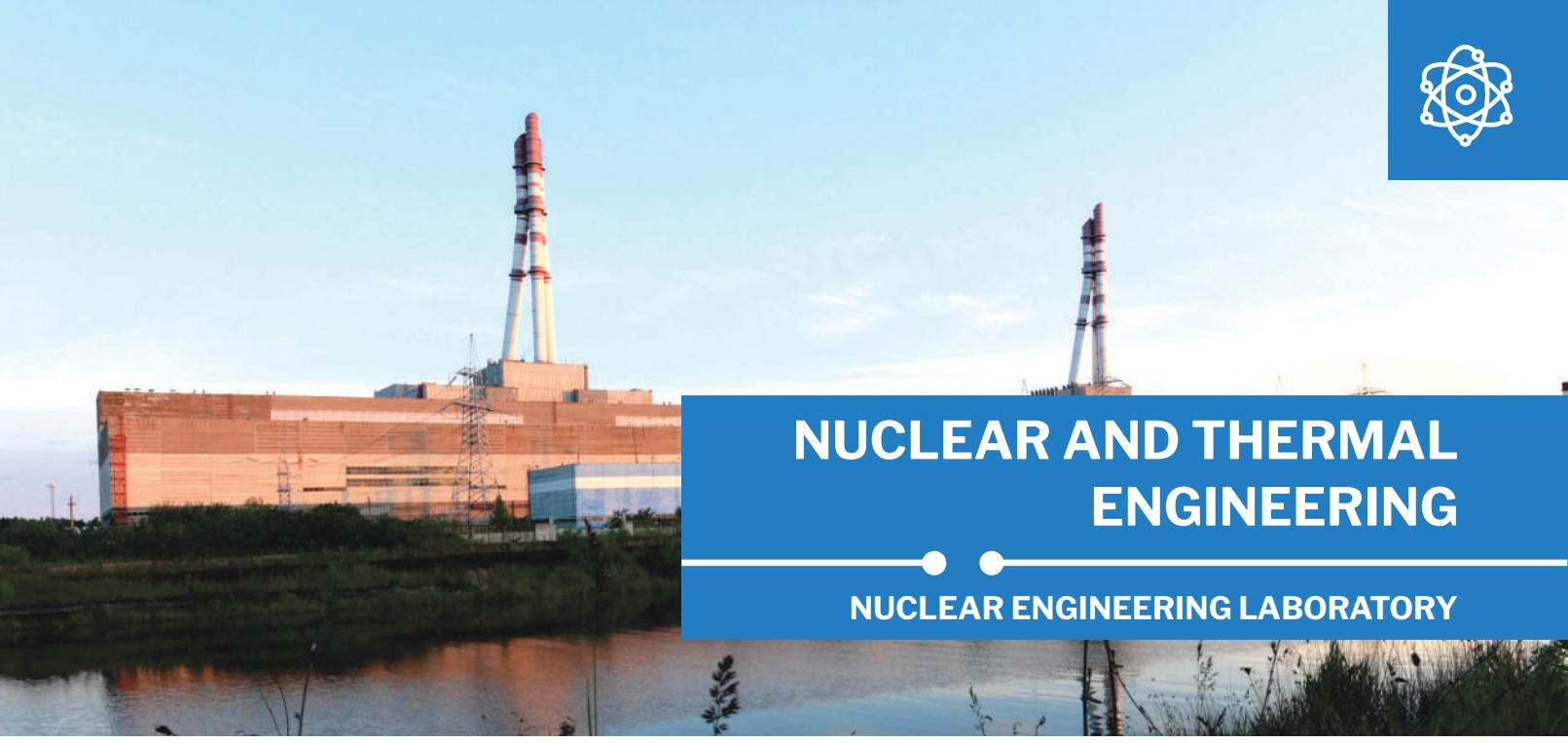
Development and EU Market placement of Advanced DUPLEX Steel Semi-Trailer Road Tanker (No. J05-LVPA-K-04-0017), 2019–2021

New product, a highly insulated, lighter semi-trailer road tanker for transporting liquid food products, during the project was developed.

The new type LEAN DUPLEX steel construction LDX2101 of so insulated tank ensures the best ratio of tonnage to unladen weight on the market.

The project has been successfully completed, after the prototype has been fully manufactured, certified and registered, it has been demonstrated to potential customers in Lithuania and abroad. Expected serial production (~ 50 units per year).

The researchers of the laboratory simulated and investigated the heat and mass transfer processes in the tanks under natural convection or mixing conditions, and performed a strength analysis of complex structures.



NUCLEAR AND THERMAL ENGINEERING

NUCLEAR ENGINEERING LABORATORY

MAIN RESEARCH AREAS OF THE LABORATORY

- Safety of spent nuclear fuel management
  - Interim storage
  - Disposal in deep geological repositories
- Safety of radioactive waste management
  - Treatment
  - Temporal and interim storage
  - Disposal in near-surface repositories
- 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.
- Waste heat recovery from flue gases during biofuel combustion and reduction of the amount of emissions from the exhaust
- Investigation of heat transfer and hydrodynamic processess in various systems and their components
- Fire safety investigation

IGNALINA NPP IMPLEMENTS THE IGNALINA NPP DECOMMISSIONING MEGAPROJECT, WHICH IS CRUCIAL AND EXTREMELY SIGNIFICANT TO THE WHOLE COUNTRY AS WELL AS UNIQUE TO LITHUANIA IN ITS SCOPE, AND THE NUCLEAR ENGINEERING LABORATORY IMPLEMENTED THE FOLLOWING RELATED PROJECTS:

- "Environmental impact assessment and safety assessment of the reconstruction of the INPP bitumen radioactive waste storage facility and its reorganization into a repository"
- "Technical Support Organisation Assistance to INPP in respect of Safety Analysis and Repository Waste Acceptance Criteria"
- "Preparation of the final safety assessment report for the new solid waste management and storage facilities"

Research has also been carried out in two Horizon 2020 programme projects, namely SHARE (2019–2021) and INNO4GRAPH (2020–2023).

SHARE
A roadmap for research in Decommissioning

INNO4GRAPH

IGNALINA NPP IMPLEMENTS THE LONG-LASTING DEEP GEOLOGICAL RADWASTE REPOSITORY PROJECT IN LITHUANIA. THE NUCLEAR ENGINEERING LABORATORY PERFORMED RESEARCH IN THE FOLLOWING RELATED PROJECTS:

Two projects in "Horizon 2020" programme:

- "Bentonite mechanical evolution" (BEACON)
- "European Joint Programme on Radioactive Waste Management" (EURAD)

BEACON
Bentonite mechanical Evolution

eurad
European Joint Programme on Radioactive Waste Management

The Laboratory also participated in the INPP project "Socio-economic assessment of potential locations for the deep geological repository" as the subcontractor to "IDOM Consulting, Engineering, Architecture SAU" (SPAIN).

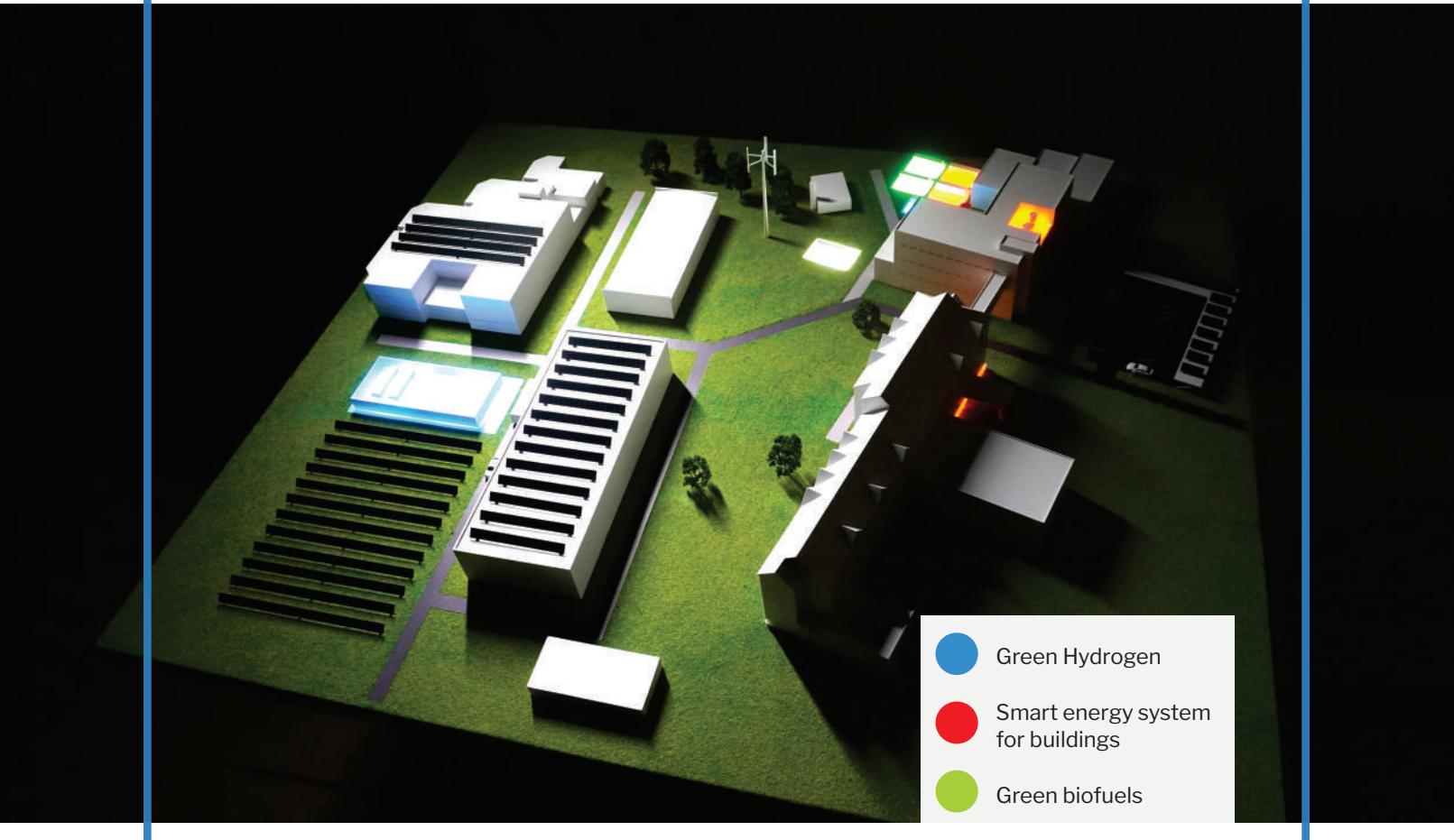
THE GREEN CAMPUS MODEL

LEI Green Campus is an exemplary model of an ecological smart town planned in the territory of the Lithuanian Energy Institute. The model incorporates and integrates technologies for the supply of renewable energy for hydrogen production and renovated buildings.

LEI's Green Campus vision resonates with the aims and objectives of the EU's mission "Climate-Neutral and Smart Cities" and with a goal set in 18-th Programme of the Government of the Lithuanian Republic – to establish a first climate-neutral and waste-free Lithuanian city by 2030.

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

INFRASTRUCTURE CONSISTS OF THREE INTEGRATED ENERGY ECOSYSTEMS:



1956 - 2021 – 65TH 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


1967


2021

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

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