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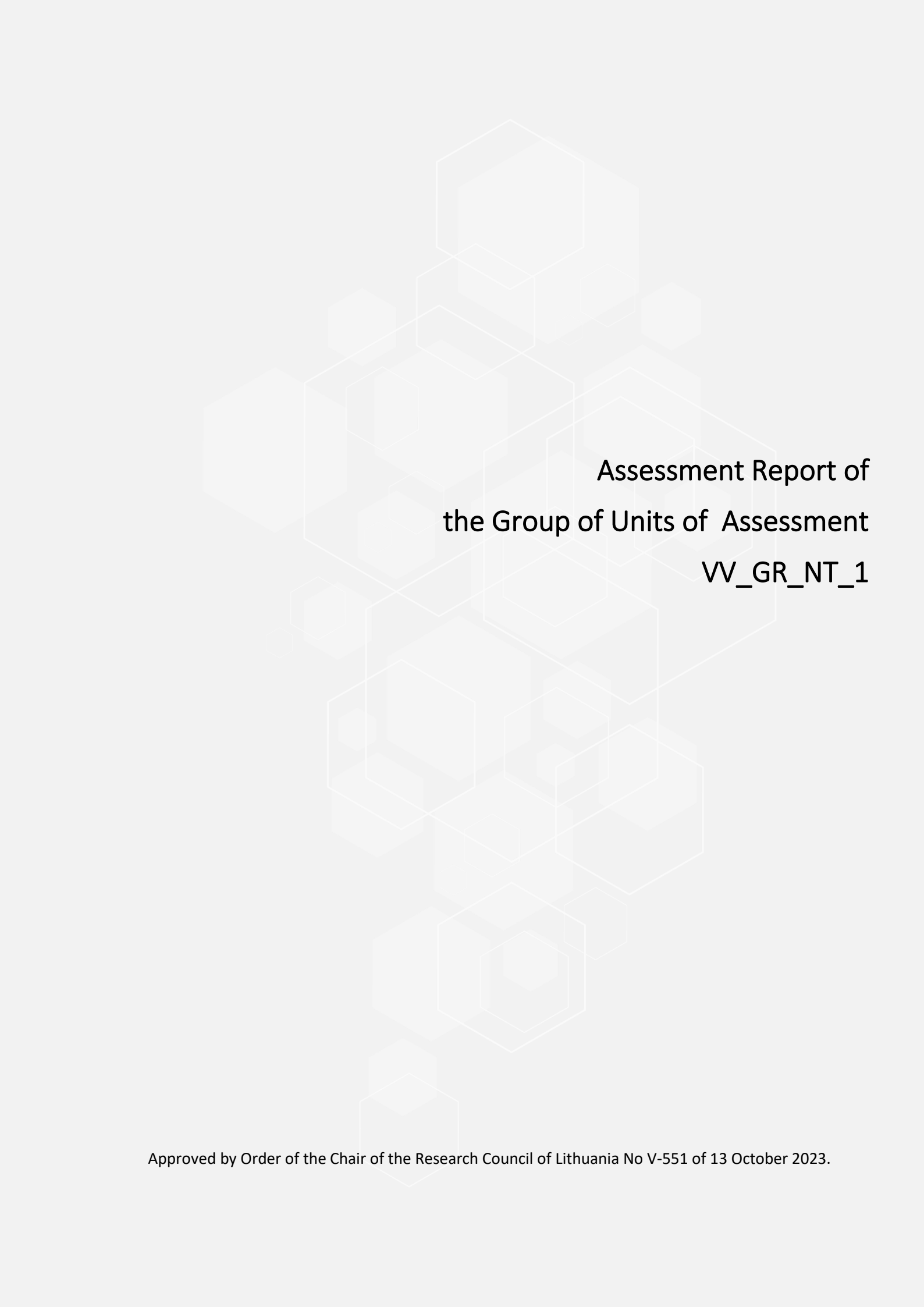
**Assessment Report of  
Comparative Expert  
Assessment of Research  
and Development Activities  
Carried out by Universities  
and Research Institutes for  
the Group of Units of  
Assessment VV\_GR\_NT\_1**

Vilnius 2023



2014-2020 Operational  
Programme for the  
European Union Funds  
Investments in Lithuania

Financed by European Social Fund and Lithuanian State Budget



**Assessment Report of  
the Group of Units of Assessment  
VV\_GR\_NT\_1**

Approved by Order of the Chair of the Research Council of Lithuania No V-551 of 13 October 2023.

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## Terms & Abbreviations

**CEA** – Comparative Expert Assessment of research and development activities carried out by Lithuanian universities and research institutes

**FTE** – Full-Time Equivalent

**Institutions** – Lithuanian universities and research institutes

**RCL** – Research Council of Lithuania

**R&D** – Research and Development

**UoA; Unit(s)** – Unit(s) of Assessment

**FTE<sup>1</sup>** – the number of working hours worked during the year by a certain group of employees divided by a number of working hours in the 12 months of that year, as set by the Minister of Social Security and Labour (with a 5-working-day week). <.> The FTE unit – a person per year.

**FTE(SD)<sup>1</sup>** – the sum of the FTE of teaching staff members with a science degree divided by 3, and the FTE of research workers and other researchers with a scientific degree.

### Research areas:

**N** – Natural Sciences; **T** – Technology

### Universities:

**KTU** – Kaunas University of Technology

**VU** – Vilnius University

### Research Institute:

**FTMC** – Centre for Physical Sciences and Technology

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<sup>1</sup> *Description of the Comparative Expert Assessment of Research and Development Activities by Universities and Research Institutes* approved by Order No V-1593 of the Minister of Education, Science and Sport of 2 September 2021

# 1. INTRODUCTION

## 1.1. Purpose, Scope, Goals of the Comparative Expert Assessment

The Comparative Expert Assessment of research and development activities carried out by universities and research institutes of Lithuania (hereinafter – CEA) was carried out in 2023 by Research Council of Lithuania (hereinafter – RCL) in accordance with the *Description of the Comparative Expert Assessment of Research and Development Activities by Universities and Research Institutes* approved by Order No V-1593 of the Minister of Education, Science and Sport of 2 September 2021 (hereinafter – the Description), the *Regulation on Procedures for the Comparative Expert Evaluation of Research and Development Activities Carried out by Universities and Research Institutes* approved by Order No V-486 of the Chair of the RCL of 8 August 2022 (hereinafter – the Regulation), and other related legislation.

The purpose of CEA is to provide a picture of research and development (hereinafter – R&D) performance, socio-economic impact, and the development potential of Lithuanian universities and research institutes (hereinafter – Institutions) based on their R&D activities during the period of 2018–2022.

The scope of CEA encompasses both state and non-state Institutions operating in Lithuania. All state universities (in total eleven) and all state research institutes (in total eleven as well), four non-state universities and two non-state research institutes were participating in the CEA in 2023. The Institutions or parts thereof were assessed as the units of assessment (hereinafter – UoA or Units). The CEA facilitates the comparison of R&D performance of the UoA against international standards and within the national context. It provides valuable evidence to R&D policymakers at different levels, as well as offers the Institutions involved in the assessment a significant incentive to enhance their performance.

Since 2018, the CEA has been an integral part of assessment of R&D activities of Lithuanian institutions. The annual assessment of R&D activities carried out by the Institutions together with CEA conducted every five years constitutes the Lithuanian assessment system of R&D activities. The results of the two-step assessment are used to allocate state funding for R&D activities for Institutions. The results of the CEA implemented in 2023 will determine 70% of state budget funding for R&D activities of Institutions for the subsequent five years.

The assessment results will also determine the continuity of doctoral studies as well as the new rights to carry out doctoral studies at Institutions in accordance with the *Regulations on Doctoral Studies* approved by Decision No. V-739 of the Minister of Education, Science and Sport of 18 May 2020. Moreover, the findings from the CEA might serve as a trusted source of evidence on R&D performance of the Institutions for assessments concerning other funding instruments or higher education studies.

## 1.2. Comparative Expert Assessment Organization and Assessment Criteria

The CEA relies on international peer review panels to evaluate Lithuanian Institutions' R&D activities. Using panels rather than individual peers creates a possibility for discussion and debate within the peer group and enabling comparison within the group.

The assessment is carried out on the UoA level, which is the organisationally defined structure – ranging from a whole Institution to a division of an Institution corresponding to the faculty or other formal structures of the Institution. In accordance with the Description the rules for the formation of the UoA are as follows:

- the UoA should be interrelated by common R&D activities and might operate in one or two research areas;
- the minimum size of the UoA should be no less than 5 full-time researchers with scientific degree (FTE(SD)) and the maximum size of UoA should not exceed 75 FTE(SD).

The exceptions could be made for better reflection of R&D activities in the Institution. If an Institution had a UoA with a higher number of FTE(SD) or/and UoA operated in three research areas, it should have submitted arguments and obtained RCL approval for participating with not typical composition.

Following the instructions, Institutions have formed eighty-five UoA. All these UoA were split into thirteen groups resulting from four to nine UoA per Panel. The interval of the UoA size ranged from slightly above 5 FTE(SD) to UoA of more than 150 FTE(SD). The number of research areas and research fields one UoA was operating in also varied, i. e., while most UoA operated in one or two research fields, there were outliers where Units were involved in up to five research fields. The variations in size, composition, and research areas among the UoA within each group posed challenges for comparison and required careful consideration by the Expert Panel.

The assessment of the Units is based on three criteria:

- The quality of R&D activities (weight 0.65) of UoA in the research field(s) (group of research fields);
- The economic and social impact of R&D activities (weight 0.2) of UoA;
- The development potential of R&D activities (weight 0.15) of UoA.

The quality of R&D activities is assessed either in each research field or the group of research fields within the research area while economic and social impact as well as development potential are assessed on the UoA level. Each assessment criterion is scored on a five-point scale, namely, ranging from excellent [5] to poor [1] or no R&D [0]. The description of the values of the scores for each criterion are provided in the Description. Half point scores were allowed, and that provided a possibility for more nuanced assessment when necessary.

The quality of R&D activities of the Unit is assessed following these rules: if UoA has at least 10 FTE(SD) in the research field or has between 2 and 10 FTE(SD) and has the right to provide doctoral studies (or intends to seek such right in the next 5 years) in the research field, then the research quality is assessed in the research field; if UoA does not meet these criteria, then the research quality is assessed in the group of research fields within the research area. In the latter case, the assessment considers the collective quality across the research fields within the group.

The assessment was based on the material provided by the UoA to the RCL information system “Vieversys” and covered the period 2018–2022, as well as summarized results of the annual assessment of R&D activities of Institutions (for 2018–2021) provided by RCL, alongside the information obtained during the visits of the Panels to the Institutions and meetings with the representatives of the UoA. Following the Description and the *Procedure for the Submission of Data on Results of Research and Development Activities Carried out by Universities and Research Institutes for the Comparative Expert Assessment* approved by Order No V-1593 of the Minister of Education, Science and Sport of 2 September 2021 (hereinafter – the Procedure for Submission of Data) relevant data was examined when assessing the UoA against each of the CEA criteria. In most cases the number of provided outputs for the assessment depended on the size of the UoA varying from a minimum of five to maximum of eighty-two outputs.

It should be noted that since the previous round of CEA in 2018, several organisational improvements of assessment have been made, therefore caution should be exercised when comparing the results of these two assessments. Some of them are worth mentioning:

- 85 UoA were formed and grouped into 13 Expert Panels in 2023, while the first CEA resulted in 117 UoA formed and grouped into 6 Expert Panels. The cause is mainly due to the change of rules for setting up a UoA. During the 2018 CEA, forming a UoA was allowed in only one respective research area, i. e., if the UoA operated in two research areas, it had to be split into two Units for the assessment purposes. In 2023 this restriction was eliminated, and Unit could easily operate in two (and in some cases in three) research areas. As well UoA formation was influenced by changing landscape of Institutions during the assessment period as mergers of several institutions took place: Aleksandras Stulginskis University and the Lithuanian University of Educational Sciences merged with Vytautas Magnus University since 1<sup>st</sup> January 2019; Šiauliai University was merged with Vilnius University, as well as the Institute of Law, the Lithuanian Institute of Agrarian Economics and the Lithuanian Social Research Center were merged into Lithuanian Centre for Social Sciences since 1<sup>st</sup> January 2021.
- The CEA scoring system has also undergone some changes. While five-point scales were used in both assessments, in 2023 half points were allowed, while in 2018 only whole numbers were used.
- There were some changes in the requirements for documentary input. In 2023 one list of Unit's R&D outputs for a five-year period was required while in 2018 a list of R&D outputs for each assessment year (from 2013 to 2017) and an additional list for the entire assessment period were required, resulting in a large volume of data.

### 1.3. Expert Panel for the VV\_GR\_NT\_1 Group of Units of Assessment

The Expert Panel for the VV\_GR\_NT\_1 group had to assess five UoA from three Institutions:

- **Centre for Physical Sciences and Technology** – 1 UoA:  
*Sustainable Chemistry* (abbr. *FTMC\_DarChem*);
- **Kaunas University of Technology** – 1 UoA:  
*Chemistry and Chemical Engineering* (abbr. *KTU\_ChemIn*);
- **Vilnius University** – 3 UoA:  
*Biochemistry* (abbr. *VU\_04P*),  
*Chemical Engineering (Biotechnology)* (abbr. *VU\_05T*),  
*Chemistry* (abbr. *VU\_CHF*).

The Units were operating in the Chemistry, Chemical Engineering, Biochemistry and Environmental Engineering research fields, and considering these research fields RCL has appointed the Expert Panel members with the main responsibility to assess UoA against three criteria and provide recommendations for UoA future development. The Panel consisted of nine members affiliated with institutions abroad:

- Ursula Liebl (*Panel Chair*), Ecole Polytechnique, France
- Andrew Cammidge, University of East Anglia, United Kingdom
- Peter Jonathan Fryer, School of Chemical Engineering University of Birmingham, United Kingdom
- Malgorzata Kacprzak, Warsaw University of Technology, Poland
- Lu-Yun Lian, The University of Liverpool, United Kingdom
- Krzysztof Miecznikowski, University of Warsaw, Poland
- Anna Maria Papini Rovero, CY Cergy Paris University, France
- Ulrich Schubert, Vienna University of Technology, Austria
- Mathias Senge, Trinity College Dublin, Ireland.

#### 1.4. Assessment Organization for the VV\_GR\_NT\_1 Group of Units of Assessment

Timeline of the assessment organization for the VV\_GR\_NT\_1 Group of UoA:

**Submission of data.** Institutions participating in the VV\_GR\_NT\_1 Group submitted data on R&D activities of their UoA to the information system “Vieversys” by the 9th of March 2023 following the Procedure for Submission of Data.

**Individual assessment.** Prior to the visit to Lithuania, the data of each UoA submitted for the assessment was individually evaluated by at least three experts from the Panel. The number of experts assigned to assess each UoA would increase based on the number of research fields within the UoA. The individual assessment of the Units within the VV\_GR\_NT\_1 Group was conducted by 17th of April 2023.

**Visit to Lithuania.** The Panel members for the VV\_GR\_NT\_1 Group visited Lithuania from the 24th to 28th of April 2023. The main objectives of the visit included discussing the results of the individual assessment within the Expert Panel, ensuring a uniform and consistent application of the assessment criteria among the Panel members; visiting and familiarizing with the academic and administrative staff, PhD students, and research infrastructure of the UoA (at least three experts from the Panel had to visit one UoA); and collectively agreeing on all scores for the Units within the group in the joint session.

**Final report.** After the visit to Lithuania, the preparation of the Panel report took place. The coordination of the preparation was done by the Panel chair. Before the submission of the Panel’s report, the institutions were given an opportunity to provide comments on the factual errors if any observed in the written justification of the scores for UoA. Taking into consideration the comments, the Panel's report has been adjusted where necessary. In addition, the Panel prepared a reply to the commenting authorities. The report was submitted to the RCL with the agreement of all Panel members.

**Appeals.** Upon receiving the final results on each Unit, the Institutions had the right to submit a substantiated appeal to the RCL if they believed there were factual errors in the justification of the UoA assessment and/or if they suspected a breach of the assessment procedures that may have affected the assessment outcome.

RCL has established an external Board of Appeal, comprised of seven members selected from the candidates nominated by the Lithuanian Research Academy, the Conference of Rectors of Lithuanian Universities, the Conference of Directors of the Lithuanian National Research Institutes, and the Ministry of Education, Science, and Sports. The Board of Appeal was responsible for determining whether the appeals adhered to the specified provisions and in case of favourable decision to examine the appeal thoroughly.

The Panel VV\_GR\_NT\_1 has received two appeals. The Board of Appeal dismissed the appeals due to non-compliance with the established appeal provisions.

**Approval of the report.** The final report of the VV\_GR\_NT\_1 group is approved by the Order of the Chair of the RCL in accordance with the Regulation.

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## 2. ASSESSMENT REPORTS

### 2.1. KTU\_ChemIn Unit of Assessment

Name of the institution	<b>Kaunas University of Technology</b>
Official abbreviation of the name of the institution	<b>KTU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Chemistry and Chemical Engineering</b>
Abbreviation of the UoA name	<b>KTU_ChemIn</b>
The scope of the UoA (FTE(SD))	<b>104,62</b>
Research area(s)	<b>T 000 - Technology, N 000 - Natural sciences</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Technology

Research field	Scope (FTE(SD))	Score (points)
<b>T 005 - Chemical Engineering</b>	<b>54,84</b>	<b>3,5</b>

#### Reasoned justification of the score

The Chemical Engineering part of the UoA consists of two parts: the Faculty of Chemical Technology and the Food Institute. The Chemical Engineering group has a total of 54,84 FTE(SD).

The publications submitted covered a wide range of subjects, including food science, building and construction materials, solar cells and OLEDs. All were published in good international discipline-specific journals. A number of publications were collaborations with international research groups. A majority had a share of the research output attributable to the Institution of greater than 0.5, with the UoA showing leadership.

The Panel saw some of the labs and equipment associated with the UoA and was impressed with the equipment and skills available – for example the presence of the INFOGEST equipment in the food laboratories will enable the Institute to participate in leading-edge research programmes nationally and across the EU.

During the evaluation period 20 theses were defended, with a total of 34 PhD students registered; this is a satisfactory number with an increasing trend. The PhD students the Panel met were enthusiastic about their work and the support they received, and most of the students had spent study time abroad. However, the requirement to publish two first author papers before students could graduate was felt to be unnecessarily restrictive, given the interdisciplinary and international nature of modern research, and could lead to the publication of weaker papers. The members of the Unit participated in conferences that were appropriate to the relevant research fields. The number of research awards, both national and international, was noted. Awards were received from the Horizon 2020 Programmes including Marie Skłodowska-Curie Action (MSCA)

Programmes and Industrial Leadership and Excellent Science Programmes, the European Regional Development Fund and the Research Council of Lithuania. International and business funding was good, but the Panel felt that more should be done to gain EU and industry funding to minimize the risk of losing support when EU structural funding ends. In discussions with academic staff, the presence of an Incubator for business support was noted favourably, and the ways in which academic staff were rewarded for publishing papers was commended. Generally, the quality of the R&D activities of research in the Department of Chemical Engineering is strong with growing international recognition.

Research field	Scope (FTE(SD))	Score (points)
<b>T 004 - Environmental Engineering</b>	<b>11,76</b>	<b>4</b>

Reasoned justification of the score

The Institute of Environmental Engineering is a small department that is divided into two centres: The Interdisciplinary Centre for Sustainability Research and the Centre of Interdisciplinary Competences for Sustainability. The Environmental Engineering group has a total of 11,76 FTE(SD). The Institute is managing an interdisciplinary Master's degree programme in Sustainable Management and Production, and a PhD joint program with Vytautas Magnus University and the Lithuanian Energy Institute, with the possibility of a double degree with the University of Bologna (Italy) on the basis of Cotutelle agreements.

During the 2018-2022 period 12 doctoral theses were defended, with an average stable number of 22 PhD students registered. This is very good given the Unit's size. The thesis subjects concerned amongst others technological aspects related to water and air purification, waste processing and life cycle approaches. The methodology and technologies used comprise advanced oxidation processes, photo-catalysts, hazardous substances monitoring, melt electrospinning, nicotine chemical modification or recovery of polymers from biodegradable waste. This confirms that most of the research performed in the Unit is closely related to chemical technology. PhD completions are satisfactory with very good publications, mostly in specialist journals.

The publication output concerned mostly new methods for microplastic removal, wastewater and waste treatment or indoor air quality. The research is focused mainly on the use of different chemical technologies and modification for environmental purposes, hence closely connected to Chemical Engineering. The manuscripts were published in internationally recognized discipline-specific journals, e.g., Chemosphere (IF 8.943), Journal of Cleaner Production (IF 11.072), Journal of Environmental Management (IF 8.91), Carbohydrate Polymers (IF 10.723). The majority had a share of the research output attributable to the Institution near 1.0, with the UoA showing leadership.

The researchers of the department participated in several important international conferences, such as the 11th IAC 2022 in Greece, the 10th LCM2021 in Germany, the 8th International Conference on Sustainable Solid Waste Management (THESSALONIKI 2021), or the 16th Conference of the International Society of Indoor Air Quality & Climate Indoor Air 2020 in Seoul. Awards are mostly national and there are many awards for young scientists and doctoral researchers, in line with active PhD programs.

Participation in projects of international R&D programs is very good. This includes an ongoing H2020 project on concepts and technologies enabling maritime growth with KTU as partner, a HORIZON Europe project on Circular Systems and a project that is funded by the European Regional Development Fund on air pollution studies.

In summary, the UoA carries out R&D at high level and is internationally recognized in the research area.

## Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 003 - Chemistry</b>	<b>38,02</b>	<b>4</b>

### Reasoned justification of the score

Chemistry is a department with the researchers' capacity of 38.02 FTE(SD). 21 theses were defended during the evaluation period, which attests to an active PhD program.

Research outputs of the UoA are at very good levels and internationally recognized, and were published in several very good to excellent scientific journals. To note in particular: Science, Nature Materials, a very recent (2022) Advanced Energy Materials paper, 2022 Nano Energy and an ACS Energy Letters, demonstrating a strong intention to publish the most relevant results in high impact journals. The Department is especially well known in the fields of materials for perovskite solar cells, as well as food science and organic solar cells.

The members of the UoA have regularly reported their results at international conferences in the respective research fields; these include the 21st World Congress of Food Science & Technology (IUFOST) in Singapore in 2022, the 9th IUPAC International Conference on Green Chemistry in Athens in 2022, and the 13th International Conference and Exhibition on Nutraceuticals and Functional Foods (ISNFF 2021) in Nanjing, China.

The UoA received national and international awards, among them the Lithuanian Science Prize 2021, the Kaunas City Scientist Prize 2022, the L'Oréal-UNESCO Baltic Young Talent Program "For Women in Science" award, the Fellow (2021) and Merit Awards (2019) by the International Society for Nutraceuticals and Functional Foods (ISNFF) and an Award for the Best Research Achievements 2022 by the University of Ljubljana.

The department participated in two H2020 projects and a very recent Horizon Europe project on the large-scale production of tandem photovoltaic modules. There is very good grant success from the Baltic Research Programme funded from the funds of financial mechanism of the European Economic Area (EEA) States (Iceland and Liechtenstein) and Norway 2014-2021, the Research Council of Lithuania: Lithuania–China (Taiwan) and Lithuania–Japan bilateral projects.

Altogether there is very good participation in competitive projects and enhanced international recognition. The quality of the R&D activities in the field of Chemistry is very strong with strong international recognition.

## Economic and social impact of R&D activities of the UoA

Score (points)
<b>4</b>

### Reasoned justification of the score

The Unit is very active in all aspects of socio-economic impact.

R&D outputs are based on grant and publication outcomes, focus on socio-economically relevant issues and are of high quality. The BIO-PLASTICS Europe project with the goal to develop and implement sustainability-

based solutions for bio-based plastic production sustainability has created networks and an online course, the Perovskite thin-film photovoltaics (PERTPV) project with results at Technology Readiness Level 9, has been licensed to a Japanese and a Swedish company, and there are several projects on organic light-emitting diodes. Moreover, a project on hybrid solar cells has been developed in collaboration with Tokyo Chemical Industry, which has acquired the license. The programme LIFE fit for REACH realized within European Union LIFE programme helped companies within the Baltic region manage chemicals and substitute hazardous substances. Moreover, the Institute of Environmental Engineering provided services for external companies concerning carbon footprint and Life Cycle Assessment analysis.

The UoA has a very good capability for translational research and sustaining contacts with industry. Overall, the socio-economic impacts are strong at national and increasingly international levels. This latter is evidenced by, e.g., increased networking with European universities. The Unit has a broad range of R&D outputs and agreements, many in critical areas (health, manufacturing, energy). Detailed impact assessments are given for all, outlining the potential societal impact, and for some projects specific financial output or improvements in industrial practice are given. The unit filed a number of patents, several are already licensed. The level of engagement, variety of outcomes, and realized and potential impact is impressive.

Several academic staff are members of the Lithuanian Academy of Sciences and of governmental advisory boards, local authorities, and local university boards. There are several memberships in national scientific associations, national industrial boards and business associations, and national standards boards. The Unit has a very strong level of national engagement and clearly is a valued, perhaps critical, advisory partner for the government and society.

The Unit is very active in establishing industrial contacts and consulting government and municipal authorities. The UoA is clearly a valued collaborator and provides services in critical areas for the customers. Details on the financial outcome of these activities would have been helpful. The level of contractual work is significant. There is a broad and extensive range of conference activities, national and abroad, covering meetings at all levels from small conferences to international meetings. Members of the UoA are participating actively in editorial boards, although editorial memberships are mostly restricted to journals with relatively modest impact factors. UoA members are very active as management committee members of different COST actions, participate in a variety of expert groups and act as expert evaluators for European projects.

There is a very good level of activities to popularize science. However, most are passive lectures, interviews, and publications. Notable activities are a TV broadcast on Lithuanian scientists, several TV interviews and participation in TV shows, webinars and online conferences. The Unit is very active and clearly sees its mission in disseminating information to the public and the authorities. Few social media activities and direct outreach activities (e.g., school engagement) are noted.

There is a significant range of cooperation agreements with national industry, all with clearly stated finance data.

While the individual level of investment often is low (EUR 10-60 thous.) the impact achieved is substantial, and one agreement (Ecolab) involves EUR 2.25 mil. These are outstanding activities in this area given the unit size.

Overall, the Unit is very active and successful in establishing collaborations, mainly with national companies, and in generating significant value for money for the customers. The Unit has a very valued and critical advisory capacity at the national level and is engaged internationally. The strength of the UoA is in industrial collaborations. Impact from basic science R&D is more limited in terms of international visibility (board

memberships, group actions). While no estimate is given for an economic impact, job creation, etc., the Unit has a very strong level of engagement.

## The development potential of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

The Unit has sufficient space, albeit in a number of different buildings. The equipment base, IT, and analytical instrumentation are at a modern and fully sufficient level and are handled on an open-access basis. Library resources appear adequate. The Unit is part of a range of consortia (e.g., the Centre of Excellence in Organic Semiconductor Research), both at the national and international level. The ISO certification of the Food Institute will enable both industry collaboration and future research. The Unit is also affiliated with several national and international educational networks and has a broad range of industrial collaborators.

There is a good distribution in the staff across age. The male/female ratio is surprisingly uneven with 2.27 female:1 male. Human resources description focuses on all standard aspects. Policies are in place for most areas (including Equality, Diversity and Inclusivity), and KTU received the Human Resource Strategy for Researchers (HRS4R) award from the European Commission. Recruitment and workload policies are in place and special attention is given to continuous development (e.g., soft skills, language training).

The strategic operating plan is well structured, has a clear vision, and notably a focus on human resources. It is well aligned with national strategies and international trends and contains a SWOT analysis. The research directions of the Faculty of Chemical Technology, together with the Food Institute and the Institute of Environmental Engineering, are based on long term synergy between research, studies, and industrial cooperation. Future areas of research at the UoA are organized in four thematic research fields: Chemical and Environmental Technologies; Food Systems and Biotechnologies; Functional Materials and Technologies; Applied and Medicinal Chemistry. The strategic plan of the UoA is well-defined with a very good description and justification of the R&D themes to be developed. The Panel felt that more specific targets or milestones would have been valuable, however.

Training activities are described for the postgraduate level and include the full breadth of activities (doctoral school, international doctorates, joint degrees). PhD students undergo both taught and research studies with very good supervisory control in place and clear outcome expectations. The unit actively supports students in international activities, soft skills development, and entrepreneurship.

The Unit is well established, has an outstanding relationship with industry, and has achieved a mature and modern level of infrastructure and equipment. R&D themes are clearly identified and well supported by the track record of the unit. Human resources policies are very good at high international standard, and staff development and care seem to be a core focus of the unit. The strategic plan(s) are well thought out and forward looking. Overall, the UoA has high potential to achieve very good ratings. Increasing internationalization of PhD studies and efforts to attract highly qualified researchers in the future should be continued.

Existing collaborations should be maintained, and new collaborations fostered. Moreover, the strategy to inform business entities about the R&D services should be enhanced. This should be fruitful, as growing demand from businesses to develop high value-added products and technologies exists.

## Recommendations for continuity and/or improvement of the activities of the UoA

The UoA operates nationally at a very good level, has a steady cohort of PhD students with significant international character and has gained international traction. It is very well funded from international and national grants and economic entities. In the future, it will be important to ensure EU and industry funding to minimize the risk of losing support when EU structural funding ends.

The UoA studies a wide variety of topics; the Panel felt that a narrower focus might be of benefit.

Some of the parts of the UoA, such as Chemical Technology, are unique in Lithuania, thus providing a competitive edge to the Unit's activities. This is a strength of the UoA that should be developed in the future.

It is worth considering whether further co-location of the staff and activities of the UoA would help in future collaborations and increase the research outputs. Our tour around the campus demonstrated that different groups working in similar broad areas were physically separated (e.g., synthetic chemistry). The space and facilities in the new building are excellent, but currently underused or under-occupied. Physical co-location and strategic, efficient use of large shared equipment should be a target to exploit synergy.

Collaborations and partnerships to use and exploit the Unit's facilities and expertise are mostly reactive rather than proactive. Strategic focus on seeking collaborative projects in high quality science requires both leadership and individual effort to make direct contacts. The aim should be to use state-of-the-art research facilities on state-of-the-art research.

The Panel recommends that targets and milestones be added to the strategic plan, so that progress can be effectively assessed.

Establishing wider international collaborations, organizing international conferences, and participating in editorial boards of international journals will enhance the UoA's international recognition and help increasing the scientific output. Care should be taken to ensure work is published in high impact journals with strong international visibility.

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## 2.2. VU\_04P Unit of Assessment

Name of the institution	<b>Vilnius University</b>
Official abbreviation of the name of the institution	<b>VU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Biochemistry</b>
Abbreviation of the UoA name	<b>VU_04P</b>
The scope of the UoA (FTE(SD))	<b>102,39</b>
Research area(s)	<b>N 000 - Natural sciences</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 004 - Biochemistry</b>	<b>102,39</b>	<b>5</b>

#### Reasoned justification of the score

The UoA (Biochemistry VU\_04P) is a subunit of the Life Sciences Center (LSC). During the evaluation period, 56 dissertations were defended. By December 2022, the UoA had 68 PhD students, eight from abroad. During the visit, there was much enthusiasm from the students about the time they spent abroad; all considered this as an important part of their PhD training, and the UoA, LSC and VU are commended for making provisions possible through funding, encouragement and flexibility of using research materials acquired abroad into the thesis. It reflects well on the international outlook of the UoA.

There are four readily identifiable international strengths in the UoA: CRISPR-related research, Epigenomics including tools development, Protein Modelling and Bioinformatics, and Enzyme-catalysed Synthesis of novel compounds. There is clear international leadership in CRISPR research and protein modelling. Success in these fields of research has been internationally recognised by a substantial number of high-quality peer-reviewed publications, often highly cited. The selected R&D outputs presented were excellent, although limited to a relatively small number of prominent researchers; hence, it was difficult to profile the entire UoA for R&D quality.

Researchers of the UoA gave invited talks at a wide range of international conferences, attesting to high international visibility. To be noted in particular are several keynote lectures, most notably on CRISPR-Cas.

Members of the UoA have been awarded very prestigious grants (e.g., ERC Advanced and Starting grants) and personal awards (Kavli Prize), the L'Oréal Women in Science Prize and L'Oréal-UNESCO Baltic For Women in Science fellowships, and first prizes in international competitions like "Critical Assessment of Protein Structure Predictions" (CASP) and "Critical Assessment of Prediction of Interactions" (CAPRI).

The international profile of this UoA is also strengthened by the establishment of a VU LSC-EMBL Partnership in 2020, enabling the recruitment of international early career researchers. Other evidence of international recognition is membership in Instruct-ERIC and a joint faculty appointment with the University of Toronto.

Leadership at the national level is evident from the success in securing substantial funding from competitive Research Council of Lithuania grants, European Structural Funds and in helping formulate government policies in the Smart Specialization Programmes.

The Panel visit was very well organised; staff and students were highly engaged and the UoA demonstrated confidence and ambition.

## Economic and social impact of R&D activities of the UoA

Score (points)

4,5

Reasoned justification of the score

The R&D activities of the UoA demonstrated high social and economic impacts. Covid-19 contributions include a SARS-Cov-2 Diagnostic Testing Laboratory established for routine testing service and to develop new SARS-CoV-2 detection methods, and a rapid multiplex test and microarray serologic test for SARS-CoV-2 developed by Lithuanian Biotech companies, UAB Imunodiagnostika and UAB Baltymas (a LSC spin-out) based on monoclonal antibodies assembled by the UoA.

Other diagnostic contributions include: AllergyCHIP, produced by UAB Imunodiagnostika using recombinant allergen produced by the UoA, and REALTIME, an innovative real-time airborne pollen identification and forecast modelling system used by Vilnius City Municipality for day-to-day management and treatment of pollen allergies, consequently improving the quality of life of allergy sufferers.

During 2018-2022 several new patents were added to the CRISPR technology portfolio. There were also long-term supply agreements with ArcDia, Abcam, serYmun, Santa Cruz Biotech to provide them with the recombinant antigens and antibodies. Output of the ERC grant EpiTrack was licensed to Tagomics Ltd (UK) (agreement signed in 2022). A spin-out company UAB LipidOhms was formed based on basic research from UoA to develop biosensors to detect bacterial infection. There were numerous industrial Cooperation and Collaborative Research Agreements involving a large multinational and several Lithuania companies for a range of technologies based on the UoA expertises.

Personnel in the UoA are members of the Lithuanian Academy of Sciences, international editorial boards or acted as guest editors. Many served on Government, Research Council of Lithuania, City Council Committees, steering committees, expert advisory groups and commissions. Being a premier Life Sciences research unit, it is inevitable that this group would have significant influence on national science policies.

During the evaluation period, the UoA had been active in organising conferences, e.g., yearly COINS conferences, the 14th International Conference of the Lithuanian Neuroscience Association and the 3rd Baltic Biophysics Conference.

Engagements with the public were excellent, with exemplary delivery and using a range of media, from hands-on activities to internet-based ones; particularly commendable were the outreach activities for school children and teachers, making podcasts and broadcasts to educate and explain specific scientific topics to the public.

In summary, the UoA carried out scientific research of exceptional importance and was a very important partner in R&D beyond the academic community with commendable interactions with businesses, decisions makers and the wider society. However, real socio-economic impact was more difficult to assess, as quantifiable data such as number/types of beneficiaries of the research outcomes and number of jobs



created were not reported. Furthermore, despite the excellent basic research, there was limited evidence of translating this to tackling health, societal and environmental issues specific to Lithuania.

## The development potential of R&D activities of the UoA

Score (points)

5

Reasoned justification of the score

This UoA is part of the LSC, the largest Lithuanian research centre in Life Sciences and Structural Biology. The LSC has modern, state-of-the-art equipment and facilities fit for 21st Century research, operating predominantly in open access modes, with additional access to national and international facilities. Membership of the Instruct-ERIC consortium (in 2020) has enabled researchers to access funds, training and internships for structural biology services and expertise in Europe. In 2020, EMBL and LSC established the VU LSC- EMBL Partnership for Genome Editing Technologies offering opportunities for collaboration, sharing infrastructure and resources and mobility of researchers and students. Participation of the LSC in the European Alliance4Life and Arqus European University Alliance are expected to further improve leadership and management practices.

There is a very good age distribution of researchers, with a healthy gender balance across all categories of staff. The succession planning for the new leadership focuses on recruiting new researchers on a competitive basis; for example, the VU LSC-EMBL Partnership has recruited six talented research leaders, some from abroad. There is one successful ERC Starting Grant in this UoA (together with an Advanced ERC Grant). During the evaluation period, there had been a good number of post-doc and early-career PhD holders, including international ones, with a mixture of funding from the Research Council of Lithuania, EMBO, Marie Skłodowska-Curie Actions (MSCA), and internal university funds. This buoyant recruitment, with some turnover, bodes well for the UoA, as new talents are being added and mentored.

The past strategic plan 2018-2020 identified becoming an integral part of the European Life Sciences community and enhancing the national Life Sciences community and priorities; this has been achieved. The current strategic plan 2022-2025 focuses on international competitiveness, enhanced educational activities and delivering national impact; the LSC has ambition to become a leader in gene editing technology. The plans are logical and exploit the strengths of the unit. International experiences for students and academic staff, a current shortcoming, will be enhanced. Sustainability of infrastructure and personnel are identified for attention. An international advisory board is planned.

In summary, this is an excellent UoA with high international recognition, an excellent infrastructure, growing research funding and high quality for training and mentoring of students and academic staff. R&D themes are clearly identified and justified by the track record of the unit. The strategic plan identifies logical areas for future development, notably internationalization, community involvement and national impact.

## Recommendations for continuity and/or improvement of the activities of the UoA

Although the UoA had performed to an exceptional standard during the evaluation period, below are some recommendations for continuation and improvement of this performance:

1. The impact of the research could additionally focus on meeting national health needs; Lithuania has specific health issues as described in the EU Report on the State of the Health in Lithuania 2021. The specific risks factors include poor diet, alcohol consumption and smoking, especially in the young. It also has a lower life expectancy compared with many EU countries. In addition, ischaemic heart disease and cancer are the two main causes of death. The UoA is well-placed to make a real impact here and contribute to societal needs, from elucidating basic disease mechanisms to finding therapeutic solutions; it is also important to clearly express how this impact would be achieved. One way to achieve this goal is to form research themes into which researchers would coalesce and pool resources and expertise; each theme could be jointly led by a medically-trained and a fundamental science-trained researcher, as it is important that the projects are driven by health and medical needs and are of relevance to Lithuania.

2. Strategic plans should be more specific on implementation and targets. It would be advisable to set targets for goals and aspirations, and a clear plan as to how these would be achieved; for example, how would more internationalisation be realised, what proportion of PhD students from abroad would the UoA aim to have and how would this be achieved, what is the target for the number of international grants, such as ERC grants and the pathway to getting them. New staff recruitment would need to be strategically driven in order to build upon existing strengths and at the same time realising future potentials.

3. One measure of a successful training programme is the career outcomes of PhD and post-doctoral personnel; some quantification of job destinations would be helpful and provides an indicator as to whether the training provided is career-enhancing and meets national needs and priorities. As the employment of PhD and post-doctoral personnel is a very good and early indicator of future labour and research trends, a successful career-tracking programme would inform the UoA on the future demands for skills; it could assist with research planning, staff recruitment and resource investments. The corollary is that some form of research and training would also be reduced in terms of the number of personnel trained and investments to be made.

### 2.3. VU\_05T Unit of Assessment

Name of the institution	<b>Vilnius University</b>
Official abbreviation of the name of the institution	<b>VU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Chemical Engineering (Biotechnology)</b>
Abbreviation of the UoA name	<b>VU_05T</b>
The scope of the UoA (FTE(SD))	<b>43,55</b>
Research area(s)	<b>T 000 - Technology</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Technology

Research field	Scope (FTE(SD))	Score (points)
<b>T 005 - Chemical Engineering</b>	<b>43,55</b>	<b>4</b>

#### Reasoned justification of the score

The Life Sciences Center (LSC) of VU is one of the leading academic institutions in Lithuania. Although LSC consists of four sub-units, most of the ongoing research activities cannot be assigned to just one subunit, as they are multidisciplinary in nature and overlap each other. It is recognized that segmentation of the LSC in several UoAs had formal reasons. However, information was lacking which research topics / research contributions are considered “Biotechnology” (Applied Biochemistry). Contributions of the “Biochemistry” and “Biotechnology” UoA to the various activities and outputs of the LSC were difficult to distinguish. As a rough guideline, the Panel considered the topics listed in Section 9 of the Unit’s report “Description and justification of the R&D themes to be developed by the UoA”, as well as the topics of ongoing PhD theses (as described by the PhD students) as the main activities in the UoA. The difficulties of getting a clear picture of the UoA’s contribution to the achievements of the LSC was also due to the fact that the analysis of research outputs of the UoA, as well as information on academic staff, awards, outreach, etc. in the provided records showed that the UoA uniformly had a share of only 30-40%.

The publications listed in the Unit’s report are of the highest level of research with regard to both quality and impact. They include papers in the most prestigious journals (e.g., Science, Nature, Cell or Cancer Cell), as well as three monographies (books). It should also be emphasized that in the assessment period LSC published almost 1000 papers. However, the UoA’s contribution to some of the top impact papers is rather small. Most of the research topics are focused on Bioscience (basic research) rather than Chemical Engineering (Biotechnology), and only a small part (not more 20%) of the performed research can be classified as Chemical Engineering (Biotechnology).

In the case of the doctoral studies, the total number of PhD students is at a stable level of about 20 (e.g., total of 23 in 2022) excluding the two years of the COVID pandemic. The proportion of international PhD students accounts for less than 5% of all doctoral students in the UoA. Considering the number of researchers

working in the Unit, the number of PhD students is low and requires increased efforts to attract more national and international PhD students. The system of PhD studies, i.e., the conditions for assessing the progress of PhD studies, is appropriate. The number of completed doctoral dissertations in the assessment period is relatively small (10 theses), and there is an evident issue with completion of PhDs in the typical timeframe, i.e., 4-5 years (only 2 PhD theses were defended after 4-5 years). In addition, the topics of the finished theses do not always correlate with the research areas in the UoA (e.g., crystallographic theses).

Regarding conference contributions abroad it should be noted that the researchers got high visibility through international conference attendance and presentations. Many plenary/keynote/invited talks at major international conferences were presented by researchers from the UoA. Again, it should be noted that these are divided between the different UoAs of LSC with typically 33 or 50 % attribution for Chemical Engineering (Biotechnology).

The same applies to awards and research grants: one of the prominent researchers participating in the UoA (Prof. V. Šikšnys) has been awarded the Kavli prize and an honorary degree from the University of Bristol. Many other researchers have received national recognition and early career international awards (e.g., L'Oréal). The numbers of research grants, as well as income from them, are impressive, including an ERC grant and other European projects, as well as many national projects. The UoA is involved in a number of consortia of national and international projects as a partner.

## Economic and social impact of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

There is significant evidence for positive effects of the UoA with regard to economic and social impact of the R&D activities and development potential. In the assessment period the researchers of the UoA played an important and dominating role throughout the COVID pandemic (especially in its early stages) and contributed to both testing and strategic management of risk. Their input had meaningful social and economic effects. Members of the research teams of the UoA cooperated with both commercial partners and the government to develop fast diagnostic tests for detection of SARS-CoV-2 that then were made commercially available during the pandemic. Although the financial impact of ongoing activities in the area COVID testing has not been disclosed, the contribution is clear and important. Furthermore, the enzymatic biocatalysis work performed within a large international collaboration also had economic impact (publications and patent, plus use by Bayer) and clearly has further potential.

It is noteworthy that the Chemical Engineering (Biotechnology) UoA successfully developed and commercialized technologies, including spin-off creation and patenting. The UoA clearly has a knack for industrial collaborations, for maximizing income from them and for delivering value for industry. This valuable utilization of research results should continue at least at the same level or be intensified.

LSC researchers have taken active roles in many commissions, such as committees appointed by state authorities, state and municipal institutions, and various organizations. An impressive list of consultations was provided, and a high proportion led to VU-company agreements.

LSC researchers had guiding organizational roles in various scientific conferences and events, mostly in the field of Biochemistry. The list of conferences covers national, regional and international events (live and

online) and demonstrates high visibility. Some conferences were organized outside Lithuania at international venues.

A significant portion of LSC researchers is involved in editorial boards of recognized journals or serves as guest editors. LSC researchers are also active in international associations with management roles, such as elected membership of EMBO or COST actions.

Activities for science popularization in media, especially related to COVID, are very good. Media coverage on CRISPR gene editing was also extensive, as well as other media comments, notably from L'Oréal award winners, who also visited schools and gave public lectures. Additional actions directed towards popularization include dedicated podcasts and YouTube media. LSC labs are opened to visitors regularly.

Overall, the UoA carries out very important scientific research and is a very important partner in R&D beyond the academic community.

## The development potential of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

In order to evaluate the Chemical Engineering (Biotechnology) UoA in the context of the development potential of R&D activities, it is necessary to look at the Unit through the LSC. R&D infrastructure has been significantly strengthened and now represents state-of-the-art in computational and structural biology, including microscopy and gene editing. Furthermore, cell and molecular biology laboratories are well equipped and state-of-the-art. In parallel with the strengthened research infrastructure, the Unit has been recruiting new research leaders, as well as opened up new research fields. It should also be underlined that the research infrastructure of LSC is accessible for national and international researchers.

The age and gender distribution of the staff is suitable and human resources policies focus on all relevant aspects. Recruitment and workload policies are in place and special attention is given to continuous development (e.g., soft skills, language training).

The strategic plan is based on existing strengths and is clearly expressed. Focus is on closer consolidation with the European Research Area (ERA), particularly in the field of gene editing and therapeutic application. LSC is part of the European Molecular Biology Laboratory and an active participant in other high profile collaborative international programs. Furthermore, the mentioned research areas in the strategic plan, such as biocatalysts for degrading polymers, biosensors and antibodies have development potential. However, the topics are wide-ranging and some focus is to be commended.

The strategy document of LSC is ambitious and sets appropriate goals that will increase visibility and international standing of the LSC, and there is some potential towards applications of Biochemistry. It is recommended that the UoA focuses on the promotion of quality research, on training and promotion of researchers, as well as on attracting foreign young researchers. The SWOT analysis is rational and mostly complete. The weaknesses are largely about administrative support and space.

Practicalities for achieving strategic aims such as increased grant income and increased publication impact are not described in detail, but for the most part the routes for implementing the specific actions are in place. The clear plans to establish an office focused on international funding are likely to be effective, and the recognition that success should be incentivised is also positive. Support and a clear pathway for researchers

to develop independence are very good. However, there did not appear to be any growth plans in terms of employees within this UoA.

In summary, with regard to current performance, human resources, infrastructure and equipment, the development potential for the UoA's R&D activities is very good.

### **Recommendations for continuity and/or improvement of the activities of the UoA**

Plans to merge the Biochemistry and Biotechnology institutes should be resolutely implemented. The evaluation has shown that the two units cannot be separated. Alternatively (but not strongly recommended), the profile of Applied Biochemistry ("Chemical Engineering (Biochemistry)") could be enhanced compared to basic research in the bioscience area. The latter would include establishing a clear context between the research topics of the Unit and its scientific output, research grants, etc., to render the Unit distinguishable from other units within the LSC. This would be helpful for increasing scientific output and international competitiveness and visibility of the LSC. Furthermore, the UoA does not fully use its very good facilities, therefore it is recommended to seek more active national and international research collaborations, as well as collaborations with industry for more intensive use of the research infrastructure. This requires increased presence in national and international conferences - not only scientific ones, but also industrial events (trade fairs, exhibitions, etc.). Likewise, more involvement of research staff, PhD students and technical staff in actively seeking international as well as national funding sources is recommended. The number of international PhD students should be increased in order to promote the aspiration of LSC as an international competence centre. Furthermore, an important element of each successful training program is feedback of the career results of doctoral students and post-doctoral personnel. Such an evaluation would be helpful and provide an indicator as to whether the training provided is career-enhancing and meets national needs and priorities.

## 2.4. VU\_CHF Unit of Assessment

Name of the institution	<b>Vilnius University</b>
Official abbreviation of the name of the institution	<b>VU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Chemistry</b>
Abbreviation of the UoA name	<b>VU_CHF</b>
The scope of the UoA (FTE(SD))	<b>33,35</b>
Research area(s)	<b>N 000 - Natural sciences</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 003 - Chemistry</b>	<b>33,35</b>	<b>3,5</b>

#### Reasoned justification of the score

The UoA of Chemistry at VU is strong at the national level, but has not yet an excellent international recognition, in a large group of research fields of Chemistry, such as in Supramolecular Chemistry, Biosensors, Bioelectronics, Electrocatalytic Materials, and Electrochemical Sensors. The major risk that the Panel members have pointed out is the limited critical mass spread into many different specific areas. Moreover, although there is consistent research activity, the level and impact are mostly moderate in terms of what would be expected. In fact, the number of citations of research articles is sometimes limited and in some cases more review articles than original scientific papers have been presented. The majority of papers are published in good, but not in highest level journals and there are few examples of ambitious and potentially ground-breaking results. A consistent number of PhD students with a very limited proportion of international students is involved in the different research groups, and in general complete their doctorate within the time frame. Some researchers have achieved visibility through international conference attendance and presentations, including a good proportion of invited talks and some keynote presentations. Most of the conferences attended are at the international level, mainly in Latvia. Several awards have been recognised, the majority to young researchers in the form of local prizes, scholarships or a journal paper prize, but limited internationally recognised awards have been presented also to the senior scientists. The UoA has received significant infrastructure funding to purchase state of the art instrumentation and set up open access. Some researchers have been coordinators or partners in a good number of European consortia grants, such as Marie Skłodowska-Curie Actions (MSCA), with a significant impact in terms of visibility and training/experience, but as yet limited in terms of high impact publications. Moreover, a number of Lithuanian or Lithuanian-partnered research projects have received significant funding, however many of them are now finished, and concrete outcomes have not been clearly presented.

Globally, the UoA is strong with international recognition not yet mature in all the research fields the researchers are involved in. In fact, the large variety of research projects developed in Chemistry at VU, with

a limited coordination with other UoAs in Lithuania in the fields of Nanobiotechnology and Inorganic Chemistry; Pharmaceutical, Polymer and Organic Chemistry; Green Chemistry and Green Synthesis of Materials; Industrial and Applied Chemistry; Analytical, Bioanalytical and Environmental Chemistry and Physical Chemistry limits the possibility to reach the critical mass required to maximise their research efforts. Therefore, Chemistry at VU could strengthen its international visibility and competitiveness by focussing the topics of their research areas by critically evaluating their scientific key competences.

## Economic and social impact of R&D activities of the UoA

Score (points)

3,5

Reasoned justification of the score

The UoA carries out important research and is an important partner in R&D outside the academic community. In fact, the UoA's researchers have established some partnerships with industries in the field of electronic waste recycling, 1D photonic metal oxide nanostructures for early-stage cancer detection, biocompatible materials, etc., thus fostering collaborations among Chemistry, Biology, Biomedical and Pharmaceutical sciences. Joint projects with industry partners have the potential to open up new possibilities for the development of functional materials and the improvement of technological solutions with the perspective of commercialization. Close relations with the largest chemicals-producing company in Lithuania – Thermo Fisher Scientific are ongoing, as well as with Lithuanian industrial companies, such as, Femtika, Optoman, Sanobiotec, etc. Interestingly, some graduates of the UoA established their own companies, such as “Cosmetic Research Center”, “Cosmoway”, maintaining collaborations aimed at joint R&D activities with the UoA. It should be noted that the UoA successfully developed and commercialized several technologies. Moreover, some spin-off companies have been successfully founded. However, considering the number of the Unit's researchers, the number of cooperation agreements between research and business entities could be increased, with the final aim of filing patents (an activity that up to now is low) and hopefully licencing for the exploitation of research results.

Graduates from the PhD program, trained in high technical, economically and societal impact areas, constitute a valuable human capital for further development of Lithuania in materials science from Basic Chemistry and Physics through Technology and processing to Engineering. The required competences that are developed inside the UoA in functional inorganic and molecular organic materials or (bio-)sensors therefore have the potential to create new business opportunities that could increase future economic development and competitiveness in Lithuania. Some products with commercial potential have been developed, such as poly-aspartic coating without volatile organic compounds for wood products, and micro-capsular coating with encapsulated active substances causing self-healing of the coating.

Various scientific conferences and events have been organised, most of them were held in Lithuania. Some members of the UoA were active in working groups, such as COST Actions, European Commission, International Atomic Energy Agency, Royal Society of Chemistry, etc. For public outreach, some events targeting school children have been organised (e.g., the Lithuanian National Chemistry Olympiad). The UoA's members have performed a range of short popularisation activities, such as interviews for web and media and occasional lectures and have produced a general book along with a YouTube video.



## The development potential of R&D activities of the UoA

Score (points)

3,5

Reasoned justification of the score

The age and gender balance across the research staff is good. The UoA's strategy and action plan for 2023-2026 years foresee to provide international, interdisciplinary and research-based education at all study cycles in the fields of Biochemistry, Chemistry, Geology, Physical Geography, Materials Technologies and Human Geography; to carry out fundamental and applied scientific research; to be an attractive and engaging scientific centre for employees, students and the society. Current performance, human resources, strategy, organisation of activities and infrastructure of the UoA will ensure conditions for good ratings in the next five years. In particular, the R&D infrastructure that has been significantly strengthened thanks to a large investment, represents a good provision of instrumentation and appropriate facilities. Further access to high level instrumentation is also provided through the link to Center for Physical Sciences and Technology (FTMC). However, the provision of future equipment is linked to the 2023-2026 research strategy, with an ambitious and inclusive approach that has been presented only partially to develop for example Energy Materials Chemistry and Technologies focusing on renewable and sustainable energy production, conversion, storage and effective usage. For instance, the UoA participates in the European Technology & Innovation Platform on batteries "Batteries Europe". The general strategy to combine fundamental science and applications-oriented research in the area of Functional Materials has a good potential to provide the scientific basis and support for potential and existing Lithuanian industries in this area, hopefully helping to attract foreign students and fostering the international standing of the UoA. Concentration on a few key competences and identifying unique strengths of the UoA will be helpful to fully exploit its potential. Especially younger scientists should be enabled to adjust their activities to scientific and technical developments at the international level in the rapidly developing area of functional materials. Teaming with FTMC is a big chance, as this cooperation partially bridges the gap between basic science and applications. Incentivisation of high-quality research, internationalisation and grant winning opportunities for junior researchers have been put forward, but little practical detail is provided. The UoA actively encourages reintegration of researchers who have gained international experience, and also provides incentives for carrying out joint interdisciplinary projects. Staff promotional pathways are clear. However, the scientific output and visibility of researchers appear overestimated, and this lack of critical judgement will limit change and improvement. Plans to integrate the Institute of Chemistry into the Central European Research Infrastructure Consortium, and the European Research Infrastructure Consortium can help the UoA to reach their goals.

## Recommendations for continuity and/or improvement of the activities of the UoA

The Panel strongly recommends increasing international recognition of the UoA with specific actions, such as recruiting more international PhD students, favouring mobility of Lithuanian PhD students, developing international collaborations, and publishing higher impact original scientific papers.

Moreover, the UoA's research is spread out into a quite large number of different areas, therefore lacking critical mass in some of the research fields. The Panel strongly recommends to establish a clear focus on some of the research topics after having critically assessed the Unit's scientific key competences. This would give a great benefit for increasing scientific output, international competitiveness and enhancing

international visibility of the UoA's researchers. In fact, the UoA's international recognition is not yet mature in all the research fields the researchers are involved in and developed in Chemistry at VU, possibly also due to a limited coordination with other UoAs in Lithuania in the fields of Nanobiotechnology and Inorganic Chemistry; Pharmaceutical, Polymer and Organic Chemistry; Green Chemistry and Green Synthesis of Materials; Industrial and Applied Chemistry; Analytical, Bioanalytical and Environmental Chemistry and Physical Chemistry. Last, but not least, increasing coordination with FTMC to exploit their very good instrumentation could be beneficial for both UoAs.

The Panel also recommends a greater involvement of employees in the active search for external funding sources, mainly for international projects.

Moreover, it could be beneficial to increase the number of cooperation agreements between research and international business entities. In fact, considering the number of UoA's researchers, a larger number of cooperation agreements could increase the possibility of filing patents (an activity that up to now is low in Chemistry at VU) and hopefully licencing to industrial partners for the exploitation of research results. This activity could also have the added value of creating job opportunities for the young researchers involved.

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## 2.5. FTMC\_DarChem Unit of Assessment

Name of the institution	<b>Center for Physical Sciences and Technology</b>
Official abbreviation of the name of the institution	<b>FTMC</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Sustainable Chemistry</b>
Abbreviation of the UoA name	<b>FTMC_DarChem</b>
The scope of the UoA (FTE(SD))	<b>80,63</b>
Research area(s)	<b>N 000 - Natural sciences</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 003 - Chemistry</b>	<b>80,63</b>	<b>3,5</b>

#### Reasoned justification of the score

The overall data presented in the Unit's report indicate that the UoA has a good degree of research intensity that is spread across several themes. The activity trends indicate an upwards trajectory. This is indicated by the rising number of PhD students and a significant number of international students (20%). However, the annual graduation number is still low compared to the size of the grouping and, although increasing, the numbers indicate slow/low completion within reasonable timeframes (total of 13 theses only within the assessment window). The topics of the theses also indicate that just a fraction of research areas is represented regularly; some areas have few or no theses.

A similar pattern is evident when analysing researcher profiles and top research outputs. There is consistent activity, but the level and volume are generally moderate in terms of what would be expected from full time researchers, many of whom are relatively senior and experienced. Publications are mostly in discipline specific journals (electrochemistry, materials, energy). There is a notable absence of any multidisciplinary high visibility publications. While some publications are in discipline specific high visibility venues (ACS Materials, Advanced Energy Materials), most are in mid-stream electrochemical journals. Several senior researchers do not feature significantly in the top outputs. In some cases, this is limited to review articles (not primary research), or as minor (not corresponding) authors on multi-author papers led by external principal investigators (PIs). A number of the best papers are only partially associated with this UoA within the institution. There is a limited number of examples where impact is evident in papers featuring the Unit as corresponding author, but most have received moderate attention within the respective communities to date. Based upon the scientific output, international collaborations are limited.

The researchers have achieved sustained visibility through international conference attendance and presentation. A good range of investigators is present on the list, although there are very few invited talks. A small number of awards have been received by the UoA's researchers. The quality of R&D is recognized at

the national level, for example, the Lithuanian National Science Prize in 2020, Juozas Matulis prize of Lithuanian Academy of Sciences, and Grand Duke of Lithuania Gediminas Order, Ritter Cross (2022). No international awards are indicated for R&D activities.

The FTMC has been successful in attracting funding from R&D projects of international and national sources (during the evaluation period > EUR 2.5 mil.), as well as from economic entities (> EUR 2 mil.). This includes two H2020 projects, although both have ended by now and two Marie Skłodowska-Curie Action (MSCA) Individual Fellowships, both also terminated. Smaller international cooperations are indicated (e.g., a Lithuanian-Taiwanese Cooperation). There has been generous funding from European structural funds, most of them completed. The grant intake, especially in terms of standard national research grants, is relatively low in comparison.

The Unit operates at a nationally competitive level. This is reflected in the level of scientific publications and awards. Research funding (including industrial funds) and conference activities include notable international impact. However, there is a lack of high impact publications and a steady base of national research grants.

## Economic and social impact of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

The UoA has been successful in attracting funding from economic entities during the evaluation period and has actively engaged in a number of projects to develop products of socio-economic relevance. Some of these research projects involved industry, e.g., the H2020 COSMOS project (ended in 2021) and the ongoing H2020 Terminus project, where the UoA is developing smart plastic materials with intrinsic recycling properties by design, with a clear societal and economic impact. Researchers have established several partnerships across other international academic groups and with industries. The COSMOS project has delivered internal impact through the management and delivery of this consortium programme. The researchers have taken the correct steps to achieve impact, including industry partnership, testing, patenting, and engagement with the trade press. Although the project did not lead to commercial (economic) or high-profile scientific impact, it has had demonstrable further benefits, particularly for increasing the visibility of the Institute and team.

The project on spectroscopic interrogation of amyloid aggregation is described as potentially impactful for Alzheimer's disease. While true, at the present stage this is rather predictive and, as is the case for some other projects, rather describes research plans than concrete outcomes. From the additional information presented, there is good evidence of engagement with international commercial partners for contract research/work. Further patents are described and at least one includes an ongoing remuneration agreement. Impacts (economic or otherwise) are not specifically defined. Other work described includes examples of ongoing patent applications. Some, in particular the solar cell work, appear promising and have potential for future impact. Several unit academic staff are members of the Lithuanian Academy of Sciences. Some memberships in governmental advisory boards (e.g., Military Science and Technology Council of the Ministry of National Defence of Republic of Lithuania, Lithuanian Research Council and other funding agencies), and local university boards are indicated. International representation and visibility are low.

The unit is very active in establishing industrial contacts and preparing international applications but has been less successful in the latter. Significant activities and contractual work are in the area of corrosion and

wastewater treatment with a range of companies. The level of contractual work is significant, internationally competitive, but appears to be mainly focused on 3-4 groups. Overall, the number and breadth of contracts are very good.

A good range of conference activities is listed. Many are for students and local interests but also include several international meetings. A few researchers are represented on journal editorial boards, although this representation is predominantly in relatively low-impact journals and in the Lithuanian journal Chemija. Some guest editing in specialist journals is described. Institute researchers hold a small number of positions in international associations (often as regional representatives) and perform occasional international project evaluations. One scientist is on the Board of Funders of EU Future and Emerging Technologies Flagships.

There is a good level of activities to popularize science. However, most activities are passive lectures, interviews, and publications. There is a lack of outreach activities (school engagement) and engagement using social media. No data are given on impact.

The unit clearly has a knack for industrial collaborations, to maximize income from these and deliver value for industry. Impact from basic science R&D – except for a range of international patents - is limited in terms of international visibility (board memberships, group actions).

## The development potential of R&D activities of the UoA

Score (points)

3,5

Reasoned justification of the score

With regard to current performance, human resources, strategy and organisation of activities and infrastructure, the development potential of the UoA is good. This is grounded in high-quality facilities, a range of established collaborations, and a sensible plan for improvement. R&D infrastructure has been significantly strengthened and now represents state-of-the-art in combined physical characterisation techniques for solids in particular. The facility is open for access by other researchers. The Unit clearly has a focus on industry-relevant analytical methods and has assured international certification of their activities. However, while state-of-the-art, the measurements themselves often do not constitute research, but rather service. The link to research and research strategy is not clear, even though topics-based “laboratories” are proposed. A number of the labs/topics proposed are relatively under-represented at the Institute in terms of research leaders. The aim is to join the European Research Infrastructure Consortium. Future developments are planned around a structure of six research laboratories (materials, high-throughput, electrochemistry, photochemistry, biomaterials, prototyping). The tenor of the description is more industrial than academic. It is expected that further development of the Center for Innovative Chemistry (INNOCHEM) research infrastructure will integrate the experts, staff and students at the FTMC and the Vilnius University Faculty of Chemistry and Geosciences working in the field of chemistry and chemical materials science into a unified competence framework, which should be impactful.

Human resources are generous and about half of the researchers are under 44 with about equal gender balance. Only very few foreign researchers are indicated. Human resources description focuses on generic job and pay scale descriptions and a list of appropriate key principles, without providing specific details on policies, management, information on promotion and recruitment of senior researchers and PhD student funding and environment.

The strategic plan 2023-2025 focuses on “top level research”, “application of scientific knowledge <...> to the development of <...> value added products and services”, and “generation <...> of companies”. The plan lists anticipated funding distribution and aims to give a breakdown of anticipated trends in implementing objectives. The list indicates a slight increase in publication impact, doctoral students (albeit with increasing graduation numbers), as well as some increase in start-up activities.

The R&D themes are elaborated in a logical manner, are in line with the strengths of the unit, and with national requirements. A detailed list of sub-themes clearly outlines the research strengths of the Unit. Impact areas and targets are given in only a general manner. Despite the clear expertise of the Unit in this area, no industrial partners are listed.

Training activities start at school level (summer camps) and some indication for outreach is given. Information on promotion of doctoral students and young researchers indicates one traineeship per student and year, but otherwise lacks specifics. There is very limited information on training programs, taught courses, mentorship, soft skills; this section falls short and lacks information on PhD-to-researcher transition and career tracks.

The Unit is well established, has an excellent relationship with industry and sees translational aspects as their main purpose. The values and goals of the Institute are ambitious and correctly have multiple agendas concerning science and technology, researchers and society. Overall, the SWOT analysis is credible and mostly complete. The threats analysis is credible and there are challenges ahead.

## **Recommendations for continuity and/or improvement of the activities of the UoA**

The UoA has clear potential to capitalize on the generated scientific knowledge, its basis of human resources, and the investments made in the past. The UoA has the capability to produce internationally leading research and to broadly expand its range of international partners and collaborations with industry. To be successful in reaching its goal several aspects require attention.

With the looming end of EU structural funding, it is imperative to increase participation in Horizon Europe and national grant initiatives. While the Unit is engaged in Horizon Europe boards, these efforts require a broader base of participating groups, establishing wider international collaborations, increasing the participation in international activities, conferences, and publication venues. A stronger focus on high impact publications and cutting-edge research topics is recommended. This can be achieved by focusing on a smaller range of projects and with full utilization of the research infrastructure for competitive research projects, rather than a broad range of low impact collaborations. Likewise, more engagement in securing a steady stream of national research funding to increase the range of PhD projects is needed. The UoA has the potential to become a leader in identifying focus areas of research and to support these with the full base of available expertise.

Future success of the UoA requires engagement with all groups of personnel (students, researchers, technical staff, principal investigators, and directors). While the student numbers are increasing, the graduation rates for PhD students must be increased. This should be accompanied by comprehensive training programs that go beyond individual departments. The PhD student base is very engaged, but would benefit from the development of dedicated career tracks. Guidelines for the requirements for a successful PhD thesis should focus on the achievement of project and training goals, foster international, interdisciplinary and collaborative research, rather than accumulation of a set number of publications. In parallel, clear policies and strategies for senior recruitments should be established. This should go hand in hand with the

identification of new research areas. The driving force should be the competitiveness of a new research area and the complementarity of expertise, not who can be hired.

The future research strategy should be streamlined and better aligned with the proposed new labs/themes. Ideally, cross-departmental research themes are needed to achieve a critical mass of internationally competitive researchers capable of attracting larger international grants and to attract more international researchers and principal investigators. Strategy development should include participation from all levels of personnel.

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### 3. FINDINGS

#### **Biochemistry**

Biochemistry is one of the strongest research fields in Lithuania, and an integral part of the European Life Science community. R&D themes are clearly identified and attractive, as demonstrated by high-level research outputs. This is particularly obvious in the fields of CRISPR-related research, epigenomics, protein modelling and bioinformatics, and enzyme-catalysed synthesis of novel compounds. International recognition is supported by prestigious awards and steadily growing research funding.

The R&D activities already demonstrate high social and economic impacts, with notable interactions with businesses and decisions makers, as well as collaborations with leading local industrial partners.

Biochemistry provides a high-quality scientific environment for PhD students and is actively making provisions to enable international research stays. PhD students were enthusiastic about the time they spent abroad and considered this an important part of their training. This should be further encouraged. The age distribution of researchers is very good, with a healthy gender balance across all categories of staff. There had been a good number of post-doc and early-career PhD holders, including international ones, demonstrating that new talents are being added and mentored.

The infrastructure is excellent, with state-of-the art equipment and facilities. An effective network of strategic partnerships offers opportunities for sharing infrastructure and resources, as well as for training, collaboration and mobility of researchers and students. Sustainability of infrastructure and personnel will be a challenge in the years to come. International experiences for students and mobility of post-graduate researchers, current shortcomings, should be strengthened.

To enhance impact and fully exploit the translational potential, the excellent fundamental research could additionally focus on meeting national health and societal needs, from elucidating basic disease mechanisms to finding therapeutic solutions. Strategic plans have appropriately identified logical goals for future development; it would be important to set defined targets and a clear planning as to how e.g., more internationalization can be realized, or follow the most appropriate pathways for international funding. New staff recruitment would need to be strategically driven in order to build upon existing strengths and at the same time realizing future potentials. The career outcomes of PhD and post-doctoral researchers are a measure of a successful training program; some quantification of job destinations would provide an indicator as to whether the training provided is career-enhancing and meets national needs and priorities.

#### **Chemistry and Chemical Engineering**

All relevant domains of applied and fundamental chemistry are represented in Lithuania. On the whole, R&D operate nationally at very good levels and are internationally recognized in the major institutions visited (Vilnius University, Center for Physical Sciences and Technology, Kaunas University of Technology), or are gaining increasing international traction. Research at these Institutions addressed a number of timely topics, reflecting socio-economic and industrial needs, together with a reasonable ratio of classical fields. Notable are research in sustainable chemistry and energy applications, solar cells, biosensors, food science, electrochemistry, enzymatic biocatalysis and materials science. In some Institutions, the research covered a wide range of topics. The panel recommends that a narrower focus in future research directions could be helpful for developing coherent and unified competence networks, and to achieve critical mass.

While some scientific outputs are published in high-impact journals or discipline-specific high visibility venues, many are published in journals with lower international impact or visibility.



Visibility has been achieved through international conference attendance and presentations, and members of the community often have advisory capacities at national level.

Chemistry institutions are frequently important partners outside academia and active in establishing industrial contacts and obtaining funding from economic entities, mainly in Lithuania. Increasing the number of cooperation agreements between research and business entities would be beneficial, and the strategy to inform business entities about R&D services should be enhanced.

The research infrastructure is of high quality, with well-equipped facilities and high-level instrumentation for industry-relevant analytical methods. Clear plans should be established to sustain infrastructure and personnel in the future.

Human resources are generous and age distribution is generally favorable. Units often have steady cohorts of PhD students, with an overall increasing number of international students. Training programs for young researchers should be strengthened and efforts to attract highly qualified researchers in the future should be continued.

Chemistry in Lithuania has clear potential to capitalize on the generated scientific knowledge, produce internationally leading research and expand collaborations with industry. Increasing participation in international networks and funding programs, and establishing wider collaborations will increase international recognition. Greater involvement of research employees in the active search for external funding sources should be encouraged.

#### **General recommendations:**

##### **Science, scientific output, PhD students**

The paper output required per PhD student (in general a minimum of two papers, at least one as first author, sometimes two) can in some cases be detrimental to publishing in very high-quality papers with broad impact and wide readerships. It should be possible to adapt a scheme that allows shared first authorship in high quality journals with a clear definition of the individual contribution of each PhD student. This is particularly beneficial (or even necessary) for interdisciplinary research.

Some of the UoAs spread their scientific efforts on a large diversity of topics and were lacking critical mass to continue their research at high international level. A better focus on topics that are likely to result in future high quality scientific output and/or socio-economic impact is desirable. Common policies to reinforce cooperation of activities at national level should be developed, e.g., in the form of clusters of excellence, competence centers, or targeted funding programs. This should be accompanied by suitable measures to enhance cohesion between individual groups.

##### **Assessment Rules:**

The Panel felt that most of the time the data provided for assessment were too vast and insufficiently structured. For instance, it was not readily obvious to identify which researcher belongs to which UoA. One suggestion is to associate one person with only one UoA to avoid overlap that hinders fair evaluation.

##### **Site visits:**

The Panel enjoyed in particular the discussions with PhD students and appreciated their enthusiasm. Formalized PhD training should be widened in some cases and include relevant courses in additional training that is distinct from their research activities. This should comprise diverse transferable skills, like scientific writing, publishing and communication, career planning, as well as ethics, gender and diversity training.

Regarding the site visits, in particular in quite diversified UoAs, the Panel should be informed well ahead of the visit about the UoA's structure and should be able to choose the facilities to visit. Also, in most cases,

the time to visit the research structure and facilities was perceived to be too short. Moreover, a short debriefing at the end of the visit with the leadership team of the UoA is recommended to allow further clarification of issues where necessary.

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