ABSTRACTS

ORAL PRESENTATIONS

Human thermal load during clear sky mornings

Erzsébet Kristóf, Ferenc Ács

ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary

Contact: ekristof86@staff.elte.hu

We investigated the human thermal load in Martonvásár (Hungarian lowland, Carpathian region) in anticyclonic weather conditions in the morning, when the sky was completely clear. A customizable clothing thermal resistance-operative temperature (rcl-To) model was used. During the observations, weather data was provided by the automatic station of the HungaroMet company and it was accessible on the company's website. The person was either walking at a speed of 1.1 ms-1 or standing. We had 136 observations in the period between 2020 and 2024. The following main results should be highlighted: 1) rcl varied between 0 and 3.5 clo for walking person. 2) rcl can tend to be zero for walking person on the mornings in summer, which means that the person feels thermal neutrality (no cool, no slightly warm, it's in between). 3) We also showed that the effect of activity (walking or standing) on rcl was significant when the heat deficit was large (rcl ≥ 2.5 clo). It should be mentioned that the analysis of typical weather situations from the point of view of human thermal load is a new field of research, since there is little information available on this subject.

Case study of radiation fog event during Budapest Fog Experiment in 2020–21

Arun Gandhi[1], István Geresdi[2], András Peterka[2], András Zénó Gyöngyösi[1,3], Ágoston Vilmos Tordai[1], Peter K. Musyimi[1], Péter Torma[4,5], András Rehak[4], Mariann Bíró-Szilágyi[4], Gyula Horváth[6], Zita Ferenczi[6], Kornélia Imre[7], István Lázár[8], Tamás Weidinger[1]

[1]*ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary*
[2]*University of Pécs, Faculty of Sciences, Institute of Geography and Earth Sciences, Pécs, Hungary*
[3]*MouldTech Systems Ltd., Zalaegerszeg, Hungary*
[4]*Budapest University of Technology and Economics, Faculty of Civil Engineering, Department of Hydraulic and Water Resources Engineering, National Laboratory for Water Science and Water Security, Budapest, Hungary*
[5]*HUN-REN-SZTE Research Group for Photoacoustic Monitoring of Environmental Processes, Szeged, Hungary*
[6]*HungaroMet, Budapest, Hungary*
[7]*HUN-REN-PE Air Chemistry Research Group, University of Pannonia, Veszprém, Hungary*
[8]*University of Debrecen, Faculty of Sciences and Technology, Institute of Earth Sciences, Department of Meteorology, Debrecen, Hungary*

Contacts: arun.elte@gmail.com, weidi@staff.elte.hu

A micrometeorological fog experiment was carried out in Budapest, Hungary during the winter of 2020–21 (October 2020 – March 2021) to enhance understanding of fog formation, evolution and dissipation. The field observation involved: i) the standard meteorological and radiosonde measurements; ii) surface radiation and energy budget components were measured using instruments installed on a tower with height of 30 m, iii) ceilometer measurements. Furthermore the air pollution data for NO_x, SO_2, CO, O_3 and PM (PM10 and PM2.5) were provided by the Hungarian Air Quality Monitoring Network. In this measurement campaign data for 23 fog events were recorded. The comparison of the data observed at the altitudes of 2.5 and 30 m reveal that the surface inhomogenity results in stronger turbulence at the altitude of 30 m. This stronger turbulence increases the flux footprints. In most of the cases the fog formation occurred due to radiative cooling (fog formation was detected when the observed relative humidity was greater than 95%). Decreased air temperature along with high specific humidity 2–3 hours prior the fog onset are important factors in fog formation and evolution. The cooling rates and break points in the time series of temperature with time resolution of 10 seconds (for profile measurements) and 10 Hz (for eddy covariance measurements), before the onset of a fog, were also analysed. Temporal trends of pollutant concentration during foggy events were also studied. We observed a sharp decrease in the concentration of both gases and PM particles before fog onset. This should be the consequence of the conversion of gaseous pollutants to secondary pollutants and formation and growth of fog particles.

Multivariate Analysis for local Meteorological Factors and Air Pollutants

Amine Ajdour[1], Houria Bouzghiba[2], Abderrahmane Mendyl[3], Anas Adnane[1], Radouane Leghrib[1], Géczi Gábor[4]

[1]*Ibn Zohr University, Faculty of Sciences, Physics Department, Laboratory of Materials, Signals, Systems and Physical Modeling, Agadir, Morocco*
[2]*MATE Hungarian University of Agriculture and Life Sciences, Doctoral School of Environmental Sciences, Gödöllő, Hungary*
[3]*ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary*
[4]*MATE Hungarian University of Agriculture and Life Sciences, Department of Environmental Analysis and Technologies, Environmental Technology Group, Gödöllő, Hungary*

Contact: amine.ajdour@edu.uiz.ac.ma

As cities and industries grow worldwide, it's essential to fully understand how weather conditions interact with air quality due to the complex nature of atmospheric and pollutant dispersion. The study aims to investigate how pollutants such as O_3, PM10, NO_2, SO_2, and CO interact with local meteorological conditions. To fully comprehend this relationship, we conducted detailed statistical analysis, including simple and multiple correlations, as well as principal component analysis (PCA) The results indicate a correlation between pollutants and combinations of temperature, humidity, pressure, and wind speed. The PCA results are grouped into four profiles: The first includes PM10, CO, and NO_2, suggesting that these pollutants respond similarly to common factors like emissions. Notable correlations were found between PM10 and SO_2, possibly due to the presence of H_2SO_4 in fine atmospheric particles, where SO_2 acts as the primary precursor. The second relationship is between SO_2 and temperature, indicating that temperature changes might reduce the intensity of vertical mixing of air masses. The third profile involves humidity and pressure, suggesting a similar effect of both parameters on pollutants such as O_3 and NO_2. The fourth profile includes O_3 and wind speed, implying that higher wind speeds are associated with higher ozone concentrations.

Development of a method and an interactive visualisation system for evaluating unusual weather

Mikes M., Dezső Zs., Hollós R., Pongrácz R.

ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary

Contact: mikess@student.elte.hu

To provide a realistic picture of the unusualness of everyday weather events to citizens, it is important to show which phenomena are considered unusual in a given location and season. For this purpose, we developed an effective method for evaluating the occurrence and coexistence of unusual weather events, followed by the development of an interactive visualisation system. The method uses the daily measured data of 70 synoptic and climatological stations in Hungary from 2002 to 2023, which are publicly available in the database of the HungaroMet Zrt. (formerly: OMSZ). Temperature, precipitation, and wind measurements are used as basic variables in the detection process of several extreme indices. The method's main strength is the customisable time window, the percentile-based thresholds, and the simplification using categories. The visualisation system will allow users to view the extremity of weather events for a single station or in terms of spatial extension on a map. Ultimately, this tool can be used as a communication platform from scientists towards non-professional users with a special focus on not necessarily extreme but still very unusual periods in a meteorological sense.

This work has been implemented by the National Multidisciplinary Laboratory for Climate Change (RRF-2.3.1-21-2022-00014) project within the framework of Hungary's National Recovery and Resilience Plan supported by the Recovery and Resilience Facility of the European Union.

Vulnerability Assessment and Co-design of GIS for Sustainable Water Management Strategies in Rural Communities linked with Climate Change

Hafsa Aeman

International Water Management Institute (IWMI), CGIAR, Pakistan

Contact: h.aeman@cgiar.org

Vulnerability assessments play a crucial role in designing exposure, mitigation, and adaptation strategies for regions impacted by climate change. This study adopts a participatory approach to assess the effects of climate change on rural communities and collaboratively develops a Geographic Information System (GIS) to identify groundwater vulnerable regions, facilitating tailored sustainable water management strategies. The assessment combines exposure, sensitivity, and adoption evaluations, employing climate variance indicators derived through principal component analysis (PCA) to pinpoint areas requiring targeted policies. Data collection methods included ground truth surveys, remote sensing, focus group discussions, and key informant interviews, with farmers and agricultural communities as the primary respondents. The study's findings reveal that approximately 30% of the Okara district, the selected case study area, is grappling with severe groundwater challenges with escalating demand for groundwater extraction through tubewells, which surged from 15,000 in 2010 to 46,000 in 2022. As a result, the average groundwater level has plummeted by up to 35 cm. The declining water table has led to increased irrigation costs and elevated operational expenses for farmers who heavily rely on groundwater for both irrigation and drinking purposes. Furthermore, the study highlights a 9.3% increase in land use and land cover change, specifically towards built-up areas, between 2000 and 2022, attributable to population growth. Disparity among farmers is evident in the analysis of water-related expenses, with 86% incurring costs exceeding 6,000 PKR for pumping water, while only 2% reported costs within the 1,000 PKR range. The study identifies areas with high groundwater vulnerability, comprising 35% of the total area, necessitating the implementation of adaptive management strategies to reduce vulnerability. The findings underscore the willingness of farmers, with 57% agreeing to invest in climate-resilient farming practices if provided with suitable technical support and capacity building. The study further advocates for increased diversification of water sources, gender-inclusive capacity building on water management strategies to mitigate vulnerability. Integration of Geographic Information System (GIS) and Information and Communication Technology (ICT) tools enhances decision-making processes, enabling stakeholders to access and analyze spatial information for groundwater and vulnerability risk assessment, thereby facilitating adaptive management strategies.

Comparison RegCM regional climate simulations for an extremely dry year using different parameterization combinations

Tímea Kalmár, Rita Pongrácz

ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary

Contact: timea.kalmar@ttk.elte.hu

Drought is one of the natural hazard risks that adversely affect agriculture and other socio-economic sectors, especially in Hungary. To better understand droughts and to provide information for adaptation strategies and risk-management systems, there is a strong need for a methodological framework to simulate drought events.

To quantify the impact of the use of different parameterization schemes on regional climate model outputs, hindcast experiments were completed applying RegCM4.7 to the Carpathian region at 10-km horizontal resolution. We test various combinations of the physics schemes (i.e., land surface, microphysics, cumulus convection, and planetary boundary layer (PBL) schemes)) for the year 2011, which was the driest year since 1901 in Hungary. Each parameterization combination leads to different simulated climate conditions, so their overall spread is an estimate of the model uncertainty arising from the representation of the unresolved phenomena.

The results show that RegCM is sensitive to the choice of parameterization scheme combinations, especially, to the applied convection scheme, but the interactions with the other schemes (e.g., land surface) also affect precipitation. For temperature, the land surface scheme is crucial, and the PBL scheme is secondary.

This work has been implemented by the National Multidisciplinary Laboratory for Climate Change (RRF-2.3.1-21-2022-00014) project within the framework of Hungary's National Recovery and Resilience Plan supported by the Recovery and Resilience Facility of the European Union. Furthermore, the Hungarian National Research, Development and Innovation Fund (K-129162) also supported the study.

Vegetation-focussed climatically analogue areas to the expected future climate of Hungary

Imelda Somodi, Ákos Bede-Fazekas

Centre for Ecological Research, Insitute of Ecology and Botany, Hungary

Contact: somodi.imelda@ecolres.hu

Potential distribution models (PDMs) are frequently applied for climate change impact assessment for biological objects, such as species and vegetation types. These models quantify environment requirements and extrapolate into the future.

To describe climate, they typically employ bioclimatic variables: combinations of monthly precipitation and temperature values. Updating the values of bioclimatic variables to reflect climate change projections allows the assessment of the expected climate change impact.

Prediction by PDMs to conditions projected under climate change is ideal if the model training area includes areas similar to the expected future conditions. We aimed to identify such areas for future Hungary as a preparation of more effective climate change impact modelling. We compared the current climate of the Balkan Peninsula and lowland part of mainland Italy with the future climate projections of Hungary for the 2071–2100 period according to 4×2 global and regional climate models obtained from Euro-CORDEX. Sigma similarity of bioclimatic variable values was calculated as a measure for climate analogy per locations.

Future projections of the western part of Hungary showed similarity to lowland Italy and north-western continental Croatia, while the climate of eastern Hungary is expected to become similar to current climate of Serbia and lower Danube floodplain.

Analysis of fog and freezing rain occurrences – challenges and results using gridded observation and simulation data

Péter Szabó, Rita Pongrácz

ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary

Contact: szabo.p.elte@gmail.com

Fog and freezing rain are adverse winter phenomena. Dense fog reduces visibility, causing traffic disruptions and accidents. Freezing rain coats surfaces with ice, damaging trees and infrastructure, and increasing the risks of road accidents and injuries. The Pannonian Basin's unique geographical features (low-lying areas, low wind speeds, and river valleys) facilitate cold-air pooling, leading to fog persistence. Freezing rain occurs when warmer Mediterranean air masses interact with this sub-freezing inversion layer. Both phenomena are challenging to predict.

To assess their impacts, we developed a methodology using daily, gridded data. For fog, we analyzed daily minimum and mean temperature, relative humidity, and wind speed from the high-resolution, homogenized HuClim observational database. For freezing rain, hourly temperature, total precipitation, and snow data were collected from the high-resolution ERA5-Land reanalysis (i.e. an observation-based but modelled dataset). Future projections utilized daily variables from an ensemble of Euro-CORDEX regional climate model simulations under three scenarios: RCP2.6 (aiming at 2°C global warming by 2100), RCP4.5 (strong mitigation from 2040), and RCP8.5 (non-mitigation).

Results indicate a slight decrease in foggy days in parts of the Pannonian Basin over recent decades, and similar changes in freezing rain. Projections suggest a significant decrease in days with tendency to fog and an even stronger decrease in days with freezing rain under the RCP8.5 scenario by the end of the 21st century. These changes are rare positive impacts of climate change over the region.

Research leading to this study has been supported by the European Climate Fund (G-2309-66801) and the Hungarian National Research, Development and Innovation Fund (under grant K-129162). This work has been implemented by the National Multidisciplinary Laboratory for Climate Change (RRF-2.3.1-21-2022-00014) project within the framework of Hungary's National Recovery and Resilience Plan supported by the Recovery and Resilience Facility of the European Union.

The assessment of water availability deficits and drought indices for the rivers watersheds south of Ukraine

Valeriya Ovcharuk, Lilia Kushchenko

Odessa State Environmental University, Ukraine

Contact: valeriya.ovcharuk@gmail.com

The study area is the zone of insufficient water content in the South of Ukraine, where periodically observed of water deficits on rivers. To determine the deficits, the "threshold" method was used, which involves comparing the daily water discharges in the low water period with the values of the minimum runoff of a given probability of exceeding. Long-term data of average daily and average monthly minimum water discharges during the winter and summer-autumn period on rivers located in different areas of river basins and significantly differing in the catchment area, for the observation period from 1953 to 2018 inclusive was used. In cases where runoff values were less than Q90% or Q97%, they were considered deficient (90%) or extremely deficient (97%). The dynamics of deficits in time are analyzed, and the number of such events by decades, frequency, average volume, duration, and intensity are determined. The chronological course of runoff volumes and deficits (90%) is graphically presented. Additionally, extreme deficits were also estimated (97%).

The study also presents the results of the calculation of various drought indices. Analyzing the obtained results, it can be noted that drought indices provide an opportunity to study climatic and hydrological trends. In particular, the SDI index correlates well with water discharges, which opens up opportunities for forecasting runoff in the dry period

Climate change impact assessment for tourism for the territory of Hungary

Attila Kovács

University of Szeged, Department of Climatology and Landscape Ecology, Szeged, Hungary

Contact: kovacsattila@geo.u-szeged.hu

Tourism is an additional sector that is highly exposed to climate change, thus it is important to investigate the present and future climate conditions in terms of suitability for tourism. In the research, I analyse the climate potential for tourism for the territory of Hungary using several climate indices that characterize outdoor activities, especially in cities (like sightseeing). For quantifying the present conditions (1971–2000), observational database CarpatClim-HU is used. Expected future conditions (2041–2070, 2071–2100) are described with the latest regional climate model projections implemented by the Hungarian meteorological service (ALADIN, REMO), using RCP4.5 and RCP8.5 emission scenarios. The spatial distribution of the climate indices are displayed on maps on a district scale and monthly basis. In the present, spring and autumn are slightly more favourable for tourism than summer. This trend may be even more pronounced in the future, since most of the spring and autumn may become more favourable, while summer seems to bring less pleasant circumstances mainly due to warmer conditions.

Project no. 142335 has been implemented with the support provided by the Ministry of Culture and Innovation of Hungary from the National Research, Development and Innovation Fund, financed under the PD_22 funding scheme.

Evaporation estimation of Lake Balaton

Péter Torma, Sebestyén D. Török, Gabriella Lükő

Department of Hydraulic and Water Resources Engineering,
Budapest University of Technology and Economics, Hungary

Contact: torma.peter@emk.bme.hu

Lakes react sensitively to climate change, including our large and shallow water bodies. Lake Balaton has struggled with several water management problems in recent decades, including a few years with very low water levels in the early 2000s due to successive years of low rainfall. Lake Balaton is an almost closed-drainage lake, as the outflow is entirely regulated. The lake's water loss is exclusively caused by evaporation, which varies depending on the available energy and is determined by meteorological processes, primarily incoming solar radiation, air temperature, wind, etc. For the sustainable water management of Lake Balaton, it is necessary to know how the evaporation of the lake will change in the future. The first step is to explore evaporation characteristics of the past decades and find an evaporation calculation procedure that can be reliably adapted to Lake Balaton and also adjusted to the climate models' output variables. Our study presents climate change characteristics typical of the Balaton area and relevant to evaporation, employing data from the last four decades. We test evaporation calculation methods with different complexity and bases. We carry out their comparative analysis and evaluation based on available hydrometeorological measurements and monthly water balance time series.

POSTERS

Some notes on the relationship between dry density of sands and the grading entropy parameters

E. Imre[1], D.K. Mwinken[1], I. Talata[1], T. Goda[1], J. Lőrincz[2], D. Barreto[3], J. Leak[3], M. Datcheva[4], W. Baille[4], V.P. Singh[5]

[1]*Óbuda University, Hungary*
[2]*BME, Hungary*
[3]*Edinburgh Napier University, U.K.*
[4]*Ruhr University of Bochum, Gemany*
[5]*Texas A & M University, U.S.A.*

Contact: delphinsrc@gmail.com

Any particle mass size distribution can be characterized by two parameter pairs (derived from the statistical entropy formula of discrete distributions) more effectively than simple diameter values (i.e., d50). The meaning of the two grading entropy parameters S_0, ΔS is as follows: the first is a kind mean log diameter, the second is a measure of the elongation of the grading curve.The first normalised entropy parameter is a continuous internal stability measure, the second one allows the definition of a unique, mean grading curve with finite fractal grain size distribution for each value of internal stability measure.

Using these parameters, in this paper some earlier dry density data were analysed, searching the relation between the minimum dry density emax and the two grading entropy parameters (mean log diameter and fraction number characteristic). The data is split into two components. It is verified by model fitting that the first data component – constituting the major part of the density – is the linear function of the mean log diameter, the second one follows the symmetric shape of the entropy diagram.

The density– in terms of fractal or mean grading curves – is maximal around the point where internal structure changes, close to the maximum entropy point. These experimental results will be further investigated by DEM in the future together with the testing conditions since arching may occur in case of too small sample size. Moreover, grain shape may strongly influence the results.

Unveiling historical wintery conditions of Istanbul: WRF simulation for the frozen Bosphorus Strait in 1954

Sinan Şahinoğlu, Barış Önol

Istanbul Technical University, Türkiye

Contact: sahinoglus20@itu.edu.tr

Extreme weather events like cold air outbreaks can persist more than a week under certain atmospheric conditions. In the historical records, the Bosphorus Strait, located in Istanbul, Türkiye, were completely frozen 12 times and partially frozen 6 times. In the warmer climate era, this phenomenon has been experienced for the last time in winter of 1954. The ice masses from Danube occupied the Bosphorus Strait in 25 February 1954 and 5 March 1954, respectively. Favorable synoptic conditions lead to frigid cold air in Eastern Europe and Türkiye, minimum temperatures in Ukraine and Romania dropped to below -30 °C and the cold air lasted 30-40 days over the interest region. In this study, we investigated the atmospheric conditions, possible trajectories of ice masses over the Black Sea which can be also drifted from the Dniester besides the Danube river through the Bosphorus Strait. To produce high resolutions atmospheric conditions, we used WRF model (Weather Research and Forecasting Model) with 4-km horizontal resolution and ERA5 Reanalysis have been applied for initial and boundary conditions. OpenDrift model has been forced with wind simulation of WRF to define trajectories of the ice masses drifting over the Black Sea.

Wind velocity and solar radiation measurements on municipal solid waste (MSW) landfill hill sites of Hungary, a student research

Emőke Imre[1,2], Péter Felker[1], Lily Tanui[2,8], Ayurzana Ulsbold[2,8], Zsolt Hortobágyi[3], Gábor Mile[4], Bálint Sinkovics[5], Zoltán Kapros[6], Delphin K. Mwinken[7], Habaguhirwa Vedaste[1], Ágnes Bálint[2,8], Ákos Nemcsics[2,9], Antal Ürmös[2,9], István Szén[9], László Tóth[2], Tibor Goda[1], Csaba Kollár[1], Ervin Rácz[2,9], Tamás Weidinger[10]

[1]*Óbuda University, Bánki Donát Faculty, Budapest, Hungary*
[2]*Óbuda University, Hydro-Bio-Mechanical Systems Research Center, Budapest, Hungary*
[3]*Budapest University of Technology and Economics, Civil Engineering Faculty, Department of Structural Mechanics, Budapest Hungary*
[4]*FKF Zrt., Budapest, Hungary*
[5]*Budapest University of Technology and Economics, Faculty of Electrical Engineering and Informatics, Budapest, Hungary*
[6]*Ministry of Construction and Transport, Budapest, Hungary*
[7]*Doctoral School of Applied Informatics and Applied Mathematics, Óbuda University*
[8]*Óbuda University, Rejtő Sándor Faculty, Budapest, Hungary*
[9]*Óbuda University, Kandó Kálmán Faculty, Budapest, Hungary*
[10]*ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary*

Contact: imreemok@yahoo.com

This paper contains the first results of the wind velocity and solar radiation measurements, as a student research, which may serve as a basis of the design of the energy hills. It is found that the geometry of the MSW hill may ensure excellent seashore wind condition, the solar radiation has a more uniform time distribution and excellent cooling condition due to the uniform, surface wind below the solar panels.

A truncated pyramid-shaped artificial hill (Pusztazámor, hill 1) with short grass cover was started to be examined statistically in terms of wind velocity and solar radiation. Results showed some special meteorological features (influencing the type of the planned wind turbines and solar panels) which are presented here.

This has some significance since in the last few decades, about fifty modern municipal landfill sites have been established in Hungary. The 5, 10 or 15 km vicinity of these municipal landfills, the 24%, 44% and 60% of the total population are found here within the 16%, 37% and 53% of the villages and cities, so a large, de-centralized energy system consisting of energy hills could be made by using all landfills.

Hydrogen economy: Globally, domestically and at Óbuda University

István Szén, Emőke Imre

Óbuda University, Kandó Kálmán Faculty of Electrical Engineering, Institute of Electrophysics, Budapest, Hungary

Contact: imreemok@yahoo.com

Following the exploration of global energy problems, science and education need to focus on solutions. Significant transformations have taken place in the EU and the domestic energy industry over the past 2-3 years (development of gas storage facilities, research on synthetic fuels, the emergence of a domestic hydrogen strategy, and continuously increasing PV penetration), which are still ongoing and influencing industrial development and our everyday lives.

One of the dominant segments of energy consumption is transportation (approximately 25% of total energy consumed is allocated to transportation). It is evident in our current times that access to fossil fuels, as well as environmental protection and air quality, have a continuous impact on our lives. We must strive to promote carbon-neutral technologies. However, it is necessary to emphasize that the rate of growth in electrification is not proportional to the pace of development of the existing electric grid. It needs to be stated that the transportation sector requires a new, alternative fuel that appears to be hydrogen in the long run.

In the field of the hydrogen industry, education on hydrogen energy applications began in 2006, and our active research activities started in 2017 at Óbuda University. We were among the pioneers in the country to focus on the role of hydrogen in electric power engineering. Our instructors and researchers initially began working on the integration of renewable energy sources into systems, but over time, our research has expanded from industrial applications to encompass the energy sector and transportation. Our research activities, industrial collaborations, and participation in grant projects involve various aspects related to hydrogen, including the installation of electrolysers, technical and economic analysis of hydrogen storage and utilization.

In a unique approach within the country, starting from the 2023/2024 academic year, we will be launching two vocational engineering programs to meet the industrial needs. We are continuously developing our industrial partnerships at both domestic and international levels. Óbuda University is committed to sustainable energy, industry, and sustainable transportation technologies.