February 2025
Volume 2

Annual Report 2024

WIND TUNNEL
NATIONAL TECHNICAL UNIVERSITY OF ATHENS

Highlights

The Wind Tunnel at the National Technical University of Athens is publishing its second Annual Report this year. The Horizon EU TWEET-IE project continued this year, with several research and outreach activities, including our first highly successful summer school and industrial info day. There were also several measurement campaigns from the AGREE, Re-Nature Cities and INDIANA projects. The Wind Tunnel Administration and Management Committee (WT-A&M) had its hands full keeping things going and on schedule.

This year also saw the beginning of a monthly round of in-house presentations of the research progress of our PhD students.

Services to industry were active in the field of photovoltaics and anemometer calibration. We received several requests in response to our now operational web page and social media presence, some of which have evolved into planned work for the upcoming year. Visits from secondary level schools as well as industrial partners took place and we were honored to host the Chinese Deputy Minister of Education and the Chinese Embassy for a tour of our facilities. The Wind Tunnel team made its second appearance at the Researcher's Night event in September.

We hope you find the newsletter interesting. As always, your feedback is more than welcome!

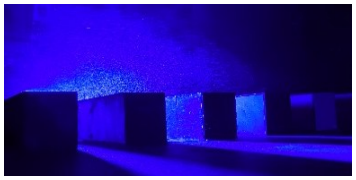
Research

Research activities from previous years continued but this year was full of wind tunnel measurement campaigns with many external groups visiting for the measurement campaigns.

"Twin Wind tunnels for Energy and the EnvironmenT - Innovations and Excellence: TWEET-IE" www.tweet-ie.eu
HORIZON-WIDERA-2021-ACCESS-03. HORIZON-CSA, Pr. #: 101079125.
NTUA Role: Co-ordinator

The research component of the TWEET-IE project involved two major measurement campaigns last year. The first involved wind turbine wake control with wind turbine models and expertise from the Technical University of Munich (TUM), brought to Athens to complement corresponding measurements already performed in the TUM wind tunnel. Measurements were conducted with the state of the art tomographic particle image velocimetry (tomo PIV) system brought in, installed and operated in the NTUA WT from Technical University of Delft (TU Delft). We were thrilled to have a huge and diverse team of experts in Athens from TUM and TU Delft for these experiments. Back-to-back to this experiment, another one was performed regarding the flow in urban street canyons. A robotic arm tomo-PIV system, also brought and operated by the TU Delft

Research (cont.)



team, was installed in the NTUA WT and measurements were performed, this time also with the valuable contribution and expertise of the Karlsruhe Institute of Technology (KIT). Further to this, members of the NTUA team travelled to Munich and Delft for the complementary leg of each of these measurement campaigns. We are just at the beginning of processing the large amount of data that was obtained from these measurements. Many thanks to all that contributed to this enormous scientific (and logistical) effort, from TUM: Prof. Carlo Bottasso, Dr. Franz Muehle, Mr. Simone Tamaro, Dr. Filippo Campagnolo, from TU Delft: Assoc. Prof. Andrea Sciacchitano, Mr. Brian Dsouza, from KIT: Dr. Christof Gromke, and all those behind the scenes. The TWEET-IE project research continues this year with the final twin test campaign, in collaboration with Polytechnico di Milano (POLIMI). Updates, further info and links to the results are and will be made available on the project web page www.tweet-ie.eu

"AGREE: Airfoil aeroelastic Gust REsponse under stall fluttEr oscillations"
Greece 2.0 Basic Research Financing Action - Funding New Researchers - Hellenic Foundation for Research and Innovation.
NTUA Role: Coordinator
Partners: von Karman Institute for Fluid Mechanics (VKI, Belgium), IDPortal engineering (UK), Aristotle University of Thessaloniki (GR).

The project aims at examining airfoil aeroelastic gust response, with applications in the UAV, Aeronautical and Wind Energy industry. In the course of the project, we have designed and installed a bespoke gust generation mechanism. This is combined with the Airfoil elastic support system, making the NTUA wind tunnel one of the few facilities globally that can perform gust response aeroelastic tests at Re numbers up to Re=2M.

"Re.Nature Cities: Experimental and numerical methods to assess the role of stReet trees as a Nature-Based Solution for climate change adaptation of Cities"
https://renaturecities.gr/
Greece 2.0 Basic Research Financing Action. Hellenic Foundation for Research and Innovation.
Coordinator: University of Patras.
NTUA Role: partner.

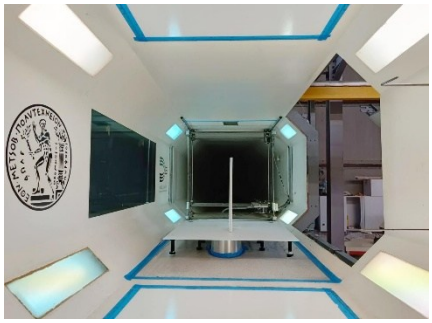
Re.Nature Cities aims to evaluate via experimental and simulation means the ability of street trees as nature-based solution (NBS), to act as an effective measure against the increased air temperature on the ambient and indoor environment, thermal discomfort, air pollution and energy

Research (cont.)

costs, caused due to the climate change, while promoting public health and the well-being of citizens. NTUA's role is to perform wind tunnel measurements of the drag coefficient of common urban tree species. This was a particularly challenging campaign as the trees were quite demanding in TLC before, throughout and after the measurements. We measured a total of four different tree species at 3 trees per species. The results are complemented by albedo, leaf area index/leaf area density measurements performed by the University of Patras (project host and coordinator) and the project research team. (The trees now proudly stand as a part of the NTUA campus environment!)

ELIDEK INDIANA: Integrated AI-aided wing design and shape optimization framework for Unmanned Aerial Vehicle applications
Coordinator: Aristotle University of Thessaloniki
NTUA Role: partner
Basic Research Financing (Horizontal support for all Sciences) National Recovery and Resilience Plan" of the Hellenic Foundation for Research and Innovation (HFRI/ELIDEK)

The first phase of the wind tunnel experiments for the INDIANA project has been successfully completed, marking a significant milestone. To carry out the experiments, UAV-iRC (AUTH) designed three wing models, while a specialized test rig was jointly developed by UAV-iRC and NTUA. The experimental results will support the broader research objectives of the INDIANA project, where an Artificial Neural Network (ANN) will be trained to:

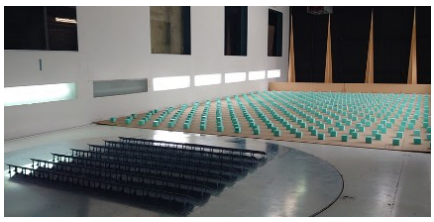


- Rapidly generate wing geometries for both conventional tube-and-wing and Blended-Wing-Body configurations.
- Identify key aerodynamic, stability, and weight parameters.
- Determine the optimal wing configuration for specific applications

Services

Measurement of wind loads on multiple rows of solar panels: A reduced-scale wind tunnel study
Contractor: DIOLY IKE

A wind tunnel study of multiple rows of PV panels was performed and the force coefficients on panels of different rows and different positions in the row were evaluated. A new pressure scanner was acquired for these measurements, in order to simultaneously monitor instantaneous local differential pressures on the panels. Comparisons with standard practice of Eurocode implementation was particularly insightful.



Collaborations

Members of the Wind Tunnel group were involved in collaborative and organizational activities:

- Assoc. Prof. V. Riziotis participates in the organization and scientific committee of the Science of Making Torque from Wind Conference 2024.
- A successful faculty exchange collaboration was realized with TU Gratz, Austria. We were delighted to have Asst. Prof. C. Irrenfried at NTUA for three months. He participated in several experimental campaigns and performed CFD studies of the flow past a building.
- Asst. Prof. M. Manolesos is a member of the scientific committee for the Wake Conference 2025 and organizes a Mini Symposium on Wind Turbine Wake modelling during WESC 2025.
- Aerodynamics Lab was selected by the European Academy of Wind Energy to host the annual PhD Seminar in 2025.
- We are happy to continue collaborations with Technical University of Denmark, Technical University of Munich, Technical University of Delft, Politecnico di Milano in the process of proposal submissions.

News And Events

- The NTUA Wind Tunnel web page continues to present activities and new developments www.wt.fluid.mech.ntua.gr
- Prof. Demetri Bouris and PhD candidate Vasso Pappa presented wind tunnel studies at the PHYSMOD 2024 – International Workshop on Physical Modelling of Flow and Dispersion Phenomena. Ecole Centrale de Lyon, Ecully, France – August 28-30, 2024.
- Asst. Prof. Marinos Manolesos and PhD students Vasso Pappa and Konstantinos Kellaris presented results at the 9th International Colloquium on Bluff Body Aerodynamics and Applications, BBAA IX, Birmingham.
- Prof. Demetri Bouris, Asst. Prof. Marinos Manolesos and PhD students Nikos Pallas and Konstantinos Kellaris presented results at the 12th National Conference on Fluid Flow Phenomena ROH2024, in Thessaloniki.
- Prof. Demetri Bouris participated in the ERCOFTAC autumn festival.
- The NTUA Wind Tunnel team is planning EAWE's 2025 PhD seminar.
- Second appearance and participation in Researcher's Night, September 30th, Athens. www.ntua.gr/ntuaren



- Asst. Prof. Marinos Manolesos participated as a member of the EAWE Wind Tunnel Committee. He began arrangements for a round robin research activity for wind tunnel measurements in the wake of porous disks.
- Asst. Prof. Marinos Manolesos, as a member of the EAWE Wakes and Wind Farm Aerodynamics Committee and the TWEET-IE project, is organizing a wake control experiment benchmark. http://tweet-ie.eu/Blind_Test
- PhD student Vassiliki Pappa spent 1 month at the Technical University of Munich, under the 2nd Twin Test of the TWEET-IE project. Together with Prof. C. Bottasso, Dr. F. Muehle, Dr. F. Campagnolo and Mr. S. Tamaro, they performed measurements at the TUM wind tunnel of wind turbine wake control. Asst. Prof. M. Manolesos joined them
- PhD student Nikos Pallas was at TU Delft for 1 month, under the 3rd twin

News And Events (cont.)

test of the TWEET-IE project. He performed tomo-PIV and pressure measurements of the flow in an urban street canyon with Assoc. Prof. A. Sciacchitano and Mr. B. DSouza. Prof. D. Bouris and Dr. C. Gromke (KIT) joined them.



- The first summer school on Wind Tunnel Testing for Wind Energy and Urban Flows was held at the National Technical University of Athens, Greece from 15-19 July. A total of 14 students from around the world participated. A huge thank you to our esteemed lecturers: Prof. Demetri Bouris, Prof. Alessandro Croce, Dr.-Ing. Christof Gromke, Asst. Prof. Christoph Irrenfried, Asst. Prof. Marinos Manolesos, Dr. Franz Mühle and Assoc. Prof. Andrea Sciacchitano. We also extend our heartfelt thanks to other invaluable contributors: Dr. Petros Chasapogiannis, Simone Tamaro, Akis Grigoropoulos, Konstantinos Kellaris, Nikos Pallas, Nikos Papakonstantinou, Vasso Pappa, Sotiris Mavrakis, Ioanna Tassi - without your help and input, this event would not have been possible!



- In the framework of the Horizon-Europe TWEET-IE project, a NTUA Wind Tunnel Technical Info Day, took place on the 26th of June at National Technical University of Athens, ANYM Building http://tweet-ie.eu/News/NTUA_Wind_Tunnel_Technical_Info_Day. The capacity for research and services was presented through presentations of past and present case studies, related to aerodynamics, wind energy, environmental flows and buildings applications. In addition, a tour of NTUA Wind Tunnel facilities gave us the opportunity to demonstrate the wind tunnel testing facility.


- The Rector of the National Technical University of Athens, Prof. I. Chatjigeorgiou, welcomed on Monday, December 9, 2024, at the Administration building at NTUA, a delegation of the Ministry of Education of the People's Republic of China led by the Deputy Minister of Education Mr. Wang Guangyan, as well as a delegation from The Hong Kong University of Science and Technology - Guangzhou (HKUST-GZ) led by the Vice President, Professor Ting Chuen Pong. https://www.linkedin.com/feed/update/urn:li:activity:7273008066256658433 . The NTUA Wind Tunnel was one of the selected university facilities that was presented to the Chinese delegation. NTUA has had traditional collaborations with Chinese Universities since 2012.

Publications

Conferences

Kellaris K, Papadakis G., Manolesos, M., (2024) On the three-dimensional coherent structures in the wake of flatback airfoils, 9th International Colloquium on Bluff Body Aerodynamics and Applications, BBAA IX, Birmingham

Pappa, V., Campagnolo, F., Tamaro, S., Mühle, F., Stegmüller, J., Croce, A., Gromke, C., Riziotis, V., Bottasso, C., Sciacchitano, A., Bouris, D. and Manolesos, M., (2024) A blind test on wind turbine wake modelling based on wind tunnel experiments: Phase I – The benchmark case, J. Phys.: Conf. Ser. 2767 092053 https://doi.org/10.1088/1742-6596/2767/9/092053

Κελλάρης, Κ., Παπαδάκης, Γ., Μανωλέσος, Μ., Μελέτη των δευτερευουσών ασταθειών στον ομόρρου αεροτομής με παχύ χείλος εκφυγής, 12ο Πανελλήνιο Συνέδριο Φαινόμενα Ροής Ρευστών ΡΟΗ2024, Θεσσαλονίκη

Kellaris K., Papadakis G. and Manolesos M., (2024, 24-26 September), Study of the three-dimensional coherent structures in the wake of flatback airfoils, 20th EAWE PhD Seminar,Visby, Sweden.

Pappa V., Gromke C., Bouris D (2024) Flow past a building with surface greening: comparison of PIV and LDV in two wind tunnels . PHYSMOD 2024 – International Workshop on Physical Modelling of Flow and Dispersion Phenomena. Ecole Centrale de Lyon, Ecully, France – August 28-30, 2024

Pappa V., Gromke C., Bouris D. (2024) Twin wind tunnel tests of flow past a building with openings and façade and rooftop greening. 9th Int. Coll. on Bluff Body Aerodynamics and Applications, University of Birmingham, Birmingham, UK, 29th July – 2nd August 2024.

Βασιλική Παππά, Christof Gromke, Δημήτρης Μπούρης (2024) Διδυμες Μελετες, Σε Αεροσηραγγες, Της Ροης Γυρω Απο Κτηριο Με Φυτεμενη Οψη Και Δωμα.. ΡΟΗ 2024 - 12ο Πανελλήνιο Συνέδριο Φαινόμενα Ροής Ρευστών. Θεσσαλονίκη, 15 – 16 Απριλίου, 2024

Franz V. Mühle, Simone Tamaro, Davide Bortolin, Filippo Campagnolo, Vasiliki Pappa, Marinos Manolesos, Andrea Sciacchitano, Brian Dsouza and Carlo L. Bottasso. (2024) The Potential of Combining Static Wake Control with Wake Mixing Techniques for Faster Wind Turbine Wake Recovery. NAWEA conference 2024 held from 29.10. – 01.11. in New Jersey

Data Sets

The wind tunnel measurement data from Phase I of the Blind Test on wind turbine wake modelling, conducted in the closed-loop, low-speed boundary layer wind tunnel of TUM, was uploaded to the Zenodo repository https://doi.org/10.5281/zenodo.10566400 .

The dataset from the second twin test conducted in the TUM and NTUA wind tunnels (wake interactions of a cluster of turbines and wake steering techniques), was uploaded to the Zenodo repository https://doi.org/10.5281/zenodo.14017240.

The dataset of measurements of tree drag coefficients from the ReNature Cities projects was uploaded and is available on the Zenodo repository https://zenodo.org/records/14442184

Education

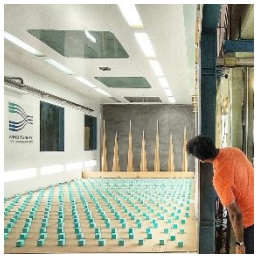
PhD's

- Pallas Nikolaos. Flow Field Simulation with combination of experimental measurements and numerical methods
- Pappa Vassiliki. Numerical and experimental study of the effect of urban structure and environmental conditions on the flow field around buildings.
- Kellaris Konstantinos. Study and Control of the Flow Past Flatback Airfoils

Education (cont.)

Undergraduate and MSc Courses

- Over 100 students directly accessed the wind tunnel facility in the past year in the framework of courses, theses and lab exercises
- The large test section of the wind tunnel was a part of lab exercises in the context of Experimental Fluid Mechanics undergraduate course (7th semester)



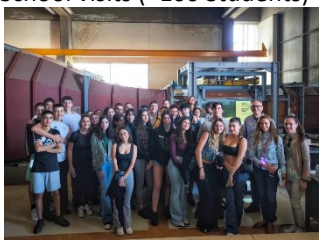
- The large test section of the wind tunnel was a part of the small wind turbine wind tunnel testing exercise in the context of Wind Energy undergraduate course.
- The large test section of the wind tunnel was a part of the small wind turbine wind tunnel testing exercise in the context of the EUREC master

Student Activities

- The Aiolos student team of the National Technical University of Athens completed the construction and the testing of a small wind turbine, which left the Aerodynamics laboratory, for the International Small Wind Turbine Contest (ISWTC) in the Netherlands!

Outreach

- 6 High School visits (>100 Students)



- Our social media presence currently stands at >700 followers in total on Facebook, LinkedIn and Instagram and >65 posts on Facebook, LinkedIn and Instagram in the past year

Personnel

Faculty

- Prof. Spyros Voutsinas
- Prof. Demetri Bouris
- Assoc. Prof. Vasilis Riziotis
- Asst. Prof. Marinos Manolesos

Research and Teaching Staff

- Dr. Petros Chasapogiannis
- Dr. John Prospathopoulos

Scientific and Technical Support

- Dr. Konstantinos Vassilopoulos
- Mr. Sotiris Mavrakis

Personnel (cont.)

Administration
- Ms. Ioanna Tassi
- Ms. Eri Margioli

PhD's
- Ms. Vasso Pappa
- Mr. Nikolaos-Petros Pallas
- Mr. Konstantinos Kellaris

Contact Info

www.wt-fluid.mech.ntua.gr

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