

Annual Report

2023



Highlights

The Wind Tunnel at the National Technical University of Athens is publishing its first Annual report this year. The Horizon EU TWEET-IE project undoubtedly marked the year with several activities redefining the wind tunnel's administration, management, outreach and, ultimately, usage. We now have a formally initiated wind tunnel administration and management committee, tackling issues such as time management, equipment upgrades and project coordination. Our new project AGREE, funded by HFRI, was also initiated in December.

In terms of personnel, Prof. Dimitris Mathioulakis retired from active involvement, but Asst. Prof. Marinos Manolesos began full activities.

Several services to industry went ahead, the wind tunnel web page began full operation and presence on social media has begun. Visits from secondary level schools as well as industrial partners took place and this was the wind tunnel's first year of participation in the Researcher's night event.

We hope you find the newsletter interesting and welcome your feedback!

Research activities from previous years continued but the year was marked by newly funded research that we expect to begin bringing in results by the end of 2024:

“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 TWEET-IE project aims to upgrade the Wind Tunnel (WT) testing activities at



National Technical University of Athens (NTUA). The NTUA WT will be rendered on par with other world class facilities for hosting a variety of research applications in the field of external aerodynamics, primarily focusing on clean-tech, energy and transport applications. It includes knowledge transfer and networking activities with 4 leading European universities: Technical University of Munich (TUM), Technical University of Delft (TU Delft), Karlsruhe Institute of Technology (KIT), Politecnico di Milano (POLIMI), which have all been successfully operating their own large WTs for decades and have remarkable scientific and research track records.

Research

Research (cont.)

TWEET-IE is conceptually based on three distinct pillars i) enhancing administration and management capacity, ii) upgrading technical competence and iii) improving visibility and profile of the facility. Renewable energy sources, clean-tech and energy efficiency in the urban environment will be the cornerstones for accomplishing EU's energy and climate ambition to render Europe the first energy neutral continent by 2050 and WT experiments are indispensable for analyzing issues related to wind energy and environmental flows. This is one reason that upgrading the in-house WT has been prioritized as a research goal of paramount importance for both the School of Mechanical Engineering, NTUA and the labs involved in the WT management and operations. TWEET-IE's primary goals will be achieved through systematic work and seamless communication between project working groups, comprising key personnel from all partners, and a series of networking, training and research activities and events, in which all leading members of the consortium play an equally important role. TWEET-IE's strategic research goal is to address the challenge of measurement conformity among different WT. Four identical state-of-the-art test campaigns will be repeated in different tunnels, serving the strategic goal, the improvement of NTUA's technical capacity and also stimulating research innovation and excellence per se.

"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

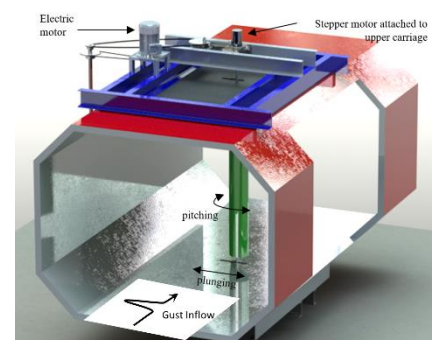
Gusts of moderate and large magnitude induce flow separation and other complexities when they interact with the lifting surfaces of air vehicles or other aerodynamic surfaces. The presence of gusts is ubiquitous in twenty-first century air vehicles and large Wind Turbines, where the classic potential flow-based methodologies applied in the past is no longer valid. A primary motivation in studying gust encounters is to understand their underlying physics and develop new and effective mitigation strategies. To achieve this, state-of-the-art tools and new ways of analysis are required.

This project will combine state-of-the-art experimental and computational tools along with a newly patented wing design concept in order

- to examine the non-linear flow and elastic mechanisms at play, when a gust encounters an aeroelastic airfoil, and
- to quantify the properties of a camber morphing design.

Data driven decomposition methods will be used in the analysis of the wind tunnel and numerical results.

In the course of the project a bespoke gust generation mechanism will be designed for the wind tunnel at the National Technical University of Athens. This will be combined with the existing Airfoil elastic set up creating a world leading facility for gust response aeroelastic tests at moderate Re numbers ($R < 2M$).



Partners include the von Karman Institute for Fluid Mechanics (VKI,

Research (cont.)

Belgium), IDPortal engineering (UK) and the Aristotle University of Thessaloniki.

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

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 a nature based solution (NBS), to act as an effective measure against increased air temperature in the ambient and indoor environment, thermal discomfort, air pollution and energy costs, caused due to the climate change, while promoting public health and the well-being of the citizens. Although street trees have been extensively investigated in the past, they have been assessed only under current conditions, without considering possible impacts under different climate change scenarios.



Re.Nature Cities has the following main objectives:

- To assess the microclimatic conditions prevailing in urban districts in the city of Athens, on the basis of the current and the estimated climate change conditions.
- To estimate the building's energy performance, as well as the thermal comfort conditions in indoor and outdoor spaces located in the examined areas, using the microclimatic data of the current and the future periods as boundary climatic conditions.
- To provide guidelines regarding the contribution of street trees as NBS to the climate resilience of the selected case study areas, i.e., on the local microclimate, the improvement of the building energy performance, the living conditions, indoor and outdoor thermal comfort and air quality.
- To create a high accuracy experimental database of foliage, thermal and aerodynamic characteristics of common urban tree species, available for use in the precise and holistic evaluation of trees effect in cities.
- To develop a decision-making toolbox, which will allow for the optimized selection street trees and planting pattern for urban areas, having similar characteristics with the examined ones.

ELIDEK INDIANA: Integrated AI-aided wing design and shape optimization framework for Unmanned Aerial Vehicle applications

Coordinator: Aristotle University of Thessaloniki

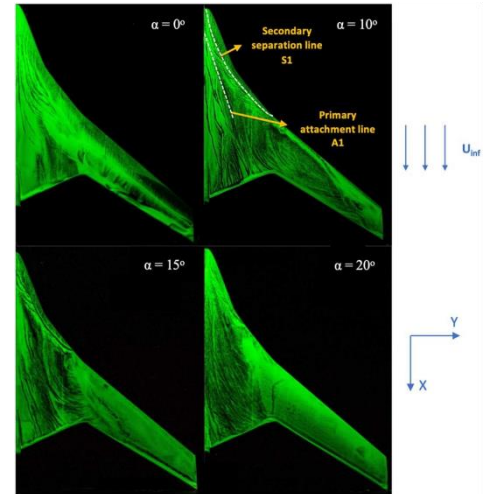
NTUA Role: partner

Basic Research Financing (Horizontal support for all Sciences) National Recovery and Resilience Plan" of the Hellenic Foundation for Research and Innovation (HFRI/ELIDEK)

The goal of the project is the development of a framework that can design and optimize wing configurations for fixed-wing Unmanned Aerial Vehicle applications. This goal will be achieved by combining multiple aerospace

Research (cont.)

engineering disciplines through the development and synergetic integration of 5 modules for the design procedure and 1 module for the optimization. The framework development will be based on the Python programming language employing an object oriented architecture. A novel Artificial Intelligence approach will be employed for the development of the aerodynamic and stability coefficients module to allow rapid acquisition of high-fidelity predictions in a reduced order modeling approach. Computational Fluid Dynamics data will be used for its training and wind tunnel experiments will be conducted to validate its results. The other 4 modules will handle the external layout parameters calculation the internal layout and weights calculation the stability assessment (0D-1D tools) and the 3D layout generation (3D CAD tool). The 5 wing design modules will be integrated into a “baseline” framework capable of producing a wing “instance”. The “baseline” framework will be coupled with an optimizer module that will generate multiple instances and evaluate them in an iterative procedure until the shape optimization target is met.



The INDIANA framework will emphasize on external shape optimization and be applicable to both conventional (wing-body-tail) and Blended Wing Body (BWB) UAV configurations where multidisciplinary is critical. Its potential on other aerospace-related applications such as commercial airliner wings and propeller blades will also be investigated. The proposed research approach inherently involves high-risk due to its novelty but can potentially yield significant improvements in the field of aviation by generating optimized wing configurations that are hard to design if not completely unattainable by a human Engineer.

The wind tunnel experiments will be conducted in the National Technical University of Athens (NTUA) while the rest of the INDIANA framework development activities analysis and coding will be conducted in Aristotle University of Thessaloniki (AUTH) which is the INDIANA Host Institution.

Services

Numerical study of aeroelastic behavior of photovoltaic panels – Experimental study of wind loads and dynamic response of photovoltaic panel arrays.

Contractor: METALOU MIN AEBE

A wind tunnel study of multiple rows of PV panels was performed and the dynamic response of the panels to the flow was evaluated. Combined with extensive CFD studies, important insight was provided regarding conditions of divergent oscillations of the panels.

New equipment – capabilities

- Low range – moderate frequency (0-35Pa, 80 Hz) pressure measurement capabilities were added to the facility for low speed wind tunnel testing.

Collaborations

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

- Assoc. Prof. V. Riziotis participated in the organization of the WESC 2023 symposium
- Assoc. Prof. V. Riziotis participates in the organization and scientific committee of the Science of Making Torque from Wind Conference 2024
- A faculty exchange collaboration has been initiated with TU Gratz, Austria. We are happy to invite Asst. Prof. C. Irrenfried to NTUA in 2024.
- We are happy to have initiated collaborations with Technical University of Berlin, University of Firenze, University of Parma, von Karman Institute for Fluid Dynamics, Center for Research and Technology Hellas in the process of proposal submission

News And Events

- The NTUA Wind Tunnel web page is operational as of this year www.wt.fluid.mech.ntua.gr
- After several decades of serving the School of Mechanical Engineering, the Fluids section and the Laboratory of Aerodynamics, Professor Demetri Mathioulakis retired this year
- Assistant Professor Marinos Manolesos joined the Fluids section and began teaching and research activities, also involving the wind tunnel facility
- A wind tunnel management committee has been established with participants from the Laboratory of Aerodynamics and the Laboratory of Innovative Environmental Technologies.
- Prof. Demetri Bouris and PhD candidates Vasso Pappa and Nikos-Petros Pallas participated in the 16th International Conference on Wind Engineering (ICWE 16, www.icwe2023.com) in Florence, Italy, Aug 27-31, 2023.
- The NTUA Wind Tunnel team of NTUA undertook the organization of EAWE's 2025 PhD seminar.
- First 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. www.eawe.eu/organisation/committees/#Wind-TunnelTestingCommittee
- Asst. Prof. Marinos Manolesos participated as a member of the EAWE Wakes and Wind Farm Aerodynamics Committee. He began a benchmark activity for wake measurements in wind tunnels. www.eawe.eu/organisation/committees/#WakeandWindfarmaerodynamicsCommittee
- PhD student Vassiliki Pappa spent 2 months at Karlsruhe Institute of Technology, Karlsruhe Germany under the 1st twin test of the TWEET-IE project. Together with Dr Christof Gromke, they performed LDV measurements at the KIT wind tunnel of the flow and air exchange of a model building with rooftop and façade greening.
- We had the pleasure of having Dr. Gromke in Athens for the

News And Events (cont.)

corresponding twin test with stereo PIV measurements in the NTUA wind tunnel.

- The [Grand Opening Event \(GOE\)](#) of the TWEET-IE project took place in Athens from 24th – 26th January with on-site participation from TUM, KIT, TU Delft and POLIMI. Apart from discussing issues related to the project's progress and planning, we were delighted to hear about managing EU projects and large Wind Tunnel Facilities, via online presentations, from experienced partners from Karlsruhe (KIT) and Delft (TU Delft). Technical presentations of state of the art Wind Tunnel Measurement techniques were presented both onsite and online (from TU Delft) and the use of advanced numerical tools was also discussed. Presentations were open to the public and attracted participants from the NTUA PhD students' community, technical staff and even NTUA's Vice Rector.



- NTUA hosted the TWEET-IE 12-month Plenary Meeting and the [Administration and Management Workshop](#) on the 9th and 10th of November in Athens, Greece. TWEET-IE partners discussed the project's developments and the results achieved in the first year. A workshop on Wind Tunnel Administration and Management also took place. Experience from the past 10-20 years in wind tunnels around the world was shared among the members of the consortium including presentations from NTUA's own research committee and visitors : Prof. Gregory Kopp from the University of Western Ontario, Canada, Prof. Georg Eitelberg from TU Delft and DNW and Prof. Sergio Ricci from POLIMI.



- The LDV and PIV dataset from the 1st Twin Test, performed at the KIT and NTUA wind tunnels, was uploaded to the Zenodo repository, publicly available for validation and other research <https://zenodo.org/records/10019002>.
- The Data Management Plan (DMP) was uploaded as a living document to the ARGOS platform, <https://argos.openaire.eu/explore-plans/publicOverview/9a13e9d1-d705-469d-87bc-6917a5d621e1>, linked to the datasets uploaded to the Zenodo repository.
- Chinese delegations visited our facility in November 2023, from : Lanzhou University of Technology, Wuhan University (State Key Laboratory of water resources engineering and management), China education association for international exchange, Zhejiang university of science and technology, Beijing normal university and others

Publications

Journals

- Kellaris K., Pallas N-P, Bouris D. 2024. "Numerical calculation of the turbulent flow past a surface mounted cube with assimilation of PIV data." Meas. Sci. Technol. 35, 015301. doi.org/10.1088/1361-6501/ad0319



Publications (cont.)

- Pappa V., Bouris D., Theurer W., Gromke C. 2023. "A wind tunnel study of aerodynamic effects of façade and roof greening on air exchange from a cubic building" Building and Environment, 110023, ISSN 0360-1323, doi.org/10.1016/j.buildenv.2023.110023.

Conferences

- Pappa V, Bakolas A, Bouris D, Gromke C. (2023) Effects of Façade and Rooftop Greening on the Surface Pressure Distribution of an isolated cubic Building with vertical Apertures. ICWE 16. 16th International Conference on Wind Engineering. August 27-31st, 2023, Florence, Italy.

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

Diploma Theses

- Characterization of velocity profiles for the wind tunnel scale simulation of the atmospheric boundary layer. 2023. Pavlos Dionysopoulos
- "Experimental modelling of wind turbine wakes using perforated disks. 2023, Mouratai Skenter.

Undergraduate and MSc Courses

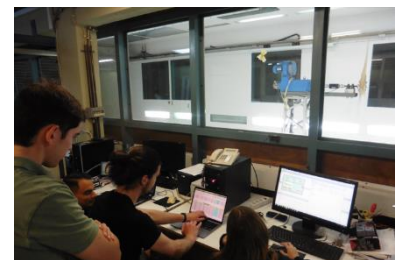
- Over 100 students directly accessed the wind tunnel facility in the past year in the framework of courses, theses and lab exercises
- The large test section of the wind tunnel was a part of lab exercises in the context of Experimental Fluid



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

- EUROAVIA Athens tested a series of aircraft propellers for an aircraft motor



Outreach

- 6 High School visits (>100 Students)



- The TWEET-IE project partners (TUM, KIT, POLIMI, TU Delft) as well as our visitor and speaker at the Administration and Management workshop Prof. Georg Eitelberg (TU Delft) visited and toured the wind tunnel facility
- Dr. C. Gromke from KIT stayed with us during PIV experiments under the TWEET-IE project
- We were happy to have Prof. Feng Shan visit us from the Huazhong University of Science and Technology, China. He presented the [lectures](#) :
 - "An Introduction to Laser-Induced Fluorescence (LIF) and Applications to Flow Visualization and Temperature Field Measurements", Wednesday 28/6
 - "An Introduction to Tomographic Particle Image Velocimetry and some real applications", Thursday 29/6
 - "What if the velocity field is not enough? Some examples of simultaneous measurements of velocity field and mass/heat transfer", Friday 30/6
- Dr. C. Gromke (Institute for Water and Environment, Karlsruhe Institute of Technology) presented a [lecture](#) on the "Vegetation in Urban Street Canyons and its Impact on Air Quality", Thursday July 13th, 2023. Dr. Gromke's presentation is in the framework of his visit for the second phase of the first Twin Test measurements of our EU Horizon TWEET-IE project.
- Prof. P. Diamessis (School of Civil & Environmental Engineering, Cornell University, USA) presented a [lecture](#) on "The development of turbulence in convectively breaking internal solitary waves of depression shoaling over gentle slopes in the South China Sea". Prof. Diamessis is a Fluids Section, Mech. Eng., NTUA alumni with whom we have a long standing association but he will be presenting his (post-graduation) work for the first time at the NTUA.
- Several private companies expressed interest and came to visit
- Our social media presence currently stands at >250 followers on Facebook, LinkedIn and Instagram and >35 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



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



Funded in part by the EU



www.tweet-ie.eu

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