

# Sustainability Dimensions

Annual Report of the Laboratory of Heat Transfer and Environmental Engineering - Mechanical Engineering Department, Aristotle University Thessaloniki, Greece

# 2016

2016 was the seventh consecutive year of economic crisis in Greece. The country is experiencing a dramatic recession with the GDP having declined by as much as 30%. Austerity measures alone do not appear to remedy the situation, while the overall crisis penetrates the entire fabric of the country's production system, amplified by several fundamental problems of structural nature, including extremely low expenses for R&D and the failure to bring up technology-based economic growth as a key issue in the public agenda.

As a consequence, a large part of the educated workforce (technicians, scientists, engineers, researchers) seeks a better future out of the country, making the recovery even more difficult. This "brain drain" is a strong negative factor for any efforts to overcome the present crisis. As a matter of fact, it is absurd that Greece, a virtually bankrupt country, indirectly supports the economies of several economically healthier countries by providing them with highest quality human capital that has been educated at the cost of the Greek people.

In spite of these adverse circumstances, Greek scientific institutions (universities, polytechnics and research centres) keep on conducting high level research – an apparent prerequisite for kicking-off technology-based economic growth. International research initiatives and an efficient networking allow involving in the different activities a respectable number of top level researchers of Greek origin in the diaspora. First examples of constructive research collaborations are encouraging, especially given the fact that Greek enterprises appear to be increasingly interested in participating to such joint ventures.

Along these lines, our Laboratory maintains close cooperation with research groups in several European countries, and this allows our being part of strong consortia competing for research funds at EU level. Three of our research proposals were approved last year, and numerous new ideas for innovative research are included in research proposals submitted to various funding agencies. Our continued efforts towards a synthesis of high level education, research and innovation are our recipe for sustaining in this difficult period for our country, but represent at the same time our contribution to overcome the crisis.

Interdisciplinary research has always been a major target for our Laboratory. Therefore, we wholeheartedly supported our University's intention to create an Interdisciplinary Centre for Research and Innovation (ICRI). Following the procedure foreseen, we succeeded to be involved in two of the first nine interdisciplinary teams affiliated to ICRI. On one hand we coordinate SUMAQ (Sustainable Management of Air Quality in the Atmospheric Environment), with the participation of colleagues from Mechanical Engineering, Chemistry and Medicine, and on the other we are partners of SASC (Sustainable Agrifood Supply Chains) coordinated by Assoc. Professor Dimitrios Vlachos from our Department. We are confident that ICRI will boost high level research in our University while providing new opportunities for fruitful collaborations with enterprises and the industry.

As an important structural change for us, Associate Professor Leonidas Ntziachristos joined our Laboratory in 2016. Leonidas is faculty member of the Department of Mechanical Engineering since September 2009. His research interests include pollutants formation and control, exhaust aerosol sampling and characterization, and emission models and projections development. Currently, he works on the development of aerosol instrumentation and sensors for diesel exhaust aerosol as well as models for the calculation of air pollutants and greenhouse gases from road transport. He obtained his PhD in our University, conducted post-doctoral research at the University of Southern California, and currently serves as part time research fellow at the Tampere University of Technology in Finland. He is responsible for the development of COPERT software, on behalf of the European Environment Agency and the EU Joint Research Centre. He co-chairs the transport expert panel of the UNECE Task Force on Emission Inventories and Projections and he is member of the steering committee of the European Research Group on Mobile Emission Sources. He has more than 100 international peer review journal publications (h-index: 31, >2400 citations) and a large number of contributions in conference proceedings and book chapters. His engagement in education and research will significantly affect the proceedings of our Laboratory in the years to come.

Prof. Dr. Nicolas Moussiopoulos  
Laboratory Director

## Air pollution policies for assessment of integrated strategies at regional and local scales (APPRAISAL)

APPRAISAL was a European project aiming at reviewing the various methodologies and tools used within the EU Member States (MS) for the assessment and management of Air Quality Plans (AQP), according to the requirements of the 2008/50/EC Directive. As a result, APPRAISAL provided insights on the way local and regional measures are implemented in different EU MS, but also on the way their efficiency is measured. An overall review of Integrated Assessment Methodologies (IAM), currently used in MS to assess regional and local scale air quality and its impacts, was also undertaken. Based on the results, a general IAM framework to fulfil policy-maker needs was proposed and accompanied by guidelines to support its implementation. The project findings can be valorized to provide scientific and technical support to policy makers.

In APPRAISAL, LHTEE participated in the review of health impact assessment methodologies at the regional and local scale and in the review on air quality assessment and source apportionment methodologies at different horizontal scales. For this purpose, the Laboratory has undertaken a review on AQP of Athens, Thessaloniki, Volos and Cyprus by distributing the relevant questionnaire to the local stakeholders. LHTEE also contributed to the preparation of the guideline documents based on the review phase and to the design of the prototype Integrated Assessment modelling System (IAS) of APPRAISAL.

The final results of the project include the development of a database containing information from the review on the methodology used by different MS to assess air pollution mitigation plans. This database was organized around five main themes: (i) Synergies across spatial scales (from European to local) (ii) Air quality assessment and Integrated Assessment approaches (iii) Health impact assessment (iv) Source apportionment (v) Uncertainty and robustness.

The database was populated on the basis of a survey sent throughout Europe, to which 59 responses from 13 countries were received, and can presently be queried online at [www.appraisal-fp7.eu](http://www.appraisal-fp7.eu). Based on the review, a set of guidelines has been prepared on best practices regarding the implementation of IAS for air quality management. The design of the IAS framework of the project was based on the DPSIR (Drivers-Pressures-State-Impact-Responses) scheme and classifies two possible decision pathways:

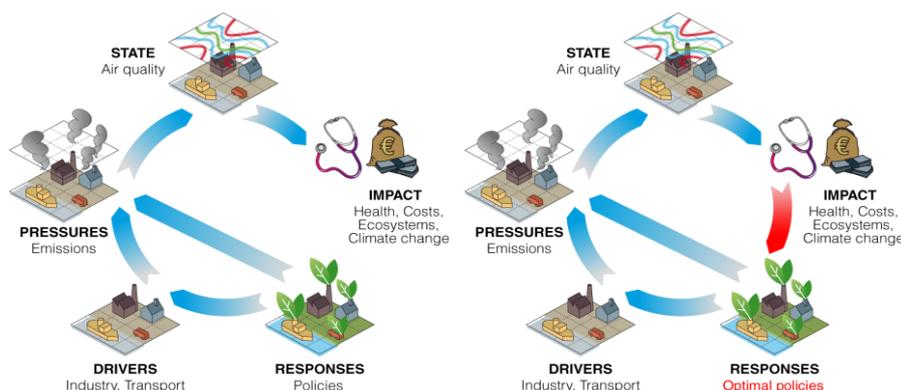
1. Scenario analysis, which was identified from the review results as the most commonly used approach to design AQ Plans and Programmes at the regional/local scales. This approach has the advantage of simplicity, however it does not include an evaluation of costs and impacts, which can only be performed "ex-post", but it is usually omitted.
2. Optimization, which uses optimization to identify cost-effective measures to achieve a given air quality target.

In APPRAISAL, the DPSIR framework concept has been adapted to interpret both pathways.

The main APPRAISAL recommendations for policy makers in regard to the preparation of AQP consider:

- Promoting the use of multi-scale IAM tools to support air quality authorities in selecting efficient mitigation strategies.
- Improving the treatment of multi-scale interactions in IAMs to include EU/national constraints in regional analyses, while at the same time providing feedbacks from the regional to the EU/national scale.
- Better integrating Air Quality and Climate Change policies in the IAM framework.
- Improving exposure estimates to better assess the impacts of poor air quality on health.
- Including socio-economic aspects in the analysis, in particular regarding the costs associated to non-technical measures.
- Incorporating uncertainty estimates in IAM to assess the robustness of the proposed solutions.

The project was funded by the EC as an FP7 Coordination and support action Project under topic ENV.2012.6.5-4 "Integrated assessment of air pollution supporting the revision of EU air quality legislation.



DPSIR scheme adapted to IAM at regional/local scale. The left figure represents the scenario analysis, while the right figure the optimization approach. The red arrow shows the "feedback on cost-effectiveness", provided by the optimization approach.

## PAY-AS-YOU-THROW

The project PAYT aimed at promoting the integration of Information Technologies (IT) into the waste management chain for supporting the general concept "Pay As You Throw" in an effort to produce a new and complete Commercial Service to Local Authorities.

In PAYT, emphasis is put on recycling and the particular principle that will be pursued behind this concept is to provide citizens with incentives and technological tools that will increase the efficiency and effectiveness of recycling in municipal scale.

The proposed system was introduced at a pilot scale in the Municipality of Kifisia in Greece. The project aimed in the development and implementation of a customized user (recycler) identification system (RFID smart card) which provided Local Authorities and citizens with a virtual identity and stored relevant data.

The identification system was adjusted to a series of dual recycling and mixed waste bins. The system uses a digital scale to determine the weight of the recyclables and transmits the output to a server. A web-based application is used to check their recycling progress, collect points and claim benefits (e.g. products, services or reduction in the waste charges).

The system supports citizens in monitoring their recycling achievements and is also able to monitor the amount of recyclables in the containers together with their filling status and location and send this information to a control centre.

Using software optimization techniques, specific algorithms allow proper management of the container location and distribution in a specific urban area, as well as the collection from each container; they also program the best time and route that every collection truck should make in order to reduce environmental and economic

impact of the collection, with particular emphasis on greenhouse gas emissions.

The implementation steps were:

- Conduction of a comprehensive market research with respect to identification procedures that can be integrated in the recycling chain,
- Detailed system analysis addressing all technological, administrative, social and financial factors that influence its design and implementation,
- Development of the identification system, bin and weighing system, web-based application as well as control system and integration into a prototype implementing the PAYT concept,
- Pilot demonstration that validates the operation and successful installation of the developed system in the Municipality of Kifisia
- Dissemination of the results to the relevant stakeholders

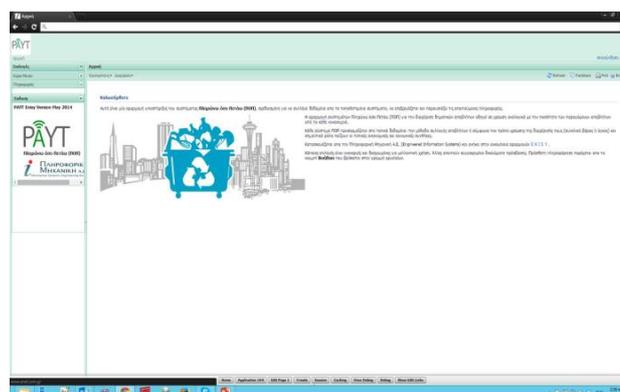
The PAYT project (<http://aix.meng.auth.gr/paytproject>) addressed two fields: information technologies and recycling operations, both of which constitute top priority areas for EU policy & research.

It resulted at the commercial exploitation by the incorporation of "smart" technologies within the recycling process and logistics, which will enhance the modernization and cost effectiveness of related waste recycling activities, keeping citizens' needs on the top. Elaborate IT methodologies have been introduced in several public services in order to facilitate their operation and to enable authorities to manage the related data under a secure, transparent and convenient manner.

The project was funded by: Ministry of Development and Competitiveness - OPCE II: Operational Programme "Competitiveness and Entrepreneurship"



The developed dual-bin system with user identification and integrated bin weighing.



Home screen of the citizen information portal.

## Membrane-based absorption process for CO<sub>2</sub> capture

The study aimed at demonstrating the potential of the membrane-based absorption process as an efficient and flexible CO<sub>2</sub> capture alternative, capable to operate over a wide range of concentration levels and volumetric flow rates.

In this frame, CO<sub>2</sub> absorption in hollow fiber polypropylene membrane was evaluated. The technical, operational and economic feasibility of the process was assessed through the analysis of data gathered during experimental implementation. The study focused on investigating the absorption performance in polypropylene membrane contactors for different membrane operating scenarios, module geometry and flow configuration.

In a membrane contactor, separation of the pollutant through the membrane is completely integrated with the absorption operation in order to exploit the benefits of both technologies. The membrane offers a flexible, modular, energy efficient device with a high specific surface area. The absorption process can offer a high selectivity and a high driving force for transport even at low concentration.

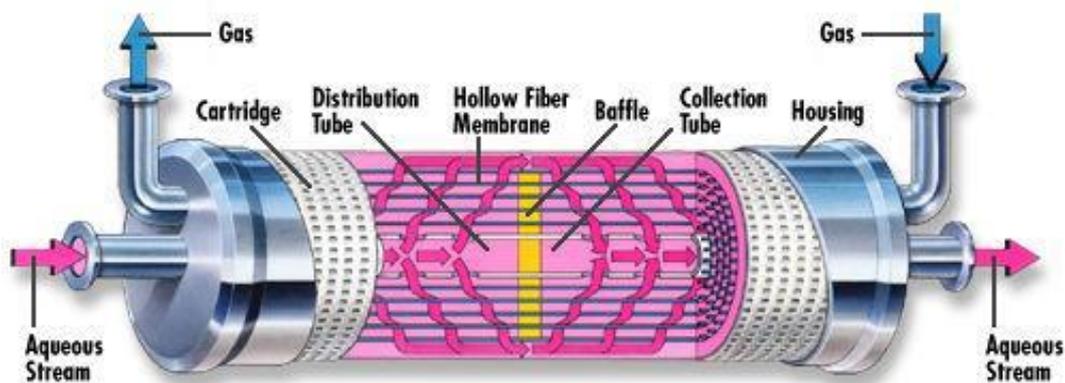
The membrane used in the contacting process is often considered passive, simply providing a support for the interface of gas and liquid. However, the membrane is a major component of the system; it constitutes one of the resistances to mass transfer and any pore wetting affects considerably the efficiency of the process, compared with a conventional gas absorption system. The goal in membrane selecting is a hydrophobic polymer material with no negative effect on the process. Considering the low cost and market availability, polypropylene (PP) is illustrated as an advantageous choice between commercial polymers. However, the susceptibility of PP membranes to wetting is considered as a major hurdle for large scale commercial applications, resulting in their rejection.

In this study, polypropylene membranes were evaluated, considering the reversible character of the membrane wetting and the possibility of initial performance recovery. The technical and economic viability of PP membranes was assessed through different scenarios of membrane operation, taking into account the membrane cost, the performance decline due to the membrane wetting and the membrane initial performance recovery cost. The scenarios were evaluated based on the classical measure of absorption technology efficiency, the height of a transfer unit (HTU). Under the same conditions, CO<sub>2</sub> absorption in PP contactors demanded lower HTU values compared to conventional packed towers, establishing the effectiveness of polypropylene membranes.

In addition to membrane chemistry and structure, successful process design should consider module geometry and flow configuration. Most of the membrane-based absorption studies have been conducted on parallel flow module. The use of cross flow membrane modules in gas absorption is limited, although it offers to the hybrid process higher mass transfer efficiency and the challenge of industrial application.

In this work, CO<sub>2</sub> absorption in parallel and cross flow polypropylene membranes was attempted to study and compare the operational flexibility and process efficiency. Commercial MiniModule<sup>®</sup> parallel flow and Liqui-Cel<sup>®</sup> cross flow contactors with Celgard<sup>®</sup> microporous PP hollow fibers, were used. The gas-liquid systems were selected in order to simplify the conditions and to facilitate the mass transfer analysis. Membrane contactors proved to have the potential to remove CO<sub>2</sub> selectively, avoiding the drawbacks of conventional processes. The mass transfer efficiency, the operational flexibility, the small size and consequently, the small investment cost and absorbent liquid pumping requirement, demonstrate the proposed technology as an alternative for CO<sub>2</sub> removal in many industrial sectors.

This work was funded by the State Scholarships Foundation/IKY as post-doctoral research of Dr. Maria Mavourdi.



Schematic of the Liqui-Cel<sup>®</sup> cross flow hollow fiber membrane contactor.

## Research

### **Alternative tourist strategies to enhance the local sustainable development of tourism by promoting Mediterranean Identity (ALTER ECO)**

*Objective:* ALTER ECO aims to enhance a balance among tourist attraction, as an economic source of growth, and the conservation of the classical Mediterranean city model as an example of sustainability, through the implementation of alternative tourist strategies in 6 pilots co-designed and implemented by stakeholders, supported through existing methods and tools. Alternative tourist strategies raised during pilot implementation will aim to improve cooperation and joint and integrated planning for the enhancement of a local sustainable and responsible development of coastal tourism to better manage conflicting interests, allowing designing common approaches at transnational level. The alternative tourist strategies will respond to different dimensions depending on the problems detected: land use planning (built environment, planning methods), mobility and transport, ecological sustainability (natural environment and landscape, energy and waste management), economic sustainability (operational environment and service structure, growth and measures) and social sustainability (housing, well-being, local culture). Thus, ALTER ECO will condense all aspects of the sustainability of tourism (environmental, social and economic) into its results and main outputs.

*LHTEE contribution:* LHTEE is the responsible partner of WP4 (Transferring). In this framework, LHTEE will develop common guidelines for delivering the different milestones, namely: (i) engagement of elected representatives towards the implementation of the proposed tourism strategies in the pilot areas, (ii) building capacities of appropriate target groups towards the implementation of the model, (iii) transferring theoretically and applying practically the methodology for the design of tourism strategies (model) to other areas. Especially for selecting areas in order to apply the methodology (model) a scientific methodology will be introduced. LHTEE will coordinate, support the partners, ensure the comparability and reliability of data and information and give clear guidance on the target groups that will be involved. In addition, LHTEE is responsible for the preparation of the pilot activities and the collection of the relative data in order to be incorporated in the CATMED GIS application.

*Funded by:* MED Programme, 2014-2020.

## Services

### **Provision of services for deliverables concerning the development of National Occupational Standards for healthcare waste managers.**

*Objective:* To produce the National Occupational Standards (in Greek) for healthcare waste managers in the frame of EU-HCWM project, co-funded by the Lifelong Learning Programme of the European Union.

*LHTEE contribution:* Development of deliverables concerning National Occupational Standards for healthcare waste managers. National Occupational Standards specify the standards of performance that managers are expected to achieve in dealing with waste generated by healthcare activities and the skills and knowledge they need to perform effectively.

*Funded by:* Sigma Consultants Ltd

### **Provision of services for the development of a Vocational Educational Training Programme concerning the waste management in healthcare facilities.**

*Objective:* To produce deliverables and training material (in Greek) for managing healthcare waste in the frame of EU-HCWM project, which is co-funded by the Lifelong Learning Programme of the European Union.

*LHTEE contribution:* Development of teaching material for a Vocational Educational Training Programme concerning the waste management in healthcare facilities. The developed material will make possible the permeability between Vocational Educational Training and Higher Education, while it will enhance the lifelong learning.

*Funded by:* Sigma Consultants Ltd

### **Assessment of the ambient air quality for the application of the environmental terms of operation of the Thessaloniki Industrial Area.**

*Objective:* To prepare the Environmental Compliance Report assessing the air quality impacts of industrial activities in the Thessaloniki Industrial Area, in fulfillment of the operator's obligation of conformance with the environmental terms of operation.

*LHTEE contribution:* Assessment of the current air quality situation in the Thessaloniki Industrial Area and the surrounding areas. Application of an advanced pollutant dispersion model in order to quantify the air quality impacts of industrial emissions on selected receptors in the vicinity of the Industrial Area.

*Funded by:* ETVA Industrial Parks SA

### **Study of the dispersion of air pollutants resulting from the operation of a waste incinerator unit.**

*Objective:* To provide support for preparing the Environmental Compliance Report in regard to the air quality impact resulting from the installation and operation of a medical waste incinerator unit in the Industrial Area of Florina.

*LHTEE contribution:* Quantification of the emission rates of several gaseous and particulate pollutants during the operation of the incinerator unit, as functions of its operational state and process parameters. Application of a pollutant dispersion model for the quantitative assessment of the impact of the unit's emissions on the ambient air quality of the Industrial Area of Florina and the surrounding areas.

*Funded by:* Research Genetic Cancer Centre Ltd.

### Events

*Members of the Laboratory participated at several important events giving speeches, chairing sessions or contributing to seminars. Among other:*

Prof. N. Moussiopoulos participated at the workshop “Digital Europe: Research and Innovation as motives for Entrepreneurship – Small-medium enterprises as an EU priority for development” in Thessaloniki, on March 4<sup>th</sup>.

Prof. N. Moussiopoulos coordinated the event “Sustainable city and the environment”, organized by the Institute for Balkan Studies in Thessaloniki, on March 9<sup>th</sup>.

Prof. N. Moussiopoulos gave a presentation on “Energy impacts on climate change and environmental pollution” in the workshop organized by the Northern Greece Law Society, “Energy: Legal and Technical Issues” Thessaloniki, on April 15<sup>th</sup>-16<sup>th</sup>.

Assoc. Prof. L. Ntziachristos gave a speech at the workshop to Promote the Understanding and Implementation of Best Available Techniques (BAT) across the Entire UNECE Region with Focus on Countries in the EECCA Region, Berlin, Germany, on April 21<sup>st</sup>.

Prof. N. Moussiopoulos and Dr. F. Barmpas participated at a scientific meeting in the Institute of Meteorology and Climatology of Leibniz University in Hannover, Germany, on April 21<sup>st</sup>-22<sup>nd</sup>.

Assoc. Prof. L. Ntziachristos gave a presentation at the COPERT 5 Methodology and Software, UN Task Force on Emission Inventories and Projections, Zagreb, Croatia, on May 16<sup>th</sup>-18<sup>th</sup>.

Prof. Nicolas Moussiopoulos attended the event “The European Energy Union: Turning the Vision into Reality” organized by the Greek Energy Forum, at the Hyatt Regency Hotel, Thessaloniki, on May 17<sup>th</sup>.

Prof. Nicolas Moussiopoulos chaired a session of the event “Cultural Politics and Local Development”, organized on the occasion of Money Show 2016 at the Hyatt Regency Hotel, Thessaloniki, on May 20<sup>th</sup>.

Prof. Nicolas Moussiopoulos gave an oral presentation within the frame of the 2nd International Conference on Sustainable Development in Thessaloniki, on May 21<sup>st</sup>.

Prof. Nicolas Moussiopoulos participated at the 8th Workshop on “Boosting the Organic & Printed Electronics Industry in Greece” at the Hyatt Regency Hotel, Thessaloniki, Greece, on May 30<sup>th</sup>.

Prof. Nicolas Mousiopoulos participated at the business mission in Germany on “Waste to energy – exploitation of organic waste through biogas”, organized by the Greek-German Chamber of Commerce and Industry, on May 31<sup>st</sup> - June 2<sup>nd</sup>.

Assoc. Prof. L. Ntziachristos gave a speech at the EIONET meeting on Environment and Transport, Copenhagen, Denmark, on June 3<sup>rd</sup>.

Dr. Christos Vlachokostas, Dr. Charisios Achillas and Ms Alexandra Michailidou participated as plenary speakers at the International Conference EnE16/ENV.net Conference in Belgrade, Serbia, on June 4<sup>th</sup>- 7<sup>th</sup>.

Prof. Nicolas Moussiopoulos gave an oral presentation at the event “Sustainable Cultural Management International Intensive Summer Course” in Thessaloniki, on June 6<sup>th</sup> – 10<sup>th</sup>.

Prof. Nicolas Moussiopoulos as former Dean of the School of Engineering delivered a speech at the opening ceremony of the event “30 years Architecture at KTIRIO”, organized by the Teloglion Fine Arts Foundation, Thessaloniki, June 13<sup>th</sup>.

Prof. N. Moussiopoulos participated at the Greek-German Workshop on good practice transfer called “Energiewende as a mean of strengthening local communities in Greece” organized by the HUMBOLDT-VIADRINA Governance Platform in Thessaoniki, on June 13<sup>th</sup> -14<sup>th</sup>.

Our Laboratory organized the one-day seminar “Climate change adaption of the structural ceramic industry through the use of recycled glass as ceramic flux” in the frame of the LIFE project CLAYGLASS, Thessaloniki, on June 27<sup>th</sup>.

Prof. Nicolas Moussiopoulos participated at the event “Presentation of the first ICRI research teams” delivering a speech on the activities of the Sustainable Management of Air Quality in the Atmospheric Environment (SUMAQ) team, as part of Aristotle University’s Interdisciplinary Centre for Research and Innovation (ICRI), and taking part at the round table discussion “The present and future of ICRI”, June 28<sup>th</sup>.

Assoc. Prof. L. Ntziachristos gave a speech at the Motorcycle working group meeting (MCWG), Brussels, Belgium, on September 22<sup>nd</sup>.

Prof. Nicolas Moussiopoulos chaired one of the discussions at the Conference on Energy Efficiency and Renewable Energy Sources in Greece’s Tourism Sector organized by the Greek-German Chamber of Commerce and Industry, Thessaloniki, on 11<sup>th</sup> October.

Prof. Nicolas Moussiopoulos participated as an invited delegate at the Thessaloniki Summit 2016, at the Hyatt Regency Hotel, Thessaloniki, on October 13<sup>th</sup>.

Prof. Nicolas Moussiopoulos was a speaker at the event “60 Years AUTH’s School of Engineering” at the Warehouse C of Thessaloniki’s Port, on October 15<sup>th</sup>.

Assoc. Prof. L. Ntziachristos gave a speech at the EARPA Form Forum, Brussels, Belgium, October 19<sup>th</sup>.

Prof. Nicolas Moussiopoulos represented the Board of the Teloglion Fine Arts Foundation at the opening of the exhibition “Teloglion Foundation of Art travels to Athens” held at the B. & M. Theocharakis Foundation, Athens, on November 10<sup>th</sup>.

Prof. Nicolas Moussiopoulos participated as an invited special guest at the ESTACA International Week, Laval, France, on November 14<sup>th</sup>-16<sup>th</sup>.

Prof. Nicolas Moussiopoulos attended the 8<sup>th</sup> City of London Biennial Meeting 2016 titled "Striving for Stability in a Highly Uncertain World", London, England, on November 16<sup>th</sup> - 19<sup>th</sup>.

## News

The first open meeting of the SUMAQ network was held on May 9<sup>th</sup> under the auspices of Aristotle University's Interdisciplinary Centre for Research and Innovation (ICRI). The meeting brought together researchers from the environmental engineering and the medical communities and was intended to establish a interdisciplinary forum for sharing experience as well as coordinating partnerships on joint research. Recent activities of the SUMAQ participating groups were presented outlining the potential for addressing forthcoming funding calls, including topic areas of the Horizon 2020 programme. Several opportunities for joint research were identified and a framework for collaboration and technical support through the SUMAQ network was proposed. The participants expressed their intent to follow up this discussion by arranging topical meetings and establishing technical exchange between their respective groups.

Vasilios-Ioannis Akylas completed successfully his doctorate and obtained his degree. Since March he is a member of Thessaloniki's Municipality "Resilient Thessaloniki" team.

Within the frame of the Finnish Meteorological Institute's (FMI) CityClim project, funded by the Academy of Finland, Dr. Fotios Barnmpas visited the FMI headquarters in Helsinki during the period September – October 2016. The main aim of the collaboration was to complete the functional testing of the PALM LES nested version focusing on atmospheric flows and dispersion of airborne agents in urban areas. To this purpose the CUTE experiment database was utilized which was made publicly available within the frame of the COST Action ES1006.

Eugenia Agorastoudi left our Laboratory to join the Ministry of Health as a civil servant. We wish her ever success in this new position.

## Papers in Journals\*

**Michailidou A.V., Vlachokostas Ch., Moussiopoulos N. and Maleka D. (2016)**

Life Cycle Thinking used for assessing the environmental impacts of tourism activity for a Greek tourism destination, *Journal of Cleaner Production*, 499-510. (Q1, 1.721)

**Kukkonen J., Karl M., Keuken M.P., Denier van der Gon H.A.C., Denby B.R., Singh V., Douros J., Manders A., Samaras Z., Moussiopoulos N, Jonkers S., Aarnio M, Karppinen A., Kangas L., Lützenkirchen S., Petäjä T., Vouitsis I. and Sokhi R.S. (2016)**

Modelling the dispersion of particle numbers in five European cities, *Geoscientific Model Development*, **9**, 451-478. (Q1, 2.855)

**Michailidou, A.V., Vlachokostas, C. and Moussiopoulos, N. (2016)**

Interactions between climate change and the tourism sector: multiple-criteria decision analysis to assess mitigation and adaptation options in tourism areas, *Tourism Management*, **55**, 1-12. (Q1, 2.45)

**Geiger F., Pope F., MacKenzie R., Brune W., Monks P., Bloss W., Fuller G., Moussiopoulos N., Hort M., Tomlin A., Presto A., van Pinxteren D., Vlachou A. et al. (2016)**

Chemical complexity of the urban atmosphere and its consequences: general discussion, *Faraday Discussions*, **189**, 137-167. (Q1, 1.559)

**Feleki E., Vlachokostas Ch., Achilles Ch., Moussiopoulos N. and Michailidou A.V. (2016)**

Involving decision-makers in the transformation of results into urban sustainability policies, *European Journal of Environmental Sciences*, **6** (1), 7-10.

**Michailidou A.V., Vlachokostas Ch., Achilles Ch., Maleka D., Moussiopoulos N. and Feleki E. (2016)**

Green tourism supply chain management based on life cycle impact assessment, *European Journal of Environmental Sciences*, **6** (1), 30-36.

**Carnevale C., Douros J., Finzi G., Graff A., Guariso G., Nahorski Z., Pisoni E., Ponche J.-L., Real E., Turrini E. and Vlachokostas Ch. (2016)**

Uncertainty evaluation in air quality planning decisions: a case study for Northern Italy, *Environmental Science and Policy*, **65**, 39-47. (Q1, 1.656)

**Thunis P., Miranda A., Baldasano J.M., Blond N., Douros J., Graff A., Janssen S., Juda-Rezler K., Karnosenoja N., Maffei G., Martilli A., Rasoloharimahefa M., Real E., Viaene E., Volta M., White L. (2016)**

Overview of current regional and local scale air quality modelling practices: Assessment and planning tools in the EU, *Environmental Science and Policy*, **65**, 13-21. (Q1, 1.656)

**Ntziachristos, L., Saukko, E., Lehtoranta, K., Rönkkö, T., Timonen, H., Simonen, P., Karjalainen, P. and Keskinen, J. (2016)**

Particle emissions characterization from a medium-speed marine diesel engine with two fuels at different sampling conditions, *Fuel*, **186**, 456-465. (Q1, 1.877)

**Ntziachristos, L., Papadimitriou, G., Ligterink, N. and Hausberger, S. (2016)**

Implications of diesel emissions control failures to emission factors and road transport NO<sub>x</sub> evolution, *Atmospheric Environment*, **141**, 542-551. (Q1, 1.999)

**Amanatidis, S., Maricq, M.M., Ntziachristos, L. and Samaras, Z. (2016)**

Measuring number, mass, and size of exhaust particles with diffusion chargers: The dual Pegasor Particle Sensor, *Journal of Aerosol Science*, **92**, 1-15. (Q1, 1.702)

**Saari, S., Karjalainen, P., Ntziachristos, L., Pirjola, L., Matilainen, P., Keskinen, J. and Rönkkö, T. (2016)**

Exhaust particle and NO<sub>x</sub> emission performance of an SCR heavy duty truck operating in real-world conditions, *Atmospheric Environment*, **126**, 136-144. (Q1, 1.999)

**Karvountzis-Kontakiotis, A., and Ntziachristos, L. (2016)**

Improvement of NO and CO predictions for a homogeneous combustion SI engine using a novel emissions model (2016) *Applied Energy*, **162**, 172-182. (Q1, 2.998)

**Amanatidis, S., Maricq, M., Ntziachristos, L. and Samaras, Z. (2016)**

Application of the dual Pegasor Particle Sensor to real-time measurement of motor vehicle exhaust PM, *Journal of Aerosol Science*, **103**, 93-104. (Q1, 1.702)

**Karjalainen, P., Ntziachristos, L., Murtonen, T., Wihersaari, H., Simonen, P., Mylläri, F., Nylund, N.O., Keskinen J. and Rönkkö, T. (2016)**

Heavy duty diesel exhaust particles during engine motoring formed by lube oil consumption, *Environmental Science and Technology*, **50**, 12504-12511. (Q2, 2.664)

**Karkania C., Perkoulidis G. and Moussiopoulos N. (2016)**

Sustainable management of household biodegradable waste: lessons from home composting programmes, *Waste and Biomass Valorization*, **7**, 659-665. (Q2, 0.411)

**Banias G., Achilles Ch., Vlachokostas Ch., Moussiopoulos N., Stefanou M. (2016)**

Environmental impacts in the life cycle of olive oil: A literature review. *Journal of the Science of Food and Agriculture*, accepted for publication. (Q1, 0.822)

\*Where appropriate, the SJR (Scimago Journal & Country Rank) quartile and indicator are given in brackets.

## Articles in Books

**Blond N., Carnevale C., Douros J., Finzi G., Guariso G., Janssen S., Maffei G., Martilli A., Pisoni E., Real E., Turrini E., Viaene P. and Volta M. (2017)** A Framework for Integrated Assessment Modelling, in *Air Quality Integrated Assessment – A European Perspective* (G. Guariso, M. Volta eds), SpringerBriefs in Applied Sciences and Technology, 9-36.

**Belis C., Baldasano J., Blond N., Bouland C., Buekers J., Carnevale C., Cherubini A., Clappier A., De Saeger E., Douros J., Finzi G., Fragkou E., Gama C., Graff A., Guariso G., Janssen S., Juda-Rezler K., Karvosenoja N., Maffei G., Martilli A., Mills S., Miranda A. I., Moussiopoulos N., Nahorski Z., Pisoni E., Ponche J. L., Rasoloharimahefa M., Real E., Reizer M., Relvas H., Roncolato D., Tainio M., Thunis P., Viaene P., Vlachokostas C., Volta M. and**

**White L. (2017)** Current European AQ Planning at Regional and Local Scale, *ibid.*, 37-68.

**Belis C., Blond N., Bouland C., Carnevale C., Clappier A., Douros J., Fragkou E., Guariso G., Miranda A. I., Nahorski Z., Pisoni E., Ponche J.-L., Thunis P., Viaene P. and Volta M. (2017)** Strengths and Weaknesses of the Current EU Situation, *ibid.*, 69-84.

**Katsis, P., Papageorgiou, T., Ntziachristos, L. (2016)** A Study on Super Credits and their Impact on Fleet-Average Real-World CO<sub>2</sub> Emissions, in *Energy and Environment* (M. Andre, Z. Samaras eds) Wiley Blackwell, 277-291.

**Vouitsis, I., Ntziachristos, L., Samaras, C., Samaras, Z. (2016)** Quantification of Non-Exhaust Particulate Matter Emissions from Road Transport, *ibid.*, 385-399.

**Samaras, C., Ntziachristos, L., Samaras, Z. (2016)** COPERT Micro: A Tool to Calculate Vehicle Emissions in Urban Areas, *ibid.*, 401-415.

## Participation at Conferences

*The list contains titles of papers given as oral or poster presentations.*

**10<sup>th</sup> International Conference on Air Quality - Science and Application, Milan, Italy, 14-18 March.**

Using a dispersion model-based approach for the spatial and temporal disaggregation of PM emissions from biomass combustion in the heating systems in Thessaloniki, Greece (N. Moussiopoulos)

Bridging the gap between multiple environmental health stressors: a holistic exposure assessment for the city centre of Thessaloniki, Greece (N. Moussiopoulos)

Operational application of an empirical approach for determining concentration increments at the street level (N. Moussiopoulos)

Intelligent Transport Systems (ITS) as a Tool to Reduce Emissions in Cities. The ICT-Emissions project (L. Ntziachristos)

**Chemistry in the Urban Atmosphere: Faraday Discussion, London, United Kingdom, 6-8 April.**

Using dispersion calculations for the quantification of the contribution of biomass combustion in heating systems to ambient PM concentrations in Thessaloniki, Greece (N. Moussiopoulos)

**6<sup>th</sup> Transport Research Arena, Warsaw, Poland, 18-21 April.**

Quantification of the effect of ITS on CO<sub>2</sub> emissions from road transportation (L. Ntziachristos)

**5<sup>th</sup> International Conference on Renewable Energy Sources & Energy Efficiency-New Challenges, Nicosia, Cyprus, 5-6 May.**

Energy policies: the gender approach (Th. Slini)

**17<sup>th</sup> International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Budapest, Hungary, 9-12 May.**

A novel metric to evaluate model's performance in predicting hazard zones (F. Barmpas)

Application of inverse dispersion modelling for the determination of PM emission factors from fugitive dust sources in open-pit lignite mines (F. Barmpas)

New inflow boundary conditions for homogeneous atmospheric boundary layer under the power law for street scale modelling (F. Barmpas)

**21st International Transport and Air Pollution Conference, Lyon, France, 24-26 May.**

Impact assessment of vehicle technology, fuel and ICT measures on CO<sub>2</sub> emissions from road traffic to 2030 (L. Ntziachristos)

Quality assurance of PEMS emissions data aimed for the development of real-world vehicle emission factors (L. Ntziachristos)

Calculating emissions from road transport on a street level with COPERT4 and COPERT Street Level, a case study (L. Ntziachristos)

ERMES - Providing consolidated emissions factors for European road transport (L. Ntziachristos)

**CIMAC Congress 2016, Helsinki, Finland, 6-10 June.**

Impact of sampling conditions and procedure on particulate matter emissions from a marine diesel engine (L. Ntziachristos)

**20th ETH-Conference on Combustion Generated Nanoparticles, Zurich, Switzerland, 13-16 June.**

Non-combustion exhaust particles observed during decelerations of heavy duty diesel vehicles (L. Ntziachristos)

**2<sup>nd</sup> National Conference on Landfill Mining and Alternative Waste Management, Athens, Greece, 15-16 June.**

Design of a Geographic Information System as a tool for enhanced landfill mining: An implementation in Central Macedonia, Greece (G. Perkoulidis)

Managing and recycling bio-waste in Greece through the implementation of a developed circular economy system (G. Perkoulidis)

**2<sup>nd</sup> Symposium on Boundary Layers and Turbulence, Salt Lake City, Utah, USA, 20-24 June.**

Nested multi-scale system in the PALM Large-Eddy simulation model

**4<sup>th</sup> International Conference on Sustainable Solid Waste Management, Limassol, Cyprus, 23-25 June.**

A technical assessment of different food waste treatment technologies in campus dining hall from the perspective of global warming and resource recovery: An implementation in the Aristotle University Thessaloniki (G. Perkoulidis)

Environmental protection through utilization of recycled glass as fluxing agent in the structural ceramics industry (G. Perkoulidis)

**8th International Congress on Environmental**

**Modelling and Software in Toulouse, France, 10-14 July.**

Air quality in urban areas: urban air pollutants, combined exposure management and planning (Ch. Vlachokostas)

**International Symposium and Workshop RE-Greece 2016 Circular Economy and Sustainable Use of Renewable Resources in the context of Climate Change and Social Upheavals, Nisyros, Greece, 20-22 July.**

Forestry residues in Greece: Resource availability and options for utilization (N. Moussiopoulos)

**13<sup>th</sup> International Conference on Meteorology, Climatology and Atmospheric Physics (COMECAP 2016), Thessaloniki, Greece, 19-21 September.**

An integrated numerical methodology for the study of transport of air pollution in the coupled indoor and outdoor environment (G. Tsegas)

An air quality management system for Cyprus: evaluation and improvements (G. Tsegas)

**35th International Technical Meeting (ITM 2016) on Air Pollution Modelling and its Application, Chania, Crete, Greece, 3-7 October.**

Assimilating anthropogenic heat flux estimated from satellite data in a mesoscale flow model (G. Tsegas)

**International Conference "Engendering Habitat III: Facing the Global Challenges in Cities, Climate Change and Transport" Madrid, Spain, 5-6 October.**

Engendering the energy policy (Th. Slini)

**16<sup>th</sup> International Conference on Sustainable Synergies from Buildings to the Urban Scale, Thessaloniki, Greece, 17-19 October.**

A holistic methodological approach in the urban context towards characterizing the environmental performance of buildings and promoting strategic governance and sustainability (Ch. Vlachokostas)

Effects of climate change on the energy required for the treatment of ventilation fresh air in HVAC systems: The case of Athens and Thessaloniki

**ESTACA – International Week, Laval, France, 14-16 November.**

A multiscale modelling approach for simulating air pollutant dispersion in urban areas (N. Moussiopoulos)

**10th National Conference on Fluid Flow Phenomena, Patras, Greece, 2-3 December.**

Impact of inflow boundary conditions on a two way coupled mesoscale - microscale modelling system (N. Moussiopoulos)

Nested multi-scale system in the PALM Large Eddy Simulation model (N. Moussiopoulos)

**Contribution to COST action genderSTE**

2-4 March: Participation of Dr. T. Slini at the event "Gender in research and application in projects: special focus on Horizon 2020 projects", Novi Sad, Serbia (Th. Slini)

## Laboratory Personnel

### Permanent staff with teaching and research assignment

Nicolas Moussiopoulos Professor, Dr.-Ing. habil. (Director)  
Leonidas Ntziachristos, PhD, Associate Professor

Fotios Barmpas, Dr.-Eng, Aerosp. Engineer, MSc  
Ioannis Douros, Dr.-Eng., Physicist, MSc  
Georgios Perkoulidis, Dr.-Eng.

Theodora Slini, Dr.-Eng., Mathematician  
Christos Vlachokostas, Dr.-Eng.

### Researchers and PhD Candidates

Lefteris Chourdakis	Dr.-Eng.
Evangelia Fragkou	Biologist, Environ., PhD
Stamatia Kontogianni	Dr.-Eng.
Apostolos Malamakis	Dr.-Eng.
Maria Mavroudi	Dr.-Chem. Engineer
Georgios Tsegas	Physicist, PhD
Eleni Feleki	Chem. Engineer, Msc
Christos Karkanias	Environ. Scientist, Msc
Alexandra Michailidou	Mech. Engineer

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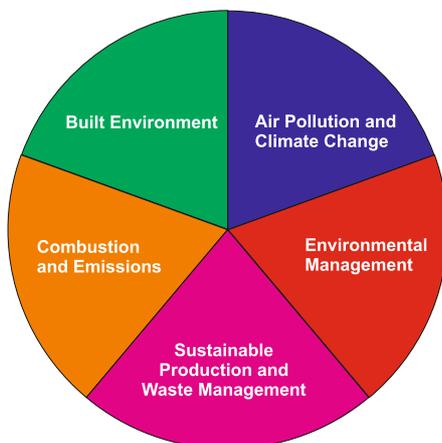
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## Main Research Topics



#### Air Pollution and Climate Change

- Multi-scale air pollution studies
- Air pollution-climate interactions
- Air quality assessment / management
- Environmental impact assessment
- Integrated environmental assessment

#### Combustion and Emissions

- Vehicle emission models
- Pollution control of stationary sources
- Field measurements
- Characterization of industrial particles
- Emissions evaluation and projections

#### Built Environment (Energy Balance, Air Quality)

- Rational use of energy
- Energy balance
- Renewable energy sources

#### Sustainable Production and Waste Management

- Contaminated site management
- Recycling, logistics, waste scenarios
- Thermal treatment and energy recovery
- Pricing schemes, decision support tools
- Sustainable consumption, social issues

#### Environmental Management

- Environmental management and design for the environment
- Decision support systems for urban sustainability
- Application of environmental assessment tools