

# Sustainability Dimensions

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

# 2007

The Laboratory of Heat Transfer and Environmental Engineering belongs to the Energy Section of the Mechanical Engineering Department of the Aristotle University Thessaloniki, Greece. The Laboratory is responsible for eleven pre-graduate courses in the Mechanical Engineering Department, while also supervising more than twenty doctoral candidates in the frame of their graduate studies. Furthermore, it has a long record of research and consulting activities, both at national and international level. Most of the research funds of the Laboratory originate from competitive programmes of the European Commission, although 2007 we received also substantial grants from national funding agencies. In the last ten years, the turnover of the Laboratory exceeded five million €.

A long-term strategic plan of our Laboratory was fulfilled in 2007: The number of our permanent staff members was increased to thirteen, to include also personnel active in research and education support. This development clearly allows more flexibility in our planning of future activities, while ensuring continuity in all areas where services are provided, both in education and research. Despite this change in personnel structure, the number of research assistants funded on a contract basis, e.g. through research grants, still exceeds by far that of our permanent staff members.

This year was characterized by alarming new evidence regarding climate change. Among other dramatic consequences of global warming that are being discussed, much attention is paid to possible impacts on air pollution levels, given the strong interrelation between climate change and air quality. Based on our Laboratory's experience from studies on atmospheric composition change, we already initiated research activities in this important area, primarily on the aspects of co-benefit analysis, biofuels utilisation and energy use in the building sector. Some of this work is within

our involvement in EEA's European Topic Centre on Air and Climate Change, while the topic is also a focus of activities within our participation in ACCENT, the European Network of Excellence on atmospheric composition change.

In the last months we also increased substantially our research activities that are related to human health. Starting with 2007, we are contributing to the CAIR4HEALTH (Clean Air for Health) project, aiming at strengthening and exploiting research results obtained by European and other projects related to air quality and health impact in relation to key European sustainable development action plans and strategies. At the same time, we are confronted with health related aspects in our indoor air quality research, where we primarily wish to investigate the correlation between thermal comfort, indoor air quality and energy consumption, aiming at the development of new materials, control strategies and the sustainable design of buildings. As a further contribution of our Laboratory to the health sector, we initiated activities towards optimizing the management of hospital wastes. Specifically, partnerships were set up with numerous health care units in Greece to analyze their solid and liquid wastes and compile management and treatment plans.

In a more regional context, since the last year we are in charge of creating an indicator-based system for characterising the state of the environment in the Greater Thessaloniki Area. Supported by an interdisciplinary team of more than twenty specialists, we compiled a set of 88 indicators, clustered in 13 categories, and presented it to a wide stakeholders forum. We are confident that the developed system will allow indentifying pollution problems, while also providing the means to monitor the effectiveness of policies for improving our environment.

Prof. Dr. Nicolas Moussiopoulos  
Laboratory Director

## Optimum management of industrial products at the end of their useful life (MIPEL)

The aim of this project was to optimize environmental management of electronic products during all phases of their lifecycle, focussing mostly on the stage of their final disposal. The goal was to decrease the quantities of industrial products that end up in a landfill through their redesign, in order that the following become possible: exploitation of specific components at the end of product's useful life, environmentally safe disposal of those components or parts that are not further exploitable, reduction of hazardous materials, as well as raw materials and natural resources, which are required in the production of such products.

The interdisciplinary collaboration of the participating organisations focused on the following issues: Life Cycle Analysis, product end of life treatment, product disassembly, product redesign, reverse logistics, cost estimation for end of life management.

In a single industrial product, not all components play the same role, both in terms of cost and environmental burden. Following Pareto's Law, only a small percentage of the components inside one product seems to be responsible for the vast majority of its production costs, as well as its overall environmental burden (80/20 rule). Therefore, it would be of great interest for any manufacturer to be in a position to identify those components with the highest potential benefit at the end of their useful life, with regard to economic aspects, environmental burden and design issues.

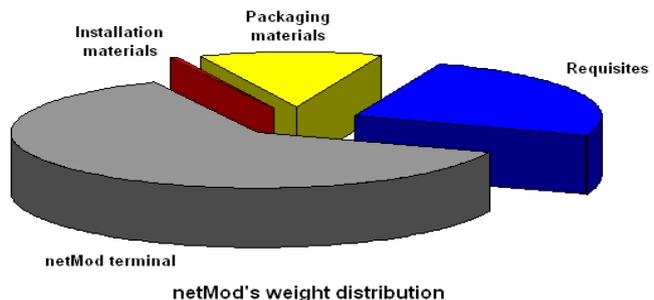
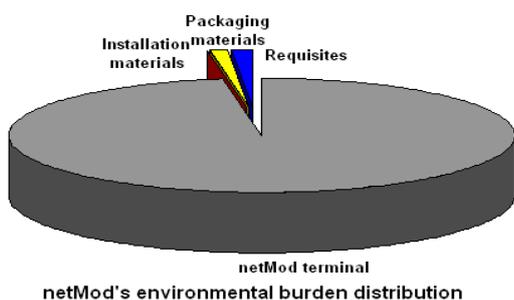
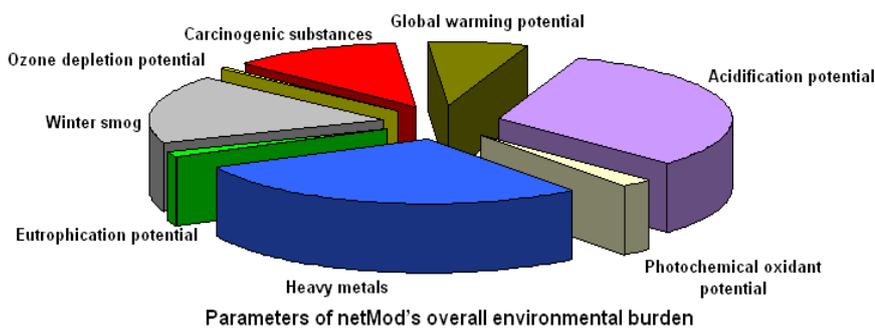
In the framework of the MIPEL project, an easy-to-use methodology (referred as "Multicriteria Matrix") has been developed based on multicriteria analysis techniques. This methodology is expected to be valuable to manufacturers having to take decisions regarding the optimisation of end of life treatment alternatives.

The "Multicriteria Matrix" methodology allows taking properly into account economic parameters as well as environmental criteria and design issues in the production of an industrial product. In particular, parameters considered include market cost, environmental burden, weight, quantity and ease of disassembly, in order to identify those components inside one product with the highest potential benefit for the producer in the case of environmentally sound end of life management. The "Multicriteria Matrix" methodology is applied on the netMod ISDN network terminal, which is developed by Intracom S.A, one of the project's major partners.

More information on the project's findings can be obtained from Pythagoras' Programme official website: <http://web.auth.gr/pythagoras>

Project funded by Hellenic Ministry of National Education and Religious Affairs, Pythagoras Programme (2004-2006). Major Partners: Aristotle University Thessaloniki - Laboratory for Machine Tools and Manufacturing Engineering and Laboratory of Quantitative Analysis, Logistics and Supply Chain Management, Technological Educational Institute of Western Macedonia, Intracom S.A.

Contact: Prof. Nicolas Moussiopoulos, moussio@eng.auth.gr



## Integrated product policy in the telecommunication sector (IPP-TEL)

Electronic products are becoming increasingly pervasive in our homes and workplaces. Each one of these products will eventually reach the end of its useful life, and will require disposition of one sort or another. The sheer number of electronic products currently in the marketplace has caught the attention of solid and hazardous waste policy makers, companies concerned with appropriate disposition, and business entrepreneurs who see value in the purported waste. In addition, technology improvements consistently result in less expensive, more powerful products, and thus may hasten the replacement and eventual disposition of electronic goods.

The IPP-TEL project referred to Eco-design and End of Life Management of telecom devices which is one of the most widespread electronic products. The main objectives of the project were:

**Eco-Design of a selected Telecom device:** This aimed to the development of an electronic product with minimised environmental impacts during the whole life cycle. Eco-Design involved the development of a device that (i) would be easy to disassemble, thus enabling the reuse of components and materials, and (ii) would have low environmental impact during production.

**End of Life Management of a selected Telecom device:** This aimed to demonstrate an eco-efficient way to close the material and component loop. It involved the development of economic efficient options for product reuse, disassembly, component reuse, as well as recycling.

Utilisation of the experience gained for the development of a methodological framework for the Eco-Design and End of Life Management of other electronic products.

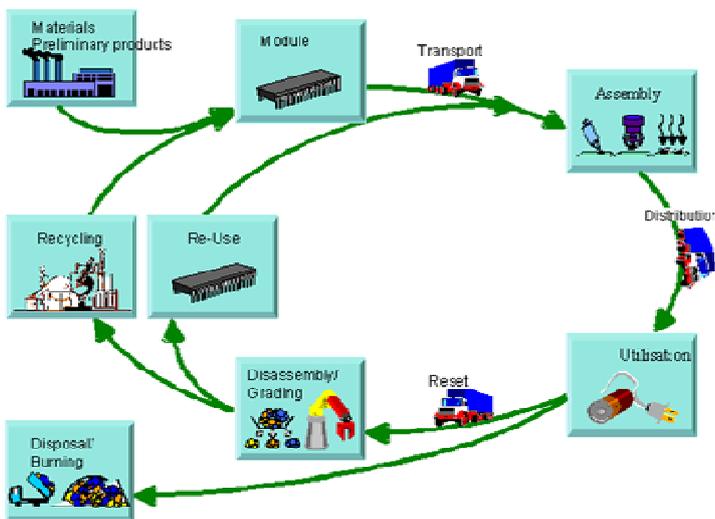
In the framework of the Life Cycle Analysis (LCA) study conducted for two Telecom devices (IRIS 6001 telephone device and netMod ISDN network terminal), the End of Life Management strategy options were investigated (reuse, recycling, landfilling and incineration) and improvements for their redesign were suggested. In the redesign the following elements were taken as objectives: (i) Minimisation of the mass of the products, (ii) elimination of the use of heavy metals, (iii) elimination of the use of lead as a solder, and (iv) use of recycled material in the device and the packaging.

In accordance with the results of the LCA study and the End of Life Management options, the redesigning of the netMod device and its production process was performed. Regarding the device redesign, the major changes involved the components replacement in order to be complied to the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive), and the reduction of their weight and mass. As far as the production phase is concerned, the redesign was focused on creating a RoHS Directive compatible process.

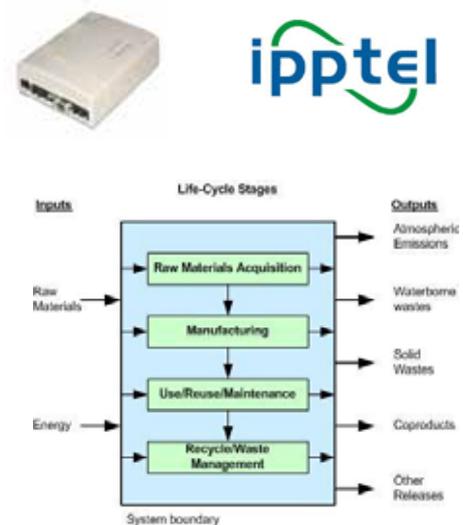
More information on the project's findings can be obtained from the IPP-TEL project's official website: <http://www.ipp-tel.gr/>

Project funded by European Commission, DG Environment, LIFE-Environment Programme (2004-2007). Major Partners: National Technical University of Athens, Intracom S.A., EPTA, Aristotle University Thessaloniki - Dep. Electrical and Computer Engineering, Anakyklosi Symmetoxiki S.A., Union of Hellenic Chambers of Commerce, Poiotiki S.A.

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Life Cycle of electronic devices



Life Cycle Assessment methodology

## Management of wastes generated by dental units - DAST

Main objective of this project was to develop an integrated training and decision support platform for informing, educating and training students and personnel in the School of Dentistry of Aristotle University of Thessaloniki, as well as field practitioners of the dental business, on the environmental impacts of wastes generated by a dental unit and the best practices for alternative and rationalised dental waste management.

As a necessary initial step, basic categorization and characterisation of dental waste according to its components and their hazardousness was performed for facilitating their sustainable management. As a result, dental waste was categorized according to their nature and hazardousness into:

- (a) Infectious (Metal- / Non-metal-bearing / Amalgam),
- (b) Non Infectious and
- (c) Household-like.

In the frame of preliminary field activities, a survey was initially performed during 2005-2006 aiming at waste characterization and collecting data and information on the quantity and quality of waste generated from private dental units in Thessaloniki, as well as on the management methods used and the existing awareness levels. A parallel objective of these activities was awareness raising of dentists and authorities for establishing measures and actions to tackle health and safety problems associated with dental waste production and to support further campaigns for environmentally responsible health care. Back-to-back research and capacity building was also conducted in the following divisions of the School of Dentistry in Aristotle University of Thessaloniki:

- Oral Pathology and Surgery
- Prosthodontics

- Orthodontics and Periodontology
- Dental Pathology and Therapeutics

As a set of main project outputs, the production and composition of generated dental wastes was investigated, analyzed, categorized and quantified for a full year (2006), by means of face-to-face interviews and use of a structured questionnaire to a sufficient random statistical sample of local dentists (both professionals and students). The overall long-term research goal was the innovative planning of an integrated Dental Waste management system in such a way that is can be implemented within any cluster of dental units regardless of its size.

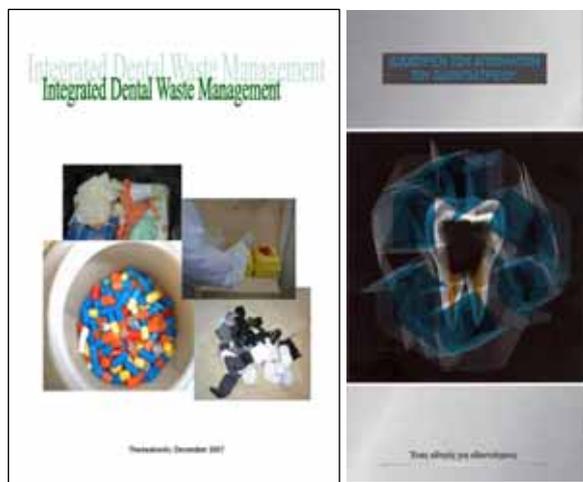
The project's main final deliverable was a handbook with practical guidelines and best practices concerning dental waste management addressing the average dentist in Greece (either professional, new or old, or student). Additionally, educational material was compiled primarily for the students of the School of Dentistry in Aristotle University of Thessaloniki, aiming at their environmental education and awareness raising regarding wastes produced during the treatment of patients on the frame of their studies and practical training within the School.

Finally, as additional side results of this project:

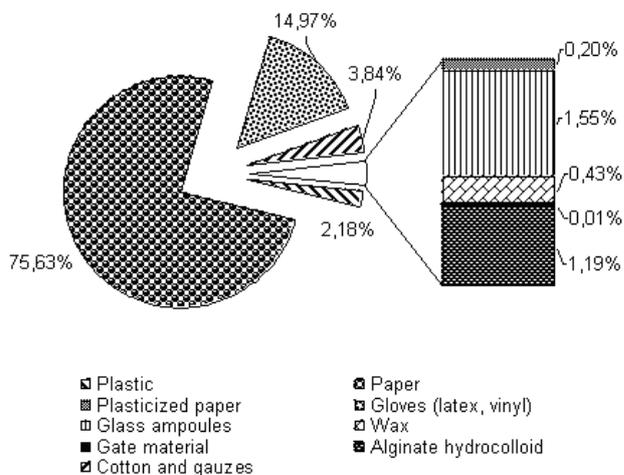
- a new teaching course on dental waste management was initiated at the School of Dentistry of Aristotle University,
- an integrated technical pre-proposal was compiled and submitted to the Hellenic Ministry of Health and Social Solidarity concerning the formulation of a national system for the alternative management of dental wastes.

Funded by: Hellenic Ministry of National Education and Religious Affairs, Pythagoras II programme (2005-2007). Major Partners: Aristotle University's Faculty of Health Sciences, School of Dentistry; Hellenic Dental Association, Thessaloniki branch.

Contact: Assist. Prof. Avraam Karagiannidis, akarag@auth.gr



Compiled handbook for practitioners and dissemination brochure



Average daily production in School of Dentistry in Aristotle University Thessaloniki during 2005-2006.

## Near-real time ozone data exchange (Ozoneweb)

The purpose of the Ozoneweb project is to build a public website, based around ozone data and air quality information integrated in the spatial data infrastructure of the European Environmental Agency (EEA). Hourly air quality data from over 700 measurement stations are published within the EEA main web site and link back to data providers as well as to national and regional ozone websites, giving easy access to more local information.

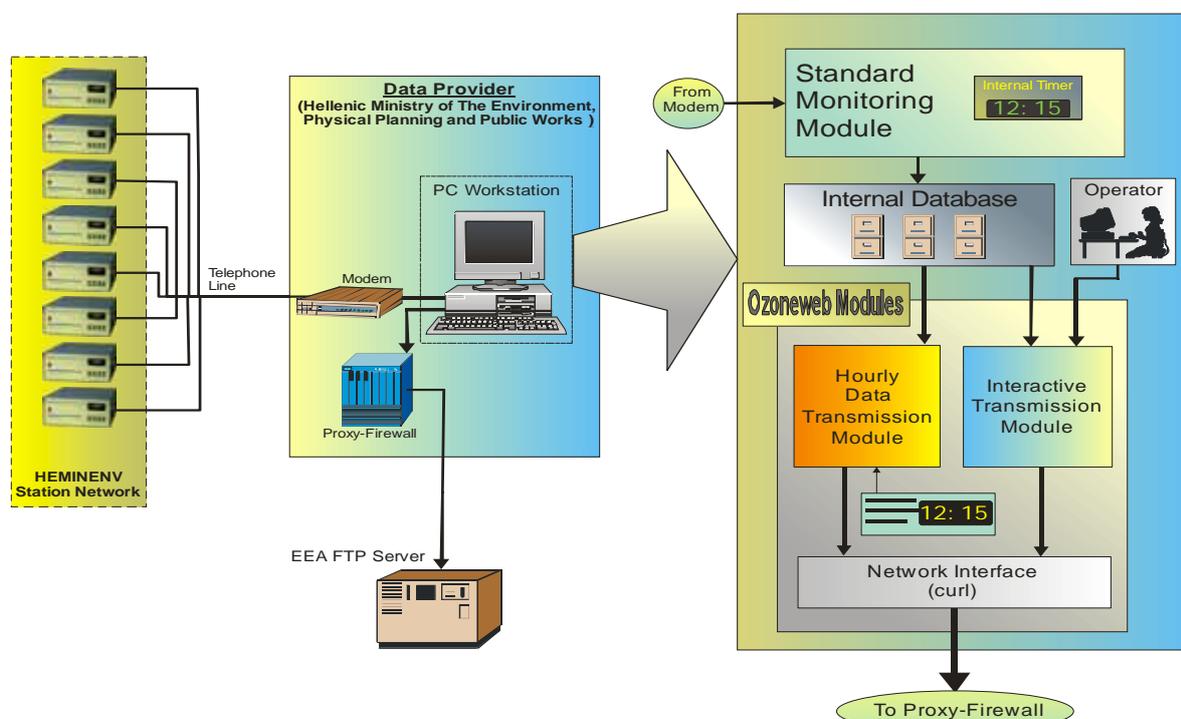
The project implements a data transmission system about ground level ozone in Europe for current and recent situations on an hourly basis, as well as for background information on specific pollutants, in accordance with the Directives 92/72/EEC on air pollution by ozone and 2002/3/EC on ozone in ambient air. The type of data being accessible on Ozoneweb depends on the type of users, including public users and air pollution expert users. For the broad public, the website (<http://www.eea.europa.eu/maps/ozone/map>) displays measured ozone levels in a map interface and provides background information on ozone and its health impact. For air quality experts, the website provides functionalities for accessing and downloading ozone data. The data are presented through maps, graphs and tables. Map viewers are provided as a web service for data suppliers for use in their own websites.

For the purpose of timely and reliable ozone data reporting from Greece, a near-real time automated data transmission system was developed and installed at the Hellenic Ministry of the Environment, Physical Planning and Public Works in Athens (HEMINENV). The system consists of software modules that continuously collect ozone data from a network of 9 stations located in the Greater Athens Area. After an appropriate data validation and check phase, the software transmits hourly data snapshots to the Ozoneweb web server. A separate administration module enables operators at HEMINENV to manually retrieve measurement data from the monitoring system's internal database, inspect them for inconsistent or missing values and make the appropriate corrections to the published data and maps. Provisions were made so that the same data exchange platform can be readily extended to other Greek and Eastern European air quality data providers.

The project is implemented as part of the task "Near-real time air quality information" of the European Topic Center on Air and Climate Change (ETC/ACC). In late 2007, more than 20 countries are already contributing with near-real time ozone data.

Project funded by European Environmental Agency, ETC/ACC. Major Partners: AEA Technology.

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Ozoneweb hardware and software setup at the Ministry of the Environment, Physical Planning and Public Works, Athens

## Ecological and aesthetic restoration of a waste disposal site (ESTRADA)

The project's primary objective was the ecological and aesthetic restoration of the closed non-engineered landfill in the municipality of Efkarpia, located within the expanding urban area of Thessaloniki, Greece.

It is well known that landfills exert a negative effect on an area's landscape, soil water balance, vegetation cover and the ecological balance in general. The possible existence of toxic elements in combination with high temperatures that develop within landfill bodies also create an unfavorable environment for the development of natural vegetation. For these reasons the restoration of old landfills becomes an urgent need especially near populated centres as well as in dry and semi-dry areas, like the Mediterranean zone, where erosion and desertification risks are also lately very high. In the above frame, ESTRADA was structured around the following main stages, tasks and actions:

- Registration and analysis of site history (field studies and surveys, questionnaires to local industries and individuals, general background data regarding the broader area).
- Evaluation of the extent and nature of the existing accumulated pollution and environmental degradation. This included surface debris removal, drilling and sampling, evaluation of spatial allocation of waste over the landfill volume, hydrological simulation of the site, as well as measurement of heavy metals' concentration in soil and solid waste samples.
- Support in the planning and implementation stages of additional necessary actions: This included literature review on existing methods, top covering, fencing of uncontrolled landfill area, irrigation and continuous overall monitoring.

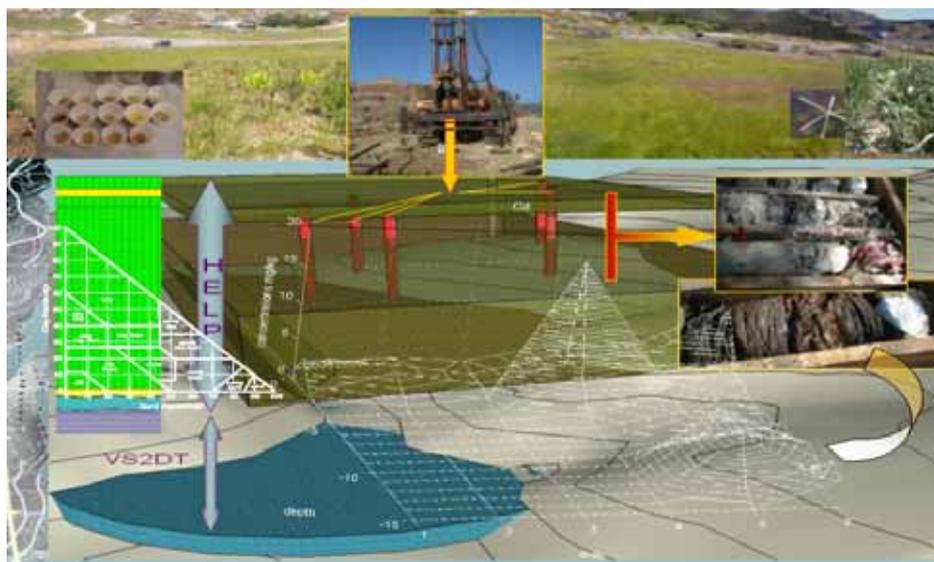
- Planting of to-be-studied plant species (trees and bushes) into appropriately prepared ground. This included levelling and covering the examined waste- containing soil of the closed disposal site with fresh, clean soil and preparation of the experimental surface for the seeding of varied bushes and grass.
- Installation of measurement systems for their related ecophysiological parameters and parallel initiation of chemical analyses.
- Study of ecophysiological response of two forage species: *Cynodon dactylon* and *Festuca arundinacea*, to soil water as well as the comparative efficiency of establishment.

Finally, assimilation and transpiration rate, stomatal conductance, water use efficiency and leaf water potential were seasonally measured in the field and laboratory; they were then correlated with available soil water, which was calculated by using the Hydrological Evaluation of Landfill Performance model for simulating the water balance in the Efkarpia landfill. Other simulations were performed for different Hellenic areas as well, coupled with surveying and registering old non-engineered landfills in various Hellenic Prefectures.

Besides the accomplished restoration and rehabilitation of the Efkarpia landfill itself, ESTRADA resulted also into a generic-use methodological tool for restoration of small old landfills emphasizing on their hydrological long-term behaviour.

Project funded by Hellenic Ministry of Development, GSRT, PENED-2001 Programme (2003-2007). Major partners: Aristotle University's Department of Forestry and Natural Environment, Laboratory of Range Management; Community (lately Municipality) of Efkarpia.

Contact: Assist. Prof. Avraam Karagiannidis, akarag@auth.gr



Schematic representation of main activities

## Development of educational material on indoor environmental quality

The aim of this project was to develop, produce and evaluate educational material on indoor environmental quality and indoor pollution. Furthermore, it was to assess the course of studies of the collaborative research groups in undergraduate and graduate level. The development of the educational material was a result of a thorough review of the educational institutes active in the field of indoor environmental quality and the respective curricula, the international bibliography and relative research activities. Moreover the needs of the Greek educational community and the society in general, concerning indoor pollution and its impacts in human health, were examined widely.

The necessity of providing education in the specific sector is driven by the increase of the significance given on indoor air quality, as well as on the syndromes and diseases that are related with the air quality in buildings. The use of modern building materials in combination with the frequently problematic function of the central heating, cooling and air condition systems and the decrease of ventilation rates result in the increase of indoor air pollutants' concentration and thereafter in the increase of diseases. The concentrations of air pollutants in the buildings are usually higher than in the ambient environment. The aggravation of the indoor environment is related with health symptoms, a phenomenon that is called in international bibliography as sick building syndrome.

As a result of the importance of indoor environmental quality, a large number of universities in the European Union and in the United States include in their graduate programmes courses related with indoor environment, comfort and energy savings, special sections dealing with issues like indoor air quality and health of buildings' users.

The ultimate goal of the programme is to add up to the knowledge in the design, construction and function of healthier buildings through the broadening of the course studies of the co-operating educational institutes.

The whole programme includes six workpackages, while the major outcomes are the development of the educational material itself and of the teaching methodology. The Laboratory of Heat Transfer and Environmental Engineering contributed actively in both of these outcomes. As far as the educational material is concerned the following three chapters were composed: a) physical parameters that determine indoor air quality, b) the aggravation of indoor environmental quality caused by heating, cooling and air condition systems and c) particulate matter pollution of the indoor environment. The main work of the laboratory relating to the development of the teaching methodology was the planning of an e-learning study course based on a web site platform.

Project funded by Greek Ministry of National Education and Religious Affairs, Pythagoras Programme (2004-2006). Major Partners: University of Athens, University of Ioannina, Technical University of Crete, TEI of Crete.

Contact: Assoc. Prof. Agis Papadopoulos, agis@eng.auth.gr



Text book on Indoor Environmental Quality

## An investigation of the factors affecting the formation of secondary aerosols in urban areas

This project aims to examine the factors affecting the formation of secondary aerosols in urban areas. Secondary aerosols are currently an issue of increasing scientific interest, as they comprise a significant part of PM<sub>10</sub>, which are known from a number of epidemiological studies to cause adverse health effects.

The project investigates the main secondary compounds of aerosol particles, in relation to the prevailing atmospheric conditions (concentrations of primary PM species, presence of photochemical oxidants and precursors, meteorological conditions) and to their physical and chemical properties (number, size, shape, composition).

The study area covers the greater urban area of Thessaloniki, Greece, where recent measurements revealed high ambient particle concentrations. For the purposes of the project, more accurate real time measurements as well as laboratory analysis of samples were undertaken. The measurement and sampling campaigns were carried out during suitable periods when atmospheric conditions favoured the formation of secondary aerosols and other photochemical pollutants.

Mathematical simulations of aerosol concentrations were performed at two scales, namely covering the greater urban area of Thessaloniki (urban background) as well as inside street canyons. The latter urban street canyons are important due to high particle traffic emissions and the limited dispersion of pollutants that occurs inside the canyon. Urban background pollution is by several aspects a more complex phenomenon, as it involves a wider number of processes that need to be taken into account.

Furthermore, the importance of natural emissions in this scale is an additional factor that contributes to the uncertainty of the calculations.

The following topics are parts of the project

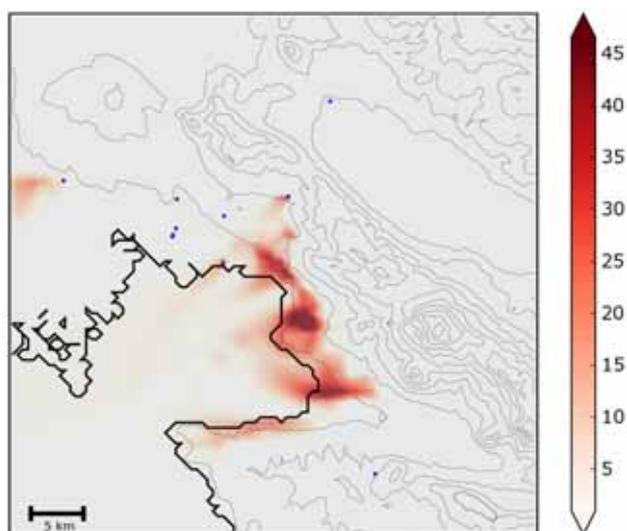
- Data update: Air pollutant emissions levels within the greater urban area of Thessaloniki were updated. Appropriate locations and time periods for the measurement and sampling campaigns were also selected and the relevant protocols were formulated.
- Measurement of physical aerosol properties: Measurements of aerosol number and mass concentration, number and mass distribution were carried out, as these properties greatly determine the interaction of aerosols with their environment.
- Determination of chemical compounds: The analysis identified ion compounds and organic and elemental carbon.
- Primary compound measurements: Measurements were also carried out for SO<sub>2</sub>, NO<sub>x</sub>, NMHCS, VOC<sub>s</sub> and O<sub>3</sub>.
- Dispersion and photochemical model application.

Simulations for the greater urban area of Thessaloniki were performed using the MEMO/MUSE-AERO modeling system, while the model OSPM was used for street canyon simulation.

The final results of this study revealed the causes and mechanisms leading to atmospheric pollution due to secondary aerosols, thus enabling a more realistic source apportionment. The outcome of this study can support the development of more efficient air pollution management strategies.

Project funded by Greek Ministry of National Education and Religious Affairs, Pythagoras Programme. Major Partners: Aristotle University Thessaloniki - Laboratory of Applied Thermodynamics and Environmental Pollution Control Laboratory.

Contact: Prof. Nicolas Moussiopoulos, moussio@eng.auth.gr



Simulated mean PM<sub>10</sub> concentrations (µg/m<sup>3</sup>) over the Greater Thessaloniki Area during one of the periods studied

## Vent discourse

The main objective of the project was to accelerate the implementation of the core area of ventilation within the Energy Performance of Buildings Directive at European and national levels and thus improve energy efficiency in buildings by directly transferring existing knowledge to appropriate actors in a suitable format.

This was achieved by developing and promoting vocational training material in a multi-lingual distance-learning format for building professionals to facilitate the implementation of best practice ventilation energy performance (both for indoor environmental quality and thermal comfort) in large new and retrofitted buildings of various types.

Development objectives included:

(a) Evaluation of vocational distance learning training methods for effective market penetration. The main idea was to produce a tool responding to the increasing demand on Continuing Professional Development (CPD arising from the implementation of the European Directive on the Energy Performance of Buildings, concerning low energy cooling, hybrid ventilation and energy conscious HVAC design and construction, as well as the systems' evaluation.

(b) Collection/evaluation/classification of existing and recently developed knowledge of energy efficient ventilation technologies into vocational distance learning training formats. Promotion objectives included pilot seminars, CPD material in professional journals and targeted initiatives in addition to the available training material in distance-learning formats.

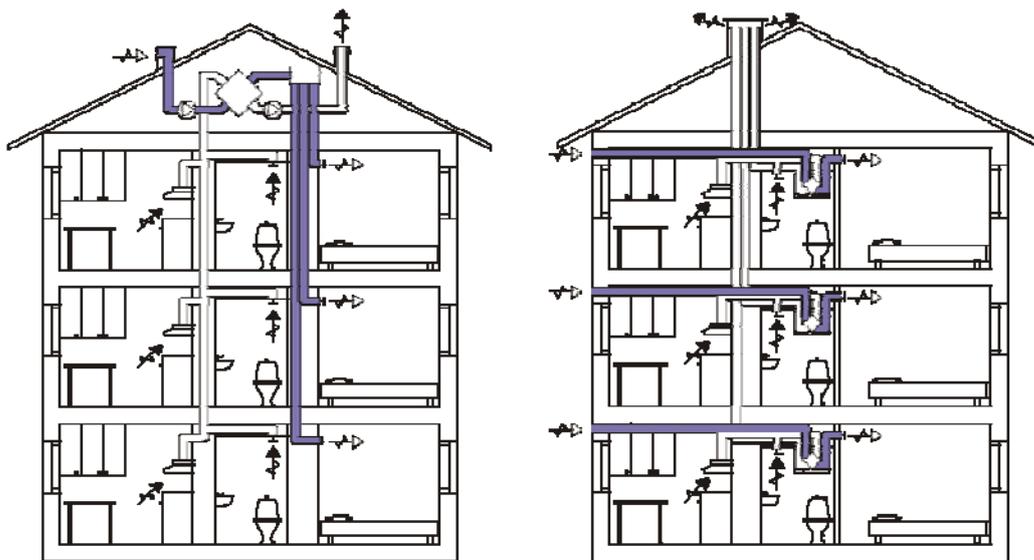
Given the plethora of scientific and empirical publications available, the challenge was to capitalize on the available expertise and to produce a knowledge database best suited to the purpose of the project.

Particular emphasis was given on the development of material consisting of (a) CPD articles in professional journals; (b) textbook and (c) electronic training material using specialised educational software. All of those included practical training exercises and assessment material. The establishment of the training methodology included the operational schedule of the material in its various facets and requirements for certification. Finally, selected European experts tested the educational package.

The main contribution of this action is that a considerable energy use reduction in buildings is possible by transferring knowledge on the latest energy efficient ventilation technologies and system design to appropriate actors in a systematic but flexible format (distance training) supported by employers and professional institutions. This will be achieved by designers having the know-how, together with calculation methods, on how to minimise the need for mechanical ventilation and specify energy efficient plants where this is necessary.

Project funded by Intelligent Energy - Europe Programme of the European Community. Coordinator: Brunel University, UK Major Partners: University of Athens, GR, École Nationale des Travaux Publics de l'État, Lyon, F, REHVA, B, Building Services Research and Information Association, UK, Veetech Ltd, UK.

Contact: Assoc. Professor Agis Papadopoulos, agis@eng.auth.gr



Ventilation options for residential buildings

## Research

### CAIR4HEALTH

*Objective:* To strengthen and exploit research results obtained by European and other projects in the field of Air Quality and Health, by examining the research and policy-related outputs from clusters, networks, projects and expert groups.

*LHTEE Contribution:* Responsibility for the dissemination and communication workpackage, which involves development and maintenance of the CAIR4HEALTH web portal, development of the project dissemination strategy, production of leaflets and other material to facilitate dissemination. LHTEE also actively contributes to the reviews conducted and reports written in all workpackages.

*Funded by:* EC, under the Sixth Framework Programme/Specific Support Action (2007-2009).

### FORWAST

*Objective:* To provide an inventory of the historically cumulated physical stock of materials in EU-27 (EU-25 plus Romania and Bulgaria), and to forecast the expected amounts of waste generated, per resource category, in the next 25 years. Furthermore, an assessment of the life-cycle wide environmental impacts from different scenarios of waste prevention will be implemented concerning recycling and waste treatment in the EU-27.

*LHTEE Contribution:* Data mining.

*Funded by:* EC, under the Sixth Framework Programme/Strep Action (2007-2009).

### SAFEMANMIN

*Objective:* To contribute to the safe management of mining wastes and waste sites in the EU, assess the state-of-the-art in this field, review risk assessment approaches and develop / disseminate a toolbox with practical guidelines.

*LHTEE Contribution:* Participation and support to all tasks, dissemination and awareness raising in Greece.

*Funded by:* EC, 6FP, CA (2007-2008).

### Information System for Demolition Waste Management

*Objective:* To develop an information system, taking care of all aspects related to demolition waste management. The ultimate aim is to minimise the waste of building materials that are discarded to landfills without any prior processing and to increase their recycling and reuse.

*LHTEE Contribution:* Project co-ordination, Architecture design and development of information system, Study on the re-use and recycling of building materials at the end of their useful lifetime.

*Funded by:* GSRT, Ministry of Development, Reinforcement Programme of Human Research Manpower - "PENED" (2005-2008).

### PTACCESS (Making public transport accessible)

*Objective:* To analyse the state of accessibility of public transport from the point of view of national disabled organisations, national transport operators, and governmental authorities. To analyse good practices and innovation in making public transport accessible to people with disabilities.

*LHTEE Contribution:* Data mining.

*Funded by:* Intelligent Energy Europe (ALTENER).

## Services

During the year, the Laboratory provided consulting and other services in the following cases:

- Quantification of the expected improvement of urban air quality in Thessaloniki, resulting from the proposed operation of a suburban sea transport service from the center of the city to the Peraia region.
- Supply of services for the development of an emission inventory that will include the creation of an air emission database and the provision of software tools for simulating ambient air quality in Cyprus.
- Energy conservation study in a residential building in Kifissia.
- Software development for calculating thermal loads of the building's shell according to EN 13790.
- Improving the draft of the legislative act on the energy performance of buildings.
- Energy design guidelines for the technopolis technological park in Thessaloniki.
- Inventorizing biomass potential for integrated energy utilization in a paper industry through combustion and anaerobic fermentation.
- Alternative management of packaging waste in Greece: Overview of present situation and investigation of the development margin for new collective systems.
- Risk assessment of an old waste disposal site.
- Investigation, identification and promotion of innovative business opportunities in utilising end products from end-of-life-tyres recycling – Phases A and B.
- Characterization and management plans for hospital wastes.

## Papers in Journals.

**Papadopoulos A.M. and Giama E. (2006)**

Environmental performance evaluation of thermal insulation materials and its impact on the building, *Building and Environment*, **42**, 2178-2187.

**Papadopoulos A.M. (2006)**

Energy cost and its impact on regulating the buildings' energy behaviour, *Advances in Building Energy Research*, **1**, 105-121.

**Vautard R., Bultjes P., Thunis P., Cuvelier C., Bedogni M., Bessagnet B., Honore C., Moussiopoulos N., Pirovano G., Schaap M., Stern R., Tarrason L., Wind P. (2006)**

Evaluation and intercomparison of ozone and PM<sub>10</sub> simulations by several chemistry transport models over four European cities within the CityDelta project, *Atmospheric Environment*, **41**, 173-188.

**Cuvelier C., Thunis P., Vautard R., Amann M., Bessagnet B., Bodogni M., Berkowicz R., Brandt J., Brocheton F., Bultjes P., Carnavale C., Coppale A., Denby B., Douros J., Graf A., Hellmuth O., Honore C., Hodzic A., Jonson J., Kerschbaumer A., de Leeuw F., Minguzzi E., Moussiopoulos N., Pertot C., Peuch V.H., Pirovano G., Rouil L., Sauter F., Schaap M., Stern R., Tarrason L., Vignati E., Volta M., White L., Wind P. and Zuber A. (2006)**

City Delta: A model intercomparison study to explore the impact of emission reductions in European cities in 2010, *Atmospheric Environment*, **41**, 189-207.

**Thunis P., Dr. Rouil L., Cuvelier C., Stern R., Kerschbaumer A., Bessagnet B., Schaap M., Bultjes P., Tarrason L., Douros J., Moussiopoulos N., Pirovano G. and Bedogni M. (2006)**

Analysis of model responses to emission-reduction scenarios within the CityDelta project, *Atmospheric Environment*, **41**, 208-220.

**Tchobanoglous G., Karagiannidis A., Leverenz H., Cadji M. and Antonopoulos I. (2006)**

Sustainable waste management at special events using reusable dishware: The example of whole earth festival at the University of California in Davis, *Fresenius Environmental Bulletin*, **15**, 822-828.

**Tsatsarelis T., Antonopoulos I., Karagiannidis A. and Perkoulidis G. (2006)**

Open dumps in the Hellenic prefecture of Laconia: Statistical analysis of characteristics and restoration prioritization on the basis of a field survey, *Waste Management and Research*, **25**, 417-425.

**Papadopoulos A.M., Glinou G.L., Papachristos D.A. (2007)**

Developments in the utilization of wind energy in Greece, *Renewable Energy*, **33**, 105-110.

**Theodosiou G., Koroneos C., Moussiopoulos N. (2007)**

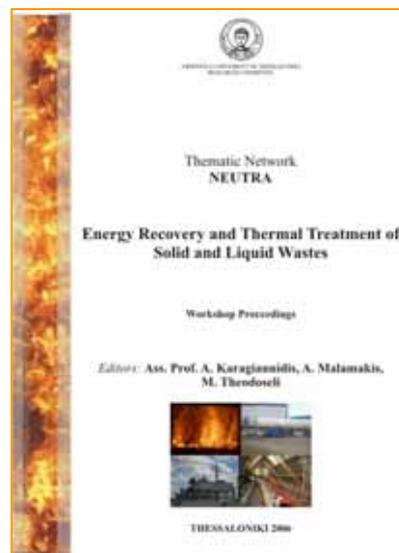
Alternative scenarios analysis concerning different types of fuels used for the coverage of the energy requirements of a typical apartment building in Thessaloniki, Greece - Part I, Fuel consumption and emissions, *Building and Environment*, **42**, 1522-1530.

## Technical Reports

**ACCENT Training Workshop and Hellenic Day** (N. Moussiopoulos, Th. Slini, E. Schuepbach, eds).



**Energy Recovery and Thermal Treatment of Solid and Liquid Wastes** (A. Karagiannidis, A. Malamakis, M. Theodoseli, eds).



## Participation at Conferences

*The list contains only the titles of papers given as oral presentations. If no name appears, the presentation was made by a scientist collaborating with the Laboratory. In several conferences also poster presentations were made.*

### **6th International Conference on Urban Air Quality, 27 – 29 March 2007, Limassol, Cyprus**

On the impact of PCDD/Fs and PM10 emitted from a 2006 landfill fire near Thessaloniki, Greece (J. Douros)

Boundary conditions and their impact on urban scale CTM simulations (J. Douros)

Uncertainty and regional air quality model diversity: what do we learn from model ensembles

(1 poster was displayed)

### **International Congress “FINE! Dust-Free into the Future”, 29 - 30 March 2007, Klagenfurt, Austria**

Air pollution at street level in European Cities with emphasis on PM<sub>10</sub> and PM<sub>2.5</sub> (N. Moussiopoulos)

### **Das ElectroG und die Praxis, 29 March 2007, Dresden, Germany**

Management of WEEE in Greece: State of the art and prospects (A. Karagiannidis)

### **2nd BOKU Waste Conference, 16 – 19 April 2007, Vienna, Austria**

Composting in the backyard in Asia: Some lessons learned through Euro-Asian collaboration for the cases of Vietnam and the Philippines

(3 posters were displayed)

### **2nd National Conference of Mechanical & Electrical Engineers, 16 - 18 May 2007, Athens, Greece**

Integrated product policy-The case study of an ISDN network terminal end of life management (G. Banias)

User requirements for the development of a demolition waste management information system (G. Banias)

### **3rd International Conference on Sustainable Development Indicators in the Minerals Industry, 17 – 20 June 2007, Milos island, Greece**

Factors affecting tree growth on bauxite mining wastes (A. Karagiannidis)

### **1st International Conference on Environmental Management, Engineering, Planning and Economics, 24 – 28 June 2007, Skiathos island, Greece**

Effect of landfill water balance on range plants cover ecophysiology (P. Rakimbei)

Biofuels market in Greece and the potential role of captive fleets (A. Karagiannidis)

Legislative framework on construction and demolition waste management (D. Aidonis)

Study of medical waste generation from hospitals in 2nd Health Region Administration of Central Macedonia (G. Sanida)

Environmental impact of fibrous insulating materials operating in harsh temperature conditions (A. M. Papadopoulos)

Roma and people with disabilities in Social Enterprises for contemporary WEEE management: Framework of a Hellenic study on related organizational issues

Investigation of the dental waste production in dental units of Thessaloniki

Need for sustainable management of electronic waste (e-waste) in Australia

Developing a holistic strategy for integrating waste management policy into municipal planning: solutions and perspectives for Hellenic municipalities

(1 poster was displayed)

### **11th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, 02 – 05 July 2007, Cambridge, United Kingdom**

Towards a modelling network in support of the Air Quality Directive (N. Moussiopoulos)

Data assimilation within the Air4EU project (N. Moussiopoulos)

Numerical study for the flow around moving cars and its effect on the dispersion of the traffic emitted pollution within a road tunnel (Ph. Barmpas)

Recommendations on spatial assessment of air quality resulting from the FP6 EU project AIR4EU

(1 poster was displayed)

### **2nd UN International Conference in Higher Education For Sustainable Development “World in Transition – Sustainability Perspectives for Higher Education”, 05 – 07 July, San Luis Potosí, Mexico**

Acquisition of competencies by sensitive social groups for sustainable waste management: A case study on Hellenic social enterprises for the end-of-life management of waste of electric and electronic equipment (A. Karagiannidis)

Some examples of generic and specific collaborative actions on thermal processing and energy recovery from wastes within Aristotle University of Thessaloniki, aiming at local and regional sustainable development (A. Karagiannidis)

### **Energy Performance and Environmental Quality of Buildings, 12 – 13 July 2007, Milos island, Greece**

An integrated assessment of the effectiveness of Feed-in Tariff concerning PV in Greece (A. M. Papadopoulos)

Data collection and analysis of the energy behavior of hotels and other touristical buildings (N.-S. Boemi)

### **Asean Energy Business Forum 22 - 24 August 2007, Shangri-La Hotel, Singapore**

Biodiesel and bioethanol: EU state-of-the-art and market development in Greece (A. Karagiannidis)

**10th Toulon-Verona Conference “Quality in Services”, 03 – 04 September 2007, Thessaloniki, Greece**

Integrated municipal solid waste management policy: Problems, challenges, opportunities, trends, needs and drawbacks for the Hellenic local governments in the frame of a holistic approach (A. Malamakis)

Logistics issues related to the collection and pre-treatment of organic substrates for energy production via thermal and biological processes (A. Malamakis)

Thermal processing of and energy recovery from wastes: Some cases of collaborative actions within a higher education institute, aiming at enhancing the quality of the related provided services (A. Malamakis)

**10th International Conference on Environmental Science and Technology, 05 – 07 September 2007, Cos island, Greece**

Integrated Assessment of air pollution in Thessaloniki (N. Moussiopoulos)

Numerical study for the potential abatement of air pollution with the use of photocatalytic façade covering materials in London (N. Moussiopoulos)

Construction and demolition waste management: State of the art trends (H. Achillas)

Promoting alternative end of life management of electrical and electronic equipment (H. Achillas)

**Abfallwirtschaft und Klimaschutz, 26 September 2007, Dresden, Germany**

Waste management and climate change in developing countries (A. Karagiannidis)

**2nd PALENC Conference and 28th AIVC Conference, Building Low Energy Cooling and Advanced Ventilation Technologies in the 21st Century, 27 - 29 September 2007, Crete island, Greece**

A study of converting a medieval tower into a museum (A. M. Papadopoulos)

Rating systems for counting buildings' environmental performance (A.M. Papadopoulos)

The impact of moisture on the thermal conductivity value of stone wool based insulating materials (A.M. Papadopoulos)

**Renewable Energy Sources and Energy Efficiency, 28 – 30 September 2007, Nicosia, Cyprus**

Efficiency of promotional schemes for renewable energy systems (A.M. Papadopoulos)

**11th International Waste Management and Landfill Symposium, 01 - 05 October 2007, Sardinia, Italy**

The effects of local cultural and socio-economic features on the structure of solid waste management in developing countries: the case of the Philippines and Vietnam

(3 posters were displayed)

**8th National Geographical Conference, 04 – 07 October 2007, Athens, Greece**

Application of GIS as a decision-making tool for prioritizing open dump restoration in the Hellenic Prefecture of Laconia (Th. Tsatsarelis)

**12th EIONET Workshop, 15 – 16 October 2007, Limassol, Cyprus**

Towards a modelling network in support of the new air quality directive (N. Moussiopoulos)

**Environmental Management in Health Services, 02 November 2007, Athens, Greece**

Integrated management and elaboration of medical wastes in Greece: Challenges, obstacles, abilities and perspectives (A. Karagiannidis)

**Future perspectives of Geographic Information for Integrated Coastal Management, 21 – 23 November 2007, Genova, Italy**

Integrated solid waste management aspects in the frame of coastal zone management and landscape protection and restoration (A. Malamakis)

(2 posters were displayed)

**WEEE and social economy, 25 November, Thessaloniki, Greece**

Social managers in WEEE management (J. Antonopoulos)

Recycling and the role of social economy (S. Kontogianni)

**National Conference on Armed Forces and Environmental Protection, 27-28 November, Thessaloniki, Greece**

Solid waste management in Greece and the role of the Hellenic Armed Forces (A. Karagiannidis)

**4<sup>th</sup> National Conference on Quality in Healthcare Services, 6-7 December, Athens, Greece**

Environmental management in healthcare services: The role of thermal treatment in the contemporary rationalized management of medical wastes (A. Karagiannidis)

**Contribution to COST Actions**

**COST 728, “Enhancing mesoscale meteorological modeling capabilities for air pollution and dispersion applications”,**

- Workshop on “Integrated Systems of Meso-Meteorological and Chemical Transport Models” DMI, where a presentation was given with regard to a multiscale modelling approach putting special emphasis on the efficient treatment of urban plumes, Copenhagen, Denmark, 21-23 May 2007 (J. Douros)
- MC meetings, Brussels, Belgium, 1-3 March and Istanbul, Turkey, 19-23 October (J. Douros)

**COST 732, “Quality assurance of microscale meteorological models”,**

- Expert meeting, Hamburg, Germany, 11-12 January (Ph. Barmpas)
- MC meetings, Brussels, Belgium, 22-23 February, Vienna, Austria, 31 May-1 June and Lecce, Italy, 25-26 October (Ph. Barmpas)

### Events

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

On 15 December 2006, a workshop was held by LHTEE and Aristotle University's NEUTRA network on Thermal Treatment of Solid and Liquid wastes, which was chaired by Assistant Professor Avraam Karagiannidis. On 21 December 2006, Aristotle University's Environment Council held a discussion whereby Professor Nicolas Moussiopoulos spoke on the "Framework of indicators for the environment and sustainable development of the Greater Thessaloniki Area". On the same topic, a public dialogue took place on 11 June.

In 2007, the Laboratory participated at numerous meetings. Ms Lora Slini attended the ACCENT Steering Committee Meeting in Interlaken, Switzerland on 11-12 January and Professor Nicolas Moussiopoulos participated at a COST meeting held in Brussels, Belgium on 21-22 February. Meanwhile, Associate Professor Agis Papadopoulos participated at the ETEK and CYS workshop on RES in buildings that took place in Nicosia, Cyprus on 7-8 March and a few days later attended the Energy Tech Conference in Thessaloniki, Greece. Professor Nicolas Moussiopoulos was invited to a panel discussion at the International Congress "FINE! Dust-Free into the Future" organized in Klagenfurt, Austria (29-30 March). Assistant Professor Avraam Karagiannidis participated in various EU meetings on mining wastes (Vienna, 18-19 January), biofuels (Rome, 15-16 February; Ljubljana, 24-25 September), waste prognosis (Orleans, 26-27 March; Vienna, 17-19 September) and WEEE (Krakow, 24-26 April). Associate Professor Agis Papadopoulos, Assistant Professor Avraam Karagiannidis and Mrs Stamatia Kontogianni attended a series of meetings on RES and solid/liquid wastes in Edmonton, Canada (4-8 June), also on the occasion of the Environment day celebration on June 5.

In the second half of the year Professor Moussiopoulos spoke in two important meetings. The first was on the topic of the "Modern developments in the energetic field and their impacts on the environment" in the framework of the International Exhibition EXPOLINK '07, organized by the Hellenic Chemists Union, in Thessaloniki, Greece. The second on the topic of "Air quality modelling to support the European Air Quality Legislation" took place at JRC, Institute for Environment and Sustainability, in Ispra, Italy. This event aimed at the development and structure of a joint EEA-JRC Modelling Network.

Assistant Professor Avraam Karagiannidis was Vice-Chairman of the 1<sup>st</sup> International Conference on Environmental Management, Engineering, Planning and Economics (CEMEPE), held on 24-28 June. With over 550 oral and poster presentations, CEMEPE aspires to become one of the top international environmental conferences. Since 2007 Assistant Professor Avraam Karagiannidis is extensively involved within the International Waste Working Group (IWWG). He was elected Vice Chairman of IWWG's Task Group on Developing Countries and was appointed upon recommendation during the Sardinia Symposium in the International Scientific Committee of the Venice Waste-to-Energy biannual conference. He furthermore became Guest Editor of a CEMEPE special issue in the International Waste Management Journal and also held an invited speech in an EU training course on Chemical Spills on July 6, in Bremen, Germany.

At the ACCENT Training Workshop which took place in Riga, Latvia, Ms Lora Slini attended the Early Career Scientists meeting on "Air Quality and Air Quality Management in Eastern Europe". At the 2<sup>nd</sup> ACCENT Symposium, held in Urbino, Italy, Professor Nicolas Moussiopoulos participated at the Scientific Steering Committee meetings of the tasks "Transport and Transportation" and "Training and Education" as well as at the kick off meeting of the ACCENT Mentoring Programme. In addition, a special meeting was organised in October at our University by Professor Nicolas Moussiopoulos on the link between Air Quality and Health. The research needs in epidemiology were discussed in conjunction with atmospheric modelling and monitoring, in order to accurately quantify the link between air quality and health. In November, Professor Nicolas Moussiopoulos participated at the 4<sup>th</sup> ACCENT Expert Workshop in Barnsdale, UK, on the important topic of Climate Change Impact on Air Quality.

Professor Nicolas Moussiopoulos and Associate Professor Agis Papadopoulos were invited into a panel discussion following the screening of the film "11<sup>th</sup> Hour" within the frame of the 48<sup>th</sup> International Film Festival of Thessaloniki. In the frame of the Thessaloniki POLIS exhibition (22-25 November), the Laboratory organized and staffed a stand on 'waste recycling and social economy' and on November 25 a related workshop was held, chaired by Assistant Professor Avraam Karagiannidis. A similar workshop held in Volos on November 30 was attended by Mr. John Antonopoulos.

Finally, Associate Professor Agis Papadopoulos and Assistant Professor Avraam Karagiannidis held invited speeches on energy and biofuels respectively in the frame of the Thessaloniki Money Show (30 November - 2 December).

### News

Two new staff members joined our Laboratory: Themistoklis Kasampalis for the Waste Management Group and Michael Michailidis for the Modelling Group. Three PhD's were concluded successfully in 2007: the first one by Ms Evangelia Kalognomou and the other two by Ms Anna Xirogiannopoulou, and Ms Panagiota Rakimbei. Anna Xirogiannopoulou now continues her career at Aristotle University's Technical Department organizing and supervising alternative waste management in the campus.

During the year Professor Nicolas Moussiopoulos went twice to Cyprus for participating at an Evaluation Committee for Private Universities. He was also appointed Jury Member of the 14<sup>th</sup> Panhellenic Student Competition on "Economy and Environment" (organised by "Kerkyra" Publications) and was elected a member on the board of directors for the newly established Association of the Tellogleio Foundation Friends. Finally, Professor Moussiopoulos also became member of the Hellenic Science Society.

We congratulate Assistant Professor Avraam Karagiannidis and Efrosini Giama for the birth of their sons. Efrosini already returned to the Laboratory after her maternity leave. We also welcome back Anastasios Karamanos who returned to the Laboratory after his military duties. Maria Theodoseli left our Laboratory for her maternity leave.

Mr. Christos Vlachokostas was elected Treasurer of the Hellenic Association of Mechanical and Electrical Engineers. Since 2007 he is also chairing the Permanent Committee on Energy of the Technical Chamber of Greece (Central Macedonia Section). Mr. George Banias was elected Chairman of the Mechanical Engineering Department's PhD students's Association.

## Laboratory Personnel

Nicolas Moussiopoulos Professor, Dr.-Ing. habil (Director)

Agis Papadopoulos Associate Professor, Dr.-Eng., MSc

Avraam Karagiannidis Assistant Professor , Dr.-Eng., MSc

Photios Barmpas, Aerosp. Engineer, MSc

Ioannis Douros, Physicist, MSc

Efrosini Giama, Mech. Engineer, MSc

Christos Naneris, Environmentalist

Afedo Koukounaris Admin. Officer

Ioannis Ossanlis, Mech. Engineer, MSc

Georgios Perkoulidis, Dr.-Eng.

Theodora Slini, Mathematician

Christos Vlahocostas, Mech. Engineer, MSc

Lazaros Sotiriadis, System Administrator

## Researchers and PhD Candidates

Christopher Koroneos

Evangelia-Anna Kalognomou

Harisios Achillas

Vasilios-Ioannis Akylas

Dimitrios Anastaselos

Ioannis-Sofoklis Antonopoulos

Aristotelis Avgelis

George Banias

Sofia-Natalia Boemi

Lia Frangou

Konstantinos Kalogeropoulos

Anastasios Karamanos

Marinos Karteris

Chem. Engineer, PhD

Dr.-Eng., MPhys

Mech. Engineer, MSc

Mech. Engineer

Mech. Engineer

Mech. Engineer

Mech. Engineer

Mech. Engineer

Mech. Engineer

Environmentalist

Biologist, Environm, PhD

Environmentalist, MSc

Mech. Engineer

Mech. Engineer

Themistoklis Kasampalis

Stamatia Kontogianni

Apostolos Malamakis

Michael Michailidis

Symeon Oxizidis

Kostantinos Papageorgiou

Panagiota Rakimbei

Dimitra Spiridi

Antis Stilianou

Maria Theodoseli

George Theodosiou

Thomas Tsatsarelis

Georgios Tsegas

Environ. Engineer, MSc

Mech. Engineer

Mech. Engineer

Mech. Engineer

Mech. Engineer

Mech. Engineer

Dr.-Eng., Env. Eng., MSc

Mech. Engineer

Mech. Engineer, MSc

Environ. Engineer, MSc

Mech. Engineer

Mech. Engineer

Physicist, PhD

## Technical Staff and Secretariat

Georgios Kotrikas

Eugenia Agorastoudi

Dimitrios Altinoglou

System Administrator

Administrative Support

Administrative Support

Konstantina Vretinari

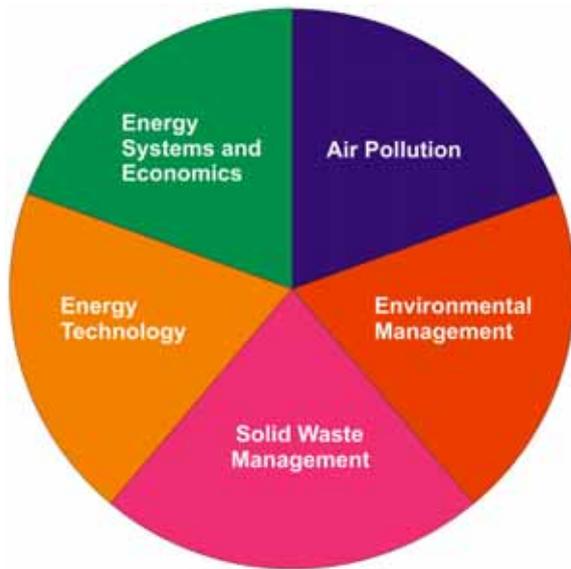
Maria Zilou-Kapaktsi

Administrative Support

Administrative Support



## Main Research Topics



### Energy Systems and Technology

- Process analysis and optimisation
- Renewable energy sources
- Rational energy use
- Life Cycle Analysis
- Sustainable production

### Air Pollution

- Transport and transformation of pollutants
- Air quality assessment and management
- Environmental impact assessment
- Integrated environmental assessment

### Waste Management

- Logistics and contaminated site management
- Recycling
- Thermal treatment and energy recovery
- Pricing schemes

## Undergraduate Courses offered by Laboratory Members

### 1<sup>st</sup> Level:

Heat Transfer

### 2<sup>nd</sup> Level:

Business Economics  
 Heating-Refrigeration-Air Conditioning  
 Introduction to Environmental Engineering

### 3<sup>rd</sup> Level:

Special topics on Heating and Refrigeration  
 Solid Waste Treatment and Management  
 Energy Design of Buildings  
 Environmental Impact Assessment  
 Economic Analysis of Energy Systems  
 Air Pollution  
 Investment Analysis and Assessment

## ISO Certificate



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