Βιογραφικό Σημείωμα
και
Συνοπτική Ανάλυση Επιστημονικού Έργου

Αγγελάκογλου Κ. Κομνηνός
Διπλωματούχος Μηχανικός Παραγωγής και Διοίκησης
Υποψήφιος Διδάκτορας Δημοκρίτειου Πανεπιστημίου Θράκης

Μάιος 2015

Πίνακας Περιεχομένων

Βιογραφικό Σημείωμα

1. Προσωπικές πληροφορίες

Επώνυμο / Όνομα	Αγγελάκογλου Κομνηνός
Διεύθυνση	Αριστοφάνους 20, Τ.Κ. 65403, Καβάλα, Ελλάδα
Τηλέφωνο	+30 2510 838165, +30 6937521305
Ηλεκτρονικό ταχυδρομείο	kangelak@pme.duth.gr

Υπηκοότητα	Ελληνική
Ημερομηνία γέννησης	14/10/1985

2. Εκπαίδευση και κατάρτιση

- **Doctor of Philosophy (Ph.D), (εκτιμώμενη ολοκλήρωση Ιούνιος 2015)**
  Τμήμα Μηχανικών Παραγωγής και Διοίκησης, Πολυτεχνική Σχολή Ξάνθης, Δημοκρίτειο Πανεπιστήμιο Θράκης.
  Βαθμολογία: -
  Τίτλος Διατριβής: «Ανάπτυξη μεθοδολογικού πλαισίου για την αποτίμηση της περιβαλλοντικής βιωσιμότητας βιομηχανικών εγκαταστάσεων και διεργασιών»

- **Δίπλωμα Μηχανικού Παραγωγής και Διοίκησης (Dip.Eng.), Ιούνιος 2008**
  Τμήμα Μηχανικών Παραγωγής και Διοίκησης, Πολυτεχνική Σχολή Ξάνθης, Δημοκρίτειο Πανεπιστήμιο Θράκης.
  Βαθμολογία: 8,17/10
  Τίτλος Διπλωματικής Εργασίας: «Ποιότητα αέρα εσωτερικών χώρων σε σχέση με τα αιωρούμενα σωματίδια – Μελέτη περίπτωσης σε πανεπιστημιακό περιβάλλον»

3. Σύνοψη γνωστικού αντικειμένου

Το γνωστικό αντικείμενο της διδακτορικής μου διατριβής, αφορά στην αποτίμηση της περιβαλλοντικής βιωσιμότητας βιομηχανικών συστημάτων. Τα ερευνητικά μου ενδιαφέροντα εκτείνονται στις αρχές και τα εργαλεία της βιομηχανικής οικολογίας, την ανάλυση κύκλου ζωής, τον υπολογισμό του ανθρακικού/οικολογικού αποτυπώματος ευρύτερων συστημάτων, την προώθηση καινοτόμων αειφορικών στρατηγικών και την αξιολόγηση λύσεων για την εφαρμογή βιώσιμων επεμβάσεων εξοικονόμησης ενέργειας. Έχω επαγγελματική/ερευνητική εμπειρία σχετικά με την αποτίμηση της βιωσιμότητας συστημάτων, την μελέτη περιβαλλοντικών επιπτώσεων και την ανάλυση κύκλου ζωής προϊόντων, διεργασιών και υπηρεσιών. Επιπλέον έχω συμμετάσχει σε περισσότερες από 50 ερευνητικές εργασίες και δημοσιεύσεις που σχετίζονται με την αξιολόγηση της αειφορικής επίδοσης συστημάτων. Στο πλαίσιο αυτό, και όπως προκύπτει από την επισυναπτόμενη επαγγελματική και ερευνητική εμπειρία εξειδικεύομαι στα εξής:

- Περιβαλλοντική και ενεργειακή αξιολόγηση συστημάτων.
- Εφαρμογές ανάλυσης κύκλους ζωής.
- Ανάπτυξη και αποτίμηση σύνθετων δεικτών.
- Βελτίωση της περιβαλλοντικής επίδοσης και βιωσιμότητας βιομηχανικών συστημάτων/προϊόντων και ανάπτυξη αναφορών βιωσιμότητας.

4. Επαγγελματική εμπειρία

Επωνυμία Εργοδότη Διάρκεια Θέση/Περιγραφή	**Δημοκρίτειο Πανεπιστήμιο Θράκης** 2009 – σήμερα Συμμετοχή σε δεκαπέντε (15) ερευνητικά προγράμματα ως ερευνητής (δες ενότητα 8-ερευνητική δραστηριότητα)
Επωνυμία Εργοδότη Διάρκεια Θέση/Περιγραφή	**Φορέας Διαχείρισης Δέλτα Νέστου – Βιστωνίδας – Ισμαρίδας** 20/12/2013 – 20/3/2015 Συντονιστής ομάδας έργου, παροχή της υπηρεσίας «Υπολογισμός και αξιολόγηση της φέρουσας ικανότητας και του οικολογικού αποτυπώματος του ΕΠΑΜΑΘ».
Επωνυμία Εργοδότη Διάρκεια Θέση/Περιγραφή	**Δήμος Καβάλας** 22/3/2012 – 22/9/2012 Υπεύθυνος εκπόνησης έργου με τίτλο «Εκπόνηση σχεδίου δράσης αειφορικής ενέργειας για το Δήμο Καβάλας».
Επωνυμία Εργοδότη Διάρκεια Θέση/Περιγραφή	**Κτήμα Βιβλία Χώρα Α.Ε.** 2010 – 2011 Ελεύθερος Επαγγελματίας, Μηχανολογικές και ηλεκτρολογικές μελέτες – Παροχή ερευνητικών συμβουλών – Τρία έργα (Μελέτη και επίβλεψη άδειας εγκατάστασης)
Επωνυμία Εργοδότη Διάρκεια Θέση/Περιγραφή	**ΙΕΚΕΜ – ΤΕΕ** 2009 Εκπαιδευτής / εισηγητής στην υλοποίηση του προγράμματος “Εφαρμογή Ευρωπαϊκών Μεθοδολογιών και Λογισμικών για την Βελτίωση της Ενεργειακής Αποδοτικότητας κτιρίων” στα πλαίσια του προγράμματος του Τεχνικού Επιμελητηρίου Ελλάδας “e-Μηχανικοί: Εκπαίδευση Μηχανικών στις τεχνολογίες πληροφορικής και επικοινωνιών”.
Επωνυμία Εργοδότη Διάρκεια Θέση/Περιγραφή	**Βιομηχανία Φωσφορικών Λιπασμάτων Α.Ε.** 1/7/2006 – 1/8/2006 Πρακτική άσκηση, Μελέτη και ανάλυση ειδικού λογισμικού για την οργάνωση του τμήματος συντήρησης και βελτίωση της βάσης δεδομένων για την καταχώρηση του μηχανολογικού εξοπλισμού.

5. Ατομικές δεξιότητες και ικανότητες

Μητρική Γλώσσα	Ελληνικά
Άλλη (-ες) Γλώσσα (-ες)	Αγγλικά (FCE Cambridge – Grade: A, CCE Michigan, Certificate of Proficiency in English Michigan)
Κατανόηση	Άριστα
Γραπτές Δεξιότητες	Άριστα
Προφορικές Δεξιότητες	Άριστα

6. Τεχνικές δεξιότητες και ικανότητες

- Γνώση των λειτουργικών συστημάτων MS Windows /XP/VISTA/7/8.
- Γνώση MS Office (Word, Excel, PowerPoint, Visio, Access)
- Γνώση των προγραμμάτων Adobe Acrobat Reader Professional, Autodesk AutoCAD (Computer Aided Design Program), SimaPro (Life Cycle Assessment software), Mathworks Matlab.
- Ικανότητα εύρεσης δεδομένων στο διαδίκτυο και διαχείρισης online προγραμμάτων.
- Εξοικείωση και ικανότητα χρήσης πληροφοριακών συστημάτων (SAP, Tiny ERP, κ.ά.).
- Εξοικείωση με τις γλώσσες προγραμματισμού C, C++.
- Εγκατάσταση και χρήση μετρητικού εξοπλισμού ποιότητας αέρα (π.χ. Grimm, TSI).

7. Άλλες δεξιότητες και ικανότητες

- Ανάπτυξη και αξιολόγηση περιβαλλοντικών δεικτών (δείκτες KPI, ανθρακικό αποτύπωμα, οικολογικό αποτύπωμα, υδατικό αποτύπωμα κλπ.).
- Ανάπτυξη περιβαλλοντικών αναφορών βιωσιμότητας και εταιρικής κοινωνικής ευθύνης.
- Ανάπτυξη και παρακολούθηση συστημάτων περιβαλλοντικής διαχείρισης – μελέτες περιβαλλοντικών επιπτώσεων.
- Εκπόνηση αναλύσεων κύκλου ζωής (ΑΚΖ) προϊόντων και διεργασιών.
- Εκπόνηση σχεδίων δράσεων αειφορικής ενέργειας.
- Αποτίμηση της βιωσιμότητας επιχειρήσεων και βιομηχανικών εγκαταστάσεων.
- Τεχνολογίες περιβάλλοντος.
- Δειγματοληψίες αιωρούμενων σωματιδίων σε ατμοσφαιρικό περιβάλλον και σε εσωτερικούς χώρους.
- Τεχνικές εξοικονόμησης ενέργειας.
- Τεχνολογία συστημάτων παραγωγής.
- Διοίκηση πληροφοριακών συστημάτων.
- Σχεδιασμός προϊόντων με έμφαση στον σχεδιασμό για το περιβάλλον (DfE).
- Γνώσεις marketing/management και ικανότητα πραγματοποίησης έρευνας αγοράς.

8. Ερευνητική δραστηριότητα

- Συμμετοχή ως ερευνητής σε δεκαπέντε (15) ερευνητικά προγράμματα :

1. **2008-2010**, S&B Βιομηχανικά Ορυκτά ΑΕ, «Ανάπτυξη μεθοδολογικού πλαισίου για την αποτίμηση της περιβαλλοντικής βιωσιμότητας βιομηχανικών δραστηριοτήτων. Μελέτη περίπτωσης: Μεταλλευτική & Εξορυκτική Βιομηχανία».
2. **2009-2010**, S&B Βιομηχανικά Ορυκτά ΑΕ, «Ανάπτυξη των ερευνητικών δραστηριοτήτων του Τομέα Υλικών, Διεργασιών & Μηχανολογίας του Τμήματος Μηχανικών Παραγωγής & Διοίκησης».
3. **2009-2011**, ΤΣΜΕΔΕ, «Ποιότητα αέρα εσωτερικών χώρων με έμφαση στα λεπτομερή αιωρούμενα σωματίδια».
4. **2010-2011**, Χρυσωρυχεία Θράκης ΑΜΒΕ, «Αξιολόγηση των περιβαλλοντικών διαστάσεων του έργου χρυσού στην περιοχή Περάματος Αλεξανδρούπολης».
5. **2011**, Μεταλλευτική Θράκης ΑΕ, «Αξιολόγηση των περιβαλλοντικών διαστάσεων του έργου χρυσού στην περιοχή Σαπών Ροδόπης».
6. **2012**, Δήμος Καβάλας, «Υπολογισμός του ανθρακικού αποτυπώματος του Δήμου Καβάλας»

7. **2013**, Δήμος Αλεξανδρούπολης, «Υπολογισμός του ανθρακικού αποτυπώματος του Δήμου Αλεξανδρούπολης»
8. **2013**, Δήμος Αλεξανδρούπολης, «Εκπόνηση ΣΔΑΕ για τον Δήμο Αλεξανδρούπολης»
9. **2012-2014**,ΤΣΜΕΔΕ, «Περιβαλλοντική Αξιολόγηση Βιομηχανικών Συστημάτων και Διεργασιών».
10. **2013**, Μεταλλευτική Θράκης Α.Ε., «Επισκόπηση, ανάλυση και αξιολόγηση αντισταθμιστικών οφελών από τα μεταλλευτικά έργα».
11. **2013-2014**, Δήμος Δράμας, «Μετρήσεις και αξιολόγηση των επιπέδων συγκέντρωσης αιωρούμενων σωματιδίων στο ατμοσφαιρικό περιβάλλον του Δήμου Δράμας».
12. **2013-2014**, Δήμος Δράμας, «Εκπόνηση ΣΔΑΕ για τον Δήμο Δράμας»
13. **2013-2015**, Ευρωπαϊκό Πρόγραμμα, JOP BSBEEP, «Σχέδιο για την εξοικονόμηση ενέργειας στα κτίρια των χωρών της Μαύρης Θάλασσας».
14. **2014**, Ευρωπαϊκό Πρόγραμμα «Energy Efficiency in Low Income Housing in the Mediterranean / ELIHMED»
15. **2015**, ΤΣΜΕΔΕ, «Περιβαλλοντική διαχείριση τεχνικών συστημάτων με έμφαση στις αρχές της βιομηχανικής οικολογίας»

- Συνεπικουρία στην κατάθεση ερευνητικών προτάσεων στο πλαίσιο Ευρωπαϊκών και Εθνικών προγραμμάτων .

- 20 δημοσιεύσεις σε διεθνή επιστημονικά περιοδικά με κριτές, 33 δημοσιεύσεις σε πρακτικά εθνικών και διεθνών συνεδρίων, 57 ετεροαναφορές (έως Μάιο 2015).

- Κριτής (reviewer) στο περιοδικό «Recourses, Conservation and Recycling», Elsevier, Impact factor 2,692.

9. Εκπαιδευτική δραστηριότητα – διδασκαλία

- Εκπαιδευτής/εισηγητής στην υλοποίηση του προγράμματος *"Εφαρμογή Ευρωπαϊκών Μεθοδολογιών και Λογισμικών για την Βελτίωση της Ενεργειακής Αποδοτικότητας κτιρίων"* στα πλαίσια του προγράμματος του Τεχνικού Επιμελητηρίου Ελλάδας "e-Μηχανικοί: Εκπαίδευση Μηχανικών στις τεχνολογίες πληροφορικής και επικοινωνιών", ΙΕΚΕΜ-ΤΕΕ, 24-31 Οκτωβρίου 2009, Κομοτηνή, Ελλάδα.

- Εκπόνηση διαλέξεων στο πλαίσιο του Μαθήματος «Τεχνολογία Περιβάλλοντος» (8^{ο} εξάμηνο) του τμήματος Μηχανικών Παραγωγής και Διοίκησης στην παρακάτω θεματολογία:
  - Η Βιομηχανική Οικολογία και τα εργαλεία της
  - Ανάλυση Κύκλου Ζωής και εκμάθηση ειδικού λογισμικού εφαρμογής

- Επικουρική επίβλεψη διπλωματικών εργασιών του εργαστηρίου ΠΔΚΒΟ .

10. Δημοσιεύσεις σε επιστημονικά περιοδικά με κριτές

Π.1: G. Gaidajis and K. Angelakoglou (2009), "Indoor air quality in university classrooms and relative environment in terms of mass concentrations of particulate matter", *Journal of Environmental Science and Health*, A44 (12) [10 citations].

Π.2: F. Filippidou, P. Botsaris, K. Angelakoglou and G. Gaidajis (2010), "A comparative analysis of a CdTe and a Poly-SI photovoltaic module installed in Northeastern Greece", *Applied Solar Energy*, 46 (3), 182-191.

Π.3: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010), "E-waste: Environmental problems and current management", *Journal of Environmental Science and Technology Reviews*, 3(1), 193-199 [28 citations].

Π.4: G. Gaidajis and K. Angelakoglou (2011), "Assessment of the environmental impacts deriving from the life cycle of a typical solar water heater", *Journal of Environmental Science and Technology Reviews*, 4(1), 92-95 [2 citations].

Π.5: G. Gaidajis, K. Angelakoglou, P. Botsaris and F. Fillipidou (2011), "Analysis of the recycling potential of used automotive oil filters using the Life Cycle Assessment approach" *Resources, Conservation and Recycling*, 55, 986-994 [6 citations].

Π.6: G. Gaidajis and K. Angelakoglou (2011), "Screening life cycle assessment of an office used for academic purposes", *Journal of Cleaner Production*, 19, 1639-1646 [7 citations].

Π.7: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2012), "Assessing the Global Warming Potential of a typical office-workstation using Life Cycle Assessment", *Fresenius Environmental Bulletin*, Issue 1/8/2012.

Π.8: G. Gaidajis and K. Angelakoglou (2012), "Indoor air quality in terms of mass concentrations of particulate matter in areas of massive public congregation", *Fresenius Environmental Bulletin*, Issue 1/8/2012.

Π.9: G. Gaidajis and K. Angelakoglou (2012), "Environmental performance of renewable energy systems with the application of Life Cycle Assessment: a Multi-Si photovoltaic module case study", *Civil Engineering and Environmental Systems, Special Issue*, 29 (4), 231-238.

Π.10: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2012), "Sustainable Development integration in Greek school of engineering – current situation, experiences and actions", *International Journal of Sustainable Engineering*, 5 (2) [1 citation].

Π.11: G. Gaidajis and K. Angelakoglou (2012), "Ambient Air Quality at the Wider Area of a Mining Facility in Stratoni, Chalkidiki, Greece", *Journal of Environmental Science and Health, Part A*, 47 (12), 1869-1877.

Π.12: K. Angelakoglou, G. Gaidajis and M. Dimitriou (2013), "Comparative evaluation of flat roof thermal systems: A life cycle analysis based approach", *Journal of Sustainable Building Technology* and Urban Development, 4 (3), 243-257. [2 citation]

Π.13: G. Gaidajis, V. Kazakidis and K. Angelakoglou (2013), "Evaluation of Environmental and Social Parameters of a gold-mining project at the pre-feasibility stage: A case study", *Global Perspective on Engineering Management*, Vol. 2 (2), 93-104.

Π.14: K. Angelakoglou, P.N. Botsaris and G. Gaidajis (2014), "Issues regarding wind turbines positioning: A benchmark study with the application of the life cycle assessment approach", *Sustainable Energy Technologies and Assessment,* 5, 7-18. [1 citation]

Π.15: G. Gaidajis and K. Angelakoglou (2014), "Indoor mass concentrations of particulate matter in hospital environment", *Global Nest Journal*, 16 (5), pp. 832-839.

Π.16: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2014), "Wintertime particulate mass concentrations in urban environment and the impact of economic crisis", *Journal of Environmental Science and Health, Part A*, Vol. 49 (14), 1653 – 1660.

Π.17: K. Angelakoglou, D. Aktsoglou, G. Gaidajis, I. Margiolaki and V. Tzomaka (2015), "A preliminary assessment of the carbon footprint of households in Greece", *International Journal of Sustainable Society* (in press).

Π.18: K. Lymperopoulos, P.N. Botsaris, K. Angelakoglou and G. Gaidajis (2015), "Analysis of the energy consumption profile and development of sustainable energy action plans of medium-sized municipalities in north-eastern Greece", *Energy research advances*, 3 (1), 11-30.

Π.19: K. Angelakoglou, G. Gaidajis, K. Lymperopoulos and P.N. Botsaris (2015), "Carbon footprint analysis of municipalities – Evidence from Greece". *Journal of Environmental Science and Technology Reviews*, (accepted).

Π.20: K. Angelakoglou and G. Gaidajis (2015), "A review of methods available for assessing the environmental sustainability of industrial systems", *Journal of Cleaner Production* (under review).

Π.21: K. Angelakoglou, and G. Gaidajis (2015), "ENSAI-index: A new methodological framework for assessing the environmental sustainability of industrial facilities", *Journal of Industrial Ecology* (to be submitted).

11. Δημοσιεύσεις σε πρακτικά συνεδρίων με κριτές

Σ.1: G. Gaidajis and K. Angelakoglou (2008), "Air quality in university classrooms - The impact of fine particulate matter", Proceedings, "*4th International Conference on Ecological Protection of the Planet Earth: Environment, Maritime Policies & Energy Issues in Black Sea*", June 12-15, 2008, Trabzon, Turkey.

Σ.2: G. Gaidajis and K. Angelakoglou (2009), "Indoor mass concentrations of particulate matter in university environment", *11th International Conference on Environmental Science and Technology*, September 3-5, Chania, Greece 2009.

Σ.3: G. Gaidajis and K. Angelakoglou (2009), "Systems thinking and environmental assessment of products – Using the Life Cycle Assessment (LCA) approach", HSSS conference "*From Systemic Thinking to Systems Design and Systems Practice*", June 24-27, 2009, Xanthi, Greece.

Σ.4: G. Gaidajis and K. Angelakoglou (2009), "Systemic thinking and industrial ecology – the concept of eco-industrial parks", 5th National & International HSSS conference "*From Systemic Thinking to Systems Design and Systems Practice*", June 24-27, 2009, Xanthi, Greece.

Σ.5: G. Gaidajis and K. Angelakoglou, "Recovery of waste lubricant oil contained in used automotive filters" (2009), *3rd International Conference "Towards Sustainable Development: Assessing the footprint of resource utilization & Hazardous Waste Management*", AMIREG 2009, September 7-9, Athens 2009.

Σ.6: Γ. Γκαϊντατζής, Κ. Αγγελάκογλου και Δ. Ακτσόγλου (2009), "Ηλεκτρονικά Απόβλητα – Περιβαλλοντικά Προβλήματα και Υφιστάμενη Διαχείριση", *1ο Ελληνοκινεζικό φόρουμ για το περιβάλλον, ΤΕΕ, 3-4/12/2009, Αθήνα.*

Σ.7: Γ. Γκαϊντατζής και Κ. Αγγελάκογλου (2009), "Ανάπτυξη ενός μεθοδολογικού πλαισίου για την εκτίμηση της περιβαλλοντικής βιωσιμότητας των βιομηχανικών δραστηριοτήτων: η περίπτωση της μεταλλευτικής και εξορυκτικής βιομηχανίας", *2ο Συνέδριο Περιβαλλοντικής Πολιτικής & Διαχείρισης*, Παρασκευή 19η - Κυριακή 21η Ιουνίου 2009, Μυτιλήνη.

Σ.8: Γ. Γκαϊντατζής, Κ. Αγγελάκογλου και Π. Μπότσαρης (2009), "Αξιολόγηση της περιβαλλοντικής και αειφορικής επίδοσης των κατασκευαστικών έργων", *2ο Συνέδριο Περιβαλλοντικής Πολιτικής & Διαχείρισης*, Παρασκευή 19η - Κυριακή 21η Ιουνίου 2009, Μυτιλήνη.

Σ.9: K. Angelakoglou, D. Aktsoglou and G. Gaidajis (2010), "Assessing the Global Warming Potential of a typical office-workstation using Life Cycle Assessment", *Second International Symposium on Green Chemistry for Environment and Health*, September 27-29, 2010, Mykonos, Greece.

Σ.10: G. Gaidajis and K. Angelakoglou (2010), "Indoor air quality in terms of mass concentrations of particulate matter in areas of massive public congregation", *Second International Symposium on Green Chemistry for Environment and Health*, September 27-29, 2010, Mykonos, Greece.

Σ.11: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010), "Integration of Sustainable Development in Engineering Universities in Greece", EESD 2010, *5th International Engineering Education in Sustainable Development Conference*, 19-22 of September, 2010,Göteborg, Sweden.

Σ.12: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010), "Incorporating Industrial Ecology as an enhancement tool for teaching Sustainable Development to Engineers - current experience from Greece", *5th International Engineering Education in Sustainable Development Conference*, 19-22 of September, 2010, Göteborg, Sweden.

Σ.13: Γ. Γκαϊντατζής, Κ. Αγγελάκογλου, και Σ. Φωτοπούλου (2010), "Ποιότητα αέρα εσωτερικών χώρων σε σχέση με τα αιωρούμενα σωματίδια – περίπτωση μελέτης σε χώρους μαζικής συνάθροισης", *Περιοδικό hygeia@ergasia*, Τεύχος 3, Σελ. 207-218. Ελληνική εταιρία ιατρικής της εργασίας & περιβάλλοντος.

Σ.14: G. Gaidajis and K. Angelakoglou (2011), "Environmental analysis of a typical solar water heater with the application of Life Cycle Assessment software", *2nd International Exergy, Life Cycle Assessment, and Sustainability Workshop & Symposium*, June 19-21, Nisyros, Greece.

Σ.15: G. Gaidajis and K. Angelakoglou (2011), "Environmental assessment of a poly-Si photovoltaic panel", *3rd International Conference on Environmental Management, Engineering, Planning and Economics (CEMEPE 2011) & SECOTOX Conference*, June 19-24, 2011, Skiathos, Greece.

Σ.16: P. Botsaris, K. Angelakoglou, G. Gaidajis and J. Tsanakas (2011), "Lifecycle costs and environmental life cycle analysis of solar water heaters in Greece", *2nd International Congress on Condition Monitoring and Diagnostics Engineering Management*, May 30 – June 1, 2011, Stavanger, Norway.

Σ.17: G. Gaidajis and K. Angelakoglou (2011), "Development of a holistic tool for assessing the environmental sustainability of mining facilities", *5th International Conference Sustainable Development in the minerals industry*, SDIMI 2011, June 14-17, Aachen, Germany.

Σ.18: Γ. Γκαϊντατζής και Κ. Αγγελάκογλου (2011), "Μέθοδοι αποτίμησης της περιβαλλοντικής επίδοσης-βιωσιμότητας βιομηχανικών εγκαταστάσεων και ανάπτυξη σχετικού εργαλείου", *4ο Περιβαλλοντικό Συνέδριο Μακεδονίας, Θεσσαλονίκη*, 18-20 Μαρτίου 2011.

Σ.19: G. Gaidajis and K. Angelakoglou (2012), "Environmental Analysis of a 3MW Wind Turbine with the Application of the Life Cycle Assessment". *Protection and Restoration for the Environments – PRE11 XI International Conference*, Thessaloniki, Greece July 3-6, 2012.

Σ.20: G. Gaidajis and K. Angelakoglou (2012), "Indoor Concentrations of Particulate Matter in Hospital Environment". *Protection and Restoration for the Environments – PRE11 XI International Conference*, Thessaloniki, Greece July 3-6, 2012.

Σ.21: G. Gaidajis, K. Angelakoglou and I. Margiolaki (2012), "A preliminary assessment of household carbon footprint in Greece", *Third international symposium on Green Chemistry for Environment*, Health and Development, Skiathos Island, October 3-5, 2012, Greece.

Σ.22: G. Gaidajis and K. Angelakoglou (2012), "Relative Contribution of the Transportation Sector to

the Carbon Footprint of an Urban Centre – A Medium Sized Greek City Case Study", *TAP 2012 Conference*, Thessaloniki, Greece, November 26-27, 2012.

Σ.23: G. Gaidajis and K. Angelakoglou (2013), "Carbon footprint and energy assessment of a medium sized municipality in Greece". CEST 2013, *13th International conference on Environmental Science and Technology*, September 5-7, 2013, Athens, Greece.

Σ.24: K. Angelakoglou and G. Gaidajis (2013), "Assessing the progress of mining industry towards sustainability – In need of new methodological frameworks", *6th International Conference on Sustainable Development in the Minerals Industry*, SDIMI 2013, Milos, 30 June-3 July.

Σ.25: D. Aktsoglou, K. Angelakoglou and G. Gaidajis (2013), "Assessing the familiarity of students in engineering with sustainability", *6th International Conference on Sustainable Development in the Minerals Industry*, SDIMI 2013, Milos, 30 June-3 July.

Σ.26: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2014), "Air quality in urban areas in terms of particulate matter concentrations – Results from a case study in North Greece", *12th International Conference on Protection and Restoration of the Environment*, June 29 to July 3 2014, Skiathos island, Greece.

Σ.27: K. Angelakoglou, M. Chatzisideris and G. Gaidajis (2014), "Moving from mere quantification to meaningful evaluation of environmental sustainability indicators in industry", *Fourth International Symposium on Green Chemistry, Health and Development*, September 24-26, Kos Island, Greece.

Σ.28: K. Angelakoglou and G. Gaidajis (2014), "Selection of indicators for assessing the environmental sustainability of industrial facilities and processes", *Fourth International Symposium on Green Chemistry, Health and Development*, September 24-26, Kos Island, Greece.

Σ.29: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2014), "Particulate matter concentration in urban environment during the winter period", *5th Environmental Conference of Macedonia*, 14-16 March 2014, Thessaloniki, Greece.

Σ.30: K. Angelakoglou and G. Gaidajis (2014), "Utilization of Industrial Ecology Principles for assessing the environmental sustainability of industries", *1st National Conference: Economics of Natural Resources and Environment – Climate Change*, ENVECON 2014, 27-27 March 2014, Volos Greece.

Σ.31: G. Gaidajis and K. Angelakoglou (2015). "Utilization of sustainable water consumption and management indicators by industrial facilities and their contribution to sustainability assessment". Wastenet, *Sustainable Solutions to Wastewater Management: 2nd International Scientific Conference*. 19-21 June, Kavala, Greece (accepted).

Σ.32: K. Angelakoglou, I. Kakanis and G. Gaidajis (2015). "An eco-label scheme of environmental sustainability for industrial facilities", *14th International Conference on Environmental Science and Technology*, CEST2015, 3-5 September 2015, Rhodes, Greece (accepted).

Σ.33: K. Angelakoglou and G. Gaidajis (2015), "ENSAI-index: A new methodological framework for assessing the environmental sustainability of industrial facilities". *International Society for Industrial Ecology, ISIE2015* – Taking stock of industrial Ecology, 7-10 July, Guildford, UK. (accepted)

12. Βραβεία και υποτροφίες

- **2005-2006**. Ά αναπληρωματικός-υποτροφία και βραβείο για την επίδοση στο 3^{ο} έτος του Τμήματος Μηχανικών Παραγωγής και Διοίκησης από το Ίδρυμα Κοινωνικών Υποτροφιών (Ι.Κ.Υ.) (2^{ος} σε επίδοση στο τμήμα).
- **2006-2007**. Υποτροφία και βραβείο επίδοσης για το 4^{ο} έτος του Τμήματος Μηχανικών Παραγωγής και Διοίκησης από το Ίδρυμα Κοινωνικών Υποτροφιών (Ι.Κ.Υ.) (1^{ος} σε επίδοση στο τμήμα).
- **2007**. Έπαινος από το Κέντρο Πρόνοιας Δήμου Καβάλας για την επίδοση στην Πολυτεχνική Σχολή του Τμήματος Μηχανικών Παραγωγής και Διοίκησης.

13. Πρόσθετες πληροφορίες

- Άδεια ασκήσεως επαγγέλματος Μηχανικού Παραγωγής και Διοίκησης.
- Εγγεγραμμένος στα μητρώα Μηχανολόγων και Ηλεκτρολόγων.
- Μέλος του Τεχνικού Επιμελητηρίου Ελλάδος (ΤΕΕ) από το 2009 (ΑΜ:120338).
- Μέλος του συλλόγου Μηχανικών Παραγωγής και Διοίκησης από το 2009.
- Μέλος της International Society of Industrial Ecology for Students.
- Ευρωπαϊκό δίπλωμα οδήγησης.
- Δυνατότητα παροχής συστατικών επιστολών εφόσον ζητηθούν.

Παραρτήματα

1. Περιλήψεις διατριβών για την απόκτηση πανεπιστημιακών τίτλων

"Ποιότητα αέρα εσωτερικών χώρων σε σχέση με τα αιωρούμενα σωματίδια – Μελέτη περίπτωσης σε πανεπιστημιακό περιβάλλον". Διπλωματική Εργασία, Τμήμα Μηχανικών Παραγωγής και Διοίκησης, Δημοκρίτειο Πανεπιστήμιο Θράκης, Μάιος 2008, Επιβλέπων Καθηγητής: Γκαϊντατζής Γεώργιος.

Η διπλωματική εργασία πραγματεύεται τον προσδιορισμό της ποιότητας αέρα εσωτερικών χώρων όσον αφορά την συγκέντρωση αιωρούμενων σωματιδίων σε πανεπιστημιακούς χώρους. Συγκεκριμένα η συγκέντρωση αδρομερών (coarse - PM_{10}) και λεπτομερών (fine - $PM_{2.5}$) σωματιδίων μετρήθηκε σε διαφορετικές αίθουσες διδασκαλίας και εσωτερικούς χώρους στην Πολυτεχνική Σχολή του Δημοκρίτειου Πανεπιστήμιου Θράκης, με την χρήση φορητού οργάνου δειγματοληψίας. Για σύγκριση, καταγράφηκαν τα επίπεδα των εξωτερικών συγκεντρώσεων, ενώ η έκθεση των φοιτητών στα αιωρούμενα σωματίδια ποσοτικοποιήθηκε μέσω «κινητών» μετρήσεων κατά τις οποίες το όργανο δειγματοληψίας ακολουθούσε τους φοιτητές σε όλες τους τις δραστηριότητες. Τα αποτελέσματα υπέδειξαν 10ωρες μέσες συγκεντρώσεις στις αίθουσες διδασκαλίας που κυμαίνονταν από 63-191 μg/m³ και 52-109 μg/m³ για τα σωματίδια PM_{10} και $PM_{2.5}$ αντίστοιχα. Συγκεντρώσεις άνω των 300 μg/m³ καταγράφονταν αρκετά συχνά μέσα στις αίθουσες, ενώ οι στιγμιαίες μέγιστες τιμές ήταν 1334 μg/m³ για τα PM_{10} και 1139 μg/m³ για τα $PM_{2.5}$. Όπως αναμενόταν, οι μέσες συγκεντρώσεις τόσο των σωματιδίων PM_{10} όσο και των $PM_{2.5}$ ήταν σημαντικά υψηλότερες στην αίθουσα-χώρο αναμονής των φοιτητών και στο γραφείο όπου οι μετακινήσεις είναι συχνότερες και το κάπνισμα εντονότερο, υποδεικνύοντας έτσι κάποιους από τους παράγοντες επιδείνωσης της εσωτερικής ποιότητας του αέρα.

"Ανάπτυξη μεθοδολογικού πλαισίου για την αποτίμηση της περιβαλλοντικής βιωσιμότητας βιομηχανικών εγκαταστάσεων και διεργασιών". Διδακτορική Διατριβή, Τμήμα Μηχανικών Παραγωγής και Διοίκησης, Δημοκρίτειο Πανεπιστήμιο Θράκης, Ιούνιος 2015, Επιβλέπων Καθηγητής: Γκαϊντατζής Γεώργιος.

Βασικός σκοπός της διδακτορικής διατριβής είναι η βελτίωση του τρόπου με τον οποίο οι βιομηχανίες αποτιμούν την περιβαλλοντική βιωσιμότητα των βιομηχανικών εγκαταστάσεων και διεργασιών τους, μέσω της ανάπτυξης ενός καινοτόμου μεθοδολογικού πλαισίου αποτίμησης. Το μεθοδολογικό πλαίσιο αναπτύχθηκε σύμφωνα με τις αρχές της Βιομηχανικής Οικολογίας για την ενίσχυση της περιβαλλοντικής βιωσιμότητας βιομηχανικών συστημάτων και με γνώμονα την αντιμετώπιση των κυριότερων αδυναμιών των διαθέσιμων μεθόδων αποτίμησης. Το αντικείμενο της διδακτορικής διατριβής δομείται σε έξι (6) αλληλένδετα Κεφάλαια, καθένα από τα οποία απαντάει σε συγκεκριμένα ερωτήματα.

Στο 1^{ο} Κεφάλαιο, ορίζεται το πρόβλημα το οποίο καλείται να επιλύσει η παρούσα διατριβή, ενώ συνοψίζονται και αναλύονται τα ιδιαίτερα χαρακτηριστικά της βιώσιμης ανάπτυξης ώστε να ενισχυθεί η κατανόηση του θεωρητικού υποβάθρου της. Στο 2^{ο} Κεφάλαιο, αναδεικνύονται τα ιδιαίτερα χαρακτηριστικά και προκλήσεις της διαδικασίας αποτίμησης της περιβαλλοντικής βιωσιμότητας. Επιπλέον, εκπονείται μια πρωτότυπη και αναλυτική βιβλιογραφική επισκόπηση των διαθέσιμων μεθόδων αποτίμησης, με στόχο την τεκμηρίωση του ερευνητικού κενού το οποίο καλύπτει η παρούσα διατριβή και την ανάδειξη των γενικών χαρακτηριστικών τα οποία θα πρέπει να εμπεριέχει μια μέθοδος αποτίμησης. Στο 3^{ο} Κεφάλαιο, αναλύονται τα χαρακτηριστικά, οι αρχές και τα εργαλεία της Βιομηχανική Οικολογίας βάσει των οποίων επιλέγονται τα στοιχεία εκείνα στα οποία μια βιομηχανία θα πρέπει να στοχεύει ώστε να βελτιώσει την περιβαλλοντική της βιωσιμότητα και κατά επέκταση χρίζουν αποτίμησης. Η Βιομηχανική Οικολογία επιλέχθηκε λόγω της ικανότητάς της να υποστηρίζει καινοτόμες και δημιουργικές δράσεις όσον αφορά την βιώσιμη

ανάπτυξη. Στο 4^{ο} Κεφάλαιο, παρουσιάζεται αναλυτικά το τελικό μεθοδολογικό πλαίσιο αποτίμησης της περιβαλλοντικής βιωσιμότητας βιομηχανικών εγκαταστάσεων και διεργασιών. Η ανάπτυξη του πλαισίου πραγματοποιείται με γνώμονα την επίλυση των αδυναμιών που παρουσιάστηκαν, της κάλυψης των αρχών της Βιομηχανικής Οικολογίας και των γενικών κανόνων ανάπτυξης σύνθετων δεικτών από την βιβλιογραφία. Αποτέλεσμα όλων αυτών των δράσεων, είναι η ανάπτυξη ενός τελικού μεθοδολογικού πλαισίου το οποίο μπορεί να εφαρμοστεί από όλες τις βιομηχανίες και αποτιμά με αξιόπιστο και αποτελεσματικό τρόπο την περιβαλλοντική τους βιωσιμότητα τονίζοντας τις περιοχές ιδιαίτερου ενδιαφέροντος. Στο 5^{ο} Κεφάλαιο, το μεθοδολογικό πλαίσιο εφαρμόζεται σε μια μελέτη περίπτωσης ώστε να αξιολογηθεί η χρησιμότητά του και να ανευρεθούν επιπλέον τρόποι βελτίωσης της χρηστικότητάς του. Στο 6^{ο} Κεφάλαιο συνοψίζονται τα βασικά συμπεράσματα της διδακτορικής διατριβής και προτείνονται πεδία μελλοντικής έρευνας για την περαιτέρω βελτίωση του τρόπου αποτίμησης της περιβαλλοντικής βιωσιμότητας βιομηχανικών/ευρύτερων συστημάτων.

2. Περιλήψεις δημοσιεύσεων σε επιστημονικά περιοδικά με κριτές

Π.1: G. Gaidajis and K. Angelakoglou (2009), "Indoor air quality in university classrooms and relative environment in terms of mass concentrations of particulate matter", *Journal of Environmental Science and Health*, A44 (12), 1227 – 1232. [10 citations]

The mass concentrations of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter were measured in different classrooms and relevant indoors areas of Democritus University, School of Engineering, Xanthi, with portable aerosol monitoring equipment. Two sampling campaigns were conducted in different seasons. The results indicated that the average concentrations in classrooms ranged from 32–188 μg/m^3 and 25–151 μg/m^3 for PM_{10} and $PM_{2.5}$, respectively. Concentration levels above 300 μg/m^3 were usually recorded, while the $PM_{2.5}/PM_{10}$ ratio was about 0.8. As expected, PM_{10} and $PM_{2.5}$ average concentrations were significantly higher in the open access meeting place of common use, indicating the significance of student trespassing and occasional smoking in the deterioration of indoors air quality.

Π.2: F. Filippidou, P. Botsaris, K. Angelakoglou and G. Gaidajis (2010), "A comparative analysis of a CdTe and a Poly-SI photovoltaic module installed in Northeastern Greece", *Applied Solar Energy*, 46 (3), 182-191.

The aim of this paper is the comparison of two different photovoltaic (PV) modules installed in North Eastern Greece, a CdTe thin film and a poly-Si PV module, in terms of energy reimbursement through the extraction of Energy Payback Time (EBPT). In addition, the environmental burden of the examined systems was assessed by examining their Global Warming Potential (GWP) and their Ecological Footprint (EF). For both the energy analysis and the environmental assessment, life cycle oriented approach was implemented using relative software and literature review. Results are expected to help decision makers, investors and researchers interested in photovoltaic technological issues and their performance.

Π.3: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010), "E-waste: Environmental problems and current management", *Journal of Environmental Science and Technology Reviews*, 3(1), 193-199. [28 citations]

In this paper the environmental problems related with the discarded electronic appliances, known as e-waste, are reviewed. Moreover, the current and the future production of e-waste, the potential environmental problems associated with their disposal and management practices are discussed whereas the existing e-waste management schemes in Greece and other countries (Japan, Switzerland) are also quoted.

Π.4: G. Gaidajis and K. Angelakoglou (2011), "Assessment of the environmental impacts deriving from the life cycle of a typical solar water heater", *Journal of Environmental Science and Technology Reviews*, 4(1), 92-95. [2 citations]

According to life cycle thinking, the environmental burden deriving from different life cycle stages of a product or a system, such as manufacturing, transportation, maintenance and landfilling should be taken into consideration while assessing its environmental performance. In that aspect, the environmental impacts deriving from the life cycle of a typical solar water heater (SWH) in Greece are analyzed and assessed with the application of relative life cycle assessment (LCA) software in this study. In order to examine various impact categories such as global warming, ozone layer depletion, ecotoxicity and so forth, the IMPACT2002+ method is applied. The aim of this study is to examine the life cycle stages, processes and materials that significantly affect the system under examination and to provide a discussion regarding the environmental friendliness of solar water heaters.

Π.5: G. Gaidajis, K. Angelakoglou, P. Botsaris and F. Fillipidou (2011), "Analysis of the recycling potential of used automotive oil filters using the Life Cycle Assessment approach" *Resources, Conservation and Recycling*, 55, 986-994. [6 citations]

The aim of this study is to evaluate whether a specific recycling system for used oil filters (UOFs) is environmentally viable by considering all steps of the product's life cycle. In that aspect an analysis of the environmental impacts regarding different waste management scenarios of UOFs in Greece is presented using the Life Cycle Assessment (LCA) approach. Waste scenarios varied from maximum feasible recycling and recovery of metals and used lubricant oil, to disposal of UOFs to landfills without any prior treatment. In order to perform this analysis, the principles of ISO 14040 were followed and a relevant LCA software was used (SimaPro 7.2). Additionally, the results of a previous work conducted by the authors were deployed, including some experimental measurements undertaken so as to evaluate and quantify the factors affecting the recovery of the lubricant oil contained in used automotive filters. Indicatively, it was estimated that a maximum of 1340 tons of used oil and 1810 tons of steel are disposed every year in Greece, as a result of the non-effective management of used automotive filters.

Π.6: G. Gaidajis and K. Angelakoglou (2011), "Screening life cycle assessment of an office used for academic purposes", *Journal of Cleaner Production*, 19, 1639-1646 [7 citations].

The aim of this study is to contribute to the analysis of the environmental impacts deriving from common aspects of the service sector activity and to identify auxiliary actions and hot spots in order to improve the environmental performance of offices used for educational purposes. In that aspect, a screening life cycle assessment (LCA) for a university office-workstation of Democritus University of Thrace, Greece, was performed with the application of the SimaPro LCA software, and the Impact 2002+ method with fifteen impact categories for the interpretation of results. Findings from this research indicated that energy consumption for the powering electronic appliances was the key factor affecting most of the environmental impact categories examined. The impact categories most seriously affected by the office life cycle were the emissions of respiratory inorganics (39%), global warming (31%) and nonrenewable energy use (27%). The saving of the energy consumed due to standby mode could lead to a reduction of 2.4% of the total energy consumption in the office in a yearly basis with proportional positive influence in all the respective impact categories. Additionally, utilization of solar energy through photovoltaic panels could lead to a reduction close to 90% for a number of impact categories. Therefore, actions and strategies for improving the environmental performance of academic offices should focus on the reduction of energy consumption.

Π.7: K. Angelakoglou, D. Aktsoglou and G. Gaidajis (2012), "Assessing the Global Warming Potential of a typical office-workstation using Life Cycle Assessment", *Fresenius Environmental Bulletin*, Issue 1/8/2012.

The perpetual development of the service providers drew the attention of environmentalists and researchers who indicated the significant amounts of materials and energy consumed, basically through material flow analysis studies. In this study, a life cycle assessment (LCA) for a typical university office was performed, with the employment of relative software. In order for the assessment to be carried out, an inventory was created including basic inputs and outputs for the system examined. This inventory included common used equipment and devices of a typical office whereas energy consumption for a given period of time was estimated. Results indicated the processes, materials and life cycle stages that highly affected GWP in terms of kg CO2 equivalent. In that aspect an initial analysis was given regarding actions for "greening" the service sector whereas the potential of expanding the boundaries of this study was further discussed.

Π.8: G. Gaidajis and K. Angelakoglou (2012), "Indoor air quality in terms of mass concentrations of particulate matter in areas of massive public congregation", *Fresenius Environmental Bulletin*, Issue 1/8/2012.

The aim of this paper is to give an overview of the air quality in terms of particulate matter concentrations in places of common interest where public congregation takes place in Greece. Thus, the mass concentrations of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter were measured in different indoors areas of massive public congregation such as bars, museums, schools, exhibition centers and churches, using portable aerosol monitoring equipment. Results indicated that average concentrations for all the areas examined, frequently exceeded the annual and 24-hour guidelines proposed by World Health Organization (WHO), whereas very high instantaneous maximum concentrations (>1000μg/m^3) were usually recorded. Moreover, specific actions such as smoking and cleaning were identified as the major causes of elevated concentrations of particulate matter and in that aspect the effects of the strict prohibition of smoking in indoors environment are discussed and moreover ameliorative measures are proposed.

Π.9: G. Gaidajis and K. Angelakoglou (2012), "Environmental performance of renewable energy systems with the application of Life Cycle Assessment: a Multi-Si photovoltaic module case study", *Civil Engineering and Environmental Systems,* 29 (4), 231-238.

Life-cycle thinking significantly affects the assessment of the environmental performance of a system. In this study, the life-cycle assessment of a multi-Si photovoltaic (PV) module was conducted in order to examine the environmental burden throughout its life cycle and benchmark it with the environmental burden of the identical conventional energy produced with the energy mix of Greece and supplied by the national energy network grid. The results indicated that aluminum, solar glass and the energy consumed during PV assembly significantly affected the environmental performance of the PV module. Non-renewable energy utilization, global warming and respiratory inorganic emissions were the major impact categories affected by the life cycle of the module examined. Significant questions were raised regarding the distance of the PV installation site from manufacturers and maintenance personnel. Still, the utilization of the system examined was more efficient than the application of conventional energy sources in terms of environmental performance.

Π.10: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2012), "Sustainable Development integration in Greek school of engineering – current situation, experiences and actions", *International Journal of Sustainable Engineering*, 5 (2). [1 citation]

In this paper, a comprehensive study regarding the assessment of sustainable development (SD) integration in Greek schools of engineering is presented. More specifically, the undergraduate and graduate curricula and websites of all schools of engineering in Greece were examined to identify SD-related content and actions. Moreover, a simple guide for embedding SD into engineering schools was established, based on the experiences of successful implementation and strategies from highly recognized technical universities worldwide, to benchmark the Greek experience and to propose

indicative measures for incorporating SD teaching in Greek universities. Results indicated that changing the curriculum is not the only way to efficiently incorporate SD in universities, whereas there are gaps concerning the integration of sustainability principles and tools in Greek engineering universities. Furthermore, the initial steps of incorporating SD-related actions at an engineering department are presented and analysed indicating some characteristic key factors affecting the efficient incorporation of SD tools in engineering courses.

Π.11: G. Gaidajis K. Angelakoglou and E. Gazea (2012), "Ambient Air Quality at the Wider Area of a Mining Facility in Stratoni, Chalkidiki, Greece", *Journal of Environmental Science and Health, Part A*, 47 (12), 1869-1877.

To assess ambient air quality at the wider area of a mining-industrial facility in Chalkidiki, Greece, the particulate matter with an aerodynamic diameter of 10 μm (PM_{10}) and its content in characteristic elements, i.e., As, Cd, Cu, Fe, Mn, Pb, Zn were monitored for a period of three years (2008–2010). Gravimetric air samplers were employed for the particulate matter sampling at three sampling stations located in the immediate vicinity of the industrial facility and at a neighboring residential site. Monitoring data indicated that the 3-year median PM_{10} concentrations were 23.3 $\mu g/m^3$ at the residential site close to the facility and 28.7 $\mu g/m^3$ at the site within the facility indicating a minimal influence from the industrial activities to the air quality of the neighboring residential area. Both annual average and median PM_{10} concentration levels were below the indicative European standards, whereas similar spatial and temporal variation was observed for the PM_{10} constituents. The average Pb concentrations measured for the three sampling sites were 0.2, 0.146 and 0.174 μg/m3 respectively, well below the indicative limit of 0.5 $\mu g/m^3$. The quantitative and qualitative comparison of PM_{10} concentrations and its elemental constituent for the three sampling stations did not indicate any direct influence of the mining-industrial activities to the air quality of the Stratoni residential area.

Π.12: K. Angelakoglou, G. Gaidajis and M. Dimitriou (2013), "Comparative evaluation of flat roof thermal systems: A life cycle analysis based approach", International *Journal of Sustainable Building Technology* and Urban Development, 4 (3), 243-257. [2 citations]

In the specific study, four flat roof thermal systems namely: the gravel ballasted roof, the green roof, the ventilated roof and the insulated false ceiling, were analyzed with the application of the life cycle assessment method (LCA). The analysis of the systems was based on literature references, theoretical calculations and extensive simulation scenarios. Various parameters were evaluated such as cost and time of application, structural loads, maintenance needs and energy efficiency. The study focused on the comparative environmental evaluation of the systems. Results indicated that the ballasted roof exhibited the best environmental performance. Extruded polystyrene and steel parts were the key parameters affecting the environmental performance of the systems. Significant results are also provided regarding the energy reimbursement and technical characteristics. The conclusions of the specific study support the need to identify alternative materials and processes for the formation of the thermal roof system layers and the integration of separation processes and partial recycling in construction activities.

Π.13: V. Kazakidis, G. Gaidajis and K. Angelakoglou (2013), "Evaluation of Environmental and Social Parameters of a gold-mining project at the pre-feasibility stage: A case study", *Global Perspective on Engineering Management*, Vol. 2 (2), 93-104.

The aim of the specific study is to present/evaluate the environmental and social parameters of a gold mining project in its pre-feasibility and permitting stages. The parameters are analyzed and evaluated for a pioneered gold-mining project in North-Eastern Greece. Results benchmark the key environmental and social parameters for the next phase of a feasibility study. Although the economic and environmental challenges of the project can be mitigated with the existing framework, the triple bottom line of sustainable mineral resource development requires the amendment of the country's

mining act. Such an amendment will take into account the needs of the people in the region to have an effective engagement in the exploitation of mineral resources in the region, based on a negotiated tri-partite mutual agreement of impacts and benefits to company, country and region. The analysis provided in this work is expected to be useful for decision makers, managers and environmentalists related to gold-mining.

Π.14: K. Angelakoglou, P.N. Botsaris and G. Gaidajis (2014), "Issues regarding wind turbines positioning: A benchmark study with the application of the life cycle assessment approach", *Sustainable Energy Technologies and Assessment,* 5, 7-18. [1 citation]

In the specific study a number of issues are addressed and discussed regarding wind turbines positioning in terms of land, coastal and offshore installation. More specifically, technical, environmental, energy, social and economical parameters are evaluated, providing thus a holistic assessment of the systems under examination. The analysis of the systems is based on literature references, theoretical calculations and simulation scenarios, taking into account life cycle thinking. The environmental assessment is performed with the application of special life cycle assessment software, and the results are considered to be representative for Greece and Mediterranean regions. Indicatively, it can be inferred that land wind turbines seem to be the environmentally friendliest choice. Significant questions are raised regarding wind turbines waste management schemes and their material usage. On the other hand, the offshore wind turbine surpasses the other two versions in terms of energy and financial reimbursement. However, existing barriers of different nature, i.e. financial, administrative and/or social may hold up the rapid development of the wind (onshore or offshore) energy in many European countries.

Π.15: G. Gaidajis and K. Angelakoglou (2014), "Indoor mass concentrations of particulate matter in hospital environment", *Global Nest Journal*, 16 (5), pp. 832-839.

The assessment of the indoors air quality where people usually spend extended time periods, especially for sensitive population groups such as patients during their hospitalization, is of major importance. Ensuring a safe level of air quality in these indoor environment serves as an amelioration factor for human health not only for the often habitués of those indoors places, but also for the working personnel that spend more than 90% of their time indoors. In that aspect the concentration of coarse (PM_{10}) and fine ($PM_{2.5}$, $PM_{1.0}$) particulate matter was measured in two Intensive Care Units (ICU), with different spatial and trespassing characteristics, of the Democritus University Hospital situated at Alexandroupolis, Greece. The measurements were conducted with the application of two portable aerosol monitoring equipment (TSI DustTrak 8520 and Grimm 107). The results indicated that the 24-h average concentrations were below the indicative limits proposed by the World Health Organization (WHO) (50 and 25 μg m^3 for PM_{10} and $PM_{2.5}$ respectively). Relatively elevated instant concentration levels (>100 μg m^3) were also recorded during specific activities and in conjunction with the temporal variation of the observed concentration levels raised questions regarding the side effects of cleaning activities.

Π.16: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2014), "Wintertime particulate mass concentrations in urban environment and the impact of economic crisis", *Journal of Environmental Science and Health, Part A*, 49 (14), 1653 – 1660.

The aim of the specific study is to discuss the impact of economic crisis on air quality in Greece in terms of particulate matter (PM) concentrations. For this purpose, three sampling campaigns were conducted during the winter period of 2012, 2013 and 2014 in two medium sized cities in North Greece (Kavala and Drama). The average concentrations measured ranged from 33–56, 28–47 and 25–44 μg/m^3 for PM_{10}, $PM_{2.5}$ and PM_1, respectively. The analysis of the daily concentration profile for all measurements indicated two distinct periods of elevated concentrations: a) during 08:00 to 10:00 and b) during 19:00 to 22:00. The observed periods of increased concentration coincided with the periods of increased urban traffic in the morning and basic heating needs in late evening. Significant

correlation was observed between PM_{10}-$PM_{2.5}$ (R^2>0.9) and $PM_{2.5}$-PM_1 (R^2≈1.0) suggesting that coarse and fine particles originate from similar sources. The $PM_{2.5}/PM_{10}$ ratio values ranged from 0.84 to 0.85 indicating a major impact of $PM_{2.5}$ to the final concentration levels recorded. The results presented in the specific study support the notion that a significant alteration is undergoing to the atmospheric air quality in Greece due to the economic crisis and the subsequent increase of biomass products combustion for residential heating. Supplemental materials are available for this article.

Π.17: K. Angelakoglou, D. Aktsoglou, G. Gaidajis, I. Margiolaki and V. Tzomaka (2015), "A preliminary assessment of the carbon footprint of households in Greece", *International Journal of Sustainable Society* (in press).

The carbon footprint deriving from the consumption needs of four households in Greece was estimated in the specific study. The specific households were chosen in order to represent different occupational and spatial profiles. A three-step method was developed to determine the relative carbon dioxide equivalent (CO_{2eq}) emissions. Various inputs and outputs of the examined system (i.e., food, clothing, electricity, heating oil) were recorded and translated into carbon footprint with the application of the Intergovernmental Panel for Climate Change (IPCC) global warming potential (GWP) impact assessment method (IPCC 2007 GWP 100a method) and the utilization of relative life cycle assessment software. Results indicated that, in the observed period, products and electricity consumption were the key factors affecting the carbon footprint (>50%) of the households examined. Furthermore, heating needs were responsible for over 25% of the total household emissions. The carbon footprint expressed in tons CO_{2eq}, ranged from 5.7 to 7.5 per person per year, indicating that households behavior varies considerably in terms of responsible attitudes regarding sustainable consumption.

Π.18: K. Lymperopoulos, P.N. Botsaris, K. Angelakoglou and G. Gaidajis (2015), "Analysis of the energy consumption profile and development of sustainable energy action plans of medium-sized municipalities in north-eastern Greece", *Advances in Energy Research*, 3 (1), 11-30.

The covenant of Mayors initiative includes the commitment of the municipalities-signatories to reduce voluntarily the greenhouse gas emissions over 20% by 2020 within their boundaries and obligates them to develop and submit an energy consumption analysis and a sustainable energy action plan within a year from the adhesion. The present paper discusses the energy profile of three medium-sized north-eastern Greek Municipalities (Kavala-MoK, Alexandroupolis-MoA, Drama-MoD) through the analysis of their municipal energy balance. The results of the total final energy consumption per capita include 14.10MWh/capita, 14.24MWh/capita and 12.91MWh/capita for MoK, MoA and MoD respectively. The analysis highlighted the increased energy consumption of the private sectors, namely residential and tertiary buildings and private transport. The assessment of the municipalities' energy profiles along with examination of national regulations and action plans and investigation of best available practices within the Covenant of Mayors shaped the development of the sustainable energy action plans of the examined municipalities that is presented in this paper. The proposed pathway towards low-carbon municipalities can be considered a representative case study and a starting point for other municipalities with similar characteristics.

Π.19: K. Angelakoglou, G. Gaidajis, K. Lymperopoulos and P.N. Botsaris (2015), "Carbon footprint analysis of municipalities – Evidence from Greece". *Journal of Environmental Science and Technology Reviews*, (accepted).

The economical crisis that hit Greece after 2009, significantly affected its energy consumption profile due to the increased price of domestic heating oil and gasoline. The specific study aims at the quantification of the carbon dioxide emissions in municipal level due to energy and fuel consumption. Three different municipalities in North Greece (Kavala, Alexandroupolis and Drama) were assessed with the application of three different carbon footprint estimation approaches in each one of them, including two life cycle assessment methods. Results ranged from 511,799 to 571,000,

435,250 to 489,000 and 355,207 to 398,000 tons CO_2 and tons $CO_{2\text{-eq.}}$ for Kavala, Alexandroupolis and Drama respectively. The analysis per energy type indicated the electrical energy consumption as the key factor affecting the results due to the relatively high CO_2 emission coefficient of the electricity produced in Greece. The analysis per sector indicated that a percentage of nearly 75% of the total carbon footprint is assigned to the building sector whereas the private and commercial transport is accountable for the rest. Municipal activities (buildings, facilities, lighting and fleet) contributed to a small percentage to the total carbon footprint (approx. 3-8%).

Π.20: K. Angelakoglou and G. Gaidajis (2015), "A review of methods contributing to the assessment of the environmental sustainability of industrial systems", *Journal of Cleaner Production* (under review).

The aim of this study is to review the available methods that can potentially be applied by industries to support the assessment of their environmental sustainability. An original four-step methodology was developed to perform the review, with a view to discuss the adequacy of such methods. Forty eight (48) methods were identified which were further classified into six (6) generic categories to facilitate their analysis: individual/set of indicators, composite indices, socially responsible investment indices, material and energy flow analysis, life cycle analysis and environmental accounting. Key attributes of every method were extracted whereas five (5) criteria were set to evaluate the selected categories: ability to promote actions of improvement, help decision making, potential for benchmarking, applicability and ease of use and integration of wider spatial and temporal characteristics. Results have indicated that there is still noteworthy potential in increasing the efficiency of environmental sustainability assessments of industrial systems. The scope of the evaluation and usability varies considerably between different methods. Over 140 different environmental issues are addressed by the examined methods to assess environmental aspects of sustainability. Energy use, human toxicity, ozone depletion and resource consumption were the most utilized parameters. Composite indices and life cycle analysis based methods, exhibit the highest potential for satisfying all five criteria set. A considerable margin of improvement was identified especially regarding methods' ability to help decision making and applicability and ease of use. The most critical future direction to enhance the effectiveness and quality of the assessment is the development of commonly accepted sustainability reference goals and thresholds so that methods will be able to express the distance from a truly environmentally sustainable performance.

Π.21: K. Angelakoglou, and G. Gaidajis (2015), "ENSAI-index: A new methodological framework for assessing the environmental sustainability of industrial facilities", *Journal of Industrial Ecology* (to be submitted).

Under development – see Σ.33.

3. Περιλήψεις δημοσιεύσεων σε πρακτικά συνεδρίων με κριτές

Σ.1: G. Gaidajis and K. Angelakoglou (2008), "Air quality in university classrooms - The impact of fine particulate matter", Proceedings, "*4th International Conference on Ecological Protection of the Planet Earth: Environment, Maritime Policies & Energy Issues in Black Sea*", June 12-15, 2008, Trabzon, Turkey.

Indoor air quality in terms of particulate matter was determined in university classrooms. The concentration of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter was measured in different classrooms and relevant indoors areas of Democritus University, School of Engineering, Xanthi, with portable aerosol monitoring equipment. The results indicated that the 10-hour average concentrations in classrooms ranged from 63-191 μg/m³ and 52-109 μg/m³ for PM_{10} and $PM_{2.5}$ respectively. Concentration levels above 300 μg/m³ were usually recorded in classrooms, while instantaneous maxima were 1334 μg/m³ for PM_{10} and 1139 μg/m³ for $PM_{2.5}$. As expected, PM_{10} and $PM_{2.5}$ average concentrations were significantly higher both in the open-access meeting place of common use and in the office where open door practice is usual, indicating the significance of student trespassing and smoking in the deterioration of indoors air quality.

Σ.2: G. Gaidajis and K. Angelakoglou (2009), "Indoor mass concentrations of particulate matter in university environment", *11th International Conference on Environmental Science and Technology*, September 3-5, Chania, Greece 2009.

The mass concentrations of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter were measured in different classrooms and relevant indoors areas of Democritus University, School of Engineering, Xanthi, with portable aerosol monitoring equipment. Two sampling campaigns were conducted in different seasons. The results indicated that the average concentrations in classrooms ranged from 32-188 μg/m³ and 25-151 μg/m³ for PM_{10} and $PM_{2.5}$ respectively. Concentration levels above 300 μg/m³ were usually recorded, while the $PM_{2.5}/PM_{10}$ ratio was about 0.8. As expected, PM_{10} and $PM_{2.5}$ average concentrations were significantly higher in the open-access meeting place of common use, indicating the significance of student trespassing and smoking in the deterioration of indoors air quality.

Σ.3: G. Gaidajis K. Angelakoglou and D. Aktsoglou (2009), "Systems thinking and environmental assessment of products – Using the Life Cycle Assessment (LCA) approach", HSSS conference "*From Systemic Thinking to Systems Design and Systems Practice*", June 24-27, 2009, Xanthi, Greece.

Consumers are becoming eager to pay more for eco-friendly products whereas the national and global regulation is getting more rigorous for industries harming the environment. As a result, tools for assessing the environmental performance of products or processes are becoming increasingly popular. Furthermore most industries have their environmental performance expressed through the reconciliation of their environmental management system with standards like ISO or EMAS. These frameworks ensure the compliance with regulations however may not be really effective due to the dynamic nature of environmental matters. In other words a more systemic and holistic view is needed when trying to assess the environmental performance. Life Cycle Assessment (LCA) is an analytical tool for assessing the environmental performance of products or procedures in a systems perspective. LCA takes into account all life stages of a product offering a complete overview of the environmental performance. In this paper a brief description of the LCA method is given whereas some case studies are presented using relative LCA software. Results indicated that changing the boundaries of our system can greatly affect the environmental performance of a product indicating that the use of a systems approach for assessing the environmental performance of products is critical.

Σ.4: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2009), "Systemic thinking and industrial ecology – the concept of eco-industrial parks", 5th National & International HSSS conference "*From Systemic Thinking to Systems Design and Systems Practice*", June 24-27, 2009, Xanthi, Greece.

A highly increasing number of agents have to deal with environmental issues due to an important increase of general concern. Industrial Ecology (IE) is a relative new theory including principles and tools for assessing and ameliorating the environmental performance of an industry thus leading to sustainability. More specifically, it is the shifting of industrial process from linear (open loop) systems to a closed loop system where wastes become inputs for new processes. In order to cope with possible problems, a satisfactory understanding of the connections that exist between different systems is needed leading to the conclusion that various aspects cannot be viewed in isolation. Based on this framework, IE handles environmental issues with a systemic thinking approach. One of the most studied and practical tools of Industrial Ecology are Eco-Industrial Parks (EIP). The basic concept of EIP is that in industrial systems, waste from a company is used as a resource by others, in parallel with ecosystems where the waste from one organism is used as input to other organisms. A holistic view is necessary in order to implement the principles of Eco-Industrial Parks. The aim of this study is to indicate how systemic thinking can lead to efficient and innovative solutions by using the Industrial Ecology concept and more specifically the EIP notion, as an example.

Σ.5: G. Gaidajis and K. Angelakoglou, "Recovery of waste lubricant oil contained in used automotive filters" (2009), *3rd International Conference "Towards Sustainable Development: Assessing the footprint of resource utilization & Hazardous Waste Management*", AMIREG 2009, September 7-9, Athens 2009.

About 7.2 million automotive filters utilized in passenger cars are annually consumed in Greece, with only a small percentage of them being recycled and the rest being disposed in the environment. In other words, based on our experiments it is estimated that a maximum of 1260 tons of used oil and 1713 tons of steel are disposed every year in Greece, as a result of the non-effective management of used automotive filters. In this paper, the factors affecting the recovery of the lubricant oil contained in used automotive filters are evaluated and quantified through experimental measurements. Furthermore, a Life Cycle Assessment (LCA) of a used automotive oil filter containing lubricant oil is performed, in order to evaluate and quantify the environmental benefits arising from the application of a used filter recycling scheme.

Σ.6: Γ. Γκαϊντατζής, Κ. Αγγελάκογλου και Δ. Ακτσόγλου (2009), "Ηλεκτρονικά Απόβλητα – Περιβαλλοντικά Προβλήματα και Υφιστάμενη Διαχείριση", *1ο Ελληνοκινεζικό φόρουμ για το περιβάλλον, ΤΕΕ, 3-4/12/2009, Αθήνα.*

Στο συγκεκριμένο άρθρο πραγματοποιήθηκε μια ανασκόπηση των περιβαλλοντικών προβλημάτων που σχετίζονται με τα ηλεκτρονικά απόβλητα. Επιπλέον αναλύονται θέματα όπως η υφιστάμενη και μελλοντική παραγωγή ηλεκτρονικών αποβλήτων, οι πιθανές περιβαλλοντικές επιπτώσεις που σχετίζονται με την απόρριψή τους και τις πρακτικές διαχείρισης. Επιπλέον παρουσιάζονται τα υφιστάμενα πλαίσια διαχείρισης ηλεκτρονικών αποβλήτων για την Ελλάδα και άλλες χώρες (Ιαπωνία, Ελβετία κ.ά.).

Σ.7: Γ. Γκαϊντατζής και Κ. Αγγελάκογλου (2009), "Ανάπτυξη ενός μεθοδολογικού πλαισίου για την εκτίμηση της περιβαλλοντικής βιωσιμότητας των βιομηχανικών δραστηριοτήτων: η περίπτωση της μεταλλευτικής και εξορυκτικής βιομηχανίας", *2ο Συνέδριο Περιβαλλοντικής Πολιτικής & Διαχείρισης*, Παρασκευή 19η - Κυριακή 21η Ιουνίου 2009, Μυτιλήνη.

In the 80s the development of an Environmental Management System (EMS) was sufficient for an organization in order to demonstrate its commitment to environmental protection. Lately however, a shift has been observed from environmental protection to the issue of environmental sustainability and from economic performance for shareholders to sustainability performance for stakeholders.

Industry needs therefore to redefine the adequacy of EMS as tools for the assessment of its environmental performance and to find other applicable tools more relevant with the sustainability framework. Those tools should address issues of broader time and space scales, such as material utilization and material scarcity, water and energy utilization, impacts to world scale environmental problems etc. In this work, the development of an easy to handle methodological framework for the reliable environmental sustainability assessment of an industrial facility-process is proposed. The derived tool gives qualitative and quantitative results for the environmental performance of an industrial facility-process, and enables its temporal and spatial comparison. The issues examined in the framework include the material utilization and material scarcity and the water and energy performance, whereas the biodiversity implications and the socioeconomic impacts from the operation of the industrial facility-process are under development. The methodological framework could be modeled through the development of the relevant software that enables its easy generalized application. As a case study, the derived methodological framework and the relevant software is applied to a mining industrial facility.

Σ.8: Γ. Γκαϊντατζής, Κ. Αγγελάκογλου και Π. Μπότσαρης (2009), "Αξιολόγηση της περιβαλλοντικής και αειφορικής επίδοσης των κατασκευαστικών έργων", *2ο Συνέδριο Περιβαλλοντικής Πολιτικής & Διαχείρισης*, Παρασκευή 19η - Κυριακή 21η Ιουνίου 2009, Μυτιλήνη.

The construction sector is considered to be one of the most important economic sectors both worldwide and for the Greek economy. Furthermore, it is one of the most demanding consumers of raw material, energy and water. As a result, the development and use of relevant tools and methodologies for assessing its environmental performance and sustainability is of major importance for governments and engineers, especially following the trend for sustainability reporting. In this paper some of those tools-methodologies are presented, followed by specific case studies in order to examine the benefits and the limitations arising from their use.

Σ.9: K. Angelakoglou, D. Aktsoglou and G. Gaidajis (2010), "Assessing the Global Warming Potential of a typical office-workstation using Life Cycle Assessment", *Second International Symposium on Green Chemistry for Environment and Health*, September 27-29, 2010, Mykonos, Greece.

The perpetual development of the service providers drew the attention of environmentalists and researchers who indicated the significant amounts of materials and energy consumed, basically through material flow analysis studies. In this study, a life cycle assessment (LCA) for a typical university office was performed, with the employment of relative software. In order for the assessment to be carried out, an inventory was created including basic inputs and outputs for the system examined. This inventory included common used equipment and devices of a typical office whereas energy consumption for a given period of time was estimated. Results indicated the processes, materials and life cycle stages that highly affected GWP in terms of kg CO2 equivalent. In that aspect an initial analysis was given regarding actions for "greening" the service sector whereas the potential of expanding the boundaries of this study was further discussed.

Σ.10: G. Gaidajis and K. Angelakoglou (2010), "Indoor air quality in terms of mass concentrations of particulate matter in areas of massive public congregation", *Second International Symposium on Green Chemistry for Environment and Health*, September 27-29, 2010, Mykonos, Greece.

The aim of this paper is to give an overview of the air quality in terms of particulate matter concentrations in places of common interest where public congregation takes place in Greece. Thus, the mass concentrations of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter were measured in different indoors areas of massive public congregation such as bars, museums, schools, exhibition centers and churches, using portable aerosol monitoring equipment. Results indicated that average concentrations for all the areas examined, frequently exceeded the annual and 24-hour guidelines proposed by World Health Organization (WHO), whereas very high instantaneous maximum concentrations (>1000μg/m^3) were usually recorded. Moreover, specific actions such as smoking and

cleaning were identified as the major causes of elevated concentrations of particulate matter and in that aspect the effects of the strict prohibition of smoking in indoors environment are discussed and moreover ameliorative measures are proposed.

Σ.11: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010), "Integration of Sustainable Development in Engineering Universities in Greece", EESD 2010, *5th International Engineering Education in Sustainable Development Conference*, 19-22 of September, 2010,Göteborg, Sweden.

In this work, a comprehensive examination of the detailed curriculum of all Technical Universities and Schools of Engineering in Greece is presented in order to assess the integration of Sustainable Development (SD) in the Engineering higher education in Greece. Moreover, a review of the experiences of successful implementation and strategies from highly recognized Technical Universities worldwide is presented. Based on this review a simple guide for embedding Sustainable Development to Engineering Schools was established in order to benchmark the Greek experience and to propose indicative measures for incorporating SD teaching in Greek universities. Results indicated that changing the curriculum is not the only way to efficiently incorporate SD in universities whereas there are worth to mention gaps concerning the integration of sustainability notion, principles and tools in Greek engineering universities.

Σ.12: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010), "Incorporating Industrial Ecology as an enhancement tool for teaching Sustainable Development to Engineers - current experience from Greece", *5th International Engineering Education in Sustainable Development Conference*, 19-22 of September, 2010, Göteborg, Sweden.

Industrial Ecology (IE) is considered to be one of the pillars for sustainability education. In this paper, the initial steps of incorporating IE related actions at an engineering department are presented and analyzed indicating some characteristic key factors affecting the efficient incorporation of IE tools in engineering courses. The necessity for interdisciplinary scientific approach, for synergies, cooperation and experience exchange among universities, for software applications and for comprehensive data from industrial sectors, municipalities, nations, etc., are some of the these factors. The benefits and shortcomings of the approach followed and the lessons learned during implementation of the IE related actions are further discussed. Additionally, in order to examine the feasibility of introducing an autonomous IE course, a survey was conducted within the students of the department, whereas the results from the discussion concerning the satisfaction of the key factors are presented.

Σ.13: Γ. Γκαϊντατζής, Κ. Αγγελάκογλου, και Σ. Φωτοπούλου (2010), "Ποιότητα αέρα εσωτερικών χώρων σε σχέση με τα αιωρούμενα σωματίδια – περίπτωση μελέτης σε χώρους μαζικής συνάθροισης", *Περιοδικό hygeia@ergasia*, Τεύχος 3, Σελ. 207-218. Ελληνική εταιρία ιατρικής της εργασίας & περιβάλλοντος.

In this study, the indoor air quality in terms of particulate matter was determined in four indoor areas of massive congregation, i.e. church, museum, elementary school and exhibition hall, with different characteristics (operation, functionality, population groups, etc). The indoors concentration of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter was measured with the application of portable optical aerosol equipment. The results indicated that average indoor concentrations in all places during working days varied from 48 to 1070 μg/m^3 PM_{10} and from 28 to 684 μg/m^3 for $PM_{2.5}$, frequently exceeding the 24-hour guidelines proposed by World Health Organization (WHO). Moreover, analysis of the results indicated that some of the indicative key factors that probably affect the indoors concentrations of PM are cleaning activities, insufficient ventilation and incense used for religious reasons.

Σ.14: G. Gaidajis and K. Angelakoglou (2011), "Environmental analysis of a typical solar water heater with the application of Life Cycle Assessment software", *2nd International Exergy, Life Cycle Assessment, and Sustainability Workshop & Symposium*, June 19-21, Nisyros, Greece.

The environmental impact from the life cycle of a typical solar water heater (SWH) is analyzed and assessed in this study with the application of relative life cycle assessment (LCA) software (SimaPro 7.2). Two impact assessment methods are applied, namely Eco-Indicator 99 and TRACI 2. The goal of this study is the identification of the life cycle stages, processes and materials that significantly affect the system under examination in terms of environmental burden.

Σ.15: G. Gaidajis and K. Angelakoglou (2011), "Environmental assessment of a Multi-Si photovoltaic module", *3rd International Conference on Environmental Management, Engineering, Planning and Economics (CEMEPE 2011) & SECOTOX Conference*, June 19-24, 2011, Skiathos, Greece.

Life cycle thinking significantly affects the assessment of the environmental performance of a system. In this paper, the life cycle assessment (LCA) of a Multi-Si photovoltaic (PV) module was conducted in order to compare the environmental burden throughout its life cycle with the environmental burden of the identical conventional energy produced with the energy mix of Greece and supplied by the national energy network grid. In order to perform this analysis LCA software was applied (SimaPro 7.2), whereas the standard four steps of ISO 14040 regarding LCA implementation were followed.

Σ.16: P. Botsaris, K. Angelakoglou, G. Gaidajis and J. Tsanakas (2011), "Lifecycle costs and environmental life cycle analysis of solar water heaters in Greece", *2nd International Congress on Condition Monitoring and Diagnostics Engineering Management*, May 30 – June 1, 2011, Stavanger, Norway.

Usually, the solar water heater (SWH) systems use the sun to heat a fluid, either water or a heat transfer fluid, such as water-glycol antifreeze mixture, in flat collectors generally mounted on the roof of residential or industrial buildings. The heated fluid is then stored in a tank similar to a convectional gas or electric water tank. Some systems use an electronic pump to circulate the fluid through collectors. In this paper, the basics of solar water heaters (SWH) life cycle costs analysis are discussed and the most popular types for Greece are examined. Life cycle costs are formed and the possibilities for reducing them are discussed. Specifically, for the cost analysis, a life cycle approach, in which the various costs are estimated annually, is considered. The analysis is performed in order to obtain the total cost (or life cycle cost) and the life cycle savings of the system. Moreover, the environmental impacts derive from the life cycle of the systems examined are analyzed and assessed with the application of relative software. In order to examine various impact categories such as global warming, ozone layer depletion, ecotoxicity and so forth, the IMPACT2002+ method is applied. In that aspect the life cycle stages, processes and materials that significantly affect the system examined are identified whereas amelioration actions and redesign "hot spots" are further discussed. The fact that both the economical and environmental pillars of sustainability are examined in this study provides a holistic approach regarding different aspects of solar water heaters life cycle. The main aspect that can be concluded is that solar water heater systems are efficient, cost effective and environmental friendly. The reduction of greenhouse gasses is the main advantage of solar energy. Therefore, solar water heater systems should be employed whenever possible in order to achieve a sustainable future.

Σ.17: G. Gaidajis and K. Angelakoglou (2011), "Development of a tool for assessing the environmental sustainability of mining facilities", *5th International Conference Sustainable Development in the minerals industry*, SDIMI 2011, June 14-17, Aachen, Germany.

The development of a tool for assessing the environmental sustainability of mining facilities is described in this study. The tool is based on the analysis of basic components of the examined system, i.e., the quantities of the incoming materials and outgoing wastes, their hazardousness and

scarcity, the utilization of water and energy resources, and the biodiversity. The developed tool provides both qualitative and quantitative assessment of the environmental performance of a mining facility in a broad time scales (past-present-future) and is easily applicable from non environmental experts. Moreover, relative software is developed to further support the application of the methodology. The implementation of the tool is expected to lead to an improved understanding of the environmental performance of a mining facility and more importantly identify the areas of significant environmental concern. However, based on feedback from industries, a number of shortcomings of the approach have been identified so far and are presented, indicating further actions for the advancement of the proposed tool.

Σ.18: Γ. Γκαϊντατζής και Κ. Αγγελάκογλου (2011), "Μέθοδοι αποτίμησης της περιβαλλοντικής επίδοσης-βιωσιμότητας βιομηχανικών δραστηριοτήτων και εγκαταστάσεων ", *4ο Περιβαλλοντικό Συνέδριο Μακεδονίας, Θεσσαλονίκη*, 18-20 Μαρτίου 2011.

In this study, the most commonly applied methodological frameworks for assessing the sustainability of industrial facilities are concisely presented, focusing mainly on the environmental aspect of sustainability. The specific analysis indicated the assumptions and shortcomings of every approach thus suggesting the combination of different assessment methods as the optimum strategy for efficiently assessing the sustainability of industries. In that aspect, the first steps of developing an innovative assessment tool, covering the aforementioned shortcomings, are presented. The methodological basis of the developed tool is that of Industrial Ecology according to which a holistic approach is needed in order to evaluate various systems.

Σ.19: G. Gaidajis and K. Angelakoglou (2012), "Environmental Analysis of a 3MW Wind Turbine with the Application of the Life Cycle Assessment". *Protection and Restoration for the Environments – PRE11 XI International Conference*, Thessaloniki, Greece July 3-6, 2012.

Wind power energy is amongst the most emerging current renewable energy technologies. The aim of the specific study is the analysis of the environmental impacts of a 3MW wind turbine, considering its entire life cycle, with the application of the Life Cycle Assessment (LCA) method. LCA is a methodological tool used to quantitatively analyze the life cycle of products/activities within the context of environmental impact. With the application of the LCA methodology, the wind turbine is analyzed during all the phases of its life cycle, from cradle to grave, taking into account the manufacture of key components, transportation, maintenance and final waste disposal scenario. The LCA model was developed with the application of relative software (Simapro 7.2), whereas the necessary data were acquired from manufacturers, installers and literature. The life cycle inventory was compiled taking into account data on basic and important components of the wind turbine such as the tower, the nacelle and the rotor. Additionally, the ReCiPe 2008 impact assessment method was used for the evaluation. ReCiPe is the advanced version of the Eco-Indicator 99 impact assessment method, comprising of two sets of impact categories, eighteen midpoint level impact categories (e.g. climate change, ozone and water depletion, eutrophication, particulate matter formation and others) and three endpoint categories (damage to human health, ecosystem diversity and resource availability). Based on the results of this study, a discussion is provided regarding issues such as material choice, transportation effect, alternative waste scenarios and placing of wind turbines in terms of their environmental burden. Conclusions could be valuable for decision-makers, producers and researchers who are interested in wind energy and wind turbines amelioration.

Σ.20: G. Gaidajis and K. Angelakoglou (2012), "Indoor Concentrations of Particulate Matter in Hospital Environment". *Protection and Restoration for the Environments – PRE11 XI International Conference*, Thessaloniki, Greece July 3-6, 2012.

The importance of the indoor air quality to human health is related to the high concentration levels of hazardous airborne emissions deriving from insufficient air exchange rate, limited spacing and the presence of hidden continuous emitting sources. A well accepted indicator of the indoor air quality is

concentration levels of particulate matter. The significance of particulate matter is well documented since one of the key features of particulate matter is its characteristic ability to act as a transportation medium of hazardous substances and chemicals into the human respiratory system. As a result, assessing the air quality of indoor environment where people usually spend extended time periods, especially for sensitive population groups such as patients during their hospitalization, is of major importance. Ensuring a safe level of air quality in these indoor environments serves as an amelioration factor for human health not only for the often habitués of those indoors places, but also for the working personnel that spend more than 90% of their time indoors. In that aspect the concentration of coarse (PM_{10}) and fine ($PM_{2.5}$, $PM_{1.0}$) particulate matter was measured in two Intensive Care Units (ICU), with different spatial and trespassing characteristics, of the University General Hospital of Alexandroupolis, Greece. The measurements were conducted with the application of two portable aerosol monitoring equipment (TSI DustTrak Aerosol Monitor Model 8520, Grimm 107). Results indicated that the 24-h average concentrations were below the indicative limits proposed by the World Health Organization (WHO) (50 and 25 $\mu g/m^3$ for PM_{10} and $PM_{2.5}$ respectively). Unexpectedly, relatively elevated instant concentration levels (>100 $\mu g/m^3$) were also recorded that in conjunction with the temporal fluctuation of the observed concentration levels raised questions regarding the efficiency of cleaning activities.

Σ.21: G. Gaidajis, K. Angelakoglou and I. Margiolaki (2012), "A preliminary assessment of household carbon footprint in Greece", *Third international symposium on Green Chemistry for Environment*, Health and Development, Skiathos Island, October 3-5, 2012, Greece.

In the specific study, the carbon footprint of four households was analytically assessed in order to identify potential carbon footprint reduction opportunities. The households were chosen so as to represent various occupational and climatic profiles. In order to quantify the carbon footprint of the specific households, an analytical mass and energy balance was developed. More specifically, various inputs and outputs of the system examined, such as food, clothing, electricity, heat oil, waste and so forth, were quantified and recorded for a one-month period. The carbon footprint was estimated with the application of the intergovernmental panel for climate change (IPCC) emission factors and the utilization of relative life cycle assessment software. Results were expressed as carbon dioxide equivalent (CO2-eq.), a commonly used carbon footprint unit. As a general statement it could be inferred that the energy consumption was identified as the major factor affecting the environmental performance of households in terms of carbon dioxide equivalent emissions. Further attention should be drawn regarding energy-responsible attitudes. Variations in the results were observed due to different occupational habits such as means of space heating and nutrition habits. Significant effort is required in order to comprehensively assess a satisfying number of households, therefore the development of analytical mass and energy balances for each household and moreover a wider scale implementation is anticipated to be a challenging task.

Σ.22: G. Gaidajis and K. Angelakoglou (2012), "Relative Contribution of the Transportation Sector to the Carbon Footprint of an Urban Centre – A Medium Sized Greek City Case Study", *TAP 2012 Conference*, Thessaloniki, Greece, November 26-27, 2012.

In the specific study, the relative contribution of the transportation sector to the total carbon footprint of a medium sized municipality was analytically quantified and assessed. The basic conclusions derived from specific study are: a) Nearly 1/4 of the total carbon footprint of the municipality examined is due to transportation needs. b) Municipal fleet, although contributing to a low percentage of the total carbon footprint, should act as an exemplar for private/commercial sector. c) Almost 1/3 of the total private/commercial CO_2 emissions are due to traffic in Egnatia Odos where the municipal authorities cannot interfere drastically. In that aspect, improvement actions should focus on reducing the utilization of private/commercial cars inside the town of Kavala. d) The impact of transferring the interurban bus station outside the city centre of Kavala, and the rail link between N.Karvali-Toxotes railway stations should be examined in terms of carbon dioxide emissions

alterations. e) Assessing the energy/fuel consumption and the respective carbon footprint for every sector in a municipality was found to be especially useful for strategic decisions, management issues and energy/fuel savings hot spots identification. The results of the specific study are expected to be useful for decision makers, local and regional authorities interested in the upturn of their environmental performance and the reduction of their carbon-environmental footprint.

Σ.23: G. Gaidajis and K. Angelakoglou (2013), "Carbon footprint and energy assessment of a medium sized municipality in Greece". CEST 2013, *13th International conference on Environmental Science and Technology*, September 5-7, 2013, Athens, Greece.

The aim of the specific study is to quantify the equivalent carbon dioxide (CO_2) emissions and to identify the most important areas of extensive energy consumption and of a medium sized municipality, namely Kavala, in Northeastern Greece. An analytical energy balance for the municipality was developed including the total electrical energy and fuel consumption (heating oil, wood, gasoline, diesel and wood) used for municipal, public and tertiary buildings and facilities, municipal lighting, and all transportation sectors (municipal, public, private and commercial). The total energy consumption of the municipality of Kavala was estimated to be 972,814 MWh for the year 2011. In order to estimate the carbon footprint of the municipality of Kavala, three different methods were applied, and more specifically: a) the IPCC standard emission factors method, b) the IPCC life cycle emission factors method and c) the life cycle assessment (LCA) method with the application of relative software. Results ranged from 511,799 to 571,000 tons CO_2 or 6.9 to 7.7 tons of equivalent CO_2 emissions per capita, exhibiting satisfying correlation among the results. Variations were attributed to the different scope and greenhouse gases inventory included in every method. The majority of CO_2 emissions were attributed to the electrical energy consumption (64%) due to the relatively high CO_2 emission factor of electricity produced in Greece. The building sector contributed significantly to the total carbon footprint. More specifically the residential building sector and the buildings of the tertiary sector contributed as much as 41% and 30% respectively of the municipality carbon footprint, whereas the private and commercial transportation sector accounted for a percentage in the order of 22%. As an overall statement it could be inferred that the quantification of the energy and carbon footprint of a municipality significantly strengthens the adoption of effective regional strategies, communication of the results and the participation in relative programs and financing.

Σ.24: K. Angelakoglou and G. Gaidajis (2013), "Assessing the progress of mining industry towards sustainability – In need of new methodological frameworks", *6th International Conference on Sustainable Development in the Minerals Industry*, SDIMI 2013, Milos, 30 June-3 July.

The aim of the specific study is twofold: a) analytically discuss the effectiveness of the existing methodologies for assessing the sustainability of mining industries and b) identify the potential characteristics of a well defined, robust and holistic sustainability assessment framework. The state-of-the art review of relative assessment frameworks indicated significant assumptions and shortcomings. High levels of subjectivity and reductionism, focus on accountability rather than performance, lack of concrete normalization procedures, non-integration of life cycle thinking are only few of the issues need to be further addressed. The combination of different assessment methods seems to be the optimum strategy for efficiently assessing the sustainability of industries. However this action entails significant amount of time, data and expertise to be performed. Based on these findings, the authors have been developing a methodological framework that will cover most of the shortcomings mentioned before.

Σ.25: D. Aktsoglou, K. Angelakoglou and G. Gaidajis (2013), "Assessing the familiarity of students in engineering with sustainability", *6th International Conference on Sustainable Development in the Minerals Industry*, SDIMI 2013, Milos, 30 June-3 July.

The incorporation of sustainability into the educational process has been highlighted as a key

objective by the Milos Declaration on Sustainability in 2003. Schools of engineering are expected to play a significant role in the promotion and integration of sustainable development (SD) in higher education. A quantitative and qualitative analysis is presented in the specific study, regarding the level of knowledge related with SD issues in an engineering department. A number of actions related with SD theory, tools and practices, have been implemented in the department under examination, during the last three years. Indicative actions include SD relative lectures, educational trips, undergraduate and graduate theses, participation in conferences, publications and so forth. In order to evaluate the outcome of the specific actions and assess the familiarity of the students of the department with sustainability related issues, a survey has been conducted. The survey was performed with the application of an online questionnaire. The specific questionnaire assesses various aspects of sustainability including their enthusiasm for sustainability issues. The degree of knowledge in each subject is graded on a scale of 1 to 4 (1.00 indicating a very low level and 4.00 an exceptional level of knowledge). A similar campaign was conducted in 2010, the results of which indicated an average level of 2.27 for knowledge of SD issues. Despite the fact that the aforementioned actions back in 2010 had only been implemented for a period of one year, they had a noticeable effect to the students' understanding of SD principles. Comparison of the previous campaign results with the forthcoming results is expected to depict more reliably the long term effect from the implementation of those practices favoring knowledge of SD issues to engineering students. The specific study is expected to be useful for stakeholders related with SD principles (e.g. universities and academic institutions and their administrative bodies etc.) who are interested in integrating SD issues and principles to their agenda.

Σ.26: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2014), "Air quality in urban areas in terms of particulate matter concentrations – Results from a case study in North Greece", *12th International Conference on Protection and Restoration of the Environment*, June 29 to July 3 2014, Skiathos island, Greece.

The aim of the specific study is to assess the air quality of the urban area of Drama, North Greece, in terms of particulate matter concentrations with an aerodynamic diameter of 10, 2.5 and 1 μm (PM_{10}, $PM_{2.5}$ and PM_1) during the winter period of 2013-2014. Results have indicated that average concentrations occasionally exceeded the 24-hour guidelines proposed by World Health Organization for both PM_{10} and $PM_{2.5}$ (50 and 25 $\mu g/m^3$ respectively). The analysis of the daily concentration profile for all measurements indicated two distinct periods of elevated concentrations: a) during 08:00 to 10:00 and b) during 17:30 to 23:00. The observed periods of increased concentration coincided with the periods of increased urban traffic in the morning and wintertime heating period starting at late evening. Concentration levels during weekends and holidays were higher than weekdays both for PM_{10} and $PM_{2.5}$. Moreover significant correlation was observed between PM10-$PM_{2.5}$ and $PM_{2.5}$-PM_1.

Σ.27: K. Angelakoglou, M. Chatzisideris and G. Gaidajis (2014), "Moving from mere quantification to meaningful evaluation of environmental sustainability indicators in industry", *Fourth International Symposium on Green Chemistry, Health and Development*, September 24-26, Kos Island, Greece.

The aim of the specific study is to discuss whether current practices and metrics for assessing the environmental sustainability of industrial systems truly promote sustainable development, and if not, what can be done to improve them. The literature review indicated that the absolute value of an environmental indicator itself may provide an idea of the environmental performance of the industry under examination; however it does not provide adequate information regarding its actual sustainability. An indicator applied over a period of time gives a trend which can express the relative improvement (or impairment) of the industry regarding the specific issue, however it does not reflect the actual distance from a sustainable performance. In that aspect a reference value is needed for every indicator. The comparison of the absolute value of the indicator with a reference value can provide a meaningful sustainability performance based on a distance-to-target approach. The specific

targets may be found in various sources such as regulatory requirements, international standards, expert judgments, goals agreed by industries and so forth. These targets must be reevaluated and modified regularly due to the dynamic nature of environmental issues and the not yet clearly defined notion of sustainability.

Σ.28: K. Angelakoglou and G. Gaidajis (2014), "Selection of indicators for assessing the environmental sustainability of industrial facilities and processes", *Fourth International Symposium on Green Chemistry, Health and Development*, September 24-26, Kos Island, Greece.

The purpose of the specific study is to enhance the process of selecting the most appropriate indicators for assessing the environmental sustainability of industrial facilities and processes. In that aspect, a general framework is under development including a number of steps to be followed by relative stakeholders and tips for increasing the quality of the assessment in every step. To ensure that the most important issues regarding environmental sustainability will be assessed, eight (8) general assessment categories were identified that cover all basic notions of environmental sustainability. Specific cut-off criteria were set for screening and selecting indicators for every category such as their ability to measure progress over time, being potentially benchmarkable, their ability to promote action and provide useful information, life cycle thinking integration etc. Additionally, a number of indicative indicators per category were identified and are presented in this study. The selection of appropriate indicators forms the basis for an effective environmental sustainability assessment.

Σ.29: G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2014), "Particulate matter concentration in urban environment during the winter period", *5th Environmental Conference of Macedonia*, 14-16 March 2014, Thessaloniki, Greece.

Airborne particles are responsible for a variety of respiratory and cardiac diseases, and are more dangerous when they contain heavy metals and other toxic organic substances. The specific research presents the results of a sampling campaign measuring particulate matter with aerodynamic diameter of 10, 2.5 and 1 μm (PM_{10}, $PM_{2.5}$ and PM_1), held in the city centre of Kavala, Greece during the period 1/1/2012-29/2/2012 and 1/1/2013-28/2/2013. Concentration levels were similar to other urban areas, surpassing however in many cases the daily average concentrations proposed by Directive 2008/50/EC. More specifically, the average daily concentrations for the year 2012 were 40, 34 and 32 mg/m^3 for PM_{10}, $PM_{2.5}$ and PM_1 respectively; while for the year 2013 were 33, 28 and 25 mg/m^3. The decrease observed could be attributed to the higher prevailing temperatures during 2013 in comparison with 2012 and consequently to the less intense needs for heating, whereas the analysis of the daily concentration profile indicated that the observed periods of increased concentration (8:00 to 10:00 and 19:00 to 22:00) coincided with the periods of increased urban activities.

Σ.30: K. Angelakoglou and G. Gaidajis (2014), "Utilization of Industrial Ecology Principles for assessing the environmental sustainability of industries", *1st National Conference: Economics of Natural Resources and Environment – Climate Change*, ENVECON 2014, 27-27 March 2014, Volos Greece.

The basic characteristics in which industries should focus on for improving their environmental sustainability were analyzed and are presented in the specific study. The characteristics were chosen according to the principles of Industrial Ecology. The integration of these principles into a sustainability assessment framework can be achieved by rewarding those industries whose operation, actions and decisions follow the proposed characteristics. Specific ways of integration are proposed whereas an ideal sustainable industrial system was developed which can be used as a benchmark standard of environmental sustainability for other industries. The adoption of certain principles which are defined by a specific and structured framework enhances the quality of assessment in contrast with selecting indicators and impact categories without specific strategy and purpose.

Σ.31: G. Gaidajis and K. Angelakoglou (2015). "Utilization of sustainable water consumption and management indicators by industrial facilities and their contribution to sustainability assessment". Wastenet, *Sustainable Solutions to Wastewater Management: 2nd International Scientific Conference*. 19-21 June, Kavala, Greece (accepted).

The aim of the specific study is to identify key indicators utilized for the evaluation of sustainable water consumption and management of industrial facilities that are included in sustainability assessment methods. For the specific purpose, relevant methods available in current literature were analyzed. In total, twelve (12) indicators were identified. The specific indicators were assessed based on five (5) predefined criteria such as their efficiency in terms of time and cost required for their estimation, their ability to help decision making, their ability to cover long-term and wide spatial boundaries and others. A five-point grading system was applied to rank the indicators in order to help industries select the most appropriate ones according to their needs. Results indicated that there is still a significant potential of improvement in terms of how industries assess water related sustainability aspects. What seems to be the most important issue is the development of commonly accepted sustainability thresholds or goals per indicator, so that industries will be able to assess their distance from a truly sustainable performance. To serve this purpose, a normalization procedure including specific reference points for a number of indicators is proposed.

Σ.32: K. Angelakoglou, I. Kakanis and G. Gaidajis (2015). "An eco-label scheme of environmental sustainability for industrial facilities", *14th International Conference on Environmental Science and Technology*, CEST2015, 3-5 September 2015, Rhodes, Greece (accepted).

The aim of the specific study is twofold: a) provide a quick presentation of the available industrial Eco-labeling schemes with a view to discuss their adequacy and b) describe a new Eco-label scheme for assessing and improving the environmental sustainability of industrial facilities and processes. The proposed Eco-Label can act as an efficient tool for monitoring and communicating the environmental sustainability of the examined facility to various stakeholders and general public. The Eco-label scheme is based on the results from the implementation of an innovative environmental sustainability assessment framework developed by the authors. The framework consists of ten (10) well defined steps that include specific guidelines and tips for its gradual implementation. Indicative actions to be taken during Eco-labeling procedure include the quantification and analysis of key environmental sustainability indicators, the enrichment of knowledge within industry regarding sustainability notions and goals, the identification of sustainable reference points, the extraction of environmental sustainability sub-indices and others. The implementation of the framework results in the extraction of a final environmental sustainability assessment index (ENSAI index). As a result, the proposed Eco-Label can be assigned to industrial facilities meeting a minimum level of sustainability performance thus encouraging industries to improve themselves and reach more sustainable goals.

Σ.33: K. Angelakoglou and G. Gaidajis (2015), "ENSAI-index: A new methodological framework for assessing the environmental sustainability of industrial facilities". *International Society for Industrial Ecology, ISIE2015* – Taking stock of industrial Ecology, 7-10 July, Guildford, UK. (accepted)

A new methodological framework for assessing the environmental sustainability of industrial facilities is proposed in the specific study. The framework consists of ten (10) well defined steps that include specific guidelines and tips that allow its gradual implementation. The steps were selected with a view to address major shortcomings identified during the analysis of forty eight (48) relevant methods available in current literature such as their ability to help decision making, the adequacy of environmental aspects examined, the applicability by non-experts and the integration of spatial and temporal characteristics in the assessment. The proposed framework was build upon the principles and proposals of Industrial Ecology (IE), in order to ensure that the most significant issues in terms of environmental sustainability will be assessed and sustainable actions highlighted by IE will be promoted (e.g. development of synergies, reduction of scarcity of materials utilized, etc.). In

particular, eight (8) assessment categories were selected namely: a) sustainable consumption of materials and resources, b) waste and emissions minimization, c) sustainable use/management of energy, d) sustainable use/management of water, e) sustainable transportations and locality, f) environmental equity and synergy, g) conservation of ecological health and biodiversity, h) conservation of human health. The categories are assessed with the application of near to fifty (50) core indicators carefully selected from a pool of environmental sustainability indicators according to pre-defined ranking criteria. The indicators are separated into two levels of assessment: a) performance and b) concern in order to enhance transparency of the assessment and better reflect the notion of environmental sustainability. A normalization procedure is applied following a distance to a sustainability reference point approach, which enables the parallel evaluation of every indicator in comparison with a commonly accepted sustainability goal or threshold. A five (5) point ranking scale is applied to perform the evaluation. Aggregation of core indicators enables the extraction of eight (8) sub-indices per assessment category, two (2) sub-indices per level of assessment and one (1) final index of ENvrionmental Sustainability Assessment of Industries (ENSAI index - I_{ENSAI}). The development of the specific framework is a good example of how Industrial Ecology principles and proposals can be translated into practical evaluation and monitoring tools of sustainable development for industry.

4. Ετεροαναφορές

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