

**«Διερεύνηση Και Αντιμετώπιση προβλημάτων  
ποιότητας ηλεκτρικής Ισχύος σε Συστήματα Ηλεκτρικής  
Ενέργειας (ΣΗΕ) πλοίων»  
(ΔΕΥ.Κ.Α.Λ.Ι.ΩΝ)**

πράξη ΘΑΛΗΣ-ΕΜΠ,  
πράξη ένταξης 11012/9.7.2012,

MIS: 380164,  
Κωδ.ΕΔΕΙΛ/ΕΜΠ: 68/1129

**Παραδοτέο: Π9.1.1**

**«Δημιουργία-Ανανέωση Ιστοσελίδας Ερευνητικού  
προγράμματος»**



## Εισαγωγή

Η ιστοσελίδα του έργου ΔΕΥΚΑΛΙΩΝ αναπτύχθηκε από τον πρώτο μήνα του έργου και φιλοξενήθηκε στον ιστότοπο με τη διεύθυνση:

[www.defkalion-thalis.org](http://www.defkalion-thalis.org)

Εκτός από την κύρια σελίδα, περιλαμβάνει σελίδες με:

- Γενική σύντομη περιγραφή του έργου
- Κύριες δράσεις (πακέτα εργασίας του έργου) με σύντομη περιγραφή και παραδοτέα
- Κατάλογο με τους ερευνητές του έργου
- Κατάλογο εργασιών που έχουν ανακοινωθεί σε πρακτικά διεθνών συνεδρίων ή/και δημοσιευθεί σε διεθνή περιοδικά

Επειδή το έργο ΔΕΥΚΑΛΙΩΝ – ΘΑΛΗΣ είναι μέρος μία συνολικότερης ερευνητικής δραστηριότητας ενός Διεθνούς Κέντρου Αριστείας (Centre of Excellence) στην επιστημονική περιοχή της Ναυτικής Ηλεκτρολογίας (Marine Electrical Engineering), όπως αυτή καλλιεργείται στο Εθνικό Μετσόβιο Πολυτεχνείο με τη συνεργασία πολλών άλλων Ιδρυμάτων στο εσωτερικό και εξωτερικό, μία παρόμοια ανάπτυξη ιστότοπου έγινε και στην εξής διεύθυνση:

[www.marineelectrical.gr](http://www.marineelectrical.gr)

και πιο συγκεκριμένα στην εξής:

<http://marineelectrical.gr/index.php/defkalion-project/>

Αντιπροσωπευτικές σελίδες του ιστότοπου παρουσιάζονται στη συνέχεια.



Διερεύνηση Και Αντιμετώπιση προβλημάτων ποιότητας ηλεκτρικής Ισχύος σε Συστήματα Ηλεκτρικής Ενέργειας (ΣΗΕ) πλοίων (ΔΕΥΚ.Α.Λ.Ι.ΩΝ)



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## Description Of DEFKALION Project

### 1. Brief Description of current status in ship electrical systems

#### 1.1 Ship electric energy systems

Electric power plant onboard has always been a rather complicated power system, comprising DC and AC subsystems of several operating voltage and frequency levels, especially in sophisticated structures with electric propulsion. The aforementioned complicity is worsened even further in the All Electric Ship (AES) systems, referring to full electric propulsion and extended electrification of all shipboard installations. On the other hand, similarly to continental grids, several steady- and transient-state phenomena, especially concerning power quality problems, emerge, and their consequences have to be thoroughly studied, analyzed and investigated. The electric power grid of a ship can be regarded as a small scale, autonomous, industrial type compact power system, although several differences between a conventional continental grid and a shipboard installation can be identified. Some of the special features of ship installations are:

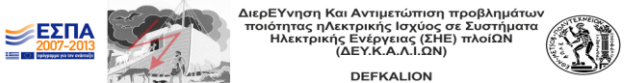
- The power system is completely autonomous.
- The total power installed per volume unit is large, especially in the electric propulsion applications.
- Electric energy is often generated by Diesel generator sets, or by shaft generators which are coupled to the main propulsion engine. Often, the fuel used is the (less costly) Heavy Fuel Oil (HFO).
- Referring to prime movers, their relative rotational inertia with respect to electric load demand is fairly small.
- The largest amount of energy is demanded by electric motors (acting either as main propulsion or as drivers of auxiliary engines).
- The electric power grid is composed of cables of small length (50m - 1000m).
- Adopting insulated neutral, i.e. 'unearthed' or 'IT' system is a common practice.
- The metal ship hull is used as a means to provide 'ideal earth' for Protective Earthing (PE).
- A considerable number of electronic devices installed onboard (automation systems, controllers, navigation systems) are sensitive to power quality and EMI problems provoked, in particular, by the extensive use of power electronics. Hence, the power quality problems are of extreme importance, and have to be analyzed thoroughly.
- Power Quality (PQ) problems onboard are of different significance, in comparison to the corresponding problems that occur in a continental power grid. In land, power quality problems may result in problematic production processes, while they may also affect the pricing relations (tariffs applied and penalties) between the utility and its clients. The latter is meaningless onboard, where the most important issue is the uninterrupted operation of the system, and its redundancy. A possible malfunction in a critical load may lead to a total loss of the whole vessel, resulting in possible human casualties and environmental pollution.

#### 1.2 Electric Power Quality (PQ) problems in ship electric energy systems - Current status

In this section, a brief description is presented regarding the PQ problems occurring in these ship sub-systems that will be investigated in the proposed here DEFKALION project.

#### 1.2.1 Shaft generator systems

Shaft generator (SG) systems have been exploited for long due to their appealing advantages, as lower cost of produced electricity, lower maintenance cost, and lower noise levels. However, the schemes currently used have certain disadvantages, as they comprise complicated configurations in order to achieve an identical performance to that of auxiliary generators. Thus, in most cases, a power electronic converter is connected downstream the generator, in order to match the output frequency of the generator with that of the rest of the electric grid. Moreover, currently, a companion synchronous motor is also connected, in order to provide the reactive power of the shaft generator system. This synchronous motor acts as a (rotating) capacitor, as it drives n load, but, still, it increases the total losses and the initial building cost. To our knowledge, no studies have been reported on an optimal exploitation of shaft generation systems via modern power converters, considering both the operational and environmental cost. Such studies should also take into account recent research on the propulsion Diesel Engines, which has elaborated



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## Defkalion Project

The proposed project deals with analysing and resolving Power Quality (PQ) problems in electric energy systems of ships with extensive electrification. Within this framework, optimized configurations of critical subsystems are studied in depth: shaft generators, thrusters, pods, earthing grids and protection against lightning. Finally, a central electric power management system is designed and tested in a manner that all PQ problems studied are monitored and mitigated. Noting the forthcoming complete ship electrification (called "All Electric Ship"), it is highlighted that this the first time that a project focuses on resolving all significant PQ problems met aboard. The anticipated results can be summarized as aiming at a greener, safer, more reliable and more economic ship. The power quality problems dealt refer to all three distinct power sub-systems: (a) generation (b) distribution, and (c) consumers. The methodology proposed, comprises both theoretical approach accompanied by experiments. This requires the interdisciplinary engagement of researchers from different scientific areas such as naval architecture, hydrodynamic engineering, marine engineering, electric grid and earthing grid engineering, electric machinery and power electronic engineering and energy engineering. Thus, the Main Research Team comprises academics grouped in 4 groups:

- a) Marine Technology
- b) Energy Saving
- c) Electromechanical Energy Conversion
- d) Electric Overvoltages

accompanied by a team of freelance researchers.

A distinguished Invited Researcher participates, too (Dr Sakis Meliopoulos, distinguished professor from Georgia Technological Institute, USA). The project is subdivided into 9 workpackages.



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Ευρωπαϊκή Ένωση  
Ευρωπαϊκό Κοινωνικό Ταμείο



ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ  
ΕΚΠΑΙΔΕΥΣΗ ΚΑΙ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗ  
*επένδυση στην κοινωνία της γνώσης*  
ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ, ΠΟΛΙΤΙΣΜΟΥ & ΑΘΛΗΤΙΣΜΟΥ  
ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ

Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης



ΕΣΠΑ  
2007-2013  
Πρόγραμμα για την ανάπτυξη  
ΕΥΡΩΠΑΪΚΟ ΚΟΙΝΩΝΙΚΟ ΤΑΜΕΙΟ



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ΔΕΦΚΑΛΙΟΝ



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