

#### INTEGRATED PLANNING TOOL FOR MEETING THE ENERGY AND WATER NEEDS OF SMALL AND MEDIUM SIZE AEGEAN SEA ISLANDS USING OPTIMUM RENEWABLE ENERGY SOURCES HYBRID SYSTEMS -(PHAROS)

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# **Presentation contents**

# ✓ Who we are

- Main activities in research, education and engineering
- ✓ The innovation and novelty of the energy and water demand problem approach
- ✓ The prospects of our work
- ✓ Discussion

**SEALAB** is part of the officially approved **ENERGY** Lab (Off. Gaz, 1041, 03-06-2015) and belongs to the Mechanical Engineers Department of PIRAEUS UNIVERSITY OF APPLIED SCIENCES (*former TEI of Piraeus*)

**SEALAB** has been founded during the end of 80's and practically starts its activities during 1991 with the support of Prof Pericles Koronakis.

The **SEALAB** collaborates with many Laboratories and Institutes in Greece and abroad. Its main partners are the Lab of **Optimisation of Production Systems**, the Lab of **Fluids and Turbomachinery** and the **Centre of Technological Research of Piraeus and Islands**, affiliated with PUAS.

# WHO WE ARE



Members of **SEALAB** and **OPS** Research and Educational Team are:

- 1. J.K. Kaldellis (Head of SEALAB)
- 2. E.M. Kondili (Head of OPS Lab)
- 3. Kosmas Kavadias
- 4. George Spyropoulos
- 5. Dimitrios Zafirakis
- 6. Christiana Papapostolou

- 7. Takis Ktenides
- 8. George Xydis
- 9. Stelios Liaros
- 10. Dimitrios Apostolou
- 11. Giota Koiliari
- 12. Rania Vardaki



### GENERAL INFORMATION (www.sealab.gr)

# **SEALAB** main activities include **EDUCATION**, **RESEARCH**, **CONSULTING** ACTIVITIES

We provide high level of <u>education</u> and we carry out <u>applied research</u> within the context of national and EU funded projects, in collaboration with public and private entities, for the last 25 years

Main research interests:

TECHNOLOGICAL EDUCATION INSTITUTE OF PIRAEUS



DEPT OF MECHANICAL ENGINEERING

- 1. Wind , Solar Energy and Hydro
- 2. Energy Storage-Hybrid Energy Systems
- 3. Green Island / Smart Grid Concept
- 4. Building Energy Efficiency
- 5. Integrated Energy & Water Schemes
- 6. Electric Vehicles



### **MSc PROGRAMMES**

**SEALAB** supports two MSc Programs:

**MSc in Energy Systems**, in collaboration with the UK-Heriot Watt University, since 2006 (Specialization *Renewable Energy Technologies* OR *Energy Systems Design*) www.sealab.gr

**MSc in** *Energy and Environmental Investments* (new autonomous program) <u>www.mbaenergy.gr</u>





- SEALAB has a long lasting research and applications oriented activity and focus to the realistic and feasible solution of the energy and water supply problem of the Greek islands or any area having **island's** characteristics.
- ✓ In fact that activity started in SEALAB much earlier than the time when many researchers and practitioners realized its importance (end of 80's).
- In this context, autonomous research activities, publications, books and many other activities have taken place before the recognition of the **problem's** importance and its support through funded programs.

- The main idea is that many of the islands have RES potential to cover not only their energy needs but also water needs. Furthermore, recent advances in technology have very much encouraged the conversion of the idea to practical and feasible solution for many of the islands. A number of research and applications projects
  - have been implemented or are in progress at the moment in this context.

# The GREEN ISLANDS

# CONCEPT

# **Green Islands Introduction**

- Many islands around the world are facing energy problems because of their remote location which force them to manage autonomously their energy needs using fossil fuels combustion.
- This results higher production costs and greenhouse gas emissions.
- They have a significant renewable energy potential (especially wind and solar).
- Latest efforts have been made in Europe for the sustainable exploitation of the available renewable energy sources (RES) in such islands in order to develop small scale RES based solutions.
- These autonomous energy systems can meet the electricity demand with relatively low production cost, providing reliable and environmental friendly solutions.
- Hellenic Islands may adopt the Green islands model, while the island of TILOS is the first European funded effort to develop a RESbased and storage solution for energy autonomy purposes.

# Main Islands Characteristics

- The limited local electrical network capacity
- The daily and seasonal electricity demand fluctuations
- The electricity consumption during summer season (June-August) which in most islands represents more than 40% of the total annual consumption
- The corresponding peak load demand which is usually two or even three times greater than the mean annual electricity demand



result in serious restriction of the maximum RES penetration <sup>12</sup>

# **Current Situation-Electricity**

Up to now, the electricity requirement has been hardly fulfilled by the existing outdated autonomous power stations, at very high fuel consumption values





 For the near future, the establishment of new electricity production plants is an extremely urgent engagement

# **Current Situation-Water Deficit**

Most Small Islands face serious water shortage problems

7%

They cover their needs using imported high cost and low quality water



covering this cost

# Main Islands Characteristics

 The majority of Aegean Archipelago islands have an excellent wind potential (the annual mean wind speed at 10m height exceeds 9m/s) and very high solar potential
WIND & SOLAR ENERGY IN GREECE



 an energy storage system, when sized appropriately, can match a highly variable wind power production to a generally variable and unpredictable system demand

### **Proposed Solution (A)-Large or Medium Size Islands**



### **Proposed Solution(B)-Small Islands**



# COLLABORATIVE PROJECTS (Hellenic-French)

#### PROMOTION OF SUSTAINABLE ENERGY AND WATER MODELS FOR MEDITERRANEAN ISLAND REGIONS (NAPOLEON)

- Framework: NSRF 2007-2015
- Partners: University of Corsica
- Duration: 24 months







### SEALAB Experimental Hybrid RES unit

The existing experimental hybrid RES unit (small wind turbine, PV, batteries) was **upgraded**, by adding a **reverse osmosis desalination unit**, suitable for the under scale experimental simulation of various RES hybrid schemes



#### **Existing Hybrid RES unit**

#### **RO** desalination unit



# NATIONAL PROJECTS - Archimedes III

COMPARATIVE EVALUATION BETWEEN HYDROGEN AND OTHER, CONVENTIONAL ENERGY STORAGE TECHNOLOGIES FOR THE SUPPORT OF RES-BASED POWER STATIONS



- Framework: NSRF 2007-2015
- Developer and Supplier of Integrated H<sub>2</sub> Solutions
- Duration: 36 months



# PHAROS - ARISTEIA II RESEARCH PROJECT

AN INTEGRATED PLANNING TOOL FOR MEETING THE ENERGY AND WATER NEEDS OF AEGEAN SEA ISLANDS USING OPTIMUM RENEWABLE ENERGY SOURCES HYBRID SYSTEMS (PHAROS)



- Framework: NSRF 2007-2015
- Partners: OSMO (Developer & Supplier of RO Desalination Unite)
- Duration: 18 months





### A Database (Database-SL) Tool, with an Integrated GIS Tool is developed

- ✓ built in C# (C Sharp)
- ✓ Long-term meteorological data for many small and medium size islands of the Aegean Sea
- ✓ Water transfers data
- ✓ Load, heating, and fuel demand annual data
- Geographical information (Natura sites, protected areas, infrastructures etc) for the siting and installation of HS in the islands examined.



Reporting (deliverables):

- Report on green, state-ofthe-art technologies for covering energy and water supply needs (del. 3.1)
- ✓ Tools implementation and Case Studies (del. 6.1)
- ✓ An integrated plan (final project report) for covering the energy and water demand needs of small and medium size Aegean island regions (del. 7.1)
- ✓ A number of conference announcements
- ✓ Peer-reviewed Journal publications on the way



# An integrated planning tool for island RES hybrid systems (ESA tool)

- ✓ built in C# (C Sharp)
- ✓ Load: meteorological data, wind turbine, PV, Batteries,
  Diesel Gen, Desalination characteristics
- ✓ Hybrid System (HS) components' economics
- ✓ HS components' power range
- ✓ Analytical Calculations & Results
- ✓ Private Investors have already expressed their interest for the tool

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### In depth Analysis of Islands

110

100

90

80

70

50

# Results for the Islands:

- ✓ Ag. Efstratios
- ✓ Donousa
- ✓ Karpathos
- ✓ Skyros
- ✓ Amorgos
- ✓ Astypalaia
- ✓ Anafi
- ✓ Sifnos
- ✓ Kos
- ✓ Kalymnos
- ✓ Megisti
- ✓ Rhodes





# HORIZON 2020 - PROJECT TILOS

### Project Title & ID

TILOS - 646529 Technology Innovation for the Local Scale, Optimum Integration of Battery Energy Storage

Project Budget EU Funding: ~11M€ - Total Grant: ~14ME

**Project Duration** Duration of 4 years - Start Date: 1/2/2015

**TILOS** aims to demonstrate the optimal integration of **local scale energy storage** in a fully-operated, **smart island microgrid** that will be developed on the island of Tilos (South-eastern Aegean Sea) and that will also communicate with a **main electricity grid** through **cable interconnection** 



# PROJECT CONSORTIUM



# **TILOS ISLAND**



# MAIN OBJECTIVES of TILOS

The main objective of TILOS will be the development and operation of a **prototype battery system** based on **NaNiCl<sub>2</sub> batteries** supporting multiple tasks, including:

- ->Synergy with wind and PV power ->Microgrid energy management
- ->Maximization of RES penetration->Grid stability
- ->Export of guaranteed energy ->Ancillary services to the main grid ->Synergy with DSM





The battery will support both stand-alone and grid-connected operation, while proving its interoperability with the rest of microgrid components, such as smart meters, demand side management devices and distributed, residential heat storage

# TILOS 6M MEETING September 2015



# **Conclusions**

- El Hierro, Isle of Eigg, Samsoe and Utsira are the first European island communities that have already exploiting the local RES potential contributing on establishing a Green island model.
- There are more than 6,000 Greek islands and islets, 227 of which are inhabited. The majority of these islands are located in the Aegean Sea possessing excellent solar and wind potential.
- This is the case of **Tilos island**, where **the first Greek Green island concept is developing with the financial support of EU**.
- According to the results obtained, the proposed RES-based solution is able to satisfy the electricity needs of the island exporting at the same time any energy surplus to the Kos electrical grid. On top of that, a preliminary economic evaluation undertaken demonstrates that the investment is viable in comparison to the current situation especially from the local community point of view.

# In conclusion ...

We believe that technology advances will keep on progressing and facilitating the implementation of the suggested solutions in the areas that all other solutions are either more expensive or not environmentally compatible.





 Furthermore, our islands are unique in Europe in location, civilization and history and are very suitable in all terms to be the focal points to demonstrate the implementation of this type of modern solutions of the energy and water problem satisfaction.

# Thank You for Your Attention