

# Welcome to REM2018



## Welcome to Applied Energy Symposium and Forum, REM2018: *Renewable Energy Integration with Mini/Microgrid*

The increasing share of variable renewable energy sources, strict targets set for the reduction of greenhouse gas emissions and the requirements on improvement of system security and reliability are calling for important changes in our energy systems. Distributed renewable energy and microgrids have emerged as effective ways for improving the quality of energy service given various types of renewable integration, and other challenges to the legacy system. The integration of distributed renewable energy and microgrids is significantly increasing the coupling and interactions between sources, and between supply and end use, at various scales (from multinational, national, and community scale down to building level). The need for energy storage and flexible demand is also increasing for improving the business case for their deployment. The issues need to be addressed to solve the challenges of intermittent power generation and mismatching of energy supply and demand over a time scale. Human behaviors should also be integrated into the energy systems to interactively improve the sustainability. Its interdisciplinary and synthetic approach not only reveals the systematic overview, but also details components of renewable energy systems.

This above background defines the aim and scope of the Applied Energy Symposium and Forum, REM2018: Renewable Energy Integration with Mini/Microgrid to be held in September 28-30, 2018 in Rhodes (Greece) organized by Applied Energy Innovation Institute (AEii) and TILOS European Project.

The REM2018, with the theme of “Distributed Energy and Microgrids for Smart Cities”, is to provide a platform focused on Distributed Energy & Microgrid (DEM). We invite all stakeholders including academia, inventors, project developers, financiers, suppliers, policy decision makers, even the public and end-users to participate in the conference. We will explore new approaches and innovative solutions to solve the challenging issues associated with new transitions of future renewable energy systems.

The event consists of keynote sessions, panel discussions, academic papers sessions, and on-site tour of renewable pilot projects.

We are looking forward to meeting you in Rhodes.

**Prof. J.K. Kaldellis**  
**University of West Attica**

**Prof. J. Yan**  
**Editor-in-Chief of Applied Energy**

# Acknowledgements



THE APPLIED ENERGY  
INNOVATION INSTITUTE



Technology Innovation for the Local Scale  
Optimum Integration of Battery Energy Storage



International Conference on Applied Energy



**MÄLARDALEN UNIVERSITY  
SWEDEN**

School of Business, Society and Engineering

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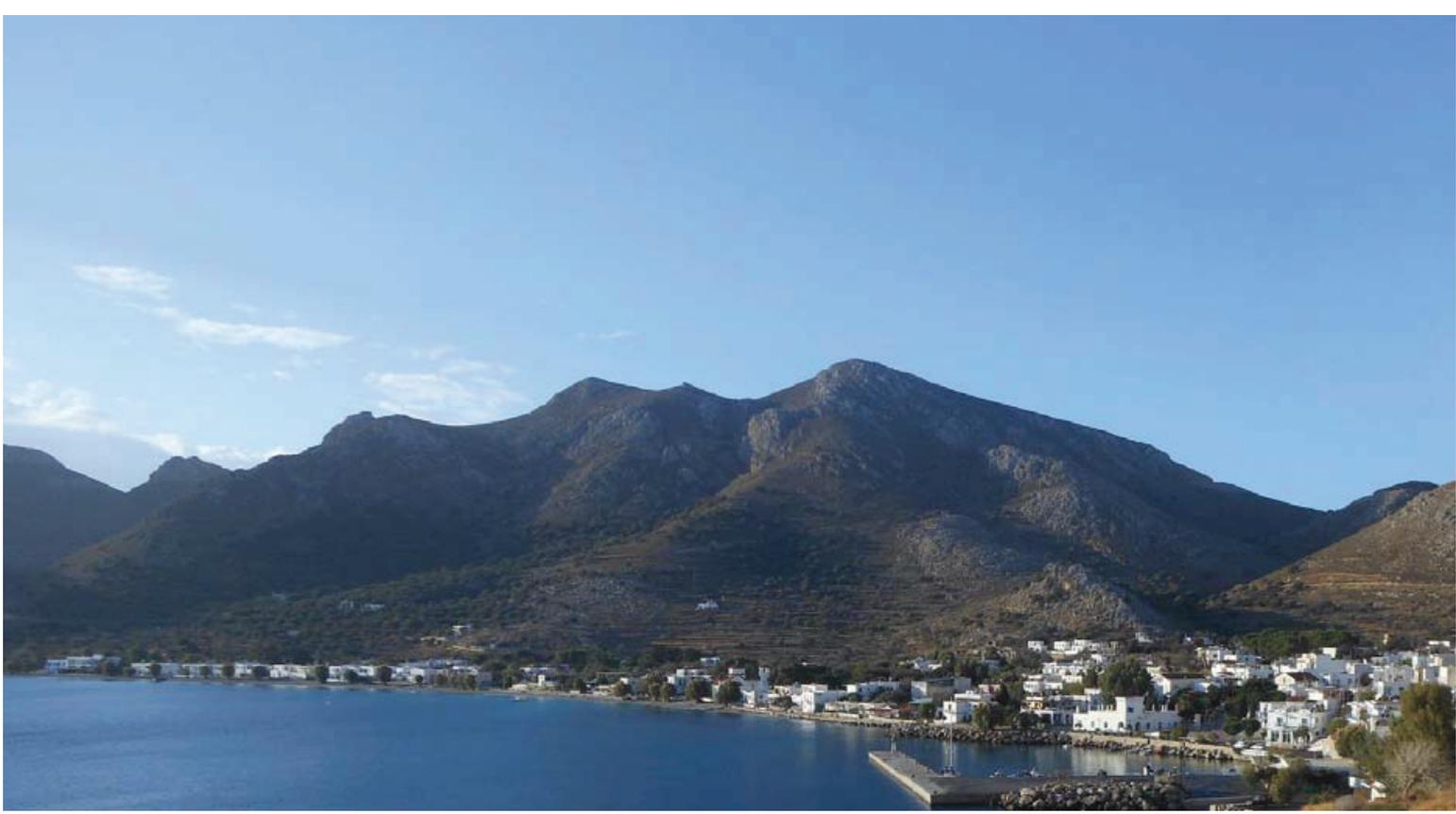
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# 'TILOS,

## Technology Innovation for the Local Scale, Optimum Integration of Battery Energy Storage



Technology Innovation for the Local Scale  
Optimum Integration of Battery Energy Storage



Horizon 2020 - Low Carbon Energy - Local / small-scale storage  
LCE-08-2014

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 646529.

“Be the change you want to see in the world around you”



Welcome to **Tilos**! A special, “S” shaped Greek island, located in the south-eastern **Aegean Sea**, part of the Dodecanese group of islands, lying midway between Kos and Rhodes. The island’s history begins after it broke off from the coast of Asia. During the years of its existence, the island was inhabited by several different nations and was influenced by multiple civilizations. Apart from its **natural beauty**, the variety of its landscape and the “grand bleu” of the Aegean Sea that surrounds it, Tilos has to show important medieval castles, a Byzantine monastery, many small picturesque churches and a village that is declared a cultural monument.

Tilos however is also known for its innovative and pioneering practices. It may be the Greek island most committed to sustainable development, having adopted a series of green policies which led the European Economic and Social Committee to characterise it a model of environmental management. In the near future, Tilos is planning to develop a recycling unit, an ecological village of 50 summer residences, a processing center for

biological, agricultural and livestock farming products etc.

Up until now, the electricity needs of the local population of Tilos, ~500 islanders, are covered through an undersea interconnection with the island of Kos, where a diesel-oil power station is operated. That means that until today the annual electricity consumption of Tilos, close to 3GWh, is covered entirely on the basis of oil imports.

What we -as a team- together with the people of Tilos aspire to accomplish, is to make this small and remote island a **blue- print** for **smart microgrids** facilitating **increased participation of renewable energy** in the local energy mix through the optimum utilisation of **energy storage**.

The participation of the local inhabitants in this project will contribute towards the protection of the environment, the reduction of the island carbon footprint, the fight against climate change and the development of sustainable energy models aiming at achieving increased energy autonomy.

## Project in a Nutshell

The main objective of the TILOS project is to maximise the use of clean (renewable) energy sources in covering **the electricity needs** of Tilos island.

In this context, a new **prototype hybrid system for electricity production and storage** consisting of a medium-scale wind turbine of 800kW, a small-scale photovoltaic park of 160kW and a battery storage system of 2.4MWh useful energy capacity, has been developed and will operate on Tilos.

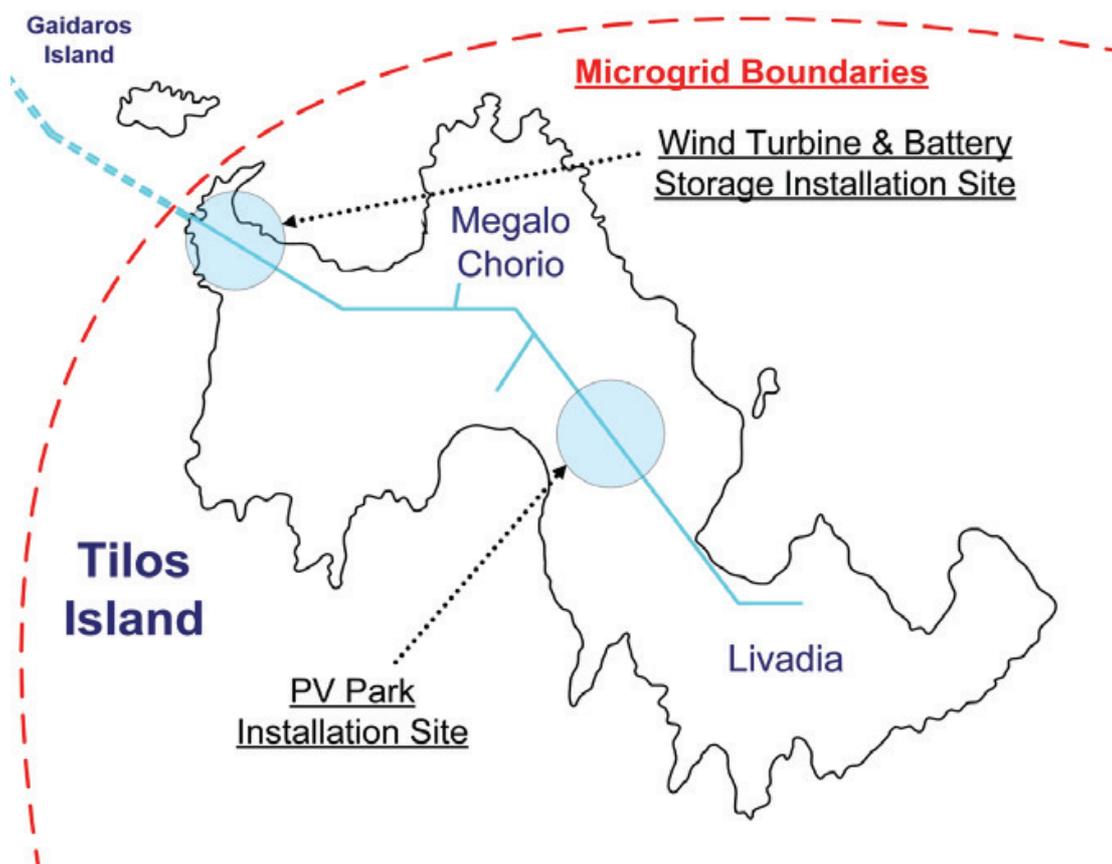
The green light for its operation was given on May 13, 2016. It was then that the production license for the hybrid power station of Tilos was issued from the Greek Regulatory Authority for Energy (RAE), making it the first power station of its kind that will operate in Greece, and among the first in Europe.

Apart from the hybrid power station, **smart meters** and **demand side management devices** have also been installed in the residential sector and other, central loads of Tilos island.

Moreover, a **smart energy management system** coordinating the operation of the various components will also be developed to achieve the highest possible electricity autonomy and balance between intermittent RES electricity production and electricity demand, with the support also of battery storage and demand side management.

The TILOS project focuses on island regions which constitute high priority areas. Apart from Tilos, other participating islands include **Pellworm** (Germany), **La Graciosa** (Portugal) and **Corsica** (France). The overall idea is to create a special platform that will enable technological know-how transfer between islands, by also exploiting the experience gained from the smart grid system of Pellworm, and that will designate new opportunities for the development of similar systems in other islands.

**This revolutionary project for Europe** will set the foundations for **the future development and replication** of similar hybrid systems in island regions and remote communities facing energy-related problems.



## It's a team effort

TILOS is an innovative, European R&D project, which ranked first among 80 competing projects under the European funding Programme Horizon 2020. The project is led by the Laboratory of Soft Energy Applications and Environmental Protection of the University of West Attica (former TEI of Piraeus). Despite that TILOS carries a national identity, the project is also multinational involving a total of 13 European partners.

The partners originate from 7 different countries across the European continent (Greece,

Germany, France, United Kingdom, Sweden, Italy, Spain).

From Greece, apart from the University of West Attica, involved in the project are also HEDNO (the Hellenic Electricity Distribution Network Operator), the widely known environmental NGO WWF-Greece and the private company Eunice, with significant experience in the field of renewable energy sources, in the Greek and the European energy market.

### Industrial / Commercial Partners

1. FIAMM Energy Storage Solutions FZSoNick (IT)
2. Younicos AG (DE)
3. EUNICE Laboratories SA (EL)
4. EUROSOL P&M GmbH (DE)

### Research / Academic Partners

5. Commissariat à l'Énergie Atomique et aux Énergies Alternatives (FR)
6. Instituto Tecnológico de Canarias S.A. (ES)
7. University of West Attica (EL)
8. University of East Anglia – Business School (UK)

9. Université de Corse (FR)
10. Rheinisch-Westfälische Technische Hochschule Aachen (DE)
11. Kungliga Techniska Högskolan (SE)

### Distribution System Operators (DSOs)

12. Hellenic Electricity Distribution Network Operator S.A. (EL)

### NGOs

13. World Wide Fund for Nature – Greece (EL)

Photos: © Dimitris Zafirakis



### Project Coordinator:

University of West Attica

**Project Start:** 01/02/2015

**Project Duration:** 4 years

**Official website & e-mail:**

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**Prof. Agis M.  
Papadopoulos**

Aristotle University of  
Thessaloniki

***Keynote: Micro-grids and cogeneration: A sustainable option for insular communities in the Mediterranean?***

Prof. Agis M. Papadopoulos completed his Diploma in Mechanical Engineering at the Aristotle University Thessaloniki, in 1989, and his Master of Science in Energy Conservation at the School of Mechanical Engineering, Cranfield University (UK), in 1990. He made his Doctorate in Mechanical Engineering, on the feasibility of solar thermal systems, at the Aristotle University Thessaloniki, in 1994. Between 1994 and 1998, he was lecturing at the Dept. of Mechanical Engineering, at the University of Thessaly, in Volos and at the Department of Business Administration, at the University of Macedonia, in Thessaloniki. In 1998, he was elected Assistant Professor on Energy Systems at the Department of Mechanical Engineering at the Aristotle University Thessaloniki. In 2004, he was elected Associate Professor. Since 2010, he is a full Professor on energy systems. His research and academic work are focused on the following topics:

- Energy conservation and rational use of energy in buildings, emphasising on energy design of buildings, thermal insulation and HVAC systems.
- Energy and environmental economics, emphasising on the feasibility of energy investments and the development of incentives for the implementation of energy policies.

He has been a board member of the Hellenic Regulatory Authority for Energy (2003-2005) and of the AHEPANS General Hospital of Thessaloniki (2005-2007), as well as a national expert to the CEC on Research and Innovation in the 6th FP, on Energy in the 7th FP and on the Ideas Programme in the 7th FP. Furthermore, he is a member of the Hellenic Technical Chamber (TEE) since 1989 and of the American Society of Heating Refrigeration Air Conditioning Engineering (ASHRAE) since 2003.

# Keynote Speakers



**Prof. Yang Hong-xing**  
The Hong Kong  
Polytechnic University

***Keynote: Potential power generation from solar photovoltaic-integrated building facades: our simulation and experimental studies***

Prof. Yang received his BEng in 1982 and MEng in 1985 in the Division of HVACR Engineering of Tianjin University, China. He obtained his PhD in 1993 in the Mechanical Engineering Department, University of Wales College of Cardiff, UK. He is now leading the Renewable Energy Research Group (RERG) in the Department of Building Services Engineering. His research interests cover a number of R&D topics in renewable energy applications and energy saving in buildings in urban areas including solar photovoltaic integration in buildings, indirect evaporation cooling, ground-coupled heat pumps and solar cell related materials. He has over 300 academic papers and 6 professional books published. According to the Shanghai Ranking's Global Ranking of Academic Subjects 2016 through Elsevier, he was on the list of 150 world most-cited researchers with impactful research in the disciplines of Civil Engineering. He was also on the list of the "Highly Cited Researchers 2017" reported by Clarivate Analytics. He is serving the International Journal of Applied Energy as associate editor, International Journal of Low Carbon Technologies as section editor and other international journals as editorial board member. He has been elected as the founding president of the Solar Energy Society of Hong Kong in 2018.

**Day 2**  
**11:00-13:00**  
**Nefeli B**

**TILOS: Technology Innovation for the Local Scale Optimum Integration of Battery Energy Storage**

TILOS is a European research project engaging 13 participating enterprises and institutes from 7 European countries (DE, FR, EL, UK, SE, IT, ES). The project's main goal is to demonstrate the potential of local / small-scale battery storage to serve a multipurpose role within an island microgrid that also interacts with a main electricity network. Among others, the project aims to achieve large-scale RES penetration and asset value maximization through the optimum integration of a hybrid RES (wind and PV) power station together with advanced battery storage, distributed, domestic heat storage, smart metering and DSM. The project progress will be discussed and an introduction will be made with regards to the scheduled, optional site visit to the island of Tilos.

***Chair:** Prof. John Kaldellis, University of West Attica, Greece*

***Participants:***

*Dr. Dimitrios Zafirakis, University of West Attica, Greece*

*Dr. Jean-Laurent Duchaud, Université de Corse Pascal Paoli, France*

*Dr. Ottorino Veneri, National Research Council (CNR), Italy*

*Dr. Clemente Capasso, National Research Council (CNR), Italy*

*Dr. Pietro Campana, KTH-Royal Institute of Technology & Mälardalen University, Sweden*

## TILOS ISLAND AND SMART ENERGY MICROGRID

**1<sup>st</sup> – 2<sup>nd</sup>, October 2018**

Tilos is a majestic, tiny island, located on the south-eastern part of the Aegean Sea, sharing the distance between the islands of Kos and Rhodes. Although the island's permanent population does not exceed 500 people, tourists arriving during the summer period may even reach an additional of 2,000. But even these numbers do not add up to compare with the dominant island species, meaning stray cats and the literally tens of thousands of wild goats spread across the whole island area. This is only one indication of the ecological culture embraced by the local habitants of Tilos, actively supporting the notion of clean energy and sustainable development. These are the grounds where the first, integrated smart energy microgrid of the Mediterranean Sea is about to start its operation under the Horizon 2020 project of TILOS (<https://www.tiloshorizon.eu/>), standing as the acronym for "Technology Innovation for the Local Scale, Optimum Integration of Battery Energy Storage".



The smart island microgrid of Tilos employs a core, MW-scale, battery-based Hybrid Power Station (HPS) -the first of its kind in Greece and among the first in Europe- that comprises an 800kW wind turbine, 160kWp of installed PV capacity and a novel, NaNiCl<sub>2</sub> battery energy storage system of 2.88MWh/800kW. The HPS of Tilos combines with a Demand Side Management (DSM) network of approximately 150 smart meters and DSM panels distributed across the residential sector and centralized water pumping systems of the island, altogether coordinated under the governance of an advanced Microgrid Energy Management System incorporating novel forecasting aspects and DSM strategies.

Once fully operational, the integrated TILOS solution is expected to achieve annual RES shares in the order of 70-75% for the island of Tilos, minimizing the supply of oil-based electricity through the existing subsea cable that comes from the thermal power station of Kos. Instead, it is expected that Tilos will also provide peak shaving services for the broader Kos system by exporting guaranteed amounts of energy during times that electricity generation is most wanted. In addition, in an effort to maximize RES penetration, green electro mobility elements have also been recently introduced in the smart island microgrid of Tilos, allowing for the expansion of clean energy to the local transportation sector as well.



The research team of TILOS Project Coordinator, belonging in the Soft Energy Applications and Environmental Protection Lab (SEALAB) of the University of West Attica (former TEI of Piraeus), has the pleasure to invite REM2018 participants in Tilos island for a site visit to the HPS and to the rest of smart microgrid components under development. SEALAB (<https://www.sealab.gr>) is an academic lab with very long experience in educational and research activities in the field of energy technologies -mainly in Renewable Energy Sources and Hybrid Energy Systems- and clean energy applications contributing to sustainable development. SEALAB relevant ongoing research activities are focusing in:

- Technical and economic evaluation of energy systems
- Novel Strategies for Increasing RES Integration
- Policy Development & Economics of Energy Storage
- Implementation of the Green Island Concept
- Optimisation of the water and energy resources management

The site visit will take place after the completion of REM2018 Conference according to the following plan.

- Departure from Rhodes island on Monday, 1st of October, at 16:00, and arrival to Tilos at 18:10 of the same day.
- Departure from Tilos island on Tuesday, 2nd of October, at 14:25, and arrival to Rhodes at 16:30 of the same day.
- The registration fee shall cover all associated costs, including travel costs to and from Tilos island, accommodation and transportation costs on Tilos, and also a traditional dinner on Monday evening.

It is noted that due to capacity limitations, there will be a maximum number of fifty (50) site visit participants. Therefore, the applications will be accepted on a priority basis up to the completion of the maximum number of participants. The registration for the site visit can be done at the following link: <https://goo.gl/forms/jxxHIKFFXpLIXgPA3>

# Programme at a Glance

Registration: Sep 28, 14:00-17:00; Sep 29, 8:00-12:00; Sep 30, 8:00-12:00				
Time	Day 1: Sep 29			
10:00-10:30	Opening			
10:30-11:30	Keynote speaker 1			
11:30-12:00	Tea/Coffee Break			
12:00-13:00	Keynote speaker 2			
13:00-14:00	Lunch			
Afternoon	1-A3	1-B3	1-C3	1-D3
14:00-14:30	9	36	10	8
14:30-15:00	13	50	14	17
15:00-15:30	20	55	26	18
15:30-16:00	29	67	31	21
16:00-16:30	Tea/Coffee Break			
Afternoon	1-A4	1-B4	1-C4	1-D4
16:30-17:00	43	69	3	41
17:00-17:30	58	76	4	61
17:30-18:00	59	92	6	75
18:00-18:30	68	52	40	106
19:30-22:00	Conference Banquet			
Time	Day 2: Sep 30			
Morning	2-A1	2-B1	2-C1	2-D1
08:30-09:00	71	34	37	33
09:00-09:30	81	39	48	45
09:30-10:00	86	49	91	25
10:00-10:30	89	56	94	117
10:30-11:00	Tea/Coffee Break			
Morning	2-A2	2-B2	2-C2	2-D2
11:00-11:30	95	66	38	Panel session
11:30-12:00	110	78	47	
12:00-12:30	60	80	93	
12:30-13:00	119	82	111	
13:00-14:00	Lunch			
Afternoon	2-A3	2-B3	2-C3	2-D3
14:00-14:30	15	87	65	112
14:30-15:00	24	98	70	19
15:00-15:30	32	30	72	44
15:30-16:00	88	90	121	96
16:00-16:30	Tea/Coffee Break			
Afternoon	2-A4	2-B4	2-C4	2-D4
16:30-17:00	63	113	62	
17:00-17:30	118	73	46	
17:30-18:00	122	99	23	
18:00-18:30	286	22	28	

	Distributed renewable energy supplies
	Control and protection schemes
	Islands energy systems
	Microgrids
	Energy storage technologies
	Economic analysis, new business models and markets
	Energy in buildings
	Weather forecasting