6th International Conference on Renewable Energy Sources & Energy Efficiency - New Challenges

www.mse.com.cy/resee2018

1-2 NOVEMBER 2018 Nicosia-Cyprus

Programme & Book of Abstracts

Venue: University of Cyprus

Under the Auspices of The Minister of Energy Commerce Industry and Tourism

Organised by:

CYPRUS CHAMBER OF COMMERCE AND INDUSTRY

www.ccci.org.cy

Main Sponsor:

Deloitte.

Conference Secretariat:

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Welcome address by the Conference Chairman

Dear colleagues and friends,

It gives me great pleasure to welcome you to the 6th International Conference on Renewable Energy Sources and Energy Efficiency - New Challenges. To our eminent speakers and all participants, I am greatly honored and pleased to welcome you to Nicosia. We are indeed honored to have you here with us.

Following the success of the previous five conferences, this biannual event, organised by the Cyprus Chamber of Commerce and Industry (CCCI), returns this year with an impressive list of plenary presentations by prominent speakers, a great number of peer-review selected scientific papers, and a number of new events addressing the scientific and research community and students as well as the business professionals. The conference takes place during an extremely challenging time for our energy strategy, which should seriously consider energy efficiency and exploitation of renewable energy sources in parallel with the exploitation of oil and natural gas reserves.

The theme that we have chosen for this conference is as much local, as it is global. Many synergies exist between renewables and energy efficiency in both technical and policy contexts. Institutions such as the International Renewable Energy Agency (IRENA) and the International Energy Agency (IEA) are working with policy makers and businesses to better understand the synergies and trade-offs of these two important tools and how to adapt policies to optimise impact.

Major challenges still have to be faced. Despite the significant increase in renewable energy deployment over the past decade, propelled by the numerous drivers and players advancing renewables and efficiency and the steady increase in support policies and targets, renewables are still far from fully integrated into the larger energy system. I am sure that our distinguished speakers, during these two days, will tell us more about the latest developments, and they will refer to success stories.

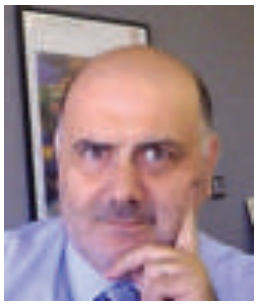
I would like to thank his Excellency the Minister of Energy, Commerce, Industry and Tourism of the Republic of Cyprus, Mr Yiorgos Lakkotrypis, for kindly accepting to put the conference under his auspices. My thanks are also extended to the members of the Organising Committee for their continuous support and their valuable contribution. My deep appreciation goes to the Scientific Committee, for preparing a dynamic scientific programme, including an impressive roster of highly respected and internationally renowned speakers to lead it. Last but not least, I want to thank Deloitte and the other sponsors for their support and valuable contribution to our conference.

We are looking forward to have a very constructive discussion during these two days. Your presence in the conference is indeed an opportunity to establish new scientific and professional bridges with all geographical realities. I sincerely hope that this conference will help to raise awareness about critical energy issues of our time.

Once again, I am most grateful for your participation and support. I wish you a fruitful Conference ahead.

Prof. Ioannis M. Michaelides
Conference Chairman

Welcome address by the Chairman of the Scientific Committee



Dear Colleagues, Dear Friends,

on behalf of the Scientific Committee of the 6th International Conference on Renewable Energy Sources and Energy Efficiency, it is my great pleasure to welcome everyone to the event.

The scientific committee has worked for almost a year towards laying the foundations for this scientific feast in Nicosia, Cyprus. More than 70 papers were received, reviewed and revised so that 52 were finally selected to be presented.

The focus is on showcasing the original research work carried out by senior and young scientists in universities, research centers, pubic authorities and private enterprises from more than 13 countries, covering a wide spectrum from state of the art renewable energy technologies to the energy efficiency of buildings and from the elaboration and implementation of policies to meeting new challenges in the environmental and economic field.

Furthermore, this year we are proud to introduce some new features:

• a session dedicated to presenting the research activities of Cyprus institutions and associations

• a poster and discussion session, where graduate students can present their work and receive feedback from the visitors, and

• a "Meet the Editors' workshop, where 3 Editors of established journals will provide guidance to PhD students and less experienced researchers, on how to prepare quality submissions.

I am confident that in addition to actively listening to the interesting presentations and participating in the workshops, there will be ample opportunities of exchanging our views and discussing ideas for future projects and co-operation.

I would like to thank all the members of the scientific committee who contributed their valuable time and hereby welcome all of you to this scientific extravaganza.

Professor Agis M. Papadopoulos
Chairman of the Scientific Committee

Scope of the Conference

The 6th International Conference on Renewable Energy Sources and Energy Efficiency (RESEE2018) follows the five successful editions held in Nicosia (2007, 2009, 2011, 2013, and 2016). The aim of the conference is to bring together all the key stakeholders interested in renewable energy sources and energy efficiency to share and discuss advances and developments in this field. It is therefore aimed at assisting researchers, scientists, manufacturers, companies, communities and agencies to keep abreast on new developments in their specialist fields and to join forces in finding alternative energy solutions to current issues. The thematic areas of the conference cover all topics of renewable energy as well as energy efficiency in all sectors.

Who should attend

- Members of the research and academic communities aiming at exchanging results, sharing similar experiences or new applications.
- Architects, engineers and energy consultants.
- Decision makers, including managers and policy makers interested in exchanging ideas and experiences and learning about new initiatives.
- Representatives of international organizations or other organizations willing to share relevant experience on renewable energy exploitation, energy efficiency techniques and developments of conventional technologies.
- Private companies interested in investing on renewable energy and energy efficiency equipment.
- Individuals who wish to be informed on new developments, tools and techniques.
- Regulators, utilities and operators enriching the conference with their views on the changing needs of systems in delivering the quality of supply that everybody expects.

Venue

University of Cyprus, Nicosia

Parallel Workshops

Industry workshops will be organised and be available on request, depending on satisfactory number of applications received.

Conference presentations

- The presentation of all the selected papers will be 15 minutes duration. Each session will be followed by a 10-minute discussion.
- Conference proceedings: All accepted papers and the papers of the invited speakers will be available to the registered participants in the Conference webpage www.mse.com.cy/resee2018
- Official language: The official language of the conference is English.

Executive Organising Committee

Chairman: **Prof. Ioannis Michaelides**

Co-Chairmen: **Prof. George Georgiou, University of Cyprus**
Prof. Theodoros Zachariadis, Cyprus University of Technology

Conference Coordinator: **Mr. Andreas Andreou, Cyprus Chamber of Commerce and Industry**

Members:

• Mr. George Partasides	Ministry of Energy Commerce Industry and Tourism, Energy Service
• Mr. Christos Maxoulis	Cyprus Scientific and Technical Chamber
• Dr. Nestor Fylaktos	The Cyprus Institute
• Prof. Theocharis Tsoutsos	Technical University of Crete, Greece
• Mr. Nicos Kyriakides	Deloitte
• Dr. Constantinos Rouvas	Electricity Authority of Cyprus
• Mr. Panayiotis Keliris	Cyprus Energy Regulatory Authority
• Prof. Michalis Komodromos	Frederick University
• Dr. Michalis Syrimis	Transmission System Operator, Cyprus

Scientific Committee

Chairman: **Prof Agis Papadopoulos, Aristotle University of Thessaloniki**

Members:

• Prof. Aristides Bonanos	The Cyprus Institute, Cyprus
• Dr. Alexandros Charalambides	Cyprus University of Technology, Cyprus
• Prof. Stelios Choulis	Cyprus University of Technology, Cyprus
• Prof. Chris Christodoulou	Frederick University, Cyprus
• Prof. Danae Diakoulaki	National Technical University of Athens, Greece
• Prof. Haris Doukas	National Technical University of Athens, Greece
• Dr. Vasiliki Drosou	Centre for Renewable Energy Sources, Greece
• Dr. Polyvios Eleftheriou	Cyprus University of Technology, Cyprus
• Dr. Flourentzos Flourentzou	Estia SA, Switzerland
• Dr. Paris Fokaides	Frederick University, Cyprus
• Mr. Avraam Georgiou	Cyprus University of Technology, Cyprus
• Dr. Harry Kambezidis	National Observatory of Athens, Greece
• Prof. George Karagiorgis	Frederick University, Cyprus
• Dr. Athanasios Kolios	Cranfield University, UK
• Prof. Elias Kyriakides	University of Cyprus, Cyprus
• Prof. Isaac Meir	Ben Gurion University of the Nagev, Israel
• Prof. Marina Neophytou	University of Cyprus, Cyprus
• Prof. Sandro Nizetic	University of Split, Croatia
• Prof. George Papadakis	Agricultural University of Athens, Greece
• Prof. Konstantinos Papakostas	Aristotle University of Thessaloniki, Greece
• Prof. Lina Seduikyte	Kaunas University of Technology, Lithuania
• Prof. Despina Serghides	The Cyprus Institute, Cyprus
• Prof. Theodoros Theodosiou	Aristotle University of Thessaloniki, Greece
• Prof. Maja Todorovic	University of Belgrade, Serbia
• Prof. Antonis Tourlidakis	University of Western Macedonia, Greece
• Prof. George Tsilingiridis	Aristotle University of Thessaloniki, Greece
• Prof. Derek Wilson	Institution of Engineering and Technology, UK

Advisory Committee

• Prof. Costas N. Papanicolas	President, The Cyprus Institute, Cyprus
• Prof. Matheos Santamouris	University of New South Wales, Australia
• Dr. Andreas Poullikkas	Chairman, Cyprus Energy Regulatory Authority, Cyprus
• Prof. Evangelos Dialinas	National Technical University of Athens, Greece
• Dr .Venizelos Efthymiou	Chairman, FOSS Research Centre for Sustainable Energy, University of Cyprus

Invited Keynote Speakers

To be announced

Publication of selected papers in Journals

Authors of selected papers presented at the conference will be invited to publish extended and revised versions, after the respective review procedure, in the SCOPUS, EI, INSPEC, etc. listed journals:

- International Journal of Sustainable Energy, Taylor & Francis
- Advances in Building Energy Research, Taylor & Francis
- Journal of Power Technologies (JPT), ITC

Conference Fees

• Early Registration before 1st October 2018	€ 250
• Registration after 1st October 2018	€ 350
• Students	€ 100

Fees cover the admission to all sessions, invitation to all coffee breaks, one lunch, conference material, and VAT.

Registration

To register please visit www.mse.com.cy/resee2018

Conference Secretariat

MSE Congress Plus
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E-mail: mse@mse.com.cy, Website: www.mse.com.cy
Conference webpage: www.mse.com.cy/resee2018

Conference topics

Papers are invited reporting original research as well as papers focusing on the results that have been achieved in the areas of Renewable Energy Sources, Energy Efficiency and Policy, Education and Research in Energy and Environment, as well as Oil and Gas Technologies. Indicative themes of the Conference are listed below:

Renewable Energy Sources

Renewable energies
Biomass, bioenergy & bio-economy
Energy storage technologies
Geothermal technologies
Photovoltaics
Power systems
Concentrated solar power
Smart networks
Energy networks
Wind energy technologies
Hybrid energy systems
Solar heating and cooling
Solar desalination
Grid Integration
Demand Response,
Demand Side Management

Energy Efficiency and Policy

Energy generation
Energy recovery
Energy management and economics
Automization of energy systems
Energy and the built environment
Bioclimatic design of buildings and public spaces
Smart cities
Building management systems
Heating, ventilating and air conditioning systems
Sustainable transport
Zero emission buildings
Energy policy, economics and planning
Energy and climate change
Environmental impact
Energy investment financing

Education and Research in Energy and Environment

Distance learning in Energy and Environmental topics
Interdisciplinary educational programmes
Large scale research facilities
Pilot and demonstration projects
Training and certification schemes

New Challenges

Security of energy supply
Carbon capture and storage technologies
Enhanced oil recovery for deep-water
Hydrocarbons exploration strategies
Natural gas liquefaction technologies
Natural gas pipeline transportation technologies
Natural gas policy issues
Enhanced oil recovery for deep-water
Oil and gas reserves and economics by region
Shale gas technologies
Energy-food-water nexus

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Co-organisers:

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Deloitte.

University of Cyprus

Cyprus University of Technology

ARISTOTLE UNIVERSITY OF THESSALONIKI

National Technical University of Athens

Technical University of Crete

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ΔΣΜΚ
Διαχειριστής Συστήματος Μεταφοράς Κύπρου
Transmission System Operator - Cyprus

Cyprus Energy Agency

cygas

Keynote Speakers

Prof. Dr. Agis M. Papadopoulos
Director, Process Equipment Design Laboratory
Department of Mechanical Engineering
Aristotle University
Thessaloniki, Greece

Keynote title:
Thermal comfort in Zero Energy Buildings: State of the art and prospects

Agis Papadopoulos is a Mechanical Engineer with an MSc in Energy Conservation and a PhD on solar systems. Since 1998 he is Professor at the Department of Mechanical Engineering of the Aristotle University Thessaloniki, Greece.

Main research interests lie in the fields of (a) Energy efficiency and integration of RES technologies in the built environment, (b) Energy conservation technologies and materials and (c) Policies and regulatory issues on energy efficiency and RES.

He has coordinated more than 65 national and international research projects and authored or co-authored more than 110 journal and 270 conference papers.

He is Editor-in-Chief of the International Journal of Sustainable Energy and visiting professor at the Technical University of Hamburg, Germany.

He was member of the Hellenic Regulatory Authority of Energy and Vice-Chairman of the Governing Board of the Open University of Cyprus.

Dr. Andreas Poullikkas
Cyprus Energy Regulatory Authority Chairman, Cyprus

Keynote title:
Development of energy strategies for sustainable future

Dr. Andreas Poullikkas holds a Bachelor of Engineering (B.Eng.) degree in mechanical engineering, a Master of Philosophy (M.Phil.) degree in nuclear safety and turbomachinery, a Doctor of Philosophy (Ph.D.) degree in numerical analysis and a Doctor of Technology (D.Tech.) higher doctorate degree in energy policy and energy systems optimization from Loughborough University, U.K. He is a Fellow of the Institution of Engineering and Technology (FIET).

He is currently the Chairman of the Cyprus Energy Regulatory Authority (CERA) and the Chairman of the Cyprus Energy Strategy Council (both appointments by the President of Cyprus). In his professional career he has worked for academic institutions and for the industry, such as, a Visiting Faculty at Harvard University, USA, the Cyprus University of Technology (Professor of Power Systems and Chair of the Department of Electrical Engineering) and the Electricity Authority of Cyprus (founder and director of the Research and Development Department). He is the Associate Editor of the Journal of Power Technologies, member of the Editorial Board of the journal Sustainable Energy Technologies and Assessments and the author of various peer-reviewed publications in scientific journals, book chapters, conference proceedings and the author of eight books.

Keynote Speakers

Mr. Avi Feldman
CEO, Green Future Technologies
Chairman, IATI Cleantech Committee

Avi Feldman, CEO, Green Future Technologies Chairman, IATI Cleantech Committee
Avi is the CEO of Green Future Technologies, a green energy & smart transportation investment firm that is focused on early stage ventures. Avi, a seasoned Incubation & VC executive, has over 20 years of experience in innovation, business development, venture capital, and international cooperation. Avi Brings expertise in scouting, investment & portfolio management with strong focus on early stage technologies.Formerly, Avi was the CEO of Capital Nature, a leading investment firm in Israel focused on incubating, funding and accelerating early stage ventures, as well as academic research in the emerging Green Energy in Israel - renewable energy generation and management, IoT & Smart Grid, energy storage, fuel alternatives, smart cities and electric transportation. Capital nature has invested in more than 18 technologies since its inception, and Avi serves in the board of many of them.Capital Nature was chartered by the State of Israel to operate the Israeli National Renewable Energy Technological Center.
Joining Capital Nature in 2012, Avi brought extensive experience managing and funding programs in the public sector, and vast experience in leadership of entrepreneurship and startup projects.
Previously, Avi was the Founder and Director of the Regional Development Center at the Ministry of Economy and delegate to the OECD LEED Executive Committee. Avi served as Legal Advisor to the Chief Scientist and director at the Governmental Start-Up Fund and the Israeli Industry Center for R&D.
Avi holds a LL.M. from The Hebrew University of Jerusalem and EMPA from Syracuse University, NY.

Dr. Charles Ellinas
E-C Natural Hydrocarbons
Company Ltd (eCNHC), UK

Keynote title:
Energy Transition and its impact on East Med and the wider region

Over 35 years experience in the oil & gas sector in senior management positions. Currently CEO of e-CNHC (E-C Cyprus Natural Hydrocarbons Company Ltd), providing management and advisory services in the oil & gas and energy sectors in Cyprus and the region. A lot needs to be done and the aim of the company is to contribute to the successful development of these sectors for the future of Cyprus.

Prior to this, as CEO of KRETYK I was responsible for implementing Cyprus government's strategy for the development of its hydrocarbons sector.

Until 2012 I was a Director of Mott MacDonald for 25 years and the Managing Director of Mott MacDonald's Oil, Gas & Petrochemicals business world-wide.

Keynote Speakers

Dr. Constantinos Varnavas
Assistant Manager,
Cyprus Transmission
System Operator, Cyprus

Keynote title:
Integration of renewable energies into the electricity market

Dr. Constantinos Varnavas has earned his PhD degree in Mechanical Engineering from the University of Illinois at Urbana-Champaign in 1994.

After his return to Cyprus, he worked for a year at the Frederick Institute of Technology.

In 1995, he was employed by the Electricity Authority of Cyprus where he worked as a power station engineer and as an assistant manager for EAC Generation. In 2013 he was assigned to the Transmission System Operator of Cyprus to work in the project of the re-design of electricity market. In this project, he had a leading role in the drafting and approval of the new Electricity Market Trading and Settlement Rules for Cyprus and the implementation of the transitory arrangements of the electricity market. Dr. Varnavas has recently been assigned to EAC Supply.

His expertise lies in the areas of optimized generation scheduling, demand forecasting, e-RES penetration and electricity markets. Dr. Varnavas has delivered numerous lectures on the Cyprus electricity market and RES participation in the electricity market.

Dr. Diego-César Alarcón-Padilla
CIEMAT-Plataforma Solar de Almeria, Spain

Keynote title:
Solar desalination: A review of the current available technologies and their economic feasibility

Dr. Diego-César Alarcón-Padilla has a PhD from the University of La Laguna and a degree in Physics by the University of Granada.

Since 1994 his research activity is linked to the Plataforma Solar de Almería (Spain), working in different activity areas related with the use of concentrated solar radiation for electricity production.

From 2001, it belongs to the Solar Desalination Unit (from which he is the current responsible), focusing his activity in the research of the use of solar thermal energy in brackish and seawater desalination.

He has participated in several research and development projects, at national and international level. He is co-author of three books and four chapter books, co-author of more than 59 publications in peer-reviewed international journals, 10 publications in technical magazines, and more than 85 contributions to international and national conferences.

He has also participated as teacher in several courses related to water treatment and solar energy. He is the current Operating Agent of IEA SolarPACES Task VI (Solar Energy and Water Processes and Applications).

Keynote Speakers

Mr.Nicos S.Kyriakides
Partner, Head of
Financial Advisory Services
Deloitte Cyprus

Keynote title:
Renewable energy framework in Cyprus and innovative solutions

Mr. Nicos is the Partner in Charge of the Limassol Office and Head of the Financial Advisory Services of Deloitte Cyprus. He has extensive experience of more than 34 years in Audit, Corporate Finance, Business Consulting and International Tax planning.

Nicos has acted as the Audit Engagement and Advisory Partner for a large number of audit clients (private and publicly listed companies), local and international business enterprises, in many industries including Hotels & Leisure, Banking and Insurance, Construction and Real Estate Development, Retailers, Investment & Finance, Shipping and Ship-management and Renewable Energy.

He has led a large number of Consultancy and Financial Advisory projects across different industries relating to Forensic work, Mergers and Acquisitions, Reorganisations of Groups of companies, Capital and Debt Restructurings, Valuations, Business Plans and Feasibility Studies / Financial Projections, Fairness Opinion Reports and Public Offerings and Flotations on Stock Exchanges in Cyprus and abroad.

Nicos has provided financial advisory services to a number of RES Projects in Cyprus and abroad, while he has participated in advisory projects for the determination of the feed-in tariff for Wind Farms, PV Parks and Biomass Plants.

Dr. Roland Roesch
International Renewable Energy Agency (IRENA)

Keynote title:
New pathways for the acceleration of the global transition to a sustainable future based on innovative renewable energy options

Dr. Roland Roesch is Senior Programme Officer - RE Markets and Technology Dialogue at International Renewable Energy Agency (IRENA).

Before Roland became in October 2010 a Professor for Energy Economics he worked for 15 years in the Oil&Gas and Utilities Industry for Shell and E.ON in his last position as General Manager Power at Shell and for E.ON as Head of Division, Project Leader, Project Executiveand Technical Project Developer.

Before he joined E.ON he worked as Energy Market Consultant for Lahmeyer International and as researcher for renewable energies. Roland has solid business experience in energy markets, energy economics and energy strategies, renewable integration management, energy project development and project financing.

He currently leads amongst other the IRENA Renewable Energy Project Development Guideline initiativeknown as IRENA Project Navigator and IRENAswork related to Renewable Energy Technology Innovation.

Keynote Speakers

Dr. Zeger Vroon
Zuyd University of Applied Sciences

Keynote title:
The Netherlands: Building Integrated PhotoVoltaics (BIPV)

Zeger Vroon (1967) studied Chemistry at University of Utrecht.

In 1995 he finished his Ph.D at the University of Twente on the preparation and transport properties of zeolite MFI membranes.

Since 1995 he works at TNO on inorganic and hybrid coatings for solar and nuclear energy.

In 2010 he became lector at Zuyd University on Sustainable Energy in the Built Environment.

He joined the Brightlands Materials Center in 2015. He was active in the EU projects Envision, Co-Pilot, Smart Windows and CATO as senior scientist and WP-leader.

Mr. Yuriy Vlasov
Founder/CEO Greentech
Entrepreneur
Watts Battery Ltd

Keynote title:
The development of Watts Battery

Mr. Vlasov is the CEO of Watts Battery Ltd, a smart and portable energy storage lithium ion power module. He has 10 years experience in corporate finance and spent 2 years in developing the Watts Battery.

He holds a Master of Business Administration (MBA) in international business from Moscow School of Management SKOLKOVO, a degree in corporate finance from Surgut State University and a degree in civil law from Tyumen State University.

Before the development of Watts Battery, Mr. Vlasov developed the ECO project (2005) which related to the utilisation and recycling of used tires and also developed a wooden heating system, Supra Rechard Le Droff, in France (2003-2004).

PROGRAMME

Thursday 1st November 2018
Friday 2nd November 2018

Thursday

08:30-09:00 Registration

09:00-09:30 **Opening Ceremony** **Chair: Mr. Leonidas Paschalides** **Room B108**

Welcome address by the President of the Cyprus Chamber of Commerce and industry, **Mr. Christodoulos Angastiniotis**

Conference scope and objectives by the Conference Chairman, **Prof. Ioannis Michaelides**

Opening address by HE the Minister of Energy, Commerce, Industry and Tourism, **Mr. Yiorgos Lakkotrypis**

09:30-11:00 Plenary session 1 Chair: Prof. G.H.Georghiou - Mr. G.Partasidis Room B108

Dr. Charles Ellinas, E-C Natural Hydrocarbons Company Ltd (eCNHC), UK: Energy Transition and its impact on East Med and the wider region

Dr Andreas Poullikkas, Cyprus Energy Regulatory Authority Chairman, Cyprus: Development of energy strategies for sustainable future

Dr. Zeger Vroon, Zuyd University of Applied Sciences, The Netherlands: Building Integrated PhotoVoltaics (BIPV)

11:00-11:15 Coffee break

11:15-13:00 Session A1: Deloitte Session Chairman: Mr. Nicos Kyriakides Room B108

Renewable energy, innovating for tomorrow

N. Kyriakides	Renewable energy framework in Cyprus and innovative solutions
A. Feldman	Promoting novel technologies in Israel – policy and investments ecosystem
Y. Vlasov	The development of Watts Battery
V. Efthymiou	The EOS 50MW CSP project in Cyprus for 24-hour solar energy
M. Georgiou	Concentrated Solar Power for the Co-generation of Electricity and Desalinated Water: The PROTEAS Experiments
Discussion:	A panel discussion to be moderated by Mr. Nicos Kyriakides will follow with the participation of the above presenters and Dr. Andreas Poullikas.

13:00-14:00 Lunch break

Thursday (Session A)

Session A2 — Chair: Prof.Th. Zachariadis – Prof.G.Karagiorgis — Room B108

Solar systems

Keynote	1828 S.Nizetic	General effectiveness of the passive cooling techniques for siliceous based photovoltaic panels
	1801 A.Demou	Thermal modelling of solar air collectors
	1848 A.Montenon	Theoretical study of a hybrid Fresnel collector to supply electricity and air-conditioning for buildings
	1810 E.Kyriaki	Phase Change Materials to increase storage in solar thermal systems for buildings
	1844 G.Panaras	Building integrated energy solutions for an indoor aquatic center
	1866 K.Dermentzis	Electrochemical Treatment of Olive mill waste powered by Photovoltaic Solar Energy

16:00-16:15 Coffee break

16:15-18:00 Session A3 — Chair: Dr.C.Rouvas - Dr.V.Efthymiou — Room B108

Energy policies in Cyprus

Keynote	C. Varnava	Integration of renewable energies into the electricity market
	C. Taliotis G. Partasides	Cyprus National Draft Plan Reference Scenario – Pathways
	N. Hadjinikolaou	Financing in Energy efficiency in buildings
	Th. Zachariadis	An Energy Efficiency Strategy for Cyprus up to 2030 and 2050
	G. Partasides N. Fylaktos	Indicative Projections based on existing policies and measures for the low carbon development strategy to achieve the EU 2030 Targets

Thursday (Session B)

14:00-16:00 Session B2 Chair: Prof. M.Todorovic- Prof. D.Serghides Room B109

Energy and Buildings 1

1875 D.Serghides	A New Approach in the Refurbishment of the Office buildings – From Nearly Zero Energy buildings to Smart Energy Buildings
1826 T.Bajc	Perception of Indoor Environment Conditions in Non-Residential Buildings: A case study in Greece and Serbia
1827 P.Antoniadou	Interaction of Individual Characteristics on Occupants' Comfort Perception in cases of Office Buildings in Greece and Croatia
1828 M.Kyprianou Dracou	EPBD legislation in practice: Challenges regarding compliance and quality of the works - The Cyprus case study
1808 C.Konstantinidou	Life Cycle and Life Cycle Cost of the use of Phase Change Materials (PCM) in office buildings in the Mediterranean climate of Greece
1871 M.Englezou	Assessment of natural lighting performance of typical in-patient rooms of healthcare facilities in Cyprus
18129 M. Aryblia	Energy Efficiency investments in the tertiary sector - Case studies and lessons from the Trust EPC South H2020 initiative

16:00-16:15 Coffee break

16:15-18:00 Session B3 Chair: Prof.K.Papakostas - Mr. C.Maxoulis Room B109

Energy and Buildings 2

18137 G.Kahwaji	Life Cycle Energy, Environmental Impact, and Cost Analysis of Eight Conventional/ Hybrid 1Cooling Systems in the United Arab Emirates
1845 A.Efstathiades	Managing Household Electricity Consumption; a Factor Analysis Study
1809 E.Giama	Energy and Environmental Performance of Airports' Operation
18111 G.Mouzeviris	Comparative analysis of air-to-water heat pumps performances – seasonal per formance for heating of domestic heat pumps in the Greek climate
1869 A. Michael	Thermal Performance and Environmental Impact of an Innovative Exterior Wall System
18117 N. Antoniou	CFD Simulations and on-site measurements of urban microclimate in a real compact urban area
1864 I.Mitropoulos	The first CasaClima House in Greece, at the island of Aegina, Attica

Thursday (Session C)

14:00-16:00 Session C2 Chair: Mr. A. Ktoris- Dr. S.Petrakides Session Open to the Public Room 010

Marine Renewable Energy Potentials, Challenges & Future Trends

A.Ktoris	Welcome Speech & Introduction of PELAGOS EU Project
T.Soukissian	Offshore Wind Energy
J.P.Kofoed	Wave Energy
P.Polycarpou	Algae to Biofuel
D.R. Hayes	Expected and actual ocean current conditions in Cyprus
X.T. Schneider	Applying Responsible Research and Innovation in Wave Energy –Lessons Learned and Best Practices

16:00-16:15 Coffee break

16:15-18:00 Session C2 (continued) Networking Session Open to the Public Room 010

B2B event	Pitching from Cypriot PELAGOS Hub Organizations

Friday

09:15-10:45 Plenary session 2 Chair: Mr. A.Ioannou - Dr. N.Fylaktos Room B108

Prof. Dr. Roland Roesch, International Renewable Energy Agency (IRENA): New pathways for the acceleration of the global transition to a sustainable future based on innovative renewable energy options

Dr Diego-Cesar Alarcon-Padilla, CIEMAT-Plataforma Solar de Almeria, Spain: Solar desalination: A review of the current available technologies and their economic feasibility

Prof. Agis Papadopoulos, Aristotle University of Thessaloniki, Greece: Thermal comfort in Zero Energy Buildings: State of the art and prospects

10:45-11:30 Coffee break - Poster tour and presentation

Friday (Session A)

11:30-13:15 Session A2 — **Chair: Mr. P.Keliris - Prof. C.Christodoulou** — **Room B108**

Biomass & Biofuels

Keynote	18141 S.Werle	Preliminary investigation on the solar pyrolysis of waste biomass: the reactor concept
	1895 M. Koutinas	Pilot evaluation of a novel anaerobic fermentation process for the production of digestate with low ammonia content
	1812 E.Dolmaci	Energy and Environmental Assessment of Pellets produced from solid residues of the winery Industry
	1890 C.Chasos	Combustion simulations of different hydrocarbon content natural gas in constant volume chamber and direct-injection spark-ignition internal combustion engine
	1839 S.Petrakides	On the Combustion of Premixed Gasoline - Natural Gas Dual Fuel Blends in an Optical SI engine
	1807 C. Christodoulou	Metal Hydride Compressor (MHC) for Hydrogen Compression to Pressure of more than 300bar

13:15-14:00 Lunch break

14:00-15:00 **Meet the Editors** — Prof. A.M.Papadopoulos, Prof.J.Milewski and Prof. S.Nizetic
The main idea of the "Meet the Editor" workshop is to help young and less experienced researchers and PhD students to be able to prepare quality submissions. Issues will be addressed related to how to write high quality papers with an impact, how to avoid usual mistakes during the paper preparation process, and how to respect the ethics in the publishing world.

15:00-16:45 Session A3 — **Chair: Prof. N.Christofides - Prof. M.Neofytou** — **Room B108**

RES Systems

Keynote	1820 J.Milewski	Mechanical strength of fibers reinforced matrices of Molten Carbonate Fuel Cell
	1897 R.Chumbinho	The role of test facilities in the development of Marine Renewable Energy – Smartbay as an example
	1821 K.Gkarakis	Performance analysis of an operating windfarm of 21MW in Greece for a period of three years
	1834 M.Chrysostomou	Cooling methods for energy efficient micro-datacentres: A comparative study
	1863 C.Yianni	Economic Viability of Battery Energy Storage for the Provision of Frequency Regulation Service
	18120 A.Arsalis	Thermoeconomic modeling of a small-scale photovoltaic-solid oxide fuel cell system for commercial applications
	1886 Z.Ali	The Role and Necessity of PLL and Current Controllers in GSC of Distributed RE Systems

16:45-17:15 Closing ceremony — Prof. I.Michaelides — Room B108

Friday (Session B)

11:30-13:15 Session B2 **Chair: Prof. Th.Tsoutsos - Ms. M.Stylianou-Michaelidou** **Room B109**

Sustainable mobility

18128 C. Mantero	Overcoming energy efficiency challenges for sustainable mobility in Madeira
18131 M. Stylianou Michaelidou	Fast tourist development and need for sustainable mobility measures. The Limassol story
18126 S.Tournaki	Environmental evaluation of mobility measures - Experience from the H2020 CIVITAS DESTINATIONS project
18127 M.Giamalaki	From Used Cooking Oil to biodiesel. Full Supply Chain demonstration
18149 E. Giannakis	Land Transport and CO2 Emissions in Cyprus: Smart Decarbonisation Strategies for Climate Change Mitigation
Round table discussion	· The future of e-mobility in the European touristic areas
	· Synergies between the local mobility and tourism sectors for new tailored services
	· Challenges – Opportunities of transport decarbonisation. Drivers-Barriers for island stakeholders
	·Existing knowhow to meet the national/EU/international targets

13:15-14:00 Lunch break

15:00-16:45 Session B3 **Chair: Dr. M.Syrimis - Prof. E.Kyriakides** **Room B109**

Grids

18143 A.Kotsonias	Conventional Weighted Least Squares State Estimation for Monitoring Low Voltage Distribution Grids
1854 C. Charalambides	Promoting Effective Generation and Sustainable Uses of electricity (PEGASUS) – The case of the FOSS lab area nanogrid
1847 K.G. Stokos	Architecture and Implementation of the Control System at PROTEAS
1884 K.Oureilidis	Demonstration Tools for Trading Flexibility in Distribution Grids in Cyprus - The Cases of A Microgrid and Dispersed Prosumers
18145 J.Kupecki	Strategies for operating solid oxide electrolyzers as a part of grid balancing systems in reference markets
1851 V.Venizelou	Pilot Implementation of Time-of-Use tariffs: Results and Lessons Learned

16:45-17:15 Closing ceremony Prof. I.Michaelides Room B108

Friday (Session C)

11:30-13:15 Session C2 — Chair: Prof. J.Milewski - Dr. E.Giama — Room 010

Energy policies

1835 H.Doukas	Fostering innovative energy policy making through integrated approaches
1849 C.Stambolis	Renewable Energy Sources in SE Europe: Challenges and Lessons to be Learned
1850 I.Kyprianou	An Overview of Energy Poverty - Policies and Measures in Cyprus
1861 A.Orlov	Classification of EU countries in terms of energy efficiency indicators
1881 M.Syrimis	Cyprus System of Guarantees of Origin
18123 C. Sotiriou	Evaluation of the cost–effectiveness of climate change mitigation measures in Cyprus

13:15-14:00 Lunch break

15:00-16:45 Session C3 — Chair: Prof. A.Bonanos - Prof. P.Fokaides — Room 010

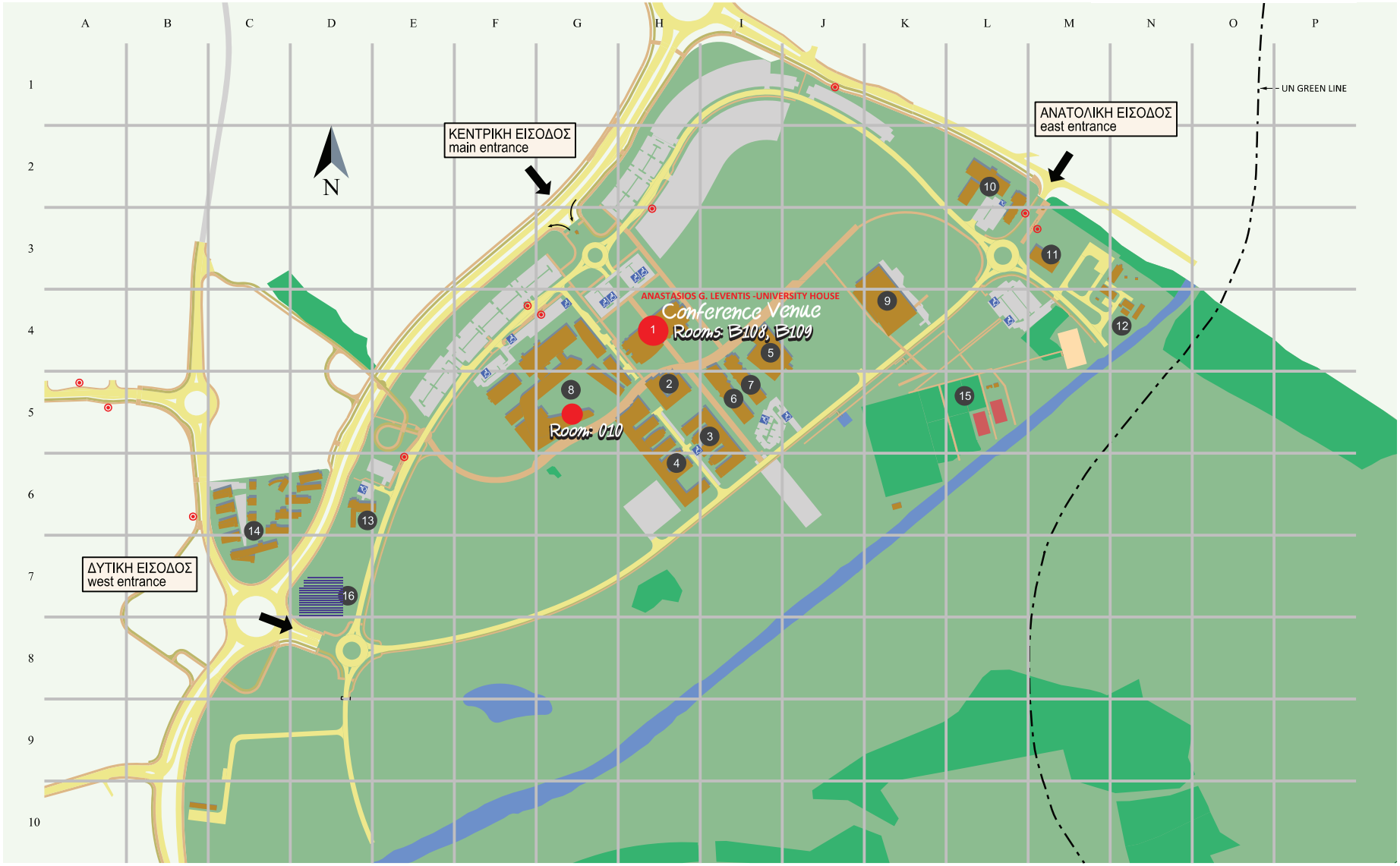
Research activities of Cyprus Institutions

M. Dikaiakos	Energy Saving in Public Academic Buildings with Data Centers (ENEDI)
T. Kouros	ENERFUND - An ENERgy Retrofit FUNDing rating tool
G.Georghiou	Stimulating scientific excellence through twinning in the quest for sustainable energy (TwinPV)
M.Achilleos	Transferring Energy Efficiency in Mediterranean Schools (TEESCHOOLS)
G.Kirkos	Networking for Excellence in Solar Thermal Energy Research (NESTER)
A.Charalambous	Enterprise Level GHG Reduction Initiative, Business4Climate

16:45-17:15 Closing ceremony Prof. I.Michaelides — Room B108

UNIVERSITY CAMPUS (ATHALASSA)

Πανεπιστήμιο Κύπρου
University of Cyprus



Conference Venue

① ANASTASIOS G. LEVENTIS -UNIVERSITY HOUSE (ADM01)
② COMMON TEACHING 01 (CTF01)
③ FACULTY OF PURE AND APPLIED SCIENCES (FST01)
DEPARTMENT OF MATHEMATICS & STATISTICS
DEPARTMENT OF COMPUTER SCIENCE
④ FACULTY OF PURE AND APPLIED SCIENCES (FST02)
DEPARTMENT OF PHYSICS
DEPARTMENT OF CHEMISTRY
DEPARTMENT OF BIOLOGICAL SCIENCES
⑤ COMMON TEACHING 02 (CTF02)
CENTRE OF TEACHING & LEARNING (KE.DI.MA)
⑥ FACULTY OF ECONOMICS AND MANAGEMENT (FEB01)
DEPARTMENT OF BUSINESS & PUBLIC ADMINISTRATION
DEPARTMENT OF ACCOUNTING & FINANCE
DEPARTMENT OF SOCIAL & POLITICAL SCIENCES
MBA
⑦ FACULTY OF ECONOMICS AND MANAGEMENT (FEB02)
DEPARTMENT OF ECONOMICS
ECONOMICS RESEARCH CENTRE
CENTRE OF BANKING & FINANCIAL RESEARCH
DEPARTMENT OF LAW
DEPARTMENT OF FRENCH STUDIES & MODERN LANGUAGES
MEDICAL SCHOOL
⑧ SOCIAL FACILITIES (SFC)
RETAIL CENTRE / CATERING FACILITIES
MEDICAL CENTRE
STUDENTS CENTRE / CLUB HOUSE
RADIO STATION / KINDERGARTEN / NURSERY
AULA THERNANTES INSTITUTE / KONFOUKIOS INSTITUTE / KIOS
⑨ INDOOR SPORTS HALL (SPF01)
⑩ SERVICES BUILDINGS (SBD)
⑪ ENERGY CENTRE (ENC)
⑫ PHOTOVOLTAIC RESEARCH LAB
⑬ CAMPUS SUPPLEMENTARY OFFICES (CDO)
⑭ RESIDENTIAL A (SRA01-14)
⑮ OUTDOOR SPORTS ACTIVITIES (SPF02,03,08-15,20)
⑯ PHOTOVOLTAIC PARK "PHAETHON" (PVP01)

CAMPUS
ROAD NETWORK
PEDESTRIAN / CYCLEWAY NETWORK
UNIVERSITY BUILDINGS
GREEN AREAS / SPORT FIELDS
PARKING
RIVER / LAKE

BUS STOP
DISABLE PARKING

0 50 100 200 m

BOOK of ABSTRACTS

(in ascending order)

Thermal modelling of solar air collectors

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KEYWORDS – solar thermal systems, solar air collector, Trombe wall, natural convection, direct numerical simulations, seasonal energy yield.

ABSTRACT

A solar air collector (SAC) is a direct gain passive solar system that can contribute to the heating of any building with a solar-facing wall. In its simplest form, a SAC consists of an air circulation channel formed between a solar-absorbing surface and a glass placed at some distance. An upper and a lower vent through the wall forms the inlet and the outlet of the room to be heated. A large portion of the solar radiation passing through the glass is absorbed by the absorbing surface raising its temperature. As the air in the cavity heats up, it rises due to buoyancy through the cavity delivering hot air to the room by natural convective heat transfer. Even though the technology incorporated in such systems is rather simple, the description of the thermal behavior of the system is challenging when all heat transfer mechanisms (conduction, convection and radiation) are taken under consideration.

In the present attempt to study a typical SAC, a segmental approach is attempted by first isolating the fluid part of the system to study the convective heat transfer before taking into account the conductive and radiative modes of heat transfer. More specifically, a series of high-resolution 3D direct numerical simulations is first performed to visualise the flow and correlate the heat flux convected by the air to the temperature of the heated surface of the system. The calculated correlation is then introduced into a 1D model that takes into account the effects of local meteorological conditions, materials used and system orientation to calculate all the associated heat flux components of the system. This simplified 1D model can be used to calculate the long-term system efficiency and the total energy yield over a whole heating season. Additionally, it can be used to assess the effects of wall thickness, solar-absorbing surface material and other parameters on the system performance. The results reveal that the efficiency of the collector is more sensitive to the material of the solar-absorbing surface than any other parameter examined. Moreover, although in cold climates the daily efficiency of the system is lower, because of the extended heating season, the seasonal energy yield of the system is comparable to hotter climates.

Life Cycle and Life Cycle Cost of the use of Phase Change Materials (PCM) in office buildings in the Mediterranean climate of Greece

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KEYWORDS – building envelope, PCM, environmental impact, LCA, LCCA

ABSTRACT

The building sector has a considerable environmental impact, being responsible for about 40% of the world's energy consumption, 30% of raw material use, 25% of solid waste, 25% of water use, 12% of land use, and 33% of the related global greenhouse gas (GHG) emissions. Specifically in Europe, non-residential buildings comprise a quarter of the EU building stock and cause approximately one third of this stock's energy consumption, while office buildings are among the most crucial contributors to demand growth. The building envelope presents an opportunity to significantly reduce the building energy demand, while improving its environmental impact through its life-cycle. This can be achieved by the materials used in its construction, with key parameters the thermal protection of the building envelope and the heat capacity of the enclosing components. This study examines the use of latent heat storage with PCMs in the building envelope which provides a potential for better indoor thermal comfort for occupants, as well as for overall lower energy consumption. In several studies, PCMs have been incorporated into building envelopes to enhance indoor thermal comfort and energy performance reporting the positive impact of PCMs on the building annual cooling and heating loads in various climate zones. Furthermore, results of past works have demonstrated a positive environmental impact from the incorporation of PCM in buildings.

The present work evaluates the environmental impact of including phase change materials (PCM) in a typical office building unit in Greece. The performance of an office building integrated with PCM based on environmental and economic performance criteria by using a Life Cycle Analysis (LCA) and a Life Cycle Cost Analysis (LCCA) is evaluated, respectively. Specifically, a Life Cycle Assessment is initially developed for an office building unit in Athens, Greece, while a Life Cycle Cost evaluation is performed to estimate the pay-back period of such PCM applications and assess their viability. The basic aim of this work is to examine whether the reduction of the environmental impact achieved during the operational phase due to the energy savings compensates for the increase in environmental impact that is induced during the manufacturing phase of PCM.

Energy and Environmental Performance of Airports' Operation

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KEYWORDS – airports, green certification schemes, energy optimization potential

ABSTRACT

Airports are typically purpose-dedicated assets of infrastructure, which serve the arrival, departure and movement of aircrafts, of their passengers as well as the respective cargo. They include buildings, run- and taxiways, handling facilities, installations and equipment to serve the overall variety of tasks required by contemporary logistics services, but also quite extensive retail and leisure services. In that sense, they have to satisfy commercial as well as entrainment services for passengers and visitors. For these reasons airports, especially big ones, show an enormous demand for energy. Except for the energy needed for transportation the energy demand can be split into electricity, space cooling and heating, steam and hot water provision.

Given these high energy requirements, but also their quite significant variation on a daily and seasonal basis, depending especially on the local climatic conditions, energy conservation measures as well as the implementation of renewables and state of the art energy management can contribute to reducing the energy demand. This can be achieved by increasing energy efficiency and by utilizing renewable energy sources. Furthermore, and in parallel with the need to reduce the energy demand, there are the important goals of optimizing the overall environmental performance, of lowering operational cost and of improving the level of services provided to passengers.

In this line of approach, this paper aims at identifying the optimization potential for the energy supply of those complex systems, both with respect to the economics and the environment. The successful operation of this optimization approach will be demonstrated in the example of a Greek regional airport. Moreover, within the paper green certification schemes and practices implemented to airports in Europe will be identify and register.

Phase Change Materials to increase storage in solar thermal systems for buildings

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KEYWORDS – thermal energy storage, central solar thermal systems, solar space heating, Phase Change Materials

ABSTRACT

Thermal energy storage, is a key issue for the use of centralized solar thermal systems in buildings. It has therefore been in the focus of research over the past few decades, as it is an important technology in order to solve the problem of temporal deviation between the availability of solar energy and the utilization of the heat generated. Thermal storage is crucial in order to bridge this gap, especially in regions where prolongued periods of reduced sunshine are common. Traditionally thermal storage is achieved by using water, which has been proven to be practical and cost effective, especially when fairly small storage capacities are required. There are however limits, mainly due to space limitations and increasing losses, as soon as bigger volumina are needed to extend the storage period.

The use of Phase Change Materials (PCMs), is an upcoming, promising technology, which has drawn the scientific's community attention for quite some years now. The main idea is to substitute water as a storage medium, with PCMs, which have larger specific energy storage capacity compared to other materials. The objective of this paper, is to present the state of the art of PCMs that can be used for low temperature Renewable Energy Sources applications and more specifically solar thermal applications and to discuss the advantages they present (a) for improving the solar fraction of the installation and (b) for reducing the space needed to achieve the same solar fraction and hence make the systems more versatile. Moreover, barriers and obstacles of the storage technologies described will be discussed, enabling a well-balanced evaluation of their suitability and feasibility.

Mechanical strength of fibers reinforced matrices of Molten Carbonate Fuel Cell

Jarosław Milewski[a], Tomasz Wejrzanowski[b], Kuan-Zong Fung[c], Łukasz Szabłowski[a], Robert Baron[b], Jhih-Yu Tang[c], Arkadiusz Szczęśniak[a], Chung-Ta Ni[c]

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Fuel cells operating at elevated temperatures are suitable for medium and large scale applications, thus they have good prospects for commercialization. Molten Carbonate Fuel Cells (MCFCs) appear among the most promising in this respect. MCFC has a number of advantages over other high temperature fuel cells: (i) high energy efficiency and high electromotive force, (ii) nickel instead of platinium as a catalyst, (iii) electrolyte thickness of about 1 mm is much more easier to manufacture, (iv) it can be used as a CO2 separator due to its ability to capture carbon dioxide from the cathode side.

A key component in the molten carbonate fuel cell (MCFC) is electrolyte matrix, which provides both ionic conduction and gas sealing. During the starting-up and operating of MCFC stacks at 650C, the matrix can experience mechanical stresses that can cause cracking. The aim of this work is to investigate the effects of adding fibers in the matrix slurry to enhance the mechanical strength. In this paper, we employed fibers as reinforcement materials to increase the mechanical strength of the α-LiAlO2 matrix.

Performance analysis of an operating windfarm of 21MW in Greece for a period of three years

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KEYWORDS - power performance, SCADA, windfarm, pre and post-construction energy production, losses

ABSTRACT

Nowadays, wind power is the fastest growing source of energy all around the world. This poses an urgent need of understanding how wind turbines perform from different perspectives. Even though condition monitoring systems have a huge impact in optimizing wind farms performance via fault anticipation, it does omit several aspects concerning performance. Seemingly, there is a scarcity of studies which attempted to deliver a quick and practical method for wind farm performance analysis which is the aim of this paper.

This paper presents a methodology to evaluate the performance of operating wind farms via the use of Supervisory Control and Data Acquisition System (SCADA) and modeled data. The potential annual energy is calculated per individual turbine considering underperforming/loss events to have their power output in accordance with a representative derived operational power curve. Losses/underperformance events are calculated and categorized into several groups aiming at identifying and quantify their causes.

The methodology requires both anemometry data from SCADA system, onsite meteorological mast, a lidar in combination with the mast as well as modeled data. The discrepancy of the data representing the valid points of the power curve is taken into consideration as well when assessing the performance, i.e. wind speed vs power output of events that are not loss/underperformance. Production loss and relative standard deviation of power/energy output are the main results obtained in this paper. Finally, a number of optimization measures are suggested in order to enhance the performance, which can lead to a boost in the financial output of a wind farm.

Aiming at judging the reliability of the proposed methodology, a case study is conducted and evaluated. The investigated case study is a windfarm with nominal capacity of 21MW in mountain Kitheronas in Viotia county, Greece which operates since November of 2014. This case study shows that the methodology is capable of determining potential energy and associated losses/underperformance events. Several questions were raised during the assessment and are discussed in this work, recommendation for optimization measures are presented at the end of the paper. Also, a discussion on the limitations and uncertainties associated to the presented methodology and the case study.

EPBD legislation in practice: Challenges regarding compliance and quality of the works - The Cyprus case study

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KEYWORDS - Reliability, Energy Performance Certificate, Quality, Works, Compliance, Frameworks.

ABSTRACT

In Europe, over 40% of the final energy use occurs in buildings, making the "building sector" the largest end-use energy consumer. The energy consumed within European buildings averages to 220 kWh/m2 per year. European Directives continuously urge towards an important change regarding the energy performance of the building sector. Europe 2020 strategy adopted by the European Commission stipulates three targets to be met by the year 2020, making the need for all new buildings to be nearly zero-energy by 2020.

The challenges to implement Nearly Zero-Energy Buildings (NZEB) and achieving minimum shares of renewable energy are tremendous. Member States are implementing the various building energy related directives and paving the way towards NZEB. However, there are various indications raising concerns, that the claimed energy performance can be different from reality, which may jeopardise the reliability of and the trust in the Energy Performance Certificate (EPC) declarations and might in parallel influence the delivered quality of the works.

This paper presents and analyses the aforementioned concerns, as well as evidence regarding the energy performance of buildings in reality ("on the ground") in Cyprus, and identifies issues in respect to existing procedures. The aim is to obtain a better understanding of the real situation regarding compliance and quality of the works influencing the energy efficiency of buildings and to identify bottlenecks, by obtaining better, well documented and structured information of the realised buildings in terms of EPC input data and quality of the works. This in turn will improve and / or support attention paid to compliance and quality procedures.

Perception of Indoor Environment Conditions in Non-Residential Buildings: A case study in Greece and Serbia

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KEYWORDS – Indoor environment, non-residential buildings, occupants' perception, Mediterranean climate, Balkan region.

ABSTRACT

Building sector is responsible for almost 40% of the primary energy consumed in Europe, with the non-residential sector characterized as a main consumer with office and educational buildings being the most populous. As determined by the existing institutional framework, the attainment of high indoor environmental conditions, is vital for the sustainability of the buildings and its users. As stated by international standards, indoor environment conditions can affect the well-being and productivity of its users and therefore, proper care should be given.

In this line of approach, a numerical evaluation of indoor environment quality is carried out in an office and an educational building in Thessaloniki, Greece, and Belgrade, Serbia, respectively. Those cities are chosen as their climate conditions are representative of the Mediterranean climate in the Balkan Region. In order to carry out the indoor environment evaluation, a series of indoor condition sensors were installed and measurements were carried out during winter and summer period. Apart from the indoor climate sensors, a meteorological station was set up in the area for monitoring the microclimate conditions. In parallel to the measurements, a revealed preference survey was conducted, aiming to demonstrate the occupants' perception of indoor conditions.

Concluding, the results collected by this study constitute a description of the monitored and perceived indoor environmental quality of typical examples for public buildings in the Balkan region, denoting the approach of the users in each case. They are therefore valuable, as they can be used both to assess and improve the prevailing conditions of the existing building stock in every country and to demonstrate possible similarities among neighboring countries.

Interaction of Individual Characteristics on Occupants' Comfort Perception in cases of Office Buildings in Greece and Croatia

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KEYWORDS – comfort perception, individual characteristics, office buildings, Mediterranean climate.

ABSTRACT

Legislative frameworks, both national and international ones, outline the need for creating and preserving high levels of comfort for the indoor environment. The attainment of such goal is imperative for both the occupants' well-being and productivity. Both factors constitute vital parameters for the decision-making process and can influence the policy makers along with the designers for the creation and renovation of a building. Furthermore, the need of extensive evaluation is noted in cases of office buildings; they not only constitute the numerically second most important category of the nonresidential sector, but it is in those buildings where users spend most of their overall time (60-90%).

In this line of approach, an integrated evaluation and determination of the personalized parameters that can affect the occupants' perception of comfort is essential and is carried out in this study. In detail, office buildings located in Thessaloniki, Greece, and Split, Croatia, were evaluated. Both cities are located in coastal areas of the Mediterranean region, with their climate denoting similarities with a series of other Mediterranean cities. In order to pursue the goal of the study, a revealed preference survey was conducted and an inferential statistical analysis was performed in the office buildings evaluated, aiming at the determination of statistical important correlations among the occupants' perception of comfort and their personalized and social parameters.

Concluding, the results of the study constitute an initial indicator of the indirect measured personalized parameters that affect the occupants' comfort, creating the perception of either a pleasant or not indoor work environment conditions. Therefore, valuable results can lead to the set of boundary conditions in the renovation scheme of the buildings in the years to come.

General effectiveness of the passive cooling techniques for siliceous based photovoltaic panels

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KEYWORDS – photovoltaics, passive cooling, efficiency, renewable energy.

ABSTRACT

Siliceous based photovoltaic (PV) technologies are currently the most present on the marked with average energy conversion efficiency ranged from about 12% to 17%. Besides the relatively high overall investment as well as modest increase in efficiency, one of the important problems related to the Si-based PV technologies is its performance degradation caused by elevated PV panel operating temperatures. Thus, in the recent years different cooling strategies have been developed in order to reduce performance drop, i.e. to ensure improvement of the photovoltaic energy conversion efficiency. According to the latest research findings the important benefit of the cooling techniques for PVs is also an increase in the PV panel. This paper will provide an overview and in general analysis of the passive cooling strategies for PVs with respect to the performance increase, i.e. effectiveness. General economic aspect of the passive cooling techniques will be also addressed and discussed with respect to the most viable passive cooling options from the practice point of the view.

Cooling methods for energy efficient micro-datacentres: A comparative study

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KEYWORDS – Micro-Datacentre, Energy, Efficiency, Thermoelectric, (4-8 keywords).

ABSTRACT

The digital era of the last decade led to the rapid growth of the Information and Communications Technology (ICT) industry. A study from National Berkley Laboratory in USA, showed that datacenters consume about 2% of the electricity in USA; similar studies show the same trend in Europe. Cloud computing has led individual small datacenter owners to go towards Micro-datacenters. Similarly, telecom systems tend to become smaller and denser. Considering that 20-50% of the energy consumption in current ICT racks is for cooling, it is important to identify efficient methods for micro scale datacenter (one rack) cooling.

Despite the specified high energy efficiency ratios (EERs) of air-conditioning units, it is very unlikely that in actual operation these are met. Free cooling has been suggested as a way to minimize the energy consumption, although, it cannot be the only solution especially in high temperature climatic conditions such those in South Europe. Despite the theoretical low efficiency of thermoelectric cooling, if combined with free cooling in a hybrid configuration, could perhaps be the solution to the problem.

The study theoretically and experimentally analyzes the cooling consumption of one ICT rack equipment (with actual loads) in the climatic conditions of Cyprus. Through this case study, energy efficient cooling solutions will be examined and proposed for South Europe and other warm climate countries.

Fostering innovative energy policy making through integrated approaches

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KEYWORDS - Energy Policy, Energy Efficiency, Uncertainty, Integrated Assessment, Decision Support Systems, Stakeholder Engagement.

ABSTRACT

Game changing transitions in the energy sector are dictated by a number of factors, including directions towards sustainable development, issues concerning security of energy supply and emergence of new technologies. Most importantly, being the key source of anthropogenic emissions, the power sector lies at the forefront of policy frameworks oriented on tackling climatic change, which features different types of uncertainties. Furthermore, these technological transitions must be driven by institutional and socioeconomic transitions represented by stakeholders, who should consequently be part of policy making. As a multi-dimensional domain, energy policy must therefore be underpinned by authoritative scientific processes. There exist a multitude of such processes and frameworks for supporting energy-related planning and policy making, ranging from energy system and integrated assessment modelling to operational research and decision support methodologies. These, however, are used across different lines, with different modelling and inclusive capacity and at different geographic or sectorial scales.

The aim of this paper is, therefore, to present modern combinatory approaches, where integration does not refer only to the use of knowledge across different domains into frameworks but also to combinations of a multitude of such frameworks and tools. The purpose of these approaches is to support decisions in energy policy design, in a robust, inclusive and transparent manner, which enhances the legitimacy of the employed frameworks and thus policymakers' trust into their results. We showcase examples of integrated approaches where energy system and climate-economy modelling frameworks are complemented by other decision support tools focusing on stakeholder engagement as well as uncertainty and risk assessment. These tools range from multicriteria decision analysis, portfolio theory and minimax regret programming to fuzzy cognitive mapping, scenario analysis and stochastic uncertainty simulations. These approaches are implemented in a number of case studies of different scope and horizon, from near-term national energy efficiency action plans to regional long-term electricity planning and global technological investments in the power sector.

On the Combustion of Premixed Gasoline - Natural Gas Dual Fuel Blends in an Optical SI engine

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Environmental impact of greenhouse gas emissions, as well as future air quality, are forcing governmental bodies to continuously update their legislations, adopting challenging emission standards. In the transportation sector, the necessity for compliance with future emission legislations has renewed the interest for the use of alternative fuels. The low carbon content and the abundance reserves, have classified Natural Gas (NG) as one of the most promising alternative transport fuels. The major constituent of NG is methane. Historically, the slow burning velocity of NG poses significant challenges for its utilization in energy efficient combustion applications. A slow burning velocity degrades the thermal efficiency of an internal combustion engine and it is a contributor for hydrocarbon emissions. It is well acknowledged that the impact of methane hydrocarbon emissions on the greenhouse effect is considerably higher than the impact of CO_2.

Generally, for Spark Ignited (SI) engine combustion, the fundamental unstretched laminar burning velocity (S_u^0) of the fuel-oxidizer mixture has been used as a major performance criterion. However, in an SI engine environment, the flame is actually continuously stretched by its curved nature and its propagation through a strained turbulent flow field. Another fundamental mixture parameter known as the Markstein length (L_b), which quantifies the response of the flame velocity to stretch, is critically essential to completely characterize the development of an expanding flame in an SI engine.

Optical diagnosis has been integrated with in-cylinder pressure analysis to investigate the mechanism of flame velocity and stability with the addition of NG to gasoline in a Dual Fuel (DF) blend. Experiments are performed in an SI engine under a sweep of engine load (MAP = 0.44, 0.51. 0.61 Bar), speed (1250, 2000, 2750 RPM) and equivalence ratio (Φ = 0.8, 0.83, 1, 1.25). NG was added to gasoline in three different energy ratios 25%, 50% and 75%. It has been found that the effect of Markstein length is dominating the lean burn (Φ<1) combustion process both from a stability and velocity prospective. The effect of the laminar burning velocity on the combustion process gradually increases as the air fuel ratio shifts from stoichiometric to fuel rich values. It has been concluded that a comprehensive understanding of the two fundamental mixture parameters S_u^0 and L_b is essential for the development of future energy efficient combustion applications.

MAP: Manifold Absolute Pressure

RPM: Revolutions Per Minute

Building integrated energy solutions for an indoor aquatic center

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KEYWORDS - Building Integrated Solar Thermal Systems (BISTS), Hybrid Photovoltaic/Thermal (PV/T) solar systems, Aquatic Center, Energy Analysis, Water Heating, Phase Change Materials

ABSTRACT

Sports centers constitute buildings of special interest as regards the achievement of thermal comfort conditions and acceptable indoor air quality throughout reasonable energy consumption. Indoor swimming pools have the highest energy consumption amongst sports centers and outdoor pools; this can be attributed to the high latent load related with the evaporation rate of the swimming pool, as well as the respective heating energy demand of the swimming pool water. In the relevant literature, the issue of energy effective indoor swimming facilities has been studied. Provided that dehumidification should be implemented, there are works studying the design and implementation of a suitable heat pump system, for covering the heating and dehumidification needs.

In the proposed work, the energy analysis of a specific indoor aquatic center located in Northern Greece is performed. According to the inspection performed at the center, the indoor climate is characterized by the presence of high relative humidity values, mainly related to the absence of a ventilation and dehumidification system, the envelope is characterized by insufficient behavior in terms of thermal insulation, while, despite the effective operation of the district heating system by winter time, significant conventional fuel consumption for water heating in summer months is reported. Within this context, special emphasis is placed on the integration of different technologies on the envelope for covering the respective water heating energy needs (swimming pool water and hot water use). The discussed technologies/interventions mainly refer to Building Integrated Solar Thermal Systems (BISTS), namely Hybrid Photovoltaic/Thermal (PV/T) solar systems, while the potential use of Phase Change Materials (PCM) is also discussed.

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Managing Household Electricity Consumption; a Factor Analysis Study

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KEYWORDS – Energy Management, Energy Efficiency, Electricity Consumption, Household Management.

ABSTRACT

Household electricity consumption is an important part in the overall energy consumption. The continuing increase in global energy needs and consequently the gases emitted from the use of fossil fuels lead to severe environmental problems. One important way to deal with this problem is to find effective energy-saving methods for households. In order to achieve this, we must first point out the factors that contribute to the consumption of electricity in the residential sector but also determine the extent to which each factor contributes. This paper focuses on the study and analysis of factors such as the use of electricity by the tenants / owners, their demographic characteristics and technical characteristics. In-depth analysis of each factor is carried out and its correlation with the total electricity consumption. The factor analysis is based on data collected via a representative sample of approximately 100 households in Cyprus.

Architecture and Implementation of the Control System at PROTEAS

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KEYWORDS – Control System, PROTEAS, Architecture, CSP.

ABSTRACT

The present work describes the architecture and implementation of the Control System (CS) at the Platform for Research, Observation and TEchnological Applications in Solar energy (PROTEAS) of The Cyprus Institute, giving emphasis to the special characteristics of the Concentrated Solar Power plant (CSP). The CS architecture has been designed taking into consideration all developmental and operational needs for a modern and robust system, suitable for an experimental facility. It is based on a decentralized and distributed approach which provides the flexibility to the developers to modify and extend the system by adding new subcomponents without disturbing its functionality.

The tools used for the implementation of the architecture to an operational CS have been also selected with the criterion to permit to the CS the necessary flexibility. The CS has been realized with the commercially available MAQ-20 system of DATAFORTH. MAQ-20 industrial data acquisition and control system is appropriate for a CSP environment, it interfaces directly to industrial sensors and transducers and communication is achieved via Modbus TCP protocol. The existing system currently comprises 9 MAQ-20 stations with 84 active units totally tracking and controlling more than 420 parameters. The slow control nature that characterizes all crucial processes of the facility permits periodic handling of the signals in the order of several milliseconds, preventing in this way the need of complicated real time loops. The user graphical interface has been developed with the LabVIEW environment. This software tool is suitable for experimental research, with various tools for data acquisition, signal processing, data analysis and visualization. Five basic Virtual Instruments (VIs) have been employed in order to supervise and control the functionality of all subsystems. In the full paper details will be given in the most basic control and monitoring processes which are: a. the speed control of the molten salt pump and the tracking of the parameters during a routine molten salt circulation experiment, b. the Heliostats Control System (HCS) and its interface to the main CS, c. the temperature control and heat losses indirect measurement in the storage tank and the ISTORE (Integrated STOrage REceiver) receiver and d. the heat tracing control procedure.

The CS monitors and controls all operations and experiments sufficiently till now; some interlocks and alarms have been implemented as part of the personnel and machine protection system; more elaborate plans have been designed to this direction and they are currently being developed.

Theoretical study of a hybrid Fresnel collector to supply electricity and air-conditioning for buildings

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KEYWORDS – Solar concentration, photovoltaics, cogeneration, air-conditioning, building integration.

ABSTRACT

Thermal comfort needs in buildings have been increasing during the previous years and especially in Mediterranean countries like Cyprus. They represent a growing share of the electricity demand at national level. Electric heat-pumps supply both cooling and heating according to the season. However fossil fuels are prominent in the Cypriot national energy mix. Air-conditioning therefore relies on the use of fossil fuels that are in fine responsible of gas emissions. The Cyprus Institute (CyI) dedicates part of its research on innovating systems able to respond to the need of communities like energy peninsulas or islands. In July 2016, CyI completed the integration of a Fresnel collector on a roof in the outskirts of Nicosia. Since then, it supplies part of the cooling demand with the help of an absorption chiller and the heating demand for the Novel Technologies Laboratory (NTL). Air-conditioning is directly supplied thanks to the local solar resource with minor electric consumption. The primary reflector constituted of 288 mirrors tracks the sun rays in order to concentrate them onto the absorber, which collects the heat for further use. The actual collector is a pilot plant and the first of its kind in the island. Although light Fresnel systems can be integrated on wide rooves, like other concentration technologies they suffer from the huge capital costs and are not competitive in regards to electric heat-pumps. Also, heating and cooling is not demanded continuously along the seasons reducing the capacity factor. This is even more the case for industrial buildings that are vacant during week-ends and bank holidays. During cloudy events, as for any concentration technology thermal production of the Fresnel collector is null. The present study proposes the upgrade of the current Fresnel collector by the implementation of customized photovoltaic panels under the mirrors able to produce electricity whenever neither heating nor cooling are necessary. With such hybridization it contributes to cover a substantial part of the building electricity consumption in urban environment where space lacks. The electricity produced can supply also heat-pumps and continuously support air-conditioning. Producing both electric and thermal needs directly on the building reduces the dependence to fossil fuels that are responsible of global warming. It also smoothers the peak demand on the national electricity network during summer. The proposed study investigates the theoretical hybridization upgrade of the operational Fresnel at CyI. It determines the potential added value of a collector which is also able to produce electricity in order to store it or sell it.

Renewable Energy Sources in SE Europe: Challenges and Lessons to be Learned

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KEYWORDS - Renewable Energy Sources, SE Europe, European Union (EU), Policies, Energy Security

ABSTRACT

The market of Renewable Energy Sources (RES) is emerging as one of the most vibrant and faster moving sectors within the broader Southeast European[1] energy sector. The huge RES potential in SE Europe, such as solar, wind, hydro, biomass, and geothermal, still remains largely unexploited by many countries mostly in the West Balkans and elsewhere. Because of SE Europe's peculiar circumstances, mainly due to the high divergence of the economies in the region, there are great difficulties in advocating common RES strategies.

Whatever the case may be in terms of adopted strategies, the further development of the RES sector in SE Europe should be seen in line with the European and global strategies for energy and environment. A number of significant developments in terms of policy and infrastructure are currently taking place in Europe, which are expected to positively impact RES penetration in SEE, helping further diversification of the energy mix. Radical changes in the energy mix (mainly due to the introduction of gas and RES), reforms already underway (unbundling procedures and market liberalization) and other transformations will enable the region to meet energy supply challenges.

The paper analyses briefly the latest RES developments in power generation in SE Europe per energy source and per country. RES policies and binding targets in the region set by the EU and Energy Community are reviewed and lessons learned analysed. Also, the funding mechanisms as well as the implications COP21 agreement could have for SE Europe are briefly discussed. The paper also identifies the role of energy storage in the further development of RES in SE Europe. Energy storage is seen as a growth area related to distributed RES power generation and electricity storage requirements. Some examples, including current and future energy storage in connection with RES, are discussed.

[1] SE European countries include Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, FYR of Macedonia, Greece, Kosovo, Montenegro, Romania, Serbia, Slovenia and Turkey.

Grid-friendly energy management algorithm to control solar PV coupled with Battery Storage

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KEYWORDS – Photovoltaics, Energy Storage Systems, Distributed Storage, Energy Management

ABSTRACT

As energy demand increases significantly in a non-sustainable way, a worldwide need arises for putting renewable energy technologies at the forefront. In particular, the recent price reduction of Photovoltaics (PV) has rendered this technology as a very attractive alternative to fossil fuel generation especially in locations with high solar resource. However, the high penetration of renewables presents the grid, in its current form, with severe operational challenges. As a result, the restructuring of the grid in order to be able to accommodate the expected high RES penetration is necessary. In light of this, the utilization of Battery Energy Storage Systems (BESS) together with demand response (DR) are considered as a sustainable solution that will partially solve grid stability issues. This combination can offer numerous services to support grid operation and allow for increased penetration of renewable energy sources.

In the above context, this paper proposes a methodology for enhancing self-consumed electricity in domestic premises by coupling BESS with solar PV systems. In particular, the development of an energy management algorithm responsible for controlling two flexible loads, namely a water boiler and a room heating/cooling system is presented. The main objective of this study is to optimize the utilization of solar PV generation by reducing the excess energy that is injected to the grid based on flexible load demand. The coupling between battery storage and PV will enhance the capabilities of the system since surplus electricity can be locally stored for later use. Knowing that the unit price of BESS and especially Lithium-based storage technology is relatively high, storage sizing is of utmost importance for such applications. As a result, the final outcome of this work will be a methodology for appropriate storage sizing based on different capacity and power needs as well as ambient temperature and PV production.

Promoting Effective Generation and Sustainable Uses of electricity (PEGASUS) – The case of the FOSS lab area nanogrid

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KEYWORDS – renewable energy sources, photovoltaics, microgrid, prosumer, demand response, distribution grid, energy management systems, energy storage systems, EV charging, smart meters.

ABSTRACT

The PEGASUS project is an Interreg MED transnational programme co-financed by the European Regional Development Fund.

PEGASUS's main objective is to contribute to an increased, efficient and effective use of renewable energy sources (RES) using microgrid technologies. It focuses on seven Mediterranean areas where microgrids are being set up and eventually aims to promote their benefits to the associated communities. PEGASUS also aims to investigate the technical and administrative obstacles, which are currently hindering the implementation of such microgrids.

Seven pilots are investigated within the project. One of the pilot sites concerns the nanogrid that will be set up at the FOSS Research Centre for Sustainable Energy, University of Cyprus. In the case of the FOSS nanogrid, this will act as a subset of the planned microgrid of the university of Cyprus. The pilot involves the setup of a nanogrid to utilise the existing PV facilities. Furthermore, three-phase smart meters, a programmable electric load to facilitate alternative load capabilities, an EV charging station and a central software management system with associated engineering for setting up the data collection infrastructure, analysis platform and reporting capabilities is envisaged.

The PEGASUS nanogrid will act as a testbed for the University's microgrid. Simulation scenarios will be carried out by using tools such as Matlab/Simulink and PowerSim. Energy production and consumption will be simulated and tested for both steady-state, dynamic and transient conditions. Furthermore, a bidirectional EV charging system for vehicle to grid (V2G) will be investigated.

A full description of the nanogrid as a testbed will be presented in this paper together with initial analysis results.

Classification of EU countries in terms of energy efficiency indicators

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KEYWORDS - European Union, cluster analysis, energy efficiency, energy consumption

ABSTRACT

In 2014, the European Union decided to create an Energy Union. One of its targets is to increase energy efficiency with the assistance of moderate demand for energy resources. On 30 November 2016 the European Commission proposed an update to the Energy Efficiency Directive. The Commission's proposals include measures for energy efficiency, renewable energy. The aim of the study is to build clusters of member countries of the European Union that differ in terms of energy efficiency indicators. For the study, the cluster analysis method is used. The conducted cluster analysis made it possible distinguishes four groups of states of the European Union. The biggest impact in 2015 on the energy efficiency of the member countries of the European Union have had three indicators gross inland consumption, final Energy Consumption and primary energy consumption, because their values of F statistic is the greatest, the least effect was shown by the indicator electricity generated from renewable sources.

The results of a cluster analysis of energy efficiency indicators show that the countries in the second and fourth cluster are leaders in the development, production and consumption of renewable energy sources. The policies of EU member states of the second and fourth cluster can serve as a guide for other EU countries located in the first and third cluster.

The results of the analysis can be applied to develop a decision support system for the formation of recommendations in the field of European Union energy policy and the integration of the European energy market.

Economic Viability of Battery Energy Storage for the Provision of Frequency Regulation Service

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KEYWORDS – Energy Storage, Frequency Regulation, Ancillary Services, Battery Energy Storage, Renewable Sources of Energy, Grid Integration

ABSTRACT

In recent years, a growing need for ancillary and supportive services has emerged due to the increasing penetration of intermittent renewable energy sources (RES). The energy supply has been less predictable and the system balance has become more challenging. The imbalances between supply and demand are becoming more frequent and severe, thus causing frequency disturbances, which render frequency regulation (FR) services and especially fast frequency regulation very significant.

Battery energy storage systems (BESS) demonstrate great potential in providing these services due to their fast response times (typically milliseconds to seconds) and the variety of additional services (such as peak shaving, voltage support, black start etc.) which can provide. Since FR is mostly a capacity service, with high power and low energy requirements, BESS can be used to provide primary frequency response and mitigate the short-term frequency fluctuations. The significant technical capabilities of BESS, as well as the low energy requirements benefit the economic viability of BESS for such a service. As a result, the use of BESS for the provision of FR service in the European energy market will be investigated in this paper and its economic viability will be evaluated. More specifically, this paper aims to achieve the following:

- To address and evaluate the cost components of frequency regulation services by traditional generation units.
- To address and evaluate the cost components of the BESS dedicated to the FR service.
- To examine the economic viability of BESS combined with traditional generation units for the provision of frequency regulation service.
- To investigate the BESS as a standalone case with direct participation in the frequency regulation market.

The first CasaClima House in Greece, at the island of Aegina, Attica

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KEYWORDS – Passive House, CasaClima, zero-energy, Aegina, insulation, building

Low or Zero Energy buildings are becoming increasing popular and the use of passive-house principles are providing a solid foundation for achieving energy consumption targets in buildings. However, this design methodology has found more response in central and northern Europe than in south and the Mediterranean, where people are used to houses that are open to the external environment, a habit that is in contrast to the basic principles of passive house.

This CasaClima design protocol, of the Italian Cetification body based at Bolzano (http://www.agenziacasaclima.it) faces this issue by designing and certifying zero-energy buildings in southern and Mediterranean climate. It balances the passive-house design requirements with the, often contradictory, local ways and demands of using the buildings. Furthermore, it places much importance on the human experience and satisfaction with the building's architecture and user's experience, rather than just the temperature & humidity levels of the space. CasaClima has already certified a significant number of projects, including works from renown architects Renzo Piano and Zaha Hadid, and this is the first project to be materialized in Greece and/or Cyprus.

The house in Aegina is currently being built and will be completed in spring 2018, thus it will be an opportunity to present in addition to design principles and methodology, the critical construction issues and challenges, practical manufacturing solutions as well as the completed project and its performance over summer.

Electrochemical Treatment of Olive mill waste powered by Photovoltaic Solar Energy

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ABSTRACT

The proposed photovoltaic electrochemical (PV-EC) process combines the autonomous and environmentally friendly photovoltaic solar energy with the capability of the combined electrocoagulation/electrooxidation process to effectively remediate toxic olive mill wastewaters and simultaneous produce electrolytic hydrogen. The photovoltaic array can be connected directly to the electrochemical reactor without batteries increasing, in this way, the system sustainability and eliminating the environmental threat of improper battery disposal. The PV-EC system is made versatile according to the instantaneous solar irradiation by adjusting the wastewater flow rate to the current intensity supplied by the photovoltaic array.

All operating parameters affecting the efficiency of the proposed process, such as wastewater conductivity, pH, flow rate, current density, electroprocessing time and solar irradiance were studied and optimal conditions were investigated. The experimental results showed that the initial COD of 21000 mg/L and turbidity of 162 NTU of the olive mill waste sample were effectively reduced to 105 mg/L and 0 NTU respectively after treatment with a current density of 60 mA cm^2 for 2 h by electrocoagulation and subsequently for 5 h by electrooxidation.

The proposed process is a safe method for effective treatment of toxic and recalcitrant wastes, such as oily olive mill wastewaters, especially for applications in remote and isolated locations with lack of electric grid.

KEYWORDS: electrocoagulation; electrooxidation; olive mill effluents; photovoltaic solar energy

Thermal Performance and Environmental Impact of an Innovative Exterior Wall System

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KEYWORDS - innovative masonry system, thermal performance, environmental impact, energy efficiency.

ABSTRACT

Exterior walls are responsible for 29-59% of the thermal losses that occur in buildings. Moreover, walls leave a significant environmental footprint on the building construction. In fact, masonry manufacturing and construction account for 13% of the total energy consumed during the building process. All the above highlight the need for parallel investigation and improvement of both the thermal and environmental features of wall systems. The present study builds on a previous work and examines an innovative wall system. The proposed system consists of modular construction components that consist of a cement based composite and polystyrene. The incorporation of polystyrene, during the components production, results in an integrated comprehensive masonry system. The construction component consists of a novel mix design in which 50% of binder is replaced by mineral admixtures, while sand is partially replaced by limestone filler, thus decreasing environmental impact.Heat flux numerical simulations are carried out, both for steady-state and transient heat analyses, on FE models to assess the thermal performance in terms of U-value, time lag and decrement factor, while data from the literature is used to compute the structure's environmental impact in terms of embodied energy. The proposed masonry system is then compared to typical construction solutions such as thermally insulated fired clay brick walls and drywall panels. Based on the findings, the proposed masonry system is capable of providing thermal comfort not only due to the low U-value but also by efficiently controlling temperature fluctuations, mainly because of its low decrement factor and high time lag, thus providing an alternative solution to typical construction wall systems with improved thermal and environmental performance.

Assessment of natural lighting performance of typical in-patient rooms of healthcare facilities in Cyprus.

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Abstract

It is generally accepted that access to daylight and sunlight can have a positive impact on people's health and well-being. This study aims to carry out a research on natural lighting performance of the most common typologies used for in-patient units.

A preliminary investigation identifies the typical in-patient rooms in a number of healthcare facilities/premises in Cyprus. At the same time, the current study presents a review of the existing literature on lighting assessment in healthcare facilities with an emphasis on the impact of daylighting on patients' health.

Moreover, natural lighting analysis simulations were conducted through advanced software tools, i.e. IES-VE 2017 and Radiance IES. The research study aims to evaluate the correlations between the room's orientation and geometrical parameters, (i.e., dimensions, height, window to floor ratio), and the daylighting performance in the spaces under study. For the daylighting assessment of the in-patient spaces, a number of widely used indicators were employed including: Daylight Factor (DF), Uniformity Daylight Factor (UDF), Daylight Autonomy (DA), Annual Sunlight Exposure (ASE) and Useful Daylight Illuminance (UDI).

The research study discloses significant differences in the levels of natural lighting metrics for different geometrical configurations and for different orientations, thus indicating the importance of the appropriate architectural design in achieving high daylighting performance of the spaces under study, as well as the need for further systematic research in the field.

Keywords:

Daylight and Sunlight Assessment, Typical In-Patient Rooms, Healthcare Facilities, Natural Lighting Analysis Simulations, Daylighting Performance Metrics

A New Approach in the Refurbishment of the Office buildings – From Nearly Zero Energy buildings to Smart Energy Buildings

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KEYWORDS – smart refurbishment, energy indicators, energy demand, Energy Performance Certificate, nearly zero energy buildings.

ABSTRACT

The government of Cyprus has developed policies and regulations addressing the energy performance of non-residential buildings, in order to achieve the national energy reduction objectives in accordance to the European Union's targets and directives. These packages consist of energy performance regulations and financial incentives.
Currently, the legislation in force, which defines the requirements and the technical characteristics to be achieved by a building in order to qualify as a nearly Zero Energy Building (nZEB) is under the Directive 366 of 2014. However, this falls short of addressing sufficiently the high cooling energy demand of the buildings in Cyprus, as well as, introducing alternative solutions to thermal insulation measures for reducing the overall energy consumption.
This paper examines the energy and economic viability of enhanced, smart refurbishment scenarios for office buildings in the Mediterranean climate by considering a University Administration Building in the city of Limassol as a case study. The energy performance of the building was calculated first for its current state and then after applying the required alterations in order to comply with the nZEB standards. Based on the nZEB model, a set of additional refurbishment measures were examined, including building control and automation systems, innovative materials and integrated vegetation solutions. Conclusively, an integrated energy refurbishment model was developed, encompassing the most energy and cost-effective measures from the study. The modelling and the simulations have been performed with DesignBuilder software.
Based on the results, the existing legislation, defining a nearly Zero Energy Building (nZEB) is reconsidered prompting a proactive discussion towards the improvement of the current energy regulating Directives.

Cyprus System of Guarantees of Origin

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Guarantees of Origin (GOs) are becoming the standard means by which the origin of electricity is disclosed to the final consumer. Transmission System Operator-Cyprus being the Authorized Issuing Body of Guarantees of Origin for RES and High Efficiency Cogeneration has set up the Cyprus Electronic Registry of Guarantees of Origin. This paper presents general information on the use of Guarantees of Origin as well as details of the Cyprus GO System. Finally, it presents the methodology applied in Cyprus for the calculation of the National and the Supplier Energy Mix of Electricity and the Disclosure of the Supplier Energy Mix.

Demonstration Tools for Trading Flexibility in Distribution Grids in Cyprus - The Cases of A Microgrid and Dispersed Prosumers

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KEYWORDS – flexibility, renewable energy sources, microgrid, photovoltaics, prosumer, demand response, building energy management systems, energy storage.

ABSTRACT

In order to achieve the ambitious targets of the European Union (EU) regarding the integration of Renewable Energy Sources (RES) without the need for significant grid reinforcements, new integrated solutions should enable demand-response schemes and combine the operation of RES with smart grid technologies and energy storage systems. Towards this direction, GoFLEX, being a Horizon 2020 European Project, aims at demonstrating flexibility-trading solutions for cost effective use of demand response schemes in distribution grids. The field tests in Cyprus investigate the cases of the microgrid and the single prosumer. For each case, the role of the Balancing Responsible Party (BRP) is assigned, as an intermediate level for trading flexibility between the microgrid/prosumers and the Distribution System Operator (DSO).

Regarding the microgrid case, the campus of the University of Cyprus (UCY) will be examined. This currently consists of several different Building Energy Management Systems (BEMS) for controlling the heating and cooling and 350 kWp Photovoltaics (PV). A 10 MWp PV system is also planned to be installed (first phase 5 MWp to be operational within the GoFLEX project) combined with a large energy storage system and a public EV charging station, thus transforming the university campus into an enabled microgrid capable of minimizing the energy cost to the university through effective use of the self-consumption scheme offered by the local Supplier. Therefore, new challenges for offering flexibility to the distribution grid emerge in the form of creating profitable business models for both the UCY and DSO. Concerning the dispersed prosumers within Cyprus, Home Energy Management Systems (HEMS) will be installed at the premises of 26 prosumers with 3 kWp rooftop PV for offering flexibility to the DSO and adopting more grid-friendly energy practices. Another 10 prosumers will test the flexibility from one single load, in order to compare the results with the more complicated HEMS solution. Finally, for both cases, a new tool will be utilised by the DSO to analyse the distribution grid and identify its flexibility needs.

Therefore, this paper is focused on investigating the flexibility offered by single prosumers and microgrids in islanded distribution grids in order to satisfy the DSO requirements. Through the installed equipment and the gathered results, new business models will emerge, providing the market environment for the commercialization of the proposed solutions throughout the EU.

The Role and Necessity of PLL and Current Controllers in GSC of Distributed RE Systems

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KEYWORDS – Renewable energy sources, phase-locked loop, current controller, grid side converter (GSC) control, power quality.

ABSTRACT

The road towards smart grids and micro-grids requires intelligent grid-connected renewable energy sources (RES). Diversifying the role of distributed renewables is therefore acquiring momentum and new ideas of how to better utilize RES are continuously emerging. It is well appreciated that RES can support and improve the power quality of the grid. The contribution of Distributed Generation (DG) systems towards abnormal grid events (such as the presence of harmonics and DC offset, asymmetric loading conditions, unbalanced faults, phase unbalance, voltage sags etc.) and the need for optimal interaction with smart grids and micro-grids, are research areas related to RES diversification. This can be accomplished through the power electronic-based Grid Side Converter (GSC) which is the main component of DG systems. Power electronics converters are associated with embedded controllers in order to achieve the smart and flexible operation of RES systems. Hence, the development of dedicated controllers for managing the operation of power electronics converters is a critical feature. The GSC control system allows the power management, and when it is intelligently designed, it can contribute to improve the power quality and provide advanced support to the grid.

The typical control system of the GSC consists of a synchronization unit referred to as Phase Locked Loop (PLL), an active (*P*)/reactive (*Q*) power controller and a current controller. The purpose of the PLL is to obtain the grid voltage information such as frequency, phase and amplitude, necessary for control purposes. The *PQ* controller is responsible for generating the reference currents as per desired load conditions and power management targets. The current controller handles the reference current tracking and PWM generation. Thus, the PLL and current controller are key modules of the GSC controller. The grid operating conditions directly influence the accuracy of the PLL and current controller. As a result, the response of these modules is critical for the expected operation of the grid-connected RES system according to grid codes and regulations. Their performance and accuracy is critical under off-nominal grid conditions such as the presence of voltage harmonics and DC offset, balanced and unbalanced grid faults, voltage sags and swells, frequency variations, and phase jumps, asymmetric and non-linear loading conditions etc. The aim of this paper is to identify, analyze and compare existing state-of-the-art three-phase PLLs and current controllers that are commonly used in the control of GSC systems. The various existing techniques will be benchmarked with simulation and experimental results in terms of their performance under grid disturbances, the computational complexity, and the dynamics. The work will highlight the importance and impact that properly designed PLLs and current controllers have to the power quality and stability of the electricity grid.

Combustion simulations of different hydrocarbon content natural gas in constant volume chamber and direct-injection spark-ignition internal combustion engine

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KEYWORDS - Combustion, Internal combustion engines, Natural gas.

ABSTRACT

The combustion of fossil fuels in transportation and stationary application produces harmful emissions. An alternative hydrocarbon fuel is the natural gas, which consists mainly of methane and it is considered as a cleaner fuel than gasoline and diesel fuel. The use of natural gas can be a promising solution for the reduction of emissions and the improvement of the engine performance. Natural gas is exploited from different reservoir sources and it is found in different chemical compositions, consisting of methane, ethane, propane, butane and traces of other gases. It is very important to investigate the effects on combustion and emission characteristics of different types of natural gas fuels in internal combustion engine applications. The main objective of the present work was to investigate the thermochemistry characteristics of different natural gas fuels and carry out combustion simulations with natural gas fuels, in order to examine the differences on the combustion characteristics in both constant volume chambers and direct-injection spark-ignition internal combustion engine. For the investigations of the present work four natural gas test fuels were examined, namely 100% methane, 96% methane + 4% ethane, 90% methane + 9% ethane + 1% propane, 86% methane + 9% ethane + 2% propane + 1% butane. For all test fuels, stoichiometric mixtures with equivalence air fuel ratio φ equal to 1, and two lean mixtures with φ equal to 0.9 and 0.8 were studied. From the thermochemistry calculations, the lower calorific value of the fuels and the adiabatic flame temperature were calculated and compared. Also, the chemical equilibrium methodology was used and predicted the combustion pressure and the produced emissions, including carbon monoxide and nitrogen monoxide. Finally, computational fluid dynamics (CFD) simulations were performed with the STAR-CD CFD code, for the investigation of the combustion characteristics in a constant volume chamber and in the cylinder of a direct-injection spark-ignition engine chamber during compression stroke close to the engine top dead center. From the results of the present work, it was found that the different types of natural gas fuels result in small differences in flame temperatures and emissions. However, the best natural gas fuel was found to be the one which consisted with the maximum content of methane. From the present work, recommendations for the application of natural gas in internal combustion engines are provided for engine performance improvement and reduction of emissions compared to gasoline fuel application.

PILOT EVALUATION OF A NOVEL ANAEROBIC FERMENTATION PROCESS FOR THE PRODUCTION OF DIGESTATE WITH LOW AMMONIA CONTENT

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KEYWORDS – anaerobic digestion, biogas, municipal biowaste, garden waste, nitrogen balance

ABSTRACT

High ammonia concentration constitutes a common inhibitor in anaerobic digestion systems (Yenigün et al., 2013). However, soluble bio-based polymeric substances (SBO) released from alkaline hydrolysates of municipal biowaste compost have been reported to enhance CH_4 production and reduce the NH_4^+ content in the digestate by promoting its conversion to N_2, when added at 0.05-0.2% concentration in the fermentation slurry feed. Based on these findings, the LIFECAB project aims to demonstrate the replicability of this technology in 3 different EU countries (Italy, Greece and Cyprus) through production of ecofriendly cost effective biogas and products for the chemical industry, agriculture and animal husbandry.

The technology involves a four-step process, including: 1) application of food waste as feedstock for two pilot anaerobic digesters, 2) co-composting of the digestate produced with green waste, 3) chemical hydrolysis of the compost generated to produce SBO, and 4) implementation of SBO in anaerobic digestion for enhanced biogas formation and production of digestate with reduced NH_3 content. Two composting cycles of green waste have been performed determining process parameters that include organic carbon content, pH, TS, VSS, ash, temperature, phytotoxicity, conductivity and moisture content, water holding capacity, phosphorus content and heavy metals. The composting parameters monitored are in agreement with the current literature. The presentation will include preliminary results from the implementation of the novel four-step process using the pilot facilities that are currently under construction in the premises of SBLA in Limassol, as well as lab-scale experiments designed to assess the fate of ammonia removed in the SBO assisted fermentation.

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The role of test facilities in the development of Marine Renewable Energy – Smartbay as an example

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KEYWORDS Renewable Energy, Ocean Energy, Research & Development, Funding, Responsible Research and Innovation

ABSTRACT

Smartbay is Ireland's national marine test and demonstration facility for the development of innovative products and services for the global maritime sector. Being one of the three test facilities for ocean energy at various Technical Readiness Levels in Ireland, Smartbay is part of the Irish commitment to support the development of the marine renewable energy (MRE) not only in Ireland but globally.

The main purpose of all the facilities at the test site is to allow adequately scaled devices to gain sea experience in less challenging conditions than those experienced at full-scale Atlantic Ocean test sites. However, test sites can have an additional and important role, one that could be a contributor to a more efficient use of the facilities and funds: they can act as attractors of public or private investment that, together with the facilities, could make up a pool of resources to be used in the test and validation of devices.

This "pooled" model is, in a way, being tested in a challenging but promising Interreg project, FORESEA - Funding Ocean Renewable Energy through Strategic European Action; Transnational Access provided by projects such as JERICO NEXT (Joint European Research Infrastructure network for Coastal Observatory - Novel European eXpertise for coastal observaTories) or MARINET 2 (Marine Renewables Infrastructure Network for Emerging Energy Technologies), are other examples. Work is also underway through the H2020 funded MARINA (Marine Knowledge Sharing Platform for Federating Responsible Research and Innovation Communities) project to explore how the application of the Responsible Research in Innovation principles can assist in progressing ocean energy and innovative marine projects in achieving sustainable solutions.

This paper presents the above ideas in more detail and gives a preliminary measure of their expected outcomes, from which conclusions are drawn on the importance of the different functions of ocean energy test sites such as Smartbay, and their role in the future of MRE.

"Applying Responsible Research and Innovation in Wave Energy – Lessons Learned and Best Practices"

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KEYWORDS – wave energy, lessons-learned, Responsible Research and Innovation, policy, commercialisation, citizen-science, co-design, co-creation.

ABSTRACT

Wave energy is still at development stage in Europe, including Ireland. Renewable energy sources and technology require wider understanding by policy-makers and society for acceptance and application. However, scientific communication towards policy, industry and society is not always fruitful. This though can be improved through the application of Responsible Research and Innovation (RRI). RRI implies that all societal actors (researchers, citizens, policy makers, businesses and third sector organisations) work together for aligning processes and outcomes with the values, needs and expectations of society for a sustainable future. This paper focuses on the lessons learned and identified best practices from forty-eight European mobilization workshops, where five (four local and one international) are about wave energy in Ireland and how to successfully engage societal actors to create a common vision and an action plan to address related challenges. The Irish workshops promote the concept of RRI and how it can facilitate commercialization of wave energy and what policy initiatives are needed. These workshops are part of the forty-eight RRI European workshops executed under the EU-funded project MARINA (www.marinaproject.eu).

COMPARATIVE ANALYSIS OF AIR-TO-WATER HEAT PUMPS PERFORMANCES – SEASONAL PERFORMANCE FOR HEATING OF DOMESTIC HEAT PUMPS IN THE GREEK CLIMATE

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ABSTRACT

The energy problem is today one of the most important concerns of the world community. Energy is a commodity with increasing demand and the impacts of its use on the environment are crucial. In this context, the European Union (EU) developed the Energy Efficiency 2020 program on the Common European Energy Strategy for the period 2011-2020. The aim of the program is to achieve the "20-20-20" targets, namely 20% share of its gross final energy consumption from renewable sources, 20% reduction in CO_2 emissions compared with 1990 levels, and 20% increase in energy efficiency. In September 2015, the EU adopted the ErP (Energy-related Products) Directive concerning the ecodesign and energy labeling of energy-related products and appliances. With the implementation of the Directive, conventional high temperature hydronic heating systems will be gradually replaced with low temperature ones. Heat pumps (HPs), and in particular air-to-water heat pumps (AWHPs), are therefore expected to be widely installed in low temperature heating systems as devices which are able to provide heating as well as cooling, at appropriate temperatures, by operating in reverse. Although they require high-cost and high-carbon electricity to operate, the majority of the energy pumped is renewable heat drawn from the environment. Heat pumps are a mature and effective technology for reducing energy consumption in buildings and with the decarbonization of the electricity sector the greenhouse gas emissions from HPs operation will be reduced to very low levels.

The aim of this paper is to present a comparative analysis of the Coefficient of Performance (COP) and the Energy Efficiency Ratio (EER) of AWHPs available in the Greek market by various manufacturers over the last 5 years. The comparative analysis is based on the technical specifications of the different models that provide each manufacturer and on the correlation of the COP and EER given in the technical manuals with: a) the nominal capacity b) the outdoor air temperature and c) the water supply temperatures to the heating and cooling system (according to Eurovent LCP/A/CHP and Eurovent LCP/A/AC conditions). The results are presented in graphs, while polynomial regression analysis is performed as well. The HPs under consideration are of low, medium and high heating and cooling capacity, and are installed in various types of buildings, mostly in thermal comfort applications.

Additionally, results from the seasonal performance of AWHPs are presented, concerning the operation during the heating season of domestic AWHPs installed in a typical apartment located at representative cities in the four Greek climate zones. These data derive from an energy analysis, according to bin method, and the calculation procedure for seasonal coefficient of performance (SCOP) according to EN 14825:2016.

The data presented in this paper can be useful for selecting an air-to-water heat pump in a building's system design project, for estimating its final energy consumption, as well as for taking investment decisions in case of a techno-economic design.

Keywords: heat-pumps, Coefficient of Performance, Energy Efficiency Ratio, heating systems, Seasonal Coefficient of Performance, energy efficiency

ENERGY AND ENVIRONMENTAL ASSESSMENT OF PELLETS PRODUCED FROM SOLID RESIDUES OF THE WINERY INDUSTRY

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ABSTRACT

The aim of the study entitled “Energy and environmental assessment of pellets produced from solid residues of the winery industry” was the assessment of the potential of waste by-products of the Cypriot winery industry, to be pelletized and used as raw material for solid biofuels. In terms of this study, two different biomass blends have been pelletized and assessed as energy source for domestic hot water boilers. The samples were composed of Grape Pomace (P1) and Grape Pomace & Vine Shoots Blends (P2). The raw material was sampled by a Cyprus local winery named Aes Ambelis (Nicosia, 35°01'12.4"N 33°09'19.5"E). The raw material was dried and pelletized at the facilities of the Agricultural Research Institute (ARI), in Cyprus. The produced pellets were analysed to define their moisture and ash content, based on well-established standardized methods, at the Sustainable Solid Fuels Lab of Frederick University. Combustion tests with the produced pellets were also carried out at the Boilers Lab of Frederick University. The measurement campaign focused on the flue gas analysis and particularly on the concentration of carbon monoxide, carbon dioxide, oxygen, lambda, water temperature and boilers efficiency measured.

The results obtained from the analysis of the investigated samples showed that the majority of the examined pellets satisfied the minimum requirements of the EN ISO 17225-2 and EN ISO 17225-6 standards for woody and non-woody pellets respectively. Ash content and moisture content for both sample were also found to be within the limits of the standards. The results of the measurement campaign were also found to be in good agreement with results delivered by other studies conducted for similar biomass raw material.

Study results showed that grape pomace and grape pomace vine shoots blend could potentially be used as an energy source for producing heat which could be exploited for both the domestic and the industrial sector. The exploitation of this waste stream for energy production purposes could offer economically and environmentally smart solutions for the winery industry in Cyprus, satisfying the circular economy principles, which are currently at the forefront of the European environmental policy

Keywords: Solid biofuels, grape pomace, vine shoots blends, pellets, ash content, moisture content, combustion emissions

Thermoeconomic modeling of a small-scale photovoltaic-solid oxide fuel cell system for commercial applications

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KEYWORDS - Fuel cell, photovoltaic, distributed energy, cost analysis, thermoeconomic modeling, combined-heat-and-power.

ABSTRACT

In this study a small-scale photovoltaic-solid oxide fuel cell (PV-SOFC) system is considered for application in commercial applications. The recent improvements in electrical efficiency and lifetime for solid oxide fuel cell technology, combined with the decrease in capital cost for photovoltaic technology improve the commercialization prospects of integrated PV-SOFC hybrid systems for adoption in building applications. Additionally the availability of heat exhausted by the SOFC stack allows heat recovery and use in buildings to cover thermal loads, such as space heating, and domestic hot water preparation. The thermoeconomic modeling for the proposed system includes modeling of both the PV subsystem and the SOFC unit. The SOFC unit is assumed to be fueled with natural gas, and therefore a fuel processor is integrated to the SOFC stack to convert natural gas to hydrogen-rich synthesis gas (syngas).
A detailed cost model is developed to determine key economic parameters, such as lifecycle cost for the cost analysis of the proposed system. The proposed system assumes autonomous operation without connection to the central power grid and is compared with three other energy generation options: (a) electricity import from a central power grid (conventional), (b) electricity import from a central power grid combined with photovoltaic subsystem (semi-conventional), (c) a solid oxide fuel cell system. The results suggest that the proposed system could become a potential candidate for decentralized power generation, as in addition to an economically competitive development of the system, the system can also offer significantly lower emissions than conventional energy generation.

Evaluation of the cost–effectiveness of climate change mitigation measures in Cyprus

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KEYWORDS – Marginal abatement cost curve, Cyprus, climate change mitigation, sectoral policies and measures, cost–effectiveness.

ABSTRACT

The continuous increase in atmospheric greenhouse gas (GHG) concentrations and the projected climate change caused by them underlines the need to implement effective policies and measures for reducing GHG emissions in order to mitigate adverse impacts of climate change in the future. This study evaluates the effectiveness and efficiency of various climate change mitigation options applied in the all sectors (residential, commercial, industrial, transport and agriculture) of the economy of Cyprus. This assessment can be illustrated in a Marginal Abatement Cost (MAC) curve constructed for a specific point in time. MAC curves are a common way to indicate the GHG emission abatement potential and the related abatement costs of various policies. The measures included are ranked according to their costs of abatement per tonne of GHG. MAC curves have been beneficial for climate policy due to the demonstration of the cost–effectiveness of different policies and measures within and among sectors. In our study, the cost–effectiveness analysis was carried out for possible mitigation options applied in the five economic sectors mentioned above. The analysis was performed i) separately for emissions in the sectors of the Cypriot economy that are not subject to the EU Emissions Trading system (non–ETS sectors), by excluding electricity generation related emissions; and ii) for the total emissions of both non–ETS and ETS sectors. Two MAC curves were thus constructed for the year 2030.

In general, the most cost-effective measures turn out to be the installation of heat pumps in pre-2008 residential buildings; roof insulation in pre–2008 residential multi-family buildings; the replacement of lighting equipment in all types of buildings; the increased use of anaerobic digestion for animal waste; and the replacement of burners, electric transformers and lighting in industry. In terms of emission abatement potential, heat pumps, animal waste exploitation, electric cars and public transport promotion seem to be the most promising measures. It is important to underline that, if implemented at the scale assumed in this study, all these emission abatement measures will not be sufficient to fulfil the commitment of Cyprus to reduce its non–ETS emissions by 24% by 2030 compared to 2005 levels.

Environmental evaluation of mobility measures - Experience from the H2020 CIVITAS DESTINATIONS project

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KEYWORDS - Sustainable mobility, environmental impact, assessment framework

ABSTRACT

Road transport accounts for 49% of freight transport activity and 82% of citizens' personal transportation in EU. The major negative impacts on the environment, energy, health and economy have led to new EU transport policies that aim to promote clean, safe, secure and efficient mobility. Under this scope, the Horizon 2020 CIVITAS DESTINATIONS project, funded by the European Commission, was launched in 2016. It integrates the tourist mobility needs and fluctuation impacts in the design of mobility solutions in order to enforce the sustainability, accessibility, attractiveness and efficiency of transport services and infrastructure for both residents and tourists in six island cities: Rethymno (Crete-Greece), Limassol (Cyprus), Valletta (Malta), Funchal (Madeira-Portugal), Las Palmas de Gran Canaria (Spain) and Elba (Italy).

The environmental impacts of the all measures in the six sites are evaluated, in measure and site level, within the Environmental Assessment Framework (EAF) developed in accordance to previous CIVITAS guidance and adapted to address the specific objectives of the project. Indicators for emissions, pollutant levels and Used Cooking Oil collection were incorporated in a refined EAF. In this frame, Rethymno, the first Greek CIVITAS city, demonstrates 14 mobility measures to address the heavy impacts of tourist flow in the transport system and the environment.

This paper analyses the methodology followed by the Technical University of Crete in Rethymno and presents findings from field measurements regarding traffic data, weather conditions (temperature, humidity, wind speed), pollutant levels (CO_2, CO, NO_2, Particulate Matter) and noise level with the installation of environmental sensors on 5 meteorological stations, along with portable equipment for additional on-site measurements in 11 different locations. The measurements are conducted in different periods of the year, following the tourist fluctuation. The collected values are assessed with respect to the legislative limits, taking into account the activities and traffic load in each area, in order to correlate the transport conditions with the environmental impacts. The indicators monitoring and impact assessment performed in Rethymno will provide the insights required to determine the suitable measures for replication and upscaling, based on real data and in comparison with the expected performance.

From Used Cooking Oil to biodiesel. Full Supply Chain demonstration

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KEYWORDS – used cooking oil, bio-waste, smart-bins, alternative fuel, biodiesel

ABSTRACT

Fostering a low carbon economy is a key pillar of EU policies for territorial sustainable development and it is especially important for the mitigation of climate change in MED regions. COMPOSE is an Interreg MED action aiming to increase the share of local renewable energy sources in the energy mix and strategies in 11 Mediterranean regions. The project provides a synthesis model for efficient RES development planning through the development of sustainable energy supply chains and the enhancement of local businesses. COMPOSE implements 15 pilot demonstration actions to enhance the use of RES and EE measures by exploiting the local potential. 3 of the demonstrations will be implemented on the island of Crete, the one targeting to increase the rate of Used Cooking Oil (UCO) recycling and to enhance its safe disposal in the city of Rethymno.

UCOs are classified as municipal wastes under the code 20 01 25 (edible oils and fats) according to the European Waste Catalogue. They are actually oils and fats that have been used for cooking or frying in the food processing industry, restaurants and at the consumer level, in households. Inappropriate disposal of UCOs may generate major problems when discharged into sewerage systems. EU members need to encourage the separate collection and the treatment of bio-waste in a way that fulfills a high level of environmental protection. Even though UCO generated in restaurants is often collected by authorized service providers, most countries lack efficient systems to collect and treat UCO produced in households.

UCOs can be used as an energy resource and via the COMPOSE, Technical University of Crete (TUC) will promote the sustainable biodiesel production through a well-functioning and sustainable local energy production chain. A network of smart-bins will be placed in Rethymno. The bins will be equipped with sensors combined with Global System for Mobile Communication (GSM) technology to transfer real-time data via an online platform. Through this smart management system, operational costs are expected to be reduced. In addition, fewer collection trips mean less fuel consumption and less greenhouse gas emissions. UCOs will be transferred to a small-scale biodiesel production unit that will also be set up in Rethymno. The quality of the produced biodiesel will be tested through chemical analyses to be undertaken by TUC. The pilot also aims to increase public interest in UCO recycling by motivating a behavioral change among citizens.

Overcoming energy efficiency challenges for sustainable mobility in Madeira

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KEYWORDS – SUSTAINABLE MOBILITY AND TOURISM, LABORATORY ISLAND, MOBILITY POLICIES FOR ELECTRICAL MOBILITY,

ABSTRACT

Madeira (Portugal) is one of the 9 European outermost regions and is currently under the spotlight due to its role in coordinating the flagship CIVITAS Destinations project, whilst levering electrical mobility policies.

For characterization of the baseline scenario that could support the promotion of sustainable urban transport experiences, one has conducted evaluation campaigns at the main gateway for entering into the Island, the airport. Results from the surveys about mobility habits show that e-cars are not yet an option for tourists to move around Madeira. In fact, only 0,3% of trips are performed by rented electrical vehicles. This result could mean that work has to be done to widen the offer of e-rented cars. But one has also realized that tourists don't use electrical vehicles in their home town as well. This can be a sign that Madeira can be at the forefront of this global change and lead by example (if tourists have good experiences in using electrical vehicles during their holidays they might be more willing to change from fossil fuel to electrically-powered vehicles).

In Madeira the ownership of electric vehicles has been growing sharply. In 2012, there were only two fully electrical passenger vehicles circulating in the island. The number of electrical vehicles reached 100 in early 2017 and 200 at the end of that year. In the meantime, batteries are getting more and more reliable and recharging points are being implemented extensively. Policy-makers and transport practioners envisage in electrical mobility the way to effectively and noticeably address the objective of reaching an attractive tourist destination, fossil free.

The local administration of Madeira is driving the revolution. One main local policy document has been issued in March 2017 (the "Deployment Programme for Electrical Mobility"). There is also running a national programme called Environmental Fund which is subsidizing the take up of electrical cars and has paid for three new plug-in passenger cars which will be delivered to Horários do Funchal (local public transport operator) in March 2018.

At the cornerstone of the strategy is the CIVITAS-Destinations project, which entails a package of effective electrical mobility measures: on the one side, an operation for a common auction to purchase several vehicles for public administration is foreseen to take place and, on the other side, the demonstration of fully electrical buses has already been implemented.

This is the sort of public-private partnerships and policies that suit a world class tourism destination such as Madeira. The region is nowadays a laboratory region and a test bed where all the impacts that these tests generate can be properly evaluated. Plus, batteries are pushed to the limit due to the rough topography of the island. Hence, there is an opportunity for manufacturers worldwide to follow with attention our demonstration activities which can be regarded as stress tests for the electric engines.

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Fast tourist development and need for Sustainable Mobility measures. The Limassol story.

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KEYWORDS – sustainability, mobility, change, modes, attitudes, islands

ABSTRACT

Fast tourist development can easily lead to neglect of sustainability considerations and practices. Limassol is an example of a destination whose popularity increased significantly, leading to further investment in tourism. More and bigger investments led to increased worries about effectiveness and profitability of businesses, problem solving and the everyday struggle to maintain and increase visitors.

Today, a few decades later, we realize the significance of taking a step back and looking at how to make the destination more sustainable thus more attractive and specifically, how to best promote sustainable mobility both for tourists and locals. Services need to be redesigned or reinvented, new products need to be introduced and most importantly attitudes should change. This difficult task is undertaken by local authorities, the official tourist body of Limassol, and the majority of entrepreneurs and official bodies who share the vision for turning Limassol into a more sustainable holiday destination, that offers a rich and memorable holiday experience, with the minimum environmental footprint.

The Limassol Tourism Board, as a partner in the Civitas Destinations project is implementing important measures to promote walking and cycling as a tourist experience, electromobility, safe routes to school, bike sharing, a more efficient public transport service and a higher level of awareness about how to move around with sustainable mobility modes in and around Limassol. At this moment research shows that only 0.7% of the population uses a bike to move around, 1.5% uses the public transport and 5.8% of the population walk to their destination. The remaining 92.1% use private cars leading to high emissions (NO$_x$ (g): 71,693, SO$_2$ (g): 6,342, CO (g): 460,034; CO_2 (g): 1.130,077). What we want to achieve is a more balanced use of the different modes and increased use of the sustainable mobility modes, aiming to minimize air pollution, noise pollution, energy consumption, traffic congestion and all the other negative results of car use. Research shows that a cleaner, greener and more sustainable environment at the destination is a significant parameter for the traveler's choice.

Life Cycle Energy, Environmental Impact, and Cost Analysis of Eight Conventional/Hybrid Cooling Systems in the United Arab Emirates

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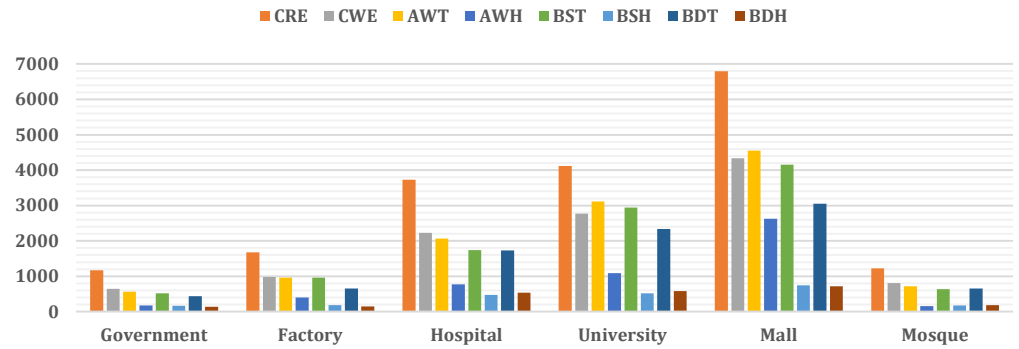
Keywords: Hybrid cooling systems, Solar assisted chillers, Life cycle assessment, Life cycle cost analysis.

The UAE government has been implementing new regulations for improving energy conservation in buildings as well as gradually pursuing to reduce its dependence on fossil fuels by increasing the percentage of electricity generated from renewable energy sources.
This study encompassed applying life cycle assessment and life cycle cost analysis methodologies to eight different solar cooling system configurations featuring conventional and thermally driven refrigeration systems working in six buildings in UAE. The benefits in terms of total costs, primary energy savings and emission reductions were estimated for each of the systems configurations when used in buildings with various cooling load profiles.

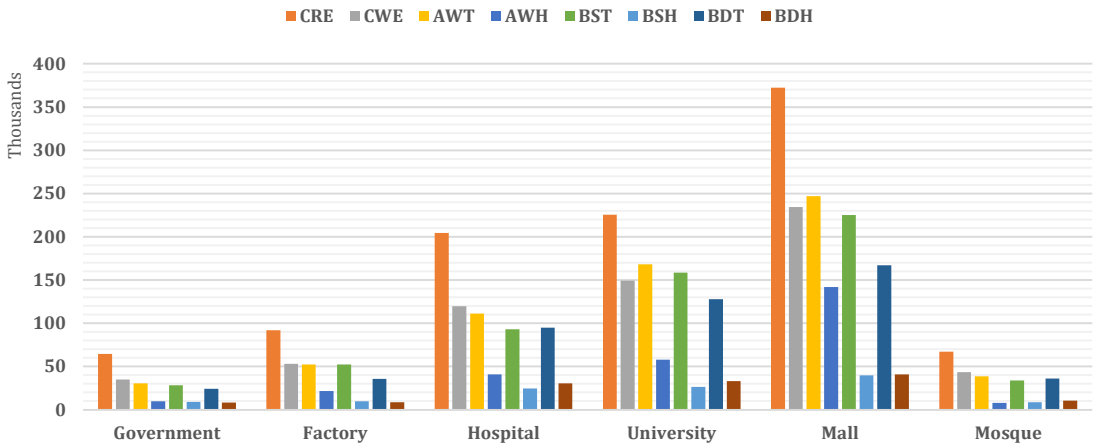
The outcome of the LCCA indicated that the Water-Cooled Assisted Hybrid Solar system, AWH, performed the best in all buildings, except for shopping malls. The AWH system achieved an average of 54% reduction in total life cycle costs compared with Conventional Air Cooled systems in all buildings, and an average of 31% compared with Conventional Water Cooled system. The different systems and their results are summarized below.

System configurations with assigned coding system

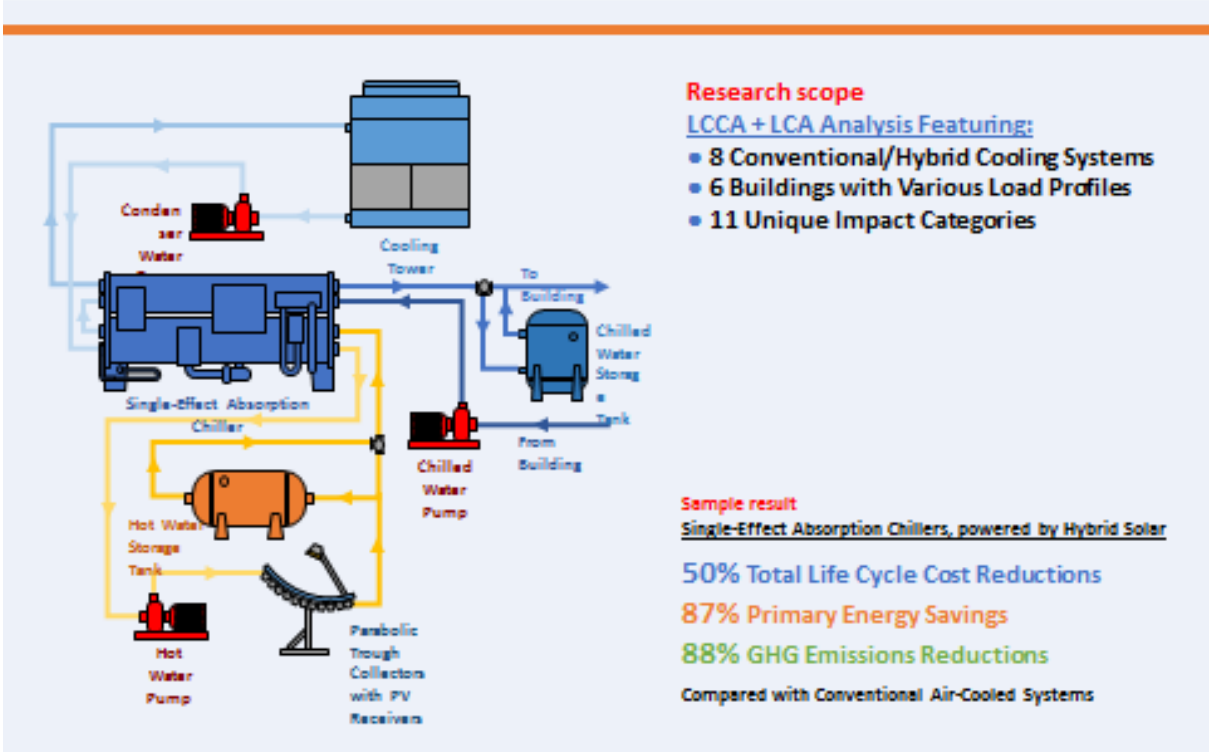
-	System Description	Code		
1	Conventional Air-Cooled	C	R	E
2	Conventional Water-Cooled	C	W	E
3	Water-Cooled Assisted Thermal Solar	A	W	T
4	Water-Cooled Assisted Hybrid Solar	A	W	H
5	Absorption Single-Effect Thermal Solar	B	S	T
6	Absorption Single-Effect Hybrid Solar	B	S	H
7	Absorption Double-Effect Thermal Solar	B	D	T
8	Absorption Double-Effect Hybrid Solar	B	D	H



GER in (TJ) for all systems with respect to each considered building



GWP in (tCO_2e) for all systems with respect to each considered building



Summary of major results

Preliminary investigation on the solar pyrolysis of waste biomass: the reactor concept

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KEYWORDS – Solar radiation, pyrolysis, biomass, reactor.

ABSTRACT

As of 2015, fossil fuels provided 78,4% of global final energy consumption (GFEC). At the same time, fossil fuel combustion is a major source of greenhouse gas emissions, which are contributing to global warming. In 2015, renewable energy provided an estimated 19.3%i of GFEC. Of this total share, traditional biomass accounted for about 9.1%, and modern renewables (eg. Solar, hydropower) increased their share relative to 2014 to approximately 10.2%. Moreover, International Energy Agency predicts that, solar become the largest source of low-carbon capacity by 2040, by which time the share of all renewables in total power generation reaches 40%.

Solar energy technology development has been largely focused on electricity generation. While solar energy is important, solar electricity does not fulfil the main advantages of high-energy density fuels (accounting for approximately 70% of the overall energy needs) for transportation, industrial processes, and heating. Consequently, it is important to utilize solar energy for the production of clean alternative fuels. One of the effective methods of solar thermochemical processes that combine concentrated solar energy and carbonaceous feedstocks together for converting solar energy to chemical fuels is solar pyrolysis.

Solar pyrolysis is the process of conversion of the carboneous feedstock into transportable and dispatchable solar fuels (biooils, biochars and gases). Bio-oil can be used as a combustion fuel for transport or electricity and heat production or as a feedstock for the production of chemicals. Biochar is attractive as a substitute fuel or for the filtration and adsorption of pollutants The gas products have various potential applications, such as being directly used for heat or electricity production, producing individual gas components (CH_4, H_2), or synthesizing liquid.

The paper presents the pyrolysis process fundamentals and assumptions for designing and constructing of experimental solar-thermal pyrolysis reactor for the waste biomass (straw, wood and sewage sludge) feedstock.

Acknowledgments

The paper has been prepared within the frame of the project "*Study on the solar pyrolysis process of the waste biomass"*, financed by the National Science Centre, Poland (registration number 2016/23/B/ST8/02101).

Conventional Weighted Least Squares State Estimation for Monitoring Low Voltage Distribution Grids

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KEYWORDS – Accuracy, investigation, low voltage distribution grid, monitoring, state estimation.

ABSTRACT

Low voltage distribution grids (LVDGs) are evolving from their traditional passive behaviour into highly active systems and will have a very significant role in the future power systems. Their secure and reliable operation will require effective control schemes which in return require reliable and accurate monitoring systems. So far, there have been little to none research efforts regarding appropriate monitoring schemes for LVDGs and most of the existing works rely on the three phase Weighted Least Squares (WLS) state estimation method which was originally developed for Medium Voltage Distribution Grids (MVDGs). However due to different characteristics between MVDGs and LVDGs this method may not be suitable for the monitoring of LVDGs. This paper investigates the performance of the WLS state estimator on a radial low voltage test feeder, where it is implicitly assumed that every consumer is equipped with a Smart Meter (SM). Due to the random nature of the measuring errors, the analysis is conducted in a Monte Carlo fashion. The investigation indicates that a significant error is imposed in the monitoring of the LVDG which is related to the loading conditions and the asymmetric operation of the distribution grid.

Strategies for operating solid oxide electrolyzers as a part of grid balancing systems in reference markets

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KEYWORDS – SOE, SOC, electrolysis, P2G, grid balancing, renewable energy

ABSTRACT

High temperature electrochemical processes occurring in solid oxide cells (SOC) can proceed both ways. The chemical energy of fuel can be converted into electricity or the electricity can be used for the steam electrolysis. The former concept has been known for years as solid oxide fuel cell (SOFC), while the later known as solid oxide electrolysis cell (SOEC) has gained a lot of attention in the last decade. The ability of the SOC to operate interchangeably between the modes allows to either deliver electricity or produce the synthetic fuel which can be a new vector in the power generator sector and serve as a storage medium. The integration of renewable energy sources such as wind and photovoltaics causes several issues to the electrical grid. Mostly, due to the intermittent character of these sources, the grid experiences imbalances which destabilize the energy system. Use of SOEC enable utilization of the excess electricity and production of the gas which can be stored for direct use during the peak hours or can be further processed to produce synthetic natural gas (SNG), liquid fuels or ammonia. The fuel can be injected into gas grids or used for various applications, including transportation. Reversion of the fuel cell can be done in a dynamic mode during operation within minutes.

System can be easily modulated and is able to frequently interchange between power-to-gas and gas-to-power modes. SOEC allows therefore the coupling of two sectors: electrical and the gas. This increases the flexibility of the combined electrical-gas grids, provides extensive storage capacities and allows way higher modulation than two separate standalone systems.

Strategies for operating solid oxide electrolyzer will be different depending on the market which is under consideration. The size of the system, the duration of the storage as well the frequency of changing the modes between SOFC-SOEC and *vice versa* relates to the energy mix, existing infrastructure, and, most importantly, the level of penetration of renewable energy sources. The article discusses possible strategies for operating solid oxide electrolysis as the technology with high potential to serve as a grid balancing tool, and also as a method to generate other products such as liquid fuels or ammonia.

Land Transport and CO_2 Emissions in Cyprus: Smart Decarbonisation Strategies for Climate Change Mitigation

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KEYWORDS: land transport sector, CO_2 emissions, climate change, smart urban isle, environmentally-extended input-output analysis, Cyprus

ABSTRACT

The transportation sector plays a key role in the economic development of Cyprus and creates high backward linkages in the economy both in growth and recession times. However, the transportation and mainly the land transport sector, is a primary source of CO_2 emissions. Between 2008 and 2013, the CO_2 emissions of the land transport sector in Cyprus were reduced by 27%, while the total CO_2 emissions were reduced by 32%; however, in the post crisis period, i.e., 2014-2016, the CO_2 emissions of the road transport sector increased by 17%, while the total CO_2 emissions rose by 6%.

An environmentally-extended input-output model was applied to estimate the direct and indirect CO_2 emissions of the economic sectors, accounting for all monetary inter-industry transactions. Our analysis indicates that the land transport sector creates the third highest (direct and indirect) CO_2 emissions within Cyprus economy; for every 1 million euro increase in the final demand of the sector's services and products, 407 additional tonnes of CO_2 are emitted. The electricity, gas and water sector and the metal and non-metal products sector generate the highest CO_2 emissions within Cyprus economy.

A case study isle in an area in the centre of the city of Limassol was selected to develop smart decarbonisation strategies in urban isles through balancing locally the energy systems and the reduction of CO_2. Our results showed that the CO_2 emissions corresponding to transportation from and to the centrally located urban isle with an average of 1000 visitors per day were 80kgCO_2/m2yr. The CO_2 emissions attributed to mobility have a share of more than 30% over the total emissions of the Urban Isle under study.

Due to anthropogenic activities, temperature in the climate hot-spot of the eastern Mediterranean is increasing at a higher rate than the global average warming. Moreover, future climate projections indicate a further increase of mean temperature throughout the year, which is expected to exceed 2°C by the end of the century, even under intermediate future scenarios. Considering that the observed and projected warming and associated impacts are strongly depending on the emissions of greenhouse gases, this study highlights the importance of implementing cost-effective strategies and technologies towards a decarbonisation pathway of the transport system in order to contribute to the mitigation of human induced climate change.

Land Transport and CO_2 Emissions in Cyprus: Smart Decarbonisation Strategies for Climate Change Mitigation

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Research Activities of Cyprus Institutions

RESEE2018 - Research activities of Cyprus Institutions – Presentation of selected research projects

1. **Energy Saving in Public Academic Buildings with Data Centers (ENEDI)** (University of Cyprus, Prof. Marios Dikaiakos)

The ΕΝΕΔΗ (ENEDI) project, aims to promote the concept of Green IT by applying energy savings in academic buildings that host data centers. Namely, for the next two years, the project aims to install and utilize photovoltaic (PV) systems to use in part for the necessary energy requirements of data centers, as well as to study and implement better energy efficiency and consumptions practices.

The latter goal will be achieved by monitoring a large set of infrastructure, energy and environmental measures that will ultimately enable automated powering on/off of virtualized resources (Virtual Machines and containers) through state-of-the art algorithms. Moreover, other scenarios will consider the migration of applications' workload amongst data centres according to the available network capacity. End-users will interface with the ENEDI platform via a modern dashboard, where they will provide access to statistical visualizations, policy editors, configurators as well as fine-granular system logs. Furthermore, the ENEDI dashboard will provide the necessary tooling that support informed decision making for green application deployment, as well as real-time notifications and alerts.

The ENEDI project is backed by a consortium of researchers and engineers from the University of Cyprus (the Laboratory for Internet Computing, the FOSS Research Centre for Sustainable Energy, and the University's Technical and IT Services), the Greek Research and Technology Network (GRNET) and the University of Crete. The project is funded through the cooperation programme Interreg V-A Greece-Cyprus.

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2. **ENERFUND - An ENERgy Retrofit FUNDing rating tool** (Cyprus University of Technology, Prof. Alexandros Charalambides)

ENERFUND is funded by the European Union's Horizon 2020 programme and poses itself the ambitious objective to enhance funding investments for deep renovation of buildings, working on three components: public awareness and trust, funding schemes and incentives and trustworthy retrofitting opportunities. The ENERFUND online app, the main project outcome, is a tool that rates and scores deep renovation opportunities.

The tool is based on a set of parameters such as Energy Performance Certificates (EPCs), number of certified installers, governmental schemes running, etc. The tool is currently being promoted and its impacts on deep-renovations will be monitored and measured.

The project consortium, led by the Cyprus University of Technology (CUT), is composed of 15 interdisciplinary organisations representing 12 EU countries, including two Universities (CUT and the Aalborg University in Denmark), two companies experienced in database creation and EPC mapping (ENERMAP from Cyprus, and Energy Action from Ireland), the Ministry of Regional Development and Public Administration of Romania as well as ten energy agencies, NGOs, SMEs and Institutions: Centre for Energy Performance of Buildings (Romania), Cyprus

Energy Agency, SERA energy & resources E.U (Austria), Energy Centre Bratislava (Slovakia), Centre for Renewable Energy Sources and Saving (Greece), Severn Wye Energy Agency (UK), Valencia Institute of Building (Spain), Sustainable Energy Development Agency (Bulgaria), Jozef Stefan Institute (Slovenia) and ENERGIES 2050 (France).

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3. **Networking for Excellence in Solar Thermal Energy Research (NESTER)** (The Cyprus Institute, Prof. Costas Papanicolas)

The Networking for Excellence in Solar Thermal Energy Research project aims in upgrading the scientific performance and innovation capacity of the Cyprus Institute (CyI) in the field of Solar-Thermal Energy and related technologies. The upgrading is targeted by embedding the Institute's activities in a network of excellence, which will provide access to the latest know-how and facilities, train CyI's scientific and technical personnel, and link it with the European Industry. Within this network the substantial investments already made by CyI in this field, but also the ones planned, will result in a harmonization and optimization of activities in STE with other leading institutions.

The NESTER project is backed by a consortium of researchers and engineers from The Cyprus Institute (CyI), Cyprus, Centro de Investigaciones Energeticas, Mebioambientales y Tecnologicas- CIEMAT (CIEMAT), Spain, Agenzia Nazionale per le Nuove Tecnologie, L'Energia e lo Sviluppo Economico Sostenibile (ENEA), Italy, Centre National de la Rescherche Scientifique (CNRS), France, and Rweinisch-Westfaelische Technische Hochschule Aachen (RWTG Aachen), Germany.

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4. **Stimulating scientific excellence through twinning in the quest for sustainable energy (TwinPV)** (University of Cyprus, Prof. George E. Georghiou)

As energy demand continues to increase in an unsustainable and non-environmental way, a worldwide need arises for advancement of renewable energy technologies. At the same time the developing world is reaching a critical pivotal point for high penetration of renewables in the national grid which is expected to result in severe operational problems unless restructuring of the current, traditional grid takes place. Thus the research field chosen to be enhanced in this project, namely PV and integration in smart grids, has a timely and significant importance of global dimensions, particularly so for regions of high solar insolation such as Cyprus and the MENA region.

The concept underpinning the project foresees linking effectively with internationally-leading research partners in the specific field. In particular, the PVlab of UCY will twin with AIT and DTU in order to enhance its research and innovation capabilities in PV and grid integration in smart grids. The specific topic has been selected based on the excellent track record and fully-operating state-of-the-art infrastructure in solar energy and PV technology research at UCY developed since 2005.

Partnering with AIT and DTU is of prime importance in seeing the targets of the PVlab materialize. The partners were carefully chosen based on their excellent track record in the field of smart grids and integration of renewables, their expertise in innovation intensive activities, spin-off companies, and industrial cooperation, as well as their know-how in institution management, operation, development and sustainability.

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5. **Transferring Energy Efficiency in Mediterranean Schools (TEESCHOOLS)** (Maria Achilleos, Cyprus Energy Agency)

TEESCHOOLS main objective is to support Mediterranean Local and Regional Authorities to comply with the Directive 2010/31/EU on energy performance of buildings and Directive 2012/27/EU on Energy Efficiency. There is an imperative need to renovate old energy consuming buildings into Nearly Zero Energy Buildings (NZEB). The need for know-how exchange and sharing of good practices is crucial for speeding up this transition. In addition, among the project's goals is to test a user-friendly software tool for simplified energy audits in the Mediterranean schools with the aim to better target the NZEB interventions and provide financial options. It will be tested in 7 pilot areas, where 35 selected school buildings will be used for energy audits, preliminary renovation plans development, calculation of carbon footprint and development of financing schemes. Training sessions will be delivered to targeted stakeholders. Schools staff, teachers and students will actively be part of communication and dissemination activities in order to tackle the behavioural change, which is a key factor for success. TEESCHOOLS' ultimate goal is to develop a set of tools and methodologies to support Municipalities, local authorities and schools' staff to conduct energy audits in an easy and cost-effective way.

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6. **Enterprise Level GHG Reduction Initiative, Business4Climate** (Cyprus University of Technology, Prof. Th. Zachariadis)

This project Business4Climate aims at the involvement of enterprises in Cyprus (non-ETS sectors) in Climate action by developing a systematic methodology of identifying GHG emissions, develop templates, evaluate performance, identify innovation projects, develop capacity building workshops, and develop financing schemes. Cyprus' national emissions reduction targets for non-ETS sectors are 5% by 2020 (baseline 2005) and 24% by 2030 (baseline in 2005). According to data from the Department of Environment of Cyprus for 2015, emissions from non-ETS sectors amount the 48% of the total emissions of 2015. Even if the national target for Cyprus of 5% reduction in emissions is achieved in 2020, the new target for 2030 (a decrease of 24% compared to 2005) is considered extremely difficult to be achieved. The project will contribute to reaching this national target by developing a systematic methodology and approach that can be transferred to all EU member states that are willing to adopt the metrics at national/regional level. Moreover, there is also absence of an instrument for capacity building for new business opportunities, circular economy and

zero carbon, and an instrument providing funding of implementation innovative project ideas in businesses.

In Cyprus (according to the official data of the Statistical Service, 2015), there are 90.162 registered enterprises in all economic sectors, including the primary sector. 95,5% is very Small enterprises, 3,8% Small, 0,6% Medium, and 0,1% Large enterprises. Thus, the target of initial signatories/participating 250 enterprises is considered achievable.
The project Business4Climate aims at the following:

- to commit more than 250 (non ETS) enterprises in all activity sectors in Cyprus to reduce their GHG emissions (not only focused on CO_2) more than 8% by 2030
- to develop a systematic methodology in order to identify baseline GHG emissions (baseline for all GHG emissions inventory) that does not currently exist is Cyprus
- to develop a template for action plan that will be used by the all signatories
- to assess the action plan, provide recommendations and approval
- to establish an Environmental Excellence Award - Business4Climate Award
- to adopt the whole project as national strategy
- to provide capacity building workshops at enterprise level including smart specialization
- to facilitating innovative projects aiming GHG emissions reductions
- to develop innovative financing scheme(s) or reward schemes for Business4Climate signatories
- to reduce GHG for the non ETS sector in Cyprus by more than 12% (by 2030)
- to develop transferable knowledge to other interested regions, countries, or organisations

The project is co-financed by Climate-KIC, supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.

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Poster Session Abstracts

Numerical modelling of cracks in PV modules

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ABSTRACT

The output of poly-and monocrystalline silicon wafers and PV cells is strongly dependent on the length, orientation and position of micro cracks in the silicon wafer. Existing micro cracks from manufacture increase the breakage risk over the whole value chain from wafer to the finished module, due to impact and thermomechanical stresses during, transportation, installation and life-field operation. The practice to reduce the thickness of the silicon wafer from about 300 to 150 µm to decrease the manufacturing costs has made PV modules more susceptible to mechanical damages. Besides the breakage risk in the production, the cells in the finished modules must be designed to withstand the stresses under outdoor operation conditions. In this work, the performance of PV modules subjected to different load types has been investigated. The finite element method has been used to study the stress field and to extract the fracture parameters needed to assess the micro crack nucleation and propagation due to the thermomechanical loads.

The impact of the design of the new UK Capacity Market on the market outcome

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Abstract

The UK Government has implemented a Capacity Market with auctions alongside the existing wholesale electricity market, to deliver reliable electricity at an affordable cost to the consumers, while moving towards a low carbon electricity market. Policy makers are concerned that the UK capacity auction, which is a descending clock auction, might be vulnerable to market power opportunities resulting in high auction prices and thus, expensive consumer bills. Some specific parameters of the UK Capacity Market have been chosen to mitigate market power opportunities. Laboratory experiments were run to investigate if those choices were justified and if the chosen design does limit the market power opportunities. The experiment was designed to study the effects of two parameters: the feedback given to participants and the pricing rule of the auction. In this experiment participants either know how many items are left in the auction at the end of each round or they have no feedback. Two pricing rules will be also tested: the last-accepted-bid, LAB, versus the first-rejected-bid, FRB. Based on the theoretical predictions it was decided to run three treatments: LAB with feedback; LAB without feedback and FRB without feedback. Although theoretical predictions show that under LAB without feedback the price of the auction will fall to the competitive equilibrium, experimental results indicate that bidders are still able to cooperate and engage in tacit collusion, driving up the price of the auction. For FRB without feedback and LAB with feedback, theory predicts a collusive equilibrium. In the experiment, bidders do exercise market power as the clearing prices are higher than the competitive equilibrium, but they do not exploit the market power opportunities fully as clearing prices are lower than the predicted ones.

EU COST Action PEARL PV: Performance and Reliability of Photovoltaic Systems: Evaluations of Large-Scale Monitoring Data

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Abstract

This poster introduces a COST Action initiated at the end of 2017 entitled PEARL PV. It shows its 4-year research and work plan with the aim to create exposure, receive feedback from various stakeholders and involve new participants to this research network. PEARL PV is the abbreviation for 'Performance and Reliability of Photovoltaic Systems: Evaluations of Large-Scale Monitoring Data'. PEARL PV aims at the formation of an inclusive network of PV system researchers, data resources that will be analyzed by researchers and experts that can include more-nuanced evidence-based reliability in PV system evaluation methods and simulation and design tools. PEARL PV aims to increase performance and lower the costs of the electricity produced by photovoltaic (PV) solar systems in Europe via (i) obtaining higher energy yields, (ii) achieving longer operational life time and (iii) lowering the perceived investment risk in PV projects. To execute the research proposed, 5 Working Groups have been set up, focused on (WG1) PV monitoring, (WG2) PV simulation, (WG3) Reliability and durability of PV, (WG4) PV in the built environment and (WG5) PV in grids.

Relationship of urban micro-climate with energy consumption and CO_2 emissions using Local Climate Zones data

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KEYWORDS – Urban Heat Island (UHI), Energy consumption, Urban form, Local Climate Zones (LCZ).

ABSTRACT

The phenomenon of Urban Heat Islands (UHIs) appears in urban areas where temperatures are higher than rural areas. Links between the occurrence of UHI and Green House Gases emissions related to energy consumption, have been recorded in recent studies (Kolokotroni et al., 2012) showing that this worldwide problem can be examined from different scientific fields. Scientific communities attempt to map the change in cities, in order to study, address and ultimately tackle the phenomenon that has a great impact on energy recourses. An example can be seen from the Geography Community that developed Local Climate Zones (LCZs) (Stewart and Oke, 2012) in an attempt to characterize cities in respect to their geographical aspect and visualize the urban micro-climate. A world database, the World Urban Database and Access Portal Tools (WUDAPT), collects the physical geographies of interested areas to offer science usable data to work with. The aim of this study is to correlate LCZ with CO_2 emissions and consequently the energy consumption. New variables were defined based on LZC. As area of study, Metropolitan London was designated due to the availability of data. End-user CO_2 emissions for the area of study with satellite imagery were collected from competent authorities to be studied. Multi-Resolution Analysis (MRA) and Principle Component Analysis (PCA) were used through a new methodology to extract results and associate the various variables of the datasets, respectively. Strong correlations between physical characteristics of cities and CO_2 emissions were identified.

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The multi-scale character in building energy demand as a guide to urban design

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KEYWORDS – Building energy demand, Urban building parameters, Urban-scale energy analysis, Multi-resolution analysis.

ABSTRACT

In this work we conduct a rigorous multi-scale analysis of high-resolution dynamic simulation output data of the energy demands in London obtained by Tian et al. (2015) and we demonstrate how such a multi-scale analysis can benefit an improved energy demand management for more energetically sustainable societies. Specifically, we analyse 24-hour evolutions of the urban energy demands for heating and cooling of the London Westminster Borough building stock over different seasons and investigate the association of these energy demands with a number of urban parameters. By using a rigorous scale-adaptive approach, the Multi-Resolution Analysis (MRA), we enable new insights to emerge into the urban- and sub-urban (e.g. district) scale energy demand behavior and therefore unveil a scale-adaptive decision-making process. Furthermore, we introduce a scale-adaptive correlation of the energy demands with the urban parameters and find rigorously how sensitive these correlations are to scale/size of the district considered. This enables decision makers to decipher the degree of impact of their proposed actions based on the size of the region over which a decision is to be applied and the urban parameter primarily involved.

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Assessment of the benefits of Battery Storage in Nearly Zero Energy Buildings for peak load shaving and increased self-consumption

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KEYWORDS – Battery Storage Systems, Lithium-ion, Nearly Zero Energy Buildings, Peak load shaving, Self-consumption, Photovoltaics.

ABSTRACT

Nearly Zero Energy Buildings (NZEBs) are to become mandatory by law by 2020 in the EU. As a result, the different member-states, including Cyprus, are developing plans to increase the number of NZEBs, which usually employ Photovoltaics (PV) to reach the renewable energy source targets for a building to qualify as NZEB (for example in Cyprus the target is 25% of the total energy demand to be covered by RES for a building to quality as NZEB). As the number of NZEBs increases, PV integration in the grid may be hindered due to the unpredictable nature of PV, unless buildings that integrate such systems become more grid-friendly. This will be achieved by using energy storage and specifically Battery Storage Systems (BSS), which will transform the building into a more predictable power source. BSS can be mainly used for peak load shaving and increase of the building's self-consumption, thus benefiting the building by minimizing grid interaction and the utility, by increasing energy security by controllable PV penetration in the energy mix and reducing CO_2 emissions from high polluting power stations. In this work, an energy management algorithm for peak load shaving and maximum self-consumption will be developed, in order to enhance the penetration of PV in the built environment. Real PV production and load profile data of prosumers in Cyprus will be used, along with indoor environmental conditions in order to meet the energy requirements and to ensure thermal comfort.

Analysis of regulatory framework for the wholesale electricity market in Cyprus

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KEYWORDS – Energy Market, Market Structure, Forward Market, Day–Ahead Market, Cyprus Wholesale Electricity Market.

ABSTRACT

The energy market structure of Cyprus is in a transitional period, influenced by this fact the aim of this study contemplates the issue of the transition in the electricity sector from monopoly market structures to competitive market structures. In particular, the application of a new competitive market structure was examined for Cyprus wholesale electricity market. Cyprus new competitive market structure is simulated by a mathematical model which analyses and solves the selected cases under investigation. Through solving the mathematical model, analytical data about the Forward and the Day-Ahead electricity markets could be exported. The functionality of the reorganized electricity market, for the selected cases under investigation, can be assessed through the results exported by the model. This mathematical model simulates the reorganized energy market of Cyprus and the way it operates. The mathematical model is modified based on the three chosen extreme cases, which stem from the historical background of Cyprus electricity market, the reorganization of other electricity markets and the new EU targets regarding its energy policy.

A rational theoretical approach of the electricity market, as the one presented in this diploma thesis, leads to a better understanding of its operation. Examining the results of the chosen cases, conclusions were drawn on how the competitive electricity market operates, on the scope of speculation and exploitation of the forthcoming electricity market, as well as on the problems that arise from the increased (excessive) injection of RES into the grid. All the results, which were exported for the selected cases under investigation, intended the optimization of the new electricity market model.

Harmonic Analysis of a grid connected 10.8 MW Wind Farm in Cyprus

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Abstract: - The work presented in this papert focuses on the harmonic analysis of waveform data recorded on two different occasions from a 10.8 MW wind farm in Cyprus. The work has identified a variation in individual and consequently total harmonic distortion levels relative to the power output of the wind farm. The voltage and current waveforms have been recorded at various power output levels of the wind farm. The power output was categorized, and the data recorded were analysed and correlated with the power output. The analysis was done using the Fast Fourier Transform (FFT) function in MATLAB and the results were subsequently compared with Institute of Electrical and Electronics Engineers (IEEE) standard limits. Although the individual current and voltage harmonics are low, significant DC distortion has been detected. As a result, the current Total Harmonic Distortion (THD) appears to violate the standard limits.

Assessment of thermal bridges in building walls using finite element heat conduction analysis

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KEYWORDS - Building wall insulation, Thermal bridge, Finite element heat transfer analysis.

ABSTRACT

The thermal energy efficiency of contemporary buildings is controlled by appropriately insulating walls, roofs, window/door openings, etc. Despite the codes developed to aid in achieving minimum thermal energy consumption in buildings, a high level of energy performance is often not attained. This happens because of the presence of thermal bridges in the building envelope, which are created where the insulation layer is penetrated by a material with higher thermal conductivity causing energy loss.

The effect of thermal bridges in building walls can be assessed by calculating the thermal energy loss. In the simple analytical expressions typically used to determine the wall thermal resistance, one-dimensional heat flow along the thickness-dimension of the wall is assumed. This is a limitation that hinders the assessment of thermal bridges, which are usually present at wall segments with junctions and irregular geometry resulting in multi-dimensional heat flow.

In the present work, two-dimensional steady state heat conduction analyses of building wall segments are performed using the Finite Element (FE) method. The analyzed walls are composed of homogeneous isotropic materials, thus constant thermal conductivity across each material is assumed. The result of each FE heat transfer analysis conducted is the two-dimensional temperature distribution in the wall segment considered, from which heat fluxes and the overall energy loss from the wall can be computed.

The FE procedure described above allows us to numerically examine a number of building wall configurations with thermal bridges encountered in construction practice. Each wall configuration is assessed with respect to the corresponding energy lost due to thermal bridging. Sensitivity analyses are performed to study the influence of variation in thermal conductivities of wall constituents on the overall energy efficiency of the wall. Suggestions are made and numerically investigated to alleviate the energy loss effect of thermal bridges.

CAN PHOTOVOLTAICS ALONE BE USED FOR SOLAR POWER FORECASTING?

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Abstract

During the past few years, with fossil fuels in the verge of exhaustion there has been major progress in the utilization of renewable energy sources (RES) to produce electricity. Solar energy has become a promising alternative source due to its advantages; abundance, pollution free and renewability. The continuous development of technologies that use solar energy, leads to the need of accurate knowledge of the amount of incident solar irradiance on the surface of the Earth. Substantial research effort is being spent by several researchers on the development of solar irradiance models, either ones based on the Angstrom equation or other more complex models based on various parameters. However, the solar energy generation is highly variable because of its dependence on meteorological conditions. This uncertainty is mainly caused by the strong impact of cloudiness on surface solar irradiance. Thus, an accurate description of the temporal development of the cloud situation is essential for solar irradiance forecasting.

In this paper, we focus our attention on solar irradiance prediction without using meteorological data or specialized equipment such as all sky cameras. The main feature of our proposed methodology is that predictions can be derived only from the output data of photovoltaic (PV) power systems. In order to validate our methodology, two exercises were undertaken. The first one was to investigate whether 'clear sky' PV production can be calculated through PV historical data (so that we can measure electricity production decreases due to the presence of clouds). The second is related to a computational exercise as to the minimum number of PVs needs to predict cloud cover.

For the first exercise, PV output data was collected from a PV station in Nicosia, Cyprus. In order to test how many days should be taken into account to get useful results, we randomly selected at first only 10 days and averaged them, and then 20 other randomly selected days and took their average. These data sets were interpolated by applying the spline interpolation method. In order to find the best fit for the given data for each month, the data obtained was correlated with clear-sky data. Therefore, four different methods were tested; a parabolic function, a nonlinear curve fitting, a modified Gaussian function and a method which detected outliers which was interpolated afterwards. A comparison from existing methods is given in Figure 1.

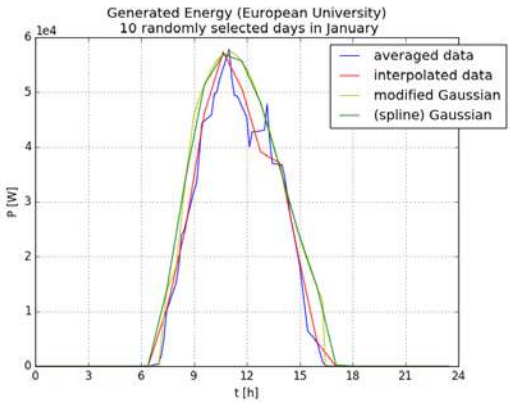

Figure 1: The amount of generated energy of European University's plant after conducting the above stated methods.

Regarding the calculation of the cloud coverage, the geographic information systems (GIS) geoprocessing over an area of 10km x 10km was used and the methodology was performed in three steps. Firstly, by using a modified version of the midpoint displacement algorithm, the fractal-based cloud shadows in the area of 100 km^2 were produced. These random cloud shadow patterns were used to calculate the real 'simulated' cloud cover to be used in the model and to identify which PV systems were under shade in order to estimate the 'predicted' cloud cover. In the next step, 1000 randomly distributed residential PV power systems were generated and two different scenarios were examined. In the first scenario, the PV systems were placed to cover the whole extent of the studied area, whereas in the second scenario big parks, roads and waterways were considered as blind areas with no PVs. Hence, the number of PVs under cloud shade was tabulated and the shade of coverage in square kilometers per okta was predicted, too. At the third step, the 'simulated' oktas was calculated based on the generated shadow cover and the estimation of the 'predicted' cloud cover from the PV systems under shade. Then, the 'simulated' cloud cover was compared with the 'predicted' cloud cover to calculate the accuracy and the associated errors of the method in each scenario using the Root Mean Square Error (RMSE).

The accuracy of the estimated cloud coverage, based on the number of shaded stations, was calculated and presented in the form of confusion matrices. Results have shown that an average accuracy of 94% was achieved with scenario one (Table 1). On the contrary, the second scenario produced slightly less accurate cloud cover estimations with an average accuracy of 88% (Table 2). Moreover, lower accuracies were achieved at cloud cover 2 and 3 oktas and at 3 to 5 oktas in scenarios one and two, respectively. It seems that when distributed PV power systems are not present throughout the whole area we get lower accuracies regarding the cloud coverage in oktas.

Table 1: Confusion matrix yielded by the proposed methodology for the evaluation of the per-okta accuracy of the estimated cloud coverage by 1000 PVs distributed in the whole area.

		Real okta								
		0	1	2	3	4	5	6	7	8
Simulated okta	0	100%								
	1		98%	10%						
	2		2%	86%	18%					
	3			4%	80%					
	4				2%	92%	2%			
	5					8%	90%	2%		
	6						8%	98%	2%	
	7								98%	
	8									100%

Table 2: Confusion matrix yielded by the proposed methodology for the evaluation of the per-okta accuracy of the estimated cloud coverage by 1000 PVs distributed in areas without parks, roads and waterways.

		Real okta								
		0	1	2	3	4	5	6	7	8
Simulated okta	0	100%								
	1		98%	6%						
	2		2%	92%	32%					
	3			2%	64%	16%				
	4				4%	82%	4%			
	5					2%	72%			
	6						24%	88%	4%	
	7							12%	96%	
	8									100%

Given the fact that PV data can provide important information about solar irradiance and cloud coverage over an area, we believe that by combining the results from the two exercises over a specific area, a model for precise forecasts of solar energy production can be developed.

High-Performance Building Envelopes: Re-leave Project. Double-Skin Green Façade Applications in Nicosia.

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KEYWORDS – Double-Skin Façades, climate responsive design, shading, green facades, passive cooling, energy retrofit.

ABSTRACT

The Postgraduate Specialization Course ARH 539 «Advanced Topics in Architectural Technology», provided by the University of Cyprus' Department of Architecture, aims at developing an energy-orientated design methodology for high-performance building envelopes. The case study building assigned for this purpose is an existing office building in Nicosia, built in the late 1970s.

As identified through in-situ preliminary audits and occupant interviews, this building has several energy-related challenges, as well as functional, construction and aesthetic issues. With the use of thermographic methods, potential thermal bridging and structural weaknesses were identified. Climatic analysis on a macro and micro scale was a prime design tool to define the passive design strategies.

The principle element of the proposal is the introduction of green facades, as their benefits are numerous on both an urban and a building scale. The climbing deciduous plants which were introduced, provide shade during the summer months and enhance evaporative cooling, while reducing the mitigation of the urban heat island effect. They protect against strong wind blasts and noise, contribute to the improvement of air quality thanks to dust filtration and oxygen production, and finally improve the productivity of the occupants by creating a friendly working environment. The double skin façade has frequent openings and is linked with two lateral ventilation towers, to extract warm air due to the stack-effect during the cooling period. Additional shade is provided by shading elements that also work as lighting shelves. During the heating period, the ventilation towers are deactivated, while the double skin construction serves as a buffer zone and a solar heat collector due to the greenhouse effect. In this way, energy, functional and aesthetical design criteria are merged into the retrofit project.

High-Performance Building Envelopes: Energy Retrofit Interventions in a High-Rise Office Building in Nicosia

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KEYWORDS – Double Skin Façades, climate responsive design, passive systems, green facades, Trombe wall, energy retrofit.

ABSTRACT

In the framework of the Postgraduate Courses provided by the Department of Architecture of the University of Cyprus, the specialization course ARH 539 «Advanced Topics in Architectural Technology», focuses on the design of energy resilient building envelopes. Emphasis is given to environmental design principles (lighting, ventilation, climatic adaptability), as well as the integration of RES-based and efficient heating, cooling and ventilation systems in energy retrofit projects.

The assigned case study building is a high-rise office building in the centre of Nicosia, Cyprus, which was built during the 1970s. It shares common characteristics with most of the office buildings constructed during the same period, i.e. a lack of thermal insulation and central heating and cooling systems, extensive glazing surfaces, single glazing openings and deficient shading. As a result, it is a highly energy-requiring and power-consuming building that, according to the occupants, fails to provide thermal and visual comfort conditions. Following a thorough climate analysis and occupant interviews, thermographic methods were used to define the renovation design strategy. Aesthetic, functional and energy-related criteria were all taken into account.

The design proposal entails the reformation of the architectural layout; i.e. the transformation of the working space into an open plan area allowing for more uniform visual and thermal distribution, as well as cross-ventilation. A high-performance double-skin façade envelope with building-integrated photovoltaics (BIPV) are incorporated on the south façade. Accordingly, high thermal mass elements (Trombe-Michel wall), in combination with adaptable shading elements are also proposed. The double façade system is used as a greenhouse during the heating period, allowing for passive heating. Deciduous climbing plants are proposed on the northeast and northwest openings for shading purposes, potential evaporative cooling, air quality improvement and glare control. Finally, an additional central heating and cooling system is proposed, along with a rain water collection system and grey water filtering system. In this way, active and passive means are merged into climate-responsive design.

Capstone Design Project: A Methodology Approach Towards Sustainable Energy Retrofit Solutions in Cyprus

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KEYWORDS – energy efficiency, dynamic simulation, passive systems, energy retrofit, educational buildings

ABSTRACT

In the framework of the Interdepartmental Postgraduate Programme «Energy Technologies and Sustainable Design» (IPP-ETSD), hosted by the University of Cyprus, the Capstone Design Project (POL 604) aims at applying a holistic design approach to building energy retrofit. Multidisciplinary teams consisting of architects and mechanical, electrical and civil engineers, are merged in order to propose sustainable energy retrofit interventions in an existing public building used for educational and office purposes located in Nicosia. The building is an example of a typical construction from the late 1970s.

The first stage of the methodology consists of a thorough analysis of the climate and a series of architectural, construction and functional attributes of the building; such as the layout, operation scheme, building materials, surrounding environment, HVAC systems, insolation and local wind conditions. Preliminary in situ audits, climate data analysis, and end user interviews are used in order to estimate the existing functional and comfort requirements. The following methodological stage, concerns the modelling and dynamic simulation of the building, using the EnergyPlus software. The simulation provides detailed calculation of the heating and cooling consumption in hourly base time-steps, enabling in this way, a comparative analysis of various parametric design solutions and intervention scenarios.

Finally, retrofit proposals focus on passive and active means, and provide solutions concerning sun shading systems, smart-responsive façades, green roofing and hybrid lighting systems, as well as RES-based and high efficiency heating, cooling and ventilation systems. Contemporary approaches regarding the prototypes of nearly-zero energy and low-carbon emission buildings, retrofitted by eco-friendly materials are also explored.

Integration of Behind-the-Meter (BtM) Battery Storage Systems (BSS) in the Cyprus Electricity Network – The StoRES Project

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KEYWORDS – Battery Storage Systems, Lithium-ion, Self-consumption, Grid interaction.

ABSTRACT

The StoRES project (co-funded by the European Union and national funds) addresses the development of an optimal policy for the effective integration of Renewable Energy Sources (RES) and Battery Storage Systems (BSS). The primary challenge is to achieve increased penetration of RES and predominantly photovoltaics (PV), in the energy mix of islands and rural areas in the Mediterranean (MED) region without compromising grid stability. The main objective of the project is to boost self-consumption in the six participating countries with the integration of optimal storage solutions. This poster presents the development and integration of the proposed solution at the residential level in Cyprus and the application of the BSS pilot functionalities to increase energy Self-consumption and Self-sufficiency. As a result, intermittent grid feed-in power from households with PVs and subsequently grid interaction are reduced. Real PV production and load profile data of prosumers in Cyprus were used to extract and analyse typical production and consumption profiles.

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