



FOSS

Research Centre for
Sustainable Energy

Annual Activity Report 2017



University of Cyprus
Research Centre for
Sustainable Energy

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About the Centre

FOSS Research Centre for Sustainable Energy was created in order to play a key role in research and technological development activities in the field of sustainable energy within Cyprus and at international level with the aim of contributing to the achievement of the relevant energy and environment objectives set out by Europe. In particular, FOSS strives to become a centre of excellence in energy that will act as a structure where world-standard R&D work can be performed, in terms of measurable scientific production (including training) and/or technological innovation. In FOSS significant research expertise from the University of Cyprus as well as from industry has been assembled that spans a host of fields: Electrical, Mechanical, Civil, Environmental, Chemical Engineering, Physics, Chemistry, Economics, Finance, Computer Science as well as Architecture.



Thematic Areas

- Renewable energy sources (RES) with an emphasis on solar energy
- Distributed generation and microgrids
- Smart electricity networks
- Nearly Zero Energy Buildings (NZEB)
- Enabling technologies including energy storage and ICT

Application Areas and Research Projects

- Energy efficiency and energy saving
- Demand Side Management
- Storage
- Energy in Smart cities
- Electric mobility
- Integrated services
- Energy Policy and Energy economics
- Education and awareness work on sustainable energy matters

Impact

FOSS aims to be established as a regional research and innovation (R&I) hub of excellence which will generate novel ideas, provide a strong stimulus for interdisciplinary co-operation and be an internationally respected, state-of-the-art training and education centre. The Centre of Excellence will generate an effective research and innovation culture in Cyprus and the surrounding region, promoting effective cooperation between academia, industry and business sectors, as well as contributing to the transfer of knowledge from advanced European clusters to the region. The Centre will create a test-bed and “living lab” in the areas of energy and sustainability and will be a major driver to facilitate commercialization of innovation in energy-related fields in Cyprus, Europe and the Middle East/North Africa (MENA) region.

Message from the Director

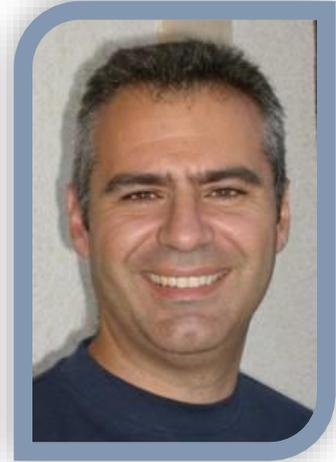
FOSS Research Centre for Sustainable Energy has shown continuous progress throughout the years, demonstrating its relentless passion to thrive in Research and Innovation through its academic accomplishments, state-of-the-art infrastructure and collaboration with leading international organisations but also in raising education awareness.

Moreover, in the past year FOSS has secured significant funding via competitive research grants that has given the opportunity to promising researchers to further their career. Some examples of new research projects currently running are inteGRIDy, PV-ESTIA, INTERPLAN, INFORPV to name a few, supported by programmes such as H2020, SOLAR ERA.NET, Interreg MED, LIFE and the Research Promotion Foundation. Simultaneously, FOSS collaborates with internationally-esteemed research institutions, such as the Austrian Institute of Technology (AIT) and the Technical University of Denmark (DTU). Additionally, FOSS promotes the dissemination of innovation throughout Cyprus and Europe, as it is a front runner in market-creating innovation. Specifically, the services FOSS offers to world renowned companies such as Honeywell, QCells and through its collaborations with IBM, EAC etc. show how committed FOSS is to offer excellent services at an international level.

Concurrently, FOSS offers numerous teaching courses for university students from undergraduate to postgraduate level as well as vocational training courses. Its focus is on smart grids for energy saving, renewable energy sources and enabling technologies. The main objective is to bridge the gap between theory and practice and boost the ability for anyone with interest in sustainable energy to be engaged at any level.

Overall FOSS had a very productive year securing record levels of competitive funding for research activities with leading organisations within and outside Europe and has provided the opportunity for new additions to its team. In fact, at the end of 2017 FOSS had a record number of members exceeding 40 people, predominantly PhD students and post-doctoral fellows. FOSS's new aspiration is to bring awareness of sustainable energy to the public through education of the younger generations, and also to foster innovation, entrepreneurship, creativity, employability and knowledge exchange.

Dr. George E. Georghiou



Message from the Chairman

The University of Cyprus and FOSS in 2017 progressed with conviction in the direction of fulfilling their societal objectives. Education and research go hand in hand and work done in 2017 reveal understanding of this real need of modern societies, but progress is slow calling for more attention in the years ahead.

FOSS is following closely the legislative procedures in Europe for transforming the clean energy package into approved legislation that is binding to all Member States so that the agreed strategy receives the required policy instruments to materialize. 2017 has seen Europe working hard in this direction and the attempts have been hugely enhanced by very promising technology developments in support of sustainable solutions:



1. RES has matured into competitive alternatives to the energy mix reaching parity in many parts of Europe (wind in the North and solar in the south).
2. Storage is rapidly becoming the technology that will suitably complement RES systems in managing intermittency, offering solutions for continuity of supply over 24 hours.
3. Smart grid solutions for managing the interconnected grid is encompassing technologies that offer the intelligence to mingle efficiently all emerging technologies offering a responsive interconnected system that safeguards security and quality of supply.
4. Efficient solutions for the final use of energy in all spheres of the economy that sees society to go in the direction of being more electric (mobility, heating, cooling etc) and seriously investigating the return to more DC in our everyday life.

In line with the above developments, FOSS is primely suited to align with these objectives and offer its services to the wider community that can deliver actions to preserve the distinctive natural resources of Cyprus and strengthen social inclusion, education and citizens' empowerment.

It is true to say that the world has never experienced such dramatic calls for transition. As can be seen from the results achieved till today, FOSS's intervention is effective with measurable results. We plan to continue in this direction, since we truly believe that Cyprus is blessed with resources to respond effectively to the objectives of the clean energy package and build a dynamic economy that is resilient and flexible.

FOSS is working hard to be responsive and adaptive to the needs of the Cyprus economy. We have tried to present in this report the most important aspects of the work done in 2017. We look forward to fulfilling planned work and objectives with realism for achieving a brighter future for the generations that are following suit. It is very encouraging that they are much more demanding with vision for a fairer society that can deliver the technologies and solutions for saving our planet. We do align with this vision calling for a concerted effort to build on the experience gained and positively capture the opportunities that are ahead of us!

Dr Venizelos Efthymiou

Committees

Board

Prof. Andreas Alexandrou, University of Cyprus

Dr. Venizelos Efthymiou, University of Cyprus (Chairman)

Prof. Costas Georghiades, Texas A&M University

Dr. George E. Georghiou, University of Cyprus (Director)

Prof. Nikos Hadjiargyriou, National Technical University of Athens

Prof. Christoforos Hadjicostis, University of Cyprus

Dr. Ioannis Krikides, University of Cyprus

Mr. Marios Tsiakkis, Secretary-General of Cyprus Chamber of Commerce and Industry

Academic Committee

Dr. Charalambos A. Charalambous, Department of Electrical and Computer Engineering

Prof. Charalambos D. Charalambous, Department of Electrical and Computer Engineering

Dr. George E. Georghiou, Department of Electrical and Computer Engineering

Dr. Demokritos Gregoriadis, Department of Mechanical and Manufacturing Engineering

Dr. Andreas Kyprianou, Department of Mechanical and Manufacturing Engineering

Dr. Marina Neophytou, Department of Civil and Environmental Engineering

Prof. Panos Papanastasiou, Department of Civil and Environmental Engineering

Dr. Marios C. Phocas, Department of Architecture

Dr. Panayiota Pyla, Department of Architecture

Members

Dr. Charalambos A. Charalambous, Department of Electrical and Computer Engineering

Prof. Charalambos D. Charalambous, Department of Electrical and Computer Engineering

Dr. George E. Georghiou, Department of Electrical and Computer Engineering

Dr. Demokritos Gregoriadis, Department of Mechanical and Manufacturing Engineering

Dr. Christos Hadjichristos, Department of Architecture

Dr. Stavros Kassinos, Department of Mechanical and Manufacturing Engineering

Dr. Andreas Kyprianou, Department of Mechanical and Manufacturing Engineering

Dr. Alexandros Arsalis, Department of Mechanical and Manufacturing Engineering

Dr. Aimilios Michael, Department of Architecture

Dr. Marina Neophytou, Department of Civil and Environmental Engineering

Prof. Panos Papanastasiou, Department of Civil and Environmental Engineering

Dr. Marios C. Phocas, Department of Architecture

Dr. Panayiota Pyla, Department of Architecture

Dr. Andreas Savvides, Department of Architecture



Memberships

European Distributed Energy Resources Laboratories (DERlab)

DERlab is the association of leading laboratories and research institutes in the field of distributed energy resources equipment and systems. The association develops joint requirements and quality criteria for the connection and operation of distributed energy resources (DER) and strongly supports the consistent development of DER technologies. DERlab offers testing and consulting services for distributed generation (DG) to support the transition towards more decentralised power systems. The various activities in research, pre-standardisation can be found at: <http://der-lab.net/>



EERA AISBL

Since April 2014, the European Energy Research Alliance EERA AISBL, as an international not-for-profit association by Belgian law, is formally the organization that works on Energy Research at European level to deliver on the SET Plan. AISBL stands for Association internationale sans but lucratif (International Non-Profit Organization). EERA AISBL has been established to obtain legal capacity to operate. The purpose of the Association is to strengthen and to expand Europe's capabilities in sustainable energy research by connecting and joining European energy research activities. The coordinated and streamlined efforts of the Association, in particular the coordinated joining of different public research programmes at regional, member state and European level, shall enable all stakeholders of energy research to optimise their research efforts and to overcome fragmentation in order to accomplish a strategic and targeted development of next generations of energy technologies. The efforts of the Association take place in the context of and contribute to the targets formulated in the Strategic Energy Technology (SET) Plan. More details can be found at: <https://www.eera-set.eu/>





European Energy Research Alliance (EERA) Joint Programme for Smart Grids

The European Energy Research Alliance (EERA) contributes to coordinate a massive public research effort to develop more efficient and cheaper low carbon energy technologies. Wind turbines and solar panels, building a “smart” electricity grid, harnessing energy from the oceans and underground heat sources, as well as finding new ways to store and use energy instead of wasting it. EERA is the public research pillar of the EU Strategic Energy

Technology Plan (SET-Plan). This tightly focused strategy aims at accelerating the development and market uptake of key low carbon technologies. The Joint Programme on Smart Grids was officially launched at the SET Plan Conference in Madrid (3-4 June 2010). The Joint Programme, coordinated by RSE and ENEA from Italy by means of an extended cross-disciplinary cooperation involving many Research and Development (R&D) participants with different and complementary expertise and facilities, aims at addressing in a medium- to long-term research perspective, one of the most critical areas directly relating to the effective acceleration of smart grid development and deployment. More details can be found at: <http://www.eera-set.eu/eera-joint-programmes-jps/smart-grids/>

The Association of European Renewable Energy Research Centres (EUREC)

EUREC, is the leading association representing research centres and university departments active in the area of renewable energy. EUREC was founded in 1991 as European Economic Interest Grouping (E.E.I.G.) with the goal of improving the quality and scope of European research and development in renewable energy technologies. The purpose of the association is to promote and support the development of innovative technologies and human resources to enable a prompt transition to a sustainable energy system. EUREC is the voice of renewable energy research in Europe, representing European Research Centres active in renewable energy. More details can be found at: <http://www.eurec.be/en/>





International Energy Agency

The International Energy Agency (IEA) Photovoltaic Power Systems Task 13 workgroup aims to improve the operation, reliability, electrical and economic outputs of photovoltaic (PV) systems. The workgroup focuses to provide reliable information to the PV industry with respect to the different PV applications and system locations (e.g. different countries, regions, and climates), technical issues such as adapting test methods and lifetime assessments and optimization of PV systems economic and institutional issues such as

the comparison of investment costs and energy costs. FOSS members have been invited to participate as observers contributing to the activities of this initiative.

Collaboration Agreements

Memorandum of Understanding between Nicosia Municipality and the FOSS Research Centre for Sustainable Energy



The Mayor of Nicosia, Konstantinos Giorkatzis, signed a Memorandum of Understanding with the Director of FOSS Research Centre for Sustainable Energy, Dr. George E. Georghiou, on February 1, 2017.

An important objective of the collaboration is the development of a Smart City Strategy for Nicosia, where FOSS Research Centre for Sustainable Energy can provide energy expertise related to a long-term plan on how the Nicosia Municipality could use

technology to improve the city's functions and the better service of the citizens. FOSS Research Centre for Sustainable Energy has already developed an important framework for cooperation with the submission of proposals on the Horizon 2020 financial framework and other competing programs. At the same time, further development of synergies between the municipality and the research sector is being promoted, thus contributing to the promotion of research and innovation and to strengthening cooperation with the academic and research institutions of the site. The Memorandum of Understanding provides the development of actions such as student internships, complementary training, dissertation, joint participation in research and other programs and the exchange of know-how.

The agreement was signed in the presence of the President of FOSS Research Centre for Sustainable Energy, Dr. Venizelou Efthymiou and the staff of the Municipality of Nicosia.

Services to the Community

Education

Members of FOSS provide teaching to students of the University of Cyprus, at undergraduate and postgraduate level. Also, for masters projects, students receive guidance from the faculty of FOSS Research Centre for Sustainable Energy. FOSS also provides vocational training courses to professionals on energy issues.



Academic Courses

ECE447: Renewable Energy Sources: Photovoltaics

This course covers theoretical and practical aspects of photovoltaic technology and in particular introduces students to aspects of solar generation, technology characteristics, design principles and system types. The course covers the following: Introduction to renewable energy sources with main emphasis on photovoltaic (PV) energy conversion. Current state in Cyprus and potential. Types of photovoltaic systems. History of photovoltaic technology development. Current status: Technology, Policy, Markets, System Design and Sizing, Grid integration.

ECE687: BIPV - Towards nearly zero energy buildings (NZEB)

This course covers theoretical and practical aspects of building integrated photovoltaics (BIPV) in the realm of nearly zero energy buildings (NZEB). The objective of the course is to train students in NZEB strategies and technologies in order to accelerate the adaptation of the recast EU Energy Performance in Buildings Directive (EPBD), which includes the obligation for all public buildings constructed after the 31st December 2018 and all buildings constructed after the 31st December 2020 to meet the EPBD NZEB standard.

Vocational Training

PV System Designer and Installer

This course covers theoretical and practical aspects for trainees to develop skills and understanding on the design and installation of both stand-alone and grid-connected photovoltaic (PV) systems alongside with innovative topics such as self-consumption, smart meters and storage. The main topics covered throughout the course include initial site assessments of the installation area using site-survey equipment, risk assessment analysis, system design, installation and basics of commissioning, maintaining and troubleshooting PV systems. Emphasis is also given to all the requirements of a grid-connected PV system according to all related international standards with main focus the design qualification and type approval requirements of terrestrial PV modules, as outlined in IEC 61215 and 61646. The general performance testing requirements according to IEC 62446 are also defined.



Grid connected PV System minimum requirements for system documentation, commissioning tests and inspection according to EN 62446

Ensuring the long-term quality and safety of a PV system is a necessary requirement in order to assure the best performance and to minimize risks of failure. In addition, the periodic verification of system performance is of utmost importance so as to check whether the system complies with warranty and equipment guarantees, minimizing in this way investment risks. This course covers theoretical and practical aspects for trainees to develop skills and understanding on the minimum requirements for documentation, commissioning and inspection of grid connected PV systems according to IEC 62446. Candidates have the opportunity to operate professional state-of-the-art equipment (located only in a few places globally) and to be trained by worldwide renowned personnel.

New electricity market rules in Cyprus

This course attempts to introduce to participants the logic of the functioning of competitive electricity markets, which have been experiencing rapid growth in the last few years on a global scale, particularly in Europe. The course is addressed to executives of electricity companies as well as to private investors who want to expand their knowledge of the energy industry. It is also aimed at anyone who wants to be actively involved in the growing energy market. The knowledge and skills acquired through the program will be able to attract potential investors and lay the foundations for their future work in this fast growing field.

Course on Nearly Zero Energy Buildings (NZEB)

At the end of 2015, a series of free postgraduate level training courses in Nearly Zero Energy Buildings (NZEB) began around Europe as part of the European project MEnS (<http://www.mens-nzeb.eu>). In Cyprus the courses are offered by the University of Cyprus and specifically FOSS Research Centre for Sustainable Energy. These courses aim to empower building professionals through the development of skills in energy efficiency and integration of renewables in the retrofit of existing housing stock. The objective of the course is to train building professionals in NZEB strategies and technologies in order to accelerate the adaptation of the recast EU Energy Performance in Buildings Directive (EPBD), which includes the obligation for all public buildings constructed after the 31st



December 2018 and all buildings constructed after the 31st December 2020 to meet the EPBD NZEB standard. The focus of the courses will be on the renovation of existing housing stock.

Educational and Testing Centre

FOSS Research Centre for Sustainable Energy has recently become an Educational and Testing Centre, certified by the Ministry of Energy, Commerce, Industry and Tourism. We will keep the public updated about these new educational goals. FOSS extends its offer to the society by conveying knowledge acquired through its research activities and provides training and education courses to professionals.

School visits

Over 250 schools have visited FOSS's PV Technology facilities to learn more about photovoltaic technology. Children have the opportunity to be exposed to the latest technologies through experiments. The presentation covers the outdoor and indoor infrastructure and tests carried out on a daily basis. At the outdoor facility the students understand the operation of both a grid-connected and stand-alone PV system. At the indoor infrastructure they see the equipment (climatic chamber and sun simulators) required for the indoor simulation of PV cells and modules.



Government, Local / Regional Authorities and Industrial Services

One of FOSS's prime objectives is to provide constant support to the various government departments, municipalities / communities and the local industry. Attempts will be continuous for building trust and be in a position to positively intervene in the day to day issues that are worrying the government, local communities and the local industry to offer services for valued solutions whenever the need arises. As covered in other areas of this report, FOSS is already cooperating on these issues signing MoU wherever needed and responding to requests for support on specific issues. FOSS can be the catalyst for informed solutions to all energy related problems that the Cypriot community is facing and we will gladly take this role since we consider it to be one of the prime objectives for the establishment of universities and more specifically for the creation of the research centre FOSS and giving it the multi-discipline character and content that is currently enjoying.



Public Awareness

An Energy Day Workshop of the SmartPV project at the University of Cyprus: “Promoting further penetration of PV aligning with the objective of Clean Energy for all Europeans”

On the 5th of May 2017, SmartPV consortium organised an Energy Day workshop titled “Promoting further penetration of PV aligning with the objective of Clean Energy for all Europeans”. The workshop was

combined with the celebrations of 25th year’s anniversary of Life programme. Ms. Marilena Papastavrou, representing the National Contact Point for Life, from the Department of Environment, gave a presentation on Life programme’s contribution the last 25 years and informed the audience about the opportunities that Life programme offers. Following that, Dr. George Makrides, Quality Manager at PV Technology Laboratory of University of Cyprus, presented the basic principles for efficient use of PV Systems. Dr. Venizelos Efthymiou, Chairman of FOSS Research Centre for Sustainable Energy of University of Cyprus, gave an interesting presentation on the Storage Systems: the next step for quality operation of my PV System offering valuable support to the grid with tangible financial benefits. At the end, Dr. George E. Georghiou, professor and Director of FOSS Research Centre for Sustainable Energy of University of



Cyprus explained the benefits that the participants of the SmartPV project gained and the importance of this project for the grid. A fruitful discussion followed the presentations and the participants of the project SmartPV (the prosumers), shared their experiences participating at the project and the results they had on their electricity bill.

The Project “Smart net metering for promotion and cost-efficient grid-integration of PV technology in Cyprus” with the Acronym SmartPV, is co-financed by the EU through the LIFE Programme. This Project is in line with the general and specific objectives of LIFE+ Environment, Policy, and Governance particularly as regards to contribution in implementation, updating and developing environmental policy. SmartPV Project thoroughly investigates pilot net metering schemes for cost-effective PV implementation and higher grid penetration in Cyprus of distributed generation with the target of achieving a WIN-WIN scenario for both consumers and energy utilities.



The SmartPV project participates at the Networking Village of the European Sustainable Energy Week (EUSEW) in Brussels

The European Sustainable Energy Week (EUSEW) is a month-long series of activities that aims to help in building a secure energy future for Europe. It brings together public authorities, private companies, NGOs and consumers to promote initiatives to save energy and move towards renewables for clean, secure and efficient power. Launched in 2006 by the European Commission, the EUSEW is organised by the Executive Agency for Small and Medium-sized Enterprises (EASME) in close cooperation with Directorate-General for Energy. The goal of the EUSEW is to spread awareness of how to use energy more sustainably, build a low-carbon economy based on renewables and have a strong, united approach to sustainable energy use.



On the 21st June 2017, the SmartPV project participated at the Networking Village of the EUSEW in Brussels. The Networking Village fosters information-sharing and new connections to promote sustainable energy innovation. It is an opportunity for participants and stakeholders to exchange ideas on policies and best practice, and a chance to lay the foundations for future cooperation. An exhibition area hosts permanent stands from EU Institutions and partners for in-depth exchanges. In the networking area, a rolling series of half-day interactive presentations and dynamic activities allow participants to engage with a large number of stakeholders throughout the event. For more direct debates, the Speaker's corner was utilised, where delegates gave fifteen-minute talks on innovative initiatives, followed by lively short Q&A sessions. SmartPV was fortunate to be given a slot at the Speaker's corner and Dr Venizelos Efthymiou, Chairman of FOSS Research Centre for Sustainable Energy, University of Cyprus, presented the most recent results emanating from SmartPV. Additionally, on the 22nd June 2017, Dr Venizelos Efthymiou, was also part of a panel discussing the challenges and solutions for clean energy on islands.

EUSEW provides visibility and huge networking opportunities, so the SmartPV consortium had the opportunity to present this extremely important project for Cyprus to a wider audience. The project involves the design of an improved energy policy on renewable energy sources (RES) in Cyprus, which is based on smart net metering and self-consumption. The aim is to encourage the use of photovoltaic technology and to enable optimal penetration in the national grid. The project focuses on the optimization of intelligent energy management systems in order to create alternative, affordable, and sustainable practices, as well as on the reassessment of existing relevant government policies. SmartPV thoroughly investigates pilot net



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Smart Energy Week at the University of Cyprus

Between 20th -24th November 2017, FOSS delivered to the Cypriot community a week with state of the art technology events and workshops centered around smart grid technologies for the seamless integration of PV systems in the energy mix.



Apart from the very important stakeholder meetings that took place in Cyprus during this week by the Governing Boards of ETIP PV and MedTP4SG under the auspices of FOSS Research Centre for Sustainable Energy, rich in content open events were planned with the active contribution of the stakeholders: Ministry of Energy of Cyprus, Ministry of the Environment of Cyprus, Distribution

System Operator of Cyprus, Joint Research Centre (JRC) of the European Union, European Technology and Innovation Platform for Smart Networks for the Energy Transition (ETIP SNET), Smart Specialization Platform for Smart Grids in EU, European Technology and Innovation Platform for PV (ETIP PV), Austrian Institute of Technology (AIT), Denmark Technology University (DTU) και Mediterranean Technology Platform for Smart Grids (MedTP4SG).

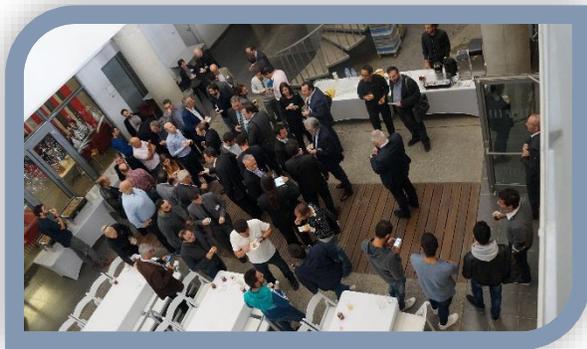
On Tuesday, 21st November 2017, the SmartPV final event took place. The consortium presented the results of the successful project SmartPV. The project focuses on the optimization of intelligent energy management systems in order to create alternative, affordable, and sustainable practices, as well as on the reassessment of existing relevant government policies. SmartPV thoroughly investigates pilot net metering schemes



for cost-effective PV implementation and higher grid penetration in Cyprus of distributed generation with the target of achieving a WIN-WIN scenario for both consumers and energy utilities. This Project is in line with the general and specific objectives of LIFE+ Environment, Policy, and Governance particularly as regards to contribution in implementation, updating and developing environmental policy.

On Wednesday, 22nd November 2017, PV lab of FOSS at the University of Cyprus and our close collaborators Austrian Institute of Technology (AIT) and Denmark Technology University (DTU) conducted this intensive workshop focused on the Cyprus PV industry. The workshop covered cutting edge research performed at UCY and partner institutions, network integration, storage and inverters and national and European funding opportunities. The presenters went beyond theory and examined how it all applies and impacts the Cyprus PV industry.

On Thursday and Friday, 23rd and 24th November 2017, two important workshops took place. The JRC workshop through the S3P platform covering the theme “Islands of Europe with emphasis on Smart Grid projects supporting the EU strategy for the energy transition towards the low emission economy”, and Regional workshop of ETIP SNET covering countries of South-East Europe addressing national and regional smart grid projects, attracted the participation of 100 persons from Cyprus and European organisations.



The JRC and ETIP Workshop on Smart Grids in Cyprus, gave the chance to participants to meet with relevant national and EU stakeholders and to discuss the priorities related to Smart Grids set out in the European Commission proposal for a new electricity market design, to exchange about the role of the Smart Specialization Platform on Energy (S3PEnergy) and of the regional innovation policy activities, to contribute to the prioritization of Smart Grids related R&I topics. A session was dedicated to challenges specific to Islands. The workshops provided a unique opportunity to know more about smart grids

projects and their findings related to energy system integration issues, exchange experiences, recommendations and best practices during technical roundtable discussions and discuss the deployment perspectives as well as the remaining challenges and barriers.

Awards & Honors

Innovative Research by the University of Cyprus Presented At A Plenary Session At The 33rd European PV Solar Energy Conference And Exhibition 2017

The research work performed by a team from the FOSS Research Centre of Sustainable Energy of the University of Cyprus (UCY) has been presented (plenary session) at the biggest conference for photovoltaics in Europe, the 33rd European Photovoltaic (PV) Solar Energy Conference and Exhibition 2017 (EU-PVSEC 2017) which took place between 25 - 29 September 2017 in Amsterdam, Netherlands.

The research work entitled “Photovoltaic Production Forecasting Model Based on Artificial Neural Networks” by Spyros Theocharides, George Makrides, Paris Kaimakis, Andreas Kyprianou and George E. Georghiou was presented at a plenary session in the field of Operations, Performance and Reliability of



Photovoltaics. Considered as one of the main features of the conference, the most remarkable and outstanding research outcomes in the field of PV, were selected for plenary session presentations from over 1500 scientific papers, based on the quality of the contents reported and on the contribution to the latest research.

The research work presented by Dr. George Makrides deals with the accurate PV production forecasting which is necessary for the optimal integration of this technology into existing power systems and is important for both grid and plant

operators. In this sense, PV production forecasting enhancements are essential in order to ensure grid stability, improve the advancement of energy commercialization for selling onto the next day market and control the dispatchability of the electric system.

In general, forecasting approaches utilized to forecast the power produced by grid-connected PV systems, focus on parametric and non-parametric models. In particular, parametric models require precise and detailed information about the characteristics and behavior of each relevant component of the PV system. Given the limitations of parametric modelling approaches, data-driven models based on machine learning, that capture the behavior of the system from historical time series of inputs and outputs, are gaining ground in the field of PV production forecasting. Such forecasting models use only historical data of meteorological variables and power measurements and therefore the forecasting accuracy depends mainly on the quality of the data and the predictive performance of the model.

The achievement comes at a time where the PV community has started to recognize the importance of multidisciplinary research and concerted effort into the accurate day-ahead forecasting of PV systems. The research undertaken over the past years at the University of Cyprus, PV Technology Laboratory focuses in forecasting the day- and hour-ahead DC power produced by different technology grid-connected PV systems, using developed machine learning models based on artificial neural networks (ANN). The scope is to improve the prediction accuracy by identifying the optimal network based on the

input parameters and architectural configuration. First forecasting accuracy results for a PV grid-connected system installed at the UCY, showed a day-ahead normalized root mean squared error (NRMSE) of less than 1 % when compared to measured DC power data-sets.

Finally, through this achievement it has been proven that the quality of the work in this field has attained high international standards and is capable of contributing to the global PV sector. This coupled with the recent funding secured by the European Regional Development Fund and by the Republic of Cyprus for the project “Innovative Forecasting PV Energy Yield Solution for Sustainable Large-Scale Deployment (INFORPV <http://www.pvtechnology.ucy.ac.cy/projects/inforpv/>)”, signifies the recognition of the work undertaken in Cyprus.

Poster Award at 33rd European Photovoltaic Solar Energy Conference and Exhibition

The presentation entitled “Development of BIPV courseware for students and professionals” received the Poster Award as part of the session 7DV.1 “PV Economics, Markets and Policies” at the 33rd European Photovoltaic (PV) Solar Energy Conference and Exhibition 2017 (EU-PVSEC 2017) which took place between 25 - 29 September 2017 in Amsterdam, Netherlands. The Dem4BIPV courseware set up developed by project coordinator Utrecht University in collaboration with FOSS Research Team along with other leading organisations, was presented by Wilfried Van Sark at the biggest conference for photovoltaics in Europe.



Dem4BiPV is based on the principle of European cooperation through which innovative educational material utilizing ICT will emerge on the topic of BIPV, which is of crucial importance for the future development and penetration of the PV market in Europe with a potential significant contribution in meeting Europe’s energy challenges. Education and training are crucial for both economic and social progress and aligning skills with labor market needs plays a key role in this. This project has been designed and structured so as to meet the real needs of the PV market and contributes positively to EU benchmarks for 2020 in relation to education. It also indirectly tackles fast-rising youth unemployment,

as it places emphasis on delivering the right skills for employment in the BIPV industry and increasing the efficiency of higher education in the field of sustainable energy and on working collaboratively with all relevant stakeholders. The information of the survey will be used for the development of course material including didactic content for students, the development of a virtual learning environment and the deployment of remote laboratories.

This achievement signifies the quality of the work in this field which is capable of contributing to the global education either professionals or students, with the secured funding of Erasmus+ to pilot the first courses by the University of Cyprus, Utrecht University and the FH Technikum Wien (Austria) in 2018.

Publications

Journals

A. Kyprianou, A. Tjirkallis, “Structural damage detection of a cantilever beam under varying temperature using a collection of time series”, *Procedia Structural Integrity*, 5, 1192 – 1197, 2017.

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Projects

Enhancing hydrogen new profiles for the coming European “green” energy models (Hy2Green)

Europe must be prepared for the necessary energy change planned for the coming years and hydrogen produced by renewable way plays a key role in this new energy scheme. Fuel cells industry provides a growth potential of up to 500,000 direct jobs in 2020 within the EU. These workers must have a specific qualification for development, implementation and deployment of these technologies. Hy2Green project aims at identifying the markets niches with higher potential of implementation and determination of most demanded profiles, identifying the technical knowledge and skills required for these profiles and innovative training methodologies to implement on the program. Design an innovative training program to these profiles, oriented to employability, efficiency and accessibility training.

Funding programme: Erasmus+

Budget: € 206.651, 00

UCY: € 29.968, 00

Dates: January 2017 – January 2020

Partners: Universidad de Huelva, Ariema Energia y Medioambiente, University of Cyprus, Inoma Renovables S.L., Università degli studi Guglielmo Marconi, Mahytec.

integrated Smart GRID Cross-Functional Solutions for Optimized Synergetic Energy Distribution, Utilization Storage Technologies (inteGRIDy)

inteGRIDy aims to integrate cutting-edge technologies, solutions and mechanisms in a scalable Cross-Functional Platform connecting energy networks with diverse stakeholders, facilitating optimal and dynamic operation of the Distribution Grid (DG), fostering the stability and coordination of distributed energy resources and enabling collaborative storage schemes within an increasing share of renewables. inteGRIDy will: a) Integrate innovative smart grid technologies, enabling optimal and dynamic operation of the distribution system's assets within high grid reliability and stability standards b) Validate innovative Demand Response technologies and relevant business models c) Utilize storage technologies and their capabilities to relieve the DG and enable significant avoidance of RES curtailment, enhancing self-consumption and net metering d) Enable interconnection with transport and heat networks, forming Virtual Energy Network synergies ensuring energy security e) Provide modelling & profiling extraction for network topology representation, innovative DR mechanisms and Storage characterization, facilitating decision making in DG's operations f) Provide predictive, forecasting tools & scenario-based simulation, facilitating an innovative Operation Analysis Framework g) Develop new business and services to create value for distribution domain stakeholders and end users/prosumers in an emerging electricity market. inteGRIDy will impact on: a) operations by reconfigurable topology control & supervision b) market by providing new services c) customer by enhanced engagement through DR mechanisms d) transmission by novel forecasting scenarios for the MV/LV areas e) part of the production incorporating innovative storage targeting the optimum use of RES f) environment by CO2 reduction inteGRIDy approach will be deployed and validated in 6 large-scale and 4 small-scale real-life demonstration covering different climatic zones and markets with different maturity.

Funding programme: Horizon 2020

Budget: €15.839.775, 00

UCY: €394.500, 00

Dates: January 2017 – December 2020

Partners: Atos Spain Sa, Siemens Public Limited Company , Ethniko Kentro Erevnas Kai Technologikis Anaptyxis, Engineering - Ingegneria Informatica Spa, Teesside University, Isle Of Wight Council, University Of Newcastle Upon Tyne, Sunergy Systems Ltd, Emsc (Uk) Ltd, A.T.Kearney Limited, Asm Terni Spa, Universita Degli Studi Di Roma La Sapienza, Politecnico Di Milano 14 Azienda San Severino Marche S.P.A., Energy@Work Societa' Cooperativa A R.L., Une Srl, Gas Natural Sdg Sa, Sistemes Avancats De Energia Solar Termica Sccl – Aiguasol, Inned Sn, Trek Consulting Anonymos Etairia Management Consultants, Electricity Authority Of Cyprus, University Of Cyprus, Ph Energia, Lda, Lisboa E-Nova Agencia Municipal De Energia E Ambiente De Lisboa, Universidade Catolica Portuguesa, Virtual Power Solutions Sa, Siveco Romania Sa, Societatea Comerciala De Distributie Si **Furnizare** A Energiei Electrice - Electrica Sa, Systems Sunlight Industrial & Commercial Company Of Defensive, Energy, Electronic And Telecommunications Systems S.A., Watt And Volt Exploitation Of Alternative Forms Of Energy Societe Anonyme.

Promoting Effective Generation and Sustainable USes of electricity (Pegasus)

PEGASUS (Promoting Effective Generation and Sustainable UseS of electricity) is a project, co-financed by the European Regional Development Fund through the MED programme that aims to promote the development of microgrids in cities, islands and remote areas. The project involves 10 partners from 8 countries: Belgium, Croatia, Cyprus, France, Greece, Italy, Malta and Slovenia. PEGASUS is focused on conducting research work in 7 pilot areas, where the functionalities of microgrids can add real value to the communities and aims to increase the share of local renewable energy sources in energy mix strategies.

Furthermore, PEGASUS will thoroughly investigate the technical and administrative obstacles that are currently hindering the implementation of microgrids in disadvantaged areas. For this reason, different business models will be utilized and evaluated featuring the advantages of the intelligence of the distribution grid, while creating the proper environment for the further establishment of microgrids.

Funding programme: Interreg Med

Budget: € 1.868.512, 00

UCY: € 157.386, 00

Dates: February 2017 – July 2019

Partners: CRES - Centre for Renewable energy sources and savings (Greece), MIEMA - Malta Intelligent Energy Management Agency (Malta), AURA-EE - Regional energy and environment agency in Rhône-Alpes (France) , ENERGAP- Energy Agency of Podravje (Slovenia), DEMEPA - Demepa (Italy), UCY - University of Cyprus (Cyprus), PREKO - Municipality Preko (Croatia), FEDARENE - European Federation of Agencies and Regions for Energy and the Environment (Belgium), ABENGOA - Abengoa Innovación S.A. (Spain).

Water Based SElective COATings for intelligent façade collectors (WABASELCOAT)

The incorporation of energy-producing, architecturally appealing, cost-efficient and multi-functional building modules are required by building designers and - industry to fulfil the goals of substantially reducing the CO₂ emissions.

Along this context, the project aims to develop coatings for a new type of solar thermal collectors, which by design is a modular building element for roofs and facades. The key - issues in the present project are increasing the solar collector's efficiency and aesthetic appearance, paint adhesion under extreme ambient conditions, environmentally friendly paint formulation, production and application, and having central focus on industrial scaling. Waterborne Thickness Insensitive Spectrally Selective (TISS) paints for application on absorbers of polymeric solar thermal collectors will be developed, optimized, scaled-up and tested outdoors. TISS paints are tailor - made, intelligent multifunctional materials based on a variety of organic macromolecules, functional and processing additives.

Innovation will be done with the formulation of new waterborne TISS coatings, where synthesis of new additives made on the basis of Polyhedral Oligomeric Silsesquioxane (POSS) molecules tailored for waterborne coating system, formulating of intelligent high solar absorptivity and low thermal emittance coatings in combination with improved weathering resistant properties are needed. Those paints should possess various colour hues (aesthetic demands), spectral selectivity (energy efficiency demands) and surface properties improved by high surface hardness, anti - soiling properties, increased thermal and UV stability (stability demands) and omitting solvent-borne resins. The demonstration polymeric absorber (prototype) will be based on PPS absorber developed by the industrial partner Aventa. The functional and aesthetic integration of new waterborne TISS coatings on current solar collector technology will be a very central topic in Task 56 Building integrated Solar Envelope systems, a project within the International Energy Agency's Solar Heating and Cooling Programme (<http://task56.iea-shc.org>).

The developed project samples and finished full - scale prototypes will be tested in conditions of Mediterranean environment including thermal impact, UV radiation and hot - cold cycling for the polymer absorber substrate with waterborne TISS coatings.

Finally, the project includes experienced project partners with competence in all stages of development, from definition of demand profile, development, and laboratory testing, full scale testing and prototype implementation.

Funding programme: M-ERA.NET (RPF)

Budget: € 416.200, 00

UCY: €93.000, 00

Dates: July 2017 – May 2020

Partners: National Institute of Chemistry Slovenia, CHEMCOLOR, Aventa AS Norway, University of Cyprus.

Innovative Forecasting PV Energy Yield Solution for Sustainable Large Scale Deployment (INFORPV)

A main challenge in the scope of ensuring large scale deployment and sustainability of photovoltaic (PV) systems is to improve the accuracy of production forecasting for both large and small systems in high concentrations on the distribution grid. Accurate point and aggregated PV production forecasts are major themes of the research roadmap of many international taskforces and are also in line with the objectives of the Solar Europe Industry Initiative (SEII) for accurate energy yield forecasting, increased flexibility of the power system and deployment. It is with this background that this project has been initiated to enable large scale deployment of PV systems through accurate production forecasting and active grid management, in countries with a high solar resource and a potentially significant PV share of small capacity systems, such as Cyprus and Israel. In particular, the project aims to develop a forecasting solution with improved accuracy for point and aggregated forecasts. The solution will be benchmarked and validated in Israel and Cyprus through a network of ground meteorological stations and monitored PV systems. The end-product will be an innovative PV production forecasting system that will provide to distribution system operators (DSO) an accurate forecast for PV systems connected at any grid location with a target root mean square error (RMSE) accuracy of less than 5 % for single plants and less than 4.5 % at a regional level for both day-ahead and hour-ahead forecasts. The system will also act as the buffer between PV systems and the grid, contributing supportive grid stability functions and enabling large scale deployment.

Funding programme: SOLAR-ERA.NET

Budget: €409.929, 00

UCY: €114.000, 00

Dates: August 2017 – July 2020

Partners: M.G.Lightning Electrical Engineering (MGL), Decision Makers Ltd (DM), Ministry of Agriculture, Rural Development and Environment (DOM), University of Cyprus (UCY), Electricity Authority of Cyprus (EAC).

Enhancing storage integration in buildings with Photovoltaics (PV-ESTIA)

The overall objective of the project is to enhance the penetration of PV's in the built environment, which is endangered due to their volatile nature and the limitations of the electrical distribution grids. By proposing an innovative management scheme of the PV and storage hybrid, the objective is to transform the buildings into a controllable energy source, thus making them grid-friendly. The planned tools to be developed during the course of the project will empower stakeholders and engineers to adequately deal with this new type of system. Also, the joint regulations and recommendations for the Balkan Med region will pave the way for new and improved policies that will facilitate the advancement of PV and storage in buildings, towards NZEB transformation. In fact, by introducing storage in buildings with PV's the self-consumption on site of PV energy increases, thus reducing the power losses associated with feeding the excess energy back to the grid. Naturally, this results in using the sustainable solar source at considerably higher efficiency. Moreover, the energy security of the region is increased, which is a major pylon of the Energy Union policy in the EU, as solar energy is at abundance in the region. An important contribution to climate change resilience comes from the fact that the higher the penetration of controllable PV energy in the energy mix of a region, the lower the conventional power generation from fossil fuel can be. Particularly for the Balkan Med region, the replacement of conventional power stations means lower greenhouse gas emissions, since the majority of them are high polluting lignite or oil plants.

Funding programme: (INTERREG V-B) BALKAN - MEDITERRANEAN 2014-2020

Budget: € 1.051.825, 83

UCY: € 335.250, 00

Dates: August 2017 – July 2019

Partners: Aristotle University of Thessaloniki, Technological Research Centre of Western Macedonia, University of Cyprus, Electricity Authority of Cyprus, Energy Agency of Plovdiv, Faculty of Electrical Engineering and Information Technologies of Ss. Cyril And Methodius University In Skopje, Ministry of Environment and Energy/ Directorate for Renewables and Electricity.

Innovative compact Hybrid electrical/thermal storage systems for low energy BUILDings (HYBUILD)

The HYBUILD project is funded by the European Union through HORIZON 2020 and focuses on the development of two innovative compact hybrid electrical/thermal storage systems for standalone and district connected buildings. HYBUILD will develop an innovative hybrid storage concept for cooling and heating energy provision, as well as for domestic hot water production, suitable for both the Mediterranean and the Continental climate. These configurations will allow for energy savings ranging from 20 to 40% on an annual basis in both Mediterranean and Continental climates. The HYBUILD systems combine thermal (sorption, latent and sensible) and electric storages in one system. Solar energy can be stored in the sorption storage (Mediterranean concept) as well as in an electric storage (both concepts). The electric power within the systems is provided by a DC-bus system, which is more efficient than a state-of-the-art AC based system. The DC architecture is expected to reduce the volume of conversion and distribution by 1/3 as compared to an AC architecture while, a long term reduction of the costs by about 20% is realistic. HYBUILD's hybrid storage systems will be used to upgrade facilities in existing buildings in three different demo sites. One of the project applications will be implemented by the Municipality of Aglantzia in cooperation with FOSS Research Centre for Sustainable Energy of the University of Cyprus and other partners. The proposed system will be installed on a vernacular dwelling located in the historic core of Aglantzia, which will be used as a Renewable Energy and smart solutions Center by the municipality with the support of the University of Cyprus. Particular emphasis will be placed on the preservation of the building's cultural heritage values and on the assessment of innovative technologies' contribution to the rehabilitation of historic buildings and settlements.

Funding programme: Horizon 2020

Budget: €6.000.000, 00

UCY: €226.250, 00

Dates: October 2017 – September 2021

Partners: COMSA Corporacion Spain, Austrian Institute of Technology Austria, Nobatek INEF4 France, CSEM Switzerland, EURAC Italy, FOSS Cyprus, Czech Republic, FAHRENHEIT Germany, Micrometal, STRESS scarl Italy, National Technical University of Athens Greece, DAIKIN Greece, FRESNEX GmbH, OCHSNER GmbH, ENGINEERING consultancy Italy, Municipality of Almatret Catalonia, AKG , R2M Solution, Municipality of Aglantzia, PINK GmbH.

INTEgrated opeRation PLAnning tool towards the Pan-European Network (InterPlan)

INTERPLAN is a project that aims to provide an INTEgrated opeRation PLAnning tool towards the pan-European network, to support the EU in reaching the expected low-carbon targets, while maintaining network security. INTERPLAN will provide a methodology for a proper representation of a “clustered” model of the pan-European network, with the aim to generate grid equivalents as a growing library able to cover all relevant system connectivity possibilities occurring in the real grid, by addressing operational issues at all network levels (transmission, distribution and TSOs-DSOs interfaces).

In this perspective, the chosen top-down approach will actually lead to an “integrated” tool, both in terms of voltage levels, going from high voltage down to low voltage up to end user, and in terms of building a bridge between static, long-term planning and considering operational issues by introducing controllers in the operation planning. Proper cluster and interface controllers will be developed to intervene in presence of criticalities, by exploiting the flexibility potentials throughout the grid.

The project ensures to achieve its goal by subdividing the necessary steps in seven work packages, each of them with a specific measurable objective.

The project is in line with the Work Programme in ensuring more flexibility and active involvement of all stakeholders, and a close coordination of TSOs and DSOs. Moreover, its versatility in the concept of grid equivalents, will allow an accurate analysis of the complex network, by considering local active elements in the grid.

Funding programme: Horizon 2020

Budget: € 2.964 362, 50

UCY: € 440.100, 00

Dates: November 2017 – November 2020

Partners: ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Austrian Institute of Technology, European Distributed Energy Resources Laboratories, University of Cyprus, Fraunhofer, Instytut Energetyki.

Energy Saving in Public Academic Buildings with Data Centers (ENEDI)

ENEDI is funded by the cooperation programme Interreg V-A Greece-Cyprus which aims to increase the competitiveness of the eligible area by supporting entrepreneurship and the use of information and communication technologies. The programme aims to integrate all issues relating to the environment, either in terms of protection against risks or in terms of promotion of the natural and cultural heritage.

The University of Cyprus together with the Greek Research and Technology Network (GRNET) and the University of Crete have joined forces to develop and apply innovative and smart energy management systems for Data Centers, connected with photovoltaic systems, based on dynamic energy efficiency policies and resource utilization and availability.

A reduction in data centers' energy consumption is suggested to be made dynamically by concentrating VMs (Virtual Machines) on fewer servers and if possible, shutting them down. Also other scenarios under consideration include the migration of VMs and Containers amongst Greece's and Cyprus' data centers.

The University of Cyprus (LiNC, Dep. of Computer Science) will develop an open source framework, required for Data Center management while still considering the intelligent placement and sharing of computing resources that aim to reduce energy consumption.

Funding programme: Interreg Greece-Cyprus

Budget: € 1.014.785

UCY Budget €332.200, 00

FOSS Budget €171.300, 00

Dates: December 2017 – November 2019

Partners: University of Cyprus, Greek Research and Technology Network (GRNET) and the University of Crete