



FOSS

Research Centre for
Sustainable Energy

Annual Activity Report 2018



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



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

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.

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 committed to fostering the sustainable development of communities continues to produce world-class research achieving imposing results. 2018 has been a very fruitful year for FOSS, positively influencing the future of our centre, our researchers and our world in general. FOSS continued its growth trajectory, and this is reflected on a variety of aspects. By the end of 2018, FOSS had a new record number of members, exceeding 50, primarily consisting of research fellows and PhD students.

However, this is particularly evident from the number of research projects currently in progress at FOSS, now standing at over 30. In this strand, in 2018 FOSS had many successful research proposals, in highly competitive calls, securing significant grant and contract funding. Examples of new research projects include MOST, ESPRESSO, DELTA, ERIGENEIA, DRIMPAC, TImPANI, DegradationLab, supported by a variety of programs, such as Horizon 2020, SOLAR ERA.NET, ERASMUS+, LIFE and the Research Promotion Foundation.



FOSS continues to be an active player in the field of sustainable energy within Cyprus and abroad. It currently collaborates with internationally esteemed research institutions and offers services to world-renowned companies.

FOSS also hosted a number of events in 2018 in order to raise public awareness and transfer knowledge on sustainability issues. Driven by the vision that education has an ever more important role in propelling climate action and most importantly prepare our future generations to be resilient to the unprecedented changes, FOSS has placed it high on its priority list. FOSS has intensified its efforts to shape the wide range of educational activities it offers. As climate change and energy security is an intergenerational and multifaceted problem, it has tailored its educational courses to meet a variety of people of different age groups, educational backgrounds, and a cross-section of topics. FOSS currently offers undergraduate and postgraduate courses, vocational training, internships and educational visits, on topics such as smart grids, renewable energy sources and nearly zero energy buildings. FOSS strives to continue to acquire and disseminate knowledge.

This report sets out the substantial progress FOSS made over the past year and gives a glimpse of our main activities for the next coming year. 2019 is expected to be exciting and dynamic year for FOSS as it embarks on a new challenging journey to start the development of its 'Living Lab for Sustainable Technologies'; a lab that is expected to have an impact not only in Cyprus, but in the Mediterranean and MENA regions as well. At its heart is an ambitious vision to bridge the gap between research and practice, link education with state-of-the-art real-life solutions and merge technological developments with practical requirements. A core aspect of the living lab is the design and deployment of a nanogrid at the University of Cyprus. The living lab will be user-centred, innovation-driven and will be integrating research, innovation and education in real-life settings, whilst allowing for co-creation. FOSS is ready to launch on this new mission, where Research and Education go hand in hand in achieving the energy transition.

Professor George E. Georghiou

Message from the Chairman

The University of Cyprus and FOSS in 2018 strengthened its presence in the field of Research and Development (R&D) covering the brought issues of sustainable energies meeting to a large extent the aspirations of the economy of Cyprus. Although FOSS has achieved more than the average in securing finance for projects through competitive calls, it is our strong belief that Cyprus is not doing enough in research and innovation, calling for corrective action from the responsible authorities of the Cyprus Government. We are ready to contribute in this direction in coordination with the university officials and the appropriate departments / ministries of the Government of Cyprus and we plan various initiatives in this direction. It is also an ambitious target of the PANTERA coordination and support action (CSA) that FOSS is coordinating with the participation of 8 strong partners from various EU countries mostly coming from areas that are low spending in R&I in the field of energy. It is a Horizon 2020 CSA that will run for four years as of 1 January 2019 and it is aiming to develop supporting mechanisms and multi-functional platforms through which the current gaps that EU is facing are smoothed out, lifting R&I activity to the desired level in support of the energy transition process.



To this effect and in view of the strategy decisions at European level for a carbon free economy by 2050 and the obligations that spring from the Paris Agreement on Climate Change, it is of vital importance that we achieve coherent policies in Cyprus in all related sectors. For this reason, FOSS is ready to contribute to the degree required to succeed in these endeavours. We have passed this willingness to the appropriate ministries, we plan to exploit the PANTERA vehicle to the maximum and we hope that coordinated actions will prevail in the months / years ahead.

The clean energy for all Europeans package is with us in its entirety, approved and ready to be transformed into national legislation. It is strongly guided by the strategy of the SET Plan for the low carbon economy to be achieved by 2050. The promising evolution of enabling technologies has influenced the policy decisions for 40% CO₂ reduction, 32.5% improvement in the efficient use of energy and 32% RES penetration by 2030. It is expected that the above targeted objectives are achievable with no negative effects on the European Economy and that is why R&I is of prime importance in the days ahead. 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 exploit the distinctive natural resources of Cyprus, support the evolution of energy communities and strengthen social inclusion, education and citizens' empowerment.

As we have said many times, 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 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 guided in its planned day to day work with the need to be responsive and adaptive to the requirements of the Cyprus economy. This is reflected in this activity document through the reported actions and activities that cover a wide range of interests and disciplines. This is evident through the reported activities, that cover a wide range of actions: research and innovation that is highly related to industry needs, community needs through continuous cooperation with the municipalities of Aglantzia and Nicosia, testing of equipment and apparatus, measurements, training and education and professional advice where needed. It is in our nature not to be complacent with current success. We are working in the direction of learning through our achievements and identified short comings for a brighter sustainable presence in the service of our future researchers that are of high quality, characterized with optimism and vision for the Cyprus of tomorrow.

Dr Venizelos Efthymiou



Committees

Board

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

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

Academic Committee

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

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

Dr. Demokratis 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

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

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

Dr. Demokratis 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/>

Services to the Community

Education

Members of FOSS provide teaching to students of the University of Cyprus, at undergraduate and postgraduate level. In addition, 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)

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.

Educational Visits

Over the years, 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

LIFE program and SmartPV at the University of Cyprus

The Environmental Department and the LIFE Cyclamen Project team organized a LIFE Program event on March 29, 2018 at the University of Cyprus.

The purpose of the event was to introduce with the LIFE Program - the EU's most important financial instrument for environment and climate change.



The main purpose of the LIFE Program is to fund and assist the implementation of Community environmental policy and legislation. It targets organizations, research centers, private and government agencies, businesses, non-governmental organizations and local authorities.

In the framework of the SMARTPV which is funded by the LIFE program, photovoltaic and smart meters were used on a pilot basis in homes in various areas of Cyprus. In addition, all owners were trained to improve their energy profile. The result was that they were able to reduce their electricity consumption and, of course, reduce the bill they were required to pay every two months. The benefit to the environment is immediate, since less consumption means

reducing carbon dioxide emissions.

All expertise developed through the SmartPV project can be used to implement future smart networks that will be available to all consumers. Coordinator of this project was the Photovoltaic Technology Laboratory of the University of Cyprus.



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.

A final multiplier event organised to present the outputs and results of the Dem4BiPV project at the premises of University of Cyprus

The multiplier event organized by the FOSS Research Centre for Sustainable Energy of the University of Cyprus on the 6th of June 2018 was within the Erasmus+ project “Developing Innovative material for Building-Integrated Photovoltaics” (Dem4BiPV).

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 were 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.

The aim of the event, which was open to all target groups, was to disseminate to all stakeholders and beneficiaries the project outputs and results (needs’ analysis, didactic material, virtual lab work) as well as provide a forum for discussion on prospects and challenges in the area of BIPV and the upscaling

potential of the project. The event brought together the academia and the industry and provided a ground for sharing and exchanging views among tutors, students, enterprises and other stakeholders on BIPV.

The Dem4BiPV, which kicked off in September 2015, as a response to the growing industry demand for a specialised BIPV workforce, has developed an innovative and multidisciplinary high quality course for Building-integrated Photovoltaics (BIPV) to train the BIPV professionals of the future. The BIPV training scheme was pilot tested at Utrecht University in the Netherlands, and the University of Cyprus, and were implemented at a postgraduate level in a number of leading universities in Europe, including the University of Applied Sciences in Vienna, as part of a Master’s in Sustainable Energy. 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.

Researchers' Night 2018

The "Researcher's Night" is an event organized by the Research Promotion Foundation (RPF) in collaboration with academic and research institutions as well as other organizations in Cyprus.

The event is an initiative of the European Commission and takes place simultaneously in almost all European countries. "Researcher's Night 2018" was organised in Lanitis Carob Mill in Limassol on 28th of September 2018. During this event, FOSS team had a strong presence with Dr. Christiana Panayi, Mr Michalis Machallekides and Mr. Marios Kynigos, introducing the SMART MANAGEMENT OF ENERGY to the audiences of different ages that had the opportunity to meet Cypriot researchers and see their work in a festive, friendly atmosphere.



The FOSS team informed the public about the role and importance of research in the modern world as well as the practical applications of its research results in everyday life. More specifically the theme dedicated for this event was focused on the Smart Energy Management at a house where home appliances and cooling functions, heating and charging of motor vehicles are planned according to our priorities or in which the energy produced from renewable sources is stored and used when needed. The audiences whom participated had the the opportunity to

enjoy a creative night-time event dedicated to science and research, through experiments, games, competitions and music.



A two-day Photovoltaic Workshop organized by TwinPV

The two-day thematic workshop and networking event taking place at the University of Cyprus on November 14 and 15, 2018 was hosted by FOSS research centre for sustainable energy of UCY, AIT the Austrian Institute of Technology AIT and DTU the Denmark Technological University DTU. The workshop was specifically geared towards the Cypriot Photovoltaic Industry with the specific aim of strengthening its ties to academia and the surrounding MENA (Middle East and North Africa) region. There were guest presentations from world-renowned researchers and leaders from Austria, Denmark, Spain, Qatar, Abu Dhabi, Jordan and U.S.A. The topics included grid integration, smart grids, soiling, new business plans for PV plants that contain storage and Quality Assurance of PV plants. The participants were exposed to new business models, new technologies and new opportunities that will influence their businesses in the very near future. The workshop attracted approximately fifty participants coming from Industry and academia from countries such as Cyprus, Austria, Denmark, Sweden, Jordan, Egypt, Qatar, Abu Dhabi, Dubai, and USA.



The workshop was funded from the European Union's Horizon 2020 research and innovation programme through the project TwinPV under the agreement No. 692031. In TwinPV three institutions from three different countries are teamed up: UCY (University of Cyprus), AIT (Austrian Institute of Technology) and DTU (Denmark Technological University). The main aim of the project was to enhance the research conducted at the University of Cyprus (UCY) through targeted twinning activities with the two internationally-leading research institutions, to help bridge the gap with the Cypriot Industry and to foster collaboration with countries from the surrounding region. TwinPV aimed to stimulate excellence and innovation capacity at UCY primarily in the field of photovoltaics (PV) and grid integration in smart grids. Twinning activities include knowledge transfer and exchange of best practice between AIT, DTU and UCY.

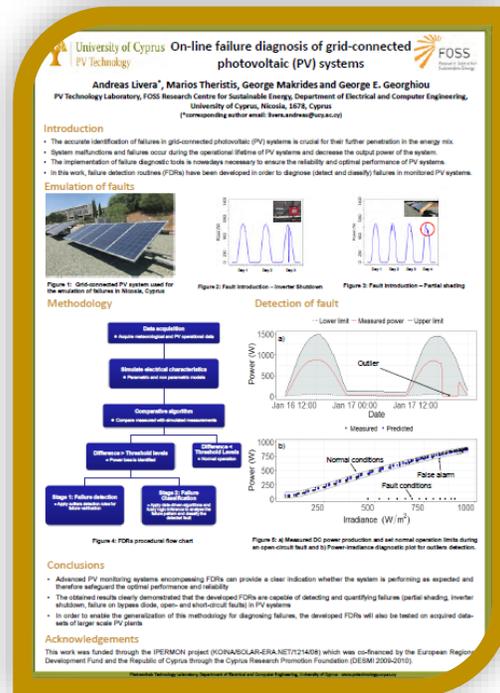
Awards & Honors

Poster Award at NREL\SNL\BNL PV Reliability Workshop 2018

An international award by the National Renewable Energy Laboratory (NREL), Sandia National Laboratories (SNL), and Brookhaven National Laboratory (BNL) was received by Andreas Livera, PhD student at the Department of Electrical and Computer Engineering of Cyprus and Special Scientist at FOSS Research Centre for Sustainable Energy. Andreas received the 2nd place award for the poster presentation entitled “On-line Failure Diagnosis of Grid-Connected Photovoltaic PV systems” received the Second Place Poster Award 2nd place as part of the Poster Session III at the annual NREL\SNL\BNL Photovoltaic Reliability Workshop (PVRW that took place between 27th of February to 1st of March 2018 in Lakewood Colorado, USA.

NREL hosts an annual Photovoltaic Reliability Workshop (PVRW) so solar technology experts can engage on current and forward-thinking subject matter in PV reliability.

This workshop provides a unique opportunity for group discussions that can yield answers and bring participants to a common understanding for current questions in module and system reliability. Improvements in PV reliability reduce the cost of solar electricity and promote investor confidence in the technology—both critical goals for moving PV technologies deeper into the electricity marketplace.



Publications

Journals

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Projects

Clean energy from road acoustic barriers infrastructure development (CEFRABID)

The CEFRABID Project Proposal concentrates on advanced photovoltaic (PV) products applications in road and rail (r&r) transport infrastructure. It is focused on PV grid integrated with noise barriers and passenger stop shelters along local r&r infrastructure for needs of powering this infrastructure, e.g. for signaling, lightning of neuralgic sections of roads and rail platforms, including r&r crossings, and last but not least, warming or cooling the passenger stop shelters of special innovatory design.

Funding programme: “RESTART 2016 – 2020” SOLAR-ERA.NET

Budget: € 452.500, 00

UCY: € 104.600, 00

Dates: January 2018 – December 2019

Partners: Główny Instytut Górnictwa, ML System S.A. Poland, University of Jaen, IBV-Fallast, University of Cyprus.

Advanced centre for testing degradation and failures in new and emerging solar cells (DegradationLab)

Since solar cells tend to degrade after a specific time of operation, characterization methods are more than necessary for the failure analysis of PV cells. New and emerging technologies such as perovskites and perovskite on silicon tandems, demand more advanced characterization methods for understanding degradation mechanisms occurring therein and subsequently contributing to improvement of their properties which can lead to their commercialization. The proposed work aims to characterize such cells indoors with several optoelectronic techniques as well as outdoors at real operating conditions for the detailed analysis of degradation mechanisms. This highlights the importance of developing a dedicated laboratory and key collaborations for addressing complex and multiple failures in perovskites-based cells in a full top-down, holistic approach. Methods of Light Beam Induced Current (LBIC), Dark Lock-In Thermography (DLIT), Lock-in Thermography (LIT), spatially-resolved Electroluminescence (EL) and Photoluminescence (PL) are expected to be setup for a complete optical and electrical characterization of cells. These methods in combination with ultrafast spectroscopy and Raman measurements and other microscopic-spectroscopic techniques such as Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), X-ray Photoelectron Microscopy (XPS) and Energy-dispersive X-ray spectroscopy (EDX) will provide a detailed failure analysis in the perovskite-based cells. The overall project pursue to the improvement of the stability and efficiency of perovskite and perovskite on silicon tandem cells and also to the creation of a new infrastructure unit for tests of emerging technology cells with significant capabilities that is absent in Cyprus and in Europe generally.

Funding programme: “RESTART 2016 – 2020” INFRASTRUCTURES

Budget: € 999.460,00

UCY: € 844.960,00

FOSS: € 641.500,00

Dates: December 2018 – December 2022

Partners: University of Cyprus, Interuniversitair Micro-Electronica, Austrian Institute of Technology GmbH, Max-Planck Institute for the Science of Light.

Future tamper-proof Demand rEsponse framework through self-configured, self-opTimized and collAborative virtual distributed energy nodes (DELTA)

DELTA proposes a DR management platform that distributes parts of the Aggregator's intelligence into lower layers of a novel architecture, based on VPP principles, in order to establish a more easily manageable & computationally efficient DR solution, ultimately aiming to introduce scalability & adaptiveness into the Aggregator's DR toolkits; the DELTA engine will be able to adopt & integrate multiple strategies & policies provided from its energy market stakeholders, making it authentically modular & future-proof.

DELTA will also deliver a fully autonomous architectural design, enabling end-users to escape the hassle of responding to complex price/incentive-based signals, while facilitating active, aware & engaged prosumers, based on innovative award schemes, a social collaboration platform & enhanced DR visualisation. Provision of full-scale market & grid services will be made possible by delivering explicit & implicit-based DR elasticity services, while pushing current market regulatory limitations so that they can be surpassed, and satisfying potential grid constraints related to flexibility activation through Multi-Factor Forecasting and Deep Reinforcement Learning Profiling. Furthermore, DELTA will propose & implement novel multi-agent based, self-learning energy matchmaking algorithms to enable aggregation, segmentation & coordination of several diverse supply & demand clusters, designed end-to-end using well-known, open protocols (i.e. OpenADR), for increasing interoperability. DELTA will set the milestone for data security in future DR applications by not only implementing novel block-chain methods & authentication mechanisms, but also by making use of Smart Contracts which would further secure & facilitate Aggregators-to-Prosumers transactions. Two pilots in UK & Cyprus will realise the DELTA concept, covering a wide variety of residential/tertiary loads (>11GWh), RES generation (>14GWh) & energy storage systems (>9MWh) (average annual measurements).

Funding programme: Horizon 2020

Budget: € 3.873.625, 00

UCY: € 411.250, 00

Dates: May 2018 – April 2021

Partners: Ethniko Kentro Erevnas & Technologikis Anaptyxis, Hypertech Innovations LTD, Archi Ilektrismou Kyprou, University of Cyprus, Kiwi Power LTD, Joint-Research Centre, C.C.I.C.C. LTD, E7 Energie Markt Analyse, Universidad Politecnica de Madrid, Norwegian University of Science and Technology.

Unified DR interoperability framework enabling market participation of active energy consumers (DRIMPAC)

Buildings constitute a vast, yet currently untapped, source of energy demand flexibility that can provide invaluable services to the energy system. This flexibility currently remains unattainable due to the lack of a technological framework that can connect the multitude of buildings and building systems with the energy system in a cost-effective manner as well as the reluctance of energy consumers to enroll in demand response programs. DRIMPAC offers a comprehensive solution to empower consumers to become active participants in the energy markets.

Funding programme: Horizon 2020

Budget: € 3770583, 38

UCY: € 373750, 00

Dates: November 2018 – October 2021

Partners: Centre for Research and Technology Hellas, Siemens SRL, Hypertech Anonymos Viomichaniki Emporiki Etaireia Pliroforikis kai Neon Technologion, Institute for Information Management in Engineering, Joint Research Centre – European Commission, Stadtwerke Trier – Anstalt des öffentlichen Rechts der Stadt Trier, MyEnergia ONER S.L., Sorea, University of Cyprus, E7 Energie Markt Analyse, STAM SRL.

The investigation of EMF Power quality and energy forecasting for the DSO of Cyprus (EMF Map)

The project investigates burning issues associated with the distribution network, namely low emf measurements emitted from electricity assets, power quality concerns especially with regards to the further penetration of PV and RES in general and attempts to develop a day ahead energy forecasting tool.

Funding programme: Electricity Authority of Cyprus

Budget: € 88000, 00

UCY: € 88000, 00

Dates: January 2018 – December 2019

Partners: University of Cyprus

Enabling rising penetration and added value of photovoltaic generation by implementation of advanced storage systems (ERIGENEIA)

The Erigeneia project targets to enable the high penetration of PV technology and to utilize its potential value in the energy system by developing a local and central energy management system (EMS) that will

combine photovoltaics (PV) with battery energy storage systems (BESS). The project will match the technical requirements imposed by the distribution system operators (DSO) with the upcoming new market regulations, capitalizing on the positive effects of PV and BESS combination. In addition, a tool for intra-hour energy forecasting will be developed and integrated into the EMS to provide a more accurate and reliable operation plan for the DSO. The proposed work is expected to have significant impact on the further penetration of PV given that the existing grid infrastructure will be utilized in a more efficient way, by increasing the hosting capacity hence deferring grid reinforcement. By promoting grid-friendly self-consumption of PV generation, grid congestion issues will be avoided. Since the EMS will increase the power usage predictability, the current expensive power reserves will be replaced by the local EMS control strategies of the combined PV and BESS EMS. Furthermore, the users will take advantage of the provided flexibility in order to lower their cost of electricity, by gaining from the new upcoming policies of Time of Use (ToU) and dynamic tariffs. Finally, a versatile algorithm capable of estimating the optimum size of BESS and PV to meet all the needs of prosumers will also be developed. Field trials will take place in Cyprus (domestic EMS) and Turkey (community EMS) and novel or more effective ancillary services will be provided to the network operators (e.g. power smoothing, voltage regulation). Finally, the economic impact of the proposed solutions will be quantified. The proposal is fully in line with the SET plan and Solar Energy Industrial Initiative objectives for effective integration of solar energy technologies in the energy system.

Funding programme: “RESTART 2016 – 2020” SOLAR-ERA.NET

Budget: € 1.087,138, 00

UCY: € 139.200, 00

Dates: May 2018 – April 2021

Partners: University of Cyprus, Austrian Institute of Technology, Fronius International GmbH, Electricity Authority of Cyprus, ADM Elektrik Dağıtım A.Ş.

Efficient Structures and Processes for Reliable Perovskite Solar Modules (ESPResSo)

This ESPResSo-project aims to bring the novel emerging hybrid organic-inorganic perovskite-based solar cell (PSC) technology to its next maturity level. In recent years (see Figure 1), this solution-processable solar technology has reached cell efficiency values rivalling those of established thin-film photovoltaic (PV) technology (CIGS, CdTe), even approaching crystalline Si (c-Si) records. The challenge is now to transfer this unprecedented progress from its cell level into a scalable, stable, low-cost technology on module level. The consortium brought together here has alternative materials, insights in novel cell concepts and architectures, and the processing know-how and equipment at hand to overcome these barriers and realize following global objective: Demonstrate a highly efficient (>17%) perovskite-based 35x35cm² module architecture that shows long-term (>20 years) reliable performance as deduced from IEC-compliant test conditions. This module is to be produced with industry-relevant low CAPEX manufacturing techniques validating a potential electricity cost as low as 0.05€/kWh in Southern Europe. Installing an actual building-integrated facade element will validate the potential contribution of this technology to the future European energy supply system. Additionally, prototyping advanced, arbitrary-shaped module architectures with specific materials and process combinations will emphasize that new highly innovative

applications like on flexible substrates or with high semi-transparency are well accessible on mid- to longer-term with this very promising thin-film PV technology.

Funding programme: Horizon 2020

Budget: € 5.412,657, 00

UCY: € 145.000, 00

Dates: April 2018 – March 2021

Partners: I Interuniversitair Micro-Electronica Centrum, École polytechnique fédérale de Lausanne, Università degli Studi di Roma "Tor Vergata", Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung eV, CSGI - Consorzio per lo Sviluppo dei sistemi a Grande Interfase, University of Cyprus, Dyenamo AB, Dycotec Materials, ONYX Solar Energy S.L, Corning SAS, M-Solv LTD, Saule SP ZOO.

Technical support on evaluating the potential and defining a policy framework for Demand Response (DR), Distributed Generation (DG), Renewable Energy Sources (RES) and Energy Storage (ES) in Cyprus.

FOSS and the Cyprus DSO, the Electricity Authority of Cyprus (EAC), are partners in many on-going as well as completed projects. This close collaboration will help in providing access to hotel, industrial, commercial and desalination data either from readily available meters or load recorders (permission must be provided by the DSO) which can be installed in specific customers for monitoring loads of interest for long periods in order to capture weekdays, weekends and seasonal variation. For this task, FOSS will utilize an existing smart meter (SM) network consisting of 300 residential prosumers with geographical dispersion that is representative of the characteristics of the prosumers in Cyprus (developed through the SmartPV, coordinated by FOSS and with the participation of the DSO, and the Cyprus Energy Regulatory Authority). Through questionnaires and visits conducted at the participants' premises, FOSS along with EAC have collected data regarding the household flexible appliances (types, power, usage time and duration). In the scope of acquiring the load profiles of the listed flexible loads, FOSS in collaboration with EAC, will install Wi-Fi smart plugs with energy monitoring capabilities at selected premises that can be considered as representative of a typical Cypriot household.

Funding programme: JRC

Budget: € 28.900, 00

UCY Budget € 28.900, 00

Dates: September 2018 – February 2019

Partners: University of Cyprus

Developing advanced master's education based on Smart Grid technology (MOST)

The project's specific objective is to develop an Innovative Advanced Master's Course on the important topic of Smart Grids, while its ultimate aim is to improve the quality and relevance of higher education to the labor market needs, since there is currently a gap in the knowledge and skills of graduate architects, engineers, planners etc. in relation to the smart grid infrastructure and operation. According to the EC (COM(2012) 669 final) European education and training systems continue to fall short in providing the right skills for employability, and are not working adequately with business or employers to bring the learning experience closer to the reality of the working environment.

Funding programme: ERASMUS+

Budget: € 441.833, 00

UCY: € 83.885, 00

Dates: September 2018 – August 2021

Partners: Università Degli Studi Di Cagliari via Università 40, Wirtschaft Und Infrastruktur GmbH, Technological Educational Institute of Western Macedonia, Hochschule ULM-Technik Informatik & Medien, University of Cyprus, Ecole Nationale Supérieure des Mines de Paris, Deloitte LTD Cyprus.

CIGS-and CZTSSe-based Thin Film Solar Cells fabricated by Pulsed Laser Deposition for terrestrial and space applications (SolaCe)

Thin-film solar cells based on the chalcopyrite compound $\text{Cu}(\text{In,Ga})\text{Se}_2$ (CIGS) have shown the highest laboratory efficiencies of thin film solar cells - up to 20.8%. In addition, CIGS solar cells are considered to be the most suitable candidate for space applications due their superior particle radiation hardness. CIGS cells are multilayer structures, with each layer serving a particular purpose. Different methods have been used to prepare each layer of CIGS solar cells which increases the fabrication cost. It is, therefore, desirable to identify a deposition technique for the fabrication of CIGS cells in order to achieve a single-step, low-cost and high-deposition-rate growth with thickness uniformity and stoichiometry over large areas. In this project, we intend to demonstrate that PLD is a suitable growth method to (i) fabricate the complicated multilayer structure of CIGS solar cells at low temperatures and (ii) achieve cost-effective and high efficiency CIGS solar cells. In addition, fabricating CIGS solar cells using PLD will provide the opportunity to study the impact of each layer and their interfaces to the efficiency of the cell. Alternative materials will also be tested, substituting for the toxic (Mo, Cd) and rare (In, Ga) elements without compromising the efficiency. By choosing alternative materials that are non-toxic and abundant, thin film solar cells will become toxic-free, environmental friendly and inexpensive, paving the way for large scale terrestrial applications. Modelling will assist in the optimization of the cell design and the understanding of its functionality. Finally, the results and knowledge that will derive from the project can be exploited by the thin-film photovoltaic industry and the research community for the development of CIGS-based solar cells that will

compete directly with polycrystalline and crystalline silicon cells, giving rise to the manufacturability of CIGS technology.

Funding programme: “RESTART 2016 – 2020” EXCELLENCE HUBS

Budget: €249.300, 00

UCY: €20000,00

Dates: January 2018 – October 2021

Partners: Complex Functional Materials Laboratory, Experimental Condensed Matter Physics Laboratory, PV Technology Laboratory and Chemical Process Engineering Research Institute.

Twinning In atmospheric Plasma science AND applications (TImPANI)

The main aim of the project is to enhance the research capacity conducted at the Electromagnetics and Novel Applications Lab (ENAL) of the University of Cyprus (UCY) through targeted twinning activities with internationally leading research institutions, namely the Leibniz-Institut für Analytische Wissenschaften-ISAS-e.V. (ISAS), and University of Jaén (UJA) in Spain. In particular, the aim will be to stimulate excellence and innovation capacity at UCY primarily in the field atmospheric pressure plasma (APP). The focus will be on fundamental science on instrumentation and applications of the APP. The Twinning activities will include knowledge transfer, exchange of best practices between UCY, UJA, and ISAS, networking with research institutions and industry. The knowledge transfer will be achieved through in person training, webinars and PhD summer schools. The results and networking will be disseminated via participation at international and national conferences and also targeted events for the stakeholders. This project will entail significant benefits for all institutions involved in terms of enhancement of their Research and Innovation (R&I) capacity in science and technology and raising their staff’s research profile. It is expected that by the end of the project the consortium will have a core group of researchers (young and experienced) with considerable expertise in numerical simulations and modelling of APP, fabrication and characterization of APP and advanced mass spectroscopy with APP. The critical mass of researchers will be able to make a significant contribution to improving the research and innovation index of Cyprus. It is also expected that the Twinning project will lead to long-term collaboration between the three partners on joint proposals and projects, joint PhD students, infrastructure sharing and innovation through some of the novel applications that will be explored during the project.

Funding programme: SOLAR-ERA.NET

Budget: € 999.625, 00

UCY: € 390.750, 00

Dates: November 2018 – October 2021

Partners: University of Cyprus, Leibniz-Institut für Analytische Wissenschaften E.V., University of Jaen.