

APOLO OPEN DAY 2022

The New Generation of Photovoltaic Cells



Preliminary Agenda

Speakers & Participating organisations

Hybrid event

Date: 7 & 8 July 2022

Place: Leitat, Terrassa (Barcelona - Spain)

<https://project-apolo.eu>



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Table of Content

1. APOLO Open Day 2022 – Preliminary Agenda	2
2. APOLO Open Day 2022 – Speakers	6
3. APOLO Open Day 2022 – Partner Organisations.....	11
Leitat	11
The “École Polytechnique Fédérale de Lausanne” (EPFL)	11
Arkema	12
CEA	12
ACCUREC	12
Fraunhofer-Gesellschaft	12
The University of Rome “Tor Vergata”	13
UNINOVA Research Institute.....	13
Greatcell Solar Italia SRL.....	13
Flexbrick.....	14
Cambridge Nanomaterials Technology Ltd (CNT).....	14
4. APOLO Open Day 2022 – Participating Organisations	14
Saule Technologies.....	14
Nanyang Technological University.....	14
University of Porto, FEUP	15
CENER.....	15
Swansea University /SPECIFIC.....	15
ADHESIVES RESEARCH	16
Senergy Innovations	16
CINEA - European Commission	16
JRC-EC	16
Helmholtz Zentrum Berlin	16
Chulalongkorn University	17
LEPABE - Laboratory for Process Engineering, Environment, Biotechnology and Energy	17
Cicci Research s.r.l.	17
SENA	17

Apolo Project

APOLO (<https://project-apolu.eu>) is a research and innovation project carried out by an international consortium led by *Leitat*. APOLO will develop flexible, reliable and fully printable perovskite solar cells (PSC) with an efficiency of 22% and with 90% of performance after aging tests. The project partners are research centres such as the *Swiss Federal Institute of Technology Lausanne*, *Fraunhofer Institute for Solar Energy Systems ISE*, *Uninova*, *Università di Roma Tor Vergata* and *CEA*, *Arkema* as a large enterprise and SME's including *Flexbrick*, *Greatcell Solar Italia*, *Cambridge Nanomaterials Technology Ltd*, and *Accurec*.

During the 4 years of the project duration, the consortium has been working on advanced optoelectronic materials and innovative green processes to bring the new generation of PSC on the market, initially in building integrated photovoltaics (BIPV), but also extending its applications to different market niches. In addition, **APOLO** is working in reducing the cost of PSC module manufacturing below 0.40€/Wp. Lastly, APOLO has also been working in producing produce PSC modules to be integrated in facings for buildings.



1. APOLO Open Day 2022 – Preliminary Agenda

This will be a great opportunity to meet the APOLO partners and learn about activities and the results of this project from a market-oriented perspective. Also meet the project partners and find out about their activities in the development of new materials for PSC, on its performance, on its manufacturing, and stability and recycling.

7 July 2022

Location: *Leitat - C/ De la Innovació, 2*

08225 Terrassa (Barcelona)

Day 1

Please take notice that all times shown in the agenda are CET.

09:00 Registration

09:35 Welcome to the APOLO Open Day 2022

Ana Milena Cruz, APOLO Project Coordinator, Leitat, Spain

APOLO Open Day 2021 Organiser

09:45 Introduction to the APOLO Open Day

Ana Milena Cruz Leitat (APOLO Project Coordinator), Spain

10:00 Ana Maria Escobar Romero, Leitat, Spain

Title: Antisoiling solutions on solar energy production

Solar power represents an abundant and clean source, thanks to environmental compatibility and it's presently regarded as the foremost important renewable energy, but still its energy conversion efficiency requires major improvements like technology design and time performance compared with the standard energy sources.

Dirt coming from various sources, natural and artificial is one of the problems strongly affecting the efficiency of solar panels in PV, even when the modules and components are not yet degraded. The use of surfaces with superhydrophobic and amphiphobic characteristics can help to overcome this problem thanks to their self-cleaning effect. LEITAT have tested different antisoiling coatings to both reduce water consumption in maintenance operations, and efficiency losses.

10:30 Silvia Colodrero Pérez, Leitat, Spain

Title: Green solvent selection methodology for printable perovskite devices

Impressive advances in the research field of perovskite solar cells have allowed reaching power conversion efficiencies above 22%, which turn them into real competitors against crystalline silicon technologies. However, solution processed perovskite materials are still based on toxic and/or hazardous solvents that, despite giving rise to an optimum control on crystallization for a wide range of compositions and deposition techniques, limit both their processing and scalability for future commercialization. For that reason, replacing those toxic solvents with green solvents is of paramount relevance for the future deployment of perovskite technology. In here, the most relevant approaches applied along APOLO project for the solvent engineering of perovskite precursors are reviewed. Based on them, the solubility of both lead halide and perovskite solutions in potential green alternatives are experimentally evaluated. The most promising solvent blends obtained after applying an exhaustive screening methodology are finally used to evaluate and optimize the processing of thin perovskite films.

11:00 Coffee Break

Visit partners virtual exhibition booths (<https://solarpowerexpo.net/>)

11:15 Bruno CHARRIÈRE, ARKEMA, France

Title: Flexible, photocurable acrylic resin for the encapsulation of perovskite cells.

Overview of Arkema as a leading supplier of specialty materials, with focus on renewable energies and photovoltaics. Review of Arkema's contribution to the APOLO project with the design of a photocurable flexible encapsulation liquid resin optimised for the protection of flexible perovskite cells.

11:50 Konrad Wojciechowski, Saule Technologies, Poland

Title: Perovskite photovoltaic technology on flexible substrates

Metal halide perovskites constitute a very attractive class of materials for optoelectronic applications, such as solar cells, light emitting diodes, lasers and photodetectors. Most notably, solid-state photovoltaic devices based on these materials have reached power conversion efficiencies (PCEs) exceeding 25% within only a decade of academic research.

Perovskite solar cells have a great market potential, but there still remain few challenges, which need to be resolved to prove viability of the technology. Some of the well-known issues include material stability. Furthermore, cost-effective, reliable fabrication process capable of delivering highly efficient, large-area perovskite modules is of paramount importance.

This talk will outline industrial opportunities of perovskite PV technology, focusing on new value propositions and market versatility. Flexible perovskite solar cells successfully passing IEC-based accelerated aging tests, including damp heat aging, will be presented. Additionally, special aspect of the perovskite technology – all perovskite tandem PV modules - will be discussed and their scalable fabrication process demonstrated, complemented with a robust encapsulation methodology.

12:15 *Visit to Leitat Labs*

Visit partners virtual exhibition booths (<https://solarpowerexpo.net/>)

12:30 *Lunch and Exhibition*

Visit partners virtual exhibition booths (<https://solarpowerexpo.net/>)

14:30 **Francesca Brunetti, UNITOV, Italy**

Title: Scaling up from flexible perovskite solar cell to modules: possibilities and open issues

Flexible perovskite solar cells (f-PSCs) have recently reached power conversion efficiency (PCE) as high as 20.7%. Although still lagging behind their rigid counterparts on glass, which in very short time have achieved 25.7% of certified efficiency, the use of flexible substrates opens up to a wide range of applications, from sensors for the Internet of Things, to the retrofitting of existing buildings to improve their energy efficiency (building-applied PV), to space, thanks above all to the high power/to weight ratio generated which is the range of 29.4 W/g compared to 8.31 W/g for amorphous silicon and 0.254 W/g for ultra-thin CdS / CdTe.

To demonstrate flex-PSC on large scale and make the technology appealing to industry, reliable and sustainable fabrication routes, compatible with high throughput roll-to-roll manufacture, must be developed. Thus far, most studies of flex-PSCs are focusing on small-scale methods and hazardous solvents such as DMF, NMP, and 2-ME.

In this presentation, the fabrication of flexible perovskite devices will be reported focussing in particular on the role of the scaling up of the realization process from solar cells to module which allowed the FPSMs to deliver 12% PCE and negligible hysteresis on 16.8 cm² and 11.7% PCE on 21.8 cm² active area. In addition to that, we present flex-PSC, in which both the electron transport layer and the absorber are deposited by air-flow assisted blade coating method on 5 × 7 cm² flexible substrates. Notably, the perovskite layer is deposited in ambient air via a double-step method, using a DMF-free solvent system by using only DMSO. By fine-tuning the coating parameters, we obtained promising results in terms of PCE reaching 12.7% for 2.5 × 2.5 cm² dimension cells obtained from cutting large-area substrates. In addition, to demonstrate the scalability of this double-step perovskite deposition method, we deposited films on flexible 10 × 10 cm² substrates.

15:00 **Stéphane Cros, CEA, France**

Title: From flexible cells to flexible modules, an Apolo story for the manufacturing of record modules (11 cm²) close to 19% efficiency

In this talk, we will list the performances that CEA achieved in Apolo project with flexible cells and modules. As compared to cells, module fabrication requests specific steps like large deposition uniformity or laser scribing. We will also highlight the importance of the stability and the challenges related to encapsulation

15:30 Enrico Leonardi, Greatcell Solar Italia, Italy

Title: Flexible perovskite solar modules on metal substrates a perspective for industrialisation

Metal foils intrinsically have extraordinary mechanical assets, i.e. ultra-low rate of water vapour permeation and excellent resistance to corrosion and conductivity, that make them very suitable as substrates for Flexible Perovskite Solar Cells (PSCs). After overviewing perovskite solar cells on metal substrate, it will be introduced the challenges of metal-based PSCs Scaling-up and then GSI APOLO activity on metal cells, showing first ever flexible perovskite solar module on metal-based substrate.

16:00 *End of day one sessions*

8 July 2022

Location: Leitat - C/ De la Innovació, 2

08225 Terrassa (Barcelona)

Day 2

09:00 Registration

09:30 Welcome to the second day of the APOLO Open Day 2022

Introduction to the session by Flexbrick

09:45 David Wilde, Leitat, Spain

Title: Life Cycle Assessment to support and validate the development of emerging technologies towards more sustainable and circular solutions – the case of the APOLO project

The presentation will provide a brief introduction into what is Life Cycle Assessment (LCA) and how it can be used to support the research and development stage of emerging or advanced technologies, such as perovskite photovoltaics, aimed at the promotion of more sustainable and circular solutions right from the outset. Following the example of the APOLO project, it will also be discussed how LCA can not only be applied to quantify the environmental performance of resulting products or processes, but how it can also be used to model future production and implementation scenarios, while exploring the associated uncertainties.

10:15 Zhanagqi Wang, Accurec, Germany

Title: Microwave: a novel process to recycle perovskite

Perovskite solar cells are composed of several layers of different materials. After assembling, the cells are encapsulated as a single system which makes them difficult to be recycled.

Accurec has proposed a novel recycling process based on microwave technology to extract the Pb out of the cell and recycle other components.

10:45 *Coffee Break*

Visit partners virtual exhibition booths (<https://solarpowerexpo.net/>)



11:00 Pedro Casariego Vales, Vicenç Sarrablo Moreno & Rafael Pardo Lloría Flexibrick, Spain

Title: APOLO prototypes.

Explanation of the design of the APOLO DEMOS.

The huge range of aesthetic applications to BIPV.

The different possibilities for architects and design. Multiple combinations are possible and final aesthetic design of the façade of the building it is no limited by product. It is the opposite, APOLO DEMOS offers multiple possibilities of design with no limits.

Final results of experimental tests.

11:30 Jelena Aleksic & Bojan Boskovic, Cambridge Nanomaterials Technology Ltd (CNT), UK

Title: Overview of current market and innovation trends

An overview of current patenting and market trends in the field of BIPV will be given including key players and ongoing projects. The importance of innovation management and modern exploitation tools will be introduced, as they are having an essential role in supporting the exploitation of cutting-age interdisciplinary technologies. In order to secure translation from excellence of science, scaling-up of manufacturing processes and establishment of an industrial sector, it is required for stakeholders to understand and apply innovation management tools.

12:00 Ana Milena Cruz, Leitat, Spain

Title: APOLO project: Flexible design of an envelope-integrated perovskite module

This session will be focus in the description of the European Project APOLO establishing where the need for APOLO comes from and how the developed products tackle the challenges to provide market niches solutions. In addition, the potential of perovskite PV technology beyond its use in BIPV will be presented as well as the future challenges that this technology faces.

12:30 Lunch, Exhibition and closure

Note It is planned that all presentations would be followed by Q&A discussion. The organisers reserve the right to change the programme, speakers or venue should circumstances require. For any further enquires please do not hesitate to contact directly the **APOLO Open Day** organiser, Dr Ana Milena Cruz on amcruz@leitat.org (Tel. (+34) 93 788 23 00).

2. APOLO Open Day 2022 – Speakers



Dr Ana Milena Cruz (APOLO Partner & Open Day Organiser)

Leitat

C/.de Innovació 2

08225 - Terrassa

Spain

Technical coordinator of APOLO project. **Dr Ana Milena Cruz Rodriguez** has a PhD in Materials Science from the Universitat Autònoma de Barcelona, a Master in Materials Engineering from the Universidade Federal de São Carlos in Brasil and a degree in Physics Engineering from the University of Cauca in Colombia. In this period her research career has focused mainly on the synthesis and characterization of materials in the area of ceramic, glass ceramic, polymer and biomaterials focusing specifically on their electrical properties. She is currently developing her professional career at LEITAT Technological Center as a senior researcher in the Energy and Photonics Conversion group. Within the group, she manages the Solar Energy area and works in the coordination, execution and exploitation of R + D + I projects financed by public or industrial contracts at national and European level. She has specialized in different technologies including photovoltaic, thermo solar,

printed electronics and thermoelectric. Her work is related to the production and integration of devices, as well as the characterization of the materials involved and the evaluation of their final behaviour. She also actively participates in European and national technology platforms and clusters such as FOTOPLAT (Spanish Photovoltaic Technology Platform), EMIRI (Energy materials Industrial Research Initiative) or the OE-A (Organic and Printed Electronics Association).



Dr Ana Maria Escobar Romero (APOLO Partner)

Leitat
c/.de Innovació 2
08225 - Terrassa
Spain

Dr Ana Maria Escobar Romero (female) is PhD in Chemistry by the Universitat de Barcelona (2018). Previously, she held the Master in Advanced Chemistry specialized in Materials Science (2011) at the same university. Both degrees were obtained under the direction of Prof. Núria Llorca Isern, at Characterization and Processes of Materials Science. During her PhD, she was involved at various national and international projects related with functionalized surfaces and coating technologies. Nowadays, she works at LEITAT Technological Center at the Surface Treatments Unit, participating in the drafting and execution of industrial, national and international R&D projects related to the surface functionalization and modification on ceramics and polymers as well as the conductive inks development.



Dr Silvia Colodrero Pérez (APOLO Partner)

Leitat
c/.de Innovació 2
08225 - Terrassa
Spain

Silvia Colodrero Pérez holds a bachelor's in chemistry (University of Cordoba) and a PhD in Materials Science (Institute of Materials Science CSIC-University of Seville). During this time, she gained expertise about the synthesis of nanostructured materials with controlled optical properties for their application in photovoltaic devices (DSSC) and sensors/detectors. After that she joined a postdoctoral researcher position at the Institute of Photonic Sciences (Barcelona), where she was dealing with the optimization of related thin film photovoltaic technologies (OPV, PVK) displaying additional features such as semitransparency and flexibility. Since March 2018 she is developing her career in LEITAT as Senior Researcher within the group of Energy Conversion & Photonics. She is involved in different projects at national and international level aimed to improve the solar energy harnessing of thermal/photovoltaic devices, to assess their long-term stability according to relevant standards, or to build models of energy generation profiles to detect soiling/fails, among others. In APOLO project, She is fully involved in solvent engineering (WP4) and stability (WP5) tasks.



Bruno Charrière (APOLO Partner)
Scientific Director, adhesives & chemistry

ARKEMA
France

Bruno Charrière graduated from Chimie ParisTech in 1982. After three years research in Materials Science at the University of Bath (UK), he joined Total chemical branch as an R&D chemist. He joined Total's adhesives business in 1994, where he held a number of positions in R&D and later in marketing. He was head of R&D and

Innovation at Bostik from 2004 to 2015. He has held the position of Scientific Director, Adhesives & Chemistry at Arkema's corporate R&D since 2016.

Konrad Wojciechowski (Guest speaker)

Saule Technologies

Dunska 11, Wroclaw,
Poland

Konrad Wojciechowski is currently a Chief Scientific Officer at the Saule Technologies and a team leader at the Saule Research Institute. He received MSc degrees from the Jagiellonian University (Poland) and Lund University (Sweden). He carried out his DPhil. studies at the group of Professor Henry Snaith at the University of Oxford (UK), graduating in 2016. He was part of the team which pioneered major developments in the field of metal halide perovskites. He is currently managing multiple commercial and scientific projects focusing on the perovskite PV technology and related optoelectronic applications.



Prof. Francesca Brunetti (APOLO Partner)

University of Rome Tor Vergata – CHOSE

Via del Politecnico 1
Rome,
Italy, 00133

Prof. Francesca Brunetti FRSC, is Associated professor at Electronic Engineering Dept. of the University of Rome Tor Vergata. Cofounder CHOSE (www.chose.it) her current research is focused on the analysis, design and manufacture of electronic and optoelectronic devices (mainly solar cells, solar modules and energy storage systems on rigid and flexible substrates), through the use of nanomaterials (carbon nanotubes and graphene), organic semiconductors and perovskites. Coordinator of several national and international projects, she authored more than 110 Paper and 6 patents. She is Associated Editor of "Sustainable Energy and Fuels" a Royal Society of Chemistry Journal focused on renewables.



Dr Stéphane CROS (APOLO Partner)

CEA

INES, 50 avenue du lac Léman
73372 Le Bourget du Lac
France

Dr Stéphane CROS has a PhD in the field of nanocomposite organic/inorganic materials (ESPCI, Paris, 2002) He joined the CEA in 2004, where he is in charge of stability/lifetime in the CEA-LCT laboratory (INES institute) making Perovskite and tandem Silicon/Perovskite solar cells. Senior Expert.

Dr Enrico Leonardi (APOLO Partner)

Greatcell Solar Italia srl

Viale Castro Pretorio 122
00185 Roma
Italy

Dr. Enrico Leonardi is Technical Project Leader for Greatcell in Italy. Enrico has had a decade of post-doctoral experience with Greatcell Solar Italia Srl (GSI), involved in scale-up of DSC, development of perovskite solar cells, PSC module and device encapsulation, plus Perovskite panel realisation. He has developed the Hyperion series of LED based solar simulators. He is Technical and Project manager of EU projects for GSI.



David Wilde (APOLO Partner)
Researcher
Leitat
c/.de Innovació 2
08225 - Terrassa
Spain

David Wilde is an environmental scientist working with Leitat Technological Center as Researcher in the Sustainability Area since 2019. He holds a bachelor's degree in International Studies and a master's degree in Environment and Development. At Leitat David has mostly been involved in diverse European projects relating to emerging and advanced technologies, but also bioeconomy, food system transition, and circular economy initiatives among others. His work centers on different aspects of environmental, economic, and social sustainability analysis from a life cycle perspective, and involves data collection and analysis, advanced modelling, stakeholder engagement, communication, and reporting.



Dr Zhanagqi Wang (APOLO Partner)
ACCUREC
Bataverstr. 21
47809 Krefeld
Germany

Dr Zhangqi Wang has received a master's degree in metallurgical engineering at RWTH Aachen University. After that, he obtained his PhD in mechanical engineering at Bochum University. Since 2017, he works in the R&D division at Accurec Recycling GmbH and participates several EU funded projects. Beside research projects he is also responsible for developing, testing and implementation of new technologies for End-Of-Life energy storage system.



Dr Vicenç Sarrablo Moreno (APOLO Partner)
Third party
Flexbrick SL
Carretera Esparreguera a Piera, Km 10
08781 Els Hostalets de Pierola
BARCELONA - SPAIN

Dr Vicenç Sarrablo is full Professor at the School of Architecture of the Universitat Internacional de Catalunya (UIC Barcelona) where he is the director of the Barcelona Ceramics Chair. As of 2014, he also assumes the coordination of the research group LITEIS (Laboratory of Technological Innovation in Industrialized and Sustainable Building).

He is the inventor of the Flexbrick patent and it stands out the national award for this invention at the XIII Spanish Biennial of Architecture and Urbanism in the category of the best product for architecture.



Pedro Casariego Vales (APOLO Partner)
Third party
Flexbrick SL
Carretera Esparreguera a Piera, Km 10
08781 Els Hostalets de Pierola
BARCELONA

Pedro Casariego is a Senior Lecturer at the School of Architecture of the Universitat Internacional de Catalunya (UIC Barcelona) where he is the Assistant Director of the School of Architecture. Member of the group of investigation LITEIS (Laboratory of Technological Innovation in Industrialized and Sustainable Building) under the direction of Vicençs Sarrablo. His specialty is building structures, researcher of cold formed steel elements and usually works as engineer consultant for Flexbrick and its cladding system.



Rafael Pardo Lloría (APOLO Partner)
Chief Technical Officer
Flexbrick SL
Carretera Esparreguera a Piera, Km 10
08781 Els Hostalets de Pierola
BARCELONA
SPAIN

Rafael Pardo Lloría is Chief Technical Officer at FLEXBRICK SL. Architect graduated at Universidad Politécnica de Valencia. Réhabilitation et mise en oeuvre, Le projet et les nouvelles technologies de l'information at Ecole d'Architecture de Marseille-Luminy. Master's degree, specialized in Technology, in Compulsory Secondary Education and Baccalaureate, Professional Training and Language Teaching at Universitat Jaume I Castellón.

Worksite manager for international projects for WOODCOM GLOBAL SL. General coordinator of business activities for ADVENTIA INGENIERÍA. Responsible of Public Works Tendering Office at GILABERT MIRO, SA. Technician for South Tarragona Area at BUREAU VERITAS building branch. Teacher at secondary education, CFP Universidad Politécnica de Valencia and other institutions. Sportsman and musician.



Dr Jelena Aleksic (APOLO Partner & Co-organiser)
Senior Innovation Manager
Cambridge Nanomaterials Technology Ltd.
14 Orchard Way, Cambourne
Cambridge CB23 5BN
UK

Dr Jelena Aleksic is a Senior Innovation Manager at CNT Ltd. She has wide project management, R&D and teaching experience. While she was working as a scientific associate at the University of Applied Sciences in Stralsund, Germany she taught subjects Fluid Mechanics, Gas Dynamics and Mathematics. During her PhD studies in fluid mechanics related to crystal growth at the University of Rostock, Germany, she developed a new temperature measurement method for fluids based on thermochromic liquid crystals (TLC). Her thesis was awarded with the first prize at the South-eastern Conference on Theoretical and Applied Mechanics in Orlando, FL, USA. She organised scientific conferences and edited an internationally published science magazine. At the CNT Ltd. she has been working extensively on developing business strategies, and preparation of customised patent landscaping and market research reports in the field of nanomaterials. Dr Aleksic has also been working on management of European collaborative R&D projects (EC FP7 & H2020) involving tasks such as innovation management, Business Model and Plan development, identification and analysis of Key

Exploitable Results, mapping and engagement with stakeholders and other relevant exploitation and dissemination tasks. Previously she worked in many different industries including renewable energies, construction and social media and she is fluent in English, German, Spanish and Serbo-Croatian.



Dr. Bojan Boskovic (APOLO Partner & Open Day Co-organiser)
Cambridge Nanomaterials Technology Ltd
14 Orchard Way, Cambourne
Cambridge CB23 5BN
UK

Dr Bojan Boskovic has more than 20 years of hands-on experience with carbon nanomaterials and composites from industry and academia in the UK and Europe. Previously, he worked as a R&D Manager at Nanocyl,. He also worked on carbon nanotube synthesis and applications as a Principal Engineer-Carbon Scientist at Meggitt Aircraft Braking Systems, as a Research Associate at the University of Cambridge, and as a Senior Specialist at Morgan Advanced Materials. During his PhD studies at the University of Surrey he invented low temperature synthesis method for production of carbon nanomaterials that has been used as a foundation patent for the start-up company Surrey Nanosystems. He was a member of the Steering and Review Group for the Mini-IGT in Nanotechnology that advised the UK Government on the first nanotechnology strategy policy document. Dr Boskovic was working as an advisor for the European Commission (EC) on Engineering and Upscaling Clustering and on setting up of the European Pilot Production Network (EPPN) and European Materials Characterisation Cluster (EMCC). He has experience in exploitation and dissemination management on a number of FP7 and H2020 European projects, including UltraWire, NanoLeap, OYSTER, M3DLoC, Genesis and nTRACK. Also, in UK Government InnovateUK funded projects, such as UltraMAT and GRAPHOSITE He is also a leader of a private Nano-Carbon Enhanced Materials (NCEM) consortium.

3. APOLO Open Day 2022 – Partner Organisations

Leitat

Web: projects.leitat.org/



Leitat is a private technical institute with more than 110 years of experience in industrial innovation processes. We transform technological and scientific results into economic and competitive value for our clients and collaborating entities. Over 1500 customers benefit from our talent, creativity and strong commitment. We bring knowledge and innovation to our customers through applied research and technical testing in the fields of chemistry, energy, environment, materials, engineering and life sciences. We rely upon our 330 highly skilled team members who deliver flexible solutions to face any industrial challenge.

The “École Polytechnique Fédérale de Lausanne” (EPFL)

Web: www.epfl.ch/labs/lsmo/



The “**École Polytechnique Fédérale de Lausanne**” (EPFL) is one of the two Swiss Federal Polytechnical Schools. A multi-cultural institution at the cutting edge of science and technology, EPFL fosters innovation and excellence. EPFL has a unique organisation that stimulates interdisciplinary research and fosters partnerships

with other institutions and companies, with both theoretical and applied research being carried out. With more than 350 laboratories and research groups on campus, EPFL is one of the Europe's most innovative and productive technology institutes and is also renowned for the quality of its teaching and training programmes. In 2014 the Shanghai Jiao Tong ranking placed EPFL third in Europe and 19th worldwide in Engineering/Technology and Computer sciences, and many other global comparisons place it among the top European universities.

Arkema



Web: www.arkema.com

Arkema is an international company with sales in the field of Specialty Chemicals. The company was created in 2004 as a spin-off of Total, a multi-national company in the field of Oil Extraction, Refining, Distribution, and Petrochemistry. Since 2004, Arkema has specialized in Industrial, and Specialty Chemicals, as represented by its three main poles: High Performance Materials, Industrial Specialties, and Coating Solutions. At present, Arkema is considered as one of the most innovative companies in the world (Thomson Reuters list of the 100 most innovative companies in the world). In 2013, Arkema's sales were of around 6,5 billion €. The company employs near 14000 people in 40 countries, and 85 industrial facilities. Arkema and its subsidiaries account for 10 R&D centers worldwide.

CEA



Web: www.cea.fr

The “**Commissariat à l’Énergie Atomique et aux Énergies Alternatives**“ (**CEA**) is an internationally recognized research organization in the domains of energy, information and health technologies and defense. Its LITEN Institute (Lab. for Innovation in New Energy Technologies and Nanomaterials, 1000 people, 770 patents) is a major partner of fab to lab R&D with 350 collaborative research contracts running this year. The laboratory of PV modules technologies develops printed cells and modules, reaching world level efficiency. The laboratory is involved in the scaling up of these technologies using industrially compatible technologies (Inkjet and roll to roll printing). Stability studies is also an important theme of research with appropriate facilities enable to measure PV parameters in various accelerated climatic conditions and the development of home-made technics particularly in the field of gas barrier and encapsulation characterization.

ACCUREC



Web: www.accurec.de

ACCUREC, founded in 1995, is a technology-based treatment company to manage secondary raw materials. At its plant in Germany ACCUREC has installed several of its unique and own developed innovative treatment techniques, dedicated to the recycling of used batteries. This European battery recycling center enables ACCUREC to recycle every modern type of industrial and consumer rechargeable battery with the best available technology at zero emission.

Fraunhofer-Gesellschaft



Web: www.ise.fraunhofer.de

The **Fraunhofer-Gesellschaft** is the leading organization for applied research in Europe. Its research activities are conducted by 69 institutes and research units at locations throughout Germany. The Fraunhofer-

Gesellschaft employs a staff of 24,500, who work with an annual research budget totalling 2.1 billion euros. Of this sum, 1.9 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

The University of Rome “Tor Vergata”



Web: web.uniroma2.it

The **University of Rome “Tor Vergata”** is based on a campus of 600 hectares with 43000 students and 19 Departments. The University has established in 2006 together with the Lazio Region the “Centre for Hybrid and Organic Solar Energy” (CHOSE). The centre's objectives are the research and development for the industrialization of organic and hybrid organic-inorganic technologies via three main steps: define a technological process for organic/hybrid cells, develop fabrication processes for industrialization, foster technology transfer towards SMEs. CHOSE has the main laboratory has a surface of 650m² with over 300sqm of class ISO7 clean room facilities with all the equipment necessary to carry out research on photovoltaic technology.

UNINOVA Research Institute



Web: www.uninova.pt

UNINOVA Research Institute is a multidisciplinary, independent, and non-profit research organization devoted to the development and application of new technologies, being organized in centers of excellence, involving more than 150 scientists and technologists. It was founded in 1986 by the Faculty of Sciences and Technology of the University Nova de Lisboa. UNINOVA will participate in the APOLO project through CEMOP – Center of Excellence in Microelectronics and Optoelectronics and Processes (Centro de Excelência de Microelectrónica e Optoelectrónica e Processos). The CEMOP areas of expertise are thin-film technologies and development of advanced materials, i.e., semiconductors, photonic material, transparent conductors, thermoelectric and electrochromic materials and devices.

Greatcell Solar Italia SRL



Web: www.greatcellsolar.com

Greatcell Solar Italia SRL (formerly known as Dyesol Italia srl) is an Italian SME member of the Greatcell solar group of companies (formerly known as Greatcell Solar), the world leader in commercialisation of DSC and PSC Cells. Greatcell solar Italia supplies laboratory manufacturing and testing equipment for research and development of DSC & PSC cells and devices. The Greatcell Solar Italia team has a long history of collaborative development programs within the EU and Swiss and Italian communities and for industrial concerns. Greatcell Solar Italia develops new products, devices, components and materials in the DSC / PSC domain. Greatcell Solar Italia provides a complete turnkey design for DSC and PSC prototyping and product manufacture. Greatcell solar Italia has a wide expertise and patent portfolio, with particular reference to: DSC & PSC cells and module design, DSC and PSC manufacturing and testing equipment.

Flexbrick

Web: www.flexbrick.net



Flexbrick is a company owned by Piera Ecocerámica y Cerámica Malpesa, dedicated to the manufacture of a new construction system. This new system consists of a woven metal mesh in which mainly ceramic pieces of different sizes, shapes and textures can be inserted, but also other types materials such as glass, metals, stone, wood, etc. Flexbricks' versatility and features allow you to “play with the design offering a wide variety of aesthetical solutions. Flexbrick has applications for both facades and floors, roofs, pergolas, false ceilings, and more. Flexbrick is an industrialised construction system that combines technological innovation with traditional materials and makes it possible to use small pieces to carry out large-scale projects.

Cambridge Nanomaterials Technology Ltd (CNT)



Web: www.cnt-ltd.co.uk

Cambridge Nanomaterials Technology Ltd (CNT) is an innovation management and nanotechnology consulting company based in Cambridge, UK. The CNT Ltd helps companies, academic and government institutions to develop world-class innovative solutions for nanomaterials related R&D and IPR strategy, partnership, products, technologies, funding and markets. CNT Ltd is specialised in carbon nanomaterials R&D consulting and collaborative R&D project management, including exploitation and dissemination management, consortium and supply chain building. CNT has done a number of patent landscaping and market research analysis studies regarding production and use of various nanomaterials helping to link inventors and technology developers with end-users and investors.

4. APOLO Open Day 2022 – Participating Organisations

Saule Technologies

Web: www.sauletech.com



Saule Technologies is a high-tech company that develops innovative solar cells based on perovskite materials. We have pioneered the use of inkjet printing for the production of flexible, lightweight, ultrathin, and semi-transparent photovoltaic modules.

Nanyang Technological University

Web: <https://www.ntu.edu.sg/>



Established in 2010, the **Energy Research Institute @ NTU (ERI@N)** distinguishes itself through research excellence directed towards outcomes of industry relevance, with focus on systems-level research for tropical megacities. The Institute integrates research across NTU in the context of the energy challenge, and then helps translate outcomes into industry and practice. As a leading Institute that is equipped with a wide range of skillsets and expertise in Science, Engineering, Technology, Policy, and Social Science that contributes to a vibrant, multidisciplinary and collaborative research environment, ERI@N strives to achieve our mission for distinction and contribute to National aspirations for a Smart and Sustainable Nation.

University of Porto, FEUP



Web: https://sigarra.up.pt/feup/pt/web_page.inicial

With origins dating back to the eighteenth century, the University of Porto (U.PORTO) is currently one of the most prestigious Higher Education Institutions of Europe. It has close to 33 000 students, 2 567 Academic & Scientific Staff along with 1 625 administrative staff within its 15 schools and 49 scientific research units, spread across 3 university campuses located in the city of Porto.

The Faculty of Engineering (FEUP) is the largest faculty of U.PORTO, with about 8570 students and 750 teaching staff and researchers across 9 departments. It is located in the Asprela Campus, the main university campus in the city of Porto. FEUP is in the heart of Porto Innovation District and is the engine behind the success of The Science and Technology Park of the University of Porto, UPTEC, the winner of the 2013 European Region Stars Award for Smart Growth.

In the FP7, FEUP was partner and/or coordinator in a total of 48 projects, including as host institution of two ERC Grants (Elastic-Turbulence and BI-DSC) and three Individual Marie Curies: one International Outgoing Fellowships (GPSMB-PPSplitter) and two International Incoming Fellowships (Micro-BioRheology and COVMAPS). Under Horizon 2020, FEUP is already partner in 35 projects funded (Marine UAS, BRIDGES, ICI-THROUGH, IN2RAIL, HYDRALAB-PLUS, FAME, ANTAREX, HEAT-SHIELD, RISEN, PRINTCR3DIT, LIQUEFACT, PRINT-AID, OPTICON, SERA, SimuSafe, InnoDC, IN2STEMPO, OptiMACS, PROSEU, SPRINT, RE-CITY, IN2TRACK2, RECLAIM, TREAL, LIKE, EuroSea, CHAMELEONS, MOVING TOGETHER, BugWright2, EMPOWER, NEWFRAC, GROOM II, REMARO, IN2TRACK3 and ORP) and is the coordinator of 10 other funded projects (SDIN, SmartHELMET, GOTSolar, EUMarineRobots, DeINAM, SED, SurfSAFE, 112CO2, TEMPEST and XeRo). FEUP is also a third party in the projects ANSWER, EMSODEV, IN2TRACK and mcBEES.

CENER

Web: www.cener.com/en/



The **National Renewable Energy Centre of Spain (CENER)** develops applied research in renewable energies, and provides technological support to companies and energy institutions in six areas: wind, solar thermal and photovoltaic solar energy, biomass, smart and efficient buildings and districts, and grid integration of energy. CENER is a technology centre with worldwide recognised prestige, activity and experience.

Swansea University /SPECIFIC

Web: www.specific.eu.com/



SPECIFIC is a UK Innovation and Knowledge Centre (IKC), accredited by UKRI, leading in energy technology research and full-scale demonstration. Our vision is a world in which 'Active Buildings' can generate, store and release their own heat and electricity from solar energy. To deliver this, we research, prove and promote early commercialisation of building-integrated technologies that can capture energy from the sun and store it in a building until it is needed. We are also investigating the role for these buildings in our national energy and transport systems.

Some of the technologies are developed here by our research teams, who specialise in scale-up of energy technology from fundamental materials chemistry to full-scale building applications. We also work with a wide range of business and academic partners to demonstrate and support early commercialisation of new renewable energy technology and systems.

Buildings account for about 40% of global carbon emissions; in the UK they consume about 40% of all the energy produced. To address the energy crisis and reduce carbon emissions we need radical change in the way buildings are designed, built and integrated into our energy system: this is our mission.

ADHESIVES RESEARCH



Web: www.adhesivesresearch.com

Adhesives Research is your expert developer and manufacturer of high-performance adhesives, tapes, specialty films, coatings, laminates, release liners and drug delivery technologies. With 300 people developing and producing adhesive tapes (and liquid) for various markets.

Senergy Innovations



Web: www.senergyinnovations.co.uk

In 2015, Senergy Innovations Ltd's Founder and CEO Christine Boyle had an idea to transform how homes and businesses are heated. With a significant career history in running a commercial roofing business, Christine identified that there was a real market gap for solar thermal panels that would be low cost, have low environmental impact in production and easily integrated into a building. The need to be low cost and low carbon impact in production inevitably meant polymers would be suitable. However, polymers are not typically suited for applications that conduct heat so Senergy was established to undertake the development of the first thermally conductive polymer solar thermal panel.

CINEA - European Commission



Web: https://cinea.ec.europa.eu/index_en

The European Climate, Infrastructure and Environment Executive Agency (CINEA) is the successor organisation of the Innovation and Networks Executive Agency (INEA). Officially established on 15 February 2021, it has started its activities on 1 April 2021 in order to implement parts of certain EU programmes. CINEA plays a key role in supporting the EU Green Deal through the efficient and effective implementation of its delegated programmes.

JRC-EC



Web: https://ec.europa.eu/info/departments/joint-research-centre_en

The Joint Research Centre is the Commission's science and knowledge service. The JRC employs scientists to carry out research in order to provide independent scientific advice and support to EU policy.

Helmholtz Zentrum Berlin



Web: www.helmholtz-berlin.de/

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB) researches solutions for a climate-neutral society. Researchers are developing and optimising efficient and cost-effective materials for solar cells, batteries and catalysts. These energy materials are essential components for achieving a CO2 neutral and secure energy supply.

Department Solution-Processing of Hybrid Materials and Devices

Since end of 2021, the Unger group is now the Department Solution-Processing of Hybrid Materials and Devices.

We are continuing our research on scalable solution-based manufacturing techniques for hybrid materials.

Focus areas of our research are:

- Precursor Ink Design, Rationalization and Solution Chemistry
- In-situ Monitoring during Processing (using optical and X-ray based techniques)
- Device and Module Prototype Manufacturing and Optimization
- High-throughput Combinatorial Materials Synthesis & Exploration of Hybrid Perovskites for alternative applications.

- The Perovskite Database

Chulalongkorn University

Web: <https://rongrongc.wixsite.com/rrreliabilitylab>



Renewable Rechargeable Reliability Laboratory (RRR lab) aims at enabling renewable solar power to be utilized more efficiently, sustainably, and widely. Our research spans from materials development, mechanistic investigation, device structural engineering, encapsulation, and operational stability testing of solar cells and energy storage devices with the goal of long-term stability with sustainable materials.

LEPABE - Laboratory for Process Engineering, Environment, Biotechnology and Energy

Web: www.lepabe.fe.up.pt/



LEPABE is a research unit of the Faculty of Engineering of the University of Porto. It has been evaluated as "Excellent" in consecutive external evaluations appointed by FCT (Fundação para a Ciência e Tecnologia). It counts with approximately 220 researchers, among which about 80 have doctoral degrees.

Cicci Research s.r.l.

Web: www.cicciresearch.it



Cicci Research was born from the center for Hybrid and Organic Solar Energy (CHOSE) of the University of Rome "Tor Vergata". Our team is composed by mechanical designers, firmware and software developers and electronic engineers with experience in photovoltaic research field. The synergy of skills and the collaboration with research labs and industrial partners are the value of our works.

SENA

Web: www.sena.edu.co



We are a public establishment of the national order and with administrative autonomy, attached to the Ministry of Labor (Colombia).

We offer free training to millions of Colombians who benefit from technical, technological and complementary programs that focused on the economic, scientific and social development of the country, enter to strengthen the productive activities of companies and industry, to obtain better competitiveness and greater results in the different markets.