Report on

Projects Funded

Public summaries of projects initiated through transnational SOLAR-ERA.NET joint calls

Status 23 December 2015

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Authorship:
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Introduction - What Is SOLAR-ERA.NET? What Is this Report about?

SOLAR-ERA.NET - the Network and its Objectives

SOLAR-ERA.NET is a network that brings together more than 20 RTD and innovation programmes in the field of solar electricity technologies in the European Research Area. The network of national and regional funding organisations has been established in order to increase transnational cooperation between RTD and innovation programmes and to contribute to achieving the objectives of the Solar Europe Industry Initiative (SEII) through dedicated transnational activities (especially transnational calls). SOLAR-ERA.NET is an EU funded FP7 project running from 2012 to 2016. Through the support of the funding organisations, more than 100 MEUR shall be mobilised for transnational RTD and innovation projects.

SOLAR-ERA.NET - the Context

SOLAR-ERA.NET is a European network of national and regional funding organisations and RTD and innovation programmes in the field of solar electricity generation, i.e. photovoltaics (PV) and concentrating solar power (CSP) / solar thermal electricity (STE). SOLAR-ERA.NET shall carry out the coordination and support actions for the implementation of the SEII between national and regional RTD and innovation programmes. The SEII is embedded in the European Strategic Energy Technology Plan (SET-Plan) which aims to increase, coordinate and focus EU support on key low-carbon energy technologies in order to achieve Europe's 2020 energy objectives in the future. The SEII is a joint initiative of the industry sector, EC and member states. The objective of the SEII is to boost the development of the PV and CSP sector beyond "business-as-usual" in the areas of Research and Development, Demonstration and Deployment. For the concerned solar electricity technologies Implementation Plans have been developed setting out priorities for RTD in Europe.

SOLAR-ERA.NET - the Activities

SOLAR-ERA.NET's goal is to undertake joint strategic planning, programming and activities for RTD and innovation in the area of solar electricity generation. Joint activities, namely joint calls, are defined for key topics and priorities in accordance with the Solar Europe Industry Initiative (SEII), based on the Strategic Energy Technology (SET) Plan and its related Implementation Plans for PV and CSP. In order to define and support the best joint activities, strategic information exchange and use of implementation tools will be carried out among the network participants and associates from key stakeholder groups.

SOLAR-ERA.NET – Joint Calls

Joint Calls are the core mission of SOLAR-ERA.NET. Through these transnational calls, innovative industrially relevant projects shall be supported. Support and funding is provided by the national and regional agencies involved in these calls.

Organisations involved in promoting SOLAR-ERA.NET transnational calls and providing support and funding to innovative industrially relevant projects.

The general scope of the SOLAR-ERA.NET Joint Calls are to: i) seek new and complementary RTD and innovation projects in the field of solar electricity technologies; ii) to strengthen the international collaboration in the field of solar power RTD and innovation, improving the effectiveness and efficiency of regional and national programmes; and iii) to contribute both to European industry competitiveness and to its innovation capability.

The aim is to fund application oriented and industrially relevant transnational RTD and innovation projects in the field of solar electricity technologies.
The project proposals must clearly demonstrate:

- Potential commercial impact / relevance to industrial and market needs / contribution to the Solar Europe Industry Initiative and added transnational value
- Scientific and technological excellence
- Quality and efficiency of the implementation and the management

The following topics have been within scope of at least one of the Joint Calls for PV respectively CSP.

PV topics:

- Innovative processes for inorganic thin-film cells & modules
- Dedicated modules for BIPV design and manufacturing
- Grid integration and large-scale deployment of PV
- High-efficiency PV modules based on next generation c-Si solar cells
- Solar glass and encapsulation materials
- Concentrator PV technology
- Si feedstock, crystallization and wafering
- Organic solar cells, perovskites and other emerging concepts

CSP topics:

- Cost reduction and efficiency increase in components
- Dispatchability through storage and hybridisation
- New heat transfer media for CSP plants
- Innovative thermodynamic cycles

According to their RTD priorities, national and regional programmes accepted applications in all or selected topics.

In all, four sets of Joint Calls are launched. The first one was launched in early 2013, the fourth one in late 2015.

What is included in this report?

This document is a collection of all summaries submitted by the project coordinators. Public summaries include a short description of the project, coordinator contact information and aggregated financial figures.

This report is continuously updated, i.e. summaries are added as soon as new projects start.

Project coordinators submit a summary at the start of the project as well as at the end of the project, the project end report replaces then the project start report in this document.

The summaries are listed according to the project number which does not necessarily reflect a chronological order.

For any further information, you may contact the project coordinator.

001 SLAGSTOCK

Low-Cost Sustainable Thermal Energy Storage Systems Made of Recycled Steel Industry Waste

Project duration: 05.2015 to 04.2018
Report submitted: 09.2015

Summary

One of the major challenges of the Concentrated Solar Power (CSP) industry is the development of cost effective high temperature thermal energy storage (TES). Currently, the most applied storage strategy in commercial CSP plants consists in a double tank configuration based on molten salt as storage material. This arrangement presents several limitations such as the reduced operation temperature range, the worldwide availability of salts and their high economic cost.

SLAGSTOCK project aims to develop an innovative thermal storage concept to overcome these drawbacks. This approach makes use of steel slags as storage material due to preliminary measurements have demonstrated that the operation temperature range of steel slags in thermal storage applications can be extended up to 1100 ºC.

Steel slags are a by-product of the steelmaking industry and currently recycled in several applications such as aggregates for construction or road materials. However, about 2,8 Mt of slags production is landfilled per year. The revalorization of steel slags as thermal storage material could represent a successful solution to obtain a low-cost storage material and hence to design an economically competitive thermal energy storage lead concept.

The versatility of the proposed solution can also be useful for different thermosolar power generation technologies such as parabolic through or power tower. In particular, the innovation proposed in SLAGSTOCK project covers the use of different heat transfer fluids such as molten salt or air in different temperature ranges. Also, in the SLAGSTOCK approach, several storage concepts are proposed which can be suitable for different CSP storage requirements.

Overall, the revalorization of this steel industry by-product into a storage material opens new possibilities within the framework of CSP and could lead to a cost-effective high temperature storage solution for both current and future thermal energy storage technologies.

Project consortium

Coordinator and contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Spain	3	919'677	259'190
Switzerland	1	160'085	120'571
Germany	1	96'888	80'740
France	1	96'636	50'707
Total	*6*	*1'273'286*	*511'208*

Contract with Swiss partner is in CHF, exchange rate applied 1 EUR = 1,05 CHF

005 LIMES

Light Innovative Materials for Enhanced Solar Efficiency

Project duration: 04.2014 to 03.2017
Report submitted: 05.2014

Summary

There is a global drive to lower the cost of solar generated electricity. The cost per watt peak (€/Wp) can be reduced by increasing PV efficiency, reducing cost of the Balance of System (BOS) and minimizing the module costs. Module assembly is material extensive and constitutes a significant part of the price. Currently, 3mm glass is the predominant cover of solar modules and it implies 30% of the price. Reduction of encapsulant materials can help to minimize the foot print of the solar panel by minimized cost over the whole chain from raw materials to installation. The aim of the project is to exploit the development of 1mm toughened glass as encapsulant to produce a light weight, low cost PV module with enhanced efficiency. To be able to reach that goal, we have constituted a consortium including necessary expertise. In the project we will develop glasses and new coatings to improve the physical properties of the cover material of PV modules. Furthermore, novel toughening techniques of thin glass will be investigated, and prototypes will be assembled. The following slogans connected to the project acronym, LIMES, explain the aim of the project.

- “Towards ultra-thin glass-glass modules”
- “Towards eliminating the transmission limit of solar glasses"
- “Towards ultra-robust module designs with extended lifetime"

LIMES aims at promoting excellence in research and innovation in order to enhance the competitiveness of European industry and increase the energy produced by sustainable solar power in the future. Results and technological advances will be disseminated by publications, seminars, conferences and reports. The results in terms of prototypes are expected to lead to patents. The initial route to market is through demonstration of new off-grid PV modules and if successful proven case histories will be presented to the BIPV industry.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Sweden	2	764’491	694’491
Spain	1	326’880	230’916
United Kingdom	2	638’679	461’616
Total	*5*	*1’931’696*	*1’387’023*

009 BLACK

Black Silicon and Defect Engineering for Highly Efficient Solar Cells and Modules

Project Duration: 04.2015 to 09.2017
Report submitted: 11.2015

Summary

This project consortium includes the leading academic groups and industrial partners from different parts of the photovoltaic value chain. The goal of the project is to test the previously studied ideas in industrial scale and take a step towards commercial applications. The final goal is to implement a prototype of a full-size solar panel with black silicon (b-Si) surface with atomic layer deposited coating, and thus demonstrate the significance and impact of the previous academic results on the industrial scale.

Project consortium

Coordinator and all contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Finland	6	864’618	381’000
Germany	1	304’773	152’386
Spain	1	75’000	75’000
Total	*8*	*1’244’391*	*608’386*

012 INTESEM

Intelligent Solar Energy Management Pipeline from Cell to Grid

Project duration: 01.2014 to 12.2016
Report submitted 05.2014

Summary

Solar energy will be a major source of electricity in the future. Cost-optimal and efficient large scale utilisation and grid integration of solar energy will require more sophisticated design, structure, control and operating model. Virtual Power Plants (VPP) are a promising solution to optimise the generation and storage assets, maximise production and facilitate efficient and balanced distribution of energy to end users.

The objectives for "Intelligent Solar Energy Management Pipeline from Cell to Grid (INTESEM)" project are to optimise a distributed solar energy system (holistic from cell to grid) in a Virtual Power Plant model to enable high PV penetration levels and at the same time minimize costs. The project team is to design, demonstrate and optimise an intelligent VPP model with energy storages, which can be expanded also to the new growing energy markets in the future. The aim is also to develop and utilise new intelligent module, inverter and storage technology to enable the efficient design and operation of the VPP model. The project partners are a Nordic energy company Fortum, a back contact module and manufacturing equipment provider Cencorp, and a solar inverter and energy storage provider Ferroamp.

The objective is to build a pilot VPP system with four commercial-scale PV plants to be located in Finland and Sweden. The plants will be selected based on characteristic variation, e.g. different load profile, size of the storage and/or capabilities for demand response. The most obvious, expected benefits can be achieved with the help of local energy storage in combination with PV modules. A further objective is to demonstrate how four-quadrant inverter technology can be used in PV installations to make them part of the VPP concept and provide grid supporting functions.

The target is 15% reduction of solar energy cost per kWh and to capture a better value for energy with an intelligent system compared to a conventional one. This 15% reduction does not take into account any further reductions in module or balance of system cost but will be based on operational efficiency. A major share of the expected cost reductions can be achieved with the help of local energy storage in combination with PV systems. Local energy storage brings several benefits to VPP operators such as possibility to reduce production and consumption peaks, provide frequency support, reduce distribution losses, and within balance responsible parties to reduce balancing costs due to forecast errors. Consumers can increase their self-consumption of PV electricity, buy off-peak electricity, reduce grid fees and have access to back-up power.

As a result PV could be installed with better cost efficiency which would enable the wider penetration of solar modules also in the Nordics. The security of supply would increase with increased storage facilities and reduced peaks in the system which would also result as more stable electricity prices.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Finland	2	1'063'800	442'530
Sweden	1	295'100	173'125
Total	*3*	*1'358'900*	*615'655*

013 NOVACOST

Non Vacuum Based Strategies for Cost Efficient Low Weight Chalcogenide Photovoltaics

Project duration: 10.2014 to 09.2017
Report submitted: 02.2015

Summary

Chalcogenide (CuInGa(S,Se)2-CIGS, Cu2ZnSn(S,Se)4-CZTS) based technologies have a strong potential for high efficiency low cost photovoltaics (PV) solar cells and modules. Indeed, thin film technologies are well adapted for the use of alternative low weight substrates that are required for the extension of PV towards large area industrial/commercial roofs and architectural facades (BIPV) where less than 4 kg/m2 modules are expected. Among thin film technologies, CIGS prepared by vacuum based methods is the one showing the higher efficiency (with a 20,4% world record on low weigh substrate (EMPA, 2013)). This explains the significant growth in the CIGS worldwide industrial production from about 150 MW/y in 2009 up to over 2 GW/y in 2011, even if the struggling market situation is forcing many CIGS based companies to bankrupt. The struggling and competitive future is driven by the fact that electricity generated by PV is becoming increasingly competitive, with an average levelized cost of energy (LCOE) estimated to be between 0,12-0,17 €/kWh in 2011, depending on regional climate conditions. This constant reduction is struggling the European industry towards i) strong reduction of the production and investment costs, that today are at ~ 1,0 €/Wp in Europe versus ~ 0,6 €/Wp in emerging countries like China and Taiwan; and ii) investment in novel “advanced” industrial processes allowing high efficiencies and low-cost device production.

NOVACOST project aims at developing a non-vacuum low cost and up-scalable roll-to-roll manufacturing method with innovative precursors and crystallisation process for the fabrication of cost-efficient low weight CIGS and CZTS-based solar cells and modules. For this purpose, two industrials partners (‘Advanced Coatings & Construction Solutions scrl’ in Belgium-Wallonia, ‘Francisco Ramos S.A’ in Spain) and two research institutions (‘Instituto de Recerca en Energia de Catalunya’ in Spain, and ‘Uppsala University’ in Sweden) will employ their knowledge and know-how on materials, processes and characterization through 8 workpackages:

- The use of innovative chalcogenide inks formulation and the improved control of coating processes to enhance the film homogeneity will be addressed for CIGS and CZTS respectively in WP1 and WP2,
- The breakthrough introduction of Intense Pulse Lighting technique for crystallization of the CIGS / CZTS layers will be investigated in WP3,
- The set-up of a methodology for quality control of these PV thin films will be addressed in WP4.

All these innovations will be assessed by solar cells and mini-module prototyping (WP5). The project includes lab scale to pre-industrial pilot development of roll-to-roll (R2R) compatible

technologies and assessment of economic and environmental benefits (WP6). The global objective is to demonstrate that the developed innovative technologies forecast a 15-50 % cost reduction in the equipment with respect to the state-of-the-art vacuum based CIGS manufacturing processes, paving the way to achieve 0,6 €/Wp system cost for the production of solar cells. Dissemination and plans for commercialization of the developed eco-friendly products and technology will be finally addressed (WP7), aiming to reinforce the industrial competitiveness of PV European actors.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Belgium-Wallonia	1	357’501	143’000
Spain	2	550’633	164’000
Sweden	1	213’000	213’000
Total	*4*	*1’121’134*	*520’000*

036 NovaZOlar

All-non-Vacuum Processed ZnO-based Buffer and Window Layers for CIGS Solar Cell Technology

Project duration: 09.2014 to 08.2016
Report submitted: 12.2014

Summary

The Cu(In,Ga)Se_2 (CIGS) thin film solar cell technology has made a steady progress within the last decade by raising the conversion efficiency to 21,7% on laboratory scale, thus exceeding the highest efficiency for polycrystalline silicon cells, whereas standard-size CIGS modules achieve efficiencies of up to 15,9%. High efficiency CIGS cells employ the so-called buffer layer of CdS deposited by chemical bath deposition (CBD), and its presence and, importantly, treatment and utilization of Cd-containing waste present a serious environmental concern. A second potential bottleneck of the CIGS technology is the transparent conductive oxide (TCO) layer of i-ZnO/Al:ZnO, which is deposited by sputtering requiring expensive vacuum equipment. A non-vacuum deposition of TCO relying on simpler equipment with lower investment costs will be more economically attractive and could increase competitiveness of CIGS modules with the mainstream silicon-based technologies.

The aim of NovaZOlar is to develop an innovative, low-cost process of in-situ monitored aqueous solution deposition of the ZnO-based buffer-window combination for high-efficiency CIGS solar cells. The novelty is to use a single deposition technique – CBD – for deposing the Cd-free window-buffer combination that should ultimately replace the present CdS/i-ZnO/Al:ZnO stack. A solar efficiency of > 20% is targeted, which is comparable to that for best cells with CdS buffer and should translate into CIGS module efficiency of 14-16%.

Besides the scientific and technological impact for developing the innovative low-temperature solution deposition and testing a new CIGS solar cell architecture, the main commercial impact will be on i) cost reductions by avoiding expensive vacuum sputtering of ZnO and toxic Cd waste disposal, and ii) simplified equipment making turn-key CIGS production lines more cost competitive. Reliable techniques for process monitoring and quality control at both in-situ and on-line levels will improve fabrication yield, and hence also contribute to reduction of manufacturing costs. Cost analysis and technical assessment of transferability of the developed solution techniques will be done by CIGS-manufacturing companies from Switzerland, France and Germany in this industry-driven project.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Switzerland	2	533'338	400'000
France	3	327'642	293'642
Germany	2	547'181	411'091
Spain	1	181'527	114'000
Total	*8*	*1'589'688*	*1'218'733*

037 HyLighT

Design, Development and Application of a Technologically Advanced System of Natural Daylight and Artificial PV Lighting - Hybrid Light Tube

Project duration: 09.2014 to 08.2016
Report submitted: 12.2014

Summary

In order to meet the lighting needs, the consumption of energy exceeds on average 10% of the total in a residential building and 30% in a commercial. It is therefore easily understood the importance of saving energy in the building's lighting sector. Appropriately controlled natural lighting in buildings offers many advantages over using artificial lighting; energy savings probably being the most important. Ideally energy savings should be combined with onsite energy production from renewable sources. Especially in the case of the building shell, the renewable energy technologies that seem likely to meet on-site energy needs are mainly those associated with the sun, as solar technologies for onsite energy production currently dominate the building sector. Acknowledging these facts, a research team consisting of a research centre in Cyprus (Frederick Research Centre), an industry in Poland (AG Metal Poland), and a consultants' team in Cyprus (Solar Century) proposes a novel BIPV concept, which combines the following features:

- The use of natural lighting, using a well-established concept, the light tube
- The utilization of renewable energy technologies to meet the needs of artificial lighting

The combination of the above resulted in a hybrid light tube (HyLighT). HyLighT project aims at the design and manufacturing of a novel concept, namely the integration of a CIGS thin-film photovoltaic membrane to a light tube. The main idea behind the proposed concept is that the energy produced by the photovoltaic membrane will be stored and used by demand to cover the needs for artificial lighting. For this purpose, LED light bulbs will be incorporated into HyLighT's body, activated either manually or by a motion detector. HyLighT aspires to be an innovative, energy efficient quality product, having a clear added value over standard light tubes. The proposed concept also aims at low cost and increased efficiency. The benefits of HyLighT are manifold; the integration and promotion of environmental-green solutions of natural lighting for new and existing buildings, the display of the European renewable energy technologies products in the international market, and the stakeholder's competitiveness boosting within the European and international markets. HyLighT project will focus on the design and functionality of the proposed solution as well as on the excellent aesthetics combined with high performance. Ease of installation and replacement as well as the reliability and the robustness of the proposed concept will also be investigated. The HyLighT project will be concluded with the testing and demonstration of the new product to the interested stakeholders and potential end-users.

Project consortium

Coordinator and contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Cyprus	2	101’464	96’318
Poland	1	137‘685	102‘755
Total	*3*	*239’149*	*199’073*

Polish data with exchange rate of 1 Euro = 4,2 Zloty

039 InnoModu

Leadfree Modules with Low Silver Content and Innovative Busless Cell Grid

Project duration: 10.2014 to 03.2016
Report submitted: 11.2014

Summary

InnoModu is an industry-driven research project striving to develop the next generation of photovoltaic (PV) cells and modules. Up to now, standard crystalline PV modules consist of solar cells whose current collection system (metal grid), fingers and busbars, needs much silver (~350mg). Additionally, the stringing of the solar cells is carried out by a lead containing soldering process. However, the silver price is expected to rise in the next years showing an impact on the PV-prices, and furthermore, lead is being banned from nearly all other electronic devices for environmental reasons. Another challenge in the PV cell production is the reduction of the shadowing of the active cell material by minimizing the contacting grid on the front side of the cells. On the one side, the grid should have a low ohmic resistance in order to reduce the energy loss. On the other side, it should enable a maximum of sun light falling on the cell with decreased shadowing. These are two contradicting demands, which need to be analyzed and improved. Additionally, the ribbons which are used for the stringing process are wider than necessary in order to compensate an inexact alignment. This leads to a further shading and power reduction of the modules.

The targets of InnoModu are threefold: (1) drastically minimize the silver content (by ~50%) in solar cells, (2) reduce the share of lead used in a module due to soldering to nearly zero, and (3) reduce the shadowing of active cell material. These three main targets will allow for considerable cost and material savings as well as environmental improvements. In addition, the novel technology will bring more cell efficiency with clear market benefits for the industrial partners. In order to reach the aims, the metal grid on the solar cell surface has to be optimized and new technologies to apply high efficient connection wires (ribbons) have to be implemented (see Fig.1).

The main innovative step of InnoModu in relation to state of the art technologies is the combination of a galvanic process with copper and a following gluing process (application of LCR) to replace the standard screen-printing process of silver paste as well as the standard soldering process (lead-containing). This offers completely new opportunities to increase the overall cell performance, reduce costs, and increase environmental compatibility. The use of electrically conductive glue will allow to fix the metal ribbons directly to the cell and thus to avoid busbars and soldering processes, which would require soldering pastes containing lead as well as overlapping ribbons and would lead to a considerable reduction of silver paste.

Additionally, it will enable the use of innovative LCR ribbons, which can dramatically reduce the ribbon-caused shadowing and thus increase cell efficiency. Furthermore, the use of galvanic metallization techniques make a completely silver free solar cell production process possible and the risk of breakage, when using thinner solar cells, is significantly reduced during module manufacturing.

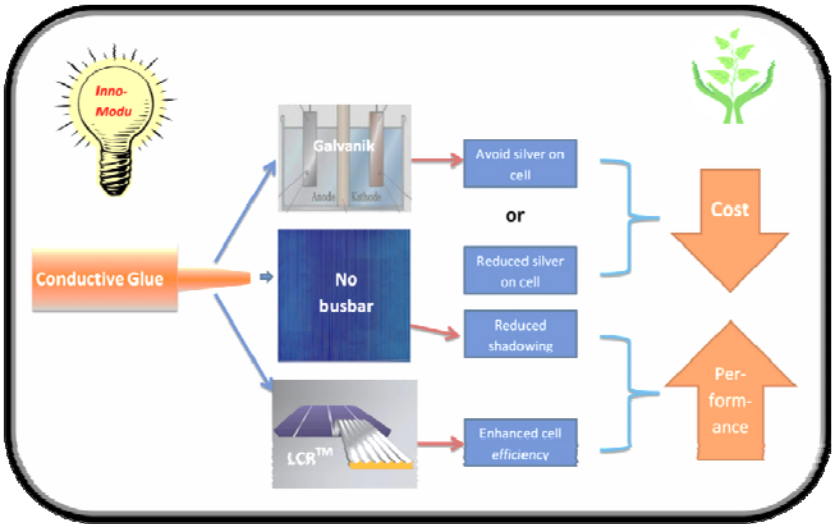

Fig.1 InnoModu project idea

Project consortium

Coordinator and contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Austria	5	538’058	389’551
Germany	2	271’287	135’644
Total	*7*	*809’345*	*525’195*

047 AER II

Industrialization and System Integration of the Aesthetic Energy Roof Concept

Project duration: 05.2014 to 04.2016
Report submitted: 01.2015

Summary

The future of the European photovoltaic industry depends heavily on breakthroughs in 'mass customization' of photovoltaic roofs, that require the European local execution of engineering, on-demand manufacturing and on-site delivery, and that need a high level of aesthetics to appeal to a broad public.

In this project the project partners Soltech, Heijmans, SEAC and AERspire join forces to research, develop, industrialize and bring to the market the Aesthetic Energy Roof (AER) concept. The AER concept is based on a patented frameless glass-glass laminate with integrated mounting functionality. AER is a full roof solution, which replaces the functionality of the conventional roofing. The building integrated energy roof concept has a unique set of properties like full roof filling, unsurpassed high-end aesthetic appearance, minimized bill-of-materials, optionally included integrated window and integrated solar thermal panel. The AER concept will result in a full range of products that can be build up modular on any type of roof at customer energy and heat demand.

The cross-border AER II project follows-up the Dutch nationally funded AER I project, in which the proof of principle for the water tightness, the mounting principle and the electricity generation of the concept has been demonstrated. The objective of the AER II project is to further develop the AER concept into more product lines, industrialize the production and bring these products to the market. A market study will deliver an overview of the various BIPV market segments and the best fit for the various AER product lines. Secondly, the base product and its manufacturing processes will be industrialized and optimized to reach the optimal price for the roof functionality and the price per Wp. A prototype roof must demonstrate the novelty of the new ventilation shaft that ensures maximum heat transfer from the module to the air in the shaft by the design of an aerodynamic profile and mounting concept.

All results and suggested improvements will be integrated in a demo-roof which roof solution will also include functional and finishing parts and all necessary components such as: PV modules, interconnections, inverter, switches and grid connection. Monitoring equipment will be installed and data will be saved for further evaluation and optimization.

Project consortium

Coordinator and contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
The Netherlands	3	506’782	299’403
Belgium-Flanders	1	80’459	44’252
Total	*4*	*587’241*	*343’655*

049 SNOOPI

Smart Network Control with Coordinated PV Infeed

Project duration: 10.2015 to 09.2018
Report submitted: 11.2015

Summary

High penetration of PV in the distribution grid will significantly impact voltage control in the distribution network. It will cause high voltage rises and fast voltage changes over a very short time period when for example clouds are passing areas with large amounts of solar power. The objective of this study is to develop and test a voltage regulation tool that is scalable and portable so that it can be used for any distribution system with high PV penetration.

The project “Snoopi” consists of 4 partners: two in Germany, namely Energynautics GmbH, EWR Netz GmbH, one institution – KTH – in Sweden and one in Austria (Fronius International GmbH). It will last in total for three years.

The project will develop and test new control methods to maintain the voltage within set limits, even if the situation in the distribution network is changing very dynamically (e.g. if electric cars are frequently connected to the distribution network together with a high share of PV).

The main challenge is to coordinate the inverter control of many battery systems and at the same time minimize the communication and measuring requirements in the distribution network. As regulating the voltage in one node indirectly regulates the voltage in the adjacent node due to the inherited interactions in the voltage, a robust control scheme must be developed. Regulating the voltage in one node should not cause problems in another, and in addition the transformer tap changer control or other controllable devices need to be taken into account in the regulation, to ensure all node voltages are within the limits.

It is the intention of the project to test the newly developed control methods in a real distribution system with considerable amounts of PV. It is planned to implement and test the voltage control tool in field tests on the EWR Grid in Germany. The EWR Grid encompasses a large amount of PV. To measure the voltage in these networks, various measurement systems will be used, e.g. phasor measurement units.

The project will be executed in six phases. In the first phase field test areas in Germany will be identified and reconstructed in network models. The voltage control tool will be developed in phase two and tested by simulations on the network models in phase three. Phase four focuses on testing the tool in the laboratory. In phase five demonstration projects will be prepared. The main goal is the execution of demonstration projects in phase six, where the tool will be tested in field tests on

the real distribution grids of EWR. During these field tests, several questions will be answered such as:

- What measurement quality is required from “Battery Inverter” and “Smart Meters”, e.g. what time delays are acceptable and what data sampling rates are needed?
- How much solar power can be installed in the distribution grid and what are the limiting factors?
- What is required to make the tool scalable and portable to other network areas?

The evaluation of the measured data as well as the delivery of the final report will also take place in phase six. The overall aim is to develop, test and validate the performance of the voltage control tool, so that it can be used as a network operating tool by distribution companies around the world.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	2	769’962	428’469
Austria	1	0	0
Sweden*	1	259’921	259’921
Total	*4*	*1’029’883*	*688’390*

**originally 2‘469‘250 SEK assuming 9,50 SEK / EUR*

071 PV4FACADES

Photovoltaics for High-Performance Building-Integrated Electricity Production Using High-Efficiency Back-Contact Silicon Modules

Project duration: 09.2014 to 08.2016
Report submitted: 01.2015

Summary

The PV4FACADES project aims at the development of low-cost and high-efficiency back-contact cell and module technology and building-integrated PV (BIPV) products based on back contact technology. This will result in higher efficiency PV modules which are perfectly suited for BIPV: much more appealing aesthetics and more suitable electrical, thermal and mechanical characteristics.

Back contact module technology is the accepted route to higher efficiency PV modules (see e.g. the SEMI PV roadmap). At the same time, back-contact module technology is also perfectly suited for BIPV in which PV elements are integrated into buildings and often have dual functions (serving as electricity generator and construction element) which reduces the balance-of-system costs. For residential rooftop and building integration, the current typical modules are aesthetically unattractive. The much more appealing aesthetics of back-contact modules make them much better suited for BIPV and for residential rooftops. In addition, the PV industry has seen little product diversification to date, and there are commercial opportunities for PV systems other than the current typical flat plate modules mounted on frames or supports.

The PV4FACADES project will run for two years and has the following main objectives:

- The development of low-cost, high-efficiency back-contact cell technologies for industrial take-up.
- The development of back-contact interconnection and lamination technologies, for 156mm x 156mm MWT (metal wrap through) and IBC (interdigitated back contact) cells, with improved integrated cell and module architecture and resulting in a lower cell-to-module loss and a lower cost than current industrial back-contact technology.
- The development of back-contact PV technology specifically designed for building integration, with improved aesthetics and resulting in a higher yearly energy yield.
- The development of module technology with thinner glass, improved reliability and lifetime.

The project includes partners from the complete manufacturing chain: from research institutes and producers of cell and module manufacturing equipment, via module producers, to producers of building integrated PV elements.

In WP1, Tempress, imec, ECN and Soltech work on development of low-cost MWT and IBC cells with efficiency over 22%, suitable and optimised for the module technologies of the later WP's.

In WP2, two innovative interconnection techniques will be tested and optimised, leading to a cell to module power loss of 0%, suitable for a module efficiency over 20,5% at lower cost. Soltech, Eurotron and Sunlego will provide the interconnection techniques and pilot scale manufacturing equipment.

In WP3, lamination materials and technologies will be developed and optimised, leading to thinner glass, new encapsulants, shorter process time, and lower cost. Sisecam will develop and demonstrate thinner glass with thickness of 2 – 2,2mm for glass-glass and glass-foil modules. Sunlego, Eurotron, and Soltech will test and optimise lamination technology and materials.

In WP4, product integration into high-performance building elements is performed by end users Wienerberger and Eternit (roof elements) in collaboration with Soltech. Also, integration of microinverters, for better shadow performance, is developed and tested by Sunlego and Soltech. Market studies and market feedback will be collected, and impact on life cycle analysis will be included.

In WP5, analysis and reliability testing is performed by Eliosys, GUNAM, imec, and ECN. Performance variations depending on different climates and the built environment, and a test method for partial shading, will be key.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
The Netherlands	3	1’188’875	712’167
Belgium-Flanders	4	686’186	531’902
Belgium-Wallonia	1	229’410	160’587
Turkey	2	502’836	334’884
Total	*10*	*2’607’307*	*1’739’540*

082 PV2GRID

A Next Generation Grid Side Converter with Advanced Control and Power Quality Capabilities

Project Duration: 04.2015 to 03.2018
Report submitted: 11.2015

Summary

Several goals have been set at international and European levels regarding the energy and climate change of the planet. According to the European Union, these objectives are well known as the “20-20-20” targets by 2020, which require that 20% of energy consumption is produced from Renewable Energy Sources (RES), a 20% reduction in greenhouse gas emissions and a 20% improvement of energy efficiency. Higher goals are being set for 2030 (27%, 40%, and 30% respectively). This project focuses on the large scale deployment of photovoltaic (PV) systems through improving their grid integration. The driving forces of this ambitious project focus on three issues of critical significance that inhibit the massive deployment of PVs: (a) the variable/insolation-dependent nature of PV generation, (b) the problems associated with massive distributed generation (e.g. grid unbalance, harmonics), and (c) the need to develop appropriate fault ride through (FRT) solutions to allow them to support the grid during faults. It is expected that the project results and products developed will address the challenges and achieve the objectives with regards to the grid interconnection and the large-scale deployment of PV systems as set by the implementation plan of the Solar Europe Industry Initiative (SEII).

The most crucial point with regards to the grid integration of PV systems is the grid side converter (GSC) which is based on power electronic technology. GSCs are still not capable of advanced control features that enable the full control of RES with FRT capabilities, reactive power support and generation control. The major objective of this project is to develop a next-generation GSC (one for single- and one for three-phase systems) with advanced control and novel operational mode capabilities, which will benefit all stakeholders of PV systems in terms of:

a) A seamless integration of PV systems in the power grid
b) A further larger scale deployment of PV systems due to the several advantages of the new converters
c) Possibilities to extend the GSC technology to other green technologies
d) Maximization of the utilization of PV systems in order to improve the power system operation
e) Increase of the incomes/returns from a solar energy investment for a self-sustainable market of PV systems.

The GSCs designed and developed in this project will achieve an improved performance ensuring the proper grid integration of PV systems under any grid conditions. Additionally, the new GSCs will be enhanced with novel operational functionalities that will allow new operating approaches. The new operating modes will contribute to the development of multifunctional industrial products

that can be used for the grid integration of several new technologies with emphasis on PV systems. The novel operational functionalities of the GSC will pave the way for a higher penetration of solar energy and will maximize the utilization of PV systems in order to:

- Enhance the value and increase the competiveness of PV systems
- Maximize the income of a solar project for a self-sustainable market of PV systems
- Enhance the stability and reliability of power systems
- Improve the power quality and minimize the power losses of Distribution Networks (DN)

The project will clearly benefit the PV industry, the power system operator at distribution and transmission level, the investors on PV systems, the electricity consumer, and the environment. A cost-effective and smooth integration of considerably more PV systems will be achieved.

The successful completion of the project is guaranteed due to world-class/pioneer partners of a balanced and complementary consortium. The partners combine great expertise on the following areas: development of advanced methodologies for GSC, design and reliability of power electronics, and power system operation/power quality/stability and investment on energy market. The result of the project can be used to enable partners to enter into the PV industry by commercializing the results on novel single- and three-phase inverters for PV systems.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Cyprus	2	90’624	84’700
Denmark	1	108432	97’589
Total	*3*	*199’056*	*182’289*

084 THESEUS

Tandem High Efficiency Solar Cells Utilizing III-V Semiconductors on Silicon

Project Duration: 06.2015 to 11.2017
Report submitted: 12.2015

Summary

This proposal seeks to develop novel, very high efficiency tandem flat plate solar cells utilising III-V semiconductors grown onto Silicon substrates, using advanced epitaxial techniques to grow SiGe and SiGeSn structures, and to integrate them into high efficiency modules and test them on sun. As such, this work meets the scope as set out in the SOLAR-ERA.NET Transnational Call PV2.4 'High-efficiency PV modules based on next generation c-Si solar cells'. By utilising tandem solar cell architectures that better match the device bandgaps to the solar spectrum it is possible to significantly enhance the efficiencies compared with conventional c-Si devices. The intention is to develop these high efficiency cells to demonstrate cell conversion efficiencies well in excess of 25%. This aim will be achieved by the combination of the extensive expertise of IQE in the field of SiGe and III-V epitaxy and the solid background of UPM in the areas of multijunction solar cell design and manufacturing. In this respect, novel epitaxial wafers of InGaAsP/SiGe(Sn) on Si solar cells grown by IQE, will be processed into solar cells at UPM facilities to be eventually incorporated into prototype modules, assembled by DHV, which will be tested on-sun by UPM in Madrid. It is anticipated that the module efficiencies utilising these novel cell architectures will be well in excess of 22%, making them significantly ahead of the current state of the art. Finally, acceleration ageing test by using climatic chambers will be carried out on these novel solar cells.

Project consortium

Coordinator and all contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
United Kingdom	1	497'000	248'500
Spain	2	175'000	25'000
Total	*3*	*672'000*	*273'500*

090 U-light

Ultra Lightweight PV Modules and their Applications in Innovative PV Systems Achieving Lowest Levelized Cost of Electricity (LCOE)

Project Duration: 11.2015 to 10.2018
Report submitted: 11.2015

Summary

In the “U-light” project new light weight, high efficiency and long life-time modules are developed with regard to lowest cost for integration into PV systems achieving lowest values of levelized cost of energy (LCOE). The new light weight modules will be generated by the use of thin, strong, low cost glass and by the use of compositions (mineral or organic) like glass-fibre reinforced plastic (GRP). Strong focus is set on the long term durability, failure probability, and energy harvest. The cell to module (CTM) losses are reduced by putting a strong accentuation on the development of novel thin glass and encapsulants with highest light transmissivity and low UV cut off as well on backsheet materials with 20% (abs.) larger reflectivity compared to state of the art products. In addition solar cells are developed which make the use of bypass diodes in modules unessential.

For the development of ultra-light weight modules the reduction of thickness for all layers is a clear objective, while keeping the required functional properties. For this the glass thickness will be reduced from to-days 2.0 mm to lower thicknesses, which will obviously lead to a reduction of raw-materials and energy consumption during manufacturing which is a key target of the European manufacturing industry. It further increases the light transmittance thus reducing cell to module losses.

The scope of the material development for the module backsheet is set on products with reflectivity >90% with 20% (abs.) larger reflectivity compared to state of the art products, while being at the same time a lightweight material. The new encapsulant materials will combine advantageous properties, e.g. a UV-cut-off below 320 nm and an outstanding transparency in the wavelength-range from 400 to 1000 nm. Additional cost saving can be achieved by the reduction of the lamination time for the respective encapsulant materials to a value below 10 minutes. For most solar module factories the lamination step is the bottle neck preventing lower cycle times therefore the project aims to set new standards with the material development.

The project will deliver certified lightweight glass/glass and glass/backsheet modules passing relevant IEC 61215 and IEC 61646 standards with a cost reduction of 30% as compared to standard modules (without cell cost) in €/Wp.

In addition the project will also evaluate alternative concepts for light weight modules like the use of GRP as an alternative to glass. Beside the cost reduction the light weight and bifaciality of the new modules will open up new applications for these modules, in example for greenhouses and parking roofs. In the frame of the project new applications will be evaluated.

The module development will be based on the latest generation of highest efficiency solar cells from ISC Konstanz, for example the bifacial BISON or the back contact IBC cell, so-called ZEBRA cell and if available inside the project HIT solar cells (either bifacial or non-bifacial depending on the individual application).

The cell research in this project will focus on the development of IBC ZEBRA solar cells with intrinsic bypass diodes without additional costs. This will allow producing solar modules without bypass diodes and leads to a price reduction on module level but most of all increase the product lifetime since failing diodes is one of the main defects of solar modules in the field.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	1	341’343	273’074
Austria	2	300’541	195’351
Switzerland	1	146’868	136’722
Total	*4*	*788’752*	*605’147*

093 InGrid

High efficiency PV modules based on back-contact cells and novel interconnecting grid

Project Duration: 01.2015 to 05.2017
Report submitted: 11.2015

Summary

The “InGrid” project aims to develop high efficiency rear contact solar cells (Zebra) interconnected on module level by conductive structures embedded or coated into the encapsulation material. The module development will be based on the latest generation of highest efficiency interdigitally back contacted cells (IBC), the so-called ZEBRA cell and focus as well on standard and bifacial solar cells.

The overall goal of the project is to develop a new module technology for high efficiency rear contact and bifacial solar cells. Inside the project strong emphasis is set on the development of a new encapsulation material with intrinsic conductive structures to replace the ribbon typically used in industry for interconnecting solar cells by soldering. For this, conductive inks are subject to development allowing for an interconnection process at low temperatures being suitable for the temperature limitations given by the encapsulant. The printing and sintering process for the conductive ink material as placed on the substrate (e.g. EVA) is a key to be reached inside the project including capabilities at low (lamination) temperatures. The high efficiency solar cell concept will be modified to suit the requirements for the conductive inks (as geometrical needs and conductivity) to allow for a reliable and low series resistance interconnection of conductive structure to cell.

The novel material combination (conductive ink on encapsulant) will be subject to climatic and outdoor testing to prove the concept and longevity of the product. Strong focus is set on the climatic testing requirements as required from IEC 61215 standards as damp heat and thermo-cycling. The typical requirements for such tests as 1000 hours and 200 cycles will be extended to exceed the specifications at least by a factor of two. The delivery of the project is a targeted loss in cell-to-module losses of max. 2% as compared to standard modules interconnected by soldering ribbon process due to the superior conduction path reached by printing conductive inks instead of soldering copper ribbon. The cost reduction at medium term will be of 5% in €/Wp with respect to conventional c-Si modules.

Regarding the processing technologies, focus is set on applying conductive inks on flexible substrates and on developing the involved materials to reach the stringent specifications of mechanical strength, electrical serial and contact resistance after a typical lamination cycle. For low series resistance interconnection of IBC cells, the metallization scheme will be adapted for encapsulation foils with integrated conductive layers.

The project “InGrid” combines product and process development and will deliver a novel module interconnection technology with superior outcome in terms of long-term stability, application and cell-to-module losses.

Project consortium

Coordinator and all contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Spain	2	299’889	169’943
Germany	1	184’994	36’999
United Kingdom	1	204’810	122’886
Total	*4*	*788’752*	*605’147*

095 Monoscribe

Roll-to-Roll Monolithic Interconnection of Customizable Thin-film Solar Modules

Project Duration: 11.2015 to 04.2018
Report submitted: 11.2015

Summary

The overall goal of the project is the development of an industrial scale Roll-to-Roll (R2R) machine prototype based on a novel solar cell interconnection technology (currently on TRL 5) that enables the production of customized **photovoltaic modules „on-the-fly“** without excessive set-up times.

The integrated and printed solar cell interconnection allows the production of photovoltaic modules with varying voltages, sizes and shapes. Combined with the pliability and the high yields of the underlying CIGS based solar cells such PV modules are ideal candidates for a multitude of applications ranging from PV-integrated products (sensors, chargers, lighting) to the use in BIPV products.

In order to achieve low production costs the whole machine set-up is based on a R2R approach wherein **laser processes** (selective ablation of thin-films, edge deletion, cutting) and **printing processes** are fully integrated (objective is TRL 7 at end of project). “Monoscribe” tackles the technical issues arising with the **low-cost R2R structuring and interconnecting of flexible thin film (CIGS) photovoltaics** leading to a groundbreaking production method with high freedom of module designs, increased efficiency and shortened production time. This innovation will be reached by the combination of cost-effective printing technology (inexpensive, digital controllable, with resolution of > 10µm) with highly precise laser structuring technology (depth resolution >50 nm, lateral resolution about 1 µm).

To solve these challenges Monoscribe´s project consortium comprises European manufacturers (PV modules, solar cells, printing inks), experts in printed electronics and micro laser processing together equipment manufacturers with a strong background in PV manufacturing. At the end of the project, the industrial feasibility will be demonstrated by producing batches of market-driven PV modules with extraordinary designs up to 300 mm width.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Austria	4	540’552	324’332
Finland	2	678’894	388’000
Germany	2	441’404	350’371
Total	*8*	*1’660’850*	*1’062’703*

102 HighCast

High Performance Silicon Casting and Wafering

Project Duration: 08.2015 to 03.2018
Report submitted: 11.2015

Summary

The project focuses on research and development of advanced casting and wafering techniques for producing silicon wafers suitable for higher efficiency solar cells. The technology developments aim to increase material quality and production performance at lower manufacturing costs, hence reducing the final cost-per-Watt of photovoltaic energy produced.

The new casting techniques comprise “High Performance Multicrystalline Silicon” (HPmcSi) and “Mono-Casting”. For HPmcSi, the nucleation phase at the beginning of the solidification is controlled either by using seed material or by use of specially designed crucible interfaces with e. g. adapted silicon nitride coatings. Thus, a high initial density of small grains evolving into larger grains with ingot height is achieved. As a consequence, the internal stress during crystal growth is diminished, leading to lower dislocation densities and grain boundaries, which are less recombination-active. The Mono-Casting technique uses monocrystalline seed crystals at the bottom of the crucible to produce ingots with a large share of monocrystalline silicon. Both techniques will be applied at laboratory scale at Fraunhofer ISE. Silicon casting on industrial scale will be carried out by Crystalox LTD, UK.

For cutting the ingot into wafers by steel wire sawing, the use of structured wires will be further developed. These structured wires can cut multicrystalline wafers as thin as 120 µm at less cost than the alternative diamond steel wires. PV Crystalox Germany is the first company worldwide to have successfully introduced the structured wire in mass production resulting in 40 % less direct cost per wafer within a year. This put PV Crystalox in a unique position to compete with Asian manufacturers at the spot market price level. Further research on this topic during this project is expected to reduce these costs by additional 25 %. The optimum wire structure will be identified taking into consideration slurry transport in the cutting slot to save further consumables costs, process time and energy. Wafering research will be performed by PV Crystalox, Germany.

Solar cells and samples in a precursor stage will be produced from selected wafers at Fraunhofer ISE at the laboratories in Gelsenkirchen and Freiburg. The development of defects after typical high temperature processes will be analysed on cell level by processing heterojunction solar cells including an amorphous Silicon layer. Since the processing temperature does not exceed 200°C, the influence of the cell processing on the material parameters to be studied can be neglected. The potential of the material is evaluated by processing and analysis of solar cells with the “Passivated

Emitter and Rear Cell" (PERC) structure.

The project is coordinated by Karlstad University, where the specific detrimental influence of single defect types (dislocations, grain boundaries) will be studied. This is achieved by combining high resolution Light Beam Induced Current (LBIC) topography with automated optical microscope imaging to measure defect densities. These results will be correlated with synchrotron based nanoprobe X-ray Fluorescence (XRF) maps carried out by MIT, Boston (using their own project). These measurements essentially support the understanding of the crystallization process and can lead to significantly improved processes for crystallization, wafering and solar cell fabrication in the industry. Additionally, the participating research partners will further strengthen their collaborative relationships and leading positions.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Sweden	1	389'870	389'870
Germany	3	993'433	562'529
United Kingdom	1	307'379	219'560
Total	*5*	*1'690'682*	*1'171'959*

Karlstadt University-contract is in SEK, exchange rate applied 1 EUR = 9,2 SEK
Crystalox-contract is in £, exchange rate applied 1 EUR = 0,7 £

112 APPI

Atmospheric Pressure Processing for Industrial Solar Cells

Project Duration: 09.2015 to 08.2018
Report submitted: 11.2015

Summary

European PV manufacturers are suffering from higher production and capital cost compared to their Asian competitors. The PV industry needs to compensate these costs by higher efficiency and higher quality, while keeping production costs as low as possible. Therefore, the retention of a PV industry in Europe depends on Europe's capacity to lead global PV innovation. This proposed project brings together large European PV industries, small to medium enterprise (SME) and research institutes, to develop solar cells exceeding 21.5% in efficiency, manufactured using low-cost atmospheric pressure (AP) processing.

Three key atmospheric pressure processes (advanced texture, high-efficiency emitter, AP passivation) will be developed for low-cost high-efficiency solar cells. Each of these processes can be individually retrofitted into an existing solar cell production line. This scenario would yield an increase of solar cell efficiency with a production cost reduction of up to 40% while keeping investment costs low. By applying these three key processes together, the production of high-efficiency solar cells without any high-vacuum processes can be realised.

The very limited investment capacity of the PV industry does not allow major modification of the production lines. Therefore the next generation of high-efficiency solar cell needs to fit current, existing equipment. The most feasible cell structure for modification is the high-efficiency passivated emitter and rear solar cell (PERC). The proposed project work plan would allow the increase of p-type PERC efficiency while reducing the production cost. It is a fundamental evolution for the competitiveness of the industry. The high-efficiency solar cells will be interconnected and encapsulated in innovative modules reducing the cell-to-module losses. This technology exploits the advantages of low processing cost and high power output.

As we are approaching the limit of the gain from reducing recombination and series resistance, the cell efficiency remains limited by optical losses. The ultimate efficiency limit for the silicon material will be obtained when all the light (in the relevant part of the spectrum) is absorbed. This is especially true for multi-crystalline silicon, which represents about 70% of the market share. In this project, a strong focus will be put on the development of advanced texturing processes based on wet and dry etching. The development of these new textures will allow obtaining high efficiency on >80% of the world market (mono- and multi-crystalline silicon). Our solar module will be specially adapted for this new texture in order to optimise light trapping.

The quality assurance of our high-efficiency modules fabricated in the project will be realised through reliability testing in an environmental chamber. Life-cycle analysis (LCA) will also be performed.

This project will directly benefit four European companies, representing a large part of the PV value chain:

- Module manufacturer with Solar Capture Technologies Limited in the UK (SME).
- Equipment manufacturer with Schmid GmbH in Germany and Nines Photovoltaics (SME) in Ireland, as associated partner.
- Gas manufacturer with Solvay Fluor GmbH in Germany as associated partner.

The collaboration between research institutes and industrial companies at different parts of the value chain will contribute greatly to reduce the time between research, development and industrial application.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	3	1’669’197	1’418’506
France	1	550’044	199’814
Spain	1	75’000	75’000
United Kingdom	1	440’516	264’474
Ireland	1	n.a.	0
Total	*7*	*2’734’757*	*1’957’794*