European Cooperation in the field of Scientific and Technical Research - COST -

Brussels, 22 November 2013

COST 076/13

MEMORANDUM OF UNDERSTANDING

Subject : Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action MP1307: Stable Next-Generation Photovoltaics: Unravelling degradation mechanisms of Organic Solar Cells by complementary characterization techniques (StableNextSol)

Delegations will find attached the Memorandum of Understanding for COST Action MP1307 as approved by the COST Committee of Senior Officials (CSO) at its 188th meeting on 14 November 2013.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action MP1307
STABLE NEXT-GENERATION PHOTOVOLTAICS: UNRAVELLING DEGRADATION MECHANISMS OF ORGANIC SOLAR CELLS BY COMPLEMENTARY CHARACTERIZATION TECHNIQUES (STABLENEXTSOL)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4114/13 “COST Action Management” and document COST 4112/13 “Rules for Participation in and Implementation of COST Activities” , or in any new document amending or replacing them, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to create an interdisciplinary network of laboratories and industry, with complementary analytical techniques to study the degradation mechanisms of state-of-the-art Organic Solar Cells to foster the Next-Generation of Organic Photovoltaics.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 76 million in 2013 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of section *2. Changes to a COST Action* in the document COST 4114/13.

A. ABSTRACT AND KEYWORDS

Organic photovoltaic devices (OPVs) have major potential as a principal source of clean electricity for the future. However, the large-scale introduction of OPVs onto the market is currently limited by their stability. Initial reports indicate that the required lifetime of more than 20 years is theoretically feasible. However, progress in this area has been slow, because the complex and hierarchical degradation paths involved can only be understood by applying complementary chemical and physical characterization techniques. The Action StableNextSol aims to create a highly interdisciplinary network of academic and industry researchers to study the degradation mechanisms occurring in state-of-the-art OPVs, based on the use of complementary analytical techniques. The Action seeks to integrate and generate fundamental knowledge and expertise to foster disruptive innovations targeted to mitigate device failure, and aims to develop new concepts for OPVs that are more stable and reach lifetimes longer than 20 years. The added value of this COST Action will be the contribution of photovoltaic researchers at the European (EU) and international levels along the entire value chain, and of public-sector decision makers who will promote the implementation of specialisation policies and standards currently lacking in this area. This Action will contribute to the development of the new generation of researchers in the field by supporting the cooperation and interaction between different laboratories and large European infrastructures.

Keywords: Organic solar cells, polymer solar cells, stability, degradation protocols, characterization.

B. BACKGROUND

B.1 General background

When industry speaks of OPVs for the future, they are specifically referring to highly efficient and flexible OPV devices, as flexibility enables low-cost fabrication. The only remaining barrier to commercial OPVs is their limited lifetime. Flexible and mobile power generation applications demand 5 to 10 years of stable operation, but building integrated and outdoor applications requires a minimum of 20 years.

Accelerated aging analyses on state-of-the-art OPVs predict 5-7 year device stability cells with rigid encapsulation. Outdoor stability studies, which remain scarce, have validated these initial estimations. Nevertheless, most of the lifetime values are not only below the requirements of industry, but also have been measured on a few materials under non-comparable ageing conditions and on laboratory-scale devices. Unravelling the different degradation mechanisms that limit the lifetime of OPVs by following standard protocols for lifetime analysis, is crucial for obtaining stable devices with predictive value. Recent research efforts have demonstrated that electrical measurements need to be complemented by many different characterization techniques, simulation and modelling, to explore the degradation processes. Such an experimental undertaking is only possible through a broad interdisciplinary collaboration between different research laboratories sharing facilities, expertise and most importantly knowledge, in a close cooperation with the industry. This COST Action will focus exclusively on understanding the degradation mechanisms behind OPV stability, by providing participants with unprecedented access to numerous complimentary experimental methods and to broad expertise. Some investigations of OPV lifetime are already being carried out by partner members at national level though own funding. However, the application of several advanced characterization techniques requires facilities dispersed around the world, which limits the output of any project funded through the national programs of single countries. At the European and international levels, significant effort is being focused on different projects that encompass all aspects of developing industrially-relevant OPVs, from synthesis of new materials to device fabrication and technology scale-up. Some of these projects include a work package on packaging or device stability. However, their scope remains limited to descriptive studies without in-depth insights due to similar reasons as national projects: lack of access to extensive characterization techniques and know-how. The European research groups active on this topic are also highly scattered among different laboratories and have access to a limited number of characterization techniques. This fragmented research on OPV lifetimes generates results that are often non-comparable, leading to false conclusions. For the same reasons, other frameworks such as **ESF, ESA, EUREKA** or similar programmes are at the moment still not suitable. The Action StableNextSol is a unique approach to build on existing OPV lifetime research: to consolidate disparate research efforts by creating a network of laboratories and experts to study the degradation and stability of OPVs. This COST Action offers the **appropriate framework** for these researchers to join forces and enhance their currently running national and European projects. The understanding and innovative solutions enabled by StableNextSol will strengthen the position of numerous European OPV companies along the value chain, from materials developers to device manufacturers. This accelerated progress will in turn contribute to earlier market introduction of OPVs. Thus, this COST Action offers the most appropriate and timely framework for collaboration among a diverse array of researchers, graduate students, engineers and industry stakeholders throughout Europe.

The main **benefits** of the Action which should arise from carrying this project within the COST framework are:

1. Combine the expertise and characterization techniques of diverse research groups in different locations to enable an in-depth description of OPV failure paths;
2. Create awareness of the state-of-the-art degradation and characterization protocols;
3. Apply, share and improve OPV degradation models, and test protocols and policies, based on ISOS;
4. Elucidate the complex, hierarchical degradation pathways of OPVs and accelerate research on the stability potential of these devices;
5. Develop innovative solutions for fabricating stable OPV devices, with lifetimes longer than 20 years;
6. Exploit existing large EU facilities and mechanisms to further research on organic material metrology;
7. Provide the European OPV industry with competitive advantages along the entire value chain: material suppliers, module manufacturers and end users;
8. Train the next generation of experts in OPV reliability and organic/soft material metrology.

The Action will advance on the knowledge and control of the degradation mechanisms in OPVs, with the expected final output of the fabrication of highly stable next-generation devices.

B.2 Current state of knowledge

Advances in the efficiency of OPVs have been enabled chiefly by the discovery of novel organic materials. The first major gain in efficiency was made with the advent of polyphenylenevinylene polymers (e.g. MEH-PPV), in the 1990s. This was followed by progress enabled by thiophene-based materials with greater air stability (e.g. P3HT). The third wave of progress, currently underway, corresponds to low band-gap materials of donor-acceptor structure, such as benzothiadiazoles (e.g. PCPDTBT) and diketopyrrolopyrroles (e.g. DPP). These materials not only enable harvesting of a wider range of the solar spectrum (meaning greater power conversion efficiency) than do earlier materials, but they also have a higher glass-transition temperature than does P3HT, thereby enabling the development of devices with greater heat-resistance. These materials have also garnered great interest due to their amenability for synthetic scale-up and to their solubility in green solvents. The stability and reliability of OPVs made with stable organic compounds are also determined at the interfaces between the distinct material layers (e.g. donor-acceptor, metal-organic, inorganic-organic, etc.), as most power generation processes occur here. Similarly to the historic gains in efficiency, progress in lifetime has been stepwise, occurring with the development of better interface or buffer layers. Initially, low-work function metals, or organic compounds with metallic properties, were used. These were subsequently replaced by wide band gap semiconductors, including transition metal oxides (e.g. ZnO, TiO_2, V_2O_5, MoO_3 and NiO). This led to substantial increases in device stability in air and light, from only a few hours to a few years. However, further progress —to reach the target lifetimes of over 20 years — requires an in-depth understanding of degradation processes. For example, many OPVs show a burn-in process which leads to a rapid initial loss in performance, followed by a slower degradation. Current studies suggest that the formation of charge carrier traps may be the principal mechanism, the root causes remain poorly understood, due to a lack of microscopic data. Another major challenge that has recently been highlighted is achieving sufficiently high mechanical strength for bending and stretching of OPV stacks and modules comprising flexible substrates and packaging.

The rapid evolution of material and device architecture is driving the need for greater understanding of general failure mechanisms.

The first studies on OPV degradation emerged around the year 2000; however, little progress was made until 2008 when the race for efficiency was the main focus. However, with efficiencies now above 10% on lab-scale devices, another improvement by a factor of 2 is very difficult. Improving lifetime by a factor of 2, which has the same effect on the cost of OPV electricity, is possible Thus, the relevance of this topic has been recognized but it still remains in its infancy. The initial and still current slow progress has largely been due to the scattered effort of few individual research laboratories. These pioneering groups identified the main stress factors for the poly(3-hexylthiophene) P3HT : [6,6]-phenyl-C61-butyric acid methyl ester PCBM, (P3HT:PCBM), based devices and contributed to the emergence of new class of interface layers. However, the device lifetime of OPVs, especially flexible devices, remained below targets mandatory for OPV commercialization, and P3HT:PCBM based OPV is not of commercial interest. The second reason that limited progress was the **lack of common standards and protocols**. As consequence, comparison between studies was difficult and lead to serious confusion about the stability potential of OPVs. The research community has recognized the two aforementioned limitations to progress in the field. The lack of standards was addressed by the definition of recommended measurement practices (the ISOS practices) that form the basis for a specific IEC standard that is currently under development. The ISOS aging recommendations resulted from a consolidated view of all major academic and industrial experts and were debated in several international summits on OPV stability (ISOS). The first international summit on organic photovoltaics (ISOS-1) was held in the

USA in 2008, followed by ISOS-2 in The Netherlands, ISOS-3 in Denmark, ISOS-4 in the USA and the last edition, ISOS-5, in The Netherlands, in December 2012. ISOS-6 will be held in France in 2013. It is important to note that most of the partners of this COST Action have been involved (as organizers or participants) in the ISOS summits and in establishing the standards. The former issue, the limited interaction between groups with device fabrication and degradation facilities and experts with access to characterization techniques, has partly been tackled in joint experiments in the frame of interlaboratory collaborations. The first interlaboratory study on the stability of OPVs in 2009 was aimed to verify how reproducible device ageing on the same sample is at different locations. This experiment was conducted without dedicated funding, but still involved 18 laboratories around the world. Based on this interest a second experiment in 2011 followed. It had the goal to compare different materials and device types that were aged at one location and then characterized at several sites using an extensive range of methods. This experiment included more than 25 laboratories not limited to European countries, but with the participation of laboratories around the globe. The generated scientific insight revealed several novel and unexpected mechanism. This large-scale collaboration outside of funded projects not only demonstrated the relevance and interest of the community, but the outcome also proved the power of multi-disciplinary collaboration on the topic of OPV stability. This effective collaboration approach can be significantly reinforced by the mechanisms provided by the COST framework.

Moreover, the establishment of a network of Energy Frontier Research Centres by the Department of energy (DoE) of United State (U.S.A), or by the Japanese government through the Kanagawa Academy of Science and Technology (KAST), is also contributing to the rapid growth and development of the field. Most of the participants of these large-scale collaborations and activities have already being contacted through the members of this COST Action, and most of them have joined this COST proposal. This demonstrates the global relevance of the OPV research area and the potential of the Action to attract wide range of non-COST Countries.

The key **innovation** for this Action is improving the utilization of methods and dissemination of knowledge generated in failure analysis of OPVs from many different laboratories and partners from industry. Lack of a better understanding of OPV degradation explains the currently time and resource inefficient trial-and-error approach that is applied to find more stable interface layer or photo-active compounds. This COST Action will initiate a disruptive cooperation network that will determine and eventually eradicate degradation paths in order to develop next-generation stable OPVs.

B.3 Reasons for the Action

"In 2004, Europe held five of the top ten positions in PV manufacturing. In 2010, only one European company remained in the top ten ranking."
(ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf)

The reason to launch the action is the crucial need to advance in the commercialization of OPVs and to strength the industrial European OPV sector such that this technology can fulfil its potential and supply clean electricity on a global scale. However, achieving this will require unification of the knowledge from diverse experts on degradation, and combination of characterization methodologies, within a network of skilled European OPV research laboratories. StableNextSol will bring together scientists from Europe and abroad, experts on different characterization, to understand OPVs degradation mechanisms. The cumulative effort will benefit from the understanding of degradation paths and will give solutions to attain highly stable OPVs. Given the consortium's level of expertise, their collaborative efforts should prove fruitful right from the start of the Action. The Action aims to unravel degradation mechanisms of OPV by the combination of characterization approaches to improve the lifetime of flexible OPVs, a goal that encompasses European economic, scientific and technological advances. By helping the European OPV industry to fabricate stable OPV modules, the Action will ultimately address the pressing societal need for reliable sources of clean energy. The main objective of the Action StableNextSol is to create a highly interdisciplinary network of laboratories and industry with different and complementary analytical techniques for the study and understanding of the degradation mechanisms taking place in state-of-the-art OPVs. The Action will draw on and expand the current expertise of the partners and generate fundamental knowledge and expertise to foster unconventional solutions to these problems and to develop innovative and much more stable OPVs. The action will promote the creation of a dynamic network among partners from academia and industry by the organization of workshops, meetings, industrial days, and exchange of researchers. It will also give particular emphasis on the training of early-stage researchers (ESR) through training schools and short-term scientific missions.

The means to be used by the Action in order to achieve the objectives are based on the expertise and the contribution from the consortium. This will permit the awareness of the technology, protocols and the fabrication of devices, with special emphasis on industrial samples. The Action will also take advantage of the ISOS protocols for the degradation of OPVs that will be updated and improved, if required, during the duration of the Action. The different equipment and knowledge required for the degradation, characterization and simulation of devices is already available within the partners of the Action. Brainstorm meetings will be organized as a mean for the consolidation of results and proposition of innovative ideas to resolve degradation paths. The Action is aimed at European scientific/technological advanced with strong focus on industrial needs. The ultimate expected result will be the fabrication of OPVs with extended lifetime through the realization of strong network of laboratories sharing expertise and knowledge. An expected outcome is the preparation of earlier stage researchers with the knowledge and expertise required to overcome future issues on the OPV research area and its commercialization. In order to maximize the outcome of the Action, the partners will publish their work in research reports, specialized and non-specialized journals, and books. They will also participate in training schools for ESR and host these researchers for short stays. Patent applications will also be considered, when appropriate. Public engagement will be made through publications in specialized and non-specialized journals, training schools and short stage technical missions for ESR. Patent applications will also be considered, when appropriate. The fabrication of novel and efficient OPVs is possible as the StableNextSol consortium members unite the most advanced processing infrastructure and knowledge in Europe and internationally. All instruments available in a COST Action like Short Term Scientific Missions (STSM) workshops, focused conferences, etc. will be considered. Also, those infrastructures at EU level, for example the Solar Facilities for the European Research Area (SPHERA), the SOPHIA and Open AIRE initiatives, etc., will be utilized. The Action StableNextSol will offer an open collaborative framework with industry partners. Industry players will contribute their expertise in different areas (materials, metrology, and OPV development and commercialization), thereby ensuring that the work is relevant to industry.

B.4 Complementarity with other research programmes

To the best of our knowledge the Action StableNextSol is unique; as no other EU research project specialized on OPV device stability is presently running. Among current EU-funded projects, research on device stability is being done through a workpackage related to packaging or device lifetime. However, these do not have the scope required for fully understanding the OPV degradation mechanisms, which is required for development of more-stable devices. The fact that OPV commercialization remains in its infancy is testament to the current lack of knowledge on OPV degradation. Yet, there are several projects that can complement the activities of the Action and that will benefit from the results obtained through this Action.

The Management Committee (MC) of the Action StableNextSol will seek to collaborate with complementary research programs at the EU and international levels. Given the broad and multidisciplinary activity of the Action, these links to other projects will strengthen specific areas in the Action, especially in materials and characterization techniques or metrology. New materials are needed in order to improve the interaction between solar cell components, especially at interfaces. And the application of novel characterization techniques can permit the discovery of new degradation paths, which can be located between organic materials, between inorganic materials, or between organic and inorganic materials.

Actions that can complement the StableNextSol project are:
*The **MP1202** Action is related to the* design of hybrid organic-inorganic interfaces at molecular and nanoscale level. It is also specialized in the application of soft inorganic chemistry that can be compatible with the fabrication methods (printing at low temperature) of OPVs. The rich chemistry of TMOs related to the changes of the metal oxide state is well known to modify the OPV performance. The collaboration with the COST Action **CM1104** (Reducible oxide chemistry, structure and functions), can complement the knowledge needed on these materials.

Active EU Programs and Initial Training Networks that include one work package on stability of OPVs and can complement the Action StableNextSol. At least one partner of the Action is working in one of these projects: - **X10D**- Efficient low cost, stable, Tandem organic devices. - **LargeCELLS** - development of organic photo voltaic cells based on innovative conjugated polymers materials, polymer-inorganic hybrid systems and their usage in large area devices fabricated using printing techniques. -**RotRot** - develop innovative materials and methods in order to elaborate future generation of tandem organic photovoltaic solar cells (OPV tandem). - **SunFlower** for the development of highly efficient, long-lasting, cheap and environmentally friendly printed organic photovoltaics. -**SOLIANCE** is the alliance of TNO, TU/e, Holst Centre, ECN, IMEC and Forschungszentrum Julich for research and development in the field of thin film photovoltaic solar energy (PV) in the ELAT-region (Eindhoven-Leuven-Aachen triangle). It encompass the study of Thin film Si, CIGS, OPVs and other generic technologies. ITN **Establish** which is focused on the synthesis of materials, fabrication of OPVs and characterization of devices. – Other related projects fully related to OPV applications are the **Clean4Yield** and the recently approved **MUJULIMA**, **ARTESUN** and **TREND**.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The Action StableNextSol aims to create a highly interdisciplinary network of academic and industrial research laboratories to study the degradation mechanisms in state-of-the-art OPVs. The Action will draw on and expand the current expertise of the partners and generate fundamental knowledge and expertise to foster unconventional solutions to these problems and to develop innovative, highly stable, flexible OPVs. The Action will promote network collaboration among partners from academia and industry by the organization of workshops, meetings and industrial days. It will also give special emphasis on the training of ESR through training schools and short-term scientific missions. The main scientific impact of this COST Action is the identification of the principal mechanisms of degradation in state-of-the-art OPVs, in order to develop highly stable next-generation OPVs. It will broaden the knowledge within the European and international communities and will speed up the market entry of OPVs. The impact of the Action may extend beyond specific areas outlined in this proposal, as the limited lifetime of organic electronic materials remains a problem in many optoelectronic applications. The Action will also influence young researchers to continue the research and understanding of photovoltaic cells, and module reliability and stability, in close collaboration with industry partners.

C.2 Objectives

The principal objective of the Action StableNextSol is to take advantage of the different and complementary analytical techniques and knowhow available within the network of partners of the consortium to study and understand the degradation in state-of-the-art OPVs. The development of next-generation OPVs with longer lifetimes can be facilitated by establishing links among and between different laboratories and research groups. The desired stability of the final devices should be comparable to the current Si-base technology: lifetimes above 20 years.

The secondary objectives are divided on Networking and Scientific/Technical objectives:

A) Networking Objectives

1. Establishment of a multidisciplinary network of research laboratories to share expertise and knowledge on the different characterization techniques required for OPV analyses.

2. To create long-term collaborative research teams. An important objective is to continue and reinforce existing collaborations among partners.
3. To train and prepare the next generation of research scientist experts on OPV stability.
4. To encourage the participation of female researchers.
5. To strength networking between European and International research laboratories around the world in order to unify protocols and expertise on the degradation and stability studies of OPVs.
6. To facilitate the networking and creation of new consortiums to apply for future EU projects under the Horizon2020 program.
7. To promote and take advantage of the different European research infrastructures in order to optimize the use of existing resources.

B) Scientific/Technical Objectives

1. Creating awareness of state-of-the-art technologies, degradation protocols and policies in the PV sector.
2. Fabrication of solar cells and test structures.
3. Following ISOS protocols for the degradation/stability analysis of OPVs.
4. Applying non-destructive characterization techniques to study degradation.
5. Applying destructive characterization techniques to study degradation.
6. Combining the results of the different characterization techniques to elucidate degradation mechanisms in detail.
7. Consolidating the different degradation mechanisms into 'families' or 'groups' in order to identify and predict the probably stability of a device depending on the characteristics of the materials composition.
8. Developing models to simulate the degradation behaviour of OPVs
9. Determination of reliable acceleration factors that allow for a fast evaluation of the behaviour of OPVs under real life conditions.
10. Proposing disruptive alternatives to reduce or eliminate the degradation paths in OPVs.
11. Fabrication of next-generation OPVs with enhanced lifetime.

C.3 How networking within the Action will yield the objectives?

The **objectives** of the Action will be achieved by enhancing the cooperation of experts which correspond to the international context of the COST organization. The transfer of knowledge between the different areas of expertise, this is, protocols, metrology, characterization techniques and fabrication of OPV devices will lead to synergetic effects to facilitate the development of disruptive solutions for stable OPVs.

58 partners from 22 Countries (19 COST and 3 non-COST countries) and 10 industries (Gender balance: female 26 of 58, 44%) have pledged their strong interest for the Action and are open to share research facilities, equipment and knowledge. They are also willing to interchange ESR on STSMs and to share their expertise under workshops, meetings, training schools and industry days, among others. The Action aims to increase the number of participating countries to 30 if possible. Initial contact with research laboratories from the following countries have also been made: Austria, Taiwan, Algeria, India, Singapore, Japan, and Mexico.

The Action will achieve its goals by the following means:

- The initial event of the action will be a kick-off meeting in which the working groups, the management committee and other formal bodies of the network will be established. The Action will take advantage of international or European conferences (for example, MRS or E-MRS meetings or the ISOS Meetings) in order to maximize the exposure of the network among partners, European researchers and industry.
- The Action will proactively advertise its activities at European and international level to attract new experts, from the academia and industry, on the degradation of OPV devices. New partners from COST and non-COST countries will be welcome in the Action.
- Creation of an Industrial Advisory Board (IAB) composed of the industry representatives.
- To carry out the organization of yearly activities like meetings, workshops, training schools and STSM, as well as the corresponding evaluation of those activities in order to optimize resources and results.
- Topical meetings such as Industry Days will be organized in order to share the expertise with industry and to disseminate results.
- Special outreach activities for women to support gender balance and get ESR fully involved.
- Coordination of dissemination activities towards specific audiences like general public, students, academia and industry.

C.4 Potential impact of the Action

The expected **benefits** of the Action are:

1. Training the next generation of researchers in the area of OPVs to be able to answer Europe's economic and technological needs in the OPV area.
2. Increasing and strengthening the knowledge on OPV stability and degradation within the partners of the
3. Action, as well as beyond the borders of the consortium.
4. Classification of general degradation paths observed in OPV depending on the nature of their constituents.
5. Ensuring the awareness of state-of-the-art problems and challenges facing the OPV research area.
6. Stimulating and encouraging the active involvement for new research projects under the Horizon2020 program.
7. Ensuring the industrial-academic long-term cooperation.
8. Encouraging benchmarking activities.
9. Impacting society's needs by the enrolment of female students, improving ESR mobility, encouraging direct connection of students with the industry and industry needs.
10. Significantly contributing to the development of the Next generation OPVs.

In this way, the Action will contribute to the development of the **European economic, scientific and technological fields**. The Action will involve the industrial partners, sharing their expertise and needs with academic partners. This is a mean to increase the effective development of highly stable next-generation OPVs and to increase their commercialization. The Action will contribute to the solution of the challenge facing the global need for energy. This has already attracted the interest of several non-COST countries. For example Japan, where efforts to establish degradation protocols and to increase the lifetime of next generation photovoltaics has already established a link between the members of this Action and the Asian country. As described before, there are also several other countries interested on similar issues, that have been contacted
by the Action, for example Australia, Taiwan, India, Singapore, Mexico, Algeria, among others. Their interest to participate in the program indicates a high potential for the StableNextSol to impact the research area at international level.

The impact of the Action on the **European societal needs** is through tackling the main remaining barrier to OPV, a technology with significant potential for a clean energy supply. The outcome of the Action StableNextSol, this is, the development of highly stable next-generation OPVs, will accelerate the access to secure and affordable energy for everyone to meet the needs of the

European society and the growing world population. While OPV is on the side of energy production, to make renewable energies fully work for the benefit of society, they have to be well integrated into the larger framework of energy production, transport and consumption. Thus, this Action will consider OPV also as part of this larger framework and policies, and promote energy literacy, fact-based policies and standards, supported by robust and objective data.

C.5 Target groups/end users

The Action foresees different target groups and end users. Among these are:

1. ESR (graduates, PhD students, young researchers, etc.) as the next generation of OPV specialists.
2. European research centres involved in OPV activity.
3. Academic institutions and Universities with activities (curses, education) on the area of materials science, metrology and energy conversion.
4. The general public that will benefit from the use of the OPV technology as end users. This group can also benefit from dissemination activities of the Action such as the open access web site of the Action and/or social networks (internet groups and similar).
5. Industries, already established in Europe that belongs to the materials, metrology and OPV sectors.
6. Among the industry partners of the Action are 10 companies who have expressed their interest in the project and expected outputs.
7. Different multinational companies established outside the European territory.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action will address the following research tasks:

Task 1: Technology Monitoring:

OPV research is a rapidly growing field. Thus, the latest developments must be continually monitored in for new information to be identified. New OPV developments can advance and influence the direction of the Action StableNextSol in four main areas: a) device materials and configuration; b) degradation protocols; c) characterization methodologies and d) packaging technologies. Several research partners and industrial members within the consortium have extensive experience in all or some of these areas and are actively working on research projects in them.

Task 2: Fabrication of reference and prototype devices and test structures

Partners with the capability to fabricate state-of-the-art OPVs (well-developed devices) by printing and/or vacuum methods will be responsible for delivering solar cell devices to the remaining partners for the stability studies. They will also be responsible for the fabrication of test structures for detail analyses and degradation tests.

Task 3: Degradation of devices following the ISOS protocols

The degradation of the devices and test structures will follow the currently recommended ISOS degradation protocols. These standardized methods of degradation were specifically developed so that OPV results from different laboratories would be comparable, thus allowing researchers to draw general conclusions from different ageing experiments. Several partners with the technical capability for the controlled degradation of devices and test structures will be responsible for this task. Since several methods for degradation can be followed, the partners responsible for Task 2 will ensure the fabrication of enough devices and test structures required for the different tests and laboratories.

Task 4. Characterization and Simulation

The devices and test structures will be characterized by destructive and non-destructive methods. Identical samples will be analyzed at different stages of their lifetime to monitor changes in the properties of the test structures and constituents materials and to develop degradation models. This procedure will facilitate the understanding of the causes of degradation and the parts of the device that are most susceptible to failure. The degradation models will be implemented in state-of-the-art simulation tools for organic solar cells for predicting OPV behavior over time under different stress conditions. Partners with the expertise will also take advantage of the different simulation tools, available free of charge, for this purpose (for example http://sourceforge.net/projects/osolsimulation). The models will be validated continuously with experimental data. Several laboratories with the required expertise in both characterization and/or simulation are already members of the Action.

Task 5: Device engineering

Regular “Brainstorming” meetings will be organized to discuss possible solutions to reduce or eliminate device degradation pathways. The feasibility of the new OPV device concept will be tested and if successful, statically relevant number of devices will be compared to reference devices following the recommended ageing protocols. For this task, the ideas and opinion of as many partners as possible will be encouraged.

D.2 Scientific work plan methods and means

The innovative research work of the Action StableNextSol will be highly focused on two aspects: elucidation of the fundamental mechanisms behind degradation of OPVs and the development of solutions to enhance OPV lifetime. These will be carried out under the careful application of degradation protocols and standards. This COST Action will promote effective network collaboration among the member laboratories to support the fast development of stable devices, which in turn will contribute to the commercialization of OPVs. At the same time, the scientific plan is sufficiently flexible to permit new partners to join the consortium at a later stage.

The project is divided in to 6 working groups. The objectives as well as the deliverables for each WG are described below.

Working Group 1 (WG1). Technology Monitoring

Objectives:

1. Materials and device configuration: An OPV device consists of several different organic materials that are sandwiched between inorganic electrodes and can be configured in various ways. For the planned experiments materials and the device configuration will be defined for all partners based on state-of-the-art devices. As more and more organic materials for OPV are synthesised and other device configurations are developed, new materials developments concerning active layer and charge transporting interlayers will be monitored in order to make sure that the consortium is working on state-of-the-art materials and industrially-relevant challenges. Another objective of this WG will be to find general degradation patterns distinctive for a certain material or family of materials combining the knowledge of the Action and latest reports in literature. Special focus will be given to those new materials with the possibility to meet the requirements of next generation OPV devices, these are, materials that can give high photovoltaic performance, synthesized through green chemistry and easily processable, and most importantly, intrinsically stable.

2. Degradation protocols and industrial requirements: Degradation protocols and standards are applied in accordance with the current ISOS recommendations and future IEC standard(s). As evolution in the testing conditions is expected during the course of the Action, the technology monitoring will also focus on any breakthroughs in accelerated testing methods, degradation protocols and standards evolving in the field. The insight into the requirement for industrial application of OPVs will be gained through regular networking events and industrial days as well as from technology and industrial reports.

3. Characterization methods: If any new characterization technique becomes known that is very useful for studying degradation, it will be considered for future integration within this Action at specific partners' institutions or by inviting new members

Main deliverables:

To be aware of the most recent advances in OPV materials, characterization methods and device development. Overview of the latest development will be included in the annual report.

Working Group 2 (WG2). Organic solar cells and test structure fabrication.

Objectives:

1. The fabrication of state-of-the-art devices will be carried out by specialized member laboratories that have the facilities to continuously provide a large enough number of comparable samples for all partners. For selecting the device structure advice from the industrial associates and the WG1 will be essential.

2. In parallel to fully working OPV devices, comparable test structures consisting of a few layers will be made at this stage. This test structures will be aged and analysed in parallel to understand interfacial mixing, reaction and degradation. The recommendations from experts in characterization in WG4 will be followed.

Main deliverables:

To provide reproducible and large number of devices and test structures to the partners for the different degradation scenarios and, thereafter, non-destructive and destructive analysis.

Working Group 3 (WG3). Solar cell and test structure degradation following protocols.

Objectives:

1. In-situ degradation of OPV will be carried out to state-of-the-art OPVs. Several sets of samples will be monitored, from reference devices to OPVs degraded at different, but well-defined, exposure times.

2. Following well-established degradation protocols for indoor and outdoor testing; a set of systematically prepared OPVs and test structures will be made and distributed to the partners for in depth degradation analysis with all complementary methods. The ageing experiment will be selected among the existing degradation protocols. Degradation protocols can also be extended and improved after agreement of all the partners, MC and SG. Some of the existing degradation protocols are:

a) Real-Time Outdoor Ageing - **ISOS-O-3**
b) Indoor High Temp. Light Soaking **- ISOS-L-2**
c) Indoor Humidity Light Soaking - **ISOS-L-3**
d) Reference Dark Storage Shelf Life - **ISOS-D-1**
e) High Temperature Dark Storage - **ISOS-D-2**
f) Damp Heat Storage - **ISOS-D-3**
g) Temperature Cycling Test - **ISOS-TC-3**
h) Low Light Testing **- ISOS-LL**

Main deliverables:
Device degradation and testing OPVs following relevant protocols and standards. Deliver systematically aged devices and test structures to WG4 and WG5.

Working Group 4 (WG4). Non-destructive analysis of degraded devices.
Non-destructive chemical and physical characterization mechanism will allow the development of a microscopic material degradation –physical parameter- device failure relationship. Non-destructive analyses allow the samples to be characterized by several means without destroying the device. This is an advantage in some cases, since the same OPV can be characterized by different and complementary analytical methods.
Objectives:

1. Comparison of the qualitative and quantitative device degradation of samples that are aged in parallel at different groups. If no standard for data exchange exists, then one will be decided on at the beginning of the Action.

2. Establish the relevant and available characterization techniques and their sequence for efficient characterization for analysis of devices aged in WG3. The WG1 will also contribute to this objective to leverage latest advances in characterization and avoid investigation of recently discovered failure paths.

3. Non-destructive characterization of devices and test structures at different stages of their degradation will be carried out successively or in parallel at different laboratories. Techniques to be considered for non-destructive testing include standard opto-electrical characterization of the OPV performance, in combination with imaging techniques to reveal the location of any failures. Chemical and surface and bulk structural characterization techniques of test structures will allow better understanding of the failure on the material level. These will be combined with physical and spectroscopic techniques to link the failure to physical parameters.

4. These tools are not only available at few locations but their often time-consuming and costly therefore the experts in WG3 and WG4 for ensure selection of only relevant samples.

5. Simulation and Modelling. Degradation can occur at different locations within the device, for example the light adsorbing layer, the electrodes, the many interfaces between layers, etc. Due to such complex structure and diverse degradation paths the application of modelling and simulation approaches is very important for the future advancement of the technology. In this respect, modelling and simulation will be used as a tool to understand OPV lifetime and results will be compared with experimental data obtained from the non-destructive and destructive analyses.

The results of the different characterization methods will be combined to aim at global understanding of the different degradation paths taking place in devices and test structures. This implies using the results both from destructive and non-destructive methods and compared to other reports in the literature.

Main deliverables:
Description of degradation mechanisms based on the large number of results obtained within the non-destructive analyses, with the aim at generalizing the finding for other materials and device structures. Suggestion to prevent these degradation routes and possible ways to derive accelerate testing methods for these particular processes. Results obtained in this WG will be combined with those observed in WG5 in order to arrive to more comprehensible degradation

mechanisms.

Working Group 5 (WG5). Destructive analysis of degraded devices.

As described for non-destructive characterization, the destructive chemical and physical characterization mechanism will also permit the understanding of the relationship between the microscopic material degradation, the physical parameters and the device failure. In this case, many samples, of the same characteristics, have to be degraded at the same time since the samples will be destroyed for final characterization.

Objectives:

1. Destructive characterization techniques will follow on the samples submitted to non-destructive techniques. These measurements can be carried out at different laboratories in parallel. Destructive techniques will enable to detect degradation at buried interface and in the bulk by relying on tools that than sputter in parallel to the analysis. The tools that are currently available allow to analyse structural and interdiffusion processes on cross-sections applying microscopy techniques, like transmission and scanning electron microscopy (TEM and SEM, respectively). Change in chemical composition or oxidation state of the compound as well as interdiffusion processes are X-ray photoelectron spectroscopy (XPS) and Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS). Impact of interdiffusion and changes at the interfaces on the mechanical strength of the devices will be measured double cantilever beam (DCB) tests. These tools are only available at few locations and they are often time-consuming and costly. Therefore the experts in WG3 and WG4 will ensure selection of the most relevant samples.

2. Modelling of the opto-electrical response of the degraded devices will be implemented combining exiting device modelling expertise and insight about the degradation mechanisms. The characterization techniques in WG4 will generate parameters such charge carrier mobility, excited state lifetime and diffusion length, energy levels, etc. that are direct input for the simulation. The modelling will aim to validate and complement the understanding extracted in WG5.

3. Experimental results generated in WG5 will also enable the modelling of the chemical interactions, material diffusion and other processes in the device during degradation. This can assist the understanding of the failure at the microscopic level. It will furthermore contribute to prediction of device performance behaviour at different stress levels which can be the foundation for accelerated lifetime models.

Main deliverables:

To describe the different degradation mechanism observed by destructive characterization analyses. To compare the opto-electrical modelling of device degradation in order to experiment results and discussion of relevant differences. To suggest how to prevent these degradation routes and possible ways to derive accelerate testing methods for these particular processes. As also described for non-destructive analyses, the results obtained in this WG will be combined with those observed in WG4 in order to arrive to more comprehensible degradation mechanisms.

Working Group 6 (WG6). New Device Engineering.

Objectives:

1. Design of the next generation stable OPVs taking into account results from other WGs, especially WG4 and WG5. Brainstorming meetings will take place, with special focus on industrial partners' input to arrive at innovative and industrially-relevant solutions for the problems encountered.

2. Simulation and Modelling. The new devices will be validated through modelling and simulation in order to predict the best device configuration and the novel OPV lifetime.

Main deliverables:

To deliver stable OPV devices based on the knowledge gained within all other working groups. Fabrication of the next-generation of OPV devices is foreseen (and these are fed back into the production and characterisation scheme starting with WG2). Degradation models to predict device lifetime at different ageing conditions.

E. ORGANISATION

E.1 Coordination and organisation

The Action StableNextSol will be chaired a Chairperson and coordinated by a Management Committee (MC), following the "Rules and procedures for implementing COST Actions".

The Action will last 4 years, and is organized into five coordination aspects: Management, Working Groups, Networking, Scientific/Technological Activities and Dissemination.

An STSM coordinator will be appointed at the first MC meeting (kick-off-meeting). He/she will ensure the evaluation of the STSM applications, the selection of successful candidates, and the approval of the scientific report of the STM applicants. The MC will be informed by the coordinator of any conclusions/decisions reached/taken by the STSM coordinator during the following MC meeting. The NM, STSM and DM will be coordinated exclusively by an ESR, at least one of which will be a woman. Those activities will then be approved by the MC. An Ethics Committee (EC), comprising the Chairperson and the WGLs, will handle any gender-related issues that arise. The Chair, WGL and Managers will be selected at the kick-off meeting.

Any research in the Action is carried out and funded by the partner members. The Action StableNextSol will provide the required coordination as described below.

1. **Management Committee (MC)**

The MC will direct and supervise all activities of the Action to ensure that the objectives and milestones are achieved. Meetings to monitor management activities will be held twice a year.

2. **The Working Group Leaders (WGL)**

The WGL will be appointed during the kick-off meeting. They will be responsible for the coordination of the research and scientific activities (experimental work) within the WGs and will report to the Chair and MC.

3. **Networking Manager (NM)**

The responsible person for the networking and capacity building activities will be an ESR. The activities will be as follows: a) facilitating networking inside and outside the Action, b) fostering links with other European and international programs, c) attracting new partners to join the Action, d) attracting ESR and female scientists to the Action.

4. **Scientific/technology Manager (STM)**

The STM, represented by an ESR, will be in charge of the scientific and technological activities of the Action and is the STSM coordinator. The activities are described as follows: a) Identify members of the Industrial Advisory Board (IAB) for the organisation of industrial days and coordination with industry, b) organization of meetings where the details work plan and management structure will be decided and discussed, c) organization of training schools, STSM, Industry Days, workshops, and similar e) coordinate children-care facilities during meetings to encourage female participation.

5. **Dissemination Manager (DM)**

The coordination of the dissemination activities will be carried out by an ESR. The activities will be coordinated and supported by the Chair, and are described as follows: a) creation and maintenance of the web site, the twitter and LinkedIn account and/or Facebook group, b) coordination of the Action newsletter, c) if possible, the creation of a smartphone application (APP) with interactive push-up notifications of the Action agenda and activities, reminders of meetings and due-reports, d) take extensive advantage of online channels for the dissemination of the Action (for example Research Gate, Wikipedia), e) organize webinars through the SOPHIA European Research infrastructure, for the broadcasting of workshops, meetings and presentations.

An important part of the organization scheme is the **monitoring and evaluation** of the Action activities. This will be made through different progress reports. The reports will be drawn up by the MC and will contain evaluations of the research carried out under the Action. To monitor the Action implementation along the four years, the achievements and effectiveness of the Action will be formally reviewed at the mid-term and at the end of the Action with progress reports. The scientific output of the Action will be evaluated, to identify the major achievements, their dissemination and possible routes to further funding for implementation. The Grant Holder of the Action will **monitor** and assess the costs incurred in order to avoid an overspending and to most efficiently use the funding in a budget period. The Grant Holder will report to the MC the available resources in the course of the project and the MC can decide whether additional activities can be implemented.

The **coordination of national research** will be implemented by taking advantage of the organization of common research teams, conferences, workshops, STSM, training schools, industrial days, and similar activities.

The **Milestones**, or major achievements crucial to the future direction of the Action StableNextSol, are described in the general structure (Table below). Some of these deliverables will be carried out every year or every two years:

Milestone	Date	Description
Kick off meeting	Year 1/Q1	First meeting of the Action. Nomination of WGL, Managers, Chair, Ethics committee and Industry advisory board.
MC Meetings	Twice/year	The general planning and review of the program of the Action will take place.
WGs Meeting	Once a year	WGs will meet once a year to discuss results and future work.
COST Annual evaluation Meeting	Once a year	Before the end of each year a yearly report will be made and the evaluation of the results will take place during annual meeting.

with reports		
Mid-term evaluation with report	End of Year 2	At the end of Year 2, a mid-term evaluation of the Action will take place with written report.
Web site creation	Year 1/Q1	Initial launching of the web page.
Web site update	Every month	The web page will be continuously updated (agenda, workshops, news, contact of members, relevant scientific documents).
Information exchange	Every month	An exchange of general information (workshops, meetings, annual reports and scientific reports, PhD thesis) will be available via the webpage in an only-partners section.
Scientific exchange programme	Every month	An exchange of scientific information (device fabrication process, ageing and analysis conditions, experimental results, publications) will be available via the webpage in an only-partners section.
Final Action evaluation report	Year 4/Q4	At the end of the Action's activities, end of the fourth year, a final report will be made with the input from all partners.
Calls	Q1 every year	Researchers will be able to submit proposals for short stays scientific missions to other laboratories within the consortium. First quarter of each year. Deadlines will be published in the Action web page by the MC
Topical Workshop	Once a year	One topical workshop per year will be organized with focus on needs of ESR. Topic and venue will be decided in a MC meeting. Themes will be decided by the WGL and MC.
Training school for ESR	Once every two years	A general training school will be organized for ESR every two years.
Industrial Days	Once a Year	Conferences given by the industrial partners.
Public event, end of the Action	Year 4/Q4	The Action to disseminate its results will organize and stimulate networking between beyond the Action will organize the most renown event in the field the ISOS Meeting.

For each meeting it will be checked whether it can be attached to/combined with one of the main EU conferences to reduce the travel load of the involved researchers (time, CO_2 emissions, etc.) without jeopardizing the goals of the Action.

E.2 Working Groups

As described in section D.2, the following six Working Groups will be established:

- Working Group 1 (WG1). WG1. Technology Monitoring
- Working Group 2 (WG2). WG2. Organic solar cells and test structure fabrication.
- Working Group 3 (WG3). WG3. Solar cell and test structure degradation.
- Working Group 4 (WG4). WG4. Non-destructive analysis of degraded devices.
- Working Group 5 (WG5). WG5. Destructive analysis of degraded devices.
- Working Group 6 (WG6). WG6. New Device Engineering.

Organization of the working groups:

Each WG will be coordinated by a working group leader (WGL) selected by the MC at the kick-off meeting. The WGL will be responsible for the correct development of the scientific/technical program. All WGs have been chosen in a way that maximum participation and collaboration exist between partners. The **main task** of the Working Group Leaders are related to the experimental and research program, while the organization of the scientific and technical activities (like STSM, topical workshops, training schools, etc.,) are the responsibility of the STM. The WGL will participate, elaborate and coordinate the WG meetings, elaborate the working plan for each group, promote and set-up joint research between partners, promote the publication of results, report to the Chair and MC on the progress of the work.

E.3 Liaison and interaction with other research programmes

The MC of the Action StableNextSol will seek for collaboration with other research programmes at EU and international level. Due to the broad and multidisciplinary activity of the Action, a connection to other projects will benefit and strength scientific and networking activities. Two main scientific areas within the Action will be improved: a) new materials and new interfaces, and b) characterization techniques. The application of new characterization techniques can permit the discovery of new degradation paths. New materials can bring better stability to solar cell components, especially at interfaces. These interactions can be between organic materials, inorganic materials or both. Active COST Actions that can complement the StableNextSol project are:

The ***MP1202*** Action is related to the design of hybrid organic-inorganic interfaces at molecular and nanoscale level. It is also specialized in the application of soft inorganic chemistry that can be compatible with the fabrication methods (printing at low temperature) of OPVs. The rich chemistry of TMOs related to the changes of the metal oxide state is well known to modify the

OPV performance. The collaboration with the COST Action **CM1104** (Reducible oxide chemistry, structure and functions), can complement the knowledge needed on these materials. ***MP1302:*** dealing with nanospectroscopy, can provide expertise on metrology—namely, knowledge on o**ptical nanospectroscopy** applications for OPV characterization.

Active EU Programs and Initial Training Networks that include one work package on stability of OPVs and can complement the Action StableNextSol. At least one partner of the Action is working in one of these projects: - **X10D**- Efficient low cost, stable, Tandem organic devices. **- LargeCELLS** - development of organic photo voltaic cells based on innovative conjugated polymers materials, polymer-inorganic hybrid systems and their usage in large area devices fabricated using printing techniques. -**RotRot** - develop innovative materials and methods in order to elaborate future generation of tandem organic photovoltaic solar cells (OPV tandem). - **SunFlower** for the development of highly efficient, long-lasting, cheap and environmentally friendly printed organic photovoltaics. -**SOLIANCE** is the alliance of TNO, TU/e, Holst Centre, ECN, IMEC and Forschungszentrum Julich for research and development in the field of thin film photovoltaic solar energy (PV) in the ELAT-region (Eindhoven-Leuven-Aachen triangle). It encompass the study of Thin film Si, CIGS, OPVs and other generic technologies. ITN **Establish** which is focused on the synthesis of materials, fabrication of OPVs and characterization of devices. – Other slightly related are **Clean4Yield**, **MUJULIMA**, **ARTESUN** or **TREND**.

The Action is also seeking for the utilization of EU large research infrastructures or resources, for example the EU-funded **SOPHIA** European Research Infrastructure that optimises the use of research infrastructures and improves their performance. **SFERA** offers European research and industry access to the best research and test infrastructures and creating a virtual European laboratory in the PV area. The **OpenAIRE** initiative aims to facilitate research data registration, discovery, access and re-use, in particular in the context of Horizon 2020 funded projects across European countries. Partners of this Action will also take advantage of **Synchrotron** facilities around Europe (the ILL, ESRF, ISIS, Diamond and ALBA synchrotrons).

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the MC will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve ESR. This item will also be placed as a standard item on all MC agendas.

A mentoring program for ESR and female researchers will be implemented. Those students seeking guidance and support for their career development will be matched with a later stage researcher for advice. The mentor-mentee pairs are encouraged to regularly exchange by phone or in person. Information on related activities (objectives, outcomes, list of mentors, etc,) will be available in the Action web page.

Gender balance

The Action StableNextSol recognizes the benefits of diverse workforce. The Action has made a commitment to implement equality targets to address men and women's participation in the programme through new **innovative plan** that is tailored to the specific research area.

The gender equality innovative plan (GE-IP) has the following actions and goals:

a) To promote an appropriate gender balance in all its activities, organizational roles and WGs.

b) To encourage young female scientists to participate and lead scientific careers in the organic photovoltaic research area, at both academia and industrial level. Mentoring scheme is encouraged though the networking events and annual meetings as described above.

c) To set a minimum of 40% on direct participation of female researchers within the Action activities like workshops, training schools, STSM, presentations, coordinate or organize the activity.

d) To facilitate participation of females to attend the Action conference/workshops and training schools. For example, facilities for children care will be organised during events to facilitate participation of parents accompanied by children.

e) An ethics committee will be implemented composed by the coordinators of each WG. Its function will be to encourage the participation of woman for the implementation of the Action and the resolution of any gender-related issues that could arise.

The Action StableNextSol includes at this stage of the proposal 58 members of which 44% correspond to female scientists.

Involvement of early-stage researchers

This Action acknowledges the importance of ESR for the future of the EU economic and technological development. The goal is to assemble a new generation of scientists with a common view on the future development of the Organic Solar Cell academic and industrial research areas. Given the interdisciplinary nature of OPV, an important condition is the education of scientist coming from a wide variety of disciplines and with broad backgrounds.

The Action will act as a platform for the development and involvement of ESR in the Action StableNextSol activities.

The early-stage researcher's innovative plan (ESR-IP) will be developed by this COST ACTION as follow:

a) Funding for conferences, STSM, training schools.

b) Direct involvement of ESR in the organization of the Action activities through management of working groups.

c) Results generated by ESR will be encouraged to present their own work at internationally recognized conferences. Therefore at least a 20% of the conferences in the Action activities will be given by ESR.

d) In order to promote the participation of as many ESR as possible, short flash-talks (5 min) and poster presentation will be part of any Action conference and workshop to encourage ESR visibility.

F. TIMETABLE

The Action will last four years. Within six months after the start of the Action the timetables, objectives and targets for the entire COST Action period will be agreed by the coordinators of each WG and the MC.

The Action will organize four topical workshops, one kick-off meeting, one midterm review meeting and one final meeting before drafting the final report. The kick-off meeting will finalize details on the WGs and R&D focus and approve the final timetable of the Action. The creation of the web page will be made the first quarter of the Year 1 and will be updated continuously. The MC will also be the responsible for organizing joint seminars when relevant. Four Industrial Days will be organized in direct coordination with the IAB. Call for proposals for STSM, travel, meetings, or similar will be published every 1st Quarter by the MC.

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Kick off meeting MC Meetings WGs Meeting Web site creation Call for proposals	Web site update Information exchange	Web site update Information exchange Topical Workshop	MC Meetings Web site update Information exchange Industrial day COST Annual

				evaluation
2	Web site update Information exchange Call for proposals	MC Meetings WGs Meeting Web site update Information exchange Training school for ESR	Web site update Information exchange Topical Workshop	MC Meetings Web site update Information exchange Industrial day COST Annual evaluation
3	Web site update Information exchange Call for proposals	MC Meetings WGs Meeting Web site update Information exchange	Web site update Information exchange Topical Workshop	MC Meetings Web site update Information exchange Industrial day COST Annual evaluation
4	Web site update Information exchange Call for proposals	MC Meetings WGs Meeting Web site update Information exchange Mid-term evaluation with report Training school for ESR	Web site update Information exchange Topical Workshop	MC Meetings Web site update Information exchange Industrial day Final evaluation report Public event, end of the Action

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CH, CY, DE, DK, EL, ES, FI, FR, IL, IT, LT, NL, PL, PT, SE, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 76 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The dissemination of the results of the Action target audiences directly and indirectly related to the Action. The first target audiences are the members of the COST Action, followed by external audiences. In general, the dissemination will address the following external audiences:

a) Researchers working directly or indirectly in the same research field.

b) Related research frameworks.

c) Research Institutes and Academia.

d) Direct and indirect users of the OPV technology

e) Industrial and commercial bodies related to materials, metrology and energy.

f) Manufacturers and Services providers from Industry.

g) EU policy makers at regional, national, European and International level.

h) General public.

The target audiences include materials, characterization and metrology, fabrication of complete devices. The knowledge can be of interest to a wide variety of public, from students/academia, to industrial partners. The industrial target can impact not only the area of OPVs, but also the organic electronics research area and related research fields.

H.2 What?

The following dissemination methods will be used:

1. Set up a web site for te publication of information related to the Action.

2. Use of the web site to give access to the partners, as well as to the general public and other audiences, to documents related to the outcomes of the Action (factsheets, posters, reports, newsletters, guidelines, manuals, etc.).

3. The web site will also be complemented with an electronic communication network (discussion forums, web mails, etc.).

4. Publications: state of the art reports, interim reports, case study reports, proceedings, guidelines, manuals, final reports. Articles in peer-reviewed scientific and technical Journals, books, etc.

5. Dissemination events: workshops, seminars and conferences organised by the MC, contributions to other

6. Attendance to national and international conferences and symposia;

7. Non-technical publications. Print a flayer with general information about the Action in order to acquire new members during the project. It will also reinforce dissemination of the activities.

H.3 How?

The dissemination of results will be made as follows:

a) The main dissemination method will be the Action web site. The information available will be: Official public documentation (MoU), basic information about the Action and its progress, links to relevant contextual material and to other relevant initiatives, links to the publications, proceedings, power point presentations and documents of the COST Action. Fact sheets, newsletters, etc. will also be accessible via the Action web page. The web page will be updated frequently a will have an interactive section where ESR and public in general, can contribute with comments and questions. The consolidation of all the information generated by the ISOS protocols will be made and published in the web page.

b) An internal website for all participants will be managed by the MC with information provided by all the WGL. It will contain the detailed work plan, working documents and reports, and any useful information for the participants in the Action, such as an agenda with internal and relevant external events or information about potential short-term scientific missions and open positions for ESR in partner institutions.

c) E-mail lists will be available, one for communication between Action participants and one for individuals or organizations that can be informed on specific progress of the Action (previously approved by the MC) without being directly involved in it. The second list will be open to anyone who wishes to join it via an electronic application form available on the project website as well as via expressions of interest gathered in attended events.

d) The Action will take advantage of EU common infrastructures such as the SOPHIA European Research Infrastructure webinars where a monthly 1-2 h seminar will be organized and broadcast to all the partners. Between 1 and 2 participants, especially ESR, will be invited to participate showing their latest results or to give a special talk. Paper documentation of the webinar will be available in the Action web page.

e) A general conference will be organized yearly where all the participants will meet with external scientists and discuss common problems and initiatives, and present the results of their collaborations. This COST Action will coordinate its activities with the schedule of the International Summit on OPV stability, or will be organized during an important European meeting, like the yearly E-MRS meeting.

f) Specialized workshops and seminars focused in specific topics will be organized each year by the Working Groups, and early-stage scientists will be particularly encouraged to attend these events. The Action will take advantage of the SOPHIA European research Infrastructure to broadcast most or all seminar activities.

g) The COST Action will aim to present ideas and results in the major international conferences and symposia about OPV, especially on stability and characterization protocols.

h) A policy workshop about the status of the OPV research and commercialization, the funding, and the overview of the status and position of OPV within renewable energies.