

PROJECT PERIODIC REPORT

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Name, title and organisation of the scientific representative of the project's coordinator¹:

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¹ Usually the contact person of the coordinator as specified in Art. 8.1. of the grant agreement

² The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

2. Publishable summary

2.1 Summary description of the project context and objectives

The Nanophotonics for Energy Efficiency (N4E) Network of Excellence, a project supported by the 7th Framework Programme of the European Commission, aims to promote nanophotonics research in energy-efficient applications by bringing together different nanophotonic laboratories and research groups across Europe. 9 institutions in 6 European countries are participating in the network, representing more than 130 scientists, engineers, technicians, and managers in the field. The project also incorporates the resources and capacities of a broad network of Associate Members. Market and industrial relevance is also ensured through the involvement of a group of industrial advisors: BASF, Centrotherm Photovoltaics, Eni S.p.A., IBM Corp., Philips Lighting, Heliatek GmbH, and T-Solar Global S.A.

Need for more efficient ways to produce and save energy

Switching to advanced lighting technologies, such as LEDs and OLEDs, offers great savings potential in terms of electricity consumption, while the uptake of solar cells would reduce the demand for oil and natural gases and in turn reduce CO₂ emissions. However to meet current targets certain challenges must be met. Solar cell efficiency should be improved by at least 30%, OLED efficiency and lifetime must be enhanced if they are to be used for general lighting purposes.

Switching to the best alternative existing technologies would save 30% of the energy needed for illumination...but would not reverse the trend towards higher energy needs.

(Photonics21 SRA 2010)

Progress during the final reporting period

During the last reporting period of the project – from January 2014 until March 2015 – our efforts have been mainly devoted towards strengthening integration and collaboration, both within the Consortium and with key external stakeholders, in order to ensure a durable scheme where collaborations and existing actions can continue beyond the project duration.

Some of the key actions undertaken to achieve that goal are:

- The number of Associate Members has kept growing: it increased from 41 Associate Members at the end of year 4 to 57 at the end of the project. Associate members include industry (31%), R&D institutions (23%) and Universities (46%). Over 90% of these members have been actively involved in project activities.
- One call for Seed Project proposals have been published in this reporting period, with a total of 17 proposals submitted and 6 projects funded.
- The LinkedIn <http://www.linkedin.com/groups/Nanophotonics-Energy-Efficiency-3705807>, twitter @NanoOptics and Facebook <https://www.facebook.com/NanoPhotonics4Energy> accounts used to publish relevant information on nanophotonics for energy efficiency continue attracting more followers. The LinkedIn group grew from 367 to 426 members, twitter account has now 226 followers (up from 167 at the end of 2013) and Facebook has 1238 followers.
- The project has published more than 40 papers in SCI-indexed journals in this reporting period, including papers in Nature Nanotechnology, Nature Communications, Advanced Materials, ACS Nano, or Nano Letters, amongst other.

All publishable summaries and reports generated within the project are available in the <http://n4e.eu/> website.

The Network organised four main events: User's Meetings in Turkey and Barcelona, open to all Associate Members and where scientific and technical developments were discussed; a PV-Nanophotonics Workshop co-organised with the European Photovoltaics Technology Platform and co-located with the EU PVSEC 2014 Conference in Amsterdam, and a SSL-Nanophotonics Workshop co-organised with ForumLED in Paris.

In order to improve collaborations among different institutions and to optimise the use of existing infrastructures, we have set up an initial-phase remote eLab infrastructure, which allows a remote user to interact directly with laboratory equipment, with close monitoring of all relevant parameters and real-

time interaction with the devices under test. Initial tests have been successfully conducted both within the Consortium and with Associate Members.

2 students from the Consortium and directly involved in the project have received the Photonics21 Student Innovation Award: Olga Malinkiewicz, a former ICFO student that has now created a Start-up company in perovskite-based solar cells received the award in 2014 and Burak Güzeltürk, currently at Bilkent University, received the 2015 Award. Olga and Burak join Sedat (2010), Dhriti (2011) and Rafael (2013) as Photonics21 Student Innovation Award price recipients for work directly related to the N4E Network of Excellence. This clearly underlines the relevance and potential industrial impact of the work carried out within this project.

A Memorandum of Understanding has been signed by all the Consortium participants with the compromise to continue collaborations beyond the duration of the project.

The project has achieved and even exceeded all the measurable targets, which include number of publications, number of co-authored publications, impact, industrial and academic participation in seed projects, and organisation of industrial workshops.

2.2 Description of the work performed since the beginning of the project and main results achieved so far

The Nanophotonics for Energy Efficiency Network of Excellence has focused on the promotion of nanophotonics research in energy efficient applications through the consolidation of existing resources and setting up new partnerships. Especial emphasis has been put to enhance information flow and collaborations between academia and industry.

WP1: Creating a Nanophotonics for Energy Efficiency Forum

Although not initially foreseen in the project, an Associate Membership scheme has been put in place in order to involve the research and innovation community in the field at large. The result has been very successful, with a total of 57 associate members at the end of the project, 53 of them actively participating in project activities.

Besides this community of 66 institutions with a tight information flow and collaboration channels, a broader community has been formed through existing social/professional networks. The project has communication and discussion channels in LinkedIn, Twitter and Facebook, each one of them with more than 200 participants. Besides that, the project web page <http://n4e.eu/> is used by over 400 unique users per month and includes a repository of all the public information generated in the project, an overview of the facilities available within the consortium and clear information on how to initiate collaborations.

The research exchange program, which was established in the second year of the project has seen a steady increase in the number of exchanges over the project duration, with a total of 16 exchanges during this last reporting period.

A Memorandum of Understanding has been signed by all Consortium members for continued collaboration beyond the project duration.

WP2: Academia-Industry Forum

The project has organised a total of 5 industrial workshops, 2 of them during this last reporting period: A Nanophotonics workshop collocated with the EU-PVSEC 2014 Conference in Amsterdam (the main conference for photovoltaics in Europe) and a Nanophotonics workshop collocated with ForumLED 2014 in Paris. All the information related to these events is publicly available at the <http://n4e.eu/> website.

Besides that, we have published a report (public deliverable) with the most relevant scientific and technology developments in both photovoltaics and solid-state lighting during each reporting period of the project.

WP3: Light Harvesting and Light Generation

A total of 7 calls for Seed Project Proposals have been published in the project. The last one of them (7th call) was published during the current reporting period and included a total of 17 proposal submissions, from which 6 were selected for funding. All projects have been finalised and reports have been generated. Besides that, an analysis of the impacts of each of the previous seed projects has been carried out and included in a Deliverable report.

WP4: Education and Training

Throughout the duration of the project, the project has (co)organised 6 schools, there have been 18 lectures in international courses, and the Consortium has produced 80 MSc theses and 32 PhD theses in subjects directly related to the activities of the Network of Excellence. Specific training has been devoted to important areas like scientific communication, intellectual property rights, or networking. Also, 2 workshops with hands-on clean-room processing training took place (at the UPC in Barcelona and the University of Southampton).

WP5: Dissemination

Significant efforts have been devoted to dissemination of project results and nanophotonics for energy efficiency in general to the scientific community, industry, and the public in general. One of the pillars of

the dissemination activities has been the close collaborations with existing institutions like Photonics21, the European Optical Society, IEEE Photonics Society, Nanophotonics Europe Association or EPIC.

As reported above, we have carried out several workshops with a clear industrial focus. Regarding the public in general, several network members have published feature articles in the daily press on topics related to nanophotonics for energy efficiency, and several events have been organised for primary and secondary school students.

The scientific output of the project includes a total of 163 SCI-indexed publications (all of them explicitly acknowledging the project), with an outstanding number of high quality outputs: 25% of them have an impact index higher than 10. Also, it is worth mentioning that 25% of the publications are the result of collaborative research, with authors from at least 2 Consortium members or Associate members.

Besides publishing scientific results, the members of the Consortium also have an active policy of protecting intellectual property, so that it can be exploited and can thus contribute to increasing European competitiveness and job creation. Consortium members have generated a total of 21 patents on topics directly related to the project.

2.3 Expected final result and their potential impact and use

Although the specific impacts of a Network of Excellence are difficult to quantify, this 5-year project has established a solid network of collaboration that spans a total of 66 different institutions. Some of the events organised, like e.g. the EU-PVSEC Workshops on Nanophotonics, are considered of top quality and have attracted some of the most reputable speakers in the field. The event will continue beyond the project duration with a 2-yearly periodicity.

Ideas and collaborations from the Network have been the seed for a good number of new results, prizes and projects, as outlined in deliverable D5.7. Some examples are the participation of Consortium members in the Graphene Flagship (on activities directly related to light harvesting at the nanoscale, originally investigated on a Seed Project), the creation of a Start-up company (on perovskite-based solar cells) by a former N4E student, the 5 Consortium students being awarded the Photonics21 Student Innovation Award, or a great number of European and National projects being funded whose initial ideas were validated on a Seed Project.

The project has achieved and even exceeded all its measurable objectives. It is important to keep in mind, however, that the outputs of the project will continue to grow even beyond the end of the project and thus the final impact will actually be larger than what can be seen at this moment.

Address of the project public website & partners contact details:

Public website: <http://n4e.eu/>

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