European Cooperation in Science and Technology
- COST -
Secretariat

Brussels, 4 July 2012

COST 4125/12

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action ES1204: Loss of the Night Network (LoNNe)

Delegations will find attached the Memorandum of Understanding for COST Action as approved by the COST Committee of Senior Officials (CSO) at its 185th meeting on 6 June 2012.

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

COST Action ES1204
LOSS OF THE NIGHT NETWORK (LONNE)

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 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to facilitate the transfer of existing knowledge between the fragmented national research projects studying the multifaceted aspects of artificial light at night, thereby stimulating future transdisciplinary research; furthermore it will initiate dialogue regarding light pollution with the whole range of concerned and involved stakeholders, in particular the general public.

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 36 million in 2012 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 Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

LoNNe aims to improve knowledge of the multiple effects of increasing artificial illumination worldwide. Innovations in technology and policy are urgently required to address the impact of artificial lighting on the natural environment, biodiversity, ecosystems, human health and society, and to identify potential corrective measures. Until now, the overwhelming focus for improvements in illumination technology has been with regard to energy and luminous efficiency. Existing research associated with the impact of artificial lighting on various aspects of our environment and lives is fragmented, and generally at best at a regional or national level. The current potential for networking to enhance mobility between different actors from science, health care, public authorities and industry is limited. LoNNe aims at a cooperation of these players in order to cross-fertilize skills, and to create standard operating procedures. The COST Action will be open to any field of research, with the explicit goals of influencing the development path of modern lighting technology, and creating guidelines for lighting concepts that are ecologically, socially, and economically sustainable.

Keywords: artificial lighting, light pollution, sustainability, environment, human health

B. BACKGROUND

B.1 General background

Technology rarely fulfils only its intended function, but often has unexpected impacts on natural and social systems. This applies especially to artificial light at night instead. The widespread application of artificial lighting (AL) has transformed civilization and certainly enhanced the quality of life. AL is a prerequisite to extend activities into the dark hours. Since extension of economic activities is a source of economic growth, there is a close interrelationship between the level of illumination and economic performance (Gallaway et al. 2010, Ecol Econ 69: 658-665). However, these benefits have been accompanied by hidden costs, leading to substantial ecological and environmental degradation and causing undesirable social, economic, and human health consequences (Hölker et al. 2010, Ecol Soc 15(4): 13).

Humans often illuminate their environment uncritically, with no regard for the manifold impacts of AL. As a result, the rapid increase in AL has fundamentally transformed our nightscapes in the past few decades (Cinzano et al. 2001, Mon Not R Astron Soc 328: 689-707). Furthermore, the generation of electricity for AL has become a major source of greenhouse gas emissions, being responsible for one-fourth of all energy consumption worldwide (IEA 2006, OECD/IEA). Thus, the illumination of our nightscapes has potentially important, albeit almost completely neglected, impacts on culture, society, human health, economy, ecology, and coupled natural-social systems. Light pollution (LP) is now a widely accepted concept for any unwanted or nuisance AL that has adverse effects on nature and humans (Rich & Longcore 2006, Island Press, Navara & Nelson 2007, J Pineal Res 43: 215-224, Hölker et al. 2010). Nevertheless, understanding of the adverse effects of LP is vague, and is based mostly on anecdotal observations and case studies, with no biological definition for LP. While air and water pollution have been investigated experimentally for decades, LP remains scientifically, culturally, and institutionally in the dark.

Europe is currently in a very dynamic phase associated with AL. The European Ecodesign Directive established a framework to phase out particularly energy-intensive lighting products, e.g. high-pressure mercury lamps by 2015 (The European Parliament and the Council of the European Union 2009, Official J Europ Union L 285:10-35). High-pressure mercury lamps are currently the dominating light source in outdoor lighting with more than 20 million light spots in Europe. Thus, a huge number of existing installations and millions of lamps have to be replaced as soon as possible. Then again, there is an extremely rapid growth in the development and use of new lighting technologies, such as energy-efficient light-emitting diodes (LEDs). LEDs are seen as viable options for high-pressure mercury lamps, although there are many aspects of LED lighting that remain yet uninvestigated. Several characteristics of LEDs differ substantially from the conventional light sources; these include easily programmable light intensity, spectrum, and light angular distribution. All these have consequences for LP with so far insufficiently assessed effects for health and the environment (Falchi et al. 2011, J Environm Manage 92: 2714-2722). A drop in the cost of lighting services will be expected, a desirable end in itself, but with possibly higher energy consumption due to rebound effects and a wider loss of natural nightscapes as a consequence (Hölker et al. 2010). For example, luminous efficiency has doubled over the past 50 years in the UK; however, per capita electricity consumption for lighting increased fourfold over the same period (Fouquet and Pearson 2006, Energy J 27:139-177).

Since the technological progress and the reduction of prices leads often to such rebound effects, the aim to decouple lighting and economic performance is crucial. The amount of wastage of resources by uncritical use of AL is yet unknown, as well the social expenses due to health effects. Technological innovations should, therefore, not only target on economical optimisation, but also consider human health, ecological, and socioeconomic aspects. However, to date, neither a worldwide nor a European interdisciplinary platform exists focuses on the impact of AL.

Given the dramatic increase in AL worldwide and the current dynamic phase in technological development, research efforts on the physiological, human health, ecological, and socioeconomic significance of the loss of the night, as well as monitoring light at night have been started. Almost all existing research programmes, however, are limited to separate fields of science or to regional and national projects. Thus, there is an urgent need for networking and capacity-building activities that address how illumination can be improved both technically and institutionally with a commensurate reduction in adverse effects. Managing darkness has to be an integral part of future conservation planning and illumination concepts. If not, our modern society may run into a global self-experiment with unpredictable outcomes (Hölker et al. 2010). The main means to achieve this objective is the generation of a network of experts in order to form a critical mass of expertise. The COST Action will provide the coordination necessary to set up an interdisciplinary and supra-regional network of research groups associated with the impacts of AL.

B.2 Current state of knowledge

Light regulates the circadian rhythm, impacting metabolism, growth and behaviour (Rich & Longcore 2006, Navara & Nelson 2007). Due to the increasing use of AL, the distinction between day and night has become blurred, disturbing the synchronization between organisms and their environment on a diurnal and seasonal basis. Over the last decade, a novel non-image forming photoreceptor system in the vertebrate retina has been discovered and characterized (e.g. Berson et al. 2002, Science 295: 1070-1073). This melanopsin based system has a peak sensitivity for blue light (around 460nm) and elicits non-visual physiological light responses in daily rhythms (e.g. sleep-wake) and annual rhythms (e.g. timing of reproduction, migration).

There is clear evidence that AL can alter physiology, including hormonal balance, as well as behaviour, orientation, organism fitness, food web interactions, and biotope connectivity (Rich & Longcore 2006, Navara & Nelson 2007). The artificial disturbance of the natural day/night cycle may, as a result, have serious psycho-physiological and even medical consequences for humans, along with ecological and evolutionary implications for animals, plants, and even entire terrestrial, freshwater, and marine ecosystems (Hölker et al. 2010). These impacts are complex and difficult to disentangle from other disturbances produced by human activities. Next to these effects, accurate knowledge of the amount of light emitted at night is sparse, let alone the night sky brightness which strongly depends on atmospheric conditions (Kyba et al. 2011, PLoS ONE 6(3):e17307). Planned models relating outdoor AL to night sky brightness will require a lot of verification and further development in order to meet the detail required by policy makers.

Light pollution is a rather young research area, compared to other environmental hazards. Today LP has no quantifying measures and lacks guidelines. The EU Ecodesign Directive established a framework to phase out incandescent bulbs and other energy intensive lighting products. Measures have been taken to improve the CO_2-balance in the lighting industry (Intelligent Energy Europe Programme, e.g. E-Street, EU Greenlight Programme). The COST Action 529 “Efficient Lighting for the 21st Century” was running from 2000 to 2005. The successful Action had as a main objective the enhancement of energy efficacy of light sources and lighting systems. However, COST-529 left aside all environmental and health issues. The Information and Communication Technologies Policy Support Programme under the Competition and Innovation Framework Programme (CIP) funds HosPilot, an EU initiative for intelligent energy saving control in hospitals, and LITES, an initiative for LED-based intelligent street lighting. EUREKA project (E! 3456-E3L) aims to define LED technologies to comply with airport lighting equipment. Most efforts to date address the energy and luminous efficiency of AL, but more and more organizations and research groups deal with the consequences of LP. The International Dark Sky Association campaigns for lighting ordinances and the conservation of natural darkness in communities, parks and reserves. Several projects under the EU LIFE+ Programme aim at improved conservation of nocturnal organisms. A recently awarded ERC Advanced Grant within the 7th EU-Framework Programme addresses ecological effects of LP (ECOLIGHT). In 2011, the European Commission launched a public consultation on opinions concerning health effects of AL.

Currently, the European Commission is launching a consultation on the Green Paper "Lighting the Future: Accelerating the Deployment of Innovative Lighting Technologies". Still, all existing programmes are limited to separate fields of science or national projects. Today, the industry lacks scientific data for technological implementation of requirements, for nature conservation, and for human well-being. Several scattered regional or national projects target these requirements, but they lack standard operational procedures (SOPs). Constitutional quantification regarding the definition of LP is urgently required to initiate innovation.

The COST Action will be innovative in addressing AL and LP with a new approach, by creating the first interdisciplinary and supra-regional network for uniting the fragmented fields of LP research and research for suitable lighting technologies and concepts, that are ecologically, socially, and economically sustainable.

B.3 Reasons for the Action

There is a strong need for the implementation of the COST Action because there are a number of new challenges associated with AL. These challenges include: quantification the state of the art of AL in Europe, definition of thresholds at which AL becomes LP, quantification of the relationship between AL and LP, organisation of data concerning the impact of AL, creating standard procedures to help decision makers quantify the consequences of LP, stimulation of interdisciplinary research, and interaction with stakeholders on the research results to increase public awareness of the impacts of AL when it becomes LP.

Efforts to collect information and data for that purpose all over Europe have so far been hampered by the lack of an appropriate network. National research groups study the coherence of increased AL and widespread diseases such as sleep disorder depression, breast or prostate cancers or obesity. Social scientists examine the effects of AL on the well-being of humans and societal behaviour, the drivers of enhanced lighting, and the possibilities and obstacles of regulation. Lighting engineers have studied the effects of light spectral distribution on human alertness and biological rhythm; these studies lack an interdisciplinary approach. Other groups are investigating LP impacts on ecosystems, food webs and biodiversity; and continuous monitoring of AL has recently started.

However, a cost-benefit analysis in the field of AL is often still missing. Recently, the 'Verlust der Nacht' project has set up a national interdisciplinary network activity in Germany. The number of available results in existing projects is still small and no harmonized standards exist. LoNNe presents an interdisciplinary and supra-regional network of all these and many more research groups associated with the impact of AL, in order to avoid duplication of efforts, and to aid collaboration at an European level. The COST Action is aimed at both economic/societal needs and scientific/technological advance.

By this COST Action existing research gaps will be filled to initiate innovation. Technological innovations such as the use of made-to-measure colour spectra in modern illumination, the sustainable use of light controlling presence detectors, intelligent lighting control systems, the design and use of lenses, shades, and reflectors will help to regulate the use, quantity and quality (e.g. colour) of AL. The development of a light monitoring system will allow future intelligent lighting systems to adapt to changing meteorological conditions (e.g. clouds, snow), and set the ground for the establishment of local LP alarm systems. LoNNe will create SOPs to help decision makers quantify the consequences of LP. SOPs will be useful as guidelines for continuative research projects and improve institutional standards. In this context also the relevant actors and their interests, the possibilities of coalitions and conflicts will be assessed. At the end of the four year period a huge network of international experts will be established, available to beneficiaries and stakeholders. One of five European 2020 targets is to lower the greenhouse gas emission by at least 20%. LoNNe will have supported European technological transfer and will have support the EU to meet the 2020 target. The network will be strengthened and expanded during the COST Action and a transdisciplinary research field for the integration into other European research programmes will have been developed.

This COST Action is a unique effort, and is the only international network worldwide for uniting the fragmented fields of research associated with LP. Indeed, this Action has the potential to provide finally the necessary framework for the set-up of a global initiative for the benefit of society, public health and the environment.

B.4 Complementarity with other research programmes

In 2010, the Standing Committee of the Parliamentary Assembly of the Council of Europe called on member states to combat the harmful effects of noise and LP. However, as stated above (B.2) most efforts to date address energy and luminous efficiency of AL. Interdisciplinary research topics dealing with the impact of AL on both, nature and humans have been implemented neither into Framework Programmes of the European Commission nor in other European programmes. The Cost Action LoNNe will be the first opportunity to unite different disciplines dealing with the effects of AL and LP within one interdisciplinary network, thus fostering the scientific exchange between the parties involved and stimulating progress in a field still largely unexplored. Complementarities of this COST Action are however seen with the research of FP 7 (ECOLIGHT, Coelux), the innovation aspects of the CIP-Programme (HosPilot, LITE) and EUREKA (E! 3456-E3L), as well as with the nature conservation activities of the LIFE+ Programme (URBAN LIGHT PLAN, Life at Night). All the projects are disciplinary approaches to AL and LP. They might be considered as contacts for the networking and exchange purposes of LoNNe, which will even further underline the need for an interdisciplinary and innovative approach to AL and LP.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The network formed by the LoNNe COST Action will facilitate the transfer of existing knowledge between the fragmented national research projects studying the multifaceted aspects of artificial light at night, thereby stimulating future transdisciplinary research; furthermore it will initiate dialogue regarding light pollution with the whole range of concerned and involved stakeholders, in particular the general public.

C.2 Objectives

The COST Action is focusing on the following objectives:

1) Creating a platform and appropriate sub-networks for enhanced collaboration of researchers involved in:

- the quantification of outdoor AL, LP, and the relationship between AL and LP;
- identifying state of the art research facilities and expertise for research exchange;
- the impacts of AL on biodiversity, ecosystems, human health and society (e.g. security, economy);
- developing of a monitoring system which will allow future intelligent lighting systems to adapt to changing meteorological conditions, and to allow for the establishment of local LP alarm systems;

2) Assessment and organisation of data concerning the impact of AL;

3) Defining thresholds at which artificial light becomes a pollutant, and how to design sustainable AL to minimize LP;

4) Interacting with stakeholders to ensure widespread recognition of the importance of community aspects in lighting design;

5) Identifying existing research gaps for follow up pan-European inter-disciplinary co-operation.

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

The above listed objectives will be achieved under the umbrella of the Cost Action LoNNe by joining the forces of experts working in different complementing disciplines, from medicine, life science, social science, and ecology to atmospheric scientists, illuminating engineers, and astronomers, who have AL and LP as their main research interest. LoNNe will stimulate interdisciplinary research and balance the often contradictory impacts of AL. For example, light spectra that are harmless to insects may affect birds; eliminating illumination entirely may improve biodiversity but could threaten the safety of humans. Solutions for different interdisciplinary problems associated with AL can be found only with the provision of a broad network. Even the term LP needs quantification including measures for light quantity as well as for light quality comprising e.g. of light spectrum, light distribution in the environment, and the direction of light. Thus, the most important challenges for the network are the quantification of AL and LP, the definition of LP, the development of SOPs, and the involvement of the industry and other stakeholders.

The COST Action will provide an excellent platform for unifying and harmonizing research strategies, which is a prerequisite to nail down crucial factors involved in AL. With this COST Action, Europe-wide collaboration will be facilitated with a significant impact on LP research all over Europe by networking of scientific experts from different disciplines from different COST countries. Moreover, the collaboration of the Action participants will be organised in conferences addressing the lighting industry such as the biannual Professional Lighting Design Convention, which is accompanied by an exclusive manufacturers' exhibition, and the triannual International Symposium on Light Source Science & Technology. Also, keen contacts are held with the International Commission on Illumination (Commission Internationale l'Eclairage, CIE), which is the head organisation in the lighting field, devoted to worldwide cooperation and the exchange of information on all matters relating to the science and art of light and lighting, colour and vision, photobiology and image technology. CIE is scientific, non-profit organisation. The COST Action will be involved in CIE conferences and Symposia as well as in CIE Technical Committee work related to photobiology and the effects of light on health.

Since it is important to have a close personal relationship within the coordination activities, staff, especially Early Stage Researchers (ESR), will visit research groups on Short-Term Scientific Missions to exchange information, demonstrate new potential techniques, and to avoid duplication of projects and initiatives. Visit reports will be made available to all participants. Meetings and training seminars structured for engineers from both academia and industry will be organized. Representatives from industry and health care will be given the opportunity to update the participants about the customer's requirements. A list of research facilities inside the consortium will be established in order to favour the standardization of experimental procedures and to share modern measurement equipment. This COST Action will bring research institutes from different fields together, enable co-operation of post-graduate students in their PhD thesis works, enable double-degree PhD works, as well as the preparation of joint scientific articles. Research data concerning AL issues will be collected on the established website of LoNNe, extending the four year period of the COST Action. This homepage will include a transdisciplinary bibliographic database and data mediated reviews. Protocols will be implemented to help mitigate the negative impacts of AL to stakeholders.

C.4 Potential impact of the Action

LoNNe will support the 7th European Framework Programme in advancing our knowledge on the interactions between the biosphere, ecosystems, and human activities such as AL, in order to develop innovative technologies and services, and to promote sustainable management of the natural and human made environments including its resources. Immediate scientific benefits will be the exchange of information and expertise between research groups of this COST Action, and thus augmented use of and access to special research facilities, such as sleeping laboratories, calibration laboratories, dark sky reserves, light fields and experimental sites for atmospheric research.

One of five European 2020 targets is to lower the greenhouse gas emission by at least 20%. The tertiary sector lighting in the EU counts for 1.6 billion lighting points (luminaries), with an annual electrical energy consumption of 200 TWh (2005) to 222 TWh (2020). The magnitude of this energy consumption can be substantially reduced by prudent design, installation, and operation of a lighting installation, supplied by the academic expertise available in this COST Action. Addressing the LP problem also provides a long-term benefit for society, including non-COST countries, and extending beyond this four years project. LoNNe will improve parameters for the lighting industry, which until now relate exclusively to energy and luminous efficiency. The benefits for the technological field will be data of impacts on human health and well-being, chronobiology, as well as on ecological consequences such as changes in food webs and biodiversity. In addition, LoNNe will support the quantification of LP and the development of a monitoring system. This will allow future intelligent lighting systems to adapt to changing meteorological conditions and is the technical base for the establishment of local LP alarm systems. Information is a prerequisite to evaluate positive and negative impacts, but also the political process and the requirements to put regulation in action have to be taken into account.

The impact arising from LoNNe's activities is also important for the quantification of the value of natural darkness (e.g. to increase value for recreation and tourism). This knowledge will benefit European regions with a lack of economic infrastructure, which is coherent with a smaller amount of AL.

C.5 Target groups/end users

This COST Action will enable a network to link national researchers in this field and deliver important insights for the stakeholders, such as industry, public authorities, and the general public. The end users of the Action are primarily experienced scientists and Early Stage Researchers. Direct beneficiaries are the European Lighting Industry. The industry is represented by CELMA (Federation of National Manufacturers Associations for Luminaires and Electrotechnical Components for Luminaires in the EU) and the ELC (European Lamp Companies Federation).

Both CELMA and ELC represent 157,000 people and generate 20 billion € annual turnover in Europe. Additionally, public authorities, urban planners, architects, lighting designers, professional associations and all other relevant stakeholders involved or interested in the topic will benefit from an improved framework for sustainable lighting.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

This COST Action will encourage experts from different fields interested in AL and LP to exchange scientific knowledge and to collaborate by means of regular meetings, staff exchanges, organising seminars for Early Stage Researchers, and conferences.

The most important research tasks to be coordinated by this Action are:

Assessment and organisation of data concerning the impact of artificial light: The most challenging task is a proper synthesis and interpretation of existing interdisciplinary data (chronobiology/medicine, ecology, epidemiology, lighting technology, atmospheric science, astronomy or social science) pertaining to the impact of artificial light on human health and well-being, chronobiology, and ecological consequences such as changes in food webs and biodiversity as well as to mitigation strategies. A main scientific challenge is a comprehensive, long-term quantification of the relationship between AL and LP, and answering the question of what characteristics of light (e.g. light intensity, direction, distribution, spectrum, exposure duration) disrupt human health and ecological systems, as well as proper monitoring of LP. This will also be the basis for improving parameters for the lighting industry, for assembling data for economic assessment of dark areas and for identifying technologies and concepts that can address the environmental, health, and economic disadvantages of current lighting practices in different areas or settlement types.

Development of research alliances to avoid duplication of investigation and increase cooperation: This includes e.g. the organisation of a network for intercomparison campaigns of lightmeters over the range of COST countries and the development of LP models. In order to avoid the development of conflicting international standards, LoNNe will also co-operate with international standardizing bodies and other relevant international organizations. The CIE is responsible for standardisation and guidelines related to lighting, and close contacts are created with this COST Action and the CIE standardisation work. This stimulates exchanges of good practices worldwide and in Europe, helps avoid overlap and avoiding duplication of activities, and becomes a vehicle for the secure transmission of immediate threats and alerts.

Definition of guidelines and SOPs: A prerequisite for this systematic interdisciplinary endeavour is the harmonization of existing guidelines and standard procedures for defining, maintaining, calibrating, and using equipment, as well as models concerning the impact of AL. The development and use of SOPs are an integral part of a successful quality system, as they provide individuals with the information needed to perform a job properly, and facilitate consistency in the quality and integrity of a product or end-result. In the context of AL and LP LoNNe helps to describe programmatic actions and technical actions such as analytical processes, and processes for defining, maintaining, calibrating, and using equipment and models. SOPs will assist LoNNe and future interdisciplinary follow up activities to maintain quality control and quality assurance processes, and to ensure compliance with governmental regulations. Moreover the different national political and regulatory frameworks have to be taken into account.

Development of a monitoring system: Overcast skies have been observed to be several times brighter than clear skies. The development of a monitoring system will allow future intelligent lighting systems to adapt to changing meteorological conditions. LoNNe will support the development of a system that allows for the establishment of local LP alarm systems.

Communication of research data and results: The communication of the research results is an important aspect of this COST Action. LoNNe sees its responsibility not only in disseminating the results within the scientific community but in making them available to a broader audience as well. LoNNe offers concrete assistance to raise public awareness of the consequences of LP, and to bridge the gap between the sometimes separated research fields on AL and LP, and between science, practice (e.g. industry), and policy, especially as research results apply to reducing health disparities and environmental disruptions. LoNNe will achieve this by partnering with organizations and on projects targeting the impact of AL.

Network for integrated publications of various fields of science: Since there are several stakeholders and end users that have significant interest to exploit the results of this COST Action, LoNNe will produce a wide spectrum of publications for customers, scientists and the general public. Thus, this research task includes joint publications of brochures, guidelines, reports and SOPs, publication of proceedings of open meetings, PhD Theses, publications in peer reviewed scientific journals, a comprehensive publication on AL and LP, and press releases.

D.2 Scientific work plan methods and means

LoNNe will be organized in the following Working Groups (WGs):

WG 1: Creating a platform and appropriate sub-networks concerning the significance of AL

The main means through which to address the significance of AL with a holistic approach is the generation of three sub-networks within the LoNNe network in order to form a critical mass of expertise encapsulating a wide range of competences in biological, social, and technological disciplines. Therefore, the following sub-networks will be established:

(i) Enhanced collaboration of researchers involved in the quantification and modelling of AL: This includes for example the organisation of an international network of lightmeters for an international measurement campaign, and collaboration on development of a LP model. There are concrete contacts to organisations and projects that are involved in such activities.

(ii) Identification of the state of the art research and development facilities and expertise for research exchange within the COST network: In order to identify shortcomings in current state of use and to pinpoint areas in which new technologies need to be developed, a review of the existing technologies and research facilities has to be made. In such a way, knowledge fragmentation can be reduced, opportunities for efficient utilisation of calibration equipment could be identified, and the efficiency in developing novel methods and devices dedicated to AL and LP will be increased.

(iii) Collaboration and cooperation for joint publications: The COST Action will provide an excellent platform for unifying and harmonizing research strategies, which is a prerequisite to nail down crucial factors involved in AL and LP. The network will formulate research programmes, disseminate information between post-graduate schools and programmes, joint numerical tools and measurement techniques as well as new joint educational programmes. Deliverables are regular seminars, Summer Schools, joint publications, Short-Term Scientific Missions, guidelines and SOPs. In addition, LoNNe will improve parameters for the lighting industry, which until now relate exclusively to energy and luminous efficiency.

WG 2: Assembling existing data concerning AL and LP

The objective of this Working Group is to establish a common database in which AL and LP data regarding for example thresholds effects, lighting installations worldwide and spectral characteristics of lighting technology, as well as monitoring data can be entered and archived as a prerequisite for the assessment of the mid- and long-term development of LP. The Working Group assembles data (i) for synthesis pertaining to the impact of AL, (ii) for developing criteria regarding the definition of LP, and (iii) for developing mitigation strategies. These activities take account of existing databases and analysis tools. The database will be implemented into the COST Action's website extending the four years period of the COST Action. In addition, the data base will include a transdisciplinary bibliographic database, data mediated reviews, and protocols to mitigate negative impacts of AL.

WG 3: Quantifying the economic value of nights with near-natural light conditions

This Working Group contributes constructively to the development of recreation, health, and dark-sky tourism. The task is especially designated for regions that lack economic infrastructure. The work package aims to assemble interdisciplinary data for economic assessment of dark areas (chronobiology/medicine, ecology, epidemiology, social science) and to review concepts for recreation, health, and dark-sky tourism. Deliverables are e.g. a review of development concepts for dark-sky areas.

WG 4: Dissemination of research results to raise awareness of the consequences of LP

The objective of this Working Group is to communicate research results. This interdisciplinary Working Group will emphasise in particular

(i) raising public awareness of the consequences of LP
(ii) technological implementation by the industry
(iii) implementation in use to municipalities and regions and
(iv) academics of various disciplines.

Deliverables are e.g. teaching modules as a result of Summer Schools and training seminars, open lectures for the interested public, organisation of session at international conferences, scientific data in creating brochures, a comprehensive publication on AL and LP, and other information media such as press releases, interviews with radio and TV stations, and co-operation with documentary makers.

E. ORGANISATION

E.1 Coordination and organisation

The COST Action organisation is defined by four technical Working Groups (WG), one Management Committee (MC), and one Steering Committee (SC). This results in a flexible framework to which new partners can easily be added. The structure of this Action follows the recommendations contained in the Rules of Procedure document. Interdisciplinary research and enhanced collaboration will be augmented by Summer Schools and training seminars for Early Stage Researchers and stakeholder on a regular basis, in order to increase research capacity. Since it is important to have a close personal relationship within the coordination activities, staff, especially Early Stage Researchers, will visit research groups on Short-Term Scientific Missions to exchange information, demonstrate new potential techniques, and to avoid duplication of projects and initiatives. Visit reports will be made available to all participants. LoNNe aims to monitor and evaluate activities and achievements against the project plan and the objectives at two levels: within the WGs by WG Leaders and Co-Leaders, and by the Steering Committee (SC).

Management Committee (MC): The MC will be appointed to supervise and manage the key issues of the Action. It will consist of two MC members (delegates or substitutes) per participating COST country, including the Working Group Leader and the Co-Leader of each WG. A Chair and a Vice-Chair will be elected by the MC at the Kick-off Meeting. The Grant Holder will be appointed at the Kick-off Meeting. The MC is going to meet once a year for the duration of the Action and will remain in close contact. The MC will be responsible for the management and coordination of the Action, the supervision of the four WGs, and for decisions regarding activities. The MC will ensure smooth operation of the individual Working Groups and arrange timely cross-fertilisation between the various groups. Furthermore, the MC will encourage exchange visits of experts and Early Stage Researchers and stimulate the initiation of new research projects (FP, national and regional research programmes) in the field of LP and the mobility of researchers, especially between academia and industry.

Working Groups (WG): Each WG is managed by a WG Leader and a Co-Leader who are going to be elected by the MC during its first meeting. The WGs will be responsible for the scientific program of the Action and their composition can be revised during the Action. WG Leader and Co-Leaders are responsible for the coordination, organization and supervision of their WG meetings. The composition of the WGs is aimed to be interdisciplinary and balanced by target groups.

Steering Committee (SC): Together with the Chair and Vice-Chair of the MC, WG Leader and Co-Leaders form the SC. The SC will evaluate the WG reports and is responsible for monitoring the progress of the Action. Under the instruction of the MC, the SC will supervise the management and evaluation of the Action. The SC will meet once a year and will produce yearly progress reports.

Milestones

The following milestones will be achieved during this Action:

- Creation of a LoNNe website as a platform for information and communication among Action participants, interested scientists, the industry, as well as the general public (year 1)
- Publication of guidelines and SOPs to study AL and LP (year 2 - 4)
- Publication of efforts for integrative research on AL and LP in Europe (year 2)
- Establishment of a database and implementation on the website in a password protected area (year 1)
- Two workshops per each WG (per year)
- Four Short-Term Scientific Missions (per year)
- International conferences (year 2 and 4)
- Summer Schools (year 2 and 4)
- Yearly training seminars for stakeholder and ESR
- Yearly intercomparison campaign of lightmeters

• Maps of measured and modelled light pollution (year 2 and 4)
• A comprehensive publication (e.g. a book) which will include the outcomings of the COST Action with conclusions (year 4)
• Development of a monitoring system (year 4)
• Integrative research proposals submitted by members of LoNNe (year 3 and 4)

E.2 Working Groups

The tasks and the scientific programme of the Working Groups have been described in detail in section D. Each Working Group is constituted by different teams, but particular teams can be involved in more than one WG. WGs meet twice a year. One yearly meeting of all WGs will take place at the annual workshop of the COST Action. The other yearly WG meetings will preferable be held at other events e.g. at the biannual Professional Lighting Design Convention. The participants of each WG will communicate via conference-calls and web-based interfaces on a regular basis. All four WGs will be inter-related and will be linked by the MC. WG 1 will be closely connected to WG 2, establishing guidelines and tools. Especially the identification and the support of technological innovations such as intelligent lighting control systems and technologies that will help to regulate the use, quantity and quality of AL and to reduce LP (e.g. the establishment of local LP alarm systems) will be an emergent output of active interaction between WG 1 and WG 2. WGs 1, 3 and 4 will support WG 2 in the in the design of the database and the implementation of WG-specific information. WGs 1-3 will support WG 4 in the dissemination of research results and to raise awareness of the consequences of LP and potential corrective measures.

E.3 Liaison and interaction with other research programmes

To this date, a holistic research approach to the aspects of LoNNE has not been implemented under any EU programme. Therefore, one goal is to prepare the grounds for LoNNe research to become part of the Specific Programme Part III "Societal Challenges" under Horizon 2020 - The Framework Programme for Research and Innovation.

An interaction with the following projects funded under FP 7 and other programmes may be conceivable: COELUX (FP7, Research for SMEs), ECOLIGHT (FP7, ERC AdG) or projects funded under the LIFE+ Programme such as URBAN LIGHT PLAN, a regional project to reduce greenhouse gas emissions, and Life at Night, a project to draw up technical guidelines for energy-efficient and environmentally friendly illumination of cultural heritage sites. Furthermore, contacts may be established to EUREKA project 3456 E3L "Embedded LED Landing Light". These interactions will be organised by exchange of information, invitations to meetings and by joint seminars. In addition, combining legacy and knowledge of COST-529 with LoNNe will lead to an almost global system description that has never accomplished up do day worldwide.

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

A selection committee will be established to attract females and ESRs to reach balance by gender and age. In addition, LoNNe aims at a balanced leadership (gender, age), i.e. putting female scientists and ESRs in roles where they can be active (e.g. WG, MC, selection committee). LoNNe will encourage female students to scientific work in this field and the researcher training aims to promote the equality of men and women in education and in the academic world. LoNNe aims at a cross-mentoring system in which experienced scientists offer scientific advice and career guidance support to ESRs. This can be combined with STSMs. An early ESR network will be stimulated within the Action as a “think tank”. Each year one of the workshops of the Action would involve ESRs from different COST countries to strengthen links with each other and with experienced scientists involved in the management of the Action. In addition, the communication among ESRs will be promoted by means of dissemination events and dedicated discussions on the website of the Action. Finally, ESRs will be encouraged to attend Summer Schools and transdisciplinary training seminars.

F. TIMETABLE

The Action is scheduled for a four year period. In the first year the goals and activities of the WGs will be set up with particular attention to the development of an effective program of Short Time Scientific Missions (STSMs) for Early Stage Researchers. The state of the art concerning AL and LP, the collection of data and development of research alliances and networks will be the main activities to be carried out within the first year. In addition, the network initially involved in the preparation of the Action will be enlarged. The scientific tasks concerning relationship between AL and LP, and answering the question of what characteristics of light (e.g. light intensity, direction, distribution, spectrum, exposure duration) disrupt human health and ecological systems, as well as proper monitoring of LP will be carried out during years 2 and 3. The creation of SOPs and guidelines, the identification of sustainable and innovative lighting technologies and the transfer of knowledge to likely end-users will be mainly carried out during the fourth year. During the total duration of the Action LoNNe will produce a wide spectrum of publications for customers, scientists and the general public.

The M C will meet once a year while WGs meet twice a year, one time on their own and another time in conjunction with the annual workshop which will involve all WGs. Annual workshops, MC meetings and SC meetings will be combined.

	Year 1		Year 2		Year 3		Year 4	
Kick-off Meeting	X							
Annual workshop		X		X		X		X
Website set-up	X							
Training seminar		X		X		X		X
Summer School			X				X	
MC meeting	X	X		X		X		X
SC meeting	X	X		X		X		X
WG 1-4 meeting	X	X	X	X	X	X	X	X
Scientific Conference				X				
Final Conference								X

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, DE, ES, FI, FR, IL, NL, SI, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 36 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?

WG 4 together with the MC will define a flexible dissemination strategy for the needs of the different target audiences through a wide range of highly adaptable communication channels whereas working towards the Action objectives. Target groups are expected to evolve with the Action development. Because of the direct societal impact of LoNNe, the dissemination strategy will cover almost all sectors of society. The expected impact is not confined to European boundaries, but is expected to be of global significance. The main target audience for dissemination will be:

- Experienced and Early-Stage Researchers of various involved disciplines (ecology, health science, cultural science, social science, economics, astronomy, atmospheric science, illuminating engineering, architecture, etc.),
- Representatives from the lighting industry for knowledge transfer, development and technological implementation,
- EU authorities and public authorities from municipalities and regions for implementation in use,
- Standardisation organisations at national and supra-national levels,
- Light designers, regional planners, and architects,
- Health professionals,
- EU research programmes,
- Economists and independent consultants, and
- The interested general public including media (scientific and non-scientific press, digital media, TV and radio).

H.2 What?

In order to spread the results of the Action a wide range of digital, printed and oral communication tools will be used.

Digital:

- A dedicated website in which general information regarding the development of the Action will be available in a well-structured manner. The website will be composed out of two parts: a private, password-protected area and a public part. The private part will contain a number of discussion forums, one for each WG activity, for the members of the Action. In addition, technical papers and all working documents will be shared within that area. The public part will be used to link the Action with national and on-going European research projects, to attract participants to the events organised by the Action, to inform the academia and industry end-users about the final achievements of the Action in terms of new standards, and to implement public surveys and citizen science activities as input for certain Action topics. The public part will also contain technical literature concerning AL and LP as well as press releases. This freely available information will be used by the target audience to better understand the final achievements of the Action.
- Digital documents produced by the Working Groups during the Action: At the end of each WG meeting a final report will be produced summarizing the findings achieved. The reports will favour the contributions of the partners to peer reviewed journals;
- A transdisciplinary bibliographic database and data mediated reviews;
- Set up of electronic communication networks (e.g. e-mail network, Facebook, Twitter);

Print (most printed products will be also available at the homepage):

- Articles in peer-reviewed scientific and technical journals (preferably open access journals);
- Publications: state of the art reports, interim reports, case study reports, protocols, proceedings, guidelines, manuals, final reports;
- A comprehensive publication (e.g. a book) concerning AL and LP geared at the general public in year 4;
- Maps of light pollution;

Oral:

- Open workshops at the two conferences
- Participation to relevant industrial association meetings and working groups;
- Structured sessions within international conferences including panel discussions and inviting journalists and a concluding dedicated conference. The structured sessions will be organized with the results achieved during the Action;
- Summer Schools and training seminars. The training seminars will be organised for a wider academic and industrial audience and for ESR and will offer the possibility to attract potential new contributors to the Action;

H.3 How?

Since one main objective is to initiate dialogue regarding light pollution with the whole range of concerned and involved stakeholders dissemination will go beyond the publication of results. Thus, LoNNe aims to interact with stakeholders to ensure widespread recognition.

- LoNNe will actively participate in citizen science activities such as Globe at Night, an international citizen-science campaign to raise public awareness of the impact of light pollution by inviting citizen-scientists to measure their night sky brightness and submit their observations to a website from a computer or smart phone.

- At open workshops during the two conferences mixed discussion groups with scientist and stakeholders will be organised.
- LoNNe aims to organise scientific sessions, including panel discussions at international conferences and inviting journalists for further dissemination of the outcomes.
- Original research articles are going to be published in peer-reviewed scientific journals; preferably in open access journals that are available to the public.
- An interactive Action website will serve as an important dissemination tool to publish the results of the scientific efforts of participating members, reports about the course of the Action as well as major results of the Action (guidelines, SOPs). The website will be established and updated on a regular basis, where the general information of the Action, the aims and planned activities will be posted.
- In order to reach the general public, press releases for newsletters and popular media will be published on the website.
- In addition, a wide range of electronic communication networks (e.g. e-mail network, Facebook, Twitter, etc.) will be used to interact with the general public.

The dissemination of information will be developed gradually in the course of the Action. During all Action activities (MC, WG meetings, annual workshops of the Action, etc.), the network members will upload Action results on the website and open the information to the larger public. In order to ensure the widest possible participation in the network, a call encouraging interested investigators to join the Action will be posted. . In particular WG 2 and 4 will perform the tasks of updating the website, collecting the reports, and organising the dissemination events. The coordinator of the WG 4 will be a mediator between the MC and the various WGs concerning the dissemination tasks. The WG 4 leader will check the efficiency of the dissemination events by means of questionnaires and specific indicators.