Task Definition Phase

IEA-SHC Task 50: “Advanced Lighting Solutions for Retrofitting Buildings”

Draft Workplan

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This workplan text was prepared by
Jan de Boer (Fraunhofer IBP, Germany)

DRAFT

With Support of
Marie-Claude Dubois (Lund University, Sweden), Marc Fontoynont (SBI, Denmark), Jérôme Kämpf (EPFL, Switzerland), Martine Knoop (TUB, Germany) and many other many participants.

Content

1. Task Description

1.1 Background

1.1.1 Lighting, Energy & C02 Emissions

Lighting accounts for approximately 19%, i.e. 2900 TWH, of the global electric energy consumption. Projections[1] by the IEA show that if governments only rely on current policies, global electricity use for lighting will grow to around 4250 TWh by 2030, an increase of more than 40%. Due to the world's growing population and the increasing demand for electrically driven services in emerging economies the increase will occur despite constant improvements in energy efficiency of lighting systems. One recent study[2] indicated that investments in energy - efficient lighting is one of the most cost-effective ways to reduce CO2 emissions.

Research and developments in the field of energy efficient lighting techniques encompassing daylighting, electric lighting and lighting controls combined with activities employing and bringing these techniques to the market can contribute significantly to reduce worldwide electricity consumptions and C02 emissions. These activities will therefore be in line with several different governmental energy efficiency and sustainability targets.

1.1.2 Potentials and barriers in lighting retrofits

With a small volume of new building constructions in the developed countries, major lighting energy savings potentials can only be realized by retrofitting the building stock. In emerging economies already several quite young buildings need to be retrofitted. As for Germany, for instance, roughly 75% of the lighting installations are considered outdated (older than 25 years) with respect to energy and lighting quality[3], i.e. not complying with nowadays lighting recommendations for mainly high value knowledge workplaces. Recent inventory of existing offices, schools, and health facilities show approximately the same in other countries as for instance Sweden (Swedish Energy Agency, 2010)[4] . The net energy demand of an old office lighting appliance can for instance easily be reduced to less than a third by employing state-of-the-art daylighting (façade) technology, electric lighting and controls – most often going along with higher lighting quality. Recent case studies proof these potentials. In a recent exemplary study a measured consumption of 60 kWh/m²a for lighting in an open floor office could be lowered to as little as 8 kWh/m²a after retrofit. In a classroom the consumption was reduced from 11 kWh/m²a before renovation to 3 kWh/m²a after retrofitting. With new roof lights for instance retail stores like supermarkets can drastically cut down electricity costs for their buildings formerly completely lit with electric lighting. These efforts very often coincide with moderate payback times often being more economical than a lot of other well-known retrofit approaches in the building sector.

[1] From LIGHT'SLABOUR'S LOST, Policies for Energy-efficient Lighting, IEA, 2006.
[2] P.-A. Enkvist, T. Nauclér, J. Rosander, A cost curve for greenhouse gas reduction: A global study of size and cost of measures to reduce greenhouse gas emissions yields important insights for businesses and policy makers, McKinsey Quarterly: the online journal of McKinsey & Co 1 (2007).
[3] ZVEI, Zentral Verband Elektrotechnik- und Elektronikindustrie, Fachverband Licht, 2012
[4] Statens energimyndighetenen, Energi i våra lokaler: Resultat från Energimyndighetens STIL2-projekt, Delrapport från Energimyndighetens projekt Förbättrad energistatistik i samhället, 2010, www.energimyndigheten.se/stil2, last accessed 27 January 2011.

General retrofit rates of the building stock are currently still low. In Europe they are at only around 1%, anticipated to be of similar magnitude in other countries. In general lighting the rates are with an approximate average of 3% higher[5], but still way behind what is economically as well as technically possible and feasible. Reasons for this shortfall include:

- *Lack of awareness of potentials:* Often little knowledge about lighting technology, system interaction, benefits of daylighting, and feasible economic potential is found in practice.

- *A confusing variety of retrofit solutions for lighting systems:* Choices out of a huge diversity of façade (sun protection, daylight utilization) solutions have to be made by designers and building owners. The same holds true for the electric lighting market, where the complexity of choices is currently rather increasing than decreasing due to new LED products.

- *Missing proven evidence on the saving potential of sound design solutions using new emerging technologies:* For instance in the young market of solid state lighting (SSL) misleading information on LED capabilities is being spread. This often results in mal investments and non-sustainable designs. Already existing results on the energy-efficiency performance of advanced façade systems and controls have not yet been communicated properly. In some parts additional research is necessary.

- *Partly lacking technical and constructive solutions:* How to solve for instance the conflict of strong insulations enlarging e.g. window fins and lowering daylight penetration needs to be clarified in the future. Low budget concepts boosting efficiency are for instance partly missing.

- *Missing of integrated rating methods on lighting energy and operational costs:* Due to this little or no understanding of investments necessary to allocate potentials and economic benefits by reduced energy costs and reduced maintenance/operation costs is a wide spread problem.

- *Lack of incentives:* In many countries a not yet sufficient support by authorities (e.g. regulations on exchange of outdated installations, incentive programs) is to be diagnosed. Focus in the field of energy efficient retrofitting up to now has often been on the building insulation and HVAC Systems. Lighting is not yet in the clear focus of policy makers.

1.1.3 Facade and Electric lighting market

Two main market sectors are relevant for this task: The electric lighting market and the façade market. The worldwide lighting market currently has a turnover of around 48 Billion € (2012). The overall market is forecasted to grow to more than 80 Billion € by 2020. Major lighting companies estimate the lighting retrofit potential at around 50 % of their turnover in the coming years. Retrofitting thus goes along with significant job development potential. The façade / window industry with currently around 40 % retrofit portion of the annual turnover for instance in Europe is

[5] Rates in fashion driven shop lighting are more, rates in domains like office and industry lighting are less favourable

in a comparable situation. In the following the market is briefly described according to technology including current R&D activities, business models, relevant stakeholders and international specifics.

Façade and Daylighting Technology

Also the façade market has grown significantly worldwide in the last decades. Innovations over the last decades took place in the glazing as well as in the sun shading sector. As for glazing, the thermal properties were significantly improved by coating techniques and multilayer glazing systems. 3 pane glazing systems are nowadays becoming the standard in numerous countries. This nevertheless reduced light transmission. For sun protection glazing nowadays matched coatings show LSG (light-to-solar-gains) close to 2, therefore offering sun protection at still good daylight supply. Especially the nineties saw the development of diverse advanced (complex) fenestration systems promising good sun protection and good daylight supply at a time. From the big variety of developed systems, only a few had lasting impact in the market, partly due to functional drawbacks, mainly due to economic reasons. With new plants being currently constructed the market sees efforts by main manufacturers to introduce electro-chromic glazing on larger scales. Another trend is the integration of active solar gain systems (photovoltaic as well as thermal collectors) directly into the façade. These approaches closely have to be matched with the needs for a sufficient daylight supply in the indoor spaces adjacent to the façade. The architectural trend of full glazed facades is generally still persistent.

Aiming especially at the retrofitting sector, special replacement techniques are being developed[6], allowing benefiting from high levels of prefabrication and minimal disturbance of occupants during retrofit.

Façade controls can nowadays be closely integrated into the building systems. Available functionalities are for instance cut-off controls, trying to find a good compromise between solar protection and daylight supply. More advanced solutions allow shading controls according to sun and shading patterns on the façade. In parts sun shading manufacturers offer these systems, in parts specialized companies are competing in the market.

On the R&D side promising developments can be seen in integrating sun shading, glare protection and light redirecting functionality into the glazing layer. Nanostructured mirror systems as venetian blinds and new micro optical light guiding components are approaching test stage. Also, the future will most probably bring OLED based glazing systems, allowing daylight to penetrate and adding on electric lighting in times of insufficient natural illumination. This reflects that a high level of innovation is to be expected in the future in the sector of smart windows. Lighting controls schemes based on auto adaptive, approaches (integrating user acceptance and energy efficiency) or CCD camera driven façade controls will add to this. It is expected that during this activity some of the products currently under development will become relevant for the market.

Electric Lighting Technology

As for electric lighting, the market has seen a continuous technological evolution in the field of classical lighting technology (fluorescent and high pressure lamps) over the last decades. This

[6] EnEffStadt: „Von der Militärbrache zur Nullenergiestadt", BMWI gefördertes Projekt

resulted in electronic ballasts with lower losses, more efficient, better quality lamps and luminaires, and better working light control gear. The implications are such, that the installed power of a standard state of the art system is generally less than a third compared to a system installed in the mid-1980s. By the induced energy savings and competitive product prices, these techniques in principle can nowadays provide a sound and economic solution for many relighting tasks.

On mid-term level LED technology will become the dominant light source in the retrofit market. LED based lighting systems are forecasted to have a market share of around 60 % in 2020 (50 out of 83 billion €). The SSL market sector in itself separates into new LED based luminaires and LED retrofit products. Both are obviously relevant for retrofits. In this young market sector, it is crucial to carefully distinguish qualities of products and solutions. Critical approaches (e.g. problem of tubular LEDs, technically and economically currently highly questionable to replace fluorescent lamps) are to be addressed. LED technology requests a different understanding of lighting economics as solutions request higher initial invests. On the other hand, they show significant higher lifetime with lower maintenance costs. The higher energy efficiencies will in addition reduce operating costs. Therefore total cost of ownerships ratings will become much more relevant in the future. LEDs in general will have a strong impact on manufacturer business models as the market for lamp replacements will drastically decrease.

With Organic LEDs (OLEDs) another promising new light source technology is in the R&D pipelines. Nevertheless as OLED technology for general lighting is still in an early stage (supposed 5-10 years behind LEDs) it will most probably not become relevant for the scope of this activity.

Business models, development of services

As technology and hereby products (for instance long lasting SSL products) are changing, business models in the market are adapted as well. Stronger integrated value chains and distribution of whole optimized solutions including services are new strategic approaches. This is accompanied by investment approaches like light contracting.

Stakeholders

Understanding the main stakeholders in the lighting retrofit market and their interaction, as depicted in Figure 1, is crucial to influence decision processes, therefore answering the key questions: Retrofit an existing lighting installation at all? And if, how? The role of the key stakeholders in lighting retrofits is briefly addressed in the following:

- *Authorities like governments and municipalities:* The lighting market in the building sector nowadays sees several interferences by authorities. Efficient technical solutions and their implementation are in the focus to meet efficiency and sustainability targets like the worldwide transition of energy systems and CO_2 reduction. This applies to the public and private building stock alike. Instruments are regulations, incentive programs allocating private investments, information and research activities and certifications. On the regulation side for instance, the European commission addresses lighting efficiency on component level (e.g. eco design 244/2009 and 245/2009) and on system level (e.g. EPBP). Standards like EN 15193-1 are used as vehicle to enforce regulations. Incentives are generally intended to foster the implementation of efficient technologies. Nevertheless activities of authorities for lighting are not yet comparable to activities regarding thermal building retrofits and retrofits in the HVAC sector. Both regulations and incentives like loan programs could be designed more efficient in order to increase lighting retrofit rates (e.g. building stock analysis generally missing). Lighting is in addition part of mainly market or NGO driven certification systems (LEED, DGNB, …) with retrofitting to be still addressed stronger.

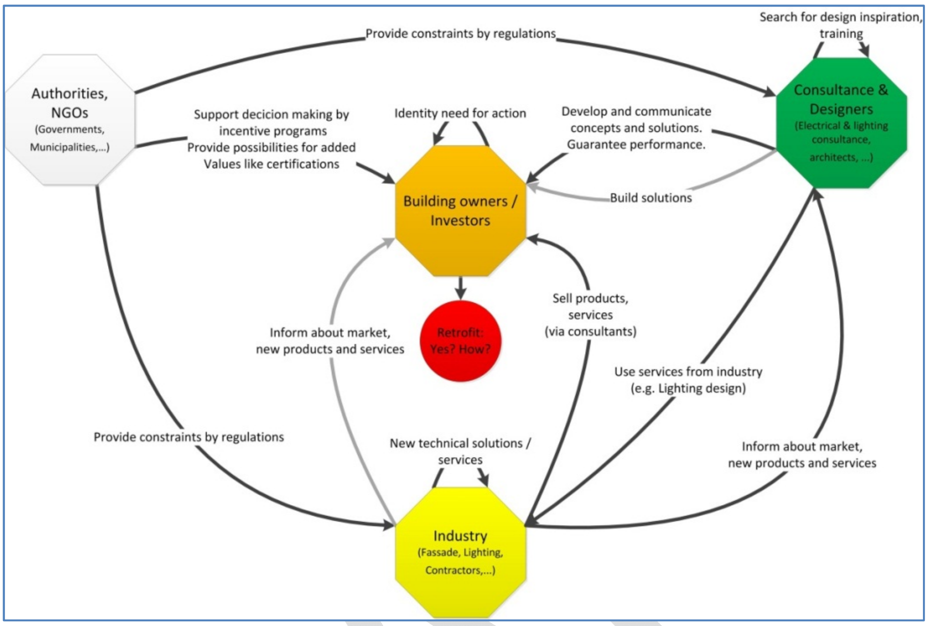


Figure 1: Stake holders in the lighting market and key interactions

- *Building owners / Investors:* Generally in focus should be the optimization of the total cost of ownerships of lighting appliances. Looking at the market from the investment horizons electric lighting and façade measures are to be considered different: electric lighting midterm (15-25 years) to short-term (5 years in stores for instance); façade rather long-term > 25 years. For electric lighting quick to moderate payback times can be achieved, whereas these are generally longer for daylight related measures. This has impacts on economic decisions and on the design process, thus underlining that for facades an appropriate, sustainable design is of especially high importance.
  For many companies energy efficiency has become a topic nowadays seriously addressed. Some owners / investors are aligning their building stock with an associated favourable corporate “green” image. Especially for companies where lighting plays an immanent role energy efficient lighting has become part of the corporate identity, specifically the corporate lighting strategy (e.g. retail sector).

- *Industry:* The obvious focus lies in optimizing sells by adapting products and services according to market figures, identified market barriers and opportunities, developed retrofit strategies, and evolving new technologies. As already addressed business models are currently being adapted into the direction of lighting services, instead of relying solely on selling of singular products, not being part of integrated solutions.

- *Consultants and designers (Architects, engineers):* Consultants and designers play a key role in decision making from the early design phase on. They develop and communicate concepts and solutions and are obliged to proof / guarantee performance for owners and investors. In many ways they have to be understood as information brokers. A good state of the art overview on as well technological, economic and legislative issues of lighting retrofits is therefore essential. They are in need to get design inspirations, to employ appropriate technologies, to obtain energy related and economic design parameters, to benefit from tailored design tools and to be informed about legislative boundary conditions.
  Practically they have to deal with the diversity of approaches in the lighting retrofit market as a function of building typology to which they have to react with distinguished approaches. Moreover consultants have to master, that lighting design (especially daylighting via the façade) is part of a multi-criteria process incorporating e.g. thermal façade behaviour. Unlike electric lighting, many more players are involved in façade design process. Thus decisions are seldom based solely on daylighting issues alone. Lighting not a single issue topic, but part of complex design process.

<u>International diversity, other factors in the market</u>

Lighting retrofit activities depend on electricity prices. These show big deviations worldwide and also between participating countries in this activity. For instance lighting has different climatic implications according to the energy mix. Different levels of product complexity and prices needed for different markets. These local specifics therefore have to be addressed in an overarching international project.

1.1.4 Relation to other IEA activities

IEA- SHC Task 21 / ECBCS Annex 29 “Daylight in Buildings”, IEA-SHC 31 “Daylighting Buildings in the 21st Century”: The activity will build on and use the outcomes related to façade technology, lighting controls and software. The proposed Task will set these items – with a clear focus on retrofits - into a broader scope with aspects concerning electric lighting. Here the activity in parts can build on IEA-ECBCS Annex 45 “Energy Efficient Electric Lighting for buildings”. Key findings and results nevertheless here have to be adapted to the fast developing market of solid state lighting. In addition the work relates to IEA-SHC Task 47 “Solar Renovation of Non-Residential Buildings”. General approaches to the overall building developed here might be of high value. Task 47 includes lighting as one part of integral retrofitting strategies, but does not cover lighting strategies in depth.

As IEA-SHC Task 46 “Solar Resource Assessment and Forecasting” develops models for outside solar resources, this might affect the prediction of daylight in the models to be developed.

The IEA SHC Daylighting Research Group was inactive in the last few years and does virtually not exist.

1.2 Why an IEA project

The International Energy Agency offers an ideal platform for international collaborative R&D work. Several added values can be identified in a collaborative, international project compared to national activities. Participating countries take profit from the specific know-how of each of the other participants (such as study of the international state-of-the-art has to be done only once). Tools such as design or simulation programs may be similar for application in different regions. An international project may be capable to bring together technology suppliers from different countries with new markets. Overall, the net profit for every participating country seems to be significantly higher compared to national activities with a similar level of effort.

1.3 Scope

The scope of the Task is on general lighting systems for indoor environments. The focus is laid on lighting appliances in non-domestic buildings. Technically the task deals with

- daylight utilization by better facade technologies and architectural solutions,
- electric Lighting schemes addressing technology and design strategies,
- lighting control systems and strategies

alike. The task targets building owners (investors), authorities, industry and consultants by providing strategic, technical and economic information and with this helping these stakeholders overcome barriers in retrofitting of lighting installations.

1.4 Objectives

The overall objective of this activity is to accelerate retrofitting of daylighting and electric lighting solutions in the non-domestic sector using cost - effective, best practice – approaches, which can be used on a wide range of typical existing buildings. This can be subdivided into the following specific objectives:

- Develop a sound view of the lighting retrofit market.
- Trigger discussion, initiate revision and enhancement of local and national regulations, certifications and loan programs.
- Increase robustness of daylight and electric lighting retrofit approaches technically, ecologically and economically.
- Increase understanding of lighting retrofit processes by providing adequate tools for different stakeholders.
- Demonstrate state of the art lighting retrofits.
- Develop as a joint activity an electronic interactive source book including design inspirations, design advice, decision tools and design tools relying on the results of the different task activities.

1.5 Outcome for different target groups

The envisaged results will enable

- *building owners* (public and private sector) to benchmark and compare their buildings, to get cost indications and hereby prepare and initiate retrofit decisions;

- *authorities* to initiate and / or improve
    - regulations,
    - incentive programs (loan, tax liability based incentives, …)
    - certification procedures

  based on for instance detailed data on the building stock with its typical lighting configurations and related energy efficiency and monetary potentials;

- *designers and consultants* to get validated design solutions, to obtain energy efficiency and economic design parameters, to employ appropriate technologies and to benefit from tailored design tools;

- *lighting and façade industry* to adapt products and services according to market figures, identified market barriers and opportunities, developed retrofit strategies (documented field results of system performance) , and evolving new technologies.

1.6 Task structure

Figure 2 shows the structure of the Task. The four different subtasks generate the key results. These results are then integrated in a joint working group in the “Lighting Retrofit Adviser”. According to the individual focus of interest the “Lighting Retrofit Adviser” will provide design inspirations, design advice, decision and design tools tailored to the need of the different stakeholders.

Figure 2: Task structure

1.6.1 Subtask A: Market and Policies

Lead Country: Denmark, (Marc Fontoynont, SBI-Aalborg University)

This subtask will identify the various possible approaches of retrofitting daylighting systems and lighting installations in buildings. It proposes to provide key figures concerning costs (Total Cost of

Ownership) and identify barriers and opportunities concerning lighting retrofit actions. Beyond costs, barriers could be related to inertia of stakeholders, poor habits or lack of knowledge. Opportunities may go beyond reduction of costs, reduction of energy requirements and may relate to added benefits for investors, building owners, building managers and occupants.

The work of Subtask A will be structured into four project areas:

A.1. Global, economic models

We will propose techno-economical costs models for various types of buildings (offices, schools, home). This will include the assessment Total Cost of Ownership (TCO) of lighting. It will be compared to TCO data on the whole building. We will then identify possible new models for costs and performance associated to the new generation of lightings schemes, with higher luminous efficacy, longer life.

Objectives

- To understand, and model, the financial and energy impact associated to retrofitting daylighting and electric lighting of buildings.

Results

- A comparative assessment of TCO of various lighting scenarios (Daylighting and electrical lighting)
- A model for estimating cost and energy benefits of lighting retrofit
- Production of strategic information for strategic decision

Activities

- Collect data, compare retrofit schemes, assess performance, propose model.
- Collect information on barriers and opportunities.

Milestones

- Collection of data on costs (TCO) 2013
- Propose models for comparison of schemes 2014

A.2. Barriers and benefits

In this section, we will try to approach the issue of lighting retrofits in a more holistic way. This means that there are many other aspects beyond lighting to take into account, based on current practice. We will collect evidence on existing reasons for conducting lighting retrofit today, which may not be solely related to improvement of lighting performance (there are other benefits). We will also identify various barriers which lead to postponement of lighting retrofits, even when they are needed and cost effective.

This will lead to identify the possible perimeter of actions dealing with retrofitting: typical budgets for investments, typical payback period, also relation between the expected performance and the acceptable costs.

Objectives

- To map the context of retrofit of building, identifying barriers and opportunities, even if they are not directly related to lighting issues

Results

- An identification of barriers and opportunities for lighting retrofit, beyond lighting
- An identification of typical budgets being allocated, or which could be allocated

Activities

- Collect information and evidence on barriers and opportunities.

Milestones

– Data on barriers and opportunities	2013
– Budget issues for retrofit	2014

A.3. Building energy regulation and certification

The normative context of the building concerning energy performance suggests performance indices for lighting installations. Such specifications are not always coherent, and consistent with other aspects. For instance, facade windows dimension and technologies are directly or indirectly suggested, but optimal performance (daylighting , heat gains, heat losses) cannot always be achieved in respecting codes).

We will therefore conduct a critical analysis of regulation and certification documents. We will identify some incoherence in these documents, and identify also opportunities. We will propose some adjustment of these reference documents.

Objectives

- To provide a critical analysis of documents used for energy regulation and certification
- To make proposals for adjustments

Results

- Benchmarking of documents (regulations, building certification)
- Proposal for adjustment of texts in the documents.

Activities

- Collect information on the way lighting retrofit is integrated in documents used for regulation and certification.
- Provide comparison
- Make proposals.

Milestones

– Collect information on the way lighting retrofit is integrated in documents used for regulation and certification.	2013
– Provide comparison	2014
– Make proposals.	2015

A.4. Proposals of action concerning the value chain

We will identify possible actions which could be taken to stimulate the development of lighting retrofit campaigns, based on the figures from section A.1, the barriers and opportunities from A.2. and the normative context (A.3).

We will identify how lighting retrofit benefits are assessed by stakeholders (manufacturers, installers, building managers, etc.). We will identify the key strategic actions, or key strategic data to deliver to each stakeholder to possibly trigger a decision concerning lighting retrofit.

Objectives

- To identify possible lack of awareness and know-how in the value chain
- To identify strategic information to deliver to stakeholders

Results

- Recording of information from stakeholders
- Proposal of actions

Activities

- Collect information through survey of stakeholders
- Make proposals of actions.

Milestones

– Recording of information from stakeholders	2014
– Proposal of actions	2015

Relation to other subtasks

- Building market data and typology (D2)
- Example of solutions with performances (B)
- Supply data and model to Lighting Retrofit Adviser (JWG)

Effort for subtask

Estimated effort is 3 person-month per participant (country) and 9 person-months (3 month per year) for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the task.

1.6.2 Subtask B: Daylighting and Electric Lighting Solutions

Lead Country: Germany (Martine Knoop, TUB)

This Subtask will deal with the quality assessment of existing and new solutions in the field of façade and daylighting technology, electric lighting and lighting controls. For replacement solutions the subtask will identify and structure existing and develop new lighting system technologies.

The work of Subtask B will be structured into six project areas:

B.1 Definition - system characterisation

Evaluation criteria and quality measures for daylighting and façade technology, electric lighting solutions and lighting controls are summarized and defined, to allow comparison of solutions. The evaluation criteria will cover human factors related aspects, such as visual comfort, and ergonomics, as well as aspects from an environmental and economic point of view, including ecological, energy, operational and maintenance related aspects. Of high importance is the evaluation with respect to the applicability in the retrofit process. Next to that, existing and new requirements from standards, regulations and legislation, especially with respect to LED lighting and controls (e.g. ASHRAE, IEC and Title 24), will be taken into consideration. Identification of demands will be a joint Subtask A, B, C & D effort, inducing development of new indices, criteria or measures. The catalogue of criteria will be used in Work Package B.2, B.3, B.4 and B.5.

Objective

- To provide a set of criteria to describe lighting technologies appropriate for the retrofit process

Results

- Catalogue of criteria to evaluate the performance of daylighting and façade technologies, electric lighting solutions and control systems.

Activities

- Collect quality criteria and evaluation measures from previous IEA Tasks and ECBCS Annexes
- Collect requirements from existing standards, regulations and legislation
- Define evaluation criteria reflecting the applicability of products in the retrofit process

Milestones

- Completion of the catalogue of criteria 2013
- Online catalogue of criteria (public) 2014

B.2. Definition of (regional) baseline conditions

Classification and rating of built-in existing solutions is essential for drawing the baselines for the later retrofits. By means of the evaluation criteria as defined in B.1 it is possible to assess existing daylighting, electric lighting and lighting control techniques. Typical lighting solutions, technology in old appliances, as collected within Work Package D.1 can be evaluated and rated, in order to establish a (regional) baseline.

Objective

- To provide figures as baseline to classify and rate existing, built-in lighting installations against new retrofit concepts.

Results

- Established (regional) baseline(s)

Activities

- Identify reasonable lighting techniques, by combining work of Subtask D.2 and B.1
- Establish (regional) baseline condition(s) for future evaluation

Milestones

- Defined regional baselines on a website 2014

B.3. Review of state of the art technology and architectural measures

A literature review and market analysis will be performed to get insight in the state of the art technology, looking into lighting components: daylighting systems, electric lighting solutions, lighting controls (e.g. daylight supply systems, daylight glare control). Furthermore, an overview of possible architectural measures for retrofitting (e.g. delete partitions or change window frames) will be provided. The reviews will consider a wide range of solutions, from low budget, basic solutions to advanced solutions. Within the market analysis, practical experience with these solutions will be collected, focussing on performance aspects. The reviews will show the current applicability of these solutions in different building categories. Furthermore, it will indicate what existing, state of the art; solutions have proven to work (technically “basic” solutions).

Objective

- To generate a profound state of the art overview on technology and architectural measures

Results

- A review on the state of the art of lighting technology

Activities

- A literature review and market analysis on daylighting systems, electric lighting solutions and lighting controls
- An overview of architectural measures for retrofitting buildings
- Identify state of the art commercially available lighting components
- Market analysis of state of the art commercially available lighting components, focussing on performance aspects

Milestones

– Review on state of the art lighting technology	2014
– Review on architectural measures	2014
– Reviews available on a website	2015

B.4 New technical developments

Within this Work Package, we will be looking at on-going research in the field of lighting to determine new technologies which are worth looking into, such as Advanced Fenestration Systems, LED solutions, and innovative lighting control algorithms, considering (technology) roadmaps as well as the work done within the Subtask B3. Within this Work Package selected new lighting technologies will also be developed. The solutions will be compared with the set of benchmarks, the (regional) baseline conditions and amongst each other.

Objective

- To generate an overview on emerging new technologies and develop selected new techniques

Results

- Evaluation of new technological developments in comparison to baseline and existing solutions.

Activities

- Identify new technologies of potential interest for retrofitting buildings
- Develop new lighting technologies of interest for retrofitting buildings (e.g. control algorithmics, fenestration systems)
- Collect information on technology roadmaps
- Evaluation of new technological solutions, based on catalogue of criteria (Subtask B.1), taking into consideration state of the art technology (B.3) and the regional baseline (B.2), using available information on technology performance
- Determine directions for lighting solutions relevant for the future

Milestones

– Investigation new technologies of interest for retrofitting buildings	2013
– Technology roadmaps available within Task	2014
– Development of new lighting technologies	2014
– Evaluation of new technological solutions	2015
– Directions for lighting solutions relevant for the future	2015

B.5 Measurements of selected state of the art technologies and new technologies

In order to evaluate state of the art technology as well as new technical developments, measurements under laboratory conditions will be carried out to assess a number of quality aspects of these solutions. This work will be linked with the work done in Subtask D3. The quality aspects, as drawn up within Subtask B.1, will define the required measurements of for example lighting, spectral and energy characteristics of daylighting systems. For new electric lighting technologies (like LED and OLED) measurements of dim and spectral characteristics need to be outlined.

<u>Objective</u>

– To generate required technical data of selected state of the art and emerging new technologies

<u>Results</u>

– Evaluation of selected state of the art technology and new technical developments under laboratory conditions

<u>Activities</u>

– Measurements of state of the art technology and new technical developments under laboratory conditions
– Evaluation of system performance under laboratory conditions based on catalogue of criteria (Subtask B.1) and regional baseline (B.2)

<u>Milestones</u>

– Completion of measurements under laboratory conditions 2015
– Evaluation of performance under laboratory conditions 2015

B.6 Source book

All knowledge and data collected within Subtask B will be published in a (Joint) source book 'Daylight and electric lighting retrofit technologies: From low budget to new advanced solutions' for world-wide-web distribution. Entries from Work Package B.1 – B.5 are foreseen.

1. Introduction
2. System characterisation
3. Regional baseline conditions
4. Review of state of the art technology and architectural solutions
5. New technical developments
6. Measurements of selected state of the art technologies and new technologies
7. Conclusions – from low budget to new advanced solutions

<u>Milestones</u>

– Source book available on a website 2015

Effort

Estimated effort is 3 person-month per year per participant (country) and 9 person-months (3 month per year) for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the task.

Deliverables

- Catalogue of criteria to evaluate the performance of daylighting and façade technologies, electric lighting solutions and control systems (Result of Work Package B.1)
- Internet site with relevant data for the public (B.1, B.2, B.3)
- (Joint) Source book to be downloadable from the internet site (B.6)

Relation to other subtasks

- Build upon building stock analysis and typology (D2)
- Supply data to Lighting Retrofit Adviser (JWG)

1.6.3 Subtask C: Methods and Tools

Lead Country: Switzerland (Jérôme Kaempf, EPFL)

Whether an intended retrofit is technically, from an energy point of view, ecologically and economically meaningful is at the moment not self-evident for the majority of stakeholders and building designers. This subtask will focus on simple computer design tools and analysis methods in order to improve the understanding of retrofit processes. This will incorporate energy and visual comfort analysis as well as the financial aspects of lighting retrofit solutions. It will also encompass advanced and future calculation methods aiming toward the optimization of lighting solutions, as well as energy auditing and inspection procedures, including lighting and energy performance assessments.

The work of Subtask C will be structured into five project areas:

C.1. Analysis of workflow and needs

Lighting retrofit strategies within existing buildings follow procedures similar to those used by designers during the first original construction of the building. Most decisions are taken accordingly at the conceptual stage, which is followed by planning and execution phases relying on technical procedures. Computer design and analysis tools play a significant role in this prospect by allowing modelling of lighting retrofit projects as well as performance evaluation and visualisation. In order to be efficient, the corresponding computer methods and tools should account for the practical workflow and practical needs of the stakeholders during renovation procedures. It requires:

- The characterization of the whole lighting retrofit process;
- The inclusion of the wishes and behaviour of the stakeholders, designers, building owners, investors;
- The inclusion of the expertise required for the renovation process;

- The acquisition of the necessary technical expertise.

Surveys and socio-professional studies carried out at national and international levels should contribute to better understand this topic. The survey will give insights about the practical workflow of practitioners, which will lead to a better understanding of the real needs in terms of computer method and tools. Further questions from ST A & B will be integrated in the survey.

Objectives

- To understand the workflows, wishes and needs with respect to tools of the stakeholders involved in a lighting retrofit process on national level by conducting and evaluating a survey

Results

- An online database containing of the results of the survey on a country-by-country basis with anonymous results.
- Documentation of the identified workflows and needs in term of computer tools.

Activities

- Identification and collection of contacts (adressees) of stakeholders involved in lighting retrofits
- Definition of an adequate set of questions for the survey in conjunction with Subtask A and B
- Preparation of on-line forms to complete the survey
- Setting-up of a Web site presenting the results of the survey
- Evaluation and documentation of the survey

Milestones

– Identification of major contacts of stakeholders	2012
– Completion of the survey	2013
– Results of survey and evaluation on web site	2014

C.2. State of the art review

Methods and tools for lighting retrofits of buildings should fulfil the needs of architects and lighting designers, which are focused on "lighting solutions"; it should also fulfil those of building services engineers, which are centred on "problem solving". Both approaches should contribute in an efficient way to:

- Support the users for the description of the lighting retrofit project;
- Allow performance assessments of alternative retrofitting solutions;
- Promote the choice of optimal retrofitting solutions;
- Use the appropriate metrics for lighting, visual comfort and energy performance assessments.

The number of simplified methods and advanced simulation tools allowing the evaluation of lighting and visual comfort metrics is currently large. Some of them can be applied both to day lighting and electric lighting allowing an integrated approach for lighting retrofit procedures. Certain methods have achieved a significant success in the building sector: ray-tracing techniques combined with daylight coefficient calculations allow the evaluation of multi annual lighting and energy performance of large buildings retrofit projects on a simple PC computer.

A state-of-the-art review of the existing simplified methods and advanced simulation tools should be carried out at the early stage of the task. "Pros and Cons" of the different approaches have to be considered in the course of the lighting retrofit process. Lighting and visual comfort assessment, as well as energy related performance, will be considered as well.

Computer software allowing an integrated approach of lighting retrofit solutions will be described and compared by the way of case studies /test cases. Benchmarks will be used to assess their facility of use as well as deliverables on the corresponding lighting retrofit projects.

<u>Objectives</u>

- To establish a list of tools and methods to assist practitioners in lighting retrofits of buildings and compare their outputs with the criteria and metrics identified in Project B.1 and ST D. This objective will be related to the different steps of the identified workflows and needs according to C.1
- To benchmark the appropriateness of tools on case studies/test cases

<u>Results</u>

- List of existing tools and their applicability (weaknesses and strength) regarding lighting retrofit workflows and procedures of buildings.
- Benchmark of the tools in case studies/test cases from STD and others.

<u>Activities</u>

- Collect information on existing tools
- Set up a scheme for comparing the features of the tools
- Determine their appropriateness on case studies / test cases

<u>Milestones</u>

- Investigation on state-of-the-art methods and tools 2012
- Results on a website 2014

C.3. Development of a simple integrated rating model

Integrated modelling procedures are necessary for architects, lighting designers and building practitioners to cope with the difficulties of using complex fenestration systems (CFS) with high performance electric lighting systems. Roadmaps fostering integrative issues in the course of the design and evaluation of daylighting and electric lighting projects should be accounted for: they will be used to achieve low energy consumption through refurbishment of existing building facades and electric lighting systems. A holistic approach, which would account for visual comfort and performance, as well as potential economic benefits of lighting retrofit solutions, is commended.

Therefore a simple tool including lighting performance, energy rating and economic performance methods will be designed and developed. The calculation scope addresses electric lighting, daylighting and controls alike, possibly including rough estimates of lighting impact on the building overall energy performance. Used computation and ratings methods shall be internationally applicable. In the development new computer tools recently being developed in this prospect will be considered.The tools shall be tested using case studies/test cases. The calculation engine shall be integrated into the lighting retrofit adviser (rf. to 1.6.5).

Objectives

- To develop a simple tool (calculation engine) for a holistic approach of potential benefits of lighting retrofit solutions to be among others to be included in the retrofit adviser.
- The simple tool should consider the performance metrics identified in C2

Results

- Descriptions of holistic method and tools for energy and economic performance estimation
- Benchmark of the holistic method and tools in case studies/test cases from STD and others
- Calculation engine for the lighting retrofit adviser

Activities

- Design a tool architecture covering the holistic approach
- Investigate the concepts of existing or emerging tools
- Development of a calculation engine
- study the appropriateness of the new tool on case studies / test cases

Milestones

– Investigation of integrated simulation tools	2013
– Calculation engine lighting retrofit adviser	2014
– Benchmark on case studies	2015

C.4. Energy Audit and Inspection Procedures

Energy audit procedures should be used in buildings before and after refurbishment to evaluate the benefits of lighting retrofit strategies. Monitoring of the daylight performance of buildings using the appropriate metrics as well as the assessment of lighting power densities and electricity consumption (energy monitoring) should be carried out in a standardized way. Long term as well as short term procedures shall be considered.

Inspection procedures should document the status of a lighting installations considering for instance the maintenance situation, electrical status, lighting quality provided (levels, glare etc.).

Objectives

- To investigate energy audit procedures in order to identify the most appropriate for lighting retrofit strategies.

Results

- Description of daylighting performance assessment methods
- Description of energy monitoring procedures for electric lighting systems
- Collection and comparison of available energy audit and inspection procedures

Activities

- Investigate existing daylighting performance assessment methods (also simple, shor term)
- Investigate energy monitoring and auditing procedures (possibly considering occupants behaviour)
- Study of their appropriateness on case studies from ST D (possibly including their correlation with the results obtained by simulation tools).

Milestones

– Investigation of daylighting performance assessment methods	2013
– Investigation of energy monitoring and auditing procedures	2014
– Benchmark on case studies	2015

C.5. Advanced and future Simulation Tools

Complex fenestration systems, composed principally of solar shadings and daylight redirection devices, can contribute to mitigating the energy consumption of buildings through reduction of thermal load and electric lighting consumption. Bidirectional light transmission properties of such systems (BTDF, Bidirectional Transmission Density Function) can be monitored using bidirectional goniophotometers.

Computer simulation programmes for the design and visualisation of complex fenestration systems located on-site (transmission of direct and diffuse daylight components) can facilitate and promote the use of CFS by architects, lighting designers and building practitioners. Software were set-up in order to achieve the same results for energy efficient light sources, such as LED sources, which require specific lighting fixtures.

Advanced simulation tools aiming at daylighting and electric lighting systems within retrofit projects will be considered as well as (future) tools under development or in planning dealing with other aspects such as decision making tools. They will be applied to several case studies of building retrofit and compared though different benchmarking exercises.

Objectives

- To establish a review of advanced simulations tools that may be used within retrofit projects for promoting complex fenestration systems and energy efficient electric lighting (such as LED).
- To list the feature of new simulation tools for different case studies and compare them to the existing tools, and ultimately give a feed-back to the tool developers.
- To advance tool development for special questions like façade design.

Results

- Website with a description and feature list of the advanced simulation tools
- Comparison of the feature list of new & existing simulation tools

Activities

- Review of existing advanced simulation tools for complex fenestration systems and optical lighting fixtures for LED light sources.
- Testing of the tools on different case studies for retrofitting buildings

Milestones

– Completion of the review of advanced simulation tools	2013
– Testing the tools on case studies	2014
– Reporting the results on the website	2015

Effort for subtask

Estimated effort is 2 person-month per year per participant (country) and 9 person-months (3 month per year) for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the task.

Deliverables

- Synthesis of workflow and needs of stakeholders regarding computer methods and tools for building lighting retrofits
- State-of-the-art review of existing computer methods and tools for lighting retrofit of buildings
- Development of a simple integrated method and computer model for lighting retrofit of buildings
- Description of available energy auditing and inspection procedures for lighting retrofit of buildings
- Description, feed-back on and development of advanced computer simulation methods for lighting retrofit of buildings

Relation to other subtasks

- Provide information on tools (,tools) for case study work (D)
- Supply workflows methods and tools to Lighting Retrofit Adviser (JWG)

1.6.4 Subtask D: Case Studies

Lead Country: Sweden (Marie-Claude Dubois, Lund University)

Case studies are essential to communicate lighting retrofit concepts to decision makers and designers. Therefore, the main aim of Subtask D is to demonstrate sound lighting retrofit solutions in a selection of representative, typical Case Studies.

The selection of Case Studies will be based on a general building stock analysis, including the distribution of building typology in relation to lighting retrofit potential. These case studies will deliver proven and robust evidence of achievable savings and show integrated retrofit strategies. Measurements and assessments will include monitoring of energy savings, lighting quality and operational costs. In addition, Subtask D will provide updated information from an analysis of previously documented Case Studies in the literature and on websites.

The work of Subtask D will be structured according to six project tasks:

D.1 Building stock/typology (selection, classification)
D.2 State-of-the-art (literature, e-info)
D.3 Assessment and monitoring procedure
D.4 Case study assessment
D.5 Overall conclusions, lessons learned
D.6 Case study book / e-documentation

D.1. Building stock/typology

The first task will consist of defining the building types and categories included in this Task. The following characteristics will have to be addressed:

- Distribution of energy/electricity use in relation to building type, in each country
- Main function of the building (i.e. office, school, healthcare, etc)
- Owner structure (i.e. public, private)
- Typical lighting approach and solutions (e.g. task-ambient lighting, etc)
- Geographical and climatic aspects
- Typical typologies of each building category
- Available Case Studies covering the different building types

Objective

- Define the building types and categories included in this Task. Develop categories and structure for the Task.

Results

- D1-1 Report about analysis of building stock and typology in relation to energy and electricity use in each country.

Activities

- Collection of data on Internet and in official publications.
- Collection of previous European projects about building typology, etc.
- Summary of this information for each country.

Milestones

- Collection of data on Internet and in official publications — March 2013
- Collection of previous European projects about building typology, etc. — March 2013
- Summary of this information for each country — June 2013

D.2 State-of-the-art (literature, e-info)

This task will consist of analysing past research projects, publications and websites in the same field and identify the already existing databases of Case Studies. The literature review will also update key information regarding energy saving strategies and solutions demonstrated in the past by research and demonstration projects.

Objectives

- Identify the already existing databases of case studies
- Update key information regarding energy saving strategies and solutions demonstrated in the past by research, monitoring or demonstration projects.

Results

- D2-1 State-of-the-art review of lessons learned from previous Case Studies

Activities

- Make a bibliographical list of relevant articles or books.
- Make a list of relevant previous research projects on lighting or lighting retrofit.
- Make a list of relevant websites to explore.
- Review the information found in the literature (journal articles, websites) and on websites.
- Write a concise summary of this information.

Milestones

- Bibliographical list – March 2013
- Relevant previous research projects – March 2013
- Relevant websites to explore – March 2013
- Review of all information found – June 2013
- Report writing – Sept 2013

D.3. Assessment and Monitoring Procedure

In this part, a consensus will be made about the key metrics to be gathered under each Case Study and also which monitoring procedure is acceptable. For example, the Case Study book could even include:

- General case story of retrofit like motivation / decision process. Economic model (part of other retrofit measures? Contracting? etc.)
- Before-retrofit analysis

- Technical retrofit solution adopted
- Monitoring procedure / program
- After retrofit analysis
- Common documentation format

Objective

- Define an applicable standard assessment and monitoring procedure for all case studies to be investigated

Results

- D3-1 Report summarizing previously used assessment protocols and procedure.
- D3-2 Document (directive) describing the new assessment protocol with procedures, metrics, and information to collect.

Activities

- Review (literature, websites and contacts) of previously used assessment protocols and procedure.
- Development of the new assessment and monitoring protocol.

Milestones

- Review of previous protocols and procedures — September 2013
- New assessment protocol with procedures — December 2013

D.4. Case Study assessment

This task is really the core task within Subtask D. In this task, the metrics and information will be collected for each Case Study. The collected material will then be harmonised to make sure that a common language and format is adopted throughout and that no information is corrupted or missing.

Objective

- Assess high quality data for each case study according to the defined procedure (C3).

Results

- D4-1 Comprehensive (large) electronic-database with retrofit cases, including measured data, pictures, decision process, tools used, and all other information required by the assessment protocol.

Activities

- Selection of Case Studies to investigate.
- Collection of information and in some cases, monitoring and assessment of the identified Case studies.
- Data control, validation.

- Importing information into the common web format.

Milestones

– Selection of Case Studies	December 2013
– Collection of information	September 2014
– Importing information into the common web format	September 2014
– Data control, validation	December 2014

D.5. Overall conclusions, lessons learned

The database of Case Studies will be supplemented by a general conclusion, which could be published as a separate report or article, where the following items will be addressed:

- Cross analysis, lessons learned
- Did the outcome meet the expected, robust evidence?
- General conclusions

Objective

- Provide a robust analysis of the performed case and derive generalized conclusions

Results

- D5-1 Report summarizing general lessons learned

Activities

- Review of case Study material.
- Writing summary.

Milestones

- Final report – June 2015

D.6. Case study book / e-documentation

The final goal of this ST is to produce a very well documented, electronic Case Study book with relevant information and graphical material (pictures of interiors). Part of this work will also concern the layout of such book, the key figures and features, the accessibility, the rights to publish, etc. The electronic Case Study book will be linked to the "Lighting Retrofit Adviser" so that when using the tool, one can view real concrete examples of similar projects and adopted solutions.

Objectives

- Produce a very well documented, e-book of case Studies linked with the Lighting Retrofit Advisor.

Results

- D6-1 Electronic Case Study book.

Activities

- Decision about layout and format of this electronic book.
- Manage the copyrights for publishing this information on a publicly available website.
- Import data into this book.
- Selection of most interesting Case Studies from material collected in D4.

Milestones

– Copyright procedure and information (by OA Task 50)	March 2013
– Selection of case Studies	June 2015
– Layout and format	June 2015
– Final import of information	December 2015.

Effort for subtask

- Estimated effort is 3 person month per participant (country) and 9 person-months (3 month per year) for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the task.

Deliverables

- D1-1 Report about analysis of building stock and typology in relation to energy and electricity use
- D2-1 State-of-the-art review of lessons learned from previous Case Studies
- D3-1 Report about previous assessment protocols and procedure.
- D3-2 New assessment protocol
- D2-1 Report about building stock
- D4-1 Comprehensive (large) electronic-database with retrofit cases
- D5-1 Report summarizing general lessons learned
- D6-1 Electronic Case Study book

Relation to other subtask

- Exchange information with Subtask A and B on D1 (A, D)
- Corporate with subtask C on tools for auditing procedure for "before retrofit analysis" and design tools for retrofit design of case studies (C)
- Supply case study information to Lighting Retrofit Adviser (JWG)

1.6.5 Joint Working Group

Lead Country: Germany (Jan de Boer, Fraunhofer-IBP)

All Subtasks will provide major parts of their results, as input to this joint activity as depicted in Figure 3. Based on these results, the joint working group will develop an electronic interactive source book (Lighting Retrofit Adviser). A central data base will include all task results and will allow the users to obtain extensive information, according to their individual focus of interest: design inspirations, design advice, decision tools and design tools. Thus, the user will be able to increase quickly and reliably his knowledge in the respective field of interest. Users will have the choice of analysing retrofit (design) scenarios themself and/or using the pool of experience gained in the case studies projects (electronic version of case study book) to access information on energy saving potentials and economic approaches. As shown in Figure 4 the Lighting Retrofit Adviser will address specific needs of different target groups and audiences (refer also to chapter 1.5).

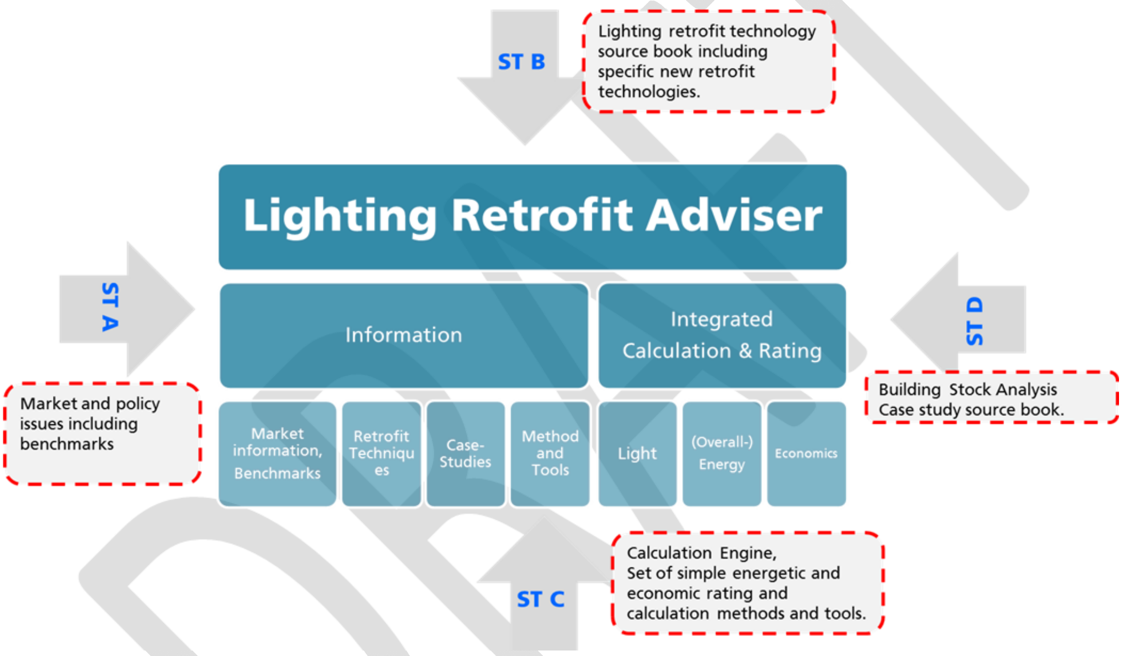


Figure 3: General structure of Lighting Retrofit Adviser, including input from the different subtasks.

Technically the Lighting Retrofit Adviser will work as a mobile, free accessible piece of software in a multilingual design, allowing easy adaption to specific needs of countries, participating in this task. It will serve as a key element in the distribution concept of the task. As helpful blueprints from previous IEA activities may serve: a) "Energy Concept Adviser" from IEA ECBCS Annex 36 "Retrofitting of educational buildings-energy concept adviser for technical retrofit measures" *(http://www.annex36.com/ergebnisse.html)*. b) the "ENERGO - IT-Toolkit" from IEA Annex ECBCS 46 *(http://www.annex46.de/tool_e.html)*. The work in the joint working group will be structured into four project areas.

JWG.1 Software Specification (Concept, Architecture and software design)

At first the general architecture of the software will be designed. Therefore the different needs of the target groups (stakeholders) will be identified and fixed in collaboration with the other subtasks. The architecture shall, as depicted in Figure 4, generally be structured into two closely interacting main components: An information part and a technical, economic computation and rating part. In order to achieve a good and broad dissemination the selection of the platform is of crucial importance. Undoubtedly mobile computing systems have to be supported (e.g. App based technology like Android or HTML 5). To allow all participating countries to contribute and benefit, the tool will be designed as an adaptable multilingual, internationally usable framework. Therefor adaptions to other languages (than English) specific market data (like electricity rates) can be performed easily. Used computation and ratings methods will be internationally applicable. Reporting and printing functions will be designed such that the information contained in the tool can easily be made available as e.g. printed design guidelines. Internally - within the task - specific formats will need to be developed with the subtasks to include relevant parts of their work results.

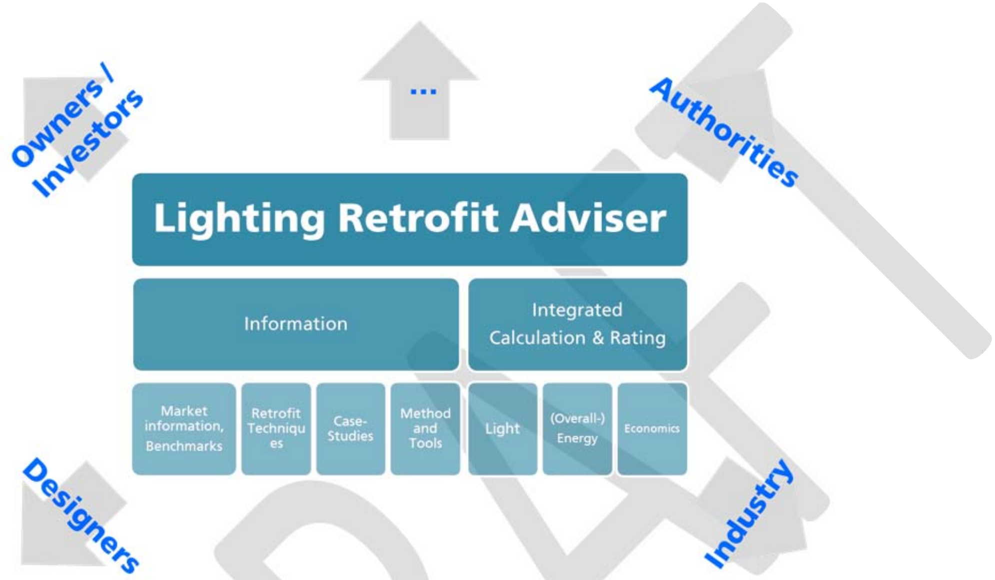


Figure 4: Lighting Retrofit Adviser as part of the dissemination concept of the task.

Objectives

- To define a software architecture and design complying with needs of the stakeholders
- To incorporate results of subtask A-D

Results

- Functional specification of Lighting Retrofit adviser
- Workplan with responsibilities
- Specification of the type and format of information needed from the other subtasks

Activities

- Joint definition with other subtasks

Milestones

- Draft Software concept 3 / 2014

JWG.2 Concept evaluation and proof

The developed software concept and architecture will be presented to the different target groups, discussed and tailored to their needs (e.g. in workshops).

Objectives

- Ensure meeting the demands of the target groups

Results

- Adapted and proofed concept

Activities

- Workshop or survey to get feedback

Milestones

Evaluated Software concept 9 / 2014

JWG.3 Implementation

Core of the information part of the tool are the datasets generated in the other activities of the task (i.e. Subtask A, B, D). The information part will strongly build upon building typology, benchmarks, market figures, technologies, and case studies. The calculation part of the Lighting retrofit adviser will be driven by the calculation engine developed in project C.3. The calculation part will be supplied with system characteristics and economic data for before retrofit analysis and retrofit concept development from Subtasks A,B, D. Data in parts will be structured country dependent, allowing adapting to regional specifics (e.g. energy rates). As “face to the customer” the graphical user interface has to be designed such, that the adviser tool can be handled in an appealing, most convenient and intuitive manner.

Objectives

- Generate a working software tool

Results

- Beta version of Lighting retrofit adviser

Activities

- Coding

Milestones

- Beta Version 3 / 2015

JWG.4 Quality assurance, validation and national adaptions

During and after implementation the tool, especially the calculation and rating part, will be tested and validated. Translation of Graphical User Interface and adaption of for instance specific market data by countries interested.

Objectives

- To ensure a high quality of the tool
- To generate country specific versions

Results

- Validated Lighting Retrofit Adviser

Activities

- Testing, translation and exchange of country specific data

Milestones

- Release "Lighting retrofit Adviser" 12 / 2015

Effort for JWG

Estimated effort is 12 person month for developing the basic version (framework) of the lighting retrofit adviser in English for central European climatic conditions. For adaption to other participating countries (translation and adaption of specific data) 3 person-months each are accounted for.

Deliverables

- Information and calculation tool "Lighting retrofit adviser"

Relation to other subtask

The lighting retrofit adviser relies on specific inputs from the other activities:

- Subtask A: e.g. market and policy data and information, benchmarks, retrofit strategies.
- Subtask B: Quantitative and qualitative information on daylighting and electric lighting technology.
- Subtask C: Calculation engine, a set of suited simple energy and economic models
- Subtask D: Building typology and case study information in standardized format.

1.7 Participation from industry

There are several actors in the lighting industry: manufacturers of luminaires, control gear, façade technology, engineering companies and installers of systems. The Task is designed to attract as many actors as possible from industry. They all can contribute a lot to the quality of the Task and they can learn a lot from other's experiences and the Task work. The Task defines two levels of participation for the industry:

- An industrial participant at level 1 should expect to participate in workshops organised by Task 50 and to receive at least once during the Task duration a visit from a Task participant to answer technical and marketing questions on lighting retrofits.

- An industrial participant at level 2 should expect level 1 commitment and should participate in all Task meetings, bringing information and feedback from the market. Level 2 participation should be seen in close connection with the main participant of the country of origin of the industry.

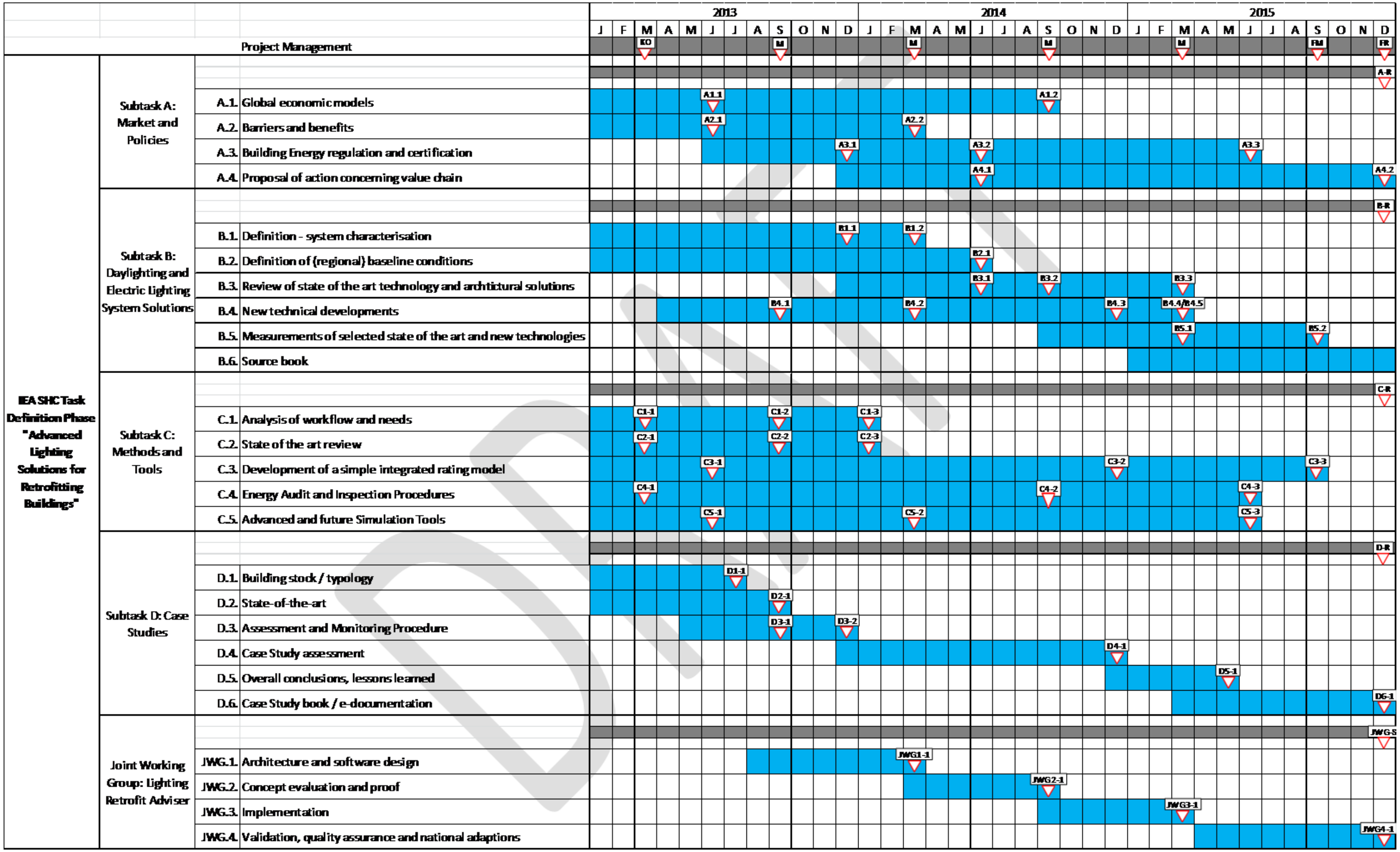
Task 50 will invite the lighting industry organisations from all participating countries, as well as the international umbrella organisations such as CELMA, EAA to participate. The financial aspects of industry participation are left to the decision of each country: either the industry will have to make its own contribution or some support can come from public funding.

2. Information Plan

The following documents or information measures are planned during the course of the Task:

1. *"Lighting retrofit market. Including policy issues and proposals of action"*, a report to be published by Subtask A by the end of Year 3.
2. "*Daylighting and electric Lighting retrofit technologies. From low budget to new advanced retrofit solutions*", a source book, to be published by Subtask B by the end of Year 3.
3. *"Set of (simple) energy and economic auditing, rating and calculation methods and tools"*, a survey / toolbox / webbased, to be compiled by Subtask C by the end of Year 3.
4. *"Applied (Advanced) lighting retrofits - realised projects and case studies for different building types* ", a source book to be published by Subtask D by the end of Year 3.
5. *Industry workshops,* during the Task duration, in conjunction with every Task meeting, will be organised in the host country of the meeting. Representatives from authorities, manufacturers, designers will be invited.
6. *National industry workshops* can also be organised by Task participants using the information gathered during Task workshops and the material produced by the Task.
7. A *Newsletter* will be produced at the end of Year 2 and 3. The Newsletter will be distributed through national channels (for instance, included in a solar industry or lighting association or lighting journal)
8. *"Lighting retrofit adviser"*, an electronic, interactive source book including design inspirations, design advice, decision tools and design tools for lighting retrofits. The adviser will work on desktops as well as mobile computing systems. It will be a joint effort of Task 50 and available at the end of the Task (Year 3).
9. Part of the information produced by Task 50 can be made available through the Internet, on the Web site of one of the national laboratories participating in the Task.
10. In general - the dissemination of results will take place at a national level.

3. Workplan and Milestones



KO	Kick-off Meeting
M	Meeting
FM	Final Meeting
FR	Final Report
A1-1	Collection of data on costs (TCO)
A1-2	Propose models for comparison of schemes
A2-1	Data on barriers and opportunities
A2-2	Budget issues for retrofit
A3-1	Collect information on the way lighting retrofit is integrated in documents used for regulation and certification.
A3-2	Provide comparison
A3-3	Make proposals.
A4-1	Recording of information from stakeholders
A4-2	Proposal of actions
A-R	**Report "Lighting retrofit market. Including policy issues and proposals of action"**
B1-1	Completion of the catalogue of criteria
B1-2	Online catalogue of criteria (public)
B2-1	Defined regional baselines on a website
B3-1	Review on state of the art lighting technology
B3-2	Review on architectural solutions
B3-3	Reviews available on a website
B4-1	Investigation new technologies of interest for retrofitting buildings
B4-2	Technology roadmaps available within Task
B4-3	Development of new lighting technologies
B4-4	Evaluation of new technological solutions
B4-5	Directions for lighting solutions relevant for the future
B5-1	Completion of measurements under laboratory conditions
B5-2	Evaluation of performance under laboratory conditions
B-R	**Source book available on a website**
C1-1	Identification of the major contacts of stakeholders
C1-2	Completion of the survey
C1-3	Results of survey and evaluation on web site
C2-1	Investigation on state-of-the-art methods and tools
C2-2	Results on a website
C3-1	Investigation of integrated simulation tools
C3-2	Calculation engine lighting retrofit adviser
C3-3	Benchmark on case studies
C4-1	Investigation of daylighting performance assessment methods
C4-2	Investigation of energy monitoring and auditing procedures
C4-3	Benchmark on case studies
C5-1	Completion of the review of advanced simulation tools
C5-2	Testing the tools on case studies
C5-3	Reporting the results on the website
C-R	**Webbased Survey, toolbox "Set of (simple) energetic and economic rating and calculation methods and tools",**
D1-1	Report about analysis of building stock and typology in relation to energy and electricity use in each country
D2-1	State-of-the-art review of lessons learned from previous Case Studies
D3-1	Report summarizing previously used assessment protocols and procedure.
D3-2	Working Document (directive) describing the new assessment protocol with procedures, metrics, and information to c
D4-1	Comprehensive electronic-database with retrofit cases
D5-1	Report summarizing general lessons learned
D-R	**Electronic Case study book "Applied (Advanced) lighting retrofits - realised projects and case studies "**
JWG1-1	Draft Software concept
JWG2-1	Evaluated Software concept
JWG3-1	Beta Version
JWG-S	**Release "Lighting retrofit Adviser" Software**

4. Contributors / participants

By 10 /2012 the following countries and institutions are intending to participate:

Research

Country	Organization	Short name /Abbreviation
Austria	Bartenbach Lichtlabor	BL
Belgium	Univerty of Louvain	UCL
China	China Academy of Building Research	CABR
Denmark	Danish Building Research Institute	SBI
	Aarhus University	ASE-AU
Finnland	Aalto University	AU
Germany	Fraunhofer Institute of Building Physics	FHG-IBP
	Technical University Berlin	TUB
	Fraunhofer Institute of Building Physics	FHG-ISE
	daylighting.de UG	DDE
	University Stuttgart	IKB2
	University of Applied Science HFT, Stuttgart	HFT
Italy	Politecnico di Torino	POLITO
	SAPIENZA University - Rome	SU
	ENEA UTEE-ERT	ENEA
Japan	Kyushu University, Fac. of Human-Environment Studies	KU
Norway	Norwegian University of Science and Technology, Trondheim	NTNU
Slovakia (Observer)	Institute of Construction and Architecture, Slovak Academy of Sciences	SAS
South Africa	Eskom	ESK
Sweden	Lund University, Div. of Energy and Building, Sweden Design	LTH
	WSP Ingineers	WSP
Switzerland	École Polytechnique Fédérale de Lausanne	EPFL / LIPID
	ESTIA	ESTIA

Industry

Country	Organization	Short name /Abbreviation
Germany	Osram	OSR
	Trilux	TR
Netherlands	Philips Lighting	PHL

The contributions are affiliated to the following subtasks:

Subtask A	**Market and Policies**	
Participant (Country)	**Organization**	**Main activities in the Subtask**
Austria	BL	A1-A2
Denmark	SBI, ASE-AU	All A
Finland	AU	A1-A2
Germany	FHG-IBP	All A
	TUB	A1
	DDE	A2
Japan	KU	A1-A2
Norway	NTNU	A2, A3
Sweden	LTH	A3
	WSP	A3
Switzerland	Estia	A1-A4
Industry Participant	**Company**	**Special Interest**
Level-1	PHL	A1-A2

Subtask B	**Daylighting and Electric Lighting System Solution**	
Participant (Country)	**Organization**	**Main activities in the Subtask**
Austria	BL	B1, B4, B5
China	CABR	B
Denmark	SBI	To be clearified
Finnland	AU	All B (focus B1, B3, B4, B5)
Germany	FHG-IBP	B1, B2, B4
	TUB	All B
	DDE	B1, B3, B4
	IKB2	B4, B5
Italy	SU	possibly B1, B4, B5
Japan	KU	possibly B3
Norway	NTNU	B1, B3, B4, B5
Slovakia	SAS	B1, B3, B6
Switzerland	EPFL-LESO	B4
	EPFL-LIPID	B1
Industry Participant	**Company**	**Special Interest**
Level-2	PHL	B1

Subtask C	Methods and Tools	
Participant (Country)	**Organization**	**Main activities in the Subtask**
Austria	BL	C1 – C4
China	CABR	C
Denmark	SBI	C1, C3
Germany	FHG-IBP	C1, C3,C4,C5
	FHG-ISE	C5
Italy	POLITO	C1
Sweden	LTH	C1
Switzerland	EPFL-LESO / Estia	All C
	EPFL-LIPID	C5
Japan	KU	C1
Industry Participant	**Company**	**Special Interest**
Level-2	PHL	C1-C4

Subtask D	Case Studies	
Participant (Country)	**Organization**	**Main activities in the Subtask**
Austria	Bartenbach Lichtlabor	D1, D3, D4
China	CABR	D1, D4
Denmark	SBI	D1 (coordination with STA), D3
	Aarhus	D2, D4, D5
Finnland	Aalto University	D1
Germany	TUB	D2 (coordination with B1)
	Daylighting.de	D4
	HFT-Stuttgart	D4
	FHG-IBP	D1, D4
	FHG-ISE	D4
Italy	Politecnico di Torino	D1, D4
Norway	NTNU	D1, D3, D4
Sweden	LTH	All D
Switzerland	LESO	D1, D4
Industry Participant	**Company**	**Special Interest**
Level-1	PHL	D1-D2

JWG	Lighting Retrofit Adviser	
Participant (Country)	**Organization**	**Main activities in the Subtask**
All	All	Interaction via subtask work
Germany	FHG-IBP	JWG1-JWG4 (set up of framework)
Open	Open	Adaption to country specific conditions
Industry Participant	**Company**	**Special Interest**
Level-2	PHL	ALL