Newsletter 2

Main Results

May 2016

IEA SHC Task 50 finished

With the activities in Task 50, we aimed at improving the lighting refurbishment process in non-residential buildings in order to unleash energy saving potentials while at the same time improving lighting quality.

The overall objective was to accelerate retrofitting of day-lighting 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 included the following activities:

- Develop a sound overview 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 (Figure 1)
- This newsletter presents an overview on key results of IEA SHC Task 50 and provides reference to further information.

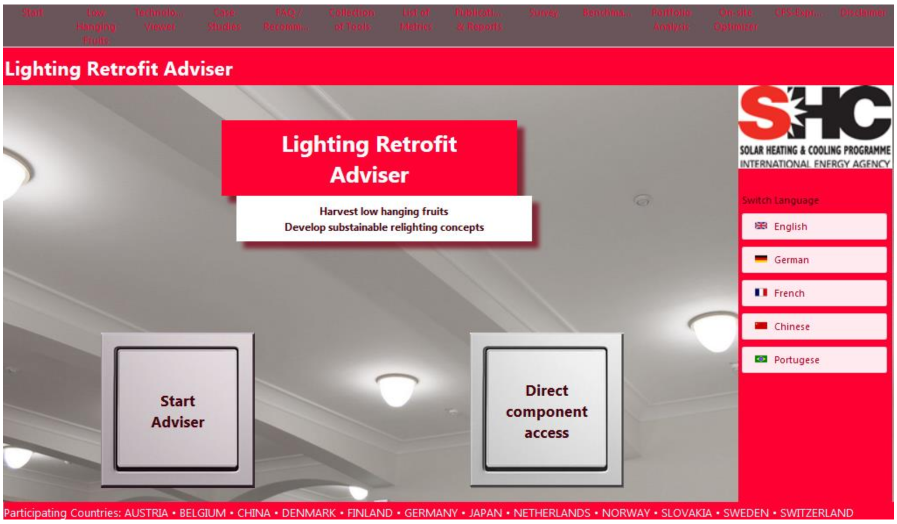
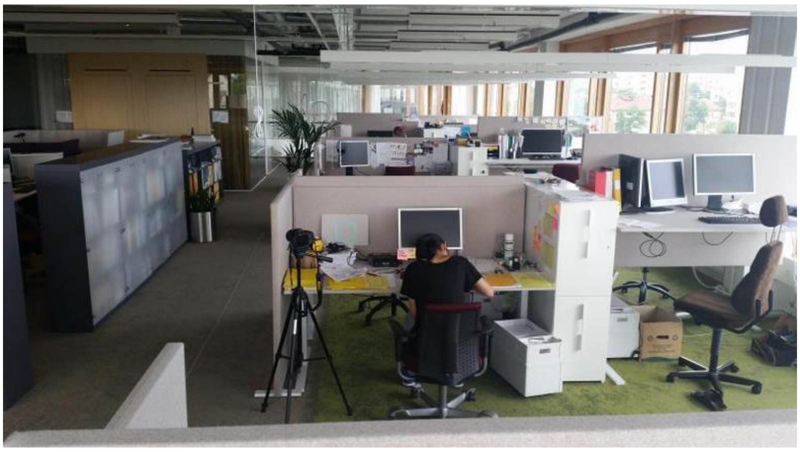


Figure 1: Electronic Source Book: the Lighting Retrofit Advisor.

Content

Status of market and policies for lighting retrofits

Marc Fontoynont, Aalborg University, Denmark



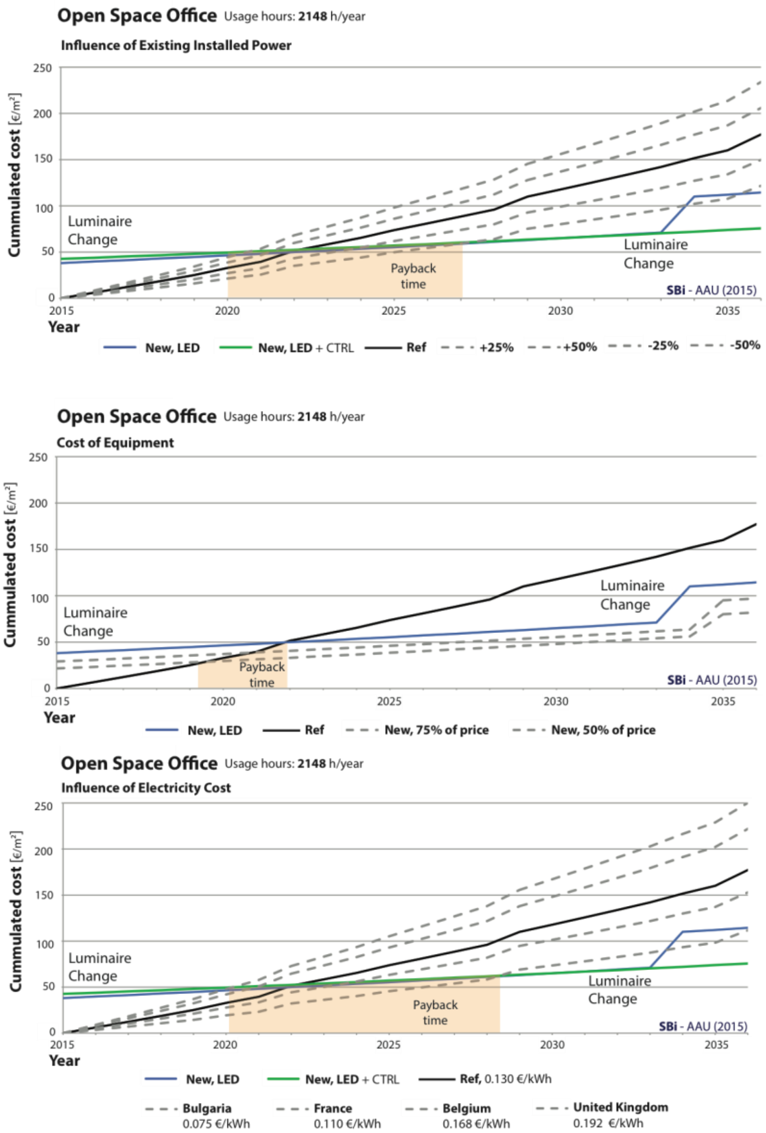


Figure 2: Cumulated costs for typical open space offices as a function of existing installed power, equipment cost and electricity costs. The same representations were generated, for personal offices, manufacturing halls and wholesale / retail.

Global economic models: TCO and Payback Analysis for typical applications

Financial data relative to lighting installations, before and after retrofit operations have been generated and analysed. Data are calculated over a large number of years to combine installation costs, maintenance, and energy use.

The general principle was to compare the running costs of a "do nothing" approach (keeping the installation as it is and let it die gradually) , and the costs associated with a retrofit with highly effiient equipment.

Long term costs of installation are quite sensitive to the initial cost, and the combined cost of electricity and energy efficiency. Therefore Total Costs of Ownership (TCO) of lighting installations have been calculated for various types of buildings: offices (Figure 2, Figure 3), schools, homes and industrial buildings.

The data we supply attempt to answer to the following questions:

- Which installations are low hanging fruits (with shortest payback time)?
- For which type of building are retrofit operation more profitable?
- How do various parameters influence the payback time (investment costs, efficacy of luminaires and sources, cost of electricity, etc.)?

Then we have investigated various financial models to initiate successful investments in retrofit operations:

- Direct investment by the user, with significant benefits after the payback time.
- Investment by the user with specific loan. This extends payback time, but does not require too high of a financial contribution at the beginning.
- Leasing of the entire installation: the building owner does not own the installation. The lighting installation is rented (installation and operation is supplied by a third party).

From our experience, it appears that leasing options are the best way to trigger lighting retrofit to overcome the barriers associated to investment.

However such possibilities requires the benefits associated to lighting retrofit to be sufficiently high: large number of ope-

rating hour, large reduction of electric power density, high electricity rates.
From the calculations, we concluded the following:
In case of high electricity costs, and low cost lighting equipment, duration of pay-back time is below 5 years, which is attractive since new SSL equipment will operate from 5 to 20 years typically.

– TCO calculations are very sensitive to parameters such as product lighting equipment cost, electricity rates, and annual duration of operation.
– In schools, refurbishment requires very low cost products (installation costs below 10€/m²) since lighting equipment operates a rather short period of the time.

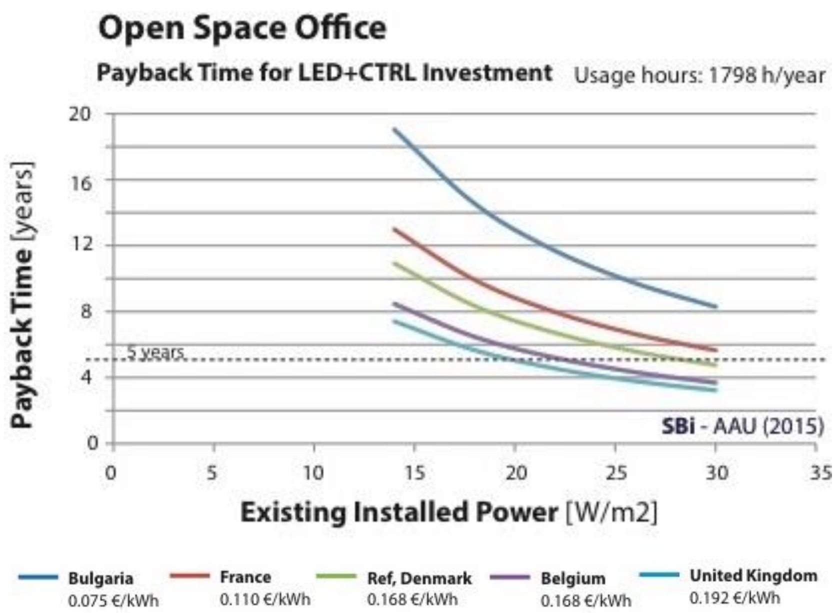


Figure 3: Payback time for typical open spaces offices as function of energy price. The same representations were generated, for personal offices, manufacturing halls and wholesale / retail.

Barriers and Benefits

Benefit of lighting retrofits should be addressed in a broad manner: energy saving, increased value (and rental value), improved functionality, human and social benefits (Figure 4). A possible way, which we pursued in this study, is to *compare benefits* of lighting retrofit with benefits of *other types of retrofits or actions* (change of furniture, change of floor, etc.). We also identified various barriers which lead to postponement of lighting retrofits, even when they are needed and cost effective.

Building Energy Regulation and Certification

Buildings are designed, constructed and operated in a context of standards, regulations or labels. 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 window dimension and technologies are directly or indirectly suggested, but optimal performance (daylighting, heat gains, heat losses) cannot always be achieved in respecting codes.
We conducted a critical analysis of regulation and certification documents, to identify some possible incoherence and also opportunities for progress. We proposed some adjustment of these reference documents.

Proposals of actions concerning the value chain

Possible options of financing building retrofits, to accelerate deployment of replacement of existing installations were identified: with financing by the building owner, by an ESCO (assisted by a bank) or by a leasing company.
From our observations, it seems that the leasing mode is the most promising, not only in relation to the added simplicity for the building owner, but also because it integrates a guarantee of service, which is a major issue with SSL products: there is indeed presently no standard light engine allowing a replacement with identical light output (power, spatial distribution, colour). This aspect appears a major barrier and suggests that the responsibility of maintenance is handed over to a third party.
Leasing transfers part of the technical challenges to the leasing company, and could be a way to offer higher quality of lighting to the clients, and reduce interest for ultra low cost (and low reliability) lighting products.
Furthermore recent interviews with professionals demonstrate that there are various new models for selling lighting, in new and retrofitted buildings. The trend is to move to full service (installation, maintenance, replacements). One issue is that cost related to lighting electricity is often not accessible, which requires a specific commissioning approach. Clients should have the evidence of the exact electric power used by their installations. It is interesting to note that this new approach triggers a new kind of competition: manufacturers, installers, utilities, facility managers are moving to this field, creating a high financial pressure on costs of products, but fortunately also on their reliability and quality.

Read more

Reports:

– **Global Economic Models**
– **Barriers and Benefits; Buidling Energy Regulation and Certification**

	Typology / best solutions	TCO of lighting €/m²	Electricity costs* kWh/m²	Value benefit	Energy benefit	Function benefit	Human benefit
1	**Offices**	36,7 €/m²	11 kWh/m² 1.4 €/m²	2000 €/m²(value) Rental 200-600 €/m² year	2 €/m².yr (lighting) 4€/m².yr (cooling & lighting)	Higher productivity 300€every year is about 1% improvement in productivity or 30 €/m2 is one worker per 10m²	Less stress Extra hours of comfortable work. Check with medical staff. €/m²
2	**Schools**	36,7 €/m²	3 kWh/m² 0.4 €/m²	€/m² (value) €/m² (efficiency of education)	.5 €/m².yr	Faster learning 1 % of total costs, including staff (200 €/m²) is 2€/m².	Less stress Higher concentration Extra hours without glare €/m²
3	**Industrial buildings**	14 €/m²	16 kWh/m² 2 €/m²	Rental value	1 €/m².yr	Gains in productivity % of income 3€/m2 if one worker per 100 m2.	Higher comfort Less stress due to daylight Extra hours of comfortable work €/m²
4	**Shops**	36,7 €/m²	33 kWh/m² 4.3 €/m²	> 1% of income	5€/m².yr	Higher % of income	Daylit shopping area, increased attractiveness by customers
5	**Supermarkets**	36,7 €/m²	33 kWh/m² 4.3 €/m²	€/m²	1€/ m².yr	Higher % of income	Daylit shopping area, increased attractiveness by customers €/m²

* *calculated for electricity price 0.13 €/kWh*

Figure 4: Possible benefits associated with an improvement of lighting installations.

Source book on 38 retrofit techniques

Martine Knoop, Technische Universität Berlin, Germany

Subtask B "Daylighting and Electric Lighting solutions" has looked into the assessment of existing and new technical retrofit solutions in the field of façade and daylighting technology, electric lighting and lighting controls. The main result is the source book „Daylight and electric lighting retrofit solutions" (Figure 5, Figure 6). The source book provides information for those involved in the development of retrofit products or involved in the decision making process of a retrofit project, such as buildings owners, authorities, designers and consultants, as well as the lighting and façade industry. In contrast to other retrofit guides, this source book addresses both electric lighting solutions and daylighting solutions, and offers a method to compare these retrofit solutions on a common basis, including a wide range of quality criteria of cost-related and lighting quality aspects.

Simple retrofits, such as replacing a lamp or adding interior blinds, are widely accepted, often applied because of their low initial costs or short payback periods. The work presented in this book aims at promoting state-of-the-art and new lighting retrofit approaches that might cost more but offer a further reduction of energy consumption while improving lighting quality to a greater extend. A higher lighting quality can increase health, self-assessed performance, and lead to a higher job satisfaction and thus productivity in work environment. In this, the use of daylight is specifically promoted, as an optimized daylighting design, or the use of innovative daylighting systems are rarely taken into consideration in the retrofit processes of buildings, and daylight utilization will both reduce energy consumption for electric lighting as well as increase user well-being.

In order to assess retrofit technologies on their ability to save electrical energy, to increase lighting quality and to affect operational costs, a *„Catalogue of Criteria"* was developed. It consists of a large number of quality measures that can be applied to evaluate the performance of lighting controls, electric lighting retrofits and daylighting retrofits. The selection of quality measures can be used to describe the performance of lighting retrofit solutions, qualitatively and to some degree quantitatively. The *„Catalogue of Criteria"* allows to make a sensible, first, decision for a (selection of) lighting retrofit solution(s). In this source book, the *„Catalogue of Criteria"* is used to evaluate the performance of a selection of retrofit solutions. Product families of lighting retrofit technologies are evaluated, and an overall performance assessment for each type of retrofit solution is given. The actual performance of a specific product in that retrofit family needs to be established within the context of a project. The assessment of selected technologies showed that

- next to replacing a lamp or adding interior blinds, a task - ambient lighting concept, occupancy sensing, personal control in daylit spaces, daylight responsive lighting control through switching, time scheduling, wireless controls (occupancy and daylight responsive), and replacing an magnetic ballast with an electronic ballast, can be economical solutions that reduce energy consumption for electric lighting.
- most electric lighting retrofit solutions offer high energy savings but do not necessarily improve lighting quality.daylighting retrofit solutions generally have higher investment costs. The energy savings potential offered by these retrofits can be (partially) harvested when applying a daylight responsive lighting control system or offering the user personal control over the electric lighting. non-economic benefits, or indirect economic benefits, such as the increase of lighting quality, can be achieved with daylighting retrofit solutions that enhance daylight provision in a room, and electric lighting and con-

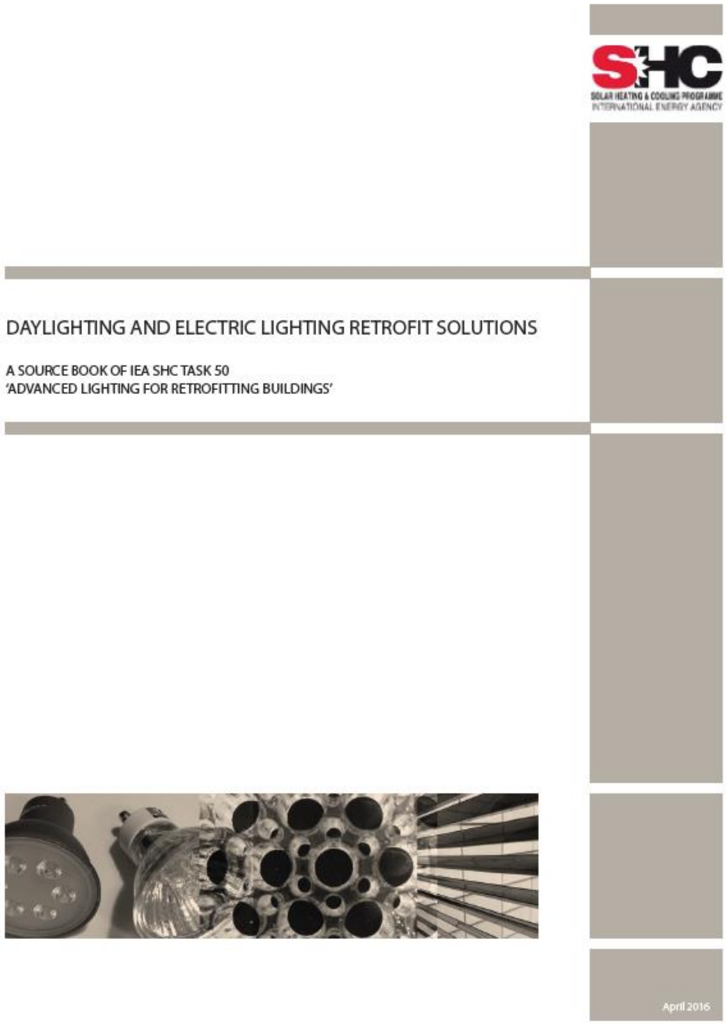


Figure 5: Source Book on lighting retrofit technologies, for download.

trol solutions that might require a redesign of the lighting installation. Whereas the choice for a lighting retrofit solutions nowadays is mainly based on cost and energy reduction, a retrofit solution can affect lighting quality and thermal loads as well, which has an indirect economical or environmental impact. This should be considered in the selection of the appropriate lighting retrofit solution. Whereas the greater part of electric lighting retrofit solutions focuses on reduced price and increased efficacy to achieve short payback periods, high end electric lighting solutions, and the majority of lighting controls and daylighting solutions are developed and applied to increase user comfort and lighting quality. The content of this source book is graphically interactive available in the Lighting Retrofit Advisor. Beside the electronic presentation, the tool allows to compare technologies on a direct one to one basis.

Read more

Technical Report
"Catalogue of Criteria"

Source Book
"Daylight and Electric Lighting Retrofit Solutions"

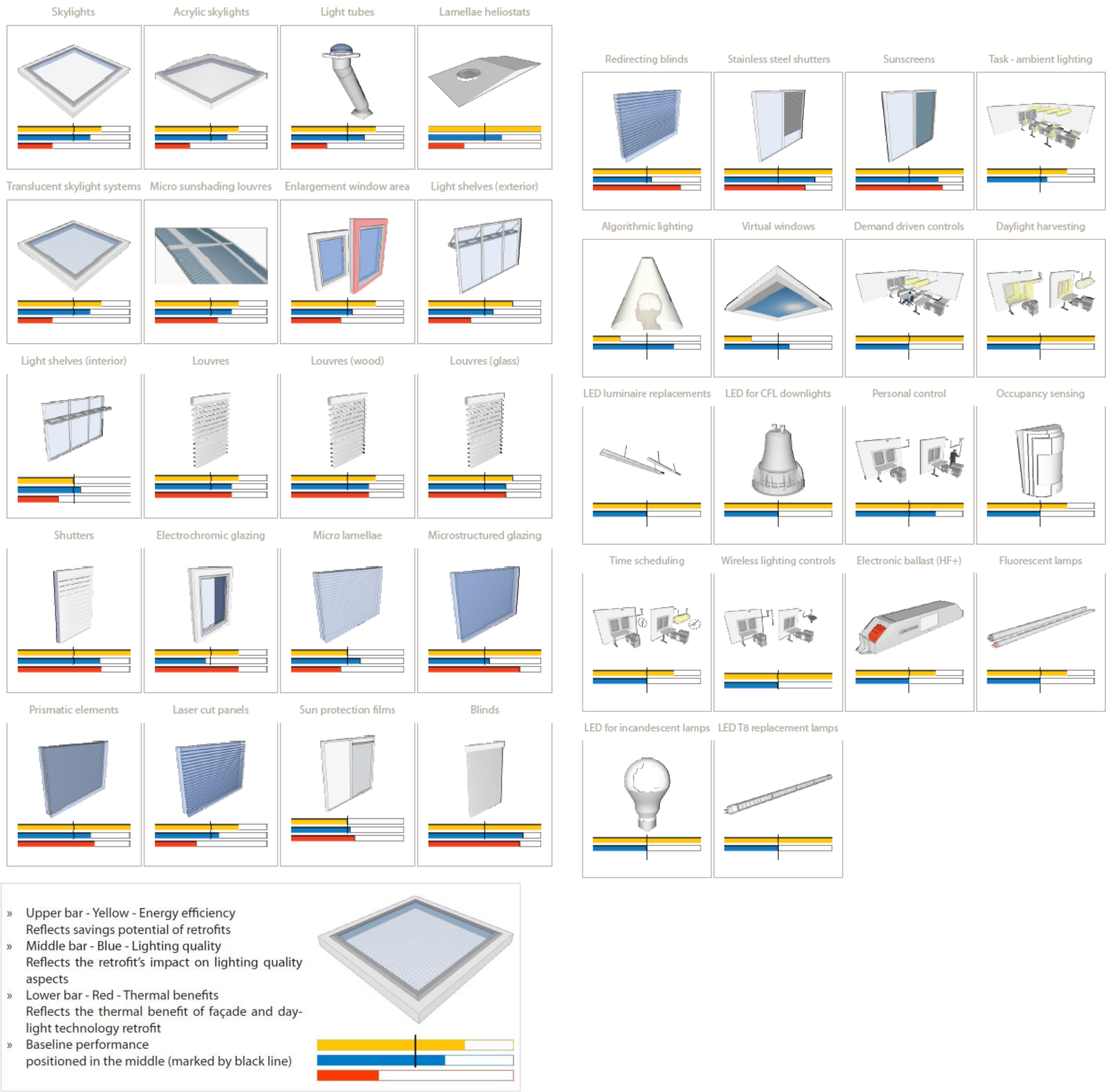


Figure 6: Overview featured technologies. A quick rating system for technologies is applied, complementing the detailed rating in the source book and the lighting retrofit adviser.

Closer look into professionals workflows and on state of the art of tools & methods for lighting retrofits

Bernard Paule and Jérôme Kaempf, Estia SA / kaemco LLC / EPFL, Switzerland

Lighting retrofit in current practice - Evaluation of an international survey
Surveys and socio-professional studies carried out at national and international levels contribute to a better understanding of the lighting retrofit process. Within the framework of ST C work an online survey on lighting retrofit was initiated in December 2013. After 9 months, more than 1000 answers were collected. The survey provides clear insights about the workflow of building professionals and leads to a better understanding of their needs in terms of computer methods and tools. One of the main outcomes of the survey is that retrofitting strategies used in practice essentially focus on electric lighting actions such as of luminaires replacement and the use of controls. Generally, daylighting strategies are not rated as the highest priority. The results also indicate that practitioners mainly rely on their own experience and rarely involve external consultants in the lighting retrofit process. Furthermore, the survey results suggest that practitioners are interested in user-friendly tools allowing quick evaluations of their project, with a good compromise between cost and accuracy, and producing reports that can be directly presented to their client. The survey also emphasized that the main barriers in using simulation tools are essentially their complexity and the amount of time it takes to perform a study. Practitioners are keen to use tools at preliminary design stage and would like to be able to estimate the cost and other key figures (energy consumption and lighting levels). From the survey recommendations for the building software developers to address the needs of practitioners in a more suitable way were deduced.

Methods and tools for lighting retrofits - State of the art review
A review of the state-of-the art of the methods and tools available on the market to support practitioners in the process of lighting retrofits was conducted. As starting point, the most used software were taken from the above mentioned survey. The methods and tools were categorised in four categories:

1. Facility management tools (global diagnostic tool including economic aspects)
2. Computer-assisted architectural drawing / Computer-aided design tools
3. Visualization tools
4. Simulation tools

In total 20 software tools were described, and their main features compared for a quick reference. Furthermore, the simulation tools were assessed using a case-study of a school refurbishment. Equivalent information given to practitioners was used to define the properties of the room (2D plans and photometric properties). Simulation experts were asked to simulate for daylight the daylight factor and for electric lighting the work plane illuminance. Results (Figure 7) indicate a rather large dispersion for daylighting results between the different tools, even though the case-study was described with great care. However, on electric lighting the results remain within 10-15% range from the median value. The obtained results indicate that practitioners can rely on illuminance values computed by the tools for night time, but that the combination of daylight and electric light remains a challenge for simulation tools.

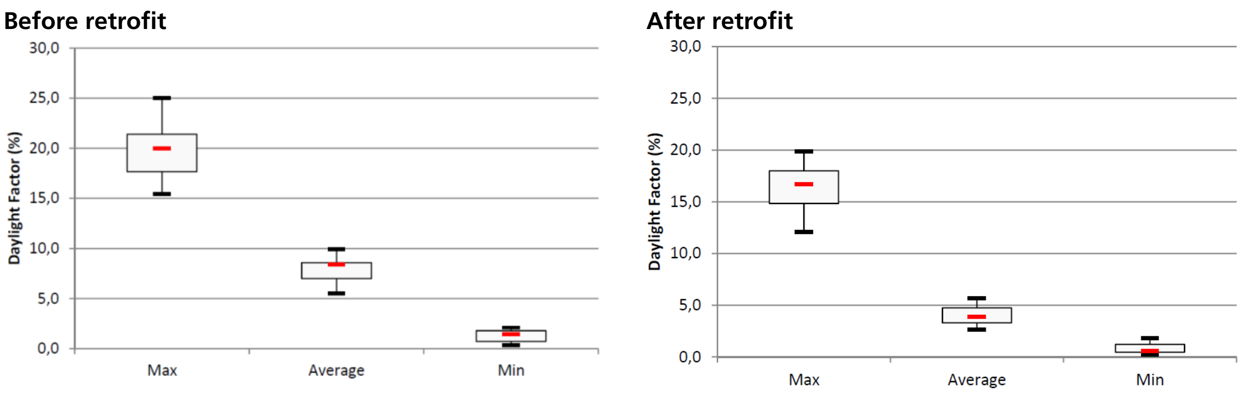


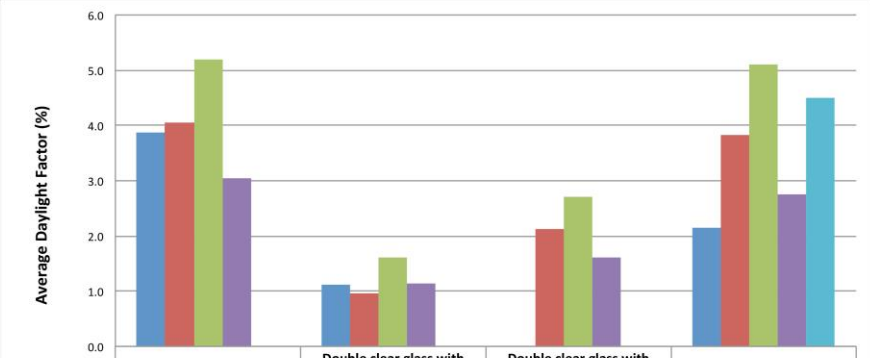
Figure 7: Exemplary results from the state of the art review of 13 simulation tools. The figures show the calculated daylight factors for a test scenario before and after retrofit. The general drop of the daylight factor due to lower light transmittance of new glazing systems (due to low ε coating) is shown. Additionally the review showed a quite significant spread of calculation results.

Energy audit and inspection procedures

Energy audit and inspection procedures were analysed in three steps. First it was looked into different metrics available to evaluate the daylight contribution. These metrics are distinguished in two categories: Daylight availability metrics and daylight glare metrics. For each of them, a short description is given, followed by an example and a description of the limitations of the metric. In a second step energy monitoring procedures for electric lighting systems were investigated. Focus was layed on the presentation of a "flash" analysis method used in Switzerland to assess the lighting status of existing buildings, based on a quick tour of the building. Finally, in step three, in a benchmark on case-studies the different metrics and simulation tools described in the state of the art review (see above) were tested.

Advanced and future simulation tools

The study looked at software able to simulate Complex Fenestration Systems (CFS) which are composed of solar shading and daylight redirection systems. Those systems might have complex light transmission properties named Bidirectional Transmission Distribution Functions (BTDF) that can be monitored using gonio-photometers or simulated using ray-tracing tools. Five tools able to simulate CFS were examined in a test case. Four kinds of CFS were considered, ranging from clear glass to lasercut panel, and were benchmarked with daylight factor values on the work plane and renderings in sunny conditions. The results showed a large discrepancy in the results for the daylight factor values, indicating the difficulty to simulate daylight likewise in the state of the art review (see description above). The renderings with sunny conditions let the user of the tools appreciate the deviation effect of the lasercut panel for instance, but the obtained images are bound to the intrinsic resolution of the monitored BTDF which may be coarse depending on the source of data. The advanced and future simulation tools can give an interesting indication of the light distribution through CFS, but practitioners should remain aware of the limits of the method using monitored data bound to a defined resolution. The results are satisfactory enough to get an idea of illuminance profiles or even heat transmission, but not for tasks that require a precise luminance distribution such as glare index calculation.



	Double clear glass	Double clear glass with diffuse blinds	Double clear glass with vertical blinds	Laser Cut Panel
DIALux evo	3.9	1.1		2.1
FENER	4.1	1.0	2.1	3.8
Geronimo	5.2	1.6	2.7	5.1
Radiance	3.0	1.2	1.6	2.8
ReluxPro				4.5

Figure 8: Daylight Factor obtained with different advanced simulation tools for 4 different complex fenestration systems.

Read more

Technical Reports

- **"Lighting retrofit in current practice, Evaluation of an international survey"**
- **"Methods and tools for lighting retrofits State of the art review"**
- **"Energy audit and inspection procedures"**
- **"Advanced and future simulation tools"**

Lessons learned from 24 case studies

Marie-Claude Dubois and Niko Gentile, Lund University, Sweden

A new monitoring protocol applicable to non-residential buildings retrofitted with electric lighting and/or daylighting technologies was developed. The Monitoring protocol has been applied to a total of 24 non-residential buildings in ten countries during the last years (Figure 10). Different building types were considered: Industry, retail, office, housing, assembly, sport/recreation and education. All case studies are presented with monitored data and key conclusions in the "Lighting Retrofit Advisor", see below. A few key lessons learned from the monitoring process are summarized below:

- Reducing energy use attributed to electric lighting was the main drive for the majority of the lighting retrofits monitored in this project.
- All retrofits monitored achieved improvements in either energy efficiency or lighting quality or both.
- The best overall results could be achieved when the focus was on an effective integration of energy performance, daylight and electric lighting.
- When the building design allows for good daylighting before the start of an electric lighting retrofit, it seems more likely that a retrofit can achieve good results with respect to user satisfaction and reduced lighting energy consumption due to effective integration with daylighting. However, as electric lighting is required for shorter periods in well-daylit spaces, lighting retrofits are less likely to be cost-effective as installation costs can easily outweigh the projected energy savings.
- When openings in the building envelope do not provide good views to the outdoors or effective daylighting in a space (e.g. because of the effective aperture being too small), building users might interact significantly less with available shading devices to regulate daylight and sunlight penetration into the space, typically resulting in even lower illumination from daylight. They might position the shading devices to avoid direct glare at specific times, but then forget to adjust the shading devices again to increase the daylight contribution later on. This could be observed before and after lighting retrofits. However, installing an integrated control system for shading and lighting to allow better daylight utilization could likely provide further energy savings potential in such a case.
- Replacing older fluorescent with appropriate LED lighting systems can lead to substantial energy savings for electric lighting. Lighting quality and user satisfaction can also be improved at the same time by providing better visual conditions in the spaces. It is, however, not recommended to just replace fluorescent tubes with LED tubes in existing luminaires other than those with diffusing panels, as it can lead to inappropriate light distribution patterns and significantly lower illuminance levels at the work plane.
- Heritage buildings present a special case, especially for daylighting and solar shading solutions, but sometimes also for electric lighting solutions, as there are typical limitations regarding alterations to exterior and/or interior building design features (depending on protection class and protected features). In the "Spanien" Public Pool and Spa in Aarhus, Denmark, the visual appearance of key luminaires had to be maintained as they are considered a part of the design heritage. Nevertheless, switching from fluorescent to dimmable LED lamps with flexible colour control inside existing luminaires resulted in a reduction in energy use and allows for the possibility to manually adjust illuminance levels and light colour depending on available daylight or other requirements.
- Upgrading older fluorescent lighting systems to newer ones can also provide benefits for both energy use and lighting quality.
- Control systems for electric lighting or solar shading devices, are frequently found to be poorly implemented, calibrated or commissioned, or perhaps too complex, resulting in reduced energy savings, annoyance of users or even in complete deactivation of the control system. This highlights the need for better guidance on the installation, commissioning and operation of lighting control systems.
- In general, the users prefer to have possibility to manually override of the control system
- The manually control of the electrical in the offices at Horsens Town Hall, Denmark, light by on/off switches are in general fulfilling the users visual needs, though a dimmable would be preferred, especially during wintertime with very low outside illumination.

It is suggested that building owners implementing a lighting retrofit strongly consider monitoring appropriate performance metrics (see monitoring protocol) before and after such a retrofit to gauge the potential for the retrofit and later assess the success of the retrofit.

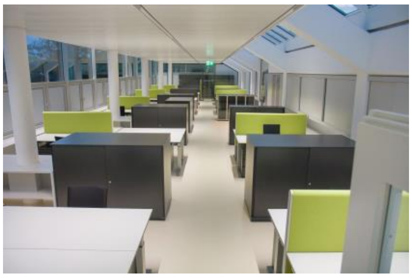


Figure 9: Pre- and post-retrofit of the Bartenbach R&D office in Austria.

Figure 10: Lighting retrofits in a total of 24 non-residential buildings case studies.

Read more

Technical Reports

- "Building Stock Distribution and Electricity Use for Lighting"
- "Daylighting and electric lighting retrofit to reduce energy use in non-residential buildings: A literature review"
- "Monitoring Protocol for lighting and daylighting retrofits"
- "Lessons learned from monitoring lighting and daylighting in retrofit projects"

Electronic Sourc Book

Detailed description of 24 case studies can be found in the Lighting Retrofit Adviser in the component "Case Studies"

The Lighting Retrofit Adviser

Simon Wössner, Jan de Boer, Fraunhofer Institute for Building Physics (IBP), Germany

The "Lighting Retrofit Advisor" is an integrative, comprehensive, multi-platform (desktop / mobile) tool for stakeholders involved in lighting retrofits and draws on the main results of the different subtasks:

- Authorities can find information on regulation and certification approaches for lighting retrofits.
- Investors can inform themselves on the economic boundary conditions of bringing new lighting systems into practice.
- Designers / consultants can make use of for instance an "On-Site Optimizer" that allows to develop retrofit concepts directly on site, while drawing from a knowledge database of 40+ retrofit techniques (daylight, electric lighting and lighting controls) and 20+ case studies.

The LRA consists of two categories of components organized in an information part and a calculation & rating part. Figure 11 gives an overview on the different components *.

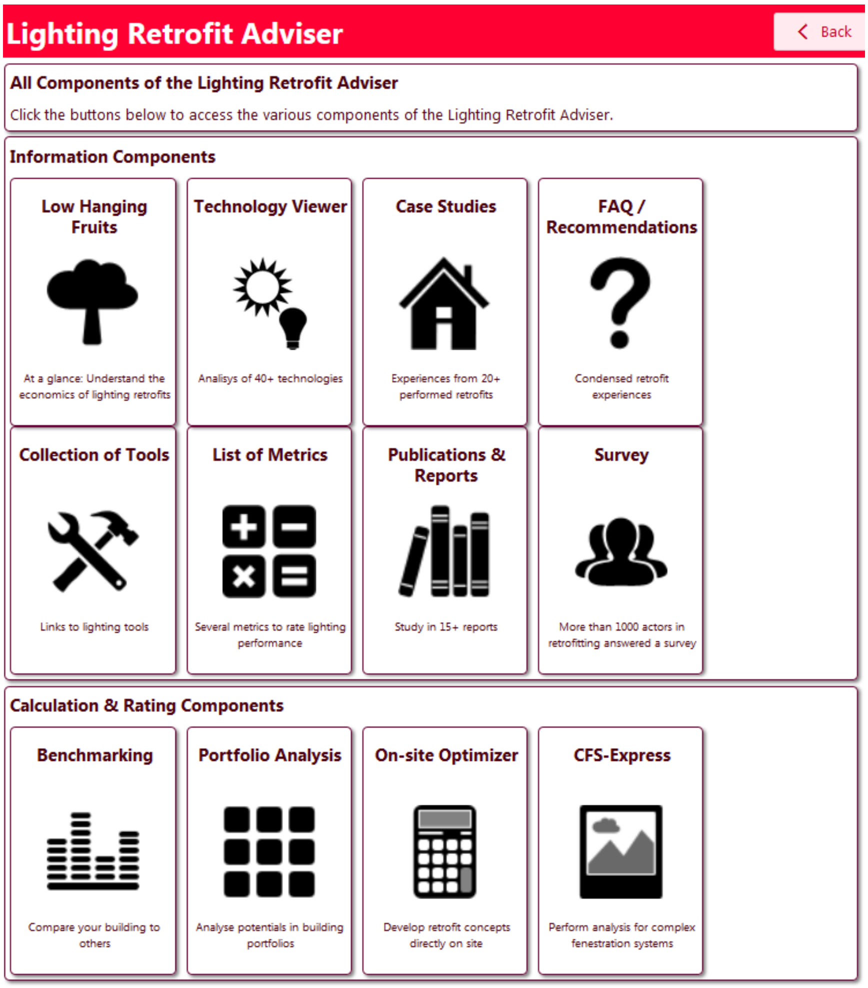


Figure 11: Components of the IEA-SHC Task 50 Lighting Retrofit Adviser:

Information components:

- Low hanging fruits: With the significant boost in efficiency in lighting in many cases a direct replacement of old installations is at little payback times an interesting option to consider. For typical applications like offices, schools, industry wharehouses / retail total cost of ownership (TCO) analysis are presented and discussed.
- Technology Viewer: More than 40 technologies in the field of electric lighting, daylight, light management and relating to measures in the building interior are described and rated according to a set of criteria on energy efficiency, lighting quality and thermal benefits. The technology viewer allows to compare different technologies on a direct one to one basis.
- Case Study Viewer: More than 20 lighting retrofit case studies in different latitudes and climatic zones covering offices, education facilities, manufacturing halls, whole sale stores, spa, etc. are presented. All case studies were assessed according to newly developed monitoring protocol which covers the aspects: Costs, Lighting Energy Use, Lighting environment and user perspectives. Several figures and data tables support the presentation.
- FAQs: Collection of frequently asked questions and answers on "General questions on lighting retrofits", "Lighting quality, "Lighting control / users' behavior".
- Collection of tools / list of metrics: These components compare different tools and metrics used / or suited for application in lighting retrofits.
- Publications & reports: Holds brief descriptions and full text version of the task reports.
- Survey: A large survey among more than 1000 practitioners on tools and methods in lighting retrofits was conducted. The results of this survey are found in this component.

Calculation Components:

- Benchmarking: Compare installed power and energy consumption for lighting purposes of your building to typical values.
- Portfolio Analysis: Analyze a portfolio of several buildings and compare it to typical consumptions of comparable portfolios.

* The LRA provides a direct access via components via stakeholder-related information.

- On-site Optimizer: Lighting is decentralized in buildings. Often there is no detailed information available on the energy performance, operation hours and in the end on the economics of the lighting installations. This component (Figure 12) allows the on-site assessment for a direct analysis of potentials (energy, CO2 emissions, economics). To support further development of retrofit options, it automatically generates retrofit proposals.
- CFS Express: The "CFS Express" allows to analyze the impact of different complex fenestration systems (sun- shading, glare protection) on natural illumination of spaces and energy demand for lighting. It delivers hourly values. It can be chosen from worldwide 19 representative locations (geographic site, and climatic data). The underlying algorithm has been optimized such, that the calculation can be performed in a few seconds (compared to hours in former calculation schemes).

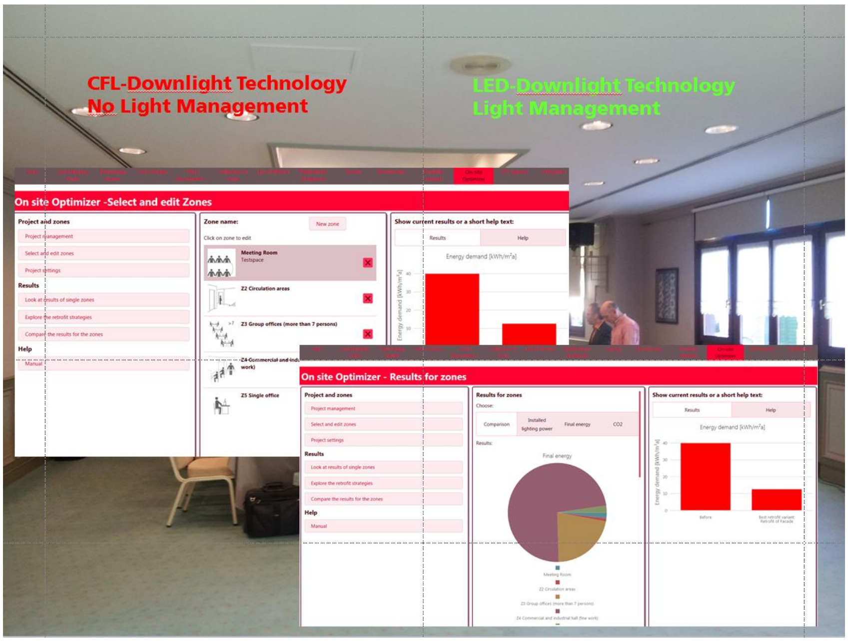


Figure 12: On site assessment of a meeting room at an IEA EXCO meeting.

Stakeholder related access to information

This access to the lighting retrofit adviser provides tailored information to different stakeholder information needs (policymakers / authorities, owners/investors, tenants, designers / consultants, industry / seller, installers (Figure 13)). In addition it directs to the most relevant information, tools, and / or reports within the tool.

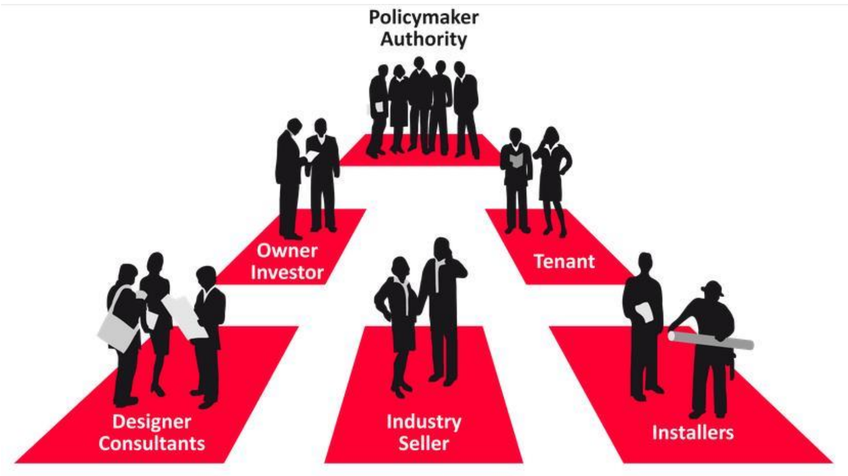


Figure 13: On site assessment of a meeting room at an IEA EXCO meeting.

Get the adviser

The tool is available under

www.lightingretrofitadviser.com

for different platforms: Desktop- - Webbased, Android, IOS, Windows Phone. Beside an English, also a Chinese, French, German and Portugese Version will be available.

Download on the App Store

GET IT ON Google Play

Get it from Microsoft

Further information on IEA SHC Task 50

Industry workshops

Figure 14: Impressions from the last IEA Task 50 industry workshop in Brasilia.

Over its duration Task 50 has attracted high interest from industry. Altogether 6 industry workshops were organized in conjunction with the task meetings in Lund, Sweden, Copenhagen, Denmark, Innsbruck, Austria, Fukuoka, Japan, Alesund, Norway and Brasilia, Brasil. With the industry workshops it was tried to continuously inform about general lighting retrofit issues and possible solutions and to mirror the Task activities with respect to industry and practitioners needs. The industry workshop were very well visited with altogether 390 participants.
IEA SHC Task 50 was organized in four Subtasks and one Joint Working Group, in which with the Lighting Retrofit Adviser was developed (Figure 15).

Task structure

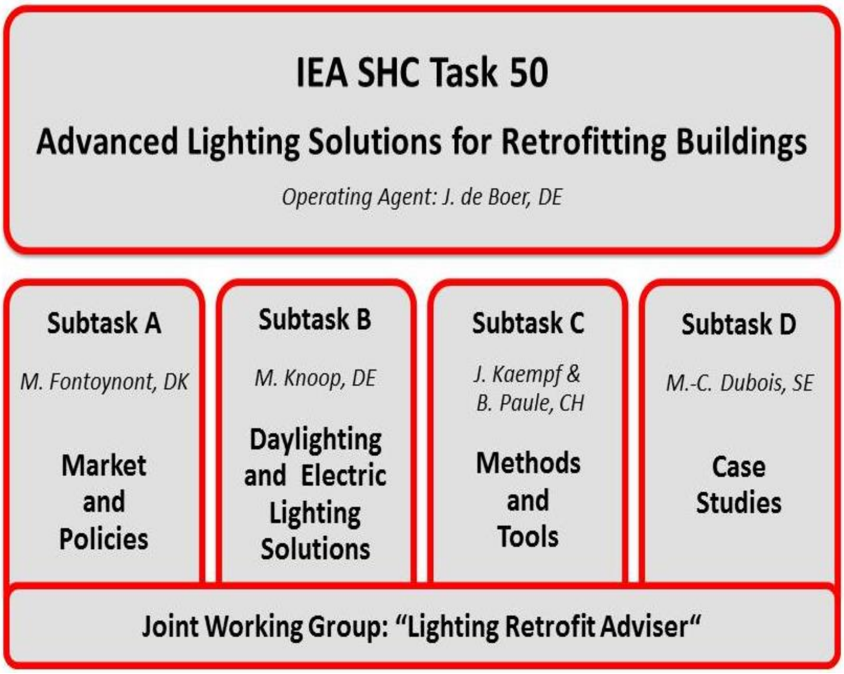


Figure 15: Structure of IEA Task 50.

Participating countries and experts

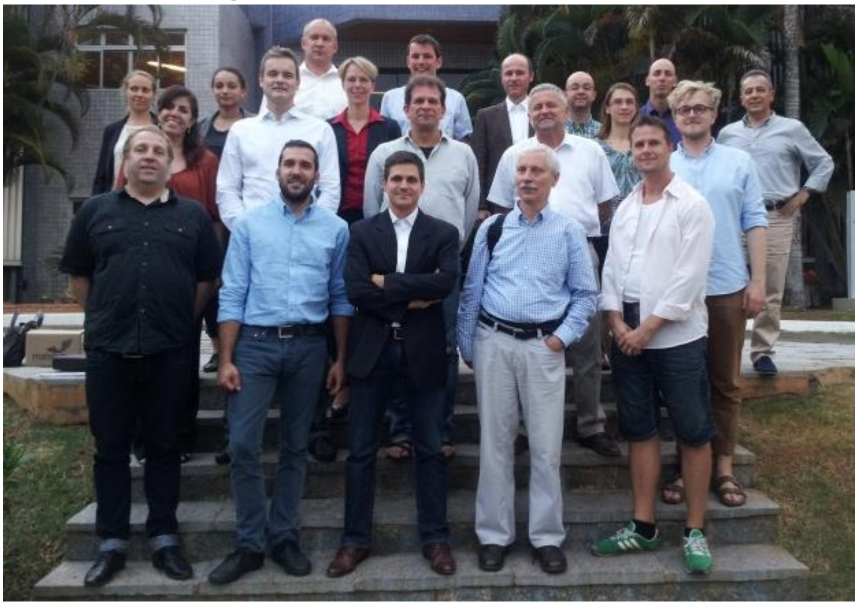


Figure 16: Participants of the 6th Task meeting in Brasilia, Brasil.

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Task Information

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