
Proposal of Actions Concerning the Value Chain

T50.A3

A Technical Report of IEA SHC Task 50
Advanced Lighting Solutions for Retrofitting
Buildings

May 20, 2016

IEA Solar Heating and Cooling Programme



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Proposal of Actions Concerning the Value Chain

A Technical Report of Subtask A, T50 A.3

IEA SHC Task 50: Advanced Lighting Solutions for Retrofitting Buildings

May 20th 2016

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PREFACE

Lighting accounts for approximately 19 % (~3000 TWh) of the global electric energy consumption. Without essential changes in policies, markets and practical implementations it is expected to continuously grow despite significant and rapid technical improvements like solid-state lighting, new façade and light management techniques.

With a small volume of new buildings, major lighting energy savings can only be realized by retrofitting the existing building stock. Many countries face the same situation: The majority of the lighting installations are considered to be out of date (older than 25 years). Compared to existing installations, new solutions allow a significant increase in efficiency – easily by a factor of three or more – very often going along with highly interesting payback times. However, lighting refurbishments are still lagging behind compared to what is economically and technically possible and feasible.

IEA SHC Task 50: Advanced Lighting Solutions for Retrofitting Buildings” therefore pursues the goal to accelerate retrofitting of daylighting and electric lighting solutions in the non-residential sector using cost-effective, best practice approaches.

This includes 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 (“Lighting Retrofit Adviser”) including design inspirations, design advice, decision tools and design tools

To achieve this goal, the work plan of IEA-Task 50 is organized according to the following four main subtasks, which are interconnected by a joint working group:

Subtask A: Market and Policies

Subtask B: Daylighting and Electric Lighting Solutions

Subtask C: Methods and Tools

Subtask D: Case Studies

Joint Working Group (JWG): Lighting Retrofit Adviser

ABSTRACT

In this section, we 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.

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

We have identified lack of awareness and know-how in the value chain, and strategic information to deliver to stakeholders.

We identified also possible models from financing lighting retrofit: with investment fully managed by the building owners, or shared with banks and ESCO's. Also we explored potential opportunities associated to "leasing" of lighting installations: in this case, the building owner does not own the lighting installation, and is not in charge of maintenance.

On the side of regulation and labels, we propose various actions by governments and energy agencies to accelerate deployment of energy efficient lighting solutions.

Globally, the proposal of actions concern accelerating retrofits before the end of existing life of lighting installations: this means that benefits justify an anticipated investment.

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Introduction

Lighting installations have to be changed at the end of their life (typically around 30 years in indoor lighting), or when a major refurbishment is planned. The IEA 50 explores possible other opportunities to conduct retrofits: when electricity consumption of existing installation are excessive in comparison with modern energy efficient ones. In this case, it may be beneficial to anticipate lighting retrofit operation alone.

But who could benefit from such anticipated operations?

Perception of benefits varies as a function of stakeholders. From this review it is expected that the way to present benefits associated to lighting retrofit should be adapted to teach target group.

1. Opportunities for actors in the construction with respect to lighting

Table 1 Profit from lighting retrofit for stakeholders

Stakeholders	Status	Financial model	Low hanging fruits
Building user / tenants	Tenants are interested in low operating costs, high quality of use, low maintenance, image, and possibly environmental performance.	Assess quality of existing lighting installation and possibly investigate improvement.	Try to assess operating costs imbedded in monthly rentals.
Building owner / investor	Renting or selling buildings with up to date energy-efficiency, and well designed lighting to facilitate sales and thus securing value of building.	Lighting refurbishment can contribute not only to accelerating sales but also, increase the perceived value, and increase selling price. Lighting refurbishment costs between 30 and 50€/m ² (but going down to 10€/m ² in industrial buildings. This reduces lighting electricity costs by 2 to 7 €/m ² per year and can lead to increasing rental value by 10-30€/m ² per year due to a combination of reduced operating costs and improvement in indoor quality.	Owner and investors should look for low hanging fruits: existing installations where benefits associated to lighting retrofits are the highest, and the fastest. For instance installations used more than 4000 hours per year, with an electric power density more than 3 times the one of modern installations: more than 12 W/m ² in offices and industrial buildings.
Policy maker / authority	Lighting retrofit can reduce annual lighting electricity consumption by 2 to 5 with reasonable investment and reduce consequently the CO ₂ emissions associated with electricity generation. Allow reallocation of electric power to more essential use (transportation, communication, etc.) Renovation of lighting installation with modern equipment can improve indoor lighting quality (work spaces).	There are benefits related to lighting retrofits in public buildings managed by authorities. Authorities can also stimulate lighting retrofits: tax deduction, subsidies, labelling, regulation, etc.	Policy makers and authorities should identify "low hanging fruits" to stimulate lighting retrofits in areas where results can be achieved more rapidly. All cases where a large fractions of lighting electricity is wasted, should be identified. For instance cases where consumption could be divided by at least 3.
Engineers / designer consultants	Develop new market, value new services	Develop value for the clients (reduction of energy, improved quality, satisfaction)	Develop cheap product with high efficiency
Installers	Expand their market through acceleration of replacing of equipment.	Find new low cost products. Get high profits by low cost but good looking products. Interested in installing products with innovative functionalities. Can also promote high quality and energy efficient products, regardless of price	Interested in products that are simple to install (plug and play)
Industry sellers	Expand their market, through creating state of the art products.	Create efficient and low cost products, which meet the client's demands. Thus can be sold at great profit.	Finding the market for where products can be most improved, industry, retail, etc. The developing high performing product for low cost.

2. Possible targeted actions

Table 2 Actions by stakeholders

Stakeholders	Actions
Building user / tenants	Contact owners and investigate possible mutual benefits associated with lighting retrofit, more particularly to reduce operating costs. Identification of possible problems (glare, flickering, insufficient illuminance, insufficient spectral quality). Possibly assess if current lighting meets standards. Identify possibility to improve lighting quality
Building owner / investor	Contact a professional (engineer, installer, etc.) and ask for an assessment of electric power of the lighting installation and annual lighting electricity consumption. Report for all spaces in building: electric power density (W/m ²), operating hours, annual electricity consumption, annual cost of lighting electricity, possible data on actual maintenance (cleaning, change of lamp, etc.) Ask a professional for a quote for lighting retrofit including installation costs, maintenance costs and estimation of annual cost for lighting electricity. Investigate specific costs associated with daylight responsive or occupancy sensors. Investigate opportunities for improving shading devices and daylight penetration. Estimate return on investment through a Total Cost of Ownership approach: cost of installations and predictions of annual costs over the next 10 years. Estimate pay-back time in years.
Policy maker / authority	Conduct an inventory status of existing lighting installations (age, performance, daylighting, control systems) Identify cases associated with largest waste of lighting electricity (private and public buildings, commercial and non commercial, etc.) Include maximum allowance for electric power for lighting in regulations (for instance W/m ²) Provide funding (subsidies, tax credit) related to amount of savings in lighting electricity achieved. Inform installers, engineers and consultants of financial incentives.
Engineers / designer consultants	Develop knowledge on innovative high efficiency lighting schemes, and products. Understand problems associated with low performing lighting installations. Develop ability to perform on-site performance assessment. Look for "low hanging fruits", for which retrofit will be easier to launch. E.g. excessive lighting power density, old luminaires, high level of usage, and poor quality.
Installers	Develop knowledge on innovative high efficiency lighting schemes, and products. Understand problems associated with low performing lighting installations. Develop ability to perform on-site performance assessment. Look for "low hanging fruits", for which retrofit will be easier to launch. E.g. excessive lighting power density, old luminaires, high level of usage, and poor quality. Select best possible offer by manufacturers for lighting products. Develop knowledge on financial incentives for lighting retrofits.
Industry sellers	Develop knowledge on innovative high efficiency lighting schemes, and products. Understand problems associated with low performance lighting installations. Develop product to counteract this. Look for "low hanging fruits", improvement of power density, high level of usage, and poor quality. Develop knowledge on financial incentives for lighting retrofits.

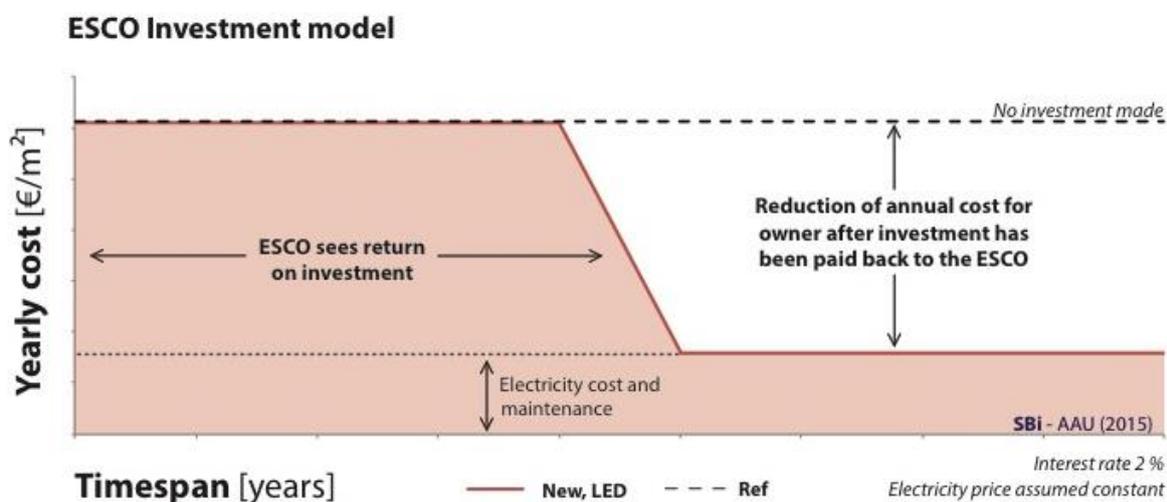
3. Possible role of ESCOs

ESCO's (energy service companies) can play two roles in lighting retrofitting.

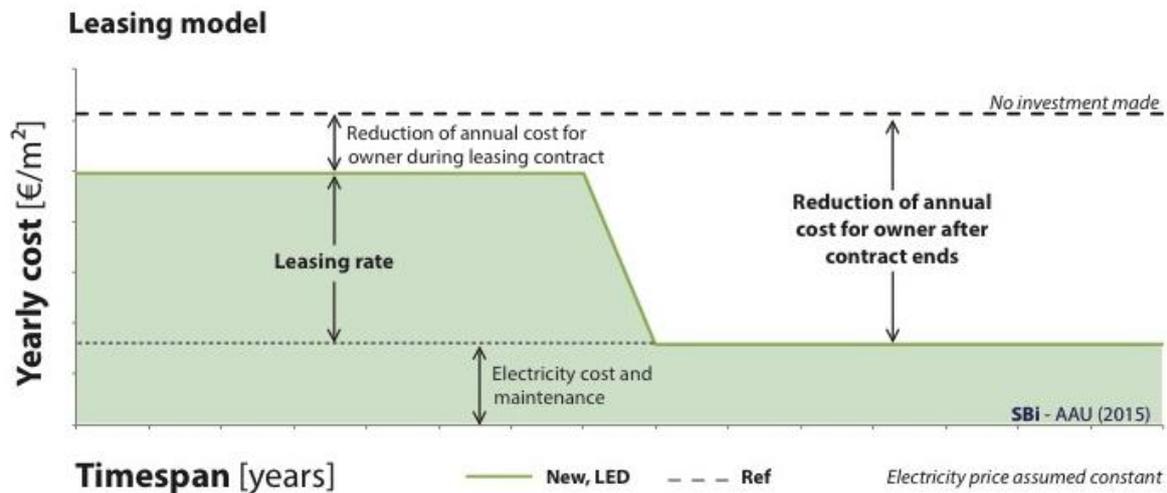
The first is as a consulting party where they advise the client on how to invest in regard to retrofitting. This consultation is applied as a one-time fee for the project. Thereby the client makes the investment and pays the ESCO to facilitate/supervise the project. Schneider Electric is an example of a company in Denmark, which has offered this service to many larger energy renovation projects. ESCO's are not limited to lighting retrofitting but apply to a wide range of energy renovation solutions.

If the clients are unable to provide the investment themselves, they can borrow the partial or full amount related to the required investment from a bank and thus are responsible to pay it back with an interest rate, which can be unaffected by the annual energy savings.

It is also possible for the ESCO to be responsible for supplying the partial or full financing of the project and thus an energy saving performance contract (ESPC) is proposed. This has the objective to share the profit, associated to the saved energy consumption, between the owner and the investing party, the ESCO, for a specified number of years until the investment is paid back. The investing party will thereby have payback plus an interest rate and the user will have a lower annually energy consumption after the payback period. However, the investing party is not necessarily responsible for the maintenance of the system after the retrofit, this can be outsourced to a third party.



One of the newer solutions supplied by companies is leasing a complete service package, which includes heating, cooling and electricity use. The lighting retrofit will thus be part of a full package and is therefore “paid off” as a part of the complete kWh consumption per year.



The leasing principle has also been proposed by various professionals: lighting manufacturers or facility managers. The partner providing the leasing is responsible for the investment and thereby establishes a contract with the user for the price of operation, installment and maintenance.

Therefore, the consumer is no longer the “owner” of the lighting system, but the provider of the leasing is. After the contract ends the service provider will propose either to remove the installation or propose a new contract with a new and more efficient lighting system, and possible new functionalities.

As a consequence, this also opens up the possibility of second hand luminaire installations, which will allow companies to exploit the full capacity of the luminaires.

The lighting manufacturer Zumtobel supplies the leasing concept with their service NOW!. Here the user leases the lighting system as a service from Zumtobel at an annual rate. The building owner therefore pays the reduced electricity cost plus the NOW! Rate, which adds up to an annual sum smaller than the energy consumption before the retrofit.

Thus the consumer has made a profit, which is then available for other investments. This NOW! Rate is a contract for the leasing period (5 – 8 years) but it is not clear from Zumtobel’s website whether ownership of the system is exchanged back to the user after the contracted period ends.

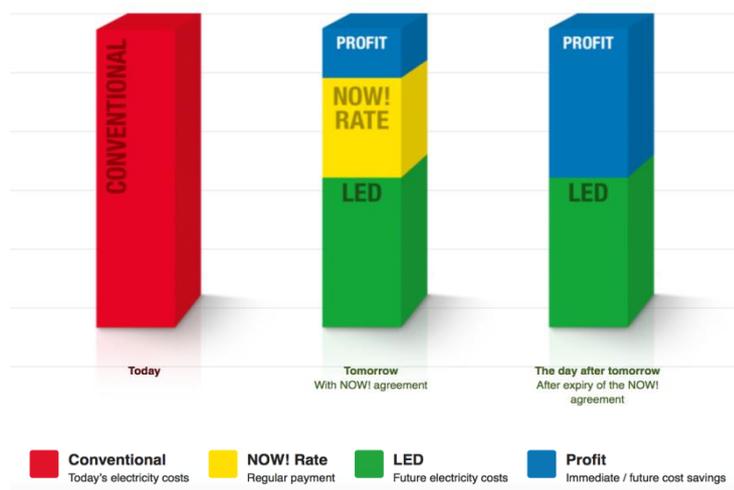


Figure 1 - Principle of NOW! Lighting,

3.1. Investment models for case scenarios

This section proposes to illustrate the application of two of the financial models:

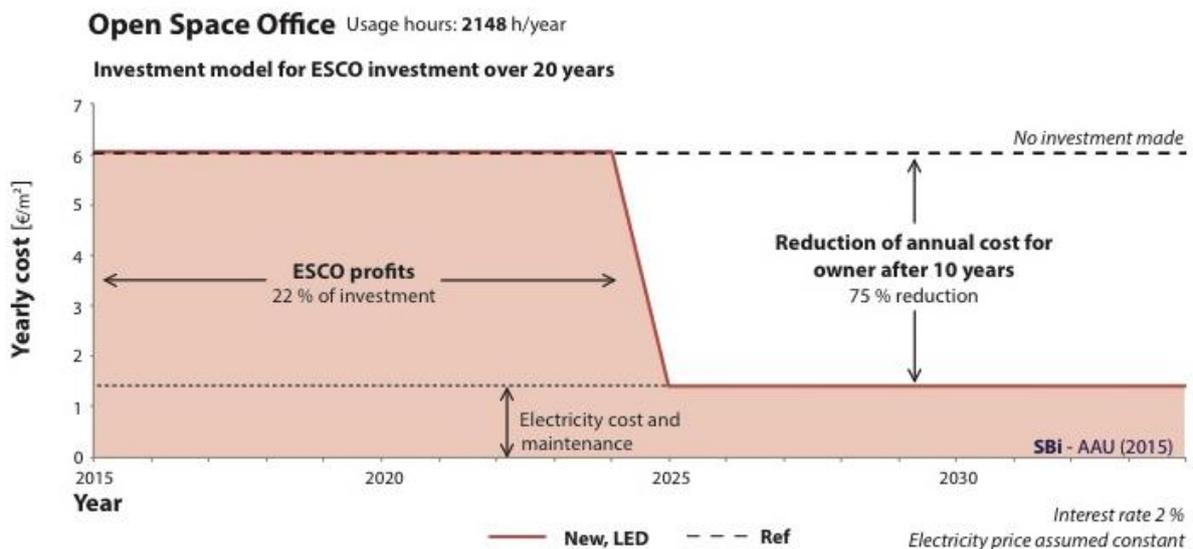
- ESCO model
- leasing agreement model

But for some of the scenarios, such as classroom and personal office, it was not possible to see a payback time less than 20 years for both models due to the low usage hours for both scenarios. For this reason, they were excluded from our analysis.

We kept Open space offices, manufacturing hall, and wholesale cases.

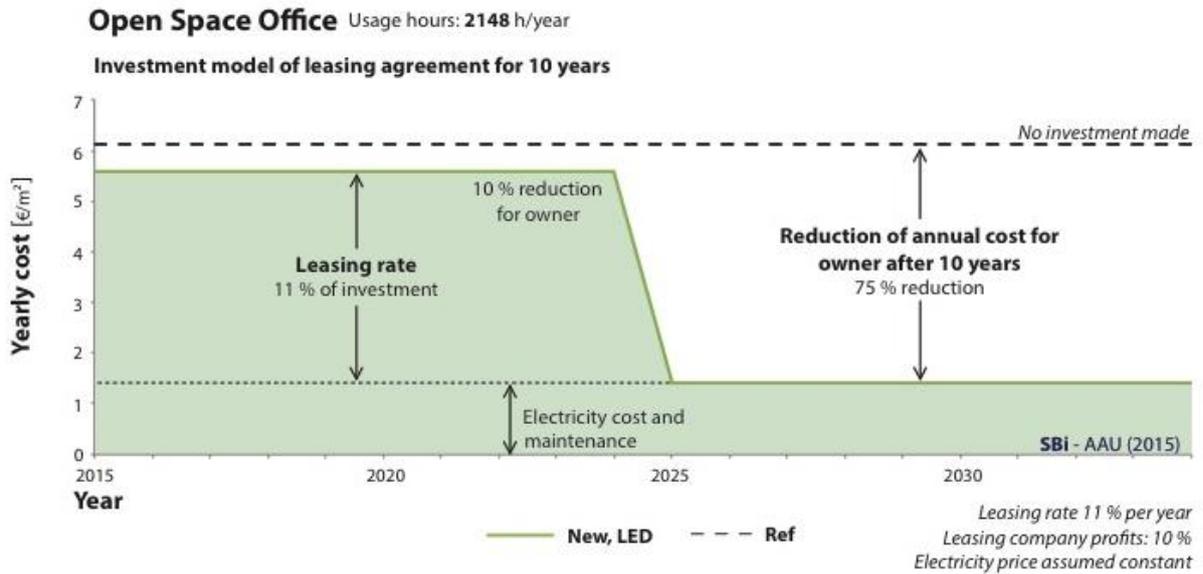
3.1.1. Open Space Office

If a ESCO company is responsible for handling the investment for the energy retrofit, then in this case, the ESCO can expect to make a 22 % profit out of the investment, if the owner accepts a loan over 10 years, and to postpone its' profits to afterwards. In this case owner sees a reduction of annual energy cost by 75% after the 10 years. (Cost of maintenance and lighting electricity reduced by a factor of 5).



Lighting can also be leased over 10 years. If lighting is leased at an annual rate, which includes 11 % of the initial investment plus the electricity cost and maintenance. Owner will have an immediate annual reduction of 10 % for 10 years and then 75 % reduction after 10 years, when the contract ends.

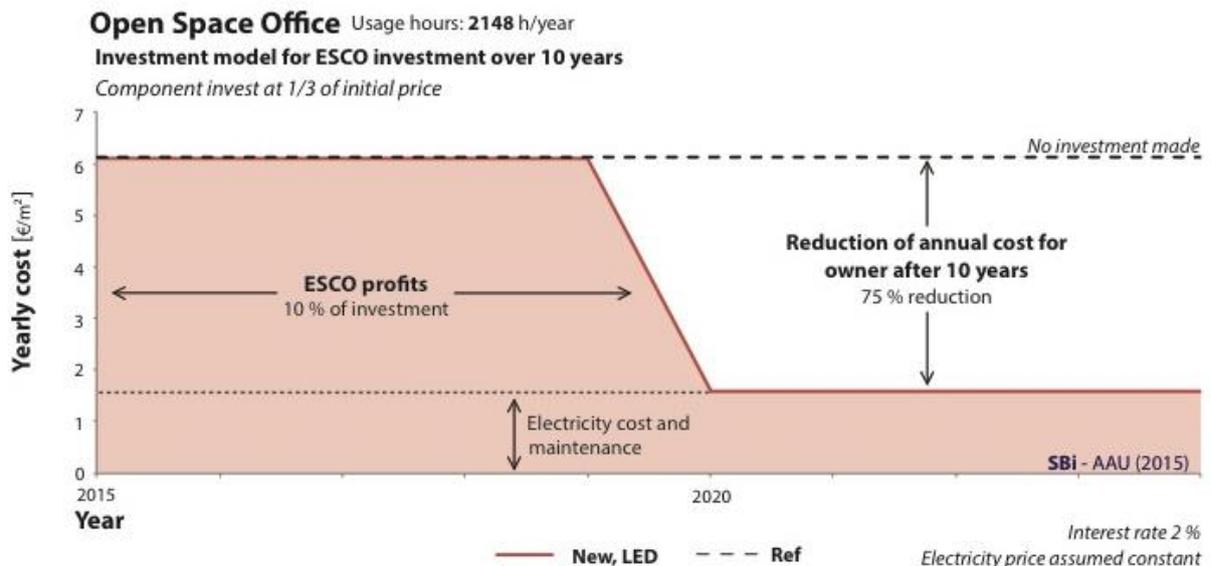
The leasing company will after 10 years have made a 10 % profit above the initial investment.



Investment models for open space office with a component cost at 1/3 of initial price

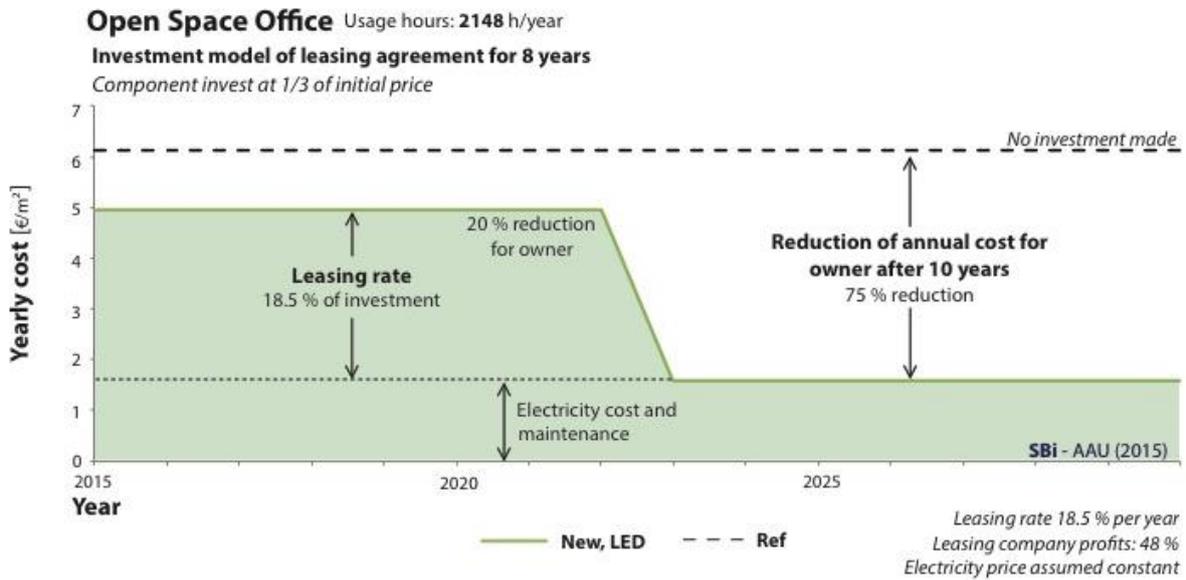
Below is a simulation of a case where the investment is lower due to the installation of equipment at a third of the price for the former case. Please note on the following table that the x-axis is using a larger scale.

In this case, the ESCO company makes a 10 % profit after only 5 years and the owner has a 75 % reduction in annual costs after 5 years only.



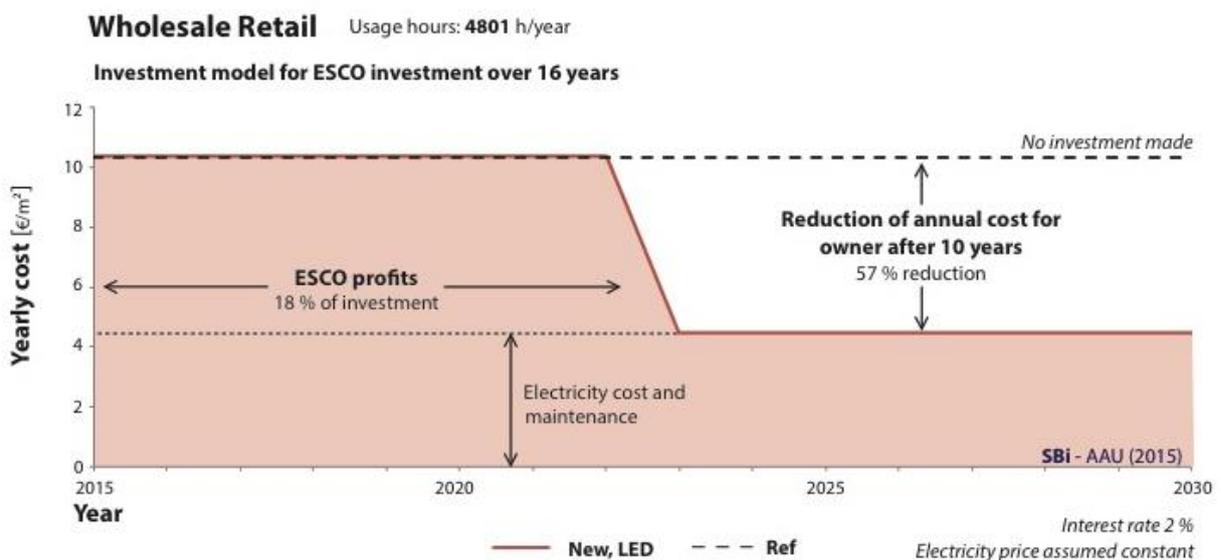
With this hypothesis, lighting can be leased at annual rate of 18,5 % of initial investment, the owner must still pay for the electricity and maintenance to the leasing company. Owner will have immediate annual reduction of 20 % for 8 years and then 75% reduction after 10 years, when the leasing contract is finished.

The leasing company will, after 8 years, have made a 48 % profit above the initial investment. (These results are however dependant on the decrease in equipment cost.)



3.1.2. Whole sale retail

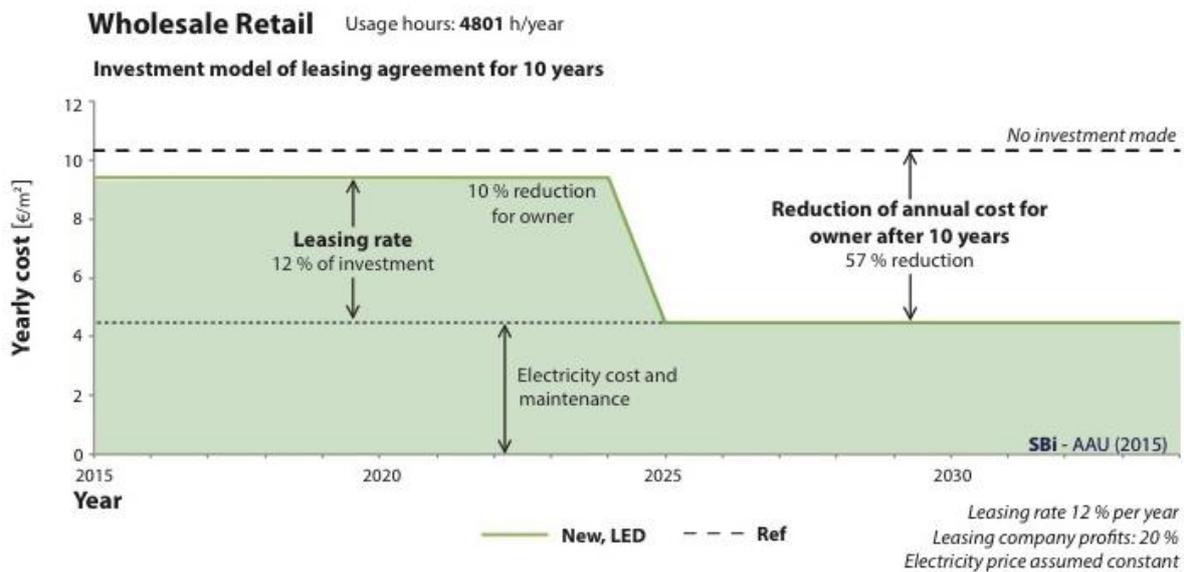
If a ESCO company is responsible for handling the investment for the energy retrofit, then in this case, the ESCO can expect to make an 18 % profit out of the investment, if the owner accepts a loan over 8 years, and to postpone its' profits to afterwards. In this case owner sees a reduction of annual energy cost by 57% after the 8 years.



A lighting leasing contract for 10 years can also be made and if lighting is leased at an annual rate, which includes 12 % of the initial investment plus the electricity cost and

maintenance. Owner will have an immediate annual reduction of 10 % for 10 years and then 57 % reduction after 10 years, when the contract ends.

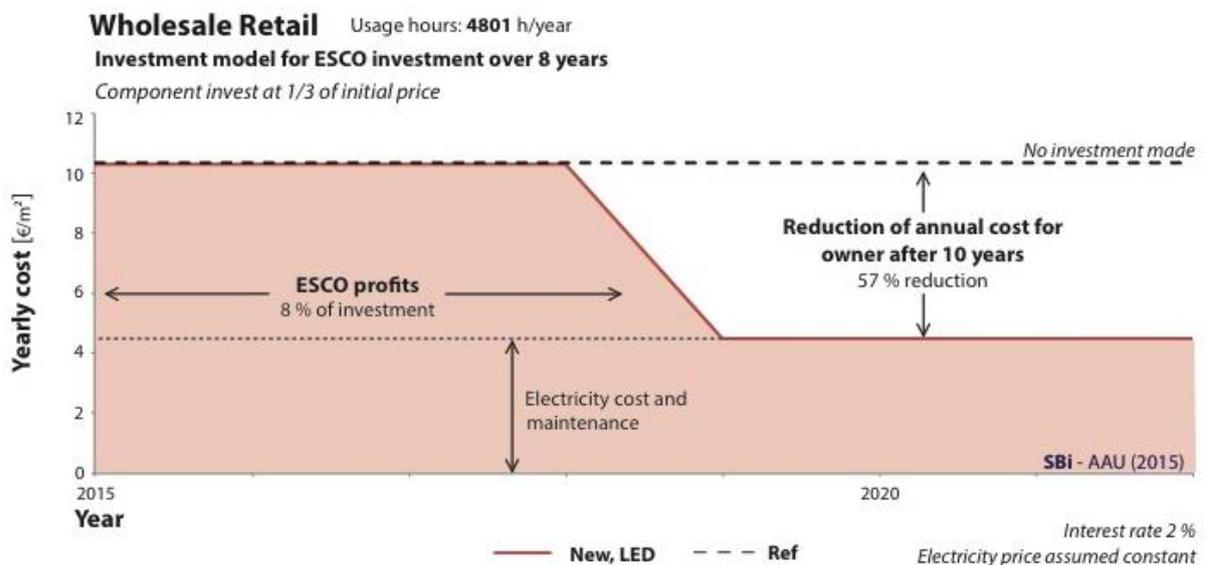
The leasing company will after 10 years have made a 20 % profit above the initial investment.



Investment models for open space office with a component cost at 1/3 of initial price

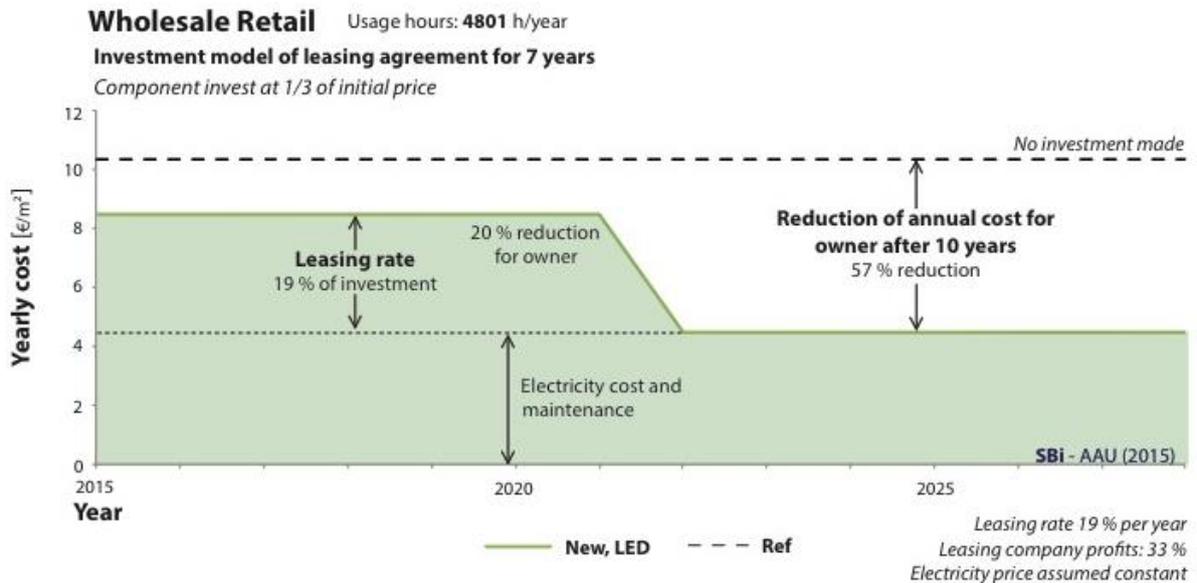
Below is a simulation of a case where the investment is lower due to the installation of equipment at a third of the price for the former case. Please note on the following table that the x-axis is using a larger scale.

In this case, the ESCO company makes an 8 % profit after only 4 years and the owner has a 57 % reduction in annual costs after 4 years only.



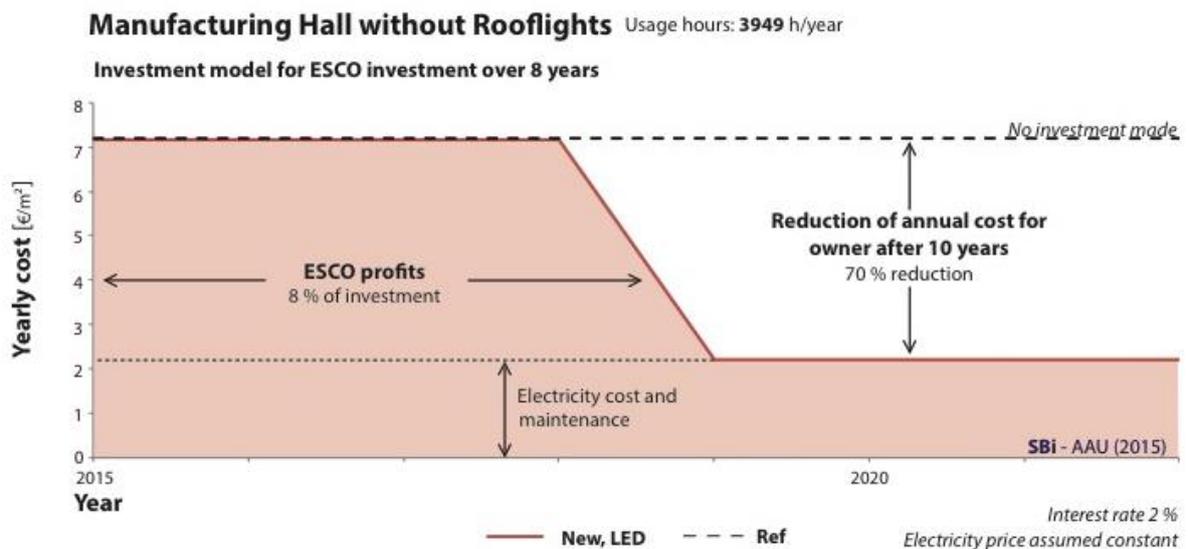
With this hypothesis, lighting can be leased at annual rate of 19 % of initial investment, the owner must still pay for the electricity and maintenance to the leasing company. Owner will have immediate annual reduction of 20 % for 7 years and then 57% reduction after 7 years, when the leasing contract is finished.

The leasing company will, after 7 years, have made a 33 % profit above the initial investment. (These results are however dependant on the decrease in equipment cost.)



3.1.3. Manufacturing Hall without roof lights

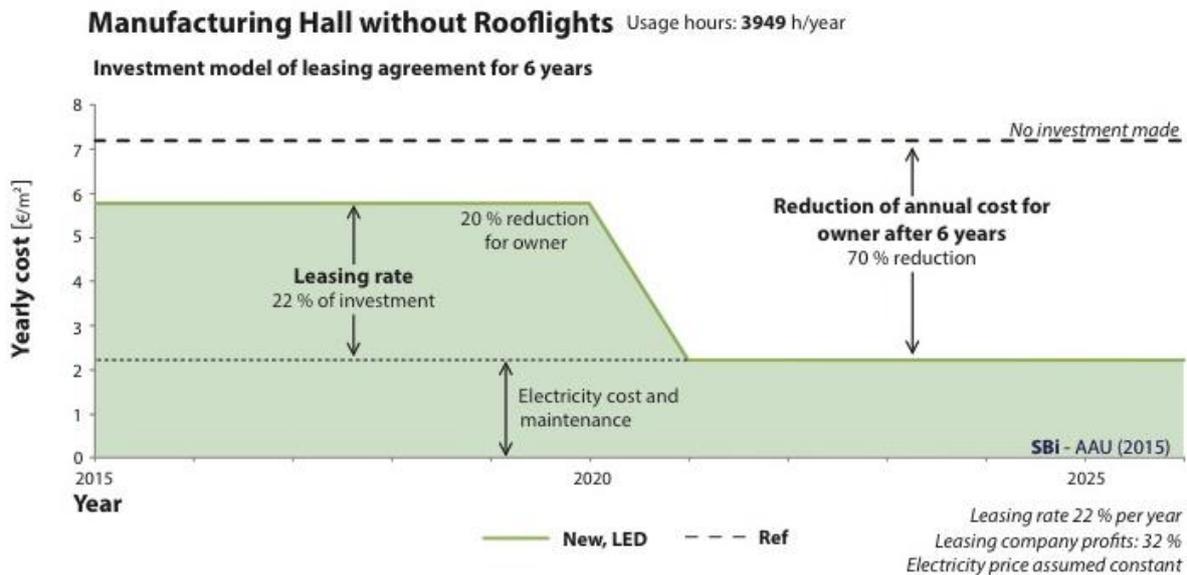
If a ESCO company is responsible for handling the investment for the energy retrofit, then in this case, the ESCO can expect to make an 8 % profit out of the investment, if the owner accepts a loan over 4 years, and to postpone its' profits to afterwards. In this case owner sees a reduction of annual energy cost by 70% after only 4 years.



A lighting leasing contract for 6 years can also be made and if lighting is leased at an annual rate, which includes 22 % of the initial investment plus the electricity cost and maintenance.

Owner will have an immediate annual reduction of 20 % for 6 years and then 70 % reduction after 6 years, when the contract ends.

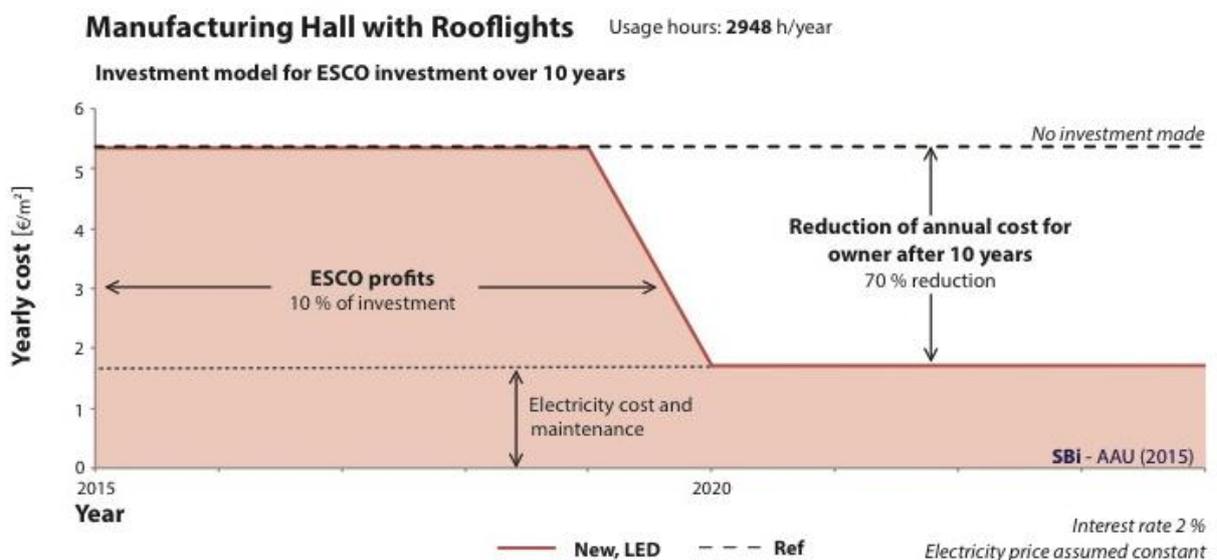
The leasing company will after 6 years have made a 32 % profit above the initial investment.



Due to the already low component cost for the manufacturing hall, there has been made no further investigations with a 1/3 of that price.

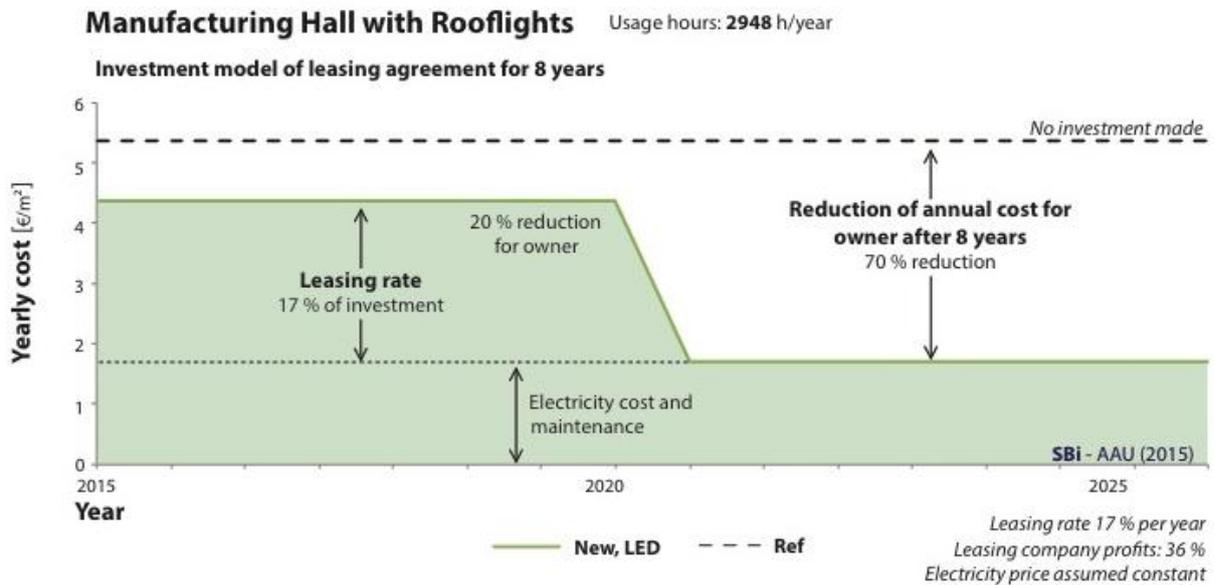
3.1.4. Manufacturing Hall with roof lights

If a ESCO company is responsible for handling the investment for the energy retrofit, then in this case, the ESCO can expect to make an 10 % profit out of the investment, if the owner accepts a loan over 5 years, and to postpone its' profits to afterwards. In this case owner sees a reduction of annual energy cost by 70% after only 5 years.



A lighting leasing contract for 8 years can also be made and if lighting is leased at an annual rate, which includes 17 % of the initial investment plus the electricity cost and maintenance. Owner will have an immediate annual reduction of 20 % for 8 years and then 70 % reduction after 8 years, when the contract ends.

The leasing company will after 6 years have made a 36 % profit above the initial investment.



Due to the already low component cost for the manufacturing hall, there has been made no further investigations with a 1/3 of that price.

4. Extended status of stakeholders

Table 3 Role of lighting clusters

Stakeholders	Lack of knowledge or needs	Possible action to raise knowledge	Format of strategic information to deliver
Building user	On non conventional lighting schemes	Show example of well accepted efficient lighting schemes	Allow access to demonstration
Building owner/investor	Relation between lighting scheme and value	Possible impact of lighting scheme on rental value	Supply examples with cost data
Building manager		Information of status on present installation	
Cost surveyor	TCO values	Difference in TCO values between schemes	Details of costs (investment, installation, maintenance, etc.)
Architects	New solutions	Raise interest on benefits and risks	Images showing that efficient lighting is also attractive
Electrical engineers	New products	Provide technical information	Web site information
Façade engineer	Visual and luminous aspects of solar shading	Document impact of façade schemes on lighting use	Solutions for glare protection, deep daylighting
Installer	Constraints related to new products	Status of new products	Show examples of lighting schemes with

			installation details (and risks)
Product distributor	More robust information on products	Criteria for product selection	Document specific quality criteria
Lighting manufacturer	Relation with final clients. New markets	New evidence on benefits	Provide evidence on other benefits. Link with lighting associations
Company doctors	Need to relate complaints and difficulties to environmental issues	Supply information on human benefits associated with successful retrofits	Possible use the professional medical associations
Office designers	Possible impact of new lighting technologies on indoor space management	Provide information of opportunities with lighting, to be developed during retrofit	Communicate errors and successes (case studies)
Electric Utilities	Evolution of electricity demand with new lighting schemes	Show evolution of variation of lighting electricity demand	Communication through events organized with utilities

From the results, it is possible to identify and communicate possible actions which could be stimulated by governments and energy agencies.

5. Conclusions and Recommendations

This report identified possible options of financing building retrofits, to accelerate deployment of replacement of existing installations: 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, on their reliability and quality.