# Evaluation of the European GreenLight Programme

**Silvia Rezessy and Paolo Bertoldi, European Commission Joint Research Centre**

**Rita Werle, European Commission Joint Research Centre**
**A+B International, Switzerland**

**Vassilios Karavezyris, European Commission Joint Research Centre**
**Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany**

**Perry Sebastian, Capella University, USA**

**ABSTRACT**

This paper is a summary of the main findings of the evaluation of the GreenLight Programme, a voluntary non-residential energy efficiency programme of the European Commission. The GreenLight Programme aims at stimulating increased investment into efficient lighting in a visible manner. The paper reports on how successful the GreenLight Programme was during the period 2000-2008 and includes recommendations for the future. These recommendations could serve well for other voluntary energy efficiency programmes.

The result of the evaluation is that the GreenLight Programme was very successful during the assessed period. The network of Partners was continuously expanding reaching 519 Partners by the end of 2008. Out of this, 90 Partners coming from the New Member States of the European Union joined between 2006-2008. New GreenLight gave an impetus to the promotion of the GreenLight Programme. It was launched in 2006 aiming to expand the GreenLight Programme to the New Member States of the European Union.

In total, Partners saved 241 GWh/year by the end of 2008 which corresponds to a saving of around 24 million EUR in running costs. From the total, almost 60 GWh/year was saved by Partners coming from the New Member States. One GreenLight Partner saved 689 MWh/year on the average, or 35.99% compared to the level of energy consumption before introducing energy saving measures.

As for technology, savings were achieved through lamp conversions and the use of lighting controls. In the case of interior lighting, changing mercury vapour lamps or fluorescent T8 tubes to fluorescent T5 tubes accounted for 23% of the assessed energy savings. Converting metal halide lamps to compact fluorescent lamps generated a further 10% saving. In the case of outdoor lighting, changing mercury vapour lamps to high pressure sodium lamps meant a saving of 13% of all the reported technology savings. By using lighting controls, Partners saved 18% within the total reported energy savings, attributable to technological changes. The rest of the savings is linked to other lamp conversions.

Based on Partners' responses to the survey, their major motivation for joining the GreenLight Programme was to reduce energy use and cut costs. More than 80% of the Partners were satisfied with the results of the lighting efficiency project, and in general with the GreenLight Programme as a whole. 14% of the respondents stated that they would have not introduced energy efficiency measures without the GreenLight Programme. Partners strongly encouraged further promotion of the GreenLight Programme both within their network and towards the public.

The GreenLight Programme shall be promoted on a wider scale through different channels (e.g. internet, television, technical literature, conferences, seminars, etc.). Programme administration could be facilitated with web-based tools, making online application and reporting possible. A requirement for remaining a Partner on the long term could be to maintain the lighting system energy efficient by regular upgrades, keeping pace with the advancements of lighting technology.

# 1. Introduction

To convince end-users to adopt efficient lighting technologies and systems and achieve a long lasting market transformation, the European Commission launched in 2000 the European GreenLight Programme ("GreenLight Programme"). It has been designed to promote energy efficiency in non-residential lighting, based on a voluntary participation. The GreenLight Programme is managed by the Joint Research Centre of the European Commission ("Joint Research Centre").

Any European public or private organisation can join the GreenLight Programme as a Partner ("Partner") or as an Endorser ("Endorser"). Partners commit themselves to upgrading the lighting system in their existing facilities or to install best available efficient lighting systems in their new buildings[1]. Endorsers are promoting the GreenLight Programme to potential Partners, and are providing assistance to Partners especially in the implementation of the energy saving measures [EGL2009]. The benefit of Partners and Endorsers in joining the GreenLight Programme is a wide public recognition for their efforts to improve lighting efficiency within their organisation.

National Contact Points[2] have been appointed in each participating country to provide information and assistance to (potential) Partners and Endorsers present in their country. They constitute a bridge between the main GreenLight Programme administration, and the (potential) programme participants.

The Joint Research Centre made a comprehensive evaluation of the results of the GreenLight Programme from its start in 2000 until the end of 2008. This paper gives an overview on the main findings, structured as follows:

- Analysis of the composition and savings of Partners: how the number of Partners and their energy savings evolved from 2000 in the participating countries.
- Analysis of changes in the applied technology, which is the source of the savings: which part of the energy savings can be attributed to a certain type of technology change.
- Analysis of the motivations for and the benefits of joining the GreenLight Programme.

# 2. Methods

Partner organisations who commit to the GreenLight Programme report on their savings and the changes in technology to the Joint Research Centre. This information served as the basis of the analysis. To evaluate the motivation of Partners for joining the GreenLight Programme and their experiences as a GreenLight Partner, a survey was conducted among the Partners. The period assessed is from 2000 to 2008[3]. The assessment was carried out using spreadsheet analysis (Excel).

Energy savings were analysed as in total (e.g. total GreenLight Programme savings) and per Partner (average and relative[4] savings). Savings were assessed according to countries and along sectoral categories. These categories were created taking into account the business area of the Partners in the first place but also the project type implemented.

As the energy savings were reported by the Partners themselves, this imposes some limitations on the results. First of all, there are more than 100 Partners with no information on their savings. Most of them did not report on their savings, others did report but the savings could not be extracted from their report. Secondly, some Partners' figures seemed inconsistent, or incomplete, which after further enquiries could be corrected, but not in all cases. Thus data which could not be justified has been excluded from the assessment, to avoid any incongruities. In the end, for 169, thus more than 30% of the Partners there is no adequate data available on the energy savings.

The extent of information provided on the savings by Partners differs which means that different subgroups of Partners were assessed with regard to total savings, relative savings and changes in technology. It shall be underlined that due to lack of sufficient data the energy savings analysed are actually less than the effective savings of all the GreenLight Partners. Nevertheless the different subgroups of Partners are considered valid for the assessment.

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[1] in case the energy savings justify such investments and the lighting quality is maintained or improved.

[2] A list of the GreenLight National Contact Points, and all further information on the GreenLight Programme and participation are available on the official GreenLight Programme website (http://www.eu-GreenLight.org).

[3] An interim evaluation of the results was given in the Five Year Report of the European GreenLight Programme [BER2005].

[4] The relative savings are expressed as a percentual value of the total energy savings (achieved by the end of 2008) divided by the energy consumption before implementing the energy saving measures. Due to compass constraints this is not discussed in this paper.

# 3. Expansion of the GreenLight Programme

## 3.1. Composition of Partners

The number of GreenLight Partners was constantly increasing through the years, from around 80 in 2002 through 267 in 2005, reaching 519 by the end of 2008. This is about twice as much as at the end of 2005 [BER2005].

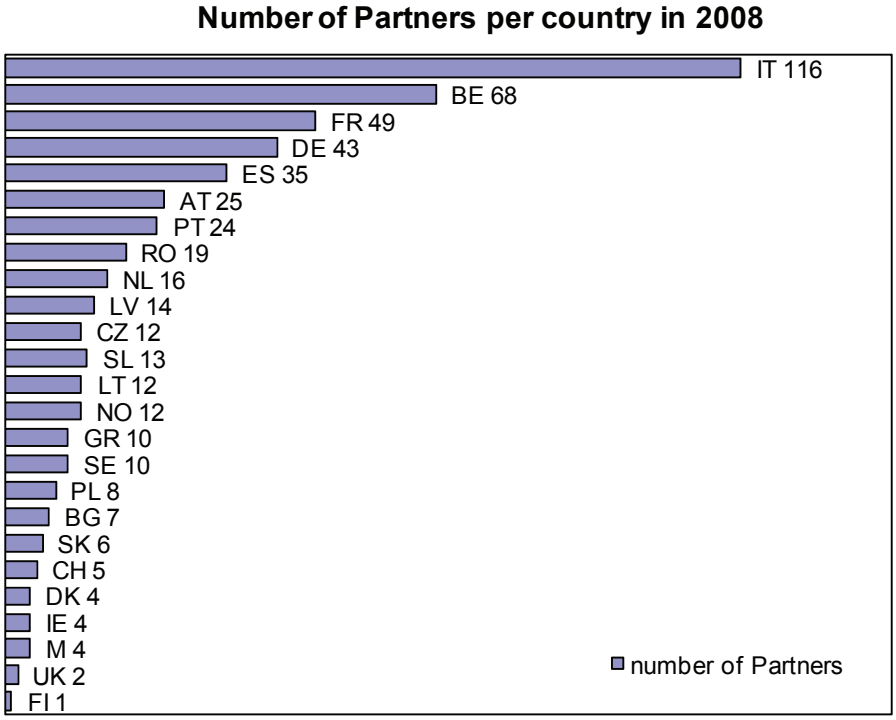



**Figure 3.1** depicts the number of Partners in the different countries at the end of 2008. There are Partners in the GreenLight Programme from the European Member States, Norway and Switzerland. Several multinational companies; Citigroup, Johnson & Johnson, McDonald's Europe and IKEA also joined the Partners' network (they are denoted under the category "M", as multinational).

**Figure 3.1. Total number of GreenLight Partners per country in 2008**

Partners from the New Member States[5] started to adhere to the GreenLight Programme only starting from 2006[6], when "New GreenLight"[7] was launched. New GreenLight was a project co-ordinated by the Czech National Contact Point, with the scope of extending the GreenLight Programme to the New Member States. It was running for two years [NGL2009]. By the end of 2008, 90 new GreenLight Partners joined the GreenLight Programme, with a total energy saving of 59.5 GWh/year. In fact, 24 organisations whose applications were received under New GreenLight were accepted as GreenLight Partners in 2009. This makes the total number of Partners joining the GreenLight Programme under New GreenLight 114, with a total saving of 68 GWh/year[8].

## 3.2. Energy savings

Considering all the energy savings reported by the end of 2008, the total savings of GreenLight Partners amount to 241 GWh/year[9]. This is more than twice as much as the savings reported by 2005 [BER2005]. As not only the savings but also the number of Partners doubled with respect to 2005, considering the reported energy savings, it can be concluded that the average saving per Partner remained constant over time.

The energy saving of 241 GWh/year generated a running cost saving of about 24 million EUR. 76% of the GreenLight Partners implemented lighting retrofits in buildings, on a total surface area of 3.5 million $m^2$. The remaining Partners' projects were street lighting upgrades. 81% of the savings was

[5] Bulgaria (2007), Cyprus (2004), Czech Republic (2004), Estonia (2004), Hungary (2004), Latvia (2004), Lithuania (2004), Malta (2004), Poland (2004), Slovakia (2004), Slovenia (2004), Romania (2007).
[6] Except for the first Slovenian Partner, who adhered to the GreenLight Programme in 2003.
[7] A project supported by the Intelligent Energy Europe Programme. For more information: http://ieea.erba.hu/ieea/page/Page.jsp?op=project_detail&prid=1644. A brochure with case studies is available on the GreenLight website (http://www.eu-greenlight.org/pdf/1_GreenLight_D4_CentralEurope.pdf.
[8] This value may differ from previously published total savings, due to corrections and updates on savings reported to the Joint Research Centre by the Partner organisations.
[9] This was reported by 350 Partners. For the remaining 169 Partners there is no adequate data available on the energy savings.

achieved indoor. This share was approximately the same between indoor and outdoor savings by 2005 as well [BER2005].

**Savings per country**

Figure 3.2 includes the total energy savings reported by GreenLight Partners in the participating countries, for the period from 2000 until 2008. The bars in green represent the savings achieved in each country by the end of 2008 (expressed in GWh/year). The orange bars show the share of energy savings in the particular country in comparison with the total GreenLight Programme savings (241 GWh/year).

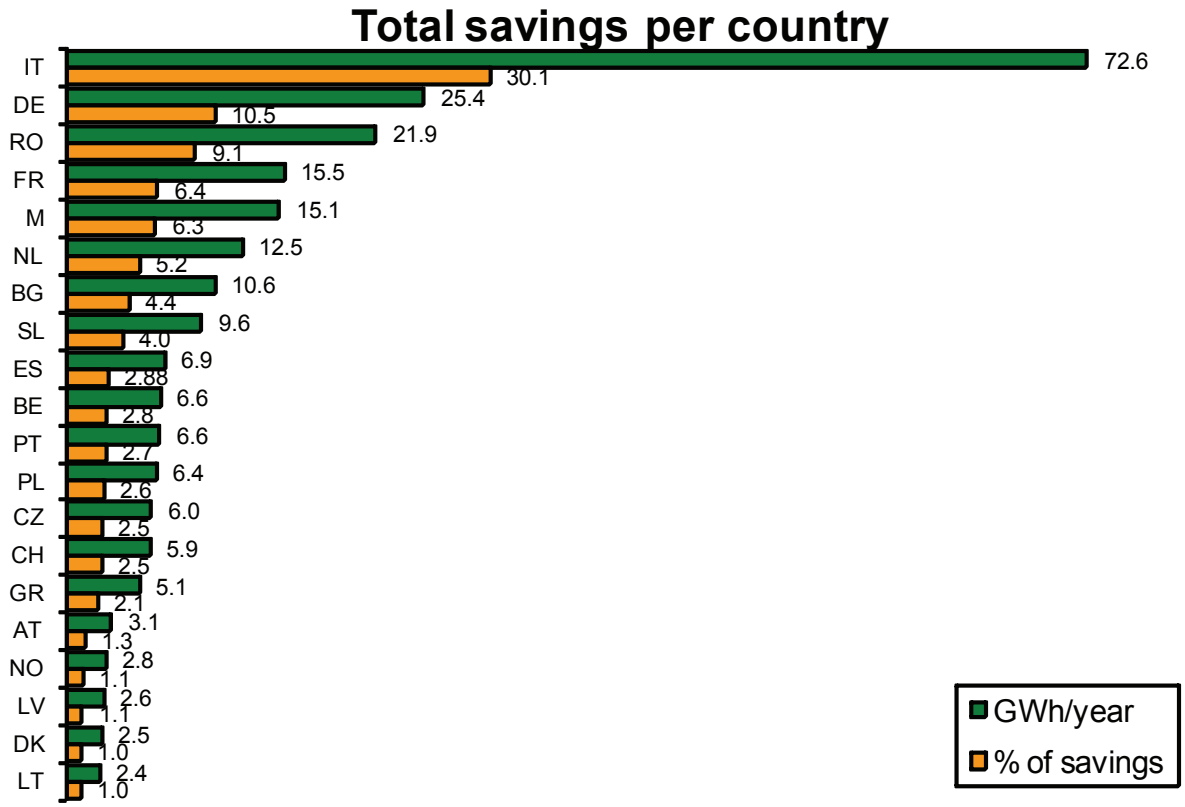



**Figure 3.2. Energy savings of all GreenLight Partners per country, by the end of 2008**
Countries with total savings below 1 GWh/year are not shown on the above figure.

Italy achieved not only the highest number of Partners but also the highest savings as within one country. Italian Partners saved 73 GWh/ year by the end of 2008 giving 30% of all the energy savings achieved within the GreenLight Programme. More than 70% of the total savings was generated by two retail chain companies: the Italian Coop contributed with almost 30.5 GWh/year to the Italian total savings, while Carrefour Italia reported savings of 21.5 GWh/year. A significant share of savings was reported by two banks: UniCredit SpA and Intesa Sanpaolo, saving 4.8 and 4.5 GWh/year respectively. It shall be considered that there is no adequate data available on savings for more than 50% of the Italian Partners, the majority of them being municipalities, who mostly implemented street lighting projects.

Germany is the country with the second highest total savings: 25.4 GWh/year. The city of Hamburg had a major contribution to this: between 2000 and 2007 about 450 public buildings were upgraded resulting in a total energy saving of about 10.3 GWh/year. To compare, this is approximately as much as the total Bulgarian energy savings. Data on the energy savings is not available for only five Partners (12% of all the German Partners).

Romania is an outstanding example of how a relatively small number of Partners can achieve significant savings and also, that there is a big potential for lighting savings in the New Member States. To translate this statement into numbers: 19 Romanian Partners joined GreenLight, starting from 2006, and they achieved a saving of 21.9 GWh which is the third highest saving per country in the GreenLight Programme. Romania is a role model – just like all the New Member States - also from the point of view that savings data is available for all the Partners in the country. The highest savings,

namely 5.1 GWh/year were reported by Metrorex s.a., who is operating the subway in Bucharest, the capital city. Four other Romanian Partners saved 7.5 GWh/year through public building retrofits, followed by six further Partners saving 7.5 GWh/year too through street lighting projects.

Considering the high number of Partners in Austria and Belgium, these countries' total savings are not high. This is due to the fact that there is no data available for about 50% of the Partners in both cases.

**Savings per category**

Figure 3.3 depicts the distribution of savings reached by 2008 across the different categories, in which the Partners are active.

| | |
|---|---|
| **R** | Retail: super markets |
| **OS** | Street Lighting (open space) |
| **P** | Production |
| **C** | City: Public Buildings |
| **HR** | Hotels/Restaurants |
| **S** | Services: bank / insurance / etc. |
| **PT** | Public Transport: railway / metro stations |
| **A** | Airports |
| **E** | Educational Buildings: schools / universities |
| **U/T** | Utilities/ Telecommunications |
| **HP** | Hospitals |
| **CP** | Car Parks |
| **O** | Other |

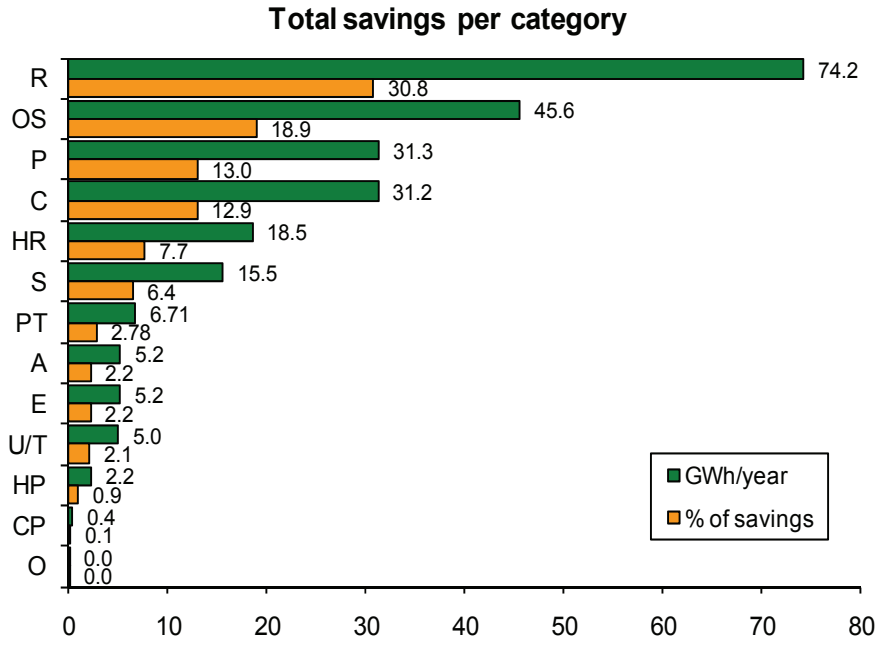



**Figure 3.3. Energy savings of all GreenLight Partners per category, by the end of 2008**

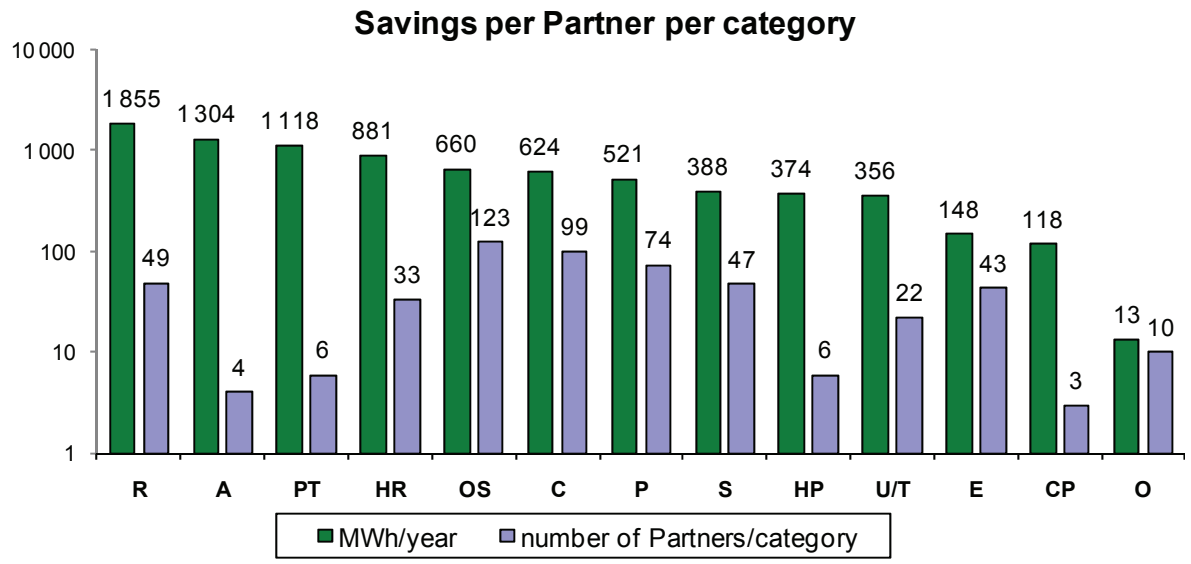
The highest total savings – 31% of the total GreenLight Programme savings - were achieved in Retail[10]. The highest savings per Partner were also reported in this category (see Figure 3.4). This is thanks to some big retailers, such as Carrefour Italia, Coop in Italy, or Distribution Casino France, who reported savings between 10-31 GWh/year each. The three of them saved altogether about 62 GWh/year, which represents 83% of the category's total. Not considering their contribution in the calculation, the average saving per Partner would be 467 MWh/year. This figure seems to be reliable for cross-comparisons, especially if we compare it to the corrected saving of Public Buildings per Partner which is 334 MWh/year (see below). In the shops lights are usually on for the entire period of the opening hours which are generally longer than the working hours, so that consumers can do their shopping before or after work. Plus, high lighting levels (up to 1,000 lux) are also required for a good product visibility. Therefore, it can be assumed that stores use more energy for lighting hence they save more in absolute figures.

10 Some examples of Partners and their savings in Retail were collected in a GreenLight brochure in 2002, available at: http://www.eu-greenlight.org/pdf/2002_GreenLight_retail_sector.pdf

The second highest total savings were reported by Partners who modernized the public lighting system, giving close to 20% of the total GreenLight Programme savings. There are small municipalities and big cities among the Partners as well, with annual energy savings ranging from 8 MWh to 5 GWh. Most of the GreenLight Partners implemented street lighting projects (see Figure 3.4). Hence, the total savings in Street Lighting are prone to show a high value, even if there is no adequate data available for 44% of the Partners in Street Lighting. The average savings per Partner equal 660 MWh/year, which is around the GreenLight Programme average.

The third highest savings, almost 15% of the total GreenLight Programme savings were achieved in Production. The number of companies active in this category is also the third greatest regarding the whole GreenLight Programme.

The number of Partners who refurbished public buildings is higher than that of producers, but their total savings are not higher. It shall be added that data on the savings is available for more Partners in Production (60) than in Public Buildings (50). Projects in the category Public Buildings did not result in very high average savings per Partner. However, this number is not reflecting well the average savings per Partner: the city of Hamburg alone saved more than 10 GWh/year by the end of 2008, followed by the city of Zürich (4.9 GWh/year). Not considering their savings in the calculation, one Partner's average savings equal 334 MWh/year. Comparing this with the average saving of a Partner in the category Utilities/Telecommunications, where most of the upgrades were focused on the modernization of office buildings, it may be assumed that this number (334 MWh/year ) appears to be a more reliable source for cross-comparison of average savings per Partner.




| | | | | | |
|---|---|---|---|---|---|
| **R** | Retail: super markets | **OS** | Street Lighting (open space) | **U/T** | Utilities/Telecommunications |
| **A** | Airports | **C** | City: Public Buildings | **E** | Educational Buildings: schools /universities |
| **PT** | Public Transport: railway / metro stations | **P** | Production | | |
| | | **S** | Services: bank/insurance/etc. | **CP** | Car Parks |
| **HR** | Hotels/Restaurants | **HP** | Hospitals | **O** | Other |

**Figure 3.4. Average energy savings for one Partner per category**
Values are shown on a logarithmic scale to better visualise the number of Partners per category.

As for Airports, the average savings per Partner are 1.3 GWh/year, the second highest. Airports are usually big complexes that have an extended surface area which needs to be illuminated, often also during night, as opposed to e.g. offices. So their absolute savings were expected to be high. The total savings are not outstanding, due to the fact that there are only a few Airports among the Partners.

The savings per Partner in Public Transport equal 1.3 MWh/year. This high value can be explained by two factors. Like Airports, companies in Public Transport have generally a big surface area which needs to be illuminated. However, this is different in the sense that an airport is rather one big conglomerate while for example an underground line consists of a number of smaller stations. Still, if added up, this results in a high surface area. Another factor is that lighting is often needed during night

as well, or in the case of an underground metro station also during the whole day. Showing some similarities, it is not surprising that Partners from Public Transport closely follow Partners from Airports as for annual savings per Partner. The total savings in Public Transport are low because of the small number of Partners in this category.

The average savings per Partner of 881 MWh/year show a high value in the category Hotels/Restaurants. Partners with high savings cause a deviation in this value: Holland Casino Breda saved 9.5 GWh/year, while McDonald's Europe saved more than 6 GWh/year. Excluding these two Partners' savings from the calculation, the resulting average saving per Partner is only 152 MWh/year.

# 4. Changes in technology

The lighting technologies used in the GreenLight Partner projects have undergone a slow transition over the last eight years, from less efficient incandescent lamps, magnetically ballasted fluorescent lamps, and mercury vapour lamps to more efficient electronic fluorescent lamps and compact fluorescent lamps. Notably in regard to fluorescent lamps, the reduction in the size of the lamp has reduced the amount of energy needed to provide the same quantity of lighting. The use of electronically induced ballasts to charge the fluorescent lamps instead of magnetically induced ballasts, has not only reduced the amount of energy consumed per fixture, the electronic technology has improved the quality of the lighting. Not all retrofit projects entailed the replacement of lamps and fixtures. In some cases, lighting control was implemented to turn lights on and off with a schedule, with some type of occupancy linking technology (e.g., motion sensors), or by using photosensors to dim lights in response to ambient daylight.

Figure 4.1 below shows the installations of the respective categories of lights over the 2000 to 2008 time period. Partners were required to report only about lighting types and quantities pertinent to their retrofit projects so it is not possible to ascertain the actual mix of lamp types in the entire facility or facilities managed by each Partner; though it is reasonable to assume that the energy savings roughly mirror the most significant sources of energy consumption.

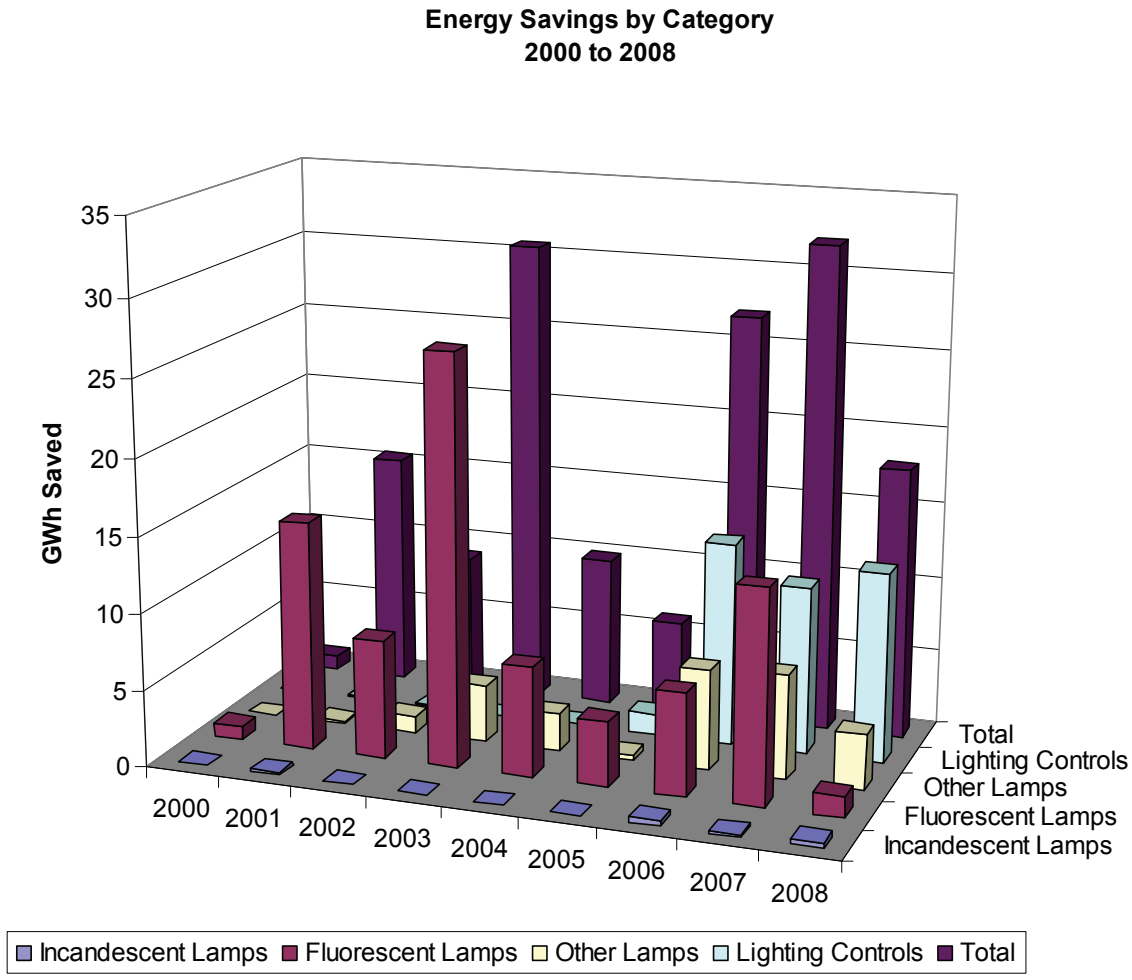



**Figure 4.1. Energy savings by lighting retrofit for the period 2000 to 2008.**

## 4.1. Changes in lamps

Table 4.1 below summarises the energy saving and Partner percentages per lamp type retrofit. The energy savings percentages sum to 100% of the total available energy savings reported by the Partners performing the lighting retrofits. However, some Partners performed multiple types of retrofits so the number of Partners will total more than the number of Partners who reported technology

changes.

**Table 4.1. Lamp changes summary**

| Retrofit category | Partners | Energy savings, % category | Energy savings kWh, category |
|---|---|---|---|
| Incandescent to incandescent* | 13 | 0,8% | 1 124 140 |
| Incandescent to fluorescent conversion | 33 | 4,0% | 5 620 690 |
| Incandescent to other conversion | 7 | 7,5% | 10 538 800 |
| Fluorescent to fluorescent | 109 | 21,6% | 30 351 730 |
| Other to fluorescent conversion | 33 | 28,3% | 39 766 390 |
| Other lamps to other lamps | 58 | 20,2% | 28 384 490 |
| Lighting Controls | 81 | 17,6% | 24 731 040 |
| ***Total*** | | ***100,0%*** | ***140 517 280*** |

* The incandescent to incandescent type of lamp retrofit is normally not allowed within the GreenLight Programme unless there is a reduction in the number of fixtures or a reduction in lamp power.

**Fluorescent to fluorescent retrofits**

The largest change in fluorescent to fluorescent retrofits has been the conversion of T8 lamps to T5 lamps, both in terms of Partners implementing the retrofit and in terms of the energy savings (approximately 10% of the total reported lamp energy savings within the GreenLight Programme). Retrofits from T12 lamps occurred earlier in the GreenLight Programme but the frequency of this retrofit has decreased considerably because most Partners have changed to T8 and T5 lamps. The T8 to T8 retrofits appear to be mostly composed of two components of savings (yielding roughly 15 – 18% energy savings per fixture); (1) changes from halophosphate lamps to triphosphate lamps and (2) from magnetic to electronic ballasts. However, some T8 to T8 lamp retrofits appear to involve delamping, though it is difficult to quantify these delamping energy savings because fixture lighting coverage area is not a reportable item and lighting changes sometimes include multiple lamp types. There were a variety of lamp changes within the "other" category, such as CFL to CFL, T5 to CFL, and T5 to T5 lamp changes, but these changes appear to be motivated by specific applications of lighting required at that Partner's facility and are not reflective of a trend. Not reflected in this data is a trend in the conversion of lamps from incandescent lamps and other types of lamps to the use of compact fluorescent lamps that are similar in application as the linear T5 lamps. There is the potential of a larger adoption of single pin fluorescents in place of the typical linear double pin fluorescent lamps because this allows greater flexibility in the placement of the lamp within the fixture. Table 4.2 below shows the percent change values by lamp change category.

**Table 4.2. Fluorescent to fluorescent lighting changes**

| Lamp change category | Partners, % category | Energy savings, % category | Energy savings kWh, category |
|---|---|---|---|
| T8 to T8 | 19,0% | 11,4% | 3 464 315 |
| T8 to T5 | 40,5% | 44,9% | 13 649 954 |
| T8 to CFL | 17,4% | 8,5% | 2 596 655 |
| T12 to T8 | 5,8% | 0,5% | 145 419 |
| T12 to T5 | 4,1% | 2,5% | 770 592 |
| T12 to CFL | 3,3% | 8,1% | 2 468 142 |
| Other | 9,9% | 24,0% | 7 307 106 |

**Other lamps to fluorescent retrofits**

The largest change in other lamps to fluorescent retrofits has been the conversion of mercury vapour lamps to T5 fluorescent lamps, both in terms of Partners implementing the retrofit and in terms of the energy savings. This category is the largest category of lamp conversion energy savings of total energy savings within the GreenLight Programme, resulting in 13% of the total energy savings. Although conversions of other lamps to T8 fluorescent lamps was accomplished by several Partners, these conversions involved relatively low levels of energy savings so these were not significant categories of retrofit. The lighting industry is migrating to T5 fluorescent lamps so future energy saving retrofit projects will likely concentrate on the use of T5 lamps. Table 4.3 shows the percent change values by category.

**Table 4.3. Other lamps to fluorescent lighting changes**

| Lamp change category | Partners, % category | Energy savings, % category | Energy savings kWh, category |
|---|---|---|---|
| Mercury vapour to T5 | 18,6% | 46,8% | 18 600 975 |
| Mercury vapour to T8 | 14,0% | 3,7% | 1 460 786 |
| Mercury vapour to CFL | 11,6% | 3,8% | 1 509 561 |
| Metal halide to T8 | 23,3% | 8,8% | 3 509 034 |
| Metal halide to CFL | 25,6% | 34,9% | 13 857 545 |
| Metal halide to T5 | 7,0% | 2,1% | 817 645 |

**Other lamps to other lamps retrofits**

For other lamps to other lamps retrofits, 58 Partners reported this type of lamp conversion. This change accounted for approximately 20.2% of the total reported technology energy savings in the GreenLight Programme during the 2000 – 2008 time period, the second largest group after fluorescent to fluorescent retrofits. There are 7 categories of other lamps to other lamps lighting changes: mercury vapour to metal halide, mercury vapour to high pressure ("HP") sodium, HP sodium to HP sodium, neon to LED, metal halide to metal halide, mercury vapour to mercury vapour, and other lamp changes.

The most significant change in other lamps to other lamps retrofits has been the conversion of mercury vapour lamps to HP sodium lamps, both in terms of Partners implementing the retrofit (59.3% of all the Partners retrofitting other lamps to other lamps) and in terms of the energy savings (17.5 GWh/year). The majority of these Partners were public sector entities upgrading their street lighting. These street lighting retrofits provide a significant amount of energy savings and account for the reason this category yielded 61.7% of the other lamps to other lamps energy savings, and approximately 12.5% of the total GreenLight Programme energy savings. Although the conversions of mercury vapour to metal halide lamps involved relatively few Partners (12.3% thus 8 Partners), some of them (active in production) achieved significant savings. This is the reason for this lamp change category yielding the second highest savings within the other lamps to other lamps retrofits (22.1% corresponding to 6.3 GWh/year). Energy savings in the other lamp change categories were not significant.

## 4.2. Ballast changes

GreenLight Programme Partners reported ballast changes for fluorescent lamps and for other lamps such as mercury vapour, metal halide, and HP sodium. Although Partners reported ballast types for lamp retrofits of mercury vapour, metal halide, and HP sodium lamps, these ballast replacements are magnetic to magnetic when a high intensity discharge ("HID") type lamp is retained with the retrofitted fixture. While there is interest in obtaining additional energy savings from the use of electronic ballasts in HID fixtures, magnetic ballasts in these fixtures still offer better cold and hot weather life and performance. Therefore the focus in this section is on the ballast upgrades of fluorescent lighting, and especially on changes from magnetic to electronic ballasts. In those cases where the Partner continued to use magnetic ballasts the energy savings were either generated by lighting controls or de-lamping of existing fixtures. If the Partner already was using electronic ballasts then the savings were obtained by implementing lighting controls and/or upgrading to better electronically ballasted lighting (such as converting T8 lamps to T5 lamps). Table 4.4 below shows the percent change values by category.

**Table 4.4. Ballast changes**

| Ballast change category | Partners, % category | Energy savings, % category | Lighting Control % category |
|---|---|---|---|
| Magnetic to electronic | 92,3% | 75,6% | 31,6% |
| Magnetic to magnetic | 3,1% | 23,5% | 2,5% |
| Electronic to electronic | 4,6% | 0,9% | 0,8% |

## 4.3. Lighting controls

Localized manual switching is providing individuals in open office configurations a local (task or work based) light switch instead of controlling the light from a single area switch; allowing each individual the opportunity to use only the lighting needed for his/her work area. Time scheduling provides an automated clock based schedule of the lighting to ensure that the lighting is turned off in work areas that are scheduled to be unoccupied. Occupancy linking allows the lighting to be turned on and off in conjunction with the occupancy of the space via some type of presence sensing control. Daylight responsive controls dim the artificial lighting when the ambient daylight reaches sufficient intensity levels.Table 4.5, Lighting controls, below, shows the percent change values by category.

**Table 4.5. Lighting controls**

| Lighting control category | Partners, % category | Energy savings, % category | Energy savings kWh, category |
|---|---|---|---|
| Localised manual switch | 40,8% | 45,0% | 11 136 515 |
| Time scheduling | 23,8% | 21,0% | 5 196 481 |
| Occupancy linking | 15,4% | 9,6% | 2 384 862 |
| Daylight responsive | 20,0% | 24,4% | 6 049 276 |

The largest amount of energy savings from lighting controls retrofits has come from installing daylight responsive controls, even though this category of savings was implemented only 20.9% of the time. The occupant density in most work spaces is highest during the day so this provides a significant opportunity to reduce energy consumption without reducing work productivity. Time scheduling was also an important lighting controls measure providing significantly higher saving by category than localized manual switching and occupancy linking. Time scheduling has the additional benefit of being relatively simple to implement and operate. It is important to have regular energy conservation training that emphasizes turning off equipment and lights when they are not needed; however, time scheduling supplements those efforts by ensuring that the lights are turned off when not needed.

## 4.4. Summary and outlook

The energy savings reported by the Partners participating in the GreenLight Programme provide a good snapshot of the energy savings that are available to those willing to upgrade their lighting systems. Partners concerned about conserving energy have many opportunities to improve the lighting in their facilities and in turn reduce their environmental footprint. Organisations interested in saving money can invest in the new lighting technologies to obtain new and better lighting systems and lower their energy bills. The basic lighting energy savings strategies are not complex. This report shows that the main strategies of converting mercury vapour lamps to more efficient lamp types, converting older fluorescent lamps and ballasts to T5 lamps and electronic ballasts, implementing daylighting controls where possible, and installing timing controls to shut off lights when the building is unoccupied, are appropriated for most Partners and tend to generate the most energy savings.

Advances in lighting technologies appear to be continuing as the lighting industry introduces better and more versatile compact fluorescent fixtures. The service life of fluorescent lamps has been increased to nearly match the life of high pressure gas lamps. The efficiency of fluorescent lamps continues to improve and may eventually be a cost competitive choice along side high pressure sodium lamps. High pressure gas discharge lamps can be installed with electronic ballasts to improve the start up of the lamp, improve the quality of the light, and lengthen lamp life. In the short and long term, LED lamps show significant potential for increasing lighting efficiency and also lighting effectiveness. Although, currently available LED lamps are less efficient than compact fluorescents, new developments indicate that efficiency of LED lamps will improve quickly. LEDs have a long service life (approximately 50.000 hours), have good colour rendering, can be dimmed, and allow for a large variety of fixture configurations. Their small size lends itself to more localised applications improving effectiveness by putting light where it is most useful. The high cost of LED lamps is still a limiting factor but the cost per lumen is expected to continue to drop.

# 5. GreenLight Partners' motivation and experience

The Joint Research Centre conducted a survey between November 2008 and June 2009 among the GreenLight Partners. The main goal of this survey was to elicit Partners' attitudes and experiences with the GreenLight Programme by 2008/2009. By use of a Questionnaire, Partners were asked to answer two issues:

- Motivation, barriers and commitment in the planning phase, i.e. before implementing the energy saving measures and applying to join the GreenLight Programme.
- Evaluation of benefits, success of the finished or ongoing project and the whole GreenLight Programme.

## 5.1. Data input

The total number of Partners participating in the GreenLight Programme within the survey period amounted to 519 by the end of 2008, but increased to 560 by the end of the survey period. Some Partners could not be reached, or could not respond within the scheduled time period for data collection. At the end of the data collection period 104 responses were available for the survey evaluation. Some of them were not complete, i.e. lacked responses to parts of the Questionnaire. Table 5.1 shows the summary of the information provided or missing in the responses finally evaluated.

**Table 5.1. General description of the data material**

| Data description | Total | % |
|---|---|---|
| **Partners (by the end of survey period)** | 560 | 100,0 |
| **Total responses** | 104 | 18,6 |
| **Complete responses** | 95 | 17,0 |
| **Non-responses** | 456 | 81,4 |

The sample of Partners represents roughly one fifth of the addressed Partners (104 from 560 Partners[11]). The distribution of countries in the sample is similar to the distribution of the entire population. The distribution of project types is also similar to that of the entire population, except for small deviations in some categories (Public Buildings and Hotels/Restaurants are weaker, while Production is stronger represented in the survey). To this extent there is the possibility of minor variances from Partner comparisons presented in this report. But in the response cases where the analysis strongly shows a clear trend or outcome, the resulting conclusions are significant and valid.

## 5.2. Results

On the basis of the responses to the Questionnaire, the results can be summarised as follows.

**Planning phase**

Most of the Partners had different motivations for joining the GreenLight Programme. The results show that energy savings and cost reduction are the most important motivations: 88% of the respondents indicated this factor as a higher motivation for joining the GreenLight Programme. This is followed by improvement of environmental image[12] (67% of the responses), lighting quality (66% the responses) and in-house environmental awareness[13] (60% the responses). However, executing a general renovation[14] which includes a renovation of the lighting system was considered to be a lower motivation for participation in the GreenLight Programme. A small part of the responses, i.e. approx. 6%, provided additional items of motivation. The compilation of those responses showed that having an additional tool for improved marketing, building networks with important stakeholders (e.g. National Contact Points, other Partners) or raising safety (Street Lighting) were important motivations.

Technical, management, and end-use problems were not deemed to be significant barriers to implement energy efficiency measures. However, the estimation of costs and benefits was a problem

[11] as at the end of the survey period.
[12] Environmental image in this survey meant the image of the organisation for the outside world (business partners, customers, etc.) regarding the organisation's commitment and concern towards environmental issues.
[13] In-house awareness in this survey meant to raise the environmental awareness of the organisation's personnel.
[14] General renovation in this survey meant the lighting project was done as a part of a larger project to renovate the facility.

for almost half of the respondents (46 from 94 responses, i.e. 44%). Several of these responses were delivered by “big” Partners, i.e. private companies with energy savings exceeding 500 MWh per year (7 responses) and providers for street lighting (4 responses from Partners who saved more than 1.4 GWh per year). The comments revealed that many Partners were not certain about their cost-benefit analysis or found it to be too time and resource consuming. There was a strong correlation between Partners who perceived cost estimation barriers and Partners who had multiple facilities and/or lacked a submetering system. A factor not explicitly included in the Questionnaire, financing the project, may actually be behind some of the responses regarding barriers. Six from the 46 Partners indicated that financing the project *per se* was the main barrier instead of the estimation of costs and benefits.

**Evaluation after project implementation**

After implementation of the project more than 75% of the responding Partners deemed project benefits (such as energy savings, cost reductions, lighting quality, in-house awareness, environmental image, and other) to be the same or higher than initially expected. Higher benefits than initially expected were stated with regard to in-house environmental awareness (44 from 92 responses) and environmental image (47 from 88 responses). This may suggest that “soft” criteria such as environmental awareness and image may be underestimated at the beginning of the planning process. Even if Partners initially focus their decision making activities for lighting efficiency on quantitative economic targets (savings), they may eventually recognise that the non-economic benefits of the project have a significant positive impact on their organisation; and also the customers and users of their products or services.

More than 81% of the responding Partners were satisfied with project outcomes, such as implementation costs, technical improvements, acceptance from personnel, users and customers.

In the end, Partners evaluated the GreenLight Programme as a whole positively: 88% of the respondents declared that they are satisfied (51%) or very satisfied (37%) with the GreenLight Programme, while 14% of the respondents stated that they would have not introduced energy efficiency measures without the GreenLight Programme.

Partners expressed a clear need for further promotion of the GreenLight Programme towards the public and within the Partners’ network.

## 5.3. Outlook

There is a need for further research in the GreenLight Programme Partners’ motivations and barriers. Evidence gained through this survey suggests some trends that should be further investigated in the future:

- Regarding motivation for Partners to participate in the GreenLight Programme, environmental image seems to be an important co-driver whenever the Partner has motivations to pursue energy savings, cost reductions, improvements of lighting quality, or raising in-house awareness.
- Participating in the GreenLight Programme does not seem to be related to doing a lighting retrofit as part of a general renovation. The motivations of the larger general renovation project may override the motivations of the lighting retrofit part of the project.
- Estimation of costs and benefits may be a problem for some Partners. They were uncertain about their cost-benefit analysis, or found it to be too time and resource consuming.
- Whereas the estimation of costs and benefits and the persuasion of senior management may impede the development of an energy efficient lighting project, financial and/or budget limitations are real barriers.
- Frequently, in-house environmental awareness and the Partner’s environmental image seem to yield a higher benefit than initially expected. Thus, “soft” criteria such as environmental awareness and environmental image may be underestimated at the beginning of the planning process.
- Improvement of lighting quality may be a more important benefit for open spaces than for indoor applications.
- Partners, who have recently joined, will probably need a period of time in order to accept the successful outcomes of their project, and then internalize the reasoning for engaging in similar energy savings projects in the future.

# 6. Conclusion

There were some challenges in evaluating the GreenLight Programme since the programme's start in 2000. The most significant barrier in the evaluation of the GreenLight Programme is how to make the reporting process more efficient so that the quality of the data reported remains high, the programme provides a good view of technology changes in Europe, and Partners are adequately encouraged to continue implementing energy efficient lighting within the programme.

Based on the analysis of the expansion of the GreenLight Programme in this report and the responses of Partners to the survey conducted, recommendations for a more widespread and smoother running GreenLight Programme may be summarised as follows:

- More publicity. Possible means: stronger public communication through the internet, television, conferences, papers, reporting. Newsletters, promotional materials, technical support and advice to Partners, best practice seminars. Participation of the National Contact Points could be of crucial importance.

- Application and reporting should be possible online. This would ensure a smoother expansion of the GreenLight Programme by speeding up the application process on both ends. On the one hand, online forms make it possible to require all the necessary information from the applicant before being able to submit the application. On the other hand, it eases the administration: if forms are filled in properly, there is no need to contact the applicants for clarifications or additional information.

- New Partners should be accepted only if data on the achieved energy savings is submitted together with the application. This would eliminate the problem of missing data which has two benefits: Partners would not need to be contacted regarding data on energy savings and an evaluation of the savings could be done easier based on a larger dataset. In addition, an online reporting form gives the possibility of controlling the data provided in real time, i.e. while the applicant is filling in the reporting form. Any inconsistencies can be pointed out, moreover, clearing existing incongruities can be made a precondition for submitting the reporting form.

- Partners should be required to upgrade their lighting system through reasonable time periods keeping up with lighting technology improvements otherwise they could drop out of the GreenLight Programme. Many Partners implemented one lighting refurbishment and joined the GreenLight Programme. After that particular refurbishment only a few Partners (e.g. Athens International Airport) planned or executed further lighting efficiency improvements in the same facilities. The optimal method for determining the frequency of upgrades to the lighting system was not discussed in this report. This could be a subject of further research. It shall be noted that since the GreenLight Programme is a voluntary programme, expanding the obligations of Partners harbours the risk of non-compliance. However, this particular recommendation is aimed at encouraging Partners to continue investing in energy efficiency by adding a reasonable extra requirement. Public recognition under the aegis of the GreenLight Programme shall be offered to Partners who earn it.

# 7. References

This paper is based on the report: The European GreenLight Programme 2000-2008 – Evaluation and outlook. The report is soon to be published and is already available on the GreenLight official website: http://www.eu-GreenLight.org.

**Further references**

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