# Task Lighting Design

# 工作照明設計

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EMSD

## Introduction

Task lighting is a lighting design approach where local lighting is applied for particular task areas. Unlike conventional general lighting approach which aims to provide a uniform illumination level for the whole lit up space, task lighting approach supplements additional light on specific areas where tasks are being performed leaving the other areas at lower ambient illumination level. Task lighting is becoming a common lighting design approach in some overseas economies (e.g. Europe and United States) as an effective energy management measures to save energy in office lighting.

This pamphlet will outline the concept of the task lighting approach together with design considerations and application examples for lighting in offices for general reference. Building owners and property management considering to adopt task lighting design for their premises could consult relevant lighting professionals and designers for further advice on design details.

## What is Task Lighting Design?

Lighting design in offices in Hong Kong commonly adopts the conventional general lighting system to provide uniform design illuminance over the whole office space. Luminaires are arranged in a regular layout in order to provide the entire office space with uniform lighting level sufficient for the most critical office tasks. This lighting set up allows flexibility for layout and orientation of tasks such that tasks can be carried out almost anywhere in the office space.

## 引言

工作照明是一種照明設計方式，是指在特定工作範圍內使用局部照明。工作照明有別於傳統的一般照明方式，後者旨在為整個空間提供一個均勻的照明水平，而工作照明則把非工作範圍保持在較低的照明水平，並在特定工作的範圍內輔加燈光來補足所需照明。工作照明逐漸被一些海外經濟體（如歐洲和美國）視為一種有效的能源管理措施，以節省辦公室照明的能耗。

這本小冊子將概述工作照明方式的概念，並包括設計上需考慮的因素和辦公室照明應用例子供一般參考。考慮在其場地採用工作照明設計的業主和物業管理公司可諮詢相關的照明專業人士和設計師以便在設計細節上獲得進一步的意見。

## 什麼是工作照明設計？

香港的辦公室照明設計通常採用傳統的一般照明系統，為整個辦公室空間提供一個均勻的設計照明度。燈具以既定的規格來排列，整個空間的照明水平以足夠進行最關鍵的辦公室工作為設計標準。這種燈光佈置方案令辦公室在佈局和調配工作位置時更具彈性。然而，一些相對較普通的工作範圍（例如擺放文件櫃的地方）和非

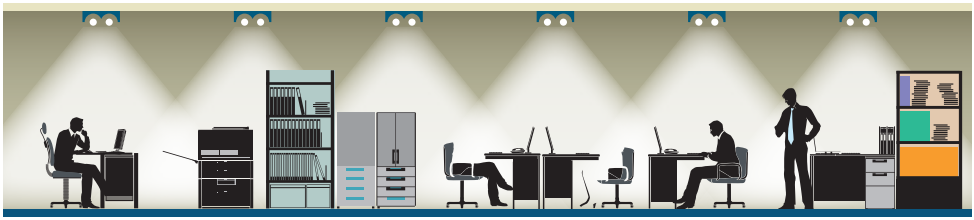


*Figure 1: Illustration of conventional general lighting system with luminaires arranged in regular layout to provide uniform lighting level to the whole office space*

*圖一： 示意圖顯示傳統的一般照明系統，燈具以既定的規格來排列，為整個辦公室空間提供均勻的照明水平*

However, energy will be consumed to illuminate the less critical task areas (e.g. file cabinet areas) and the non-task areas (e.g. circulation areas) at an unnecessarily higher lighting level (see Figure 1).

An alternative way of illuminating the office space is to employ the task lighting design approach. This approach provides the ambient illuminance for the entire areas with moderate background level of uniform illuminance, and complement with additional luminaires located at the task areas for achieving higher illumination level needed for the tasks.

工作的範圍（例如通道地方）則無需要地被照亮至較高的照明水平，因而消耗能源（見圖 1）。

另一種辦公室空間照明設計是採用工作照明設計方式。這種方式為整個辦公室空間提供均勻但較低照明度的背景照明，並在工作範圍內配置輔助的燈具以達致工作所需要的較高照明水平。

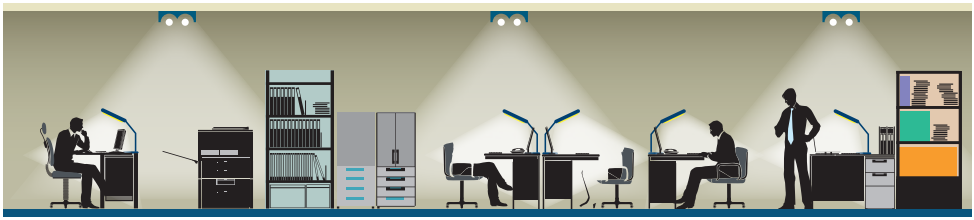


*Figure 2: Illustration of a typical task lighting system with less ambient lighting together with additional luminaires at the task areas*

*圖二： 示意圖顯示一個典型的工作照明系統，辦公室的環境燈光減少，並在工作範圍內配置輔助的燈具*

Task lighting can be an energy efficient approach for providing adequate task illumination while keeping other areas at lower illumination to save energy. It also enables a user to have some control over the amount and distribution of light on the task by switching off or dimming down the light source and for portable task light cases, by changing the position of the luminaire relative to the task.

工作照明可以是一種具能源效益的方式在工作範圍提供足夠的照明，並同時在其他範圍內保持一個較低的照明度來節省能源。用戶可透過關掉或調暗工作燈光源來控制光度；使用便攜式工作燈的用戶還可以透過擺放燈具的位置來控制光線的分佈。

## Task Lighting Design in Offices

When carrying out lighting design in offices, reference could be made to the publications published by relevant professional bodies such as the Society of Light and Lighting (SLL) under the Chartered Institution of Building Services Engineers (CIBSE) and Illuminating Engineering Society of North America (IESNA).

## 辦公室的工作照明設計

當進行辦公室照明設計時，可參考有關的專業團體例如英國特許屋宇設備工程師學會 (CIBSE) 轄下的燈光和照明學會 (SLL) 和北美照明工程學會 (IESNA) 所出版的刊物。

The following table summarizes the design lighting level for offices given in the publications of SLL/CIBSE and IESNA:
以下列表為 SLL/ CIBSE和IESNA刊物所刊載的辦公室照明設計水平：

| | SLL/CIBSE* | IESNA** |
|---|---|---|
| Office for mainly screen based work<br>主要以螢光幕工作的辦公室 | 300 lux*** | 150 to 300 lux (depend on nature of specific task)<br>(視乎特定工作的性質而定) |
| Office for mainly paper based work<br>主要以文書工作的辦公室 | 500 lux | 300 to 500 lux (depend on nature of specific task)<br>(視乎特定工作的性質而定) |

* Publication: The SLL Lighting Handbook, 2009
刊物：燈光和照明學會出版的照明手冊(2009年)

** Publication: The IESNA Lighting Handbook Reference and Application, 10th Edition, 2011
刊物：北美照明工程學會出版的“照明手冊參考和應用”(2011年，第10版)

*** lux 即“勒克司”

As the use of computers is becoming common in offices, designers may consider to design the ambient lighting at an average level of 300 lux to suit the screen based work with additional task lights which could be switched on as desired to increase the local lighting level to an average of 500 lux to suit the paper based works such as reading or writing at task planes.

由於在辦公室使用電腦漸趨普遍，設計者可考慮以300 lux的平均水平來設計辦公室的環境照明，以適應螢光幕工作，並可以根據需要開啓附加的工作燈，以增加局部的平均照明水平至500 lux，來配合在工作平面上進行如閱讀或寫作等的文書工作。

## Energy Saving Potential

The application of task lighting can effectively lower the lighting power density of the installation and hence lighting energy consumption. For example, when reducing the ambient illumination level of a space from 500 lux to 300 lux, the illumination level will be reduced by 40%. However, actual energy saving in real life application cases is likely to be less than 40% and would be different from site to site as the proportion of lit up areas with tasks needing higher illumination level, the duration of task lights to be operated during the day, choice of lighting fixtures, quantities of task lights required, spacing of lighting fixtures, dimensional constraints (e.g. room dimensions) and ceiling grid pattern etc. will also affect the energy saving potential.

## 節能潛力

工作照明的應用，可以有效地降低裝置的照明功率密度，從而減少照明的能源消耗。例如，把空間的環境照明從500 lux降低至300 lux時，照明水平會減低百分之四十。然而，實際的應用個案所節省的能源可能會少於百分之四十，而在不同的地點所節省的多少亦會有所不同。這是由於需要較高照明水平範圍的比例、工作燈在每天裡需要開著的時間、所選用的照明燈具、工作燈所需的數量、照明燈具的排列距離、空間上的限制 (例如房間的尺寸) 和天花板的格局等都會影響到工作照明設計的節能潛力。

In general, an open plan office accommodated with many workstations will likely save less energy, as more task lights will be needed to illuminate the workstations. On the other hand, a relatively spacious open plan office will tend to have more saving because less task lights are needed to be put on. A computer simulation on task lighting design is included in the Case Study section of this pamphlet to illustrate the energy saving potential of task lighting design for offices for reference. In addition, for an air-conditioned office, some saving in air conditioning energy would also be anticipated due to lower lighting power density and hence less heat dissipation from the lighting.

## Key Considerations in Task Lighting Design

Task lighting design needs to deal with issues relating to both ambient lighting and task light. The followings are some typical examples:

**1. Light distribution and uniformity**

For visual comfort, a uniform and shadow free light distribution over the full task area is one of the key attributes for desirable task lighting. Depending on the light distribution of the ambient lighting, some work surfaces directly below the light fittings may be higher than and some work surfaces may fall below the average illuminance. To achieve satisfactory uniformity for the ambient lighting at 300 lux for task lighting design instead of 500 lux for conventional design, the types of lighting fixtures and their spacing should be carefully chosen. In fact, the design norms applicable for conventional ambient lighting level targeting at 500 lux, such as number of fluorescent tubes per light fixture, size of light fixture and spacing between light fixtures, may not be optimal for task lighting design with ambient lighting level at 300 lux.

In an open plan office, the use of partitions between individual workstations to sub-divide the office may create certain degree of obstruction and affect the lighting uniformity. In general, the

在一般情況下，一個容納許多工作台的開放式辦公室，可能會節省較少的能源，原因是需要更多的工作燈照亮工作台。另一方面，在一個相對地較寬敞的開放式辦公室，由於需要點亮較少數量的工作燈，故可以節省更多能源。本小冊子的個案例子部份內包括了電腦模擬個案來說明工作照明設計應用於辦公室的節能潛力，以供參考。此外，在空調的辦公室內使用工作照明可降低辦公室的照明功率密度，有助減少從照明產生的熱量，因而可以節省一部份空調用的能源。

## 工作照明設計的主要考慮因素

工作照明設計需要處理有關環境照明和工作燈的事宜。以下是一些典型的例子：

1. 光分佈和均勻度

就視覺舒適而言，在整個工作範圍內確保均勻和沒有陰影的光分佈是理想的工作照明需具備的一個主要特質。根據環境照明的光分佈，直接在照明裝置以下的工作表面可能會比平均照度為高，而一些工作表面也可能低於平均照度。由於工作照明設計以300 lux作環境照明有別於常規設計的500 lux，應慎重選擇照明燈具的類型和其間距，以達致令人滿意的均勻程度。事實上，適用於傳統環境照明目標水平為500 lux的設計範例，如每個燈具的光管數量，燈具的尺寸及之間的間距，可能並非以環境照明為300 lux的工作照明設計的理想藍本。

在一個開放式辦公室，使用分隔板來分隔獨立的工作台可能會造成一定程度的阻礙而影響照明均勻度。在一般

higher the partition is, the greater the obstruction will be. The effect of workstation partitions height should be considered in the ambient lighting design.

2. **Light contrast between surrounding and task areas**
   For task lighting design, illumination level at the task areas (with task lights) is higher than that at the surrounding areas and the contrast in illuminance may have impact on the visual senses of the occupants. Occupants may need to adapt to the illuminance environment provided by the task lighting design.

3. **Glare from lighting**
   Glare may be created by both ambient lighting and task light. Lighting with appropriate fixture design should be selected to eliminate glare (including direct glare and reflective glare) to the users.

4. **Lighting controls for ambient lighting**
   Appropriate lighting controls could be adopted for energy conservation. For areas with daylighting, lighting control system with photo-sensors could be incorporated to dim down or turn off the lighting for the ambient environment when daylight is available to achieve the design lighting level. In addition, sectional controls and occupancy sensors could be installed to switch off the ambient lighting when the particular space is not occupied.

## Task Light

Adopting task lighting design means two types of lighting would be employed, including ambient lighting and task light. For an office space, additional task lights will be required to complement the ambient lighting to achieve a higher level of illuminance in the task areas. An additional ceiling light directly above the task area could be installed as a task light with an independent on/off control for the user. Alternatively, a portable task lamp can be employed as the task light. The latter option can be more flexible and easier to implement.

情況下，較高的分隔板會做成較大的阻礙。應在環境照明設計上考慮工作台分隔板的高度帶來的影響。

2. **工作範圍與周圍的光線對比**
   以工作照明設計的話，在工作範圍內的照明水平(設有工作燈)會高於周邊範圍，照度的對比可能會影響用戶的視覺感官。用戶可能需要適應以工作照明設計的照明環境。

3. **照明的眩光**
   環境照明和工作燈兩者也有可能產生眩光。應選擇具適當設計的燈具以免用戶被眩光（包括直接眩光和反射眩光）影響。

4. **環境照明的燈光控制**
   採用適當的照明控制可節省能源。在有日光照射的範圍內，可配合有感光器的照明控制系統，並在有日光時把環境的燈光調暗或關掉來維持照明設計水平。此外，亦可安裝分區控制和用戶感應器，在特定的空間沒有人使用時關掉環境照明。

## 工作燈

採用工作照明設計會應用兩種類型的照明，包括環境照明和工作燈。以一個辦公室空間為例，需要附加工作燈以補足環境照明，令工作範圍內有較高的照度水平。附加的燈可以直接安裝於工作範圍天花板之上，並配置獨立的開 /關控制讓用戶自行選用。此外，也可使用便攜式的工作燈。後者的選擇可以更靈活，更容易落實。

## Selection of Portable Task Lamp

The following points should be considered when selecting portable task lamps:

1. **Light distribution**
   The light distribution should adequately cover the full task surface (e.g. area of the office desk). Portable task lamp with a narrow light distribution should be avoided for carrying out reading task. Appropriate shielding should be provided to avoid glare to the user when the lamp is used for reading. Reference could be made to its photometric data to ensure the portable task lamp selected can achieve the required illuminance with acceptable uniformity on task plane.

2. **Energy efficiency**
   Typical energy efficient light sources used in task lights include compact fluorescent lamp (CFL) and LED. To avoid standby power loss in a portable task lamp with LED, select the lighting fixture with the on/off and dimming switch located between the plug and the power supply unit instead of located at the downstream of the power supply unit. Consult the portable task lamp manufacturers for advice as necessary.

3. **Compliance with safety requirements**
   As an electrical product, a portable task lamp shall comply with the applicable safety requirements of the Electrical Products (Safety) Regulation and shall be issued with valid certificates of safety compliance.

4. **Length of the Swing Arm**
   A portable task lamp may incorporate a swing arm to enable the user to position the light source to the task area. The length of the swing arm should be suitably selected to ensure that the direction of the light source can be adjusted in order to focus on the task area without obstructing the user in carrying out the task.

## 選擇便攜式工作燈

選擇便攜式工作燈時，應考慮以下幾點：

1. **光線分佈**
   光線的分佈應充分覆蓋整個工作的表面上（例如辦公桌的範圍）。應避免使用具狹窄光分佈的便攜式工作燈進行閱讀。使用工作燈來進行閱讀時，應配置適當的遮罩，以防止眩光溢散至用戶。可參考有關光度數據資料，以確保選定的便攜式工作燈可令工作平面上達致所需的光照度及可接受的均勻度。

2. **能源效益**
   典型具能源效益的工作燈使用緊湊型熒光燈（CFL）和發光二極管(LED)。為了避免便攜式LED工作燈在待機時的功耗，應選擇開/關和調光制設於插蘇和電力供應器之間而不是設於電力供應器下游的燈具。有需要時可向便攜式工作燈製造商諮詢意見。

3. **符合安全規格**
   便攜式工作燈屬於電氣產品，必須符合《電氣產品(安全)規例》的適用安全規格，並具備有效的「符合安全規格證明書」。

4. **搖臂的長度**
   便攜式工作燈可能配備搖臂，使用戶能夠把光源定位於工作範圍。應適當地選擇工作燈搖臂的長度，以確保光源可以在不妨礙用戶進行工作情況下調整至工作範圍內。

5. **Hinges for adjustment**
   The hinges of the swing arm or lamp head should be rigid enough to hold the swing arm or lamp head to the position set by the user. It should not get loosened easily causing the swing arm or lamp head to drop or move away from the set position.

6. **Fixing mechanism**
   A portable table lamp can either be free standing type with a heavy base to be placed on the desk or clamping/clipping type with a clamp or a clip to be attached onto the edge of the desk. Free standing type gives more flexibility as it can be moved easily around on the desk. However, if the desk area is small, the space occupied by the portable table lamp may affect the user's work. Clamping/clipping type occupies less desk area but since it has to be attached on the edge of the desk, user has less freedom to decide where to put the lamp.

7. **Photo-biological impacts from task light**
   To ensure that effect of visible and non-visible radiation, if any, from the light source is properly tackled by the portable task lamp manufacturers, the portable task lights should comply with relevant standards on photo-biological effects (e.g. IEC 62471).

## Case Study

Computer simulations have been carried out to illustrate the energy saving potential of adopting task lighting design for general lighting in offices. Nevertheless, actual saving for real life applications is site specific depending on many factors such as size of office, office layout, type and wattage of light fixtures used and type of task lamp etc.

5. **搖臂鉸的調節**
   搖臂鉸或燈頭應穩固於用戶所設置的位置或固定的角度。它不應該容易地鬆脫而造成搖臂擺動或令燈頭倒下或移離預設的位置。

6. **穩固工作燈的模式**
   一個便攜式檯燈可以是自由站立型，即包含一個重的基座以便放置在辦公桌上；或是夾鉗型，將燈具夾接到辦公桌的邊緣。自由站立型較具靈活性，在辦公桌上的位置可以按需要而被移動。但是，如果桌子的面積小，便攜式檯燈佔用的空間可能會影響用戶的工作。由於夾鉗型燈是安裝於辦公桌的邊緣，它相對只佔辦公桌較小的地方，但使用夾鉗型，用戶有較少的自由度去決定燈的位置。

7. **工作燈在光生物方面的影響**
   為了確保便攜式工作燈的製造商有效地處理從光源引致的可見和非可見輻射，如有的話，工作燈應符合相關光生物效應的標準（例如IEC62471）。

## 個案研究

以下是透過電腦模擬結果以說明採用工作照明設計於辦公室一般照明的節能潛力。在現實生活中應用工作照明設計的實際節能情況按不同地點而異，並取決於很多因素，例如辦公室的大小及佈局、使用燈具的類型和功率、及工作燈的類型等。

## Case 1: The energy saving potential of a typical open plan office
## 個案1：一個典型的開放式辦公室的節能潛力

Assumptions used in the computer simulation for the typical office example:

### Office space:

Dimensions - Width = 15m, Length = 33m
Total area = 495m$^2$
Height = 2.5m

Reflectance – Ceiling = 0.7, Wall = 0.5
Floor = 0.2

### Office workstation:

Dimensions of each workstation: 2m(W) x 2.2m(L) = 4.4m$^2$

Assume that 15% of the total office space is for ancillary areas (e.g. filing/general storage, and office equipment).

Based on the dimensions of the office and the workstation, it is estimated that around 55 workstations can be set up in this office.

(i.e. average office space per workstation = 495/55 = 9m$^2$ /workstation)

應用於電腦模擬的假設：

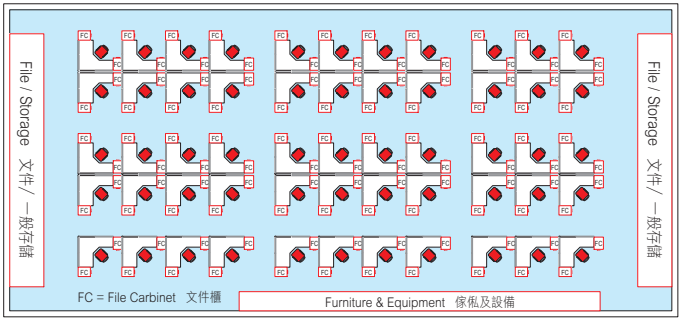
### 辦公室空間：

空間尺寸 - 寬度=15米，長度=33米
總面積 = 495平方米
高度=2.5米

反射比 - 天花板= 0.7，牆身= 0.5
地面= 0.2

### 辦公室工作台：

每個工作台尺寸：2米 (闊) × 2.2米(長) = 4.4平方米
假設百分之十五的辦公室空間總面積為附屬設備用地方（如文件/一般存儲、辦公室設備等）
根據辦公室和工作台的尺寸，估計可設立約55個工作台
（每個工作台平均佔用辦公室空間=495/55 = 9平方米/工作台）




### Lighting used:

Ambient lighting fixtures adopted – T5 fluorescent luminaire, 3 x 14W recessed mounted luminaires with high gloss reflector
Luminaire maintenance factor = 0.8
Lamp maintenance factor = 0.8

Energy consumption of each light fitting (including ballast) = 48W

Task lamp adopted – 27W CFL portable task lamp

### 環境照明的燈具：

環境照明裝置—配置高亮度反射罩的嵌入式T5熒光燈燈具，3 ×14 W (即“瓦”)
燈具保養系數= 0.8
燈泡保養系數= 0.8

每個燈具的能源消耗=48 W (包括鎮流器)

工作燈- 27 W緊湊型熒光燈 (便攜式工作燈)

### Simulation result:

Based on the assumptions above, the lighting layout for the general lighting systems could be designed as follows:

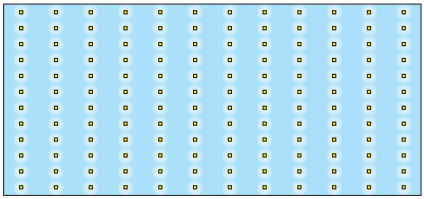


*Figure 3a: General lighting layout to achieve 500 lux*
*圖 3a： 一般照明的佈局，以實現500 lux*

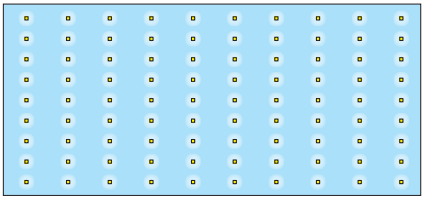


*Figure 3b: General lighting layout to achieve 300 lux*
*圖 3b： 一般照明的佈局，以實現300 lux*

### a) Conventional Design Approach

Quantity of light fittings for general lighting system (based on design illumination level of 500 lux) = 156nos.

Projected average ambient illumination level =550 lux
Projected uniformity = 0.82

Energy consumption of ambient lighting system = 156 nos. x 48W = 7,488W

### b) Task Lighting Design Approach

Quantity of fittings for ambient lighting system (based on design illumination level of 300 lux)
= 90 nos.
Projected average ambient illumination level = 322 lux
Projected uniformity = 0.81

Assume each workstation to be provided with a task light, hence, 55 nos. of task lights will be required.

Energy consumption of ambient lighting system = 90 nos. x 48W = 4,320 W
Task lighting consumption = 55 nos. x 27W = 1,485W
Hence total lighting energy consumption = 4,320W + 1,485W = 5,805 W

### Energy saving Potential:

The above case shows energy saving of around 22% when adopting tasking lighting design. More savings are possible if the task lights provided to the users will turn off sometime during the day (say, for example, when screen operated tasks are being carried out). In addition, energy saving will also be affected by the workstation density in the office.

### 模擬的結果

基於上述的假設，一般照明系統的燈具佈局可安排如下：

### a) 傳統的設計方法

一般照明系統的燈具裝置的數量（按照500 lux 的照明設計水平）= 156 個燈具

估計平均環境照度水平= 550 lux
估計均勻度=0.82

環境照明系統的能源消耗= 156x48W = 7,488W

### b) 工作照明設計方法

環境照明系統的燈具數量（按照300 lux 的照明設計水平）
=90個燈具
估計平均環境照度水平= 322 lux
估計均勻度=0.81

假設每個工作台均設置一個工作燈，因此將需要55個工作燈。

環境照明系統的能源消耗= 90x48W = 4,320W
工作燈能耗= 55 x 27W=1,485 W
因此，照明的總能源消耗=4,320W + 1,485W = 5,805W

### 節能潛力：

上述案例顯示採用工作照明設計可節能約百分之二十二。如果提供給用戶的工作燈在白天的某些時候關掉的話（例如當執行屏幕操作工作時），節能可能更多。此外，節能多少亦會因辦公室工作台的密集情況而有所改變。



*Energy saving tips: Keep lighting fittings clean to maintain optimum lighting performance*

## Case 2: The energy saving potential of a more spacious open plan office
## 個案2：一個較寬敞的開放式辦公室的節能潛力

In this Case 2 example, all assumptions are the same as in Case 1 except that each workstation occupies larger space.

### Assumptions for office workstation:

This scenario is for a relatively spacious open plan office as reflected in the average office space per workstation.

Dimensions of each workstation: 2m(W) x 3m(L) = 6m$^2$

Based on the dimensions of the office and the workstation, it is estimated that around 30 workstations can be set up in this office
(i.e. average office space per workstation = 495/30 = 16.5m$^2$ /workstation)

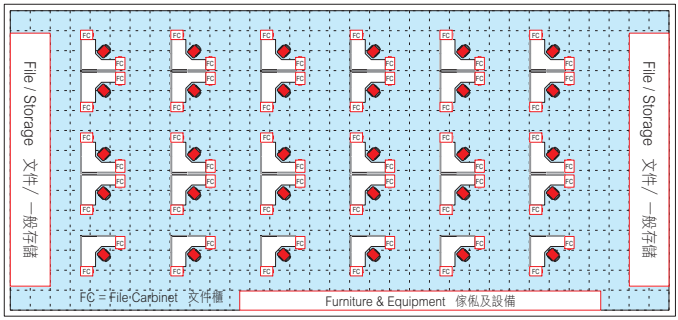
在個案2例子所採用的假設與個案1例子的情況相同，但個案2例子中每個工作台佔用較大的空間。

### 辦公室工作台的假設：

從每個工作台佔平均辦公室空間可顯示本個案是一個相對寬敞的開放式辦公室

每個工作台尺寸：2米 (闊)× 3米 (長) = 6平方米

假設百分之十五的辦公空間總面積為附屬設備用地方（如文件 /一般存儲、辦公設備等）根據辦公室和工作站的尺寸，估計可設立約30個工作台
(每個工作台平均佔用辦公室空間 = 495/30 =16.5平方米/工作台)




### Result:
### 結果：

| | Conventional Design Approach 傳統的設計方法 | Task Lighting Design Approach 工作照明設計方法 |
|---|---|---|
| Ambient lighting consumption (W) 環境照明能耗（W） | 156 nos. x 48W = 7,488<br>156個燈具 x 48W = 7,488 | 90 nos. x 48W = 4,320<br>90個燈具 x 48W = 4,320 |
| Task lighting consumption (W) 工作燈能耗（W） | -- | 30 nos x 27W = 810<br>30個燈具x 27 = 810 |
| Total energy consumption for lighting (W) 用於照明的能源消耗總量（W） | 7,488 | 5,130 |
| Energy Saving Percentage 節能率 | -- | 31% |

Case 2 shows that more saving (up to around 31%) could be obtained when adopting task lighting design in a more spacious office in comparison with Case 1 above.
上述個案2顯示採用工作照明設計於一個較寬敞的辦公室時（相對於個案1），可以有較高的節能率（高達 31%）。

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