ENVIRONMENT BUREAU

FINAL REPORT

FOR

CONSULTANCY AGREEMENT NO. EG 08-051/2

STUDY ON OVERSEAS PRACTICES IN GUIDING AND REGULATING EXTERNAL LIGHTING

CONTENTS

Tables **Page**

Tables

Figures

Figures **Page**

Abbreviations

AO/PA	-	Administration offices (industrial) or public activity (leisure) area (行政办公(工业)区/公共活动区)
AS	-	Australian Standards
AS/NZS	-	Australian/New Zealand Standards
BS	-	British Standards
BS EN	-	British Standards version of European Standards
CC	-	Commercial Centre (商业中心区)
C&CRB	-	Commercial & commercial/residential boundary
CIBSE	-	Chartered Institution of Building Services Engineering
CIE	-	Commission Internationale de l'Eclariage (International Commission on Illumination)
DB	-	Local (Municipal or Provincial) Standard of People's Republic of China 地方标准 (中华人民共和国)
IDA	-	International Dark-sky Association
IESNA	-	Illuminating Engineering Society of North America
ILE	-	The Institution of Lighting Engineers (UK) (currently named as the Institution of Lighting Professionals (ILP))
ISO	-	International Organization for Standardization
JGJ	-	Trade Standard (Construction Industry) of People's Republic of China 中华人民共和国行业标准(建筑工业)
MOE-LPCG	-	Ministry of the Environment Light Pollution Control Guideline (Japan)
MLO	-	Model Lighting Ordinance
RDS	-	Residential – dark surrounds
RE	-	Residential Estate (居住小区)
RLS	-	Residential – light surrounds
RPFI	-	Residential premises facing inside of estate (面向小区内侧的住户)
RPFO	-	Residential premises facing outside of estate (面向小区外侧的住户)
RPFS	-	Residential premises adjacent to street (居住区临街侧)
RPNFS	-	Residential premises not adjacent to street (居住区非临街侧)
SLL	-	Society of Light and Lighting – a Society within the CIBSE

Key Symbols

Symbol		Description
E_{eye}	-	Illuminance on a plane perpendicular to the line of sight to the luminaire (due to a single luminaire or a group of luminaires on the same pole)
E_v	-	Vertical illuminance (due to all light sources) on a relevant surface (such as window or façade) of residential premises for controlling illumination on surrounding properties (light trespass).
h	-	Luminaire height
I_d	-	Luminous intensity emitted by a luminaire towards the line of sight (apply to a single luminaire)
m	-	Magnitude, used to measure brightness of celestial body
$L \cdot A^{0.5}$	-	Luminaire's greatest (average) luminance (in cd/m^2) in the direction between 85° and 90° from the downward vertical multiplying the square root of the light emitting surface area of the luminaire (in m^2) in the direction 90° from the downward vertical.
L_b	-	Building façade luminance for controlling effects of over lit building facades. It is taken as the product of the design average illuminance and reflectance factor divided by π.
L_s	-	Sign luminance for controlling effects of over lit signs. It is taken as the product of the design average illuminance and reflectance factor divided by π, or for self-luminous signs, its average luminance.
L_v	-	Veiling luminance. It is the luminance of scattered light in the background which reduces the luminance contrast between the object and the background.
LPD	-	Lighting power density in W/m^2.
TI	-	Threshold increment, the measure of disability glare expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present.
ULR	-	Upward light ratio

Executive Summary

Introduction

1. The objectives of the study report are to review the overseas experience in selected 8 metropolises (i.e. Shanghai, Tokyo, Singapore, Sydney, New York City, Los Angeles, London & Frankfurt) and 6 economies (i.e. Yangtze River Delta in PRC, State of New South Wales in Australia, State of California in USA, Province of Ontario in Canada, England in UK and European Union) in dealing with and regulating the impacts of external lighting and to identify relevant overseas practices that are applicable to Hong Kong.

Shanghai

2. The Shanghai government adopts mandatory regulatory approach and makes reference to reference standards to govern the use of new and existing external lightings. The authority can direct the responsible parties to rectify the lighting devices causing the light nuisances. Light nuisance is assessed on a case-by-case basis.

3. Shanghai Environmental Protection Regulation (《上海市环境保护条例》) is the mandatory document and effective on 1 May 2006 to govern the use of new and existing external lighting installations related to light pollution issue.

4. The Shanghai Municipal Standard 上海市地方标准 DB31/T316-2004 《城市环境（装饰）照明规范》 (Urban Environment (Decorative) Lighting Standards) issued on 1 September 2004 is adopted as the reference standards in Shanghai Environmental Protection Regulation.

5. The City Appearance and Environmental Sanitation Department (CAESD) enforces Shanghai Environmental Protection Regulation (《上海市环境保护条例》) with reference to the Shanghai Municipal Standard (上海市地方标准 DB31/T316-2004 《城市环境（装饰）照明规范》) to assess and investigate the light nuisance upon receiving a complaint. If the CAESD considers that there exists a nuisance, an abatement notice will be issued requiring that the nuisance be ceased or abated within a set timescale. From time to time, the CAESD also reviews and amends the technical standard where appropriate.

Tokyo

6. The Tokyo government adopts, for new and existing external lighting installations, non-mandatory approach for light pollution control and tries to prevent light pollution using voluntary guidelines without binding force.

7. There is no mandatory regulation governing external lighting in Tokyo. At the national level, the Ministry of the Environment (MOE) has published voluntary light pollution control guidelines to help local authorities to formulate light pollution control measures.

8. In Tokyo, there are voluntary guidelines, namely, Light Pollution Control Guidelines, Manual for Local Planning of Lighting Environment and Guidebook on Light Pollution Preventive Measures. All of them are technical guideline for reference only and are not mandatory requirements to cope with light pollution of external lighting installations.

Singapore

9. The Singapore government has made a policy statement which touches upon the use of new external lightings but it has no mandatory regulation or voluntary guideline.

10. The policy statement is made in the lighting plan of the Urban Redevelopment Authority (URA), which is a plan for new lighting installations in government and private sector firms. According to the policy statement, the URA will prevent glare, light trespass and light pollution in the planning of lighting installations for beautification of Singapore. From our surveying, there is no concrete action plans or measures to implement the policy statement.

Sydney

11. The Sydney government adopts mandatory regulatory approach with reference standards to govern the use of new external lightings.

12. The City of Sydney Exterior Lighting Strategy is the mandatory document issued by the City of Sydney Council with reference standards to govern new exterior lighting installations by the private sector. It specifies the conditions under which the authority will grant development consent for building and under-awning illumination.

13. All new decorative lighting proposals are required to be submitted by the private sector for Development and/or Construction Certificate Approval to comply with the development control policies stated in the strategy. The City of Sydney Council would assess and issues the development consent to the proposals before submit the proposals to the Director of Development as Development Applications for development and construction certificate approval under Environmental Plans, Development Control Plan (DCP) and the Environmental Planning & Assessment (Amendment) Act 1997.

14. Central Sydney Local Environmental Plan (LEP) 1996, Central Sydney DCP 1996 and Sydney Regional Environmental Plan (REP) No.26 have been prepared in accordance with the *Environmental Planning and Assessment Act 1979* (the Act).

15. Australian Standards AS/NZS1158-3.1:1999 Pedestrian Area (Category P) Lighting (Note: new edition published in 2005 with amendment in 2008) and AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting are the technical reference standards.

New York City

16. The New York City government adopts mandatory energy code and energy efficiency standards to govern the energy consumption of new external lightings.

17. In New York City, the government adopts Energy Conservation Construction Code of New York State 2007 (main code) which based on ASHRAE 90.1-2004 (alternative code) to set the maximum energy allowed for all new outdoor lightings by type of use, such as facade or area lighting, on private property. In addition, the zoning resolution also has mandatory requirement to regulate all new signs. The requirements are applicable to the installation of new external lightings. Existing lightings which do not comply with the requirements are generally allowed to remain.

18. Department of Buildings enforces the building, energy conservation and zoning codes and examines individual building sites according to the Energy Conservation Construction Code of New York State or the standard ASHRAE 90.1-2004.

Los Angeles

19. The Los Angeles government adopts the mandatory energy code and energy efficiency standards to govern the energy consumption of new external lightings.

20. In Los Angeles, the local government adopted the *2005 Building Energy Efficiency Standards,* including *California Building Standards Administrative Code Title 24, Part 1 & California Energy Code CCR, Title 24, Part 6* as mandatory regulatory document. The requirements are applicable to newly installed lightings and additions and alterations (A&A) to existing externally illuminated signs. (Remarks: A&A works covered under the Code include increase in connected lighting load, replacement and rewiring of more than 50 percent of the ballasts, or relocation of the sign to a different location on the same site or on a different site.)

21. Los Angeles Department of Building & Safety enforces the building, energy conservation and zoning codes and examine individual building sites according to 2008 LA Amendment for Building Code which incorporates, by reference, the California Building Code and California Energy Code *Title 24, Part 6* as well as the Planning & Zoning Code. California Energy Commission (CEC) formulates energy efficiency standards to reduce California's energy consumption, including regulations on limiting power density for outdoor lighting.

<u>London</u>

22. The London government adopts mandatory regulating approach and planning guidelines to govern the use of new and existing external lightings.

23. In London, the Clean Neighbourhoods and Environment (CNE) Act 2005 provides local authorities with power and tools to tackle nuisances from artificial light in new and existing external lighting installations.

24. In addition, the Act makes reference to the Institution of Lighting Engineers (ILE) document *Guidance Notes on the Reduction of Light Pollution.*

25. Light pollution (like noise and air pollution) falls under the purview of the Environmental Health Department of the Local Council. If light pollution is identified, the local Environmental Health Department would issue an abatement order to the party causing the pollution problem and if that was not complied with, legal procedures would be taken. If the owner of the new and existing installations did not rectify his lighting installation which causes the light nuisance, he might be taken to the court.

26. When assessing a case, the local authorities would consider factors like duration, frequency of use of artificial light. The technical parameters formulated by the standard issued by the ILE may help relevant parties consider whether there is light nuisance in a particular case.

Frankfurt

27. The Frankfurt government adopts mandatory regulating approach with reference standards to govern the use of new and existing external lightings.

28. "Gesetz zum Schutz vor schaedlichenUmwelteinwirkungen durch Luftverunreinigungen, Geraeusche, Erschuetterungenund aehnliche Vorgaenge" (translated into Act on the Prevention of Harmful Effects on the Environment caused by Air Pollution, Noise, Vibration and Similar Phenomena) (Federal Pollution Control Act - BImSchG) is the mandatory regulation for external lightings, whose requirements are applicable to both new and existing lightings.

29. "*Messung und Beurteilung von Lichtimmissionen künstlicher Lichtquellen* " (translated into Measurement and assessment of light pollution from artificial light sources) is the reference standard, published by the German Lighting Engineering Society (LiTG), to recommend the maximum admissible levels and details of the measurement and assessment methods to help implement the Federal Pollution Control Act.

30. The light pollution laws in Germany are primarily issued by the Federal Government (the Bundestag) and cover the whole country; there is no particular local standard in Frankfurt. The purpose of the Act is to protect human beings, animals and plants, the soil, water, the atmosphere as well as cultural assets and other material goods against harmful effects due to any air pollution, noise, vibration, light, heat, radiation and similar effects on the environment and to prevent the emergence of any such effects, also from hazards, considerable disadvantages and considerable nuisance caused in any other way, and to take precautions against the emergence of any such harmful effects on the environment.

31. When assessing a case, the city council would consider factors like duration, frequency of use of artificial light. The technical parameters formulated by the standard issued by LiTG may help relevant parties consider whether there is light nuisance in a particular case.

Yangtze River Delta, PRC

32. At present, there is no mandatory regulation in Jiangsu province and Zhejiang province on controlling the use of external lighting. There is no mention of any controls over the impacts of external lighting in《江苏省环境保护条例》(Environmental Protection Ordinance of Jiangsu Province) and《江苏省节约能源条例》(Energy Conservation Ordinance of Jiangsu Province). There is also no sub-provincial government regulation to control the impacts of external lighting.

33. Since there is no legislation governing external lighting in the area, the Shanghai Municipal Standard DB31/T316-2004 is often referred to in published articles concerning light nuisances. Recently a China Trade Standard (Construction Industry) JGJ/T163-2008 《城市夜景照明设计规范》 (Code for lighting design of urban nightscape) has become effective from 1 May 2009 as a voluntary industry standard to give guidelines in the design of outdoor lightings in new building, additions and alterations (A&A) works, commercial pedestrian street, square, park, advertising and logo.

34. In the website of Jiaxing Environmental Protection Bureau (嘉兴市环境保护局), it is mentioned that the Shanghai Municipal Standard DB31/T316-2004 《城市环境(装饰)照明规范》 is a local reference standard in Jiaxing. It is also mentioned that the China Trade Standard (Construction Industry) JGJ/T 163-2008 《城市夜景照明设计规范》 (Code for lighting design of urban nightscape) is the recommended industry standard in Jiangsu and Zhejiang Provinces.

State of New South Wales, Australia

35. According to the information obtained, there is no mandatory regulation for external lighting in New South Wales.

36. The Australian Standards AS4282:1997 and AS/NZS1158.3.1:2005 are voluntary guidelines for new installation and existing lighting in the whole Australia including NSW State.

State of California, USA

37. The government in the state of California adopts mandatory energy code and energy efficiency standards to govern the energy consumption of new external lighting.

38. The California Energy Commission Title 24 Section 132 Outdoor Lighting Controls and Equipment and 2005 Building Energy Efficiency Standards applicable to the installation of lightings are mandatory to govern the energy consumption of newly constructed lightings and additions and alterations (A&A) to existing external illuminated signs. It ensures compliance with energy conservation standards and imposes lighting control. (Remarks: A&A works covered by the regulation include increase in the connected lighting load, replacement and rewiring of more than 50 percent of the ballasts, or relocation of the sign to a different location on the same site or on a different site.)

39. California Buildings Standards Commission (CBSC) is responsible for administering California's building codes and standards, including those on external lighting while California Energy Commission (CEC) formulates energy efficiency standards to reduce California's energy consumption, including regulations limiting the power density for external lighting. The Building Department inspects new constructions to determine whether they are consistent with the approved plans and specifications, and in compliance with the 2007 California Energy Code.

Province of Ontario, Canada

40. The government in Province of Ontario adopts mandatory energy code to govern the energy consumption for use of new external lighting.

41. The Ontario Building Code governs the energy consumption of newly constructed lightings. Ontario's new Building Code has been approved with the filing of Ontario Regulation 350/06 (2006 OBC) and replaces the previous building code regulation enacted in 1997. The Building and Development Branch of the Ministry of Municipal Affairs and Housing administers the Ontario Building Code.

42. The building code is promulgated by the Building and Development Branch and enforced usually by inspectors of local building department. The building permit application form is published by the Ministry but submitted for a project to the local authority, usually a municipality.

England, UK

43. The government in the England UK adopts mandatory regulating approach and planning guidelines with binding force to govern the use of new and existing outdoor lightings. Planning guidelines are a form of legislative control under local authority's jurisdiction.

44. In England UK, the Clean Neighbourhoods and Environment (CNE) Act 2005 provides local authorities with power and tools to tackle nuisance from artificial light in all external lighting installations.

45. Planning Policy Guidance (PPG) and Planning Policy Statement 23 (PPS): Planning and Pollution Control aim to assist local authorities in preparing their development plans and making decisions on individual planning applications and appeals to complement the pollution control framework under the *Pollution Prevention and Control Act (PPC) 1999* and the *PPC Regulations 2000*. Pollution Prevention and Control (PPC) is a regulatory regime for controlling pollution from certain industrial activities. From 6 April 2008 it has been incorporated into the framework of the Environmental Permitting Regulations (EPR). PPS and their predecessors Planning Policy Guidance (PPG) are prepared by the UK government after public consultation to explain statutory provisions and provide guidance to local authorities and others on planning policies and the operation of the planning system. The regional planning bodies and the local planning authorities should take into account the policies stated in PPS and PPG when preparing their development plans and making decisions on individual planning permission applications. New buildings or major changes to existing buildings including changes to outdoor lighting fixtures require planning permission from the local planning authority.

46. Department for Environment, Food and Rural Affairs (DEFRA) is responsible for policy on artificial light from premises and provides guidance to local authorities in enforcing nuisance legislation. Department for Communities and Local Government (DCLG) sets out the national planning policy on lighting in the planning regime.

47. Upon receiving a complaint, the Local Environmental Health Department will assess the case. If the department considers that there exists a statutory nuisance, an abatement notice will be issued requiring that the nuisance cease or be abated within a set timescale. Environmental Health Department would issue an abatement order and if that was not complied with then legal procedures would be enacted. If the owner of the lighting installation did not rectify his lighting installations causing the light nuisance, he might be taken to the court.

<u>European Union</u>

48. The European Union directives (Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Energy using Products (EuP) Directive 2005/32/EC with regard to ecodesign requirements) give general guidance and suggest a legislative framework to control lighting products for the governments of member states. The member states decide whether any legislation and enforcement measures should be adopted within their states.

49. However, there is currently no EU directive specifically on light pollution although there has been significant pressure from NGOs and affected pressure groups for a standard to be written. The need of EU directive was debated at the "7th European Symposium for the Protection of the Night Sky Light Pollution and Global Warming with International Exhibition: Quality Lighting and Light Pollution" held in Bled, Slovenia on 5-6 October 2007 to which representatives of the EU were invited. In EU, some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia, and Croatia have light pollution laws.

Hong Kong

50. In Hong Kong, there is currently no regulation or guideline concerning light nuisance and energy wastage caused by external lighting installations. Complaints against external lighting installations such as advertising signs are dealt with by the relevant Government department(s), including the Buildings Department, the Fire Services Department, the Marine Department, the Hong Kong Police Force, the Civil Aviation Department, and the Food and Environmental Hygiene Department, depending on the nature of the complaints.

51. After reviewing overseas practices on the controls of external lighting, we find out that mandatory outdoor lighting regulations are still not widely adopted in the selected metropolises and economies.

52. By visual observation of external lightings in current Hong Kong situation, the extent of light nuisance in general is considered not that significant except some isolated spots, e.g. areas in some districts with high density of external lighting installations, including advertising signs, and/or with relatively higher ambient light level at night for members of the public and visitors to enjoy night life (e.g. dining and recreation).

53. One of the advantages of using legislative approach to control light nuisances is that the relevant authorities will have legal power to investigate into light nuisance cases, order for improvements, and make prosecution where appropriate. However, the main drawback of the legislative approach is that it is usually difficult to prescribe concrete objective parameters for the authorities to determine whether a case constitutes light nuisance. The light nuisance may also be attributed to multiple light sources.

54. The advantage of using voluntary guidelines to address light nuisance problems is that best practices and/or reference standards can be provided to prevent light nuisances, taking account of the need to balance the conflicting requirements of human activity and impacts of light nuisance. The guidelines can provide advice on outdoor lighting design to minimize their adverse impacts on residents, road users and astronomical observers. The main disadvantage of a voluntary approach is that the government has no authority to "enforce" the recommended best practices and reference standards.

55. At present, there is no legislative control on external lighting in Hong Kong and mandatory regulations on light nuisances are still not uncommon in the selected metropolises and economies. Besides, legislative control on external lighting may not be appropriate at the moment taking into account the pros and cons of such approach and the current situation of Hong Kong. Therefore, the issue of guidelines on the prevention of light nuisances and energy wastage of external lighting is recommended. The implementation of the guidelines will be on a voluntary basis depending on the cost-benefits of adopting the guidelines, and public awareness of the environmental impacts of light nuisance and their social responsibilities.

56. As a first step to deal with the problems of external lighting, a set of guidelines with a view to limiting the adverse impacts of external lighting on the general public (the guidelines) could be developed. The Government should encourage the voluntary compliance with guidelines by trades, professionals and other stakeholders through publicity and education.

57. The set of guidelines could recommend parameters with a view to preventing adverse effects of external lighting to residents, road users and astronomical observers, and prescribe limits on the energy consumption of different types of external lighting installations. The guidelines could define a zoning system to classify different areas in Hong Kong into commercial, residential and rural zones. The recommended curfew hour and a relevant set of reference values on various parameters of a lighting device (e.g. glare, upward light ratio for each lighting zone) can be specified for each lighting zone.

58. The stakeholders are encouraged to follow the proposed guidelines through education and publicity, or persuasion when the recommendations in the guidelines are not followed. If a lighting installation subject to complaint is found not following the guidelines and its owner(s) can be identified by complainant(s), pressure group(s) or the Government, the Environmental Protection Department or other relevant department(s) can provide advice for the owner(s) to improve the lighting installation. Education and publicity campaigns are effective measures as some past examples show that reputable companies or organizations would respond positively to complaints against light nuisances and energy wastage caused by their external lighting installations through the implementation of various mitigation measures.

59. After gaining some experience in implementing the voluntary guidelines for a period, say 3 years, the effectiveness of the guidelines should be reviewed. Opinion surveys of stakeholders and the general public on the guidelines and their implementation should be conducted. The experience gained and the opinions collected should then be analyzed in order to determine whether further regulatory measures, such as legislation for mandatory control of external lighting with respect to light nuisance and energy efficiency, is necessary.

1. INTRODUCTION

1.1 Background

1.1.1 The Government has announced in the 2008/09 Policy Agenda that it plans to study the issue of energy wastage of external lighting and assess the feasibility of regulating external lighting by legislation. As such, a consultancy study has been commissioned by the Government to review overseas experiences, the impacts of external lightings and identify relevant overseas practise to be applicable in Hong Kong.

1.2 Objectives of study

1.2.1 The main objectives of the study are to:

(i) Review overseas experience in 8 metropolises and 6 economies in dealing with and regulating the impacts of external lighting in urban, sub-urban, rural areas and etc. Such impacts include human health, energy efficiency and potential nuisance to nearby inhabitants; and

(ii) Identify relevant overseas practices that are applicable to Hong Kong and modify them, where appropriate, to suit Hong Kong conditions.

1.2.2 The study consists of tasks defined to achieve the above two objectives, which include the followings:

(i) To review overseas experience in addressing problems associated with external lighting.

(ii) To identify relevant overseas practices that are applicable to Hong Kong

1.3 Scope of study

1.3.1 The study covers the review of overseas experience in dealing with and regulating the impacts of external lighting in 8 metropolises and 6 economies and the following places have been selected according to the aspects of building forms, population density, economic activities and land use and building mix that are of comparable situation to Hong Kong relating to external lighting:

<u>Metropolises</u>

(a) Shanghai;

(b) Tokyo;

(c) Singapore;

(d) Sydney;

(e) New York City;

(f) Los Angeles;

(g) London;

(h) Frankfurt;

Economies

(i) Yangtze River Delta in PRC;

(j) State of New South Wales (NSW) in Australia;

(k) State of California (California) in the United States;

(l) Province of Ontario in Canada;

(m) England in UK; and

(n) European Union.

1.3.2 The current situation on overseas experience in dealing with and regulating the impacts of external lighting in the 8 metropolises and 6 economies are reviewed in the following aspects:

(a) major approaches:

(i) mandatory regulation on light nuisance and energy efficiency;

(ii) non-mandatory/ voluntary control through guidelines/standards on light nuisance and energy efficiency;

(b) parameters on assessing light nuisance and energy efficiency;

(c) practices and measures in addressing problems of external lighting

(d) problems encountered and arrangements to deal with such problems

1.3.3 External lighting in this study includes signs (advertising or non-advertising, standalone or on building facades, self-luminous or illuminated), lighting for building facades and features, lighting outside buildings, shops, restaurants, other public entertainment venues, and permanent external video structures. External lighting in this study excludes road lighting, lighting at public transport interchange or terminus, airport and container port, air and marine traffic lighting, lighting of construction sites, and lighting of which the operation is of transient nature.

1.4 Methodology

This study adopts a desktop research method, which involves Internet research, literature review and documentation analysis, and consultation with relevant organizations or bodies relating to external lighting.

1.5 Structure of Report

In addition to this Introduction Chapter which gives the background, objective and methodology of the study, the report consists of the following chapters:-

Chapter 2: **Impacts of external lighting on human health, nuisance and energy efficiency**

gives a brief discussion on the impacts of external lighting on human health, nuisance and energy efficiency and overview of current state of knowledge.

Chapter 3: **Review of regulatory approaches and measures adopted by the 8 selected metropolises**

summarizes the approaches adopted by the 8 metropolises in dealing with and regulating the impacts of external lighting in the 8 metropolises (mandatory regulatory approaches or non-mandatory/ voluntary control through guidelines/standards on new and existing external lighting).

Chapter 4: **Review of regulatory approaches and measures adopted by the 6 selected economies**

summarizes the approaches adopted by the 6 economies in dealing with and regulating the impacts of external lighting (mandatory regulatory approaches or non-mandatory/ voluntary control through guidelines/standards on new and existing external lighting).

Chapter 5: **Summary of the review of overseas experience on the 8 selected metropolises and 6 economies**

summarizes the overseas experiences in the 8 selected metropolises and 6 selected economies (i.e. whether they adopt mandatory regulations/voluntary standards on light nuisance or energy efficiency, and the parameters adopted).

Chapter 6: **Discussions on the recommended approaches for addressing external lighting problems and impacts in Hong Kong**

gives a brief discussion to the recommended approaches for addressing external lighting problems and impacts in Hong Kong

Chapter 7: **Recommendations**

gives the recommended practice for measuring and assessing the impacts of external lighting in Hong Kong.

2 IMPACTS OF EXTERNAL LIGHTING ON HUMAN HEALTH, NUISANCE AND ENERGY EFFICIENCY – OVERVIEW OF CURRENT STATE OF KNOWLEDGE

2.1 Human health

2.1.1 Since the beginning of the 1980's, the effect of light on human performance and health has been a point of discussion and research. Disruptions to our circadian rhythms, the pattern of behavioral and physical processes including hormone secretion which is very dependant on light-dark cycles, has been linked to an increased risk to hormone dependant cancers such as breast and prostate cancer (Bartsch, et al 1985). Bartsch also concluded that "melatonin controls not only the growth of well differentiated cancers, but also possesses anti-carcinogenic properties."

2.1.2 From the figure 2.1. below we can see the normal cycle of melatonin secretion based on the day night cycle. Lewy (et al 1980) showed that artificial lighting at night could also suppress melatonin (using 2500 lux of white light for between 2 to 4 hours).

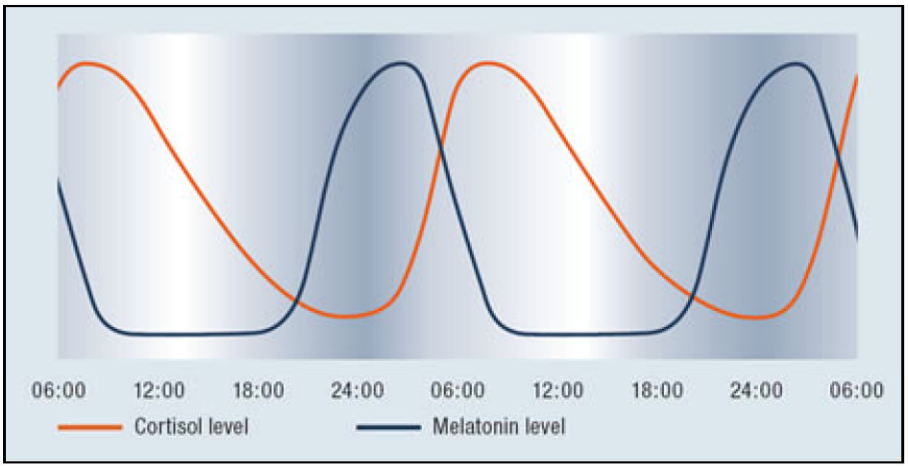

Figure 2.1 - Circadian rhythm, hormone secretion: *The hormones responsible for the circadian rhythm in humans are melatonin, which is released in response to increasing levels of darkness and which promotes sleep, and cortisol, which is the biological opposite of melatonin and an indicator of the level of human activeness. (Figure from Osram)*

2.1.3 From an exterior lighting perspective the question is whether levels and/or certain types of lighting can cause the suppression of melatonin levels at night through light trespass and therefore adversely affect the health of residents. The spectrum of the light can also have an influence with shorter wavelength lighting having more of an impact. The amount of light needed has to be of a sufficient level and applied for a sufficient amount of time to have an effect on melatonin levels. The figure 2.2. below (Figueiro et al, 2006) shows this relationship.

Table 2: Predicted Human Nocturnal Melatonin Suppression from Incandescent and Daylight Illumination [46] of Varying Corneal Illuminances and Durations, Based on Rea et al. [37]

Incandescent

Illuminance (lx)	Melatonin suppression after 30 minutes	Melatonin suppression after 60 minutes	Melatonin suppression after 90 minutes
0.1	0%	0%	0%
0.3	0%	0%	0%
1	0%	1%	1%
3	1%	2%	2%
10	3%	5%	5%
30	8%	11%	13%
100	19%	25%	27%
300	35%	42%	45%
1000	54%	59%	60%
3000	65%	68%	69%

Daylight

Illuminance (lx)	Melatonin suppression after 30 minutes	Melatonin suppression after 60 minutes	Melatonin suppression after 90 minutes
0.1	0%	0%	0%
0.3	0%	0%	1%
1	1%	1%	1%
3	2%	3%	4%
10	6%	9%	10%
30	14%	19%	20%
100	29%	36%	39%
300	47%	53%	55%
1000	62%	65%	66%
3000	69%	71%	71%

Figure 2.2 – Predicated Human Nocturnal Melatonin Suppression from Incandescent and Daylight illumination of Varying Corneal Illuminances and Durations.

2.1.4 Marianna Figueiro, et al, 2006 research reported in the Journal of Carcinogenesis states regarding the impact of Light at Night (LAN) on residents from street lighting systems that "These light levels rarely exceed 10 lux at the cornea outdoors. Indoors, behind closed curtains, the levels would likely to be much lower. Further, the human eyelids transmit only about 1% to 3% (Robinson et al, 1991) in the short wavelength region of the visible spectrum…. Given the available published data on human melatonin suppression in response to light, light trespass through residential windows is an unlikely cause of melatonin suppression, simply because the light levels are so low, particularly with the eyes closed."

2.2 Nuisance

2.2.1 Effects on residents

(i) Light Trespass:

This includes the effects due to spill light entering a residential premises, e.g. house, apartment unit, hotel, hostel, hospital ward, etc, during the hours of darkness. The spill light may cause annoyance, stress, discomfort and reduced sleep quality, etc. The commonly used term to describe this obtrusive light effect is 'Light trespass' although sometimes this term may have wider meanings including the effects of glare from bright light sources and signs.

(ii) Glare from bright luminaires:

Glare is caused by the direct view of bright luminaires from normal viewing directions causing annoyance, distraction or discomfort. CIE and many other authorities assess this effect separately from the general effects of light trespass although glare may also be caused by spill light entering the resident's premises. The Illuminating Engineering Society of North America (IESNA)[1] considers glare as an effect grouped within light trespass, but in IESNA TM-15-07 (Addendum A), a new glare rating system is proposed.

(iii) Glare from over-lit building facades and over-bright signs and billboards:

Other than causing light trespass, over-lit building facades and over-bright signs and billboards close to residential units can also cause glare to residents.

2.2.2 Effects on road users

2.2.2.1 Effects on road users (e.g. motorists, cyclists, pedestrians) normally involve a reduction of visibility of objects caused by disability glare from bright light sources. The apparent contrast of objects against their backgrounds will be lowered, rendering them less visible or even invisible, especially if the environment is intrinsically dark. The magnitude of the effect will depend on the level of lighting to which the user is adapted.

[1] **IESNA** is one of the most well-known illuminating engineering society in the world. It is a recognized technical authority on lighting. Guidelines and recommendations in its technical publications and standards are used not only in North America but also in many parts of the world.

2.2.3 Effects on astronomical observers

2.2.3.1 Sky glow is the brightening of the night sky that results from the reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gas molecules, aerosols and particulate matter), in the direction of observation. Sky glow actually occur naturally due to radiation from celestial sources and luminescent processes in the Earth's upper atmosphere. Light from outdoor lighting installations, including light emitting directly upwards and light reflected from the ground, contribute to sky glow significantly if not controlled adequately. The effect of sky glow caused by outdoor lighting is often called 'light pollution' although the term can have a wider meaning to include all adverse effects of light at night.

2.2.4 Effects on Wildlife

2.2.4.1 Light pollution resulting from the increasing illumination of the planet by mankind is having an increasing influence on wildlife (Rich and Longcore, 2006)[2]. The ecological consequences of artificial night lighting are becoming increasingly worrying for nocturnal species of animal across the UK and Europe.

2.2.4.2 The Conservation (Natural Habitats, &c.) Regulations 1994[3] implement EC Directive 92/43/EEC known as The Habitats Directive protects a number of species from disturbance (therefore increased lighting), including all bats, specific invertebrate and some mammal species.

2.2.4.3 Increased lighting can affect the behaviour of fauna in both a detrimental and beneficial way and therefore can be interpreted as a disturbance to their natural behaviour. Possible disturbance might include:

- *Predation risk* – increased light levels has the potential to increase the predation of insects and mammals, for example kestrels have been observed hunting bats flying under well lit underpasses;
- *Fragmentation of habitats* - increase of lighting may lead to fragmentation of habitats, producing small isolated colonies. This may then affect the long term survival of populations due to reduced gene pool;
- *Effects on life cycle* – increased lighting can affect intricate life cycle triggers for example, it has been noted that blackbirds and robins lay their eggs 2-3 weeks earlier in urban areas compared to rural. This could in turn lower survival rates in young due to cooler temperatures and reduced food sources;

[2] **Rich, C., and T. Longcore (2006)**. Ecological consequences of artificial night lighting. Island Press, Washington, D.C., 458 pp.
[3] http://www.naturenet.net/law/habsregs.html

- *Barrier* – nocturnal mammals are likely to be disturbed by the presence of bright artificial lighting and could be deterred from using established foraging and breeding areas, and;
- *Enhancement* – street lights with a high UV component are beneficial to insectivorous bat species because they attract insects and therefore increase foraging opportunities within that environment.

2.2.4.4 Within the UK the use of artificial lighting and the resulting light pollution is considered to be particularly significant on the 16 species of bat present within the UK. Measures to reduce the use of lighting and reduce the significance of impacts of lighting on bats are routinely provided as part of UK developments. Linear features, such as roads are seen as significant barriers to bats, particularly when they are accompanied by significant amounts of artificial lighting. The Design Manual for Roads and Bridges (DMRB) (www.standardsforhighways.co.uk) includes information on minimising the impacts of roads on bats. Specific guidance is contained "Interim Advice Note 116/08 Nature conservation in relation to bats"[4] which includes specific measures for reducing the light cast onto bat flyways and roost sites. This can include not providing lighting at particularly important road crossing points, and the use of directional lighting or screens to prevent unnecessary light spillage. For certain species within the UK, such as the very rare greater horseshoe bat, measures to control lighting are considered to be essential to ensure their conservation is preserved.

2.3 Energy efficiency

2.3.1 Outdoor lighting installations consume energy. Hence, excessive and inappropriate use of outdoor lighting produces an impact on energy consumption. Almost all existing outdoor lighting installations use non-renewable energy generated by burning of fossil fuels. The energy consumed in producing the obtrusive light can be considered to be wasted since the obtrusive light is unwanted. Energy efficient outdoor lighting can reduce CO_2 emission and thus contributes to the reduction of the greenhouse effect.

2.3.2 Energy consumption of outdoor lighting installations depends on the efficacy and lamp characteristics of lamps and control gear used, the efficiency (or light output ratio) of the luminaires, the time of operation as well as the level of illumination. Regulation of lighting equipment is becoming more prevalent with a number of economies such as Australia and the EU banning incandescent lamps and the use of more energy efficient lamps and control gear, reduction of time of operation and reduction of illumination level all help in reducing energy consumption by outdoor lighting. Good maintenance procedures are essential for maintaining the correct level of energy consumption through the working life, i.e. the replacement of lamps at their optimal lamp mortality/ efficacy point is essential.

[4] http://www.standardsforhighways.co.uk/ians/pdfs/ian116.pdf

2.3.3 To ensure this might happen a minimum Maintenance Factor for schemes could be utilized. Up to date, none of the regulatory frameworks have legislated for maintenance factor and this is left to the choice of clients and their design teams. Maintenance standards for lighting are generally poor and this is highlighted in Organisation for Economic Co-operation and Development (OECD), International Energy Agency (IEA)'s Publication "Light's Labour's Lost" 2006.

2.3.4 It should be noted that the types of lighting installation, such as decorative or functional, often affect both the energy usage and the selection of different type of more efficient luminaires and other lighting equipment related to the lighting effect from the lighting designer. Therefore the most efficient and least polluting schemes may not result. It is against these design drivers that legislative frameworks must be conceived and must address the sustainable triple baseline of Social, Environmental and Economic benefit.

2.3.5 Data on global lighting energy consumption are available in the OECD, IEA's Publication "Light's Labour's Lost" 2006. This document aims at coordinating governmental policies toward reducing internal and external lightings' electrical energy consumption. "Light's Labour's Lost" is a key strategic document for governments to formulate lighting regulatory policy. Its prime objective is to reduce the carbon emissions of all aspects of electric lighting and gives significant background information on lighting generally. It mentions that the light emitted by outdoor illumination devices has become so pervasive and is so poorly directed that in most of our urban environments, it is no longer possible to see any but the brightest of stars at night because of the glare from artificial light scattered back to ground from the sky vault. Light pollution is not only a waste of light energy but also diminishes our perception of the wider universe. The document is key to assessing the energy saving possibilities of lighting installations.

3 REVIEW OF REGULATORY APPROACHES AND MEASURES ADOPTED BY THE 8 SELECTED METROPOLISES

3.1 Introduction

3.1.1 This part of the study covers eight (8) metropolises, including Shanghai, Tokyo, Singapore, Sydney, New York City, Los Angeles, London and Frankfurt, and focuses on their approaches and current practices to control external lighting and examine whether they adopt mandatory regulations or non-mandatory/voluntary measures through the issue of guidelines and reference standards.

3.1.2 The following is a summary of the salient points found out in the study for discussion.

3.2 Shanghai

3.2.1 Districts and county under the jurisdiction of Shanghai Municipal Government

3.2.1.1 At present, Shanghai is divided into 17 districts and one county as listed below:

Nine districts forming the core city:

Huangpu District (黄浦区), Luwan District (卢湾区), Jing'an District (静安区), Yangpu District (杨浦区), Hongkou District (虹口区), Zhabei District (闸北区), Putuo District (普陀区), Changning District (长宁区), Xuhui District (徐汇区).

One district with sub-provincial city status:

Pudong New Area (浦东新区)

Seven suburban districts:

Jiading District (嘉定区), Baoshan District (宝山区), Minhang District (闵行区), Qingpu District (青浦区), Songjiang District (松江区), Jinshan District (金山区), Fengxian District (奉贤区).

One rural county:

Chongming County (崇明县) (outlying islands at the mouth of Yangtze River).

Figure 3.2.1 shows a map of boundaries of the administrative districts in Shanghai.

Figure 3.2.1 Map of Shanghai showing the nine core city districts (1-9), Pudong New Area, seven suburban districts and the outlying rural Chongming county.

3.2.2 Characteristics of external lighting

3.2.2.1 Recently, Shanghai has hosted the World Expo 2010. The city has been gearing up to construct numerous infrastructures and buildings for this mega-event. In order to equip the city for the World Expo, new lighting systems have been developed to decorate the bridge, road, river, street and some landmarks of the city. The governments at all levels paid efforts on the planning and construction of outdoor lighting for beautification of the city. The lighting of significant buildings and the landscape lighting of main scenic spots are all centrally managed by Shanghai Nightscape Management Centre. Today, scenes with significant nightscape lighting include the Bund, People's Square, Yu Yuan, Nanjing Road, Yan An Road Viaduct, Lujiazui, Century Avenue, etc. Figure 3.2.2 shows the Bund and Figure 3.2.3 shows Lujiazui of Pudong at night.

Figure 3.2.2 The Bund at night

Figure 3.2.3 Lujiazui (Pudong) at night

3.2.3 Approaches adopted by Government regarding external lighting

3.2.3.1 Introduction of Government approach

The Shanghai government adopts mandatory regulatory approaches and adopts reference standards as regulations to govern the use of new and existing outdoor lightings. Light nuisance is assessed on a case-by-case basis. The City Appearance and Environmental Sanitation Department (CAESD) (市容环卫部门) can order owners to rectify their lighting installations to abate light nuisance. If the order by CAESD is not complied, the CAESD can put the case to the People's Court (人民法院) for the Court's order for making improvement work on the

external lighting to comply with the requirements. The Court can then decide on the penalty if the order is not complied with.

3.2.3.2 Mandatory Regulation implemented by the CAESD

(i) Shanghai Environmental Protection Regulation (《上海市环境保护条例》)

(a) Shanghai Environmental Protection Regulation (《上海市环境保护条例》) sets out the legal requirements to govern the use of new and existing outdoor lighting installations and prevent light nuisance. The Regulation became effective on 1 May 2006.

(b) The clause 40 of this regulation states that all outdoor lighting installations should comply with "This City's Environment Decorative Lighting Standards" (本市环境装饰照明技术规范) (the standard). External lighting should not affect the normal living of nearby residents. The CAESD can require owners of outdoor lighting installations which do not comply with the standards to make improvement for compliance the standards before a specified date. The original clause is extracted here: "在室外使用灯光照明设备，应当符合本市环境装饰照明技术规范的要求，不得影响周围居民的正常生活。未按照技术规范要求使用室外灯光照明设备的，由市容环卫部门责令限期改正。"

(c) Although the actual reference document "本市环境装饰照明技术规范" (this city's Environment Decorative Lighting Technical Standard) is not clearly indicated, it should refer to the Shanghai Municipal Standard 上海市地方标准 DB31/T316-2004 《城市环境（装饰）照明规范》 (Urban Environment (Decorative) Lighting Standards).

3.2.3.3 Reference Standards whose requirements are adopted by the Regulation

(i) Urban Environment (Decorative) Lighting Standards 《城市环境（装饰）照明规范》

(a) Urban Environment (Decorative) Lighting Standards (《城市环境（装饰）照明规范》DB31/T316-2004[5]) is a trade standard in Shanghai and issued by Shanghai Municipal Bureau of Quality and Technical Supervision on 1 September 2004.

(b) This is the first standard in China on the design and technical aspects of external lighting. The standard was developed to improve external lighting in Shanghai by enhancing the visibility at night to satisfy the basic needs of people engaging in night-time activities. The standard also takes into account the requirements of ecological and environmental

[5] "行业标准" is translated as Trade Standards or Professional Standards or Industry Standards. Trade Standards (行业标准) are just one level lower than the GB National Standards (国家标准). Trades Standards are one level higher than the Local (Municipal or Provincial) Standards (地方标准), i.e. Trade Standards prevail over Local Standards. The **/T** denotes a voluntary standard.

protection , and minimizes the impact of light pollution on the nocturnal environment through the control of various lighting technical parameters in terms of lighting quality.

(c) *Parameters for evaluating impacts of external lighting*

The parameters used to measure the impacts of external lighting and the limiting values used to minimize these impacts are described below:

1. Zoning control for assessing/regulating outdoor lighting

   i) Two zones are adopted for assessing/regulating impacts on residential premises.

2. Curfew time for external lighting

   i) The curfew time is 23:00 for all zones.

3. Limitation of glare produced by urban lighting luminaires (on road users)

   i) The parameter used to measure glare produced by urban lighting luminaires is $LA^{0.5}$, where L is the luminaire's greatest (average) luminance (in cd/m^2) in the direction between 85° and 90° from the downward vertical and A is the light emitting surface area of the luminaire (in m^2) in the direction 90° from the downward vertical (see Figure 3.2.4). The standard states that this parameter is for the control of disability and discomfort glare caused by spill light/spray light from urban lighting facilities on pedestrians and drivers.

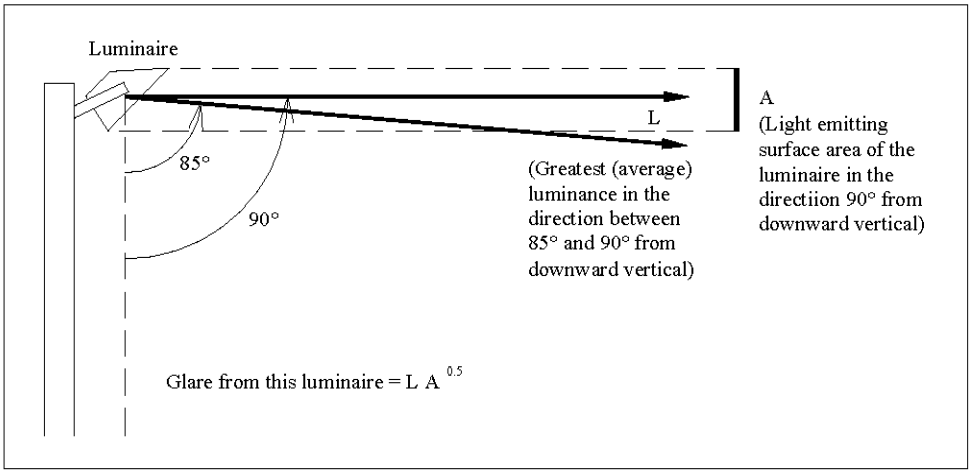

Figure 3.2.4 - Definition of *L* and *A* for glare evaluation using the parameter $L \cdot A^{0.5}$

   ii) Technical parameter and limits for the assessment of glare on road users produced by urban lighting luminaires are listed in the following table 3.1.

Table 3.1 - Light technical parameter and limits for the assessment of glare on road users produced by urban lighting luminaires.

Installation Height (m)	Limiting values of $LA^{0.5}$
$h \leq 4.5$	$LA^{0.5} \leq 4000$
$4.5 < h \leq 6$	$LA^{0.5} \leq 5500$
$h > 6$	$LA^{0.5} \leq 7000$

Note: L is the luminaire's greatest (average) luminance (in cd/m^2) in the direction between 85° and 90° from the downward vertical and A is the light emitting surface area of the luminaire (in m^2) in the direction 90° from the downward vertical.

iii) Limitation of upward light ratio (ULR) to control sky glow

iv) Limitation of obtrusive light on residential units for the assessment of/control on light trespass.

3.2.3.4 Enforcement Agent (CAESD)

The CAESD enforces Shanghai Environmental Protection Regulation (《上海市环境保护条例》) with reference to the Shanghai Municipal Standard 《城市环境（装饰）照明规范》DB31/T316-2004 to investigate and assess the light nuisance upon receiving a complaint. If CAESD considers that there exists a nuisance, an abatement notice will be issued requiring that the nuisance be ceased or abated within a specified period. If the order issued by CAESD is not complied with, the CAESD can put the case to the People's Court (人民法院) for the Court's order for making improvement work on the external lighting to comply with the requirements. If the order is not complied with, the Court can then decide on the penalty.

3.2.4 Summary of experience in addressing problems of external lighting

3.2.4.1 Practices and measures in addressing problems of external lighting

3.2.4.1.1 The CAESD uses the trade standard (Urban Environment (Decorative) Lighting Standards《城市环境（装饰）照明规范》DB31/T316-2004) as technical guideline to assess light nuisance complaints from new and existing external lighting installations on a case-by-case basis.

3.2.4.2 The problems encountered and arrangements to deal with such problems

3.2.4.2.1 There is no known example found concerning the handling of light pollution cases in Shanghai after the Shanghai Environmental Protection Regulation (《上海市环境保护条例》) became effective on 1 May 2006.

3.3 Tokyo

3.3.1 The administrative areas of Tokyo Metropolis

3.3.1.1 The Tokyo Metropolis (東京都) is one of the 47 prefectures of Japan and is the country's capital. Under Japanese administrative area division, Tokyo is the only prefecture designated as *to* (都), translated as metropolis. In the eastern part of the metropolis, there are 23 special wards (特別区), each governed as a city with a mayor and a council, covering the area that was once the city of Tokyo, with a population of over 8 million. The western part of the prefecture comprises 26 cities (市) collectively known as Western Tokyo or the Tama Area (多摩地域). The far west is mountainous and divided into 3 towns (町) and 1 village (村). Under the administration of Tokyo Metropolis, there are numerous outlying islands administratively grouped into 2 towns and 7 villages. The total population of Tokyo Metropolis exceeds 12 million.

3.3.1.2 The special wards differ from other cities in western Tokyo in that they have a unique administrative relationship with the Metropolitan Government. Certain municipal functions, such as waterworks, sewerage and fire-fighting, are handled by the Tokyo Metropolitan Government.

3.3.1.3 Tokyo is a major international finance center, houses the headquarters of several of the world's largest investment banks and insurance companies, and serves as a hub for Japan's transportation, publishing, and broadcasting industries.

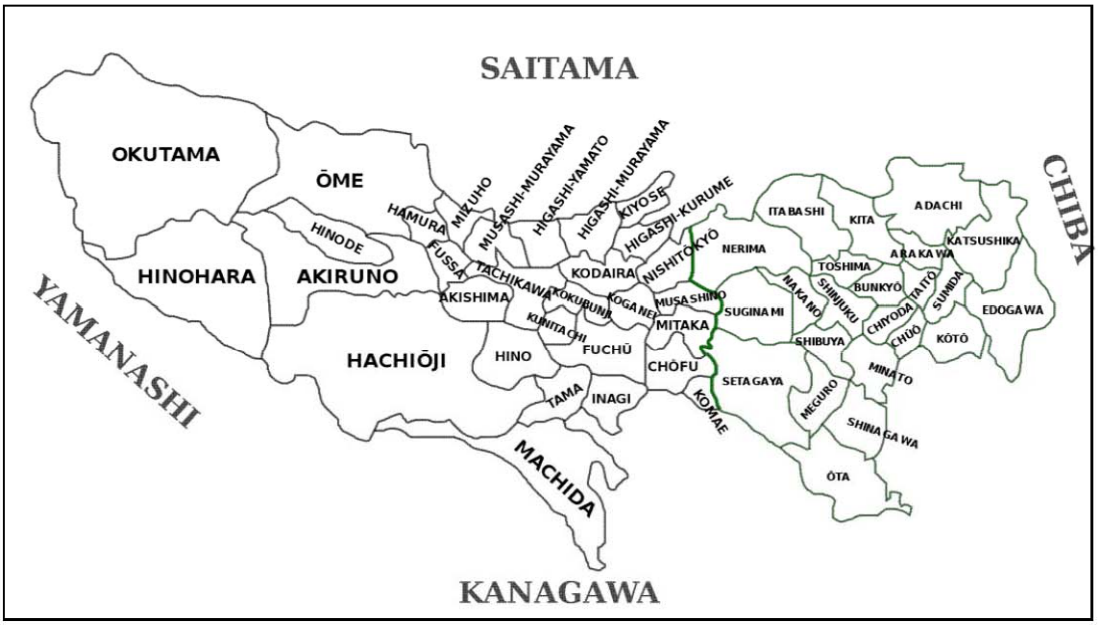

Figure 3.3.1 The Mainland portion of Tokyo Metropolis comprising 23 special wards of the former city of Tokyo and the 26 cities of Western Tokyo known as the Tama Area, and 3 towns and 1 village of the far western mountainous area.

3.3.2 Characteristics of external lighting

3.3.2.1 The Tokyo Metropolitan Government Headquarter is located at the ward of Shinjuku (新宿区). This ward is a major commercial and administrative centre, housing one of the busiest train station (Shinjuku Station) in the world. Several of Tokyo's tallest buildings are located in Shinjuku, e.g. Tokyo Metropolitan Government Building, KDDI Building and Park Tower. Surrounding Shinjuku Station are department stores, specialist electronic and camera shops, cinemas, restaurants and bars. All these stores and shops have signs of various sizes on top of buildings, on facades and extended outward from buildings. Many of these signs have special lighting effects, e.g. flickering, moving graphics, changing colour etc. The famous entertainment and red-light district Kabukicho (歌舞伎町) is in Shinjuku. Kabukicho is often called the sleepless town with all night activities and outdoor lighting all night. Several wards surrounding Shinjuku also have large department stores, electronic and camera shops, restaurants and bars with outdoor lighting and signs similar to those in Shinjuku. Some examples of nighttime lighting in Tokyo are shown in the following pictures (Figures 3.3.2 to 3.3.5).

Figure 3.3.2 Bright signs in Shibuya at night

Figure 3.3.3 Shinjuku at night with signs of shops and restaurants on top of buildings and extending outward from buildings.

Figure 3.3.4 One entrance to Kabukicho, showing also the nighttime lighting alongside the restaurants and bars in the street.

Figure 3.3.5 A busy street in Shinjuku at night with large bright outdoor signs and video structure.

3.3.3 Approaches adopted by Government regarding external lighting

3.3.3.1 Introduction of Government approach

The Tokyo government adopts, for all external lighting installations, non-mandatory approach and guidelines without binding force.

3.3.3.2 Non-Mandatory /Voluntary approach in Tokyo

There is no mandatory regulation governing external lighting in Tokyo. Most of the light pollution regulations in some cities and towns of Japan have been initiated and enforced at the local level. At the national level, the Ministry of the Environment (MOE) has published voluntary light pollution control guidelines to help local authorities formulate light pollution control measures.

3.3.3.3 Voluntary guidelines

(i) In Tokyo, Light Pollution Control Guidelines, Manual for Local Planning of Lighting Environment and Guidebook on Light Pollution Preventive Measures are technical guidelines for the prevention of light pollution.

(ii) The Illuminating Engineering Institute of Japan (IEIJ) established "Special Committee for Research and Study on the Effects of Lighting on Environment" and examined the condition of external lighting facilities throughout Japan. Based on such findings, the Environmental Agency prepared the "Light Pollution Control Guidelines"[6] in 1998 (revised in 2006), which defines specific measures for local governments, residents and businesses to cope with light pollution. In 2000, the same agency prepared the "Manual for Local Planning of Lighting Environment"[7], in order to

[6] Environment Agency Japan: Light Pollution Control Guidelines, Environment Agency Japan, 1998 (in Japanese). 1998 version: http://www.env.go.jp/air/life/hikari_g/index.html 2006 version: http://www.env.go.jp/air/life/hikari_g_h18/index.html

[7] Environment Agency Japan: Manual for Local Planning of Lighting Environment, Environment Agency

provide guidelines for local authorities. Furthermore, a "Guidebook on Light Pollution Preventive Measures"[8] was also published in 2001. This guidebook includes some extracts of legislative measures (related to astronomical observations) in Okayama Bisei (岡山県美星町) and Alpine village in Gunma Prefecture (群馬県高山村) of Japan and elsewhere for prevention of light pollution.

(iii) Light Pollution Control Guidelines

(a) *Parameters for evaluating impacts of external lighting*

The parameters used to measure and control the impacts of external lighting and the limiting values recommended for minimizing the impacts are described below:

1. Zoning control for regulating/assessing external lighting
2. Curfew time for regulating external lighting
3. Limitation of obtrusive light on residential units for assessment of/control on light trespass
4. Limitation of glare effect on road users (drivers, cyclists, pedestrians)
5. Limitation of upward light ratio (ULR) to control sky glow

3.3.4 Summary of experience in addressing problems of external lighting

3.3.4.1 Practices and measures in addressing problems of external lighting

3.3.4.1.1 According to a public pollution survey (公害苦情調査) in Tokyo which gives the number of complaints on different kinds of pollution / nuisance caused to the public, light pollution represents less than 0.2% of the total number of complaints in Tokyo. The following figures are found from the website of the Bureau of Environment, Tokyo Metropolitan Government.

3.3.4.1.2 The number of complaints on light pollution in more recent years is not presented as an individual item but are just grouped into "Others", therefore no figures on light pollution complaints are found for more recent years.

	2002	2003
Total complaints	8,326	8,479
Light pollution	15 (0.18%)	13 (0.15%)

3.3.4.2 The problems encountered and arrangements to deal with such problems

3.3.4.2.1 There is no known example found on the handling of light pollution cases in Tokyo.

Japan, 2000 (in Japanese). http://www.env.go.jp/air/life/m-syomei/index.html

[8] Environment Agency Japan: Guidebook on Light Pollution Preventive Measures, Environment Agency Japan, 2001 (in Japanese). http://www.env.go.jp/air/report/h13-02/index.html
including some extracts of legislative measures in 岡山県美星町「美しい星空を守る美星町光害防止条例」(translated into *Okayama Bisei "Hikarityou Bisei damage prevention ordinance to protect the beautiful starry sky"*) and 群馬県高山村「高山村の美しい星空を守る光環境条例」(translated into *Alpine village in Gunma Prefecture "Ordinance to protect the light environment of the beautiful alpine village stars") where locate outside Tokyo.*

3.4 Singapore

3.4.1 The city-state of the Republic of Singapore

3.4.1.1 Singapore is an island city-state located at the southern tip of the Malay Peninsula. Singapore is divided into 5 districts: South West, North West, Central Singapore, North East and South East. Each of these districts has a Community Development Council (CDC) and is headed by a mayor. The CDCs initiate, plan and manage community programmes to promote community bonding and social cohesion. Regarding management of public facilities and areas in housing estates, there are 16 town councils taking responsibilities which include maintenance of lightings. In terms of urban planning, the Urban Redevelopment Authority (URA) organizes the 55 urban planning areas into five regions: Central Region, East Region, North Region, North-East Region and West Region, which are not the same as the CDC districts.

Figure 3.4.1 A simple map of Singapore.

3.4.2 Characteristics of external lighting

3.4.2.1 The Orchard Road shopping district is one of Singapore's most well-known and popular areas for tourists. Popular spots for nightlife in Singapore include Boat Quay and Clarke Quay. These are sites by the Singapore River and many shophouses on these sites have been carefully conserved. There are various bars, pubs and restaurants. Despite a popular spot for nightlife activities, there are not many large and bright signs. These shopping and nightlife areas are not as bright as many tourist shopping and nightlife spots in other cities.

3.4.2.2 The URA of Singapore has announced that the city would be transformed into a more vibrant and exciting place with more buzz by lighting up the city completely. The lighting plan is described in the URA website titled "Lighting up our city centre": www.ura.gov.sg/lightingplan/. The plan says "*Good lighting of buildings and public spaces can develop a signature image for the city, create a beautiful nightscape and enliven the visitor's experience. The signature of a vibrant global city calls for an alluring nightscape that is evocative and leaves a lasting impression.*" This would make Singapore livelier and help to create a captivating night scene to increase Singapore's appeal and high ranking status in the world. The most prominent transformation of the city would be its city skyline in the Central Business District (CBD). By 2009, each and every skyscraper in the CBD would be lit up with bright and colourful neon lights that would change from time to time, festive occasions and events. Waterfront shows would also be held daily during the night. The many changes to the four main areas at night include:

- Orchard Road: Vibrant building facades that would jazz up shopping experiences, funky touches such as street seating that changes colours when someone sits down and trees that are brightly lit to promote Singapore as a Garden City.
- Bras Basah and Bugis: Highlighting gateways and focal entry points with innovative light-integrated sculptures and markers would increase the feeling that a person is in a fun and vibrant entertainment hub. There would be more luminous signboards, 3D "art-vertisements" and animations on walls. Well-designed neon advertisements would also be put up.
- Singapore River: This includes Clarke Quay and Boat Quay. "Jellyfish" lights would float in the river at Boat Quay. Banks and walls of the river would be illuminated, adding to ambience, and brightly-lit up river-taxis. Underpass along the stretch of 3 km would be lit up with various designs and murals.
- CBD and Marina Bay: This area is the centre-piece of the whole project. There would be white street lights, instead of the current orange-yellow, to help make people feel that the place is more of an ultra-modern financial hub. There would be the lighting plan of the city skyline, Marina Bay Financial Centre and Integrated Resort. Lights on skyscrapers would also change time to time, with music in the streets and water shows by the bay to add more life and vibrancy.

3.4.2.3 The following pictures (Figures 3.4.2 to 3.4.5) show the existing night time outdoor lighting in several tourist and nightlife spots in Singapore.

Figure 3.4.2 Orchard Road lit up for Christmas. Apart from festival lighting, outdoor lighting is not as bright as popular shopping spots in other cities.

Figure 3.4.3 Marina Centre and Marina Bay at night.

Figure 3.4.4 Boat Quay at night.

Figure 3.4.5 The Merlion at night.

3.4.2.4 Another organization concerning about the night sky environment of Singapore is the Science Centre Singapore. It has published an article giving an overview to light pollution in Singapore.[9] With reference to this article, it is observed that, night golfing activities are becoming more popular in the past few years in Singapore and floodlights in multitude are used to light up vast areas of greens as well as the sky above golf-courses. It has become one of the major contributing factors to local sky glow.

[9] http://www.science.edu.sg/ssc/virtual_ssc.jsp?type=4&root=140&parent=181&cat=182

3.4.3 Approaches adopted by Government regarding external lighting

3.4.3.1 Introduction of Government approach

The Singapore government has made a policy statement on the use of new external lightings. There is no mandatory regulation or voluntary guidelines for external lighting.

3.4.3.2 Policy Statement made by the URA

1. The policy statement made by URA is provided below –

   There is a growing concern about the excessive use of lights to illuminate the cityscape. Night lighting should thus be executed sensitively to avoid glare, light trespass and light pollution. Pedestrians, residents, drivers, and other fields of vision shall be considered to prevent light spillage and to increase the energy efficiency of the lighting."

   The National Environment Agency (NEA) is responsible for improving and sustaining a clean and green environment in Singapore, but all its publications, including guidebooks, handbooks and codes of practice, do not have any guidelines on the control on external lighting.[10] It has published a Code of Practice on Pollution Control[11], but light pollution is not included in this code of practice. Besides, the Singapore government has announced its vision and initiatives for sustainable development.[12] It has set some goals to be achieved for the year 2030, but the control on light pollution is also not included in the blueprint of sustainable development.

2. There is no guideline on the use of parameters for evaluating the impacts of external lighting.

3.4.4 Summary of experience in addressing problems of external lighting

3.4.4.1 Practices and measures in addressing problems of external lighting

3.4.4.1.1 From available information, the quote of Urban Redevelopment Authority (URA) is a policy statement and there is no concrete action plan or measure to implement the policy statement in Singapore to deal with glare, light trespass and light pollution.

3.4.4.1.2 The policy statement is part of the URA lighting plan which is a plan for new lighting installations in government and private sector firms.

3.4.4.2 The problems encountered and arrangements to deal with such problems

3.4.4.2.1 The government of Singapore runs a website called "Cut Waste"[13] to collect suggestions on how the government can cut waste in public expenditure. Through this website people can also report or complain any misuse of external lighting. Some of the complaints concerning light pollution are summarized as follows:

[10] http://app2.nea.gov.sg/resources_home.aspx
[11] http://app2.nea.gov.sg/data/cmsresource/20090312534898283541.pdf
[12] http://app.mewr.gov.sg/web/Contents/ContentsSSS.aspx?ContId=1034
[13] http://app.mof.gov.sg/cutwaste/suggestion.asp

Subject	Complaints/ Suggestions	Response by government (only summary given here)
Excessive lighting in Singapore leading to light pollution	Request for a government planning to improve the quality of nighttime outdoor lighting[14]	Responded by Head (Resource Conservation Department) National Environment Agency (NEA): The NEA would initiate discussions with the public agencies that are responsible for providing outdoor lightings to study the idea with the aim of improving energy efficiency in lighting.
Glorious Light-up at new Institute of Technical Education (ITE) regional campus	Complaints of energy wastage by overnight lighting of ITE regional campus[15]	Responded by Senior Executive (Quality Assurance), Higher Education Division, Ministry of Education: Over the last few months, the College has been working closely with the consultants and contractors in the testing and commissioning of the system. Besides the need for ITE to ensure that the quality of the lighting fixtures and accessories are of acceptable quality, there was also a need for ITE to test and fine-tune the Intelligent Building Management System used to schedule the switching of lights based on the actual evening class timetables in the Jan 2005 intake. These testings have been completed in middle of Feb 2005 and the 3 modes of lighting schedule have since been fully implemented.
Stadium Lighting at Queentown	Complaints of energy wastage by floodlight of the Queentown Stadium that switched on at 0430[16]	Responded by Director, Sports & Recreation Centre, Singapore Sports Council: In response to the increasing public requests to jog at our stadium before the break of dawn, the Singapore Sports Council (SSC) had reviewed the requests and it has since opened its stadiums (with jogging track) islandwide at 4.30am daily. This group of users comprises mainly of senior citizens and working adults. For reasons of safety, we provide lighting from 4.30am to 7.00am. As we are mindful of conserving electricity, our lighting is kept to a minimum at all our stadiums.

3.4.4.2.2 In Singapore, a non-governmental organization runs a website called website17 describing light pollution in Singapore. This organization aims to raise public's awareness to light pollution, promote top-down approaches to control external lighting and application of good lighting practices. The website claims that the stars seen in Singapore have undergone a dramatic

[14] http://app.mof.gov.sg/cutwaste/suggestionview.asp?id=15815
[15] http://app.mof.gov.sg/cutwaste/suggestionview.asp?id=17915
[16] http://app.mof.gov.sg/cutwaste/suggestionview.asp?id=44796
[17] http://lightpollutionsg.tripod.com/

drop since the industrialization began in the 1960s. It mentions that the cause of light pollution is poor design of external lighting fixtures. However, the website has not been updated since 2005. There are some other informal websites [18] explaining and illustrating the problem of light pollution in Singapore.

3.4.4.2.3 In summary, there is little information concerning how the government or other organizations deal with problems created by external lighting.

[18] http://library.thinkquest.org/04apr/00533/Astronomy%20Web%20Site/lightpollution.htm
http://www.singastro.org/web/mediawiki/index.php/Best_observation_sites_in_Singapore

3.5 Sydney

3.5.1 The local government areas commonly recognized as making up Sydney

3.5.1.1 The metropolitan area of Sydney is commonly regarded as comprising the City of Sydney itself and the neighboring 37 local government areas (LGAs) in the Cumberland Plain and Hornsby Plateau. The 38 LGAs, all under the State Government of New South Wales, commonly regarded as making up the metropolitan area of Sydney are: *Ashfield, Auburn, Bankstown, Blacktown, Botany Bay, Burwood, Camden, Campbelltown, Canada Bay, Canterbury, Fairfield, The Hills, Holroyd, Hornsby, Hunter's Hill, Hurstville, Kogarah, Ku-ring-gai, Lane Cove, Leichhardt, Liverpool, Manly, Marrickville, Mosman, North Sydney, Parramatta, Penrith, Pittwater, Randwick, Rockdale, Ryde, Strathfield, Sutherland, Sydney, Warringah, Waverley, Willoughby, Woollahra.* Figure 3.5.1 shows the 38 LGAs commonly described as Inner Sydney and Outer Sydney.

3.5.1.2 There is no central metropolitan governing body having jurisdiction in the above all areas. These areas are all under the New South Wales State Government. Most activities are controlled by the state government. These include public transport, main roads, traffic control, policing, education above preschool level, and planning of major infrastructure projects. Each LGA has an elected council which is responsible for the local area planning and development, water and sewer supply, waste management and other functions delegated by the state government. As such, the local councils have responsibility on outdoor lighting planning and approval for new installation.

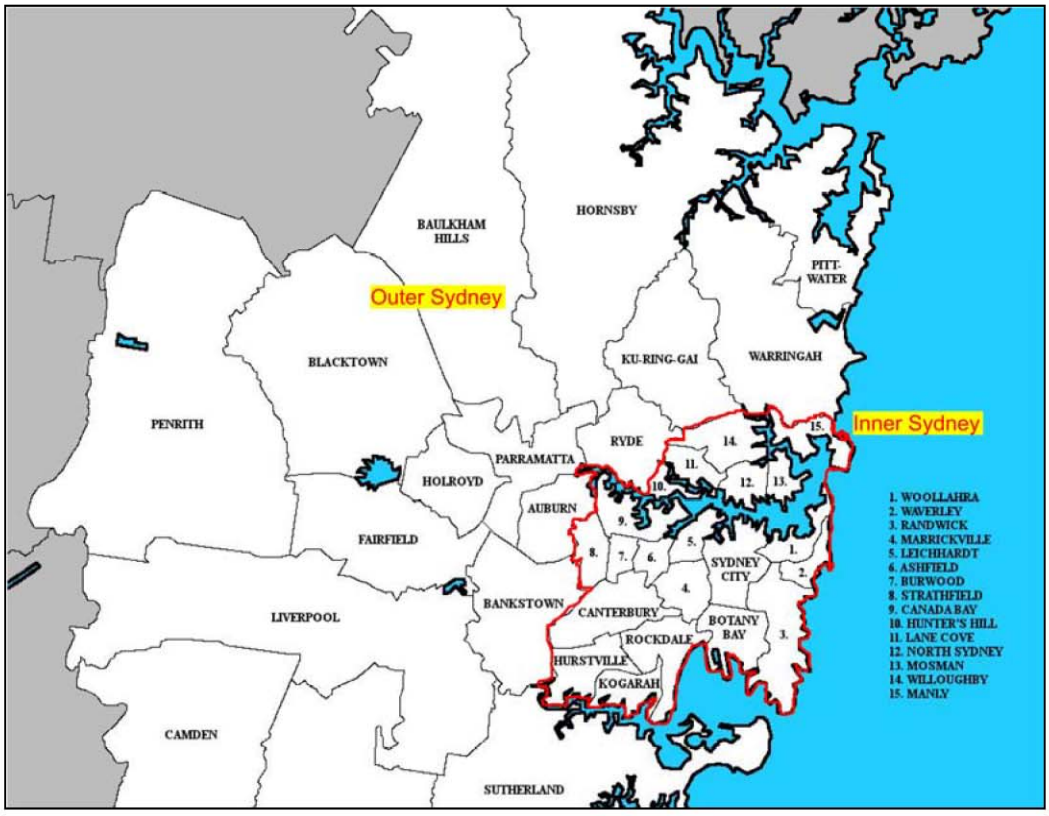

Figure 3.5.1 The 38 Local Government Areas (LGAs) commonly regarded as making up metropolitan Sydney

3.5.2 Characteristics of external lighting

3.5.2.1 The City of Sydney has installed permanent decorative lighting in several precincts of the City. Discrete lighting of heritage facades enhances Sydney Town Hall and the Queen Victoria Building. In Chinatown and at Railway Square new decorative lighting sculptures span the roadways. The City has also a decorative lighting program at Sydney Cove, including colour washing of strategic building facades and projected images. These installations are capable of being choreographed to create changing effects.

3.5.2.2 The City has installed lighting for prominent trees and the sandstone cliff along the Tarpeian Way near the Opera House. In the City Centre in-ground lights have been installed to illuminate tree canopies in areas such as Chifley Square, Pitt Street Mall and Castlereagh Street.

3.5.2.3 The City also uses temporary decorative lighting, associated with special events, to create theatrical displays for cultural and civic festivals. Two principal locations for the staging of major events and associated special light shows are at Circular Quay and Darling Harbour on the edges of the City.

3.5.3 Approaches adopted by Government regarding external lighting

3.5.3.1 Introduction of Government approach

The Sydney government adopts mandatory regulatory approach and reference standards in the regulations to govern the installation of new external lightings.

3.5.3.2 Mandatory Regulation implemented by the City of Sydney Council

(i) City of Sydney Exterior Lighting Strategy

(a) The City of Sydney Exterior Lighting Strategy is the mandatory document issued by the City of Sydney Council.

(b) The City of Sydney council has adopted, since the year 2000, "The City of Sydney Exterior Lighting Strategy", which contains the objectives, strategies and reference standards for lighting in the public domain for the City of Sydney to govern the installation of new exterior lighting installations within the boundary of the City of Sydney.

(c) The document also gives requirement on the conditions of consent in private sector development applications for illuminated signage, exterior lighting of buildings and under-awning lighting. This is the local government's lighting strategy applicable to the City of Sydney. Lighting proposals submitted for Development and/or Construction Certificate Approval are required to comply with the development control policies stated in the lighting strategy, including the requirements under the Central Sydney Local Environmental Plan (LEP) 1996; Central Sydney Development Control Plan (DCP) 1996,State Regional Environmental Plan No.26, Sydney Regional Environmental Plan (REP) No.26 - City West, and the *Environmental Planning & Assessment (Amendment) Act 1997*. The City of Sydney council welcome discussions at the early stage of design development and lighting proposal submissions in order to better ensure the delivery

of effective, safe and efficient schemes of exterior lighting by practitioners.

(d) The Exterior Lighting Strategy covers the following lighting types:

1. Lighting for public and pedestrian spaces
2. Street lighting
3. Lighting of trees and landscape features
4. Decorative lighting
5. Development controls for new/upgraded building lighting

(e) The overall objectives of the Exterior Lighting Strategy are:-

1. to improve the illumination of the City of Sydney at night to ensure public safety, public enjoyment, architectural appreciation, and night-time entertainment
2. to establish the City of Sydney as Australia's premier city and one of world recognition for the lighting of the public realm
3. to create a greater sense of civic pride in the City at night, encouraging more frequent visits by residents and tourists
4. to seek an expression of Australian and Sydney City culture and custom, to mark Sydney's unique role as a gateway destination and to give emphasis to the character of individual precincts within the City
5. to provide best practice guidelines for exterior lighting design
6. to implement high environmental lighting standards, including the sustainable use of energy where feasible, in order to
   i) prevent an increase in 'sky glow', which affects the clarity of astronomical observations, and
   ii) conserve energy and minimise the unnecessary emission of greenhouse gases
7. to promote a glare free environment for traffic and pedestrians
8. to utilise the latest technology for effective conversion of light into illumination
9. to create an aesthetic appearance for night-time illumination and lighting infrastructure during daylight hours.

(f) In order to ensure a degree of overall uniformity of appearance and long term maintenance benefits, the City council will liaise with local authorities controlling those areas including Sydney Harbour Foreshore Authority, Royal Botanical Gardens and Domain Trust, Darling Harbour Authority and Sydney Opera House Trust.

(g) The Exterior Lighting Strategy states that all outdoor lighting installations, including decorative lighting and building signage illumination, are to comply with the Australian Standards AS/NZS1158-3.1:1999 Pedestrian Area (Category P) Lighting (new

edition published in 2005 with amendment in 2008) and AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting.

3.5.3.3 Reference Standards adopted by the Regulation

(i) Australian Standards AS/NZS1158-3.1:1999

(a) In 1999 the Australian and New Zealand Standards introduced a revision to the street lighting code. AS/NZS1158.3.1 was introduced as a pedestrian area Category P lighting performance and installation design requirements. The Standard addressed the problems of light emitted to the sky and light spill into properties. New edition was published in 2005 with amendment in 2008.

(b) It specifies requirements for lighting systems for local roads and other outdoor public areas, primarily to provide a safe and comfortable visual environment for pedestrian movement at night. It applies to areas that are devoted solely to pedestrian use and to other areas where there is a mix of pedestrians and vehicles or cyclists. A multi-level specification of lighting performance is given for selection having regard to attributes such as the degree of activity (of pedestrians and vehicles), the perceived risk of crime and the need to enhance the prestige of the locality.

(ii) AS4282:1997

(a) It sets out guidelines for control of the obtrusive effects of external lighting and gives recommended limits for the relevant lighting parameters to contain adverse effects of external lighting within tolerable levels.

(b) It refers to the potential effects of lighting systems on nearby residents, users of adjacent roads and transport signalling systems, and on astronomical observations.

(c) It does not apply to road lighting; internally illuminated advertising signs; brightly-lit surfaces (e.g. floodlit buildings and advertising signs); lighting systems installed for the purposes of television broadcasting; and lighting systems that are of a cyclic or flashing nature.

(iii) Reference Parameters adopted for evaluating impacts of external lighting

The parameters used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are described below.

(a) Zoning Control for regulating/assessing outdoor lighting

(b) Curfew time for regulating outdoor lighting

(c) Limitation of glare effect on road users (drivers, cyclists, pedestrians)

(d) Limitation of upward waste light ratio (UWLR) to control sky glow

(e) Luminaire classification based on intensity distribution

3.5.3.4 Enforcement Agent

The City of Sydney Council assesses all new decorative lighting proposal submission from the private sector to comply with the requirements as specified in the respective Australian Standard and issues the development consent to the submitted proposals as Development Applications to the Director of Development for development and construction certificate approval under the Central Sydney LEP 1996; Central Sydney DCP 1996; State REP No. 26; Sydney REP No. 26 – City West, and *the Environmental Planning & Assessment (Amendment) Act 1997*. The Development Application is to include photomontages or computer modeling of the effects of the proposed lighting installation, a statement of the environmental impacts and full details of the equipment to be used, supported by quantified technical data required by Australian Standard AS4282:1997. The consent authority (i.e. City of Sydney Council) may require pilot testing prior to the issuance of development consent / construction approval.

3.5.4 Summary of experience in addressing problems of external lighting

3.5.4.1 Practices and measures in addressing problems of external lighting

3.5.4.1.1 In the State of the Environmental Reports 2007/08 [19] published by the government of the City of Sydney, a plan of efficient lighting system is adopted as one of the city's energy saving measures. The lighting initiatives include adopting a public domain lighting design code and strategy as well as a trial installation of LED street lights. The measure relating to light pollution is the promotion of Earth Hour campaign. The campaign is to encourage the public/private sector to switch off all lights for one or two hours on selected day(s). With reference to the Environmental Management Plan 2007[20] also published by the government of the City of Sydney, one of the targets is about public lighting. It relates to the installation of efficient lighting to minimize greenhouse gas emissions, reduce light pollution and improve lighting levels. No detail has been provided on how to reduce light pollution caused by lighting system or fixture.

3.5.4.2 The problems encountered and arrangements to deal with such problems

3.5.4.2.1 As the City of Sydney Exterior Lighting Strategy only deals with new lighting installations, any problem of glare or excessive brightness caused by existing lighting installation can only be dealt with by persuasion and/or public pressure. In Sydney, there are some organizations promoting the protection of the night sky. One of the active organizations, the Sydney Outdoor Lighting Improvement Society Inc (SOLIS), comments that the "*Australian Standard AS4282:1997 is very specific in that it deals primarily with obtrusive lighting within residential and urban areas, where a measurement of light on residential windows is considered, but has few references to requirements or locations of illuminated signs in rural areas. It is not mandatory but any disregard for the requirements causing incidents which could lead to litigation obviously places the person or organization responsible for the*

[19] http://www.cityofsydney.nsw.gov.au/Environment/Overview/StateOfEnvironmentReporting.asp
[20] http://www.cityofsydney.nsw.gov.au/Environment/Overview/EnvironmentalManagementPlan.asp

installation in a difficult situation."[21] SOLIS is a Sydney community organization formed since 1998. It aims to promote better outdoor lighting and save the night sky. Despite that Australian Standard AS 1158.3.1[22] gives the maximum UWLR allowed for pedestrian lighting, the director of the Outdoor Lighting Improvement Section of the Astronomical Society of Victoria has commented that many local councils, companies and individuals in Australia ignore Australian Standards in installing and maintaining fence-top, pole-top and cluster-mount globe luminaire that send as much as 60% of the emitted light above the horizontal when the globes are clean and 70% or more when they have collected grime as usual on their lower parts.[23]

3.5.4.2.2 Another active organization which promotes the protection of the night sky is the Strathfield Light Pollution File[24]. It is a website collecting many photographs documenting the extent and nature of lighting pollution in Strathfield, which is an inner suburb of Sydney, and nearby areas in Sydney. It also includes a document prepared in 2005 for the submission to Strathfield Council.[25] The document explains the causes and effects of light pollution. Besides, it also requests that intrusive lighting should be placed on equal footing with other environmental nuisances. The document said that the problem of obtrusive lighting is not mentioned at all on the council website, while noise, water and air pollution is included. It requests that the quality of the night time visual environment should be included in Councils regular State of the Environmental Reports.

3.5.4.2.3 There are also some voluntary campaigns aiming to raise awareness about the growing problem of light pollution, like the "SOS Save Our Southern Cross" project conducted by the Redeemer Baptist School, North Parramatta, NSW.[26] They are trying to measure the light pollution levels in the Sydney region and comparing the results with different locations around the world. Recently, a lighting event called "Smart Light Sydney" is being held in May and June 2009.[27] The main theme of this event is on smart lighting that is low in its use of energy and production of light pollution, but the nature of this festival seems to focus more on the artistic side of lighting design.

[21] http://www.solis.org.au/B1.html
[22] Australian/New Zealand Standard. *Lighting for Roads and Public Spaces Part 3.1: Pedestrian area (Category P) lighting – Performance and design requirements.* AS/NZS 1158.3.1:2005.
[23] B.A.J. Clark, *Outdoor Lighting and Crime Part 2: Coupled Growth.* p35, 2003. http://www.asv.org.au/lpoll/lpdoc.htm
[24] http://www.cooke.id.au/
[25] http://www.cooke.id.au/Vision_2020_Submission_small.pdf
[26] http://www.sydneyatnight.org/
[27] http://www.smartlightsydney.com/

3.6 New York City

3.6.1 Districts and other areas under the jurisdiction of the City of New York

3.6.1.1 The City comprises five boroughs: Brooklyn, Manhattan, Queens, Staten Island and the Bronx.

Figure 3.6.1 Overall Map of New York City, showing boroughs

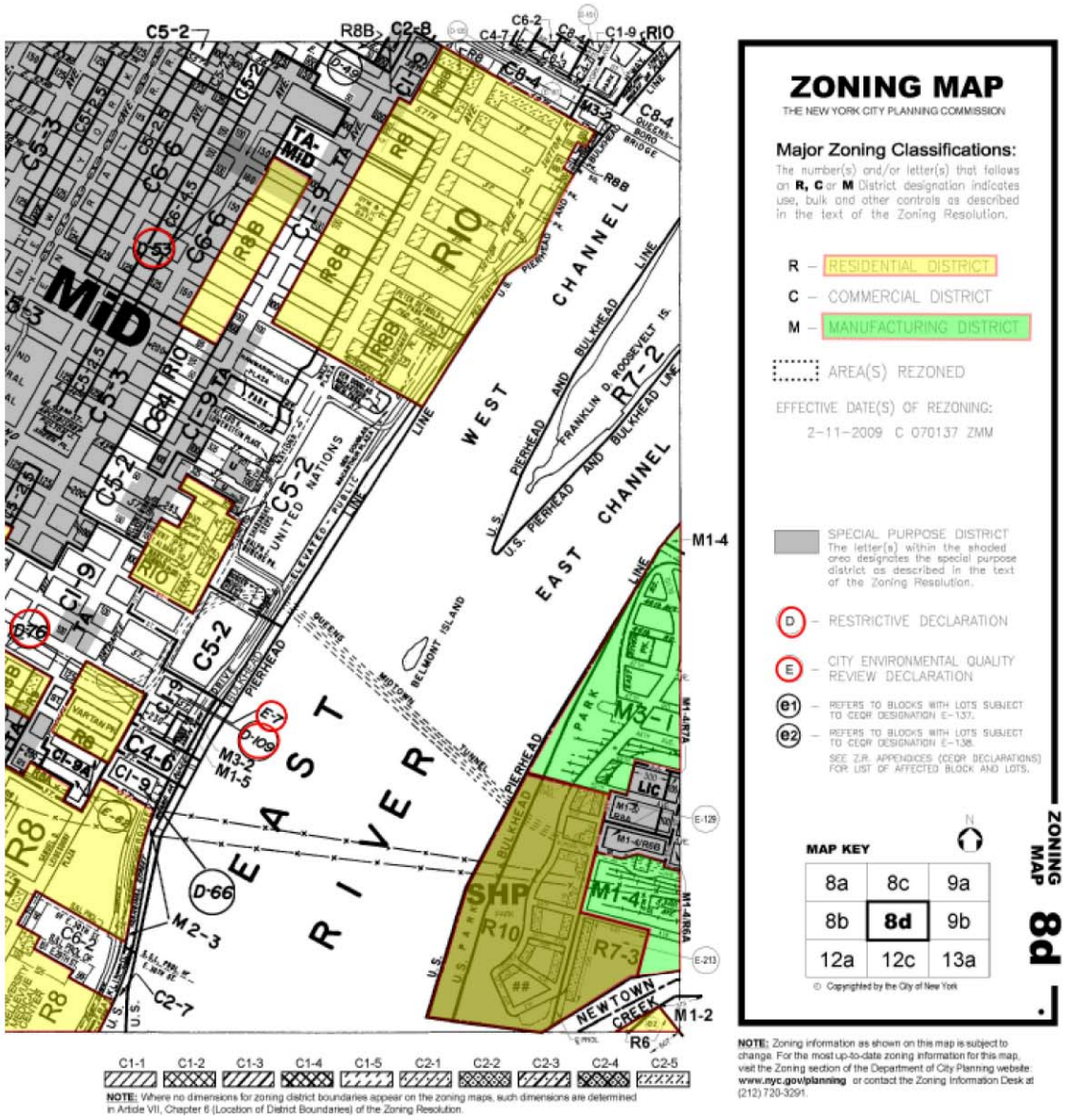

Figure 3.6.2 Sample zoning map

Figure 3.6.3 Night view in New York City

3.6.2 Approaches adopted by the Government regarding external lighting

3.6.2.1 Introduction of Government approach

(a) The New York City government adopts mandatory energy code and energy efficiency standards to govern the energy consumption of new outdoor lightings.

(b) The government adopted the first version of the zoning resolution and Energy Conservation Construction Code of New York State in 1916 and 1979 respectively in New York City. The current Energy Conservation Construction Code of New York State (ECCCNYS) 2007 (main code) or the standard ASHRAE 90.1-2004 (alternative code) is the mandatory document to set maximum energy allowed for all new outdoor lighting installations by type of use, such as facade or area lighting, on private property. In addition, the zoning resolution is also adopted as the mandatory document to regulate all new signs. Existing conditions are generally allowed to remain.

3.6.2.2 Mandatory Regulation

(i) Zoning Resolution

(a) One way of regulating outdoor lighting, especially related to signs, is through the Zoning Resolution. It is enforced at the level of each property by the Department of Buildings. Zoning regulation is done entirely at the local level, usually by a county or municipal (city) government. Zoning usually regulates the size and use of buildings and sites. Most code and zoning regulations in the United States regulate new construction and major renovations. Existing conditions are generally allowed to remain.

(b) According to the clause "Sign Regulations" in zoning resolution regarding all residence districts, "*...for hospitals and related facilities illuminated non-flashing accessory signs are permitted in all districts.... Any number of illuminated non-flashing identification or directional signs are permitted, provided that the total surface area in square feet of said illuminated signs or the combined total surface area in square feet of the illuminated and non-illuminated identification or directional signs does not exceed 25 square feet on any one street frontage or 15 percent of such street frontage in feet, whichever is less, and provided further that the Commissioner of Buildings determines that such signs are so located as to cause a minimum amount of light to be projected onto abutting or adjacent residences. In addition to illuminated or non-illuminated accessory signs, one illuminated non-flashing directory or bulletin board or combination thereof is permitted in lieu of a non-illuminated directory or bulletin board or combination thereof provided that the total sign area does not exceed 50 square feet and provided further that the Commissioner of Buildings determines that such sign is so located as to minimize the amount of light projected on the abutting or adjacent residences.*"

(ii) ECCCNYS and ASHRAE standard 90.1

(a) There is no law at the federal level of the US directly regulating energy use in private buildings and their sites. However, the federal Energy Policy Act of 1992 does require every state government to create an energy conservation construction code such as ECCCNYS equal to or more stringent than the current ASHRAE standard 90.1. Therefore, each state legislature has passed a law that 1) declares a need for a building code or energy conservation code, and 2) directs a state executive agency to create such a code, either by writing it or by adopting an existing standard such as ASHRAE 90.1. ASHRAE is one of several non-governmental agencies that create standards for governments to use.

(b) The ASHRAE 90.1-2004 sets maximum energy allowed for new outdoor lighting installation by type of use, such as facade or area lighting, on private property. Existing installations are exempted. More specifically, the clause 9.4.5 of ASHRAE standard says "*The total exterior lighting power allowance for all exterior building applications is the sum of the individual lighting power densities permitted ... ...for these applications plus an additional unrestricted allowance of 5% of that sum.*" In addition, there are requirements for controls: "*Lighting for all exterior applications not exempted ... shall have automatic controls capable of turning off exterior lighting when sufficient daylight is available or when the lighting is not required during nighttime hours.*"

(c) The ASHRAE standard regulates the light emanating from buildings by requiring interior fixtures to be turned off automatically when the entire building, or in some cases an individual space, is not occupied. Building operator is required to ensure the automatic control devices are in order. A building inspector can cite an owner for a code violation by site inspection after completion of the new installation. Penalties vary including a fine or imprisonment. In addition, the building operator will implement the operation of automatic control to save the energy consumption effectively and reduce the energy cost.

(d) Mandatory *parameters for evaluating impacts of external lighting*

The parameters used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are described below.

1. Zoning resolution to controlling sizes and locations of illuminated signs
2. Limitation of Wattage /Lighting Power Density (LPD)
3. Automatic switching control

3.6.2.3 Enforcement Agent

Department of Buildings (DOB) enforces the building, energy conservation and zoning codes and reviews construction on individual building sites according to the Energy Conservation Construction Code of New York State or the standard ASHRAE 90.1-2004.

3.6.2.4 Voluntary guidelines

Voluntary guidelines/ standards on light nuisance include

(a) RP-33-99 Lighting for Exterior Environments – an IESNA Recommended Practice

(b) TM-11-00 Technical Memorandum on Light Trespass: Research, Results and Recommendations

3.6.3 Summary of experience in addressing problems of external lighting

3.6.3.1 Practices and measures in addressing problems of external lighting

The mandatory energy code and energy efficiency standards governed the energy consumption of new outdoor lightings, but do not deal with their potential light nuisance. None of the mandatory regulations specifies or requires measuring actual maximum illuminance or luminance. As described above, constraints are placed on the power or physical size of light fixtures or illuminated displays rather than on the light they produce.

3.6.3.2 The problems encountered and arrangements to deal with such problems

At present, problems of glare or excessive brightness can only be dealt with by persuasion and/or public pressure. Complaints could be addressed to local elected officials and publicized in the news media. Most famous international companies are willing to make some improvement to reduce glare or excessive brightness problems in order to maintain the good reputation of their companies.

3.7 Los Angeles

3.7.1 Districts under the jurisdiction of the City of Los Angeles

3.7.1.1 The Planning and Zoning Code creates zones within the city by building type and use, as well as defining Redevelopment Project Areas and Enterprise Zones. Regulation of lighting for signs and some types of parking is done by zone. The Department of Building and Safety enforces the Planning and Zoning Code and the Building Code at the level of each property. This department also reviews construction on individual building sites according to the California Energy Commission adopted the 2005 changes to the Building Energy Efficiency Standards including California Code of Regulations (CCR), Title 24[28], Part 1 & Part 6. Lighting of streets is regulated by the Bureau of Street Lighting in the Department of Public Works. See general street map below.

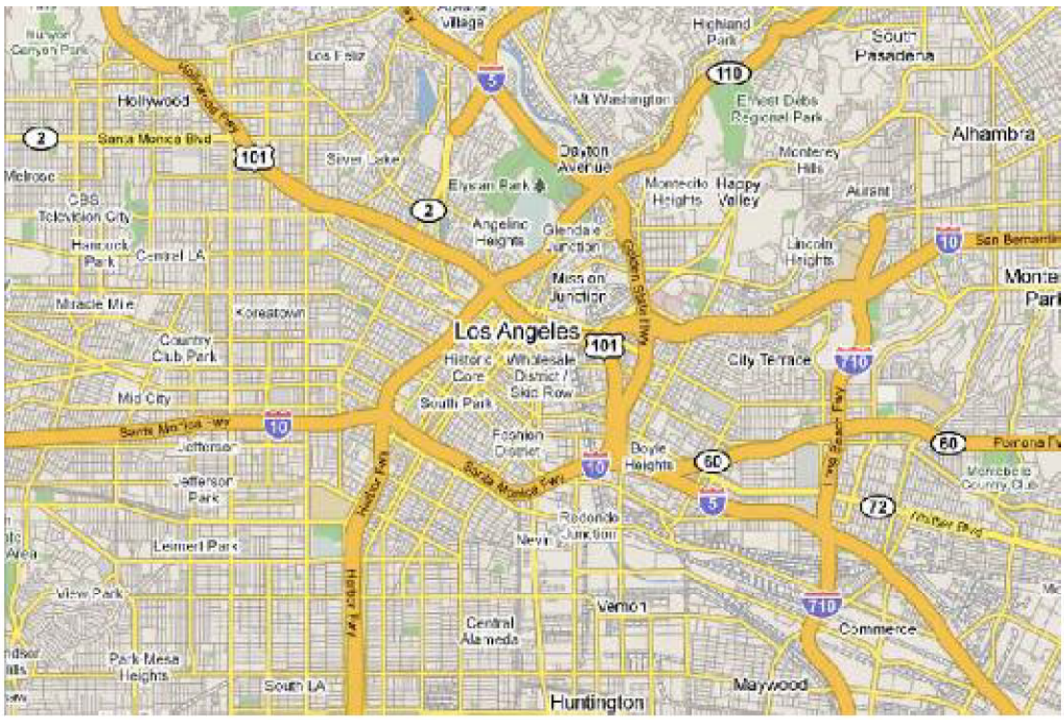

Figure 3.7.1 General street map

[28] Title 24 is the 24th title within the CCR. The CCR is divided into 28 separate titles based on subjects or state agency jurisdiction. The California Building Standards Code in CCR Title 24 is published by the California Building Standards Commission and it applies to all buildings (as defined in Health and Safety Code Section 18908 of the California Building Standards Law) throughout the State of California. The current edition of CCR Title 24 includes Part 1 to 12; and CCR Title 24 Part 1 is California Building Standards Administrative Code (mean the California Building Standards Code); Part 2, Volume 1 and 2, which is named the California Building Code based on the 2006 International Building Code; and Part 6 is named the California Energy Code.

3.7.2 Characteristics of external lighting

3.7.2.1 Illuminated advertising signs of various types and "architectural canopy signs" are allowed in certain districts as described in the Planning and Zoning Code. The features regulated include sign area, height, clearance above grade, placement to allow emergency personnel access, illumination concept, lighting system certification, and projection from a building.

3.7.2.2 The streets are illuminated for public safety and security according to Illuminating Engineering Society recommendations by the Bureau of Street Lighting.

3.7.2.3 Parking fixtures must not shed light on adjacent properties, and illumination must be above a certain minimum illuminance but below a maximum wattage depending on use and location.

Figure 3.7.2 Night view in Los Angeles

3.7.3 Approaches adopted by Government regarding external lighting

3.7.3.1 Government Approach

(a) The Los Angeles government adopts the mandatory regulatory approach with mandatory energy code and energy efficiency standards to govern the energy consumption of new outdoor lightings.

(b) In Los Angeles, the local government adopted the *2005 Building Energy Efficiency Standards,* including *California Building Standards Administrative Code Title 24, Part 1 & California Energy Code CCR, Title 24, Part 6* as mandatory document to applicable to the newly constructed lightings and additions and alterations (A&A) to existing externally illuminated signs. (Remarks: A&A works include increase in the connected lighting load, replacement and rewiring of more than 50 percent of the ballasts, or relocation of the sign to a different location on the same site or on a different site.)

3.7.3.2 Mandatory Regulation

(i) Building Energy Efficiency Standards including California Energy Code, CCR Title 24, Part 6

(a) The LABC adopts by reference portions of the California Building Code (CBC) which is CCR Title 24, Part 2 and is administered by the California Building Standards Commission (BSC)[29]. The LABC includes regulation for all new lighting system to comply with the current energy conservation requirement contained in the CCR, Title 24, Part 6.

(b) CCR, Title 24, Part 6 is the 6th of 12 parts of the official triennial compilation and publication of the adoptions, amendments and repeal of administrative regulations to *California Code of Regulations, Title 24*, also referred to as the *California Building Standards Code*. This part is known as the *California Energy Code*. The energy code is composed of the Energy Efficiency Standards for Residential and Nonresidential Buildings and is administered by the California Energy Commission (CEC)[30].

(c) The energy code uses an approach to regulating outdoor lighting that might be described as "context sensitive", establishing "Lighting Zones" by amount of ambient illumination. The maximum wattage allowed in a zone with high ambient illumination is greater than wattage allowed in a zone with low ambient illumination. The wattage within each zone is also limited by type of use, such as facade or area lighting. And the energy code includes regulations limiting power density for newly constructed outdoor lighting and additions and alterations to existing internally and externally illuminated signs.

(d) According to the clause 8502.11 of the 2008 LA Amendment for Building Code, all new lighting systems shall comply with the current energy conservation requirements contained in California Energy Code. An Existing Building with a Joint Living and Work Quarter need not comply with the Building Envelope requirements of the California Energy Code, if the Building Envelope is not altered in anyway due to compliance with other code requirements.

(e) The following table summarizes reference sections in *California Energy Code related to outdoor lighting*.

Occupancies	**Application**	**New installation**	**Additions/ Alterations**
Non-Residential, High-Rise Residential and Hotels/Motels	Outdoor Lighting	Sections 119, 130, 132	Section 149
Signs	Indoor and Outdoor	Sections 130, 132	
Low-Rise Residential	Outdoor Lighting	Sections 119(d), 150 (k)	Section 152

[29] The BSC is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California.

[30] The Energy Resources Conservation and Development Commission (the formal name for the Energy Commission) was established by the Legislature in 1974 to address the energy challenges facing the state. The Energy Commission is the state's principal energy policy and planning organization.

The key provisions under those sections are listed below:-

- Section 119 regarding lighting control devices including automatic/ astronomical time switch, daylight, luminaires,
- Section 130 regarding luminaire power
- Section 132 regarding use of high lamp efficacy, luminaire cutoff requirement, controls for outdoor lighting by a photocontrol or astronomical time switch that automatically turns off the outdoor lighting when daylight is available.
- Section 150 (k)13 regarding use of high lamp efficacy luminaires
- Section 149 to list the applicable requirements under prescriptive and performance approaches.
- Section 152 regarding energy efficiency standards under prescriptive and performance approaches.

(f) Mandatory *parameters for evaluating impacts of external lighting*

The parameters used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are described below

1. Zoning Control for regulating/assessing outdoor lighting
2. Cut-off /shielding requirement of outdoor luminaires
3. Limitation of Wattage /lighting power density (LPD)
4. Automatic switching control

ii) Los Angeles Planning and Zoning Code

(a) The Los Angeles Planning and Zoning Code describes the allowable sizes and locations of illuminated signs, sets minimum illuminance levels (for emergency personnel access) for parking, and gives vague instructions regarding aiming of luminaires.

(b) The Los Angeles Planning and Zoning Code is the body of law that regulates the planning zones in the city to determine the type of areas (e.g. parks, rural area, urban area and entertainment areas). The regulations (i.e. Planning and Zoning Code) govern the height and area of buildings, distance between buildings, uses permitted, amount of vehicle parking, size of signs, and other aspects of the built environment. The California Building Energy Efficiency Standards regulate energy use associated with buildings. These Standards regulate outdoor lighting on building sites according to use and the brightness of the surrounding environment. There are four defined Lighting Zone types, separated by ambient illumination: LZ1, Dark (for example, parks); LZ2, Low (rural areas); LZ3, Medium (urban areas); and LZ4, High (entertainment areas).

3.7.3.3 Enforcement Agent

Los Angeles Department of Building & Safety (LADBS) enforces the building, energy conservation and zoning codes and reviews construction on individual building sites according to 2008 LA Amendment for Building Code which incorporates, by reference, the California Building Code and California Energy Code *Title 24, Part 6* as well as the Planning & Zoning Code. CEC formulates energy efficiency standards to reduce California's energy consumption, including regulations limiting power density for outdoor lighting.

3.7.3.4 Penalty for violation

LADBS can issue orders to contractors to stop the works that are not in compliance with the building codes. If a contractor continues to violate the codes, he can be taken to the Contractors State License Board, and the contractor's license can be in jeopardy. LADBS can also levy fines and revoke a Certificate of Occupancy for a code violation.

3.7.3.5 Appeal mechanism

If a dispute concerning a provision of the 2007 California Energy Code arises between an applicant for a building permit and the LADBS, appeal can be sent to the local Board of Permit Appeals or other higher local review body. Notice of appeal shall be sent to CEC 15 days before the appeal is heard, and the result of the appeal shall be sent to CEC within 15 days after the decision is made. If either party to the dispute is dissatisfied with the result of the appeal, one may apply for a determination from CEC. CEC may then make a written determination, which is binding on both parties. Appeal will conduct in LA City Attorney Hearings and in court.

3.7.4 Summary of overseas experience in addressing problems of external lighting

3.7.4.1 Practices and measures in addressing problems of external lighting

3.7.4.1.1 Lighting power density and energy consumption, instead of light nuisances, such as glare, trespass, etc. are controlled by the Energy Code in Los Angles. None of the mandatory regulations specifies or requires measuring actual maximum illuminance or luminance. Constraints are placed on the power, physical size of light fixtures or illuminated displays rather than on the luminous environment they produce. The cost of light fixtures could be increased due to increase number of light fixtures as cut-off luminaries are required to be adopted.

3.7.4.2 The problems encountered and arrangements to deal with such problems

3.7.4.2.1 Currently any difficulty with glare or excessive brightness will be dealt with by persuasion and/or public pressure. Complaints could be addressed to local elected officials and publicized in the news media. Most famous international companies are willing to make some improvement to reduce glare or excessive brightness problems in order to maintain the good reputation of their companies.

3.8 London

3.8.1 Boroughs under the jurisdiction of Greater London Authority

3.8.1.1 The elected Mayor of London and the Greater London Authority (GLA) are responsible for providing the strategic policies which govern all aspects of life that are deemed to have significance for the whole of London.

3.8.1.2 The GLA is made up of selected representatives from the elected London Borough Councils. The borough councils are democratically elected by the general population within the borough who are eligible to vote. The GLA produce the Plan for London which includes statements on external lighting policy.

3.8.1.3 The boroughs are generally divided into two groups Inner London boroughs and Greater London Boroughs. The Inner London boroughs are predominantly Urban areas with very high levels of light pollution but with areas of relative darkness within them such as parks, commons and heaths which are seen as being protected areas with greater protection from light pollution. The greater London Boroughs will be either urban or semi urban areas generally with significantly more areas of darkness such as green belt land.

3.8.1.4 There is also socio-geographical split in London with the western and northern sectors being generally more affluent than the southern and eastern sectors of the city. This is reflected in the concerns that the local authorities exhibit towards the problems of light pollution. Local Authorities are the local elected councilors and their departments' employees. The planning applications for new lighting are dealt with by the Local Planning Authority/department (LPA) and the councilors who sit on the planning committee make the final decision, with an appeals process that goes right up to the secretary of state for the environment for large and controversial schemes.

3.8.1.5 The LPAs are concerned with all aspects of the planning of new and refurbishment of buildings, roads and railways in fact any development that will materially affect the local environment within their jurisdictions.

3.8.1.6 Local authorities also have Environmental Health Officers whose remit is to protect and ensue that the regulatory policies are enforced. In the case of light pollution they are concerned with existing developments and will be first point of contact for registering complaints from members of the public.

Figure 3.8.1 Map of London Boroughs

3.8.2 Characteristics of External Lighting

3.8.2.1 The characteristics of external lighting within London are determined primarily by function and location. External lighting excluding road lighting has the following major functions:-

- Visual Amenity
- Commercial benefit
- Increased security
- Health and safety

Figure 3.8.2 Aerial Photograph of Westminster

Please note the areas of darkness in St James Park and Hyde Park in the heart of London. These areas are tightly controlled for light pollution via planning and laws.

Figure 3.8.3 - Amenity Lighting in London

a) Tower Bridge

b) St Pauls Cathedral

c) Laser Bridge Blackfriars

d) St James Park

e) Tower of London

f) Houses of Parliament

g) Piccadilly Circus

h) West End Theatre Advertising

Figure 3.8.4 Aerial Photograph of Existing Light Pollution in London

3.8.3 Approaches adopted by Government regarding external lighting

3.8.3.1 Government approach

The London government adopts the mandatory regulatory approaches with legislation and planning guidelines to govern the use of all outdoor lightings.

3.8.3.2 Mandatory Regulation

(i) The Clean Neighbourhoods and Environment (CNE) Act 2005

(a) The CNE Act 2005 is adopted as mandatory document to provide local authorities with power and tools to tackle nuisance from artificial light in new and existing external lighting installations.

(b) The CNE Act 2005 amended section 79(1) of the Environmental Protection Act 1990 to include under the statutory nuisance regime (in England and Wales) "*artificial light emitted from premises so as to be prejudicial to health or a nuisance*" (commenced on 6 April 2006). Conformance/non-conformance with the legislation is decided by the Local Environmental Health Department who is responsible for handling complaint. The owner of the installation would firstly be given opportunity to rectify the lighting with necessary actions. If the owner refuses to do so, the case would probably be escalated to the court and the owner may need to pay a fine.

(c) Planning Policy Guidance (PPG) and Planning Policy Statement 23 (PPS): Planning and Pollution Control aim to assist local authorities in preparing their development plans and making decisions on individual planning applications and appeals to complement the pollution control framework under the *Pollution Prevention and Control Act (PPC) 1999* and the *PPC Regulations 2000*. Local authorities enforce local planning Bye laws that give additional powers within their local jurisdiction.

3.8.3.3 Reference Standards adopted by the Regulation

(i) ILE's Guidance Notes for Reduction of Obtrusive Light (GN01:2005)

(a) The CNE Act makes reference to the Institution of Lighting Engineers (ILE) document *Guidance Notes on the Reduction of Light Pollution* which gives good advice for overcoming and mitigating many of the problems of light pollution. These notes are intended as guidance only and the application of the suggested values in GN01:2005 should be given due consideration along with all other factors in the lighting design. Lighting is a complex subject with both objective and subjective criteria to be considered. The notes are therefore no substitute for professionally assessed and designed lighting, where the various and maybe conflicting visual requirements need to be balanced.

(b) ILE recommends the environmental zones as listed in ILE's Guidance Notes for Reduction of Obtrusive Light (GN01:2005) which allows local planning authorities to specify environmental zones (similar to the CIE zoning system) for exterior lighting control in development plans in conformity with the CNE Act as part of mandatory regulations.

(c) CIE (CIE-126:1997 & CIE-150:2003) recommends the use of four environmental zones to classify the surrounding environment according to the prevailing brightness of the environment. A description of these four zones is given in the following Table 3.2.

Table 3.2. Classification of environmental zones for external lighting

Zone	Surrounding	Lighting Environment	Examples
E1	Natural	Intrinsically dark	National parks or protected sites
E2	Rural	Low district brightness	Industrial or residential rural areas
E3	Suburban	Medium district brightness	Industrial or residential suburbs
E4	Urban	High district brightness	Town centres and commercial areas

ii) Parameters for evaluating impacts of external lighting

The technical parameters specified in GN01:2005 are used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are described below:-

(a) Zoning Control for regulating/assessing outdoor lighting

(b) Curfew time for regulating outdoor lighting

(c) Limitation of obtrusive light on residential units for assessment of light trespass

(d) Limitation of sign and building facade luminance for assessment of glare on residents

(e) Limitation of glare effect on road users (drivers, cyclists, pedestrians)

(f) Limitation of upward light ratio (ULR) to control sky glow

3.8.3.4 Enforcement Agent

Light pollution (like noise and air pollution) falls under the purview of the Environmental Health Department of the Local Council. If light pollution is identified, the local Environmental Health Department would issue an abatement order to the party causing the pollution problem and if that was not complied with, legal procedures would be taken. If the owner of the new and existing installations did not rectify his lighting installation which causes the light nuisance, he might be taken to the court.

3.8.3.5 Penalty for violation

Offender of statutory nuisance is subject to imprisonment for a term not exceeding 12 months; or a fine not exceeding 50,000(HK$588,450). A planning breach in itself is not illegal and the Local District or Borough Council may permit a retrospective application. However, if the breach involves a previously rejected development or the retrospective application fails, the Local District or Borough Council may issue an enforcement notice. It is illegal to disobey an enforcement notice. If the Local District or Borough Council decides to take the offender to court, the offender may have to pay a fine.

3.8.3.6 Appeal mechanism

Appeal against an abatement notice can be made to the local magistrate's court within 21 days from the notice being issued. Appeal against the decision on planning permission can be made to the Planning Inspectorate within six months from the date of the application decision letter.

3.8.4 Summary of experience in addressing problems of external lighting

3.8.4.1 Practices and measures in addressing problems of external lighting

3.8.4.1.1 All new projects on external lighting installations are required to have planning approval by the local Authorities (i.e. Greater London Authority (GLA)) - Project design teams are required to supply details of their external lighting scheme. The scheme is then assessed against the legislation (i.e. the CNE Act 2005) and the best practice guidance (such as ILE's Guidance Notes on the Reduction of Light Pollution). The nature of the assessment is determined by the borough's policy towards external lighting and light pollution. Some boroughs might impose additional criteria as part of planning permission such as the colour of the light source. For example the borough of Westminster has a different policy with regard to advertisement and coloured façade lighting due to the presence of the West End Theatre district within its boundaries whilst Lambeth which is just immediately south of Westminster does not allow coloured lighting at all .

3.8.4.1.2 A typical scenario for a new project would be for the Council of the Greater London to evaluate the proposed scheme against its planning policies which are implemented through legislation and best practice guidance and then to form a project planning constraints for this project. The tightness of this planning constraint will be determined by the council and the nature of any concerns of local residents to the proposed project.

3.8.4.1.3 The council may require the project to provide an overarching Environmental Impact Assessment (EIA) which will identify the existing conditions, those relating to lighting would be current lighting, current use of the area, residential properties and animal habitats and will also include details on the net change in environment caused by the proposed project on its own site and the surrounding area. Light pollution concerns will form part of these EIAs. Once the existing conditions have been evaluated, a recommendation will be made in EIA to prevent the proposed lighting installation from causing light

nuisance. Proposal of lighting installation will be submitted separately for approval.

3.8.4.1.4 The requirement of an EIAs tends to be restricted to more rural areas but EIA may also be required for high profile projects such as the London 2012 Olympics project where an environmental strategy is imposed across the whole of the project with individual project teams being requested to respond to the overall strategy via means of project specific EIAs.

3.8.4.2 The problems encountered and arrangements to deal with such problems

3.8.4.2.1 Light nuisance will be assessed on a case-by-case basis as there is no set level of artificial light above which a statutory nuisance is caused. When assessing a case, the representative of local authorities should consider factors like duration, frequency of use of artificial light. The technical parameters formulated and issued by ILE may help relevant parties consider whether there is light nuisance.

3.9 Frankfurt

3.9.1 Boroughs under the jurisdiction of Frankfurt

3.9.1.1 Germany is a federal republic governed centrally from the capital Berlin where the federal government sits in the Bundestag. The Bundestag is the main elected assemblies for the federal German government and is responsible for issuing of federal laws and guidance that cover the whole of Germany.

3.9.1.2 Frankfurt is located within the Lande of Hessen, which equates an autonomous state similar to the American States in the USA. Hessen has a state parliament which imposes local laws within the Lande of Hessen. Frankfurt has a city council which imposes city wide laws which cover the whole of Frankfurt.

3.9.1.3 Frankfurt is located on both sides of the River Main in the south-west part of Germany. The southern part of the city contains the Frankfurt City Forest (Frankfurter Stadtwald), Germany's largest forest within a city. The centre of Frankfurt is located on the north side of the river. The city is divided into 46 Stadtteile or Ortsteile which are again divided into 118 Stadtbezirke. The largest Ortsteil is Sachsenhausen-Süd. Most Stadtteile are incorporated suburbs (Vororte), or previously separate cities, like Höchst. Some like Nordend arose during the rapid growth of the city in the Gründerzeit following the unification of Germany. Others were formed from settlements which previously belonged to other city divisions, like Dornbusch. The 46 city divisions are combined into 16 area districts or Ortsbezirke, which each have a district committee and chairperson.

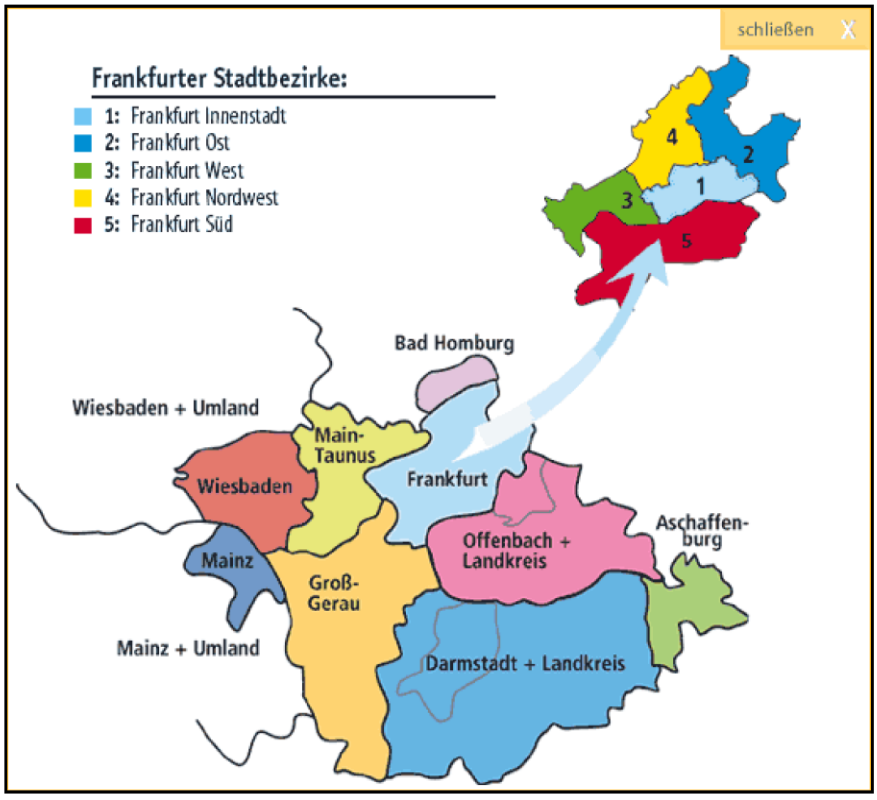

Figure 3.9.1 – A simple map of Frankurt

3.9.2 Characteristics of External Lighting

3.9.2.1 In Frankfurt, there are many sources that contribute to light pollution, mainly artificial light that is scattered in the atmosphere:

(i) direct and indirect lights for advertising seem to play a minor role in Frankfurt, because these are restricted, mainly for traffic security reasons. However sky beamers used mainly by discotheques are increasingly disturbing. These are powerful moving spotlights that sometimes are visible over dozens of kilometers. In several cases even animals (mainly birds, but perhaps also amphibians) have been threatened by these lights.

(ii) direct and indirect lights from private households, e.g. illuminated windows, unshielded garden lighting, and continuously shining security lights.

(iii) Street lighting seems to be one of the major contributors to light pollution.

(iv) Traditionally the mercury vapor light has been the lamp source of choice for street lighting and external schemes

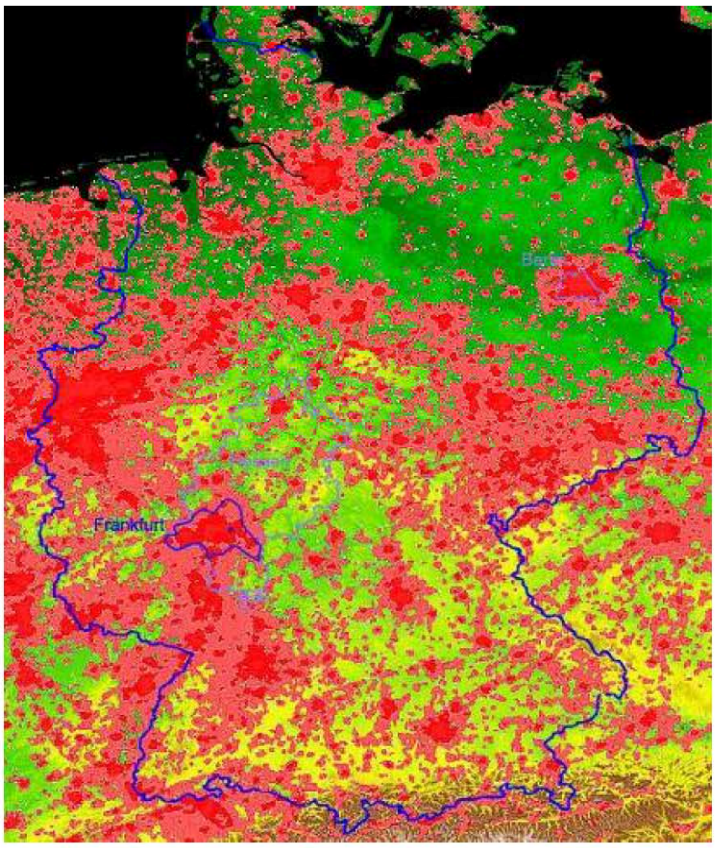

Figure 3.9.2a False Colour Rendering of Light Pollution in Germany

(Remarks: There is a general convention that red represents the most polluted with yellow next and then green blue and black being the least polluted)

Figure 3.9.2b Panoramic view of Frankfurt at Night

Figure 3.9.2c Aerial View of Frankfurt

Figure 3.9.2d River View of Frankfurt showing Laser/Lighting display

3.9.3 Approaches adopted by Government regarding external lighting

3.9.3.1 Government approach

The Frankfurt government adopts the mandatory regulatory approach with reference standards to govern the use of new and existing outdoor lightings.

3.9.3.2 Mandatory Regulation

i) Federal Pollution Control Act - BImSchG

(a) "Gesetz zum Schutz vor schaedlichenUmwelteinwirkungen durch Luftverunreinigungen, Geraeusche, Erschuetterungenund aehnliche Vorgaenge" (translated into "Act on the Prevention of Harmful Effects on the Environment caused by Air Pollution, Noise, Vibration and Similar Phenomena") (Federal Pollution Control Act – BimSchG) is the

mandatory document regarding external lighting and its requirements are applicable to new and existing lightings.

(b) The light pollution laws in Germany are primarily issued by the Federal Government the Bundestag and cover the whole country; there is no particular local laws adopted in Frankfurt. The legislation is:

Federal Pollution Control Act - BImSchG of 15 March 1974 (Federal Law Gazette I, p. 721, 1193) as amended and promulgated on 14 May 1990 (Federal Law Gazette I. p. 880), as last amended by Article 1 of the Act of 3 May 2000 (Federal Law Gazette I. p. 632).

(c) The purpose of the Act is to protect human beings, animals and plants, the soil, water, the atmosphere as well as cultural assets and other material goods against harmful effects due to any air pollution, noise, vibration, light, heat, radiation and similar effects on the environment and to prevent the emergence of any such effects, also from hazards, considerable disadvantages and considerable nuisance caused in any other way, and to take precautions against the emergence of any such harmful effects on the environment.

(d) One of the key elements of the regulatory scheme under the BImSchG is the term "*harmful environmental impacts*," which is defined as "*emissions which, according to their type, scope or duration, may cause dangers, substantial disadvantages or nuisances for the public or the neighborhood.*" The term "*emissions*" is defined as "*air pollution, noise, vibration, **light**, heat, radiation and similar phenomena originating from an installation.*"

3.9.3.3 Reference Standards adopted by the Regulation

(i) "Messung und Beurteilung von Lichtimmissionen künstlicher Lichtquellen" (Measurement and assessment of light pollution from artificial light sources) issued by Deutsche Lichttechnische Gesellschaft (LiTG) (German Lighting Engineering Society)

(a) (Measurement and assessment of light pollution from artificial light sources) is the technical guideline, published by LiTG, to indicate maximum admissible levels and details of the measurement and assessment methods to help for implementation of the Federal Pollution Control Act.

(b) Although no concrete ceilings are defined in light pollution laws in the Federal Pollution Control Act, help is provided by the LiTG publication. In it, the LiTG publishes maximum admissible levels and details of the measurement and assessment methods used for new and existing lightings.

(ii) "*Hinweise zur Messung und Beurteilung von Lichtimmission*" (Measurement and assessment of light emissions) issued by *Länderausschuss für Immissionsschutz* (LAI)

(a) The Immission Control Committee of Germany's federal states (*Länderausschuss für Immissionsschutz* – LAI) has adopted these methods and ceilings in its guideline "*Hinweise zur Messung und Beurteilung von Lichtimmissionen*" (Measurement and assessment of light emissions) and recommends that they should be applied by environmental protection agencies. A number of federal states have issued "lighting guidelines" on the subject.

(b) The guidelines for implementation of the law are covered by the "*Hinweise zur Messung und Beurteilung von Lichtimmission*" (Measurement and assessment of light emissions). The standards are primarily formulated to prevent light pollution from affecting adjacent buildings and cover both illuminance and luminance constraints. The guideline refers to *Panel Sources* which mainly refers to illuminated advertisements or the effects of multiple lamp sources which may be considered to give a cumulative light pollution effect greater than if measured as single sources.

(c) The main function of the guideline is to provide a framework of permissible illuminance and luminance limits with respect to differing zones of occupancy and to further restrict those limits during periods of the night.

(d) To determine whether the guideline has been followed, physical measurements of parameters at windows are made. However, there is no specific detail on what calculation methods are used and there is no reference to existing levels of ambient light pollution.

(iii) Reference Standards Parameters for evaluating impacts of external lighting

The technical parameters formulated by "Measurement and assessment of light emissions" (LiTG) are used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are described below which is as a tool to show the compliance with the Federal Pollution Control Act – BimSchG.

(a) Zoning Control for regulating/assessing outdoor lighting

(b) Curfew time for regulating outdoor lighting

(c) Limitation of obtrusive light on residential units for assessment of light trespass

(d) Limitation of sign and building facade luminance for assessment of glare on residents

3.9.4 Summary of experience in addressing problems of external lighting

3.9.4.1 The problems encountered and arrangements to deal with such problems

Light nuisance is assessed on a case-by-case basis as there is no objective and set level of artificial light above which a statutory nuisance is considered to have been caused. When assessing a case, the representative of the City council should consider factors like duration, frequency of use of artificial light. The technical parameters formulated by the standard issued by LiTG may help relevant parties consider whether there is light nuisance in a particular case.

4 REVIEW OF REGULATORY APPROACHES AND MEASURES ADOPTED BY THE 6 SELECTED ECONOMIES

4.1 Introduction

4.1.1 This part of the study covers six (6) economies, including Yangtze River Delta in PRC, State of New South Wales (NSW) in Australia, State of California (California) in the United States, Province of Ontario in Canada, England in UK and European Union, and focuses on their relevant government approaches including mandatory regulations, non-mandatory/voluntary control through guidelines and standards, and current practices on the control and understanding of the light nuisance and energy efficiency of external lighting issue.

.

4.2 Yangtze River Delta, PRC

4.2.1 Areas commonly considered as the Yangtze River Delta (excluding Shanghai) – Jiangsu and Zhejiang provinces

4.2.1.1 The Yangtze River Delta generally comprises the triangular-shaped territory of Shanghai, southern Jiangsu (江苏) province and northern Zhejiang (浙江) province of China. This refers to the region extending as far north as Lianyungang (连云港), Jiangsu and as far south as Taizhou (台州), Zhejiang. The map in Figure 4.1.1 shows the areas commonly described as the Yangtze River Delta. Currently, the area is home to an economy with the size of a medium-sized developed country, encompassing a GDP (adjusted to purchasing power) of some US$2 trillion, which is 40% of the national economy[31]. The urban build-up in the area has given rise what may be the largest concentration of adjacent metropolitan areas in the world. It covers an area of 99,600 km^2 and is home to over 80 million people as of 2007, of which an estimated 50 million are urban residents.

[31] http://en.wikipedia.org/wiki/Yangtze_River_Delta

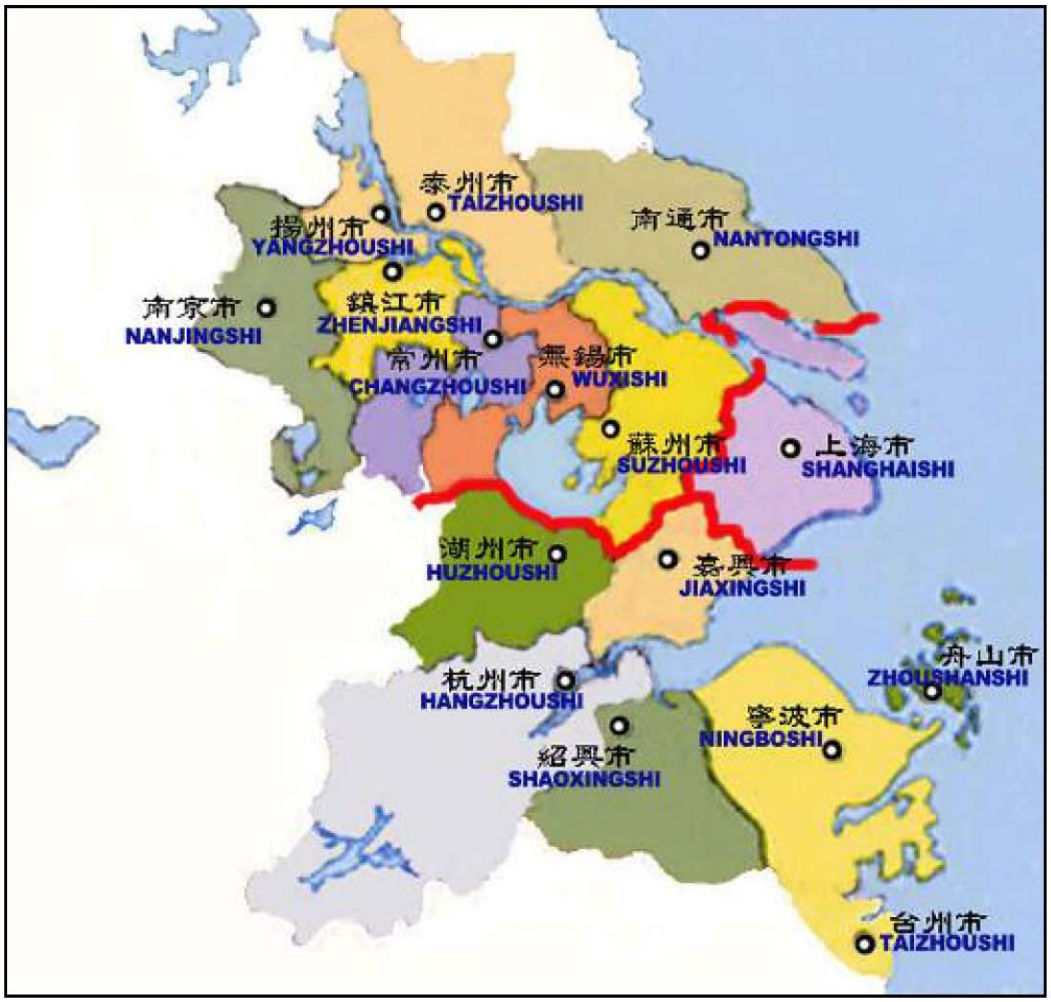

Figure 4.1.1 The major cities in the Yangtze River Delta economic zone.

4.2.1.2 There are over twenty developed urban cores in the Yangtze River Delta region. These include the Shanghai municipality and the following cities in southern Jiangsu province and northern Zhejiang province.

(a) *Southern Jiangsu Province:* Nanjing (南京, capital of Jiangsu province), Suzhou (苏州, including county-level urban centres of Changshu 常熟, Taicang 太仓, Kunshan 昆山, and Zhangjiagang 张家港), Wuxi (无锡, including county-level urban centres of Yixing 宜兴 and Jiangyin 江阴), Nantong (南通, including county-level urban centres of Qidong 启东 and Tongzhou 通州), Changzhou 常州, Zhenjiang 镇江 (including county-level urban centres of Danyang 丹阳, Jurong 句容, Yangzhong 杨中), Yangzhou (扬州) and Taizhou (泰州).

(b) *Northern Zhejiang Province:* Hangzhou (杭州 capital of Zhejiang province, including county-level urban centres of Jiande 建德, Fuyang 富阳 and Lin'an

临安); Ningbo 宁波 (including county-level urban centres of Cixi 慈溪, Fenghua 奉化 and Yuyao 余姚), Shaoxing (绍兴), Jiaxing (嘉兴), Huzhou (湖州), Zhoushan (舟山), Taizhou (台州) and Jinhua (金华)

The following picture shows the nighttime lighting in Nanjing.

Figure 4.1.2 Nanjing at night.

4.2.2 Government approaches and measures adopted in Jiangsu and Zhejiang Provinces

4.2.2.1 *Introduction of Government approaches*

(a) Jiangsu Province

At present, there is no mandatory regulation in Jiangsu province on controlling the use of outdoor lighting. There is no mention of controlling the impacts of outdoor lighting in《江苏省环境保护条例》 (Environmental Protection Ordinance of Jiangsu Province) and 《江苏省节约能源条例》 (Energy Conservation Ordinance of Jiangsu Province). There is also no sub-provincial government regulation on controlling the impacts of outdoor lighting.

(b) Zhejiang Province

At present, there is no mandatory regulation in Zhejiang province on controlling the use of outdoor lighting. There is also no sub-provincial government regulation on controlling the impacts of outdoor lighting.

4.2.2.2 Recommended Voluntary Standard

In the website of Jiaxing Environmental Protection Bureau (嘉兴市环境保护局), the Shanghai Municipal Standard DB31/T316-2004 《城市环境(装饰)照明规范》 is posted as a local standard for Jiaxing and China Trade Standard (Construction Industry) JGJ/T 163-2008 《城市夜景照明设计规范》 (Code for lighting design of urban nightscape) as a recommended industry standard in Jiangsu and Zhejiang Provinces.

4.2.2.3 Parameters for voluntary standards/guidelines adopted for evaluating impacts of external lighting

As there is no regulation or guideline on outdoor lighting, there is also no recommendation on parameters for evaluating impacts of outdoor lighting in Jiangsu and Zhejiang Provinces except Jiaxing. For Jiaxing, the Shanghai Standard 《城市环境(装饰)照明规范》is adopted and the parameters are given in Section 3.2.3.3.

4.2.3 Summary of experience in addressing problems of external lighting

4.2.3.1 Practices, measures and guidelines in addressing problems of external lighting

4.2.3.1.1 Since there is no legislation or guidelines in the area, the Shanghai Municipal Standard DB31/T316-2004 is often referred to in published articles dealing with light nuisance at night. Recently a China Trade Standard (Construction Industry) JGJ/T 163-2008 《城市夜景照明设计规范》 (Code for lighting design of urban nightscape) has become effective from 1 May 2009 as a voluntary industry standard to give guidelines in the design of outdoor lightings in new building, additions and alterations (A&A) construction works, commercial pedestrian street, square, park, advertising and logo.

4.2.3.1.2 The main technical contents related to the external lightings in "Code for lighting design of urban nightscape" (JGJ/T163-2008) are summarized as follows:-

1) The basic requirements specification, design principles, lighting, lighting and electrical accessories selection
2) Lighting Evaluation: illuminance, or brightness, color, uniformity, contrast and three-dimensional feeling, glare restriction
3) Lighting design: buildings, structures and special landscape elements, commercial walking street, squares, parks, advertising and logo
4) Energy Saving Lighting: Lighting energy-saving measures, lighting power density (LPD)
5) Restrictions on light pollution
6) Lighting control

4.2.3.1.3 This standard listed four principles for restrictions on light pollution in chapter 7 of this standard which is extracted from the following: -

"7.0.1 光污染的限制应遵循下列原则 (Light pollution restrictions should be guided by the following principles)：

1 在保证照明效果的同时，应防止夜景照明产生的光污染 (While ensuring the lighting effects, light pollution shall be prevented to produce by night landscape lighting)；

2 *限制夜景照明的光污染，应以防为主，避免出现先污染后治理的现象 (To avoid dealing with the light pollution after problem appears, the main purpose of limiting the night landscape lighting is to prevent the lighting pollution)；*

3 *对已出现光污染的城市，应同时做好防止和治理光污染工作 (For the city that light pollution has emerged should prevent and control the pollution at the same time)；*

4 *应做好夜景照明设施的运行与管理工作，防止设施在运行过程中产生光污染。(To avoid night landscape lighting generate light pollution in process, facilities should be well operated and managed) "*

4.2.3.2 The problems encountered and arrangements to deal with such problems

It was reported that the Nanjing Purple Mountain (Zijinshan) Observatory (紫金山天文台) has been seriously affected by the increasing sky glow caused by urban developments. Nighttime observations are almost totally impracticable. An academic in Jiangsu Province expressed that strict legislative control on outdoor lighting would affect commercial and economic development. Another academic mentioned about the reduction in crime within a brighter city. Experts' recommendation to deal with outdoor lighting problems is to have a better city nightscape planning with appropriate brightness distribution taking into account the effects on the environment and residents.[32]

[32] http://news.xinhuanet.com/st/2004-09/22/content_2006277.htm

4.3 State of New South Wales, Australia

4.3.1 Areas under the jurisdiction of the State of New South Wales

4.3.1.1 The State of New South Wales (NSW) is Australia's most populous state. It is located in the south-east of the country. There are 152 local Councils governing local government areas (LGAs) and one unincorporated area. The estimated population of NSW at the end of June 2007 was 6.9 million people (estimated from population figures given in NSW Government website for all the 152 LGAs). About 63% of NSW's population is based in Sydney. NSW has the largest economy in Australia, representing about 33% of Australia's GDP. Sydney alone already accounts for about three quarters of NSW's GDP or one quarter of Australia's GDP. Financial services and information technology are the major industries which are centred in Sydney. Apart from these, NSW's economy comprises manufacturing, export of coal and related products, tourism and agriculture.

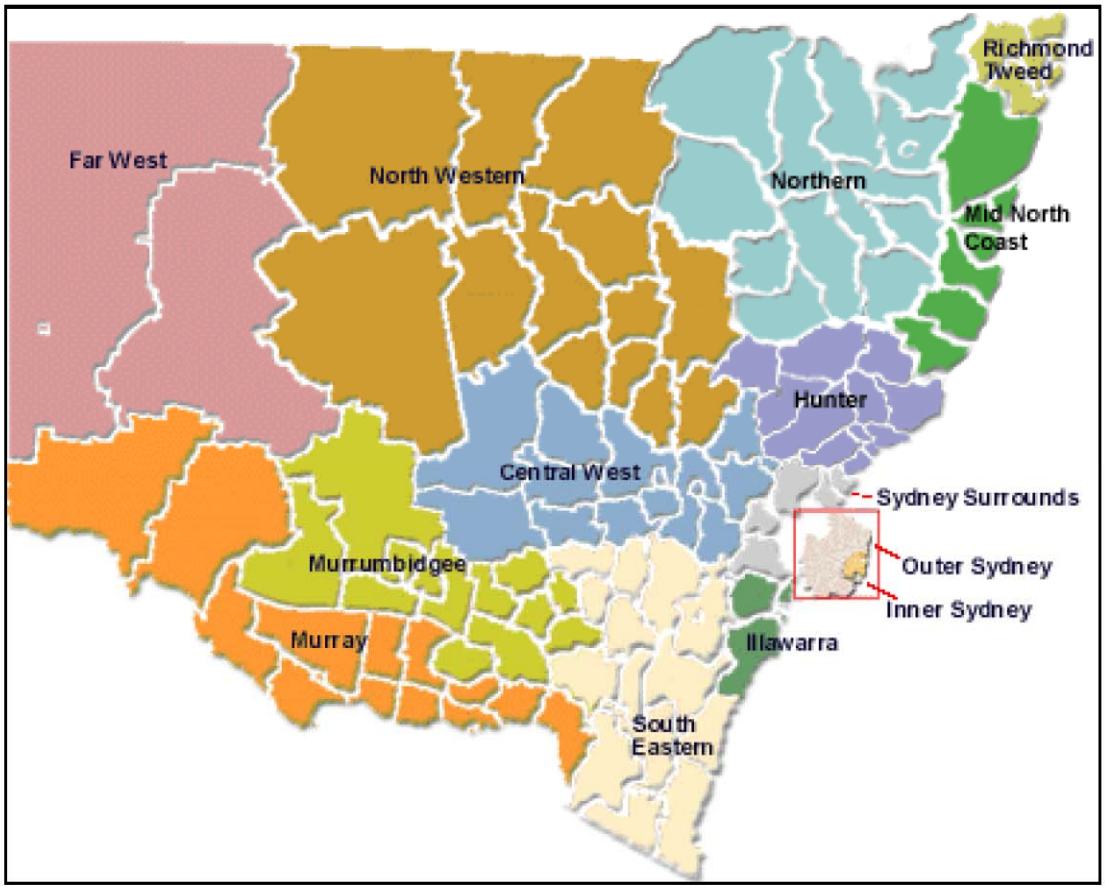

Figure 4.3.1 The local government areas (LGAs) of New South Wales (only region names are shown as there are totally 152 LGAs) (from NSW Government website)

4.3.2 Government approaches and measures adopted in New South Wales

4.3.2.1 Government approaches

There is no mandatory regulation imposed by the government on external lightings in New South Wales.

4.3.2.2 No mandatory regulation

There is no state legislation concerning outdoor lighting. In NSW State, the Department of Environment and Climate Change is responsible for the control of pollution.[33] Light pollution is not included in the "environmental issues" section of its website, while air, water and noise pollutions are included.

4.3.2.3 Recommended non-Mandatory Standard

Australian Standards AS4282:1997 (Control of the Obtrusive Effects of Outdoor Lighting) and AS/NZS1158.3.1:2005 (Pedestrian Area (Category P) Lighting with amendment in 2008) are applicable to installation of lightings. As the Australian Standards AS4282:1997 and AS/NZS1158.3.1:2005 are applicable to the whole country, including NSW State.

4.3.2.4 Voluntary Parameters for evaluating impacts of external lighting

In Australian Standards AS4282:1997 and AS/NZS1158.3.1:2005, the parameters used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are .

a) Zoning Control for regulating/assessing outdoor lighting

b) Curfew time for regulating outdoor lighting

c) Limitation of glare effect on road users (drivers, cyclists, pedestrians)

d) Limitation of upward waste light ratio (WULR) to control sky glow

e) Luminaire classification based on intensity distribution

[33] http://www.environment.nsw.gov.au/

4.3.3 The problems encountered and arrangements to deal with such problems

There are some voluntary campaigns aiming to raise awareness about the growing problem of light pollution, like the "SOS Save Our Southern Cross" project conducted by the Redeemer Baptist School, North Parramatta, NSW.[34] They are trying to measure the light pollution levels in the Sydney region and comparing the results with different locations around the world. Recently, a lighting event called "Smart Light Sydney" is being held in May and June 2009.[35] The main theme of this event is on smart lighting that is low in its use of energy and production of light pollution, but the nature of this festival seems to focus more on the artistic side of lighting design.

[34] http://www.sydneyatnight.org/
[35] http://www.smartlightsydney.com/

4.4 State of California, USA

4.4.1 Areas under the jurisdiction of the State of California

The state is divided into counties, within which are cities and towns, including the City of Los Angeles. The state allows the formation of municipal lighting maintenance districts.

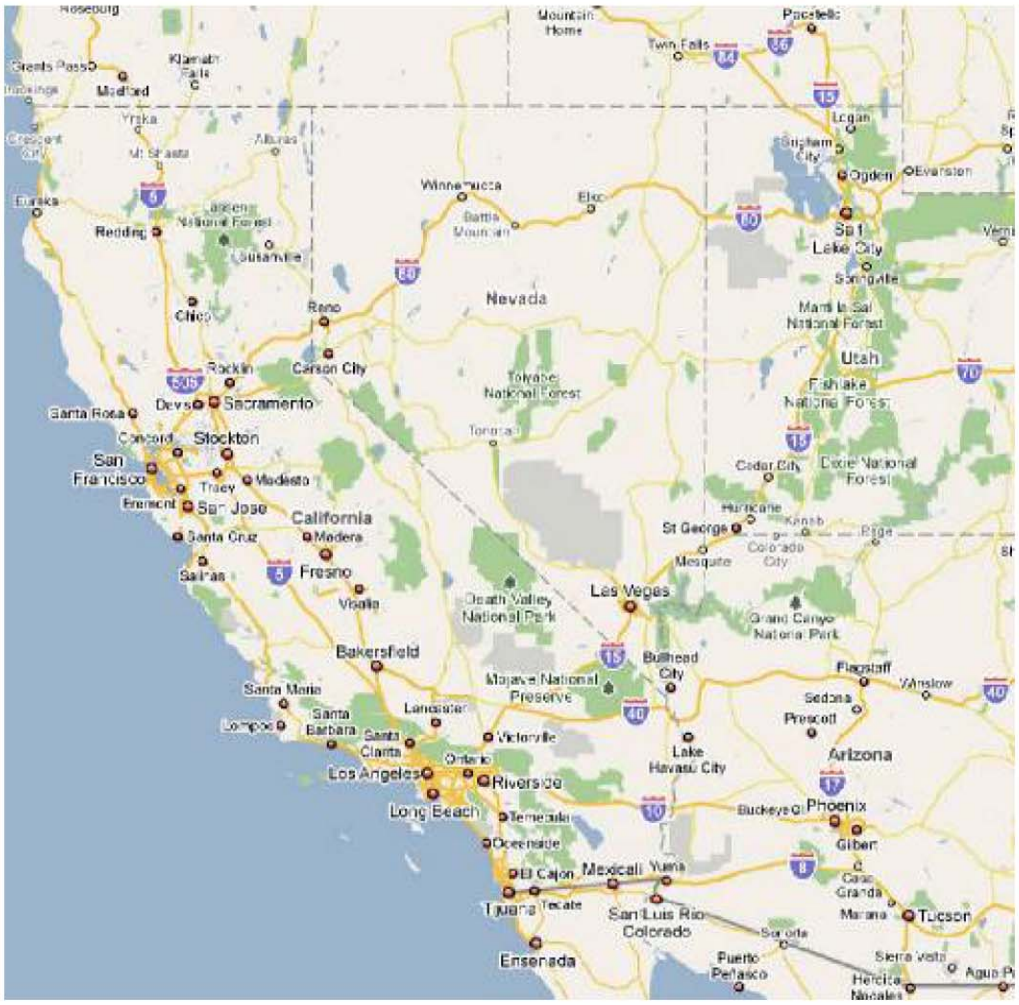

Figure 4.4.1 Map of City of Los Angeles

4.4.2 Government approaches and measures regarding external lighting adopted in the State of California (see also City of Los Angeles)

4.4.2.1 Government approach

The government in the state of California adopts mandatory regulatory approaches with mandatory energy code and energy efficiency standards to govern the energy consumption of new outdoor lightings.

4.4.2.2 Mandatory Regulation

The California Energy Commission Title 24 Section 132 Outdoor Lighting Controls and Equipment and 2005 Building Energy Efficiency Standards are applicable to installation of new lightings. They are the mandatory regulation to govern the energy consumption of newly constructed lightings and additions and

alterations (A&A) to existing externally illuminated signs to ensure compliance with energy conservation standards and lighting control. (Remarks: A&A works include increase in the connected lighting load, replacement and rewiring of more than 50 percent of the ballasts, or relocation of the sign to a different location on the same site or on a different site.)

The following table summarizes reference sections in *California Energy Code related to outdoor lighting.*

Occupancies	Application	New installations	Additions/ Alterations
Non-Residential, High-Rise Residential and Hotels/Motels	Outdoor Lighting	Sections 119, 130, 132	Section 149
Signs	Indoor and Outdoor	Sections 130, 132	
Low-Rise Residential	Outdoor Lighting	Sections 119(d), 150 (k)	Section 152

4.4.2.3 Enforcement Agent

California Buildings Standards Commission (CBSC) is responsible for administering California's building codes and standards, including those on outdoor lighting, and California Energy Commission (CEC) formulates energy efficiency standards to reduce California's energy consumption, including regulations limiting power density for outdoor lighting.

The Building Department inspects new constructions to determine whether they are consistent with the approved plans and specifications, and in compliance with the 2007 California Energy Code.

4.4.2.4 Penalty for violation

The Building Department has options including issuing orders to stop the works of the contractors or builders in case of non-compliance with the building codes. If a contractor continues to breach the codes, the violation can be taken to the Contractors State License Board, and the contractor can be fined or contractor's license can be in jeopardy.

4.4.2.5 Appeal mechanism

If a dispute concerning a provision of the 2007 California Energy Code arises between an applicant for a building permit and the Building Department, appeal can be sent to the local Board of Permit Appeals or other higher local review body. Notice of appeal shall be sent to California Energy Commission (CEC) 15 days before the appeal is heard, and the result of the appeal shall be sent to CEC within 15 days after the decision is made. If either party involved in the dispute is dissatisfied with the result of the appeal, one may apply for a determination from

CEC. CEC may then make a written determination, which is binding on both parties.

4.4.2.6 Mandatory regulations on energy efficiency

(i) California Code of Regulations, Title 24

(a) The California Code of Regulations, Title 24 covers buildings and their sites.

- Part 2 is the California Building Code, administered by the California Building Standards Commission. The building code includes regulation for all new lighting system to comply with the current energy conservation requirement contained in Part 6 of Title 24 of the California Code of Regulations (California Energy Code).
- Part 6 of Title 24 is composed of the Energy Efficiency Standards for Residential and Nonresidential Buildings, or California Energy Code, and is administered by the California Energy Commission. The energy code includes regulations limiting power density for newly constructed outdoor lighting and additions and alternations to existing internally and externally illuminated signs.

(b) "Title 24", the energy code part, regulates outdoor lighting that might be considered as "context sensitive", establishing "Lighting Zones" by amount of ambient illumination. The maximum wattage allowed in a zone with high ambient illumination is greater than wattage allowed in a zone with low ambient illumination. The wattage within each zone is also limited by type of use, such as facade or area lighting.

4.4.2.7 Mandatory parameters for evaluating impacts of external lighting

The parameters used to measure and control the impacts of outdoor lighting and the limiting values used for minimizing the impacts are described below

a) Zoning Control for regulating/assessing outdoor lighting

b) Cut-off /shielding requirement of outdoor luminaires

c) Limitation of Wattage /lighting power density (LPD)

d) Automatic switching control

4.4.2.8 Voluntary guidelines/ standards on light nuisance and energy efficiency

The following Voluntary guidelines/ standards on light nuisance and energy efficiency are applicable to the new installation lightings in the State of California which similar to New York City.

1. RP-33-99 Lighting for Exterior Environments – an IESNA Recommended Practice
2. TM-11-00 Technical Memorandum on Light Trespass: Research, Results and Recommendations

4.4.3 Summary of overseas experience in addressing problems of external lighting

4.4.3.1 *Practices, measures and guidelines in addressing problems of external lighting*

Lighting power density and energy consumption, instead of light nuisances, such as glare, trespass, etc. are controlled by the Energy Code in California. None of the mandatory regulations specifies or requires measuring actual maximum illuminance or luminance. Constraints are placed on the power, physical size of light fixtures or illuminated displays rather than on the luminous they produce.

The codes are enforced at the local level by building inspectors, such as the staff of the City of California Department of Building and Safety. The codes are reviewed and updated every few years.

4.4.3.2 The problems encountered and arrangements to deal with such problems

Minimum illuminance requirements for egress and maximum power density allowances would appear to conflict. Possible conflict is dealt with in the energy code by allowing a higher power density and for a specific minimum average illuminance.

4.5 Province of Ontario, Canada

4.5.1 Areas under the jurisdiction of the Province of Ontario

Local government divides into regions or counties, and municipalities including the City of Toronto. Natural reserves are regulated by the Ministry of Natural Resources, and include Provincial Parks and Conservation Reserves.

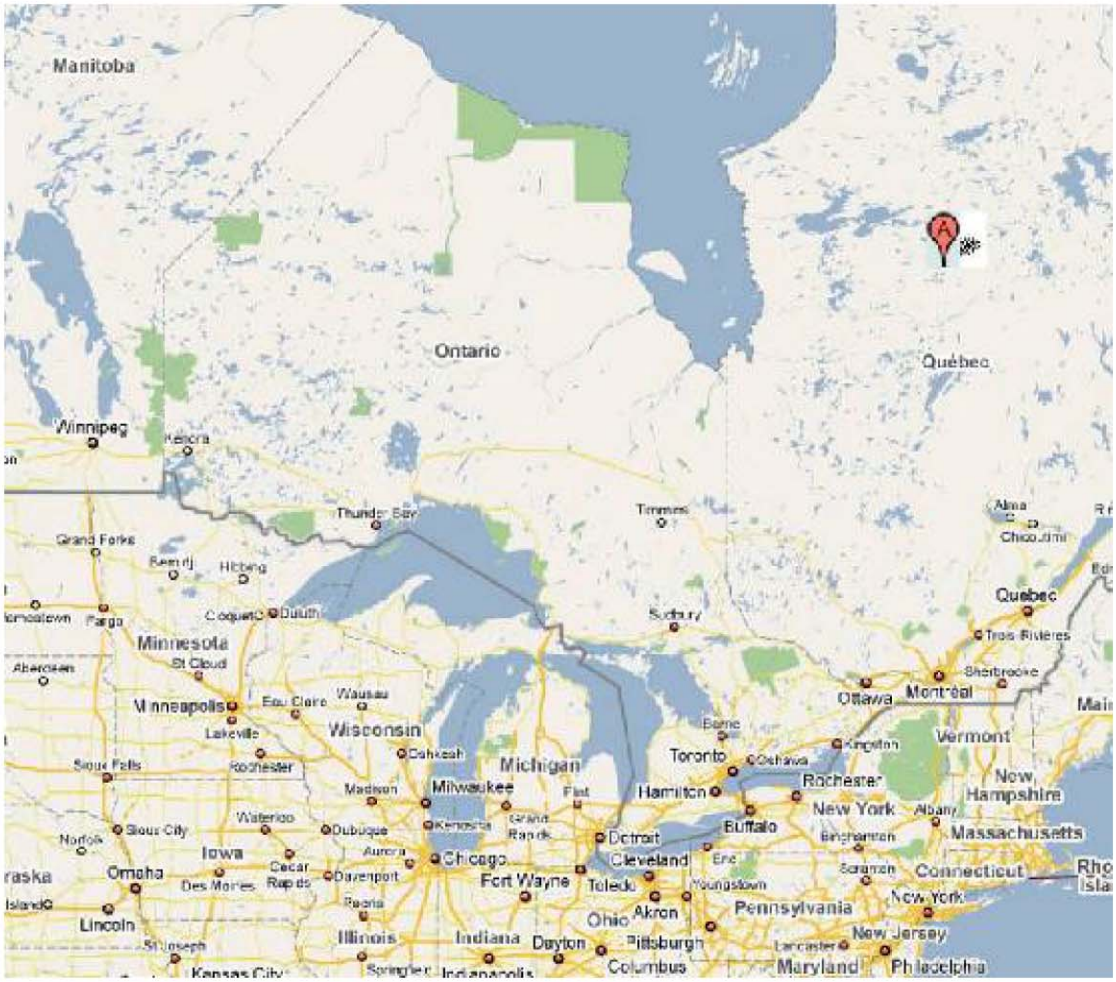

Figure 4.5.1 Map of Province of Ontario, Canada

4.5.2 Government approaches and measures regarding external lighting adopted in the Province of Ontario

4.5.2.1 Introduction of Government approach

4.5.2.1.1 The government in Province of Ontario adopts mandatory energy code to govern the energy consumption for use of new outdoor lightings. *A building inspector has the authority to review a project designed and built under the code and to inspect the installation after its completion. If the operation of the lighting (or any other aspect of the project) is no longer in compliance with the code, the inspector may issue a citation to the owner. Penalties vary including a fine or, in extreme cases, imprisonment. If an owner doesn't rectify the code violation, the building inspector will issue a citation to the owner until the non-compliance is rectified.*

4.5.2.1.2 *Existing conditions are generally allowed to remain. Upon carrying out maintenance or alteration of an existing installation, the owner should follow the energy code and submit design documents for approval.*

4.5.2.2 Mandatory Regulation

4.5.2.2.1 The Ontario Building Code is the mandatory document to govern the energy consumption for use of the newly constructed lightings. Ontario's new Building Code has been approved with the filing of Ontario Regulation 350/06 (2006 OBC) and replaces the previous building code regulation released in 1997. The Building and Development Branch of the Ministry of Municipal Affairs and Housing administers the Ontario Building Code.

4.5.2.2.2 Decisions of enforcement officials can be appealed, and innovative building materials may be approved and introduced. Ontario's Building Code Commission operates as an expert adjudicative body where Building Code disputes are heard in a timely manner. In addition, the Building Materials Evaluation Commission (BMEC)[36] and Minister's Rulings[37] serve as ways to receive evaluation and approval for new building products.

4.5.2.3 Enforcement Agent

The building code is promulgated by the Building and Development Branch of the Ministry of Municipal Affairs and Housing and enforced usually by inspectors of local building department. The building permit application form is published by the Ministry. The form of each project is submitted to the local authority, usually a municipality.

4.5.2.4 Penalty for violation

Failure to meet the code during plan review results in denial of a building permit to start construction. Failure to build according to approved plans can result in denial of a certificate of occupancy.

[36] The BMEC is a regulatory agency authorized under the Building Code Act, 1992 (BCA). It has a mandate to conduct or authorize the examination of materials, systems and building designs for construction. When approving a material, system or building design, the BMEC may attach certain conditions for its use. The BMEC may also make recommendations to the Minister regarding changes to the BCA or Building Code.

[37] Building materials, systems or designs that are approved by the National Research Council's Canadian Construction Materials Centre may be used for construction in Ontario through a Minister's Ruling. In such a Ruling, the Minister may impose terms and conditions on the use of the material, system or design.

4.5.2.5 Ontario Building Code

4.5.2.5.1 The local building department can deny a building permit after plan review, stop work during construction, or require removal of work in case of non-compliance.

4.5.2.5.2 The Ontario Building Code regulates exterior lighting associated with new or renovated buildings under the "Resource Conservation" section of the code. It also requires minimum illuminance levels for means of egress out to "an open public thoroughfare". The code limits the power used by outdoor lighting according to allowable watts per area for particular uses in order to establish a lighting power budget for a site.

4.5.2.5.3 The Code does not limit the illumination on surrounding sites (as with a system of zones) or impose requirements on the distribution of light fixtures (say by requiring cutoff optics). So, there does not appear to be a regulation at the province level limiting light trespass directly.

4.5.2.5.4 The code limits the impact of outdoor lightings by requiring automatic controls to shut off fixtures when they are not needed.

4.5.2.6 Mandatory parameters for evaluating impacts of external lighting

4.5.2.6.1 For lighting mounted on the exterior of a building or on the site of building project the code limits the wattage used. Power densities are assigned for various uses and then figure into a lighting power budget.

4.5.2.6.2 The building code also requires controls such that "lighting for exterior applications shall have automatic controls capable of turning off exterior lighting when (a) sufficient daylight is available, or (b) the lighting is not required during night time hours."

4.5.2.7 Recommended non-Mandatory Standard

4.5.2.7.1 The Ontario Ministry of Natural Resources (MNR) establishes guidelines for activities and structures in the parks and reserves. The Ministry issued a special Statement of Conservation Interest[38] in February 2006 (to replace the previous one in 1999) to reflect MNR's evolving views on the management of conservation reserves, and to make the Torrance Barrens Conservation Reserve a Dark Sky Reserve.

4.5.2.7.2 A Statement of Conservation Interest is prepared under the direction of MNR's Procedural Guideline A – Resource Management Planning (PL. Procedure .03.05). The purpose of this Statement of Conservation Interest is

[38] http://www.rasc.ca/im/lpa/torrancebarrenscrfebruary06final1.pdf

to identify and describe the values of Torrance Barrens Conservation Reserve. The Statement of Conservation Interest also outlines the activities that currently occur within the conservation reserve and provides guidelines for the management of current and future activities for protecting the natural, recreational and cultural values.

4.5.2.7.3 The absence of light pollution in the night sky above the conservation reserve is remarkable. The Muskoka Heritage Foundation (Goering, 1998)[39] and other interest groups suggest to preserve this favorable condition through appropriate land use controls both inside and outside the conservation reserve.

4.5.2.7.4 The Muskoka Heritage Foundation requested that the stargazing opportunities be recognized by MNR through supportive management guidelines and by designating the conservation reserve a "Dark Sky Reserve". MNR proposed the area for protection in 1995 and public meetings were held in April 1995 and October 1996. Broad-based public input supported the protection of the area provided that existing uses were permitted to continue. Support at and since the October 19, 1996 Public Open House included submissions from the respective organizations and individuals. This was done during the preparation of the 1999 Statement of Conservation Interest for this site. Torrance Barrens Conservation Reserve was Canada's first "Dark Sky Reserve" and was publicly announced at the Royal Astronomical Society of Canada's annual meeting in Toronto in July 1999.

4.5.2.7.5 As mentioned above, to preserve the dark sky, MNR has made the Statement of Conservation Interest which say "*While there is no intent at present to provide or permit any new development in this conservation reserve that would require lighting, should this be considered at some point in the future the MNR will not allow unnecessary, undirected light pollution.*" and "*MNR would support any municipal decision in the future to adopt guidelines or a by-law for the design and placement of outside lighting to prevent light pollution within an appropriate range of the conservation reserve*".

4.5.2.7.6 The Statement of Conservation Interest also advised that "*MNR has supported astronomy activities at Torrance Barrens Conservation Reserve, and has designated the site a Dark Sky Reserve. MNR supports the Dark Sky Reserve theme and educational and stewardship activities of the Muskoka Heritage Foundation in promoting this use, its potential benefits to local tourism and the need for the cooperation of all private landowners around the periphery of the conservation reserve.*"

[39] Goering, P. 1998. Torrance Barrens Reserve Sky Park. Letter to OMNR. Bracebridge: Muskoka Heritage Foundation, September 1998.

4.5.3 Summary of experience in addressing problems of external lighting

4.5.3.1 Practices, measures and guidelines in addressing problems of external lighting

4.5.3.1.1 The building code is enforced at the local level, for example by the building inspectors of Toronto Buildings. Failure to meet the code during plan review results in denial of a building permit to start construction. Failure to build according to approved plans can result in denial of a certificate of occupancy

4.5.3.1.2 Preserving the night sky over natural reserves currently is mostly a volunteer and public relation effort. Much of the writing about Torrance Barren, for example, comes from the Royal Astronomical Society of Canada and the Muskoka Heritage Foundation. The Statement of Conservation Interest also state that "*MNR partners (Muskoka Heritage Foundation and municipalities) are encouraged to continue monitoring land use activities around the perimeter of the conservation reserve to ensure that night sky values are not compromised by night light pollution of the skies around the conservation reserve; we would also support related education and stewardship programs.*"

4.5.3.2 The problems encountered and arrangements to deal with such problems

4.5.3.2.1 Currently there are no legal measures to back up the idea of a dark sky reserve; it depends entirely on the vigilance of the general public. Complaints could be addressed to local elected officials and publicized in the news media. Problems will be settled through educational, stewardship and promotion activities as well as the cooperation of all private landowners.

4.5.3.2.2 The purpose of "A Statement of Conservation Interest" is to provide guidance for the management of the conservation reserve and the basis for the ongoing monitoring of activities. Should significant facility development or other uses be considered or complex issues arise which require additional studies, management direction or special protection measures, a detailed Resource Management Plan will be prepared by MNR partners (Muskoka Heritage Foundation and municipalities) for public consultation. Nearby property owners and other interested stakeholders will be invited to review a draft of this revised Statement of Conservation Interest. Their comments would be considered in the finalization of this document. The document will require the approval of the District Manager and Regional Director.

4.6 England, UK

4.6.1 Areas under the jurisdiction of England, UK

4.6.1.1 United Kingdom legislation derives from a number of different sources. The United Kingdom does not have a single body of legislation, but is divided into three states, each with its own laws and legal system: England and Wales (English law), Scotland (Scots law), and Northern Ireland (Northern Ireland law).

4.6.1.2 Parliament of the United Kingdom

Statutory instruments (for example, orders or regulations) made by a Minister or by the Queen-in-Council, generally subject either to parliamentary approval (affirmative procedure) or parliamentary disallowance; these are made either under Acts or by the royal prerogative.

4.6.1.3 National Assembly for Wales

Statutory instruments made by the National Assembly for Wales

4.6.2 Government approaches and measures adopted in the England, UK

4.6.2.1 Government approach

The government in the England UK adopts mandatory regulatory approaches with legislation and planning guidelines with binding force to govern the use of new and existing outdoor lightings. Planning guidelines are a form of legislative control under local authority's jurisdiction.

4.6.2.2 Mandatory Regulation

4.6.2.2.1 In England UK, the Clean Neighbourhoods and Environment (CNE) Act 2005 provides local authorities with power and tools to tackle nuisance from artificial light from all external lighting installations.

4.6.2.2.2 Planning Policy Guidance (PPG) and Planning Policy Statement 23 (PPS): Planning and Pollution Control aim to assist local authorities in preparing their development plans and making decisions on individual planning applications and appeals to complement the pollution control framework under the *Pollution Prevention and Control Act (PPC) 1999* and the *PPC Regulations 2000.* PPS and their predecessors Planning Policy Guidance (PPG) are prepared by the UK government after public consultation to explain statutory provisions and provide guidance to local authorities and others on planning policies and the operation of the planning system. The regional planning bodies and the local planning authorities should take into account the policies stated in PPS and PPG when preparing their development plans and making decisions on individual planning permission applications. New buildings or major changes to existing buildings including changes to outdoor lighting fixtures require planning permission from the local planning authority.

4.6.2.2.3 Department for Environment, Food and Rural Affairs (DEFRA) is responsible for policy on artificial light from premises and provides guidance to local authorities in enforcing nuisance legislation. Department for Communities and Local Government (DCLG) sets out the national planning policy on lighting in the planning regime.

4.6.2.3 Reference Standards adopted by Regulation

In addition, the Act makes reference to the ILE document *Guidance Notes on the Reduction of Light Pollution.*

4.6.2.4 Enforcement Agent

4.6.2.4.1 Local Environmental Health Department and Local District or Borough Council enforce local planning Bye laws that give additional powers within their local jurisdiction e.g. South Northampton council, to suit.

4.6.2.4.2 Upon receiving a complaint, the Local Environmental Health Department will assess the case. If the department considers that there exists a statutory nuisance, an abatement notice will be issued requiring that the nuisance be eliminated or abated within a set timescale. Alternatively, the complainant may take a private action through the local magistrates' court under section 82 of the Environmental Protection Act 1990

4.6.2.4.3 The Local Environmental Health Department would issue an abatement order and if the order was not complied with, legal procedures would be taken. If the owner of the installation did not rectify his lightings causing the light nuisance, he might be taken to court.

4.6.2.4.4 Local council websites often give specific guidance to residents on measures to be taken and methods for seeking redress. These websites also refer to any local planning Bye-laws that maybe in place to address local issues.

4.6.2.5 Penalty for violation

Offender of statutory nuisance is subject to imprisonment for a term not exceeding 12 months; or a fine not exceeding 50,000(HK$588,450). A planning breach in itself is not illegal and the Local District or Borough Council may permit a retrospective application. However, if the breach involves a previously rejected development or the retrospective application fails, the Local District or Borough Council may issue an enforcement notice for new and existing lighting. It is illegal to disobey an enforcement notice. If the Local District or Borough Council decides to take the offender to court, the offender may have to pay a fine.

4.6.2.6 Appeal mechanism

Appeal against an abatement notice can be made to the local magistrate's court within 21 days from the notice being issued. Appeal against the decision on planning permission can be made to the Planning Inspectorate within six months from the date of the application decision letter.

4.6.3 Summary of experience in addressing problems of external lighting

4.6.3.1 Practices, measures and guidelines in addressing problems of external lighting

4.6.3.1.1 In United Kingdom, light trespass is governed by two public acts. The Clean Neighbourhoods & Environment Act 2005 makes light pollution a statutory nuisance under the Environmental Protection Act 1990. The artificial light nuisance is defined as a source of light that interferes with someone's use of their property and/or might be prejudicial to someone's health.

4.6.3.1.2 The act states that "*artificial light emitted from premises so as to be prejudicial to health or a nuisance" constitutes "statutory nuisances", "and it shall be the duty of every local authority to cause its area to be inspected from time to time to detect any statutory nuisances…* " and, *"where a complaint of a statutory nuisance is made to it by a person living within its area, to take such steps as are reasonably practicable to investigate the complaint."*

4.6.3.1.3 The Act provides for major exclusions which exempts a wide range of public *transport* buildings: the clause does not apply to (a) an airport; (b) harbour premises; (c) railway premises, not relevant to separate railway premises; (d) tramway premises; (e) a bus station and any associated facilities; (f) a public service vehicle operating centre; (g) a goods vehicle operating centre; (h) a lighthouse; (i) a prison.

4.6.3.1.4 There is no specific quantitative requirement on the parameters of outdoor lighting. However, the Department of Environment, Food and Rural Affairs (DEFRA) has published a guidance document, *Statutory Nuisance from Insects and Artificial Light*, in order to provide advice for practitioners such as councils on how to put the Act's measures into practice effectively. With reference to this document, light pollution could be defined as any form of artificial light which shines outside the area it needs to illuminate, including light that is directed above the horizontal into the night sky creating sky glow, or which creates a danger by glare. However, it states that light pollution is not necessarily a statutory nuisance and the statutory nuisance regime is not an appropriate tool with which to address light pollution. Therefore, the light pollution creating sky glow may not constitute a statutory nuisance.

4.6.3.1.5 The document mentions that the potential sources generating complaints include domestic and commercial security lights, healthy living and sports facilities, domestic decorative lighting, exterior lighting of buildings and

decorative lighting of landscapes, as well as laser shows, sky beams or light art. The healthy living and sports facilities include the floodlighting of play field and sport grounds. The document suggests that much artificial light nuisance is caused by excessive levels of illuminance and glare. Several lighting design considerations are recommended in order to reduce the glare impact:

- Minimum level of illumination necessary to light a property should be used.
- Security lighting and floodlighting that is shielded or angled down is encouraged.
- Recommendations of the International Commission on Illumination (CIE) and Institution of Lighting Engineers (ILE) should be observed.

4.6.3.1.6 Besides, the South Northamptonshire Council has adopted a supplementary planning guidance on light pollution which includes specific policies on obtrusive light. It gives several suggestions on the planning and design of lighting systems:

- Care should be taken to ensure that the intensity and focus of security lighting will not cause unnecessary obtrusive and glaring light.
- For sports pitches and courts, in order to avoid light spillage, the main beam angle of all lights should not exceed 70° from the vertical. Light shields should be fitted to avoid both upward glare and the direct illumination of areas beyond a distance of 10 m from the pitch. The power of each lamp should normally be limited to 1 kW with internal louvers fitted and asymmetric beams utilized that permit the front glazing of the unit to be kept at or near parallel to the surface being lit. Besides, time limits are enforced to the use of floodlights at night.
- Illumination to advertisements and signs should not position where they may affect the clarity of traffic signs or disturb those living close by.
- Direct light downwards wherever possible to illuminate its target, not upwards.
- Use of sensor switches for domestic or small scale security lighting.
- Use of full cut-off lighting fixture for street lighting.

4.6.3.2 The problems encountered and arrangements to deal with such problems

Light nuisance will be assessed on a case-by-case basis as there is no set level of artificial light above which a statutory nuisance is considered to have been caused. When assessing a case, the representative of local authorities should consider factors like duration, frequency of use of artificial light. The technical parameters formulated by the standard issued by the ILE may help inform consideration of the level of sensitivity to light easily.

4.7 European Union

4.7.1 The European Union and its member states

4.7.1.1 The European Union (EU) is an economic and political union of 27 member states, located primarily in Europe. These 27 sovereign member states are: Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Committed to regional integration, the EU was established by the Treaty of Maastricht on 1 November 1993 upon the foundations of the pre-existing European Economic Community. With almost 500 million citizens, the EU combined generates an estimated 30% share (US$18.4 trillion in 2008) of the nominal gross world product.

4.7.1.2 The judicial branch of the EU consists of the European Court of Justice (ECJ) and the Court of First Instance. Together they interpret and apply the treaties and the law of the EU. The Court of First Instance mainly deals with cases taken by individuals and companies directly before the EU's courts, and the ECJ primarily deals with cases taken by member states, the institutions and cases referred to it by the courts of member states. Decisions from the Court of First Instance can be appealed to the Court of Justice but only on a point of law.

4.7.1.3 The EU is based on a series of treaties. These first established the European Community and the EU, and then made amendments to those founding treaties. These are power-giving treaties which set broad policy goals and establish institutions with the necessary legal powers to implement those goals. These legal powers include the ability to enact legislation which can directly affect all member states and their inhabitants. Under the principle of supremacy, national courts are required to enforce the treaties that their member states have ratified, and thus the laws enacted under them, even if doing so requires them to ignore conflicting national law, and (within limits) even constitutional provisions.

4.7.1.4 The ECJ in Luxembourg can judge member states over EU law. The main legal acts of the EU come in three forms: regulations, directives and decisions. Regulations become law in all member states the moment they come into force, without the requirement for any implementing measures, and automatically override conflicting domestic provisions. Directives require member states to achieve a certain result while leaving them discretion as to how to achieve the result. The details of how they are to be implemented are left to member states. When the time limit for implementing directives passes, they may, under certain conditions, have direct effect in national law against Member States. Decisions offer an alternative to the two above modes of legislation. They are legal acts which only apply to specified individuals, companies or a particular Member State. They are most often used in Competition Law, or on rulings on State Aid, but are also frequently used for procedural or administrative matters within the institutions. Regulations, directives and decisions are of equal legal value and apply without any formal hierarchy.

4.7.1.5 One of the complicating features of the EU's legal system is the multiplicity of legislative procedures used to enact legislation. The treaties micro-manage the EU's powers, indicating different ways of adopting legislation for different policy areas and for different areas within the same policy areas. A common feature of the EU's legislative procedures, however, is that almost all legislation must be initiated by the Commission, rather than member states or European parliamentarians. The two most common procedures are co-decision, under which the European Parliament can veto proposed legislation, and consultation, under which Parliament is only permitted to give an opinion which can be ignored by European leaders. In most cases legislation must be agreed by the council.

4.7.1.6 National courts within the Member States play a key role in the EU as enforcers of EU law, and a "spirit of cooperation" between EU and national courts is laid down in the Treaties. National courts can apply EU law in domestic cases, and if they require clarification on the interpretation or validity of any EU legislation related to the case it may make a reference for a preliminary ruling to the ECJ. The right to declare EU legislation invalid however is reserved to the EU courts.

Figure 4.7.1 The 27 member states of the European Union

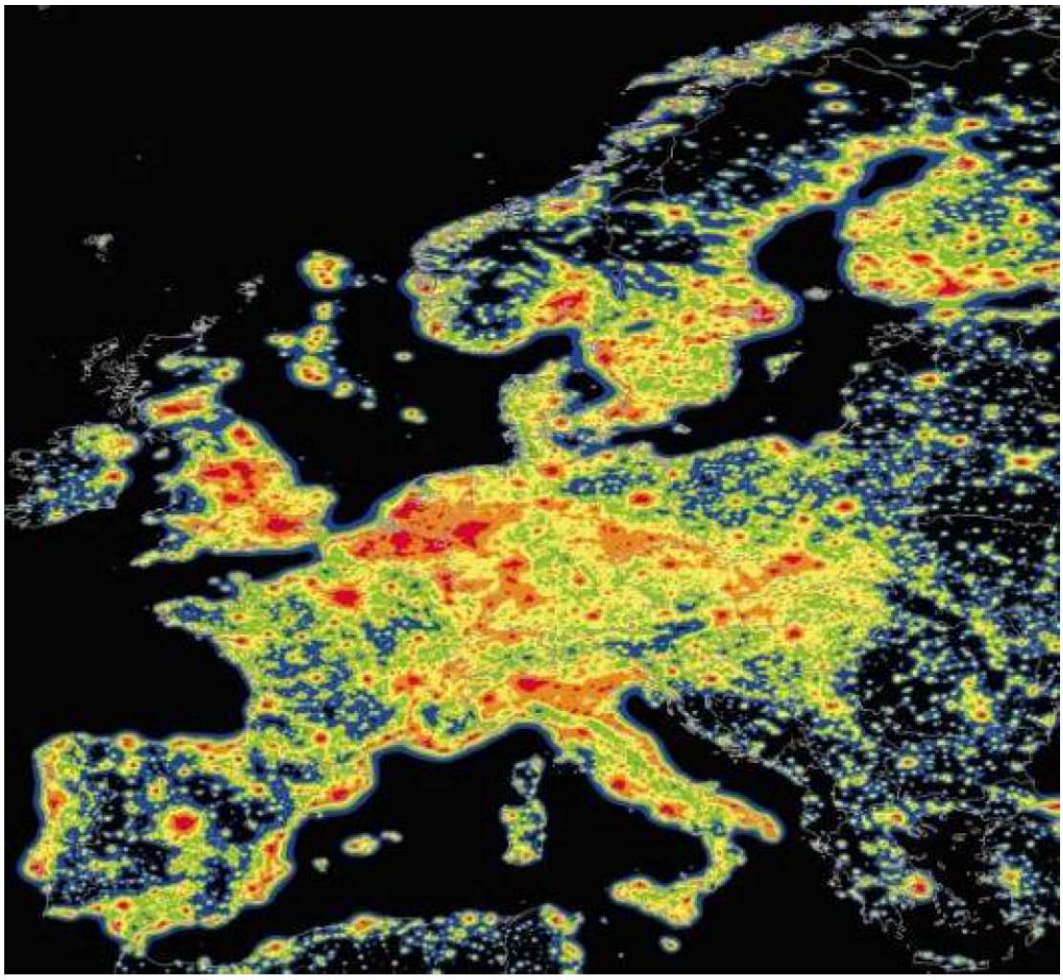

Figure 4.7.2 False colour render of Light Pollution in Western Europe

Least polluted

Most polluted

(Remarks: There is a general convention that red represents the most polluted with yellow next and then green blue and black being the least polluted.)

4.7.2 Government approaches and measures adopted in the European Union

4.7.2.1 Government approach

4.7.2.1.1 The European Union adopts European Union directives to give general guidance and a legislative framework to member states but it is the member states that provide the final legislation within their states and decide on the enforcement practices.

4.7.2.1.2 There is currently no EU Directive specific to Light Pollution although there is significant pressure from associated non-governmental organizations (NGOs) and affected pressure groups for a standard to be written and this issue was debated at the previous conference held in Bled Slovenia 5-6 October 2007[40] at which representatives of the EU were invited.

4.7.2.1.3 European Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Energy using Products (EuP) Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements give mandatory requirement in the application of different types of luminaires such as fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps.

4.7.3 Summary of experience in addressing problems of external lighting

4.7.3.1 Practices, measures and guidelines in addressing problems of external lighting

4.7.3.1.1 Regarding the existing national lighting pollution laws, many regions, provinces and states in various countries have mandatory controls on obtrusive light emission and energy consumption of outdoor light sources. Spain has a national law on light pollution but it only applies in the Canary Islands. The honour of being the first country with a *national* law dealing with light pollution across the whole nation goes to Czechia, which included provision for municipal lighting controls in its Protection of the Atmosphere Act of 25 March 2002. When introduction of the Czech law was being debated, opponents with vested interests predicted increases in lawlessness and accidents. Consequently the need for compliance with the light pollution controls was removed from the law despite the absence of valid evidence to justify these concerns. The current version of the Act merely defines light pollution of the air (i.e. light travelling unobstructed into the sky) and empowers municipalities to ban skybeams. Many municipalities have done so.[41]

[40] 7th International Symposium for Dark Skies, Light Pollution and Global Warming, International Exhibition: Quality Lighting and Light Pollution

[41] A rationale for the mandatory limitation of outdoor lighting issued by Barry A. J. Clark, PhD, Director, Outdoor Lighting Improvement Section of Astronomical Society of Victoria Inc, Australia. Document Version 2.5.1, 4 April 2009. http://www.asv.org.au/dmdocuments/lp181v251.pdf

4.7.3.1.2 The original form of the Czech law was based on law number 17/2000 of the Lombardy region in Italy. In Lombardy itself, introduction of the regional law had substantial popular support and produced a somewhat surprising result: it revitalised the Italian lighting market by introducing an emphasis on improved technical performance (Bonata 2002). By 2007, 17 of the 21 regions in Italy have laws against light pollution.

4.7.3.1.3 The world's second national law that included light pollution came into force in the UK in April 2006. Following a House of Commons inquiry into light pollution, the UK Environment Protection Act 1990 was amended by Section 102 of the Clean Neighbourhoods and Environment Act 2005. Artificial light is included in the statutory nuisance provisions (Morgan-Taylor 2007). Allowing 'exterior light' to be 'emitted from premises so as to be prejudicial to health or a nuisance' is now a criminal offence. The provision applies to light from 'premises' only and exclude other important sources of light and light pollution such as streetlights and public transport terminal lighting. The stated intention was to deal with these other sources separately, and action along these lines does appear to be progressing.

4.7.3.1.4 In Germany, an official directive was issued in 2000 on the measurement and evaluation of light pollution (e.g. for North Rhine and Westphalia, LNRW (2000)). Illuminance maxima were set for bedroom windows, ranging from 1 lx in country areas to 15 lx in city centres. Lower maxima were set for the second half of the night.[42]

4.7.3.1.5 The legislature in Slovenia passed the world's first national stand-alone light pollution law on 30 August 2007. It is largely based on the lighting law in Lombardy, Italy, but includes some limits which are useful and more stringent. In most cases, outdoor lighting must be fully shielded and installed to ensure that no direct emission of light takes place above the horizontal. Residences are protected against light spill. Municipalities are responsible for limiting energy used for lighting, by limiting intensities, numbers of luminaires and hours of use.

4.7.3.1.6 In November 2007, the President of Croatia accepted a new law on the protection of nature. Article 31 deals with the definition of light pollution and reasons why limits need to be enforced. It is like the law in Czechia insofar as it would be relatively easy for the lighting lobby to have it rendered ineffective, but this has not yet happened in Croatia. In the meantime, every day that passes is likely to weaken any case for reducing the effect of the law.

[42] Comparable limits and lighting zones were incorporated in CIE (2003). Although this is an international standard, it is not mandatory unless individual countries make it so by legislation or regulation.

4.7.3.2 The problems encountered and arrangements to deal with such problems

4.7.3.2.1 Light nuisance is assessed on a case-by-case basis as there is no objective and set level of artificial light above which a statutory nuisance is considered to have been caused.

4.7.3.2.2 According to the report on light pollution prepared by committee on the Environment, Agriculture and Local and Regional Affairs of the Council of Europe on 22 March 2010[43], at European level, the question of light pollution is not dealt with by the European Commission at present. At the level of the States, where light pollution is concerned, a number of European countries including the Czech Republic, the United Kingdom, Belgium and Italy have incorporated it into their legislation. A British law of 2006 tackles the problem of intrusive light on grounds that it may adversely affect people's health. Among the States with a federal system it should be noted that most of the Italian regions have promulgated laws to combat light pollution and promote energy-saving, with the result that over two-thirds of Italy's population is now governed by laws regulating outside lighting. The decree issued by the Lombardy region (Italy's most populated, with 9 million inhabitants and the most heavily polluted by light) - entitled *Urgent measures for energy-saving on outside lighting and the combating of light pollution* is exemplary: all new installations must comply with the provisions concerning light pollution. No light may be emitted above the horizontal; lighting facilities must be equipped with the most efficient lamps possible and with systems allowing for the reduction of light emission at a given time; ground lighting must not exceed certain levels. Moreover, in the protection zones around observatories, the existing lighting systems must be replaced within four years to bring them into line with the new standards.

[43] http://assembly.coe.int/Main.asp?link=/Documents/WorkingDocs/Doc10/EDOC12179.htm

5 SUMMARY OF THE REVIEW OF OVERSEAS EXPERIENCE IN 8 METROPOLISES AND 6 ECONOMIES

5.1 Practices in dealing with the impacts of external lighting in 4 selected metropolises and 2 selected economies of Asia Pacific

5.1.1 In the study, the 4 selected metropolises in Asia are Shanghai, Tokyo, Singapore and Sydney while the 2 selected economies are Yangtze River Delta in PRC and State of New South Wales in Australia.

5.1.2 There is no mandatory regulation governing outdoor lighting with regard to nuisance or energy consumption in Tokyo, Singapore, Yangtze River Delta in PRC and State of New South Wales in Australia. In Shanghai, a clause in Shanghai Environmental Protection Regulation (《上海市环境保护条例》) states that new and existing outdoor lighting installations should comply with the Shanghai Urban Environment Decorative Lighting Technical Regulations (本市环境装饰照明技术规范). The outdoor lighting should not affect the normal living of nearby residents. The City Appearance and Environmental Sanitation Departments (市容环卫部门) should require outdoor lighting installations which do not comply with the regulations to make improvement for compliance before a specified date. In Sydney, the Exterior Lighting Strategy in the City of Sydney is mandatory document issued by the City of Sydney Council with reference standards to govern new lighting installations to prevent light nuisances.

5.1.3 There are local or national voluntary standards or guidelines for minimizing the adverse effects of outdoor lighting in Shanghai (local standard), Tokyo (national guidelines), and New South Wales (national standards). These guidelines/standards use similar approaches to deal with the problems of light trespass, glare and sky glow. The approach is also similar to that recommended in CIE-150:2003. There is no announced plan of making the voluntary guidelines into mandatory regulations in the metropolises and economies studied.

5.2 Practices in dealing with the impacts of external lighting in 2 selected metropolises and 2 selected economies of North America

5.2.1 In the study, the 2 selected metropolises in North America are New York City and Los Angeles while the 2 selected economies are State of California in USA and Province of Ontario in Canada.

5.2.2 Mandatory regulatory approach has been used by the city/state governments to control external lighting in selected metropolises and economies of North America.

5.2.3 There is the enactment of a state law requiring a certain type of mitigation for light pollution. Several states within the US have enacted legislation requiring the use of "full cut-off" or "fully-shielded" luminaires to be used on all new projects which use state funds. These laws generally control roadway and transportation projects which are typically constructed using public funds. Current states such as Maine, Connecticut, Texas, Arizona, Illinois and Colorado have this type of legislation. However, New York has been trying to enact a similar state law for approximately 8 years but the legislation is still not enacted to date. The New York legislation is opposed by the state agency that operates and maintains the roadway lighting system as well as some suppliers of lighting devices/equipment which would be banned by this legislation. The state agency contends that the use of full cutoff luminaires would cost them more money to install and maintain new lighting. If non-full cut-off luminaires need to be replaced by full cut-off luminaires, the lighting levels would be less than, or different from, the original design. Even though from a technical standpoint these issues could be overcome, the resistance of the agency to make the change and the political strength of this agency and manufacturers to fight this change, have stopped the legislation from being passed. This situation is also not uncommon. Several states including Massachusetts have had pending legislation which has not had enough political support to pass.

5.2.4 Mandatory building codes are another indirect method used in selected metropolises and economies of North America to assert requirements on light nuisance. The type of facility usually controlled by this type of regulation is private building and site owners, as well as residential properties..

5.2.5 Many building codes use power consumption and the associated control systems to regulate the quantity of light used by external lighting. In addition to that general requirement, "full cut-off" is required to further control light nuisance within portions of above ground, open-sided parking structures. California uses a building code developed by the California Energy Commission for controlling light pollution. New York has adopted its own Energy Conservation Construction Code of New York but also allows the use of ASHRAE 90.1 as part of it's building code. The Province of Ontario also uses its own energy code, not

adopting the Model National Energy Code of Canada for Buildings (MNECB) prepared by the Canadian Commission on Building and Fire Codes.

5.2.6 Enforcement of these codes is done as part of the building permit process and review of construction drawings and specifications before and during construction. The application for a building permit shall include the applicable Certificate of Compliance, supporting documentation, plans and specifications to demonstrate compliance with the requirement as stipulated in Building Energy Efficiency Standards in California. Without meeting the requirements of the applicable building code, a building permit will not be issued for construction or building occupancy permit will not be issued upon final completion.

5.2.7 The use of regulations and building codes are all viable options and can be enforced but enforcement of any law is limited by the resources made available. When used as regulations for new construction or changes at existing facilities, the authority having jurisdiction usually requires corrections when construction plans are submitted for building permit approval. After approval, enforcement is done by the authority responsible for inspecting and issuing a certificate of occupancy for the facility. Informal discussions with various government officials regarding the actual enforcement of these types of regulations varies considerably. Much enforcement depends on the size of the staff and available resources to effectively review plan submissions before construction. The inspection process is also limited by the resources available to perform them. To assist in this, local building inspectors have required and accepted documents from licensed professionals showing compliance with regulations relating to outdoor lighting. The regulations typically have to do with energy conservation or zoning. The documents might include calculations of the lighting power budget, equipment specifications, lighting fixture layouts, and drawings of control systems. Failure to submit such documents could result in denial of a building permit. Failure to build according to the construction contract documents could lead to denial of a certificate of occupancy. Many agencies also require the engineer to certify that the project was constructed in accordance with the plans and specifications. Another trend starting to appear in this process is the commissioning of facilities. In the commissioning process, a third party will confirm that the initial facility requirements have been met after final construction.

5.3 External Light Regulations in 2 selected metropolises and 2 selected economies of Europe

5.3.1 In the study, the 2 selected metropolises in Europe are London and Frankfurt while the 2 selected economies are England in UK and European Union.

5.3.2 There is no EC directive specific to light pollution, only directives (such as Energy using Products (EuP) directives to control the lighting product. Any lighting specific statuary requirements need to be implemented by the member country.

5.3.3 Historically EU member states have had there own standards for lighting (both exterior and interior), but there is now a drive for harmonisation aided by the EN standards.

5.3.4 The diversity of economics and population density across Europe is reflected in the levels of light pollution. The higher levels of light pollution in the UK compared to the Baltic states (Estonia, Latvia, Lithuania) are an example. The diversity of favoured lamp types and luminaire types across Europe – particular for road lighting. Italy's sole use of full cut off road lanterns compared to UK, Holland and Belgium and France who utilise the semi cut-off lantern or dropped canopy luminaire is a good example.

5.3.5 Regarding the existing national lighting pollution laws, some regions, provinces and states in various countries have mandatory controls on light pollution. Spain has a national law on light pollution but it only applies in Canary Islands. Czechia is the first country with a national law dealing with light pollution across the whole nation, which included provision for municipal lighting controls in its Protection of the Atmosphere Act of 25 March 2002.

5.3.6 London and Frankfurt have legislation on light nuisance. But the laws do not specify limiting values for the evaluation of light nuisance such as light trespass and glare. Supplementary guidelines or standards may be referred to by the enforcement authorities.

5.4 Summary tables of the review of overseas experience

5.4.1 According to review on the practices adopted in the 8 selected metropolises and 6 selected economies, a summary of the experiences is given in tables under the following headings for easy reference:

1. Summary of overseas experience for regulating external lighting by light nuisance and energy efficiency identified in the selected metropolises and economies (refer to Table 5.1)
2. Mandatory regulations on light nuisance identified in the selected metropolises and economies (refer to Table 5.2)
3. Mandatory regulations on energy efficiency identified in the selected metropolises and economies (refer to Table 5.3)
4. Reference/Voluntary guidelines/standards on light nuisance & energy efficiency identified in the selected metropolises and economies (refer to Table 5.4)
5. Parameters in reference standards for mandatory regulations on light nuisance identified in the selected metropolises and economies for new lighting installation (refer to Table 5.5)
6. Parameters in reference standards for mandatory regulations on light nuisance identified in the selected metropolises and economies for existing lighting installation (refer to Table 5.6)
7. Parameters in reference standards for mandatory regulations on energy efficiency identified in the selected metropolises and economies for new lighting installation only (not applicable to existing lighting installation) (refer to Table 5.7)
8. Summary of part of LPD limits (for Tradable Surfaces & non-Tradable Surfaces) from ASHRAE 90.1-2004 (refer to Table 5.7.1a & b)
9. Summary of part of LPD limits from Building Energy Efficiency Standards (CCR Tile 24, Part 6) (refer to Table 5.7.2a &b)
10. Summary of part of LPD limits from Ontario Building Code (Refer to Table 5.7.3)
11. Enforcement agent, penalty and approval in Mandatory Regulation for new external lightings (refer to Table 5.8)
12. Enforcement agent, penalty and approval in Mandatory Regulation for existing lightings (refer to Table 5.9)
13. Parameters in Voluntary guidelines / reference standards on light nuisance identified in the selected metropolises and economies (refer to Table 5.10)
14. Parameters in Voluntary guidelines / reference standards on energy efficiency identified in the selected metropolises and economies (refer to Table 5.11)

Table 5.1 - Summary of overseas experience for regulating external lighting by light nuisance and energy efficiency identified in the selected metropolises and economies

Metropolis/ Economy	Mandatory regulations			
	Light nuisance		**Energy efficiency**	
	Applicable to **EXISTING** external lighting installation	Applicable to **New** external lighting installation	Applicable to **EXISTING** external lighting installation	Applicable to **New** external lighting installation
Shanghai	**Yes**	**Yes**	Nil	Nil
Tokyo	Nil	Nil	Nil	Nil
Singapore (See Note 1)	Nil	Nil	Nil	Nil
Sydney	**No**	**Yes**	Nil	Nil
New York City	Nil	Nil	**No**	**Yes**
Los Angeles	Nil	Nil	**No**	**Yes**
London	**Yes**	**Yes**	Nil	Nil
Frankfurt	**Yes**	**Yes**	Nil	Nil
Yangtze River Delta	Nil	Nil	Nil	Nil
New South Wales	Nil	Nil	Nil	Nil
California	Nil	Nil	**No**	**Yes**
Ontario	Nil	Nil	**No**	**Yes**
England	**Yes**	**Yes**	Nil	Nil
European Union	See Note 2	See Note 2	See Note 2	See Note 2

Note:

1. For Singapore, the case relating to planning submission to Urban Redevelopment Authority (URA) or related authority in order to expedite the realization of the overall Night Lighting Master Plan for the Central Business District, Marina Centre and Marina Bay. The quote of URA is a policy statement and there is no mandatory regulation and voluntary guidelines for external lighting in Singapore.
2. For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia and Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of outdoor light sources.
3. For the details of Mandatory regulations on light nuisance and energy efficiency identified in the selected metropolises and economies, please refer to the table 5.2 to 5.9.

Table 5.2 - Mandatory regulations on light nuisance identified in the selected metropolises and economies

Metropolis/ Economy	Mandatory regulations on light nuisance	Reference standards for mandatory regulations	Applicable to Existing external lighting installation	Applicable to New external lighting installation
Shanghai	Clause 40 in Environmental Protection Regulations 《上海市环境保护条例》	Shanghai Municipal Standard 《城市环境（装饰）照明规范》 DB31/T316-2004	Yes	Yes
Tokyo	Nil	Nil	Nil	Nil
Singapore	Nil	Nil	Nil	Nil
Sydney	The City of Sydney Exterior Lighting Strategy under Environmental Planning & Assessment (Amendment) Act 1997	(i) AS4282:1997 (ii) AS/NZS1158.3.1:1999	No	Yes
New York City	Nil	Nil	Nil	Nil
Los Angeles	Nil	Nil	Nil	Nil
London	Clean Neighbours and Environment Act 2005 (See Note 1)	ILE Guidance Notes for Reduction of Obtrusive Light	Yes	Yes
Frankfurt	Federal Pollution Control Act – BImSchG Act on the Prevention of Harmful Effects on the Environment caused by Air Pollution, Noise, Vibration and Similar Phenomena	Measurement and assessment of light pollution from artificial light sources issued by the German Lighting Engineering Society (LiTG)	Yes	Yes
Yangtze River Delta	Nil	Nil	Nil	Nil
New South Wales	Nil	Nil	Nil	Nil
California	Nil	Nil	Nil	Nil
Ontario	Nil	Nil	Nil	Nil
England	Clean Neighbours and Environment Act 2005 (See Note 1)	ILE Guidance Notes for Reduction of Obtrusive Light	Yes	Yes
European Union	See Note 2	See Note 2	See Note 2	See Note 2

Note:

1. For London & England, the government in the England UK adopts mandatory regulatory approaches with legislation and planning guidelines with binding force to govern the use of new and existing outdoor lightings. Clean Neighbours and Environment Act 2005 is a law that allows the enforcement of light pollution being a statutory nuisance which is much wider ranging and open to interpretation. New buildings or major changes to existing buildings including changes to outdoor lighting fixtures require planning permission from the local planning authority as stated in PPG & PPS.
2. For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia and Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of new and existing outdoor light sources.

Table 5.3 - Mandatory regulations on energy efficiency identified in the selected metropolises and economies

Metropolis/ Economy	Mandatory regulations on energy efficiency	Applicable to Existing external lighting installation	Applicable to New external lighting installation
Shanghai	Nil	Nil	Nil
Tokyo	Nil	Nil	Nil
Singapore	Nil	Nil	Nil
Sydney	Nil	Nil	Nil
New York City	(i) New York State 2007 Energy Conservation Construction Code (main code) (ii) ASHRAE 90.1-2004 (alternative code)	No	Yes
Los Angeles	(i) 2005 Building Energy Efficiency Standards (See Note 1) (ii) California Energy Commission Title 24	No	Yes
London	Nil	Nil	Nil
Frankfurt	Nil	Nil	Nil
Yangtze River Delta	Nil	Nil	Nil
New South Wales	Nil	Nil	Nil
California	(i) 2005 Building Energy Efficiency Standards (See Note 1) (ii) California Energy Commission Title 24	No	Yes
Ontario	Ontario Building Code	No	Yes
England	Nil	Nil	Nil
European Union	Nil	Nil	Nil

Note:
1. The 2008 Standards will be effective from 1 January 2010, replacing the 2005 Building Energy Efficiency Standards.

Table 5.4- Reference/Voluntary guidelines / standards identified in the selected metropolises and economies

Metropolis/ Economy	Reference standards for mandatory regulations	Non-mandatory or Voluntary measures through guidelines /standard on light nuisance	Non-mandatory or Voluntary measures through guidelines /standard on energy efficiency
Shanghai	Shanghai Municipal Standard 《城市环境（装饰）照明规范》DB31/T316-2004	Nil	Nil
Tokyo	Nil	Light Pollution Control Guidelines 2006	Light Pollution Control Guidelines 2006
Singapore	Nil	Nil	Nil
Sydney	(i) AS4282:1997 (ii) AS/NZS1158.3.1:1999	Nil	Nil
New York City	Nil	(i) IESNA RP-33-99 (ii) IESNA TM-11-00	Nil
Los Angeles	Nil	(i) IESNA RP-33-99 (ii) IESNA TM-11-00	Nil
London	ILE Guidance Notes for Reduction of Obtrusive Light	Nil	Nil
Frankfurt	Measurement and assessment of light pollution from artificial light sources issued by the German Lighting Engineering Society (LiTG)	Nil	Nil
Yangtze River Delta	Nil	(i) Shanghai Standard DB31/T316-2004 (ii) JGJ/T 163-2008 《城市夜景照明设计规范》 (Code for lighting design of urban nightscape)	JGJ/T 163-2008 《城市夜景照明设计规范》 (Code for lighting design of urban nightscape)
New South Wales	Nil	(i) AS4282:1997 (ii) AS/NZS1158.3.1:1999	Nil
California	Nil	(i) IESNA RP-33-99 (ii) IESNA TM-11-00	Nil
Ontario	Nil	(i) IESNA RP-33-99 (ii) IESNA TM-11-00	Nil
England	ILE Guidance Notes for Reduction of Obtrusive Light	Nil	Nil
European Union	See Note 2	EC Directive 92/43/EEC, The Conservation of Natural Habitats	Energy using Products (EuP) Directive 2005/32/EC

Note:

1. For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia, Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of new and existing outdoor light sources.

Table 5.5 – Parameters in Reference standards for Mandatory regulations on light nuisance identified in the selected metropolises and economies For new lighting installation only

Metropolis/ Economy	Mandatory regulations	Zoning	Curfew	Light trespass on residents	Glare on residents	Glare on road users	Luminaire classification based on intensity distribution	Sky glow (See Note 1)
Shanghai	Yes [44]	2 zones for assessing impacts on residential premises	23:00 for all zones	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance	$L \cdot A^{0.5}$ used to assess glare effects on pedestrians and cyclists	Nil	Upward light ratio (ULR)
Tokyo	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Singapore	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Sydney	Yes	3 zones for assessing impacts on residents and road users in residential areas	23:00 for all zones	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance	Threshold increment	Classification based on intensity distribution for glare control and UWLR	Upward waste light ratio (UWLR)
New York City	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Los Angeles	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
London	Yes	ILE Guidance Notes recommend the use of 4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	23:00 for all zones (as recommended by CIE)	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance (iv) Restriction on tilt of luminaires not greater that 5 deg above horizontal	Threshold increment	Nil	Upward light ratio (ULR)

[44] In Shanghai, the Environmental Protection Regulation (《上海市环境保护条例》) in the clause concerning outdoor lighting refers to Shanghai Municipal Standard **《城市环境（装饰）照明规范》**DB31/T316-2004 where parameters are used to persuade the offender to reduce the relevant light nuisance.

Table 5.5 – Parameters in Reference standards for Mandatory regulations on light nuisance identified in the selected metropolises and economies For new lighting installation only

Metropolis/ Economy	Mandatory regulations	Zoning	Curfew	Light trespass on residents	Glare on residents	Glare on road users	Luminaire classification based on intensity distribution	Sky glow (See Note 1)
Frankfurt	Yes	4 zones for controlling light trespass	22:00 for all zones	Illuminance in the window level of dwellings and/or, with balconies or terraces, the delimitation surfaces of dwellings	Luminous intensity of glare source in the direction of dwellings. Also use of photographic technique to establish luminance ratios and visible size of offending source in a field of view.	Nil	Nil	Nil
Yangtze River Delta	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
New South Wales	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
California	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Ontario	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
England	Yes	ILE Guidance Notes recommend the use of 4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	23:00 for all zones (as recommended by CIE)	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance (iv) Restriction on tilt of luminaires not greater that 5 deg above horizontal	Threshold increment	Nil	Upward light ratio (ULR)
European Union	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2

Notes to Table 5.5:

1 Sky glow is also parameter in reference standards for Mandatory regulations on light pollution identified in the selected metropolises and economies.

2 For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia, Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of outdoor light sources

Table 5.6 – Parameters in Reference standards for Mandatory regulations on light nuisance identified in the selected metropolises and economies For existing lighting installation

Metropolis/ Economy	Mandatory regulations	Zoning	Curfew	Light trespass on residents	Glare on residents	Glare on road users	Luminaire classification based on intensity distribution	Sky glow (See Note 1)
Shanghai	Yes[45]	2 zones for assessing impacts on residential premises	23:00 for all zones	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance	$L \cdot A^{0.5}$ used to assess glare effects on pedestrians and cyclists	Nil	Upward light ratio (ULR)
Tokyo	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Singapore	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Sydney	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
New York City	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Los Angeles	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
London	Yes	ILE Guidance Notes recommend the use of 4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	23:00 for all zones (as recommended by CIE)	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance (iv) Restriction on tilt of luminaires not greater that 5 deg above horizontal	Threshold increment	Nil	Upward light ratio (ULR)
Frankfurt	Yes	4 zones for controlling light trespass	22:00 for all zones	Illuminance in the window level of dwellings and/or, with balconies or terraces, the delimitation surfaces of dwellings	Luminous intensity of glare source in the direction of dwellings. Also use of photographic technique to establish luminance ratios and visible size of offending source in a field of view.	Nil	Nil	Nil

[45] In Shanghai, the Environmental Protection Regulation (《上海市环境保护条例》) in the clause concerning outdoor lighting refers to Shanghai Municipal Standard 《城市环境（装饰）照明规范》DB31/T316-2004 where parameters are used to persuade the offender to reduce the relevant light nuisance.

Table 5.6 – Parameters in Reference standards for Mandatory regulations on light nuisance identified in the selected metropolises and economies For existing lighting installation

Metropolis/ Economy	Mandatory regulations	Zoning	Curfew	Light trespass on residents	Glare on residents	Glare on road users	Luminaire classification based on intensity distribution	Sky glow (See Note 1)
Yangtze River Delta	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
New South Wales	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
California	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Ontario	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
England	Yes	ILE Guidance Notes recommend the use of 4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	23:00 for all zones (as recommended by CIE)	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance (iv) Restriction on tilt of luminaires not greater that 5 deg above horizontal	Threshold increment	Nil	Upward light ratio (ULR)
European Union	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2

Note to Table 5.6:

1 Sky glow is also parameter in reference standards for Mandatory regulations on light pollution identified in the selected metropolises and economies.

2 For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia and Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of outdoor light sources.

Table 5.7 – Parameters in Reference standards for Mandatory regulations on energy efficiency identified in the selected metropolises and economies
For new lighting installation only (Not applicable to existing lighting installation)

Metropolis/ Economy	Mandatory regulation	Zoning	Cut-off / shielding requirements of outdoor luminaires	Wattage / LPD limits	Automatic switching off requirements
Shanghai	No	Nil	Nil	Nil	Nil
Tokyo	No	Nil	Nil	Nil	Nil
Singapore	No	Nil	Nil	Nil	Nil
Sydney	No	Nil	Nil	Nil	Nil
New York City	Yes	Zoning resolution to controlling sizes and locations of illuminated signs	Nil	LPD limits for lighting (e.g. Building Facades, canopies, building entrance, etc) specified in ASHRAE 90.1-2004 (See note 1)	ASHRAE 90.1-2004 requires that all exterior lighting to have automatic controls capable of turning off exterior lighting
Los Angeles	Yes	4 zones for specifying lighting power limits	Cut-off requirements	LPD limits for lighting (e.g. Building Facades, non-sale canopies, etc) specified in Building Energy Efficiency Standards (CCR Title 24, Part 6) (See note 2)	Automatic timer and/or photosensor lighting control requirement for permanently installed outdoor lighting specified in Building Energy Efficiency Standards (CCR Title 24, Part 6)
London	No	Nil	Nil	Nil	Nil
Frankfurt	No	Nil	Nil	Nil	Nil
Yangtze River Delta	No	Nil	Nil	Nil	Nil
New South Wales	No	Nil	Nil	Nil	Nil
California	Yes	4 zones for specifying lighting power limits	Cut-off requirements	LPD limits for lighting (e.g. Building Facades, non-sale canopies, etc) specified in Building Energy Efficiency Standards (CCR Title 24, Part 6) (See note 2)	Automatic timer and/or photosensor lighting control requirement for permanently installed outdoor lighting specified in Building Energy Efficiency Standards (CCR Title 24, Part 6)
Ontario	Yes	Nil	Nil	LPD limits for lighting (e.g. Building facades, canopies, etc) specified in Ontario Building Code (See note 3)	Nil
England	No	Nil	Nil	Nil	Nil
European Union	No	Nil	Nil	Nil	Nil

Note for Table 5.7:

1) *The allowable sizes and locations of illuminated signs are described with dimensions in feet. Energy conservation limits for lighting are set by assigning power densities to establish a budget in total watts for a particular portion of a site, as follows from* ASHRAE 90.1-2004

Table 5.7.1a – Summary of part of LPD limits (for Tradable Surfaces) from ASHRAE 90.1-2004

Tradable Surfaces a)	*Description*	*Power densities*
(Lighting power densities for building grounds, building entrances & exits, canopies & overhangs may be traded.)	***Building Grounds***	
	Walkways less than 10 feet wide	*1.0 W/linear foot*
	Walkways 10 feet wide or greater *Plaza areas* *Special feature areas*	*0.2 W/sft*
	Building Entrances and Exits	
	Main entries	*30 W/linear foot of door width*
	Other doors	*20 W/linear foot of door width*
	Canopies and Overhangs	
	Canopies (free standing, attached & overhangs)	*1.25 W/sft*

a) For surfaces defined as "tradable", lighting power density not applied in the power budget to one surface may be applied to another.

Table 5.7.1b – Summary of part of LPD limits (for non-Tradable Surfaces) from ASHRAE 90.1-2004

Non-Tradable Surfaces	*Description*	*Power densities*
(Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	***Building Facades***	*0.2 W/sft for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length*
	Entrances & gatehouse inspection stations at guarded facilities	*1.25 W/sft of uncovered area (covered areas are included in the "Canopies & Overhangs" section of "Tradable Surfaces")*
	Loading areas for law enforcement, fire, ambulance & other emergency service vehicles	*0.5 W/sft of uncovered area (covered areas are included in the "Canopies & Overhangs" section of "Tradable Surfaces")*

2) Table 5.7.2a – Summary of part of LPD limits from Building Energy Efficiency Standards (CCR Tile 24, Part 6)

*TABLE 147-A **LIGHTING POWER ALLOWANCES** FOR GENERAL SITE ILLUMINATION (W/FT² UNLESS OTHERWISE NOTED) extracted from 2005 Building Energy Efficiency Standards (California Code of Regulations Tile 24, Part 6).*

Lighting Application	*Allowed Area*	*Lighting Zone 1*	*Lighting Zone 2*	*Lighting Zone 3*	*Lighting Zone 4*
Building Entrances (without canopy)	*Width of doors plus 3 ft on either side times a distance of 18 feet outward.*	*0.35*	*0.50*	*.70*	*1.00*

Table 5.7.2b – Summary of part of LPD limits from Building Energy Efficiency Standards (CCR Tile 24, Part 6)

TABLE 147-B LIGHTING POWER ALLOWANCES FOR SPECIFIC APPLICATIONS (W/FT² UNLESS OTHERWISE NOTED) extracted from 2005 Building Energy Efficiency Standards (California Code of Regulations Tile 24, Part 6).

Lighting Application	*Lighting Zone 1*	*Lighting Zone 2*	*Lighting Zone 3*	*Lighting Zone 4*
Building Facades	*Not allowed*	*0.18*	*0.35*	*0.50*
Ornamental Lighting	*Not allowed*	*0.01*	*0.02*	*0.04*

3) Table 5.7.3 – Summary of part of LPD limits from Ontario Building Code

	Exterior Area	*Lighting Power Density*
1	*Walkways less than 3m wide*	*3.3 W/linear m*
2	*Walkways 3m or greater, plaza areas, special feature areas*	*2.2 W/sm*
3	*Building main entries*	*98 W/linear m of door width*
4	*Other doors*	*66 W/linear m of door width*
5	*Canopies (free standing, attached & overhangs)*	*13.5 W/sm*
6	*Building facades*	*2.2 W/sm for each illuminated wall or surface or 16.4 W/linear m for each illuminated wall or surface length*
7	*Loading areas for law enforcement & emergency service vehicles*	*5.4 W/sm of uncovered area*

Table 5.8 – Enforcement agent, penalty and approval in Mandatory Regulation for new external lightings

Continent / Region	Item	8 Metropolises / 6 Economies	Enforcement Agent	Penalty	Approval
Asia Pacific	1	Shanghai	City Appearance and Environmental Sanitation Departments (市容环卫部门)	Nil	Nil
	2	Tokyo	Nil	Nil	Nil
	3	Singapore	Nil	Nil	Nil
	4	Sydney	The City of Sydney Council	Refuse to grant approval	a. All decorative lighting proposals are to be submitted as Development Applications to the Director of Development for development and construction certificate approval under the Central Sydney LEP 1996; Central Sydney DCP 1996; State Regional Environmental Plan No. 26; Sydney REP No. 26 – City West, and the Environmental Planning & Assessment (Amendment) Act 1997. b. The consent authority may require pilot testing prior to the issuance of development consent.
North America	5	New York City	Department of Buildings	Design professionals and contractors can be fined or denied certain privileges of licensing, or both, by the Department of Buildings.	Department of Buildings reviews construction on individual building sites according to the Energy Conservation Construction Code of New York State or the standard ASHRAE 90.1-2004.
	6	Los Angeles	Department of Building and Safety	Same as those of State of California; the LA Department of Building and Safety can levy fines and revoke a Certificate of Occupancy for a code violation.	The Department of Building and Safety reviews construction on individual building sites according the California Building Code and the California Energy Code.
Europe	7	London	Local authority environmental heath departments	Same as those of England	Same as those of England. The legislation is national. (i.e. England but each of the Borough Councils/Authorities within London are responsible for local interpretation and implementation within their jurisdiction.)
	8	Frankfurt	Local City Pollution Control Committee (City Council)	Nil	Approval sought for avoiding "the possibility of light emissions" at the design stage. Local city council in line with the national guidelines
Asia Pacific	9	Yangtze River Delta, PRC	Nil	Nil	Nil
	10	State of New South Wales, Australia	Nil	Nil	Nil

Table 5.8 – Enforcement agent, penalty and approval in Mandatory Regulation for new external lightings

Continent / Region	Item	8 Metropolises / 6 Economies	Enforcement Agent	Penalty	Approval
North America	11	State of California, USA	Local City Building Department	The Building Department has options including stopping work orders for contractors of builders that are not in compliance with the building codes. If a contractor continues to be in non-compliance, the violation can be taken to the Contractors State License Board, and the contractor's licence can be in jeopardy through fines, fees or restrictions.	For all newly constructed buildings or alterations to existing buildings including changes to outdoor lighting fixtures, building permit applications with building plans and energy compliance documentation should be submitted to the local Building Department for approval.
	12	Province of Ontario, Canada	The building code is enforced at the local level by building inspectors, such as the staff of Toronto Buildings.	The local building department can deny a building permit after plan review, stop work during construction, or require removal of work not in compliance.	For all newly constructed buildings or alterations to existing buildings including changes to outdoor lighting fixtures, building permit applications with building plans and energy compliance documentation should be submitted to the local Building Department for approval.
Europe	13	England, UK, European Union	Local Environmental Health Department Local District or Borough Council	1. Offender of statutory nuisance is subject to imprisonment for a term not exceeding 12 months; or a fine not exceeding 50,000(HK$588,450) 2. A planning breach in itself is not illegal and the Local District or Borough Council may permit a retrospective application. However, if the breach involves a previously rejected development or the retrospective application fails, the Local District or Borough Council may issue an enforcement notice. It is illegal to disobey an enforcement notice. If the Local District or Borough Council decides to take the offender to court, the offender may have to pay a fine.	New buildings or major changes to existing buildings including changes to out door lighting fixtures require planning permission from the local planning authority.
	14	European Union (see Note 1)	See Note 1	See Note 1	Approval sought for avoiding "the possibility of light emissions" at the design stage.

Note for Table 5.8:

1. For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia, Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of outdoor light sources.

Table 5.9 – Enforcement agent, penalty and approval in Mandatory Regulation for existing lightings

Continent / Region	Item	8 Metropolises / 6 Economies	Enforcement Agent	Penalty	Approval
Asia Pacific	1	Shanghai	City Appearance and Environmental Sanitation Departments (市容环卫部门)	Nil	Nil
	2	Tokyo	Nil	Nil	Nil
	3	Singapore	Nil	Nil	Nil
	4	Sydney	Nil	Nil	Nil
North America	5	New York City	Nil	Nil	Nil
	6	Los Angeles	Nil	Nil	Nil
Europe	7	London	Local authority environmental heath departments	Same as those of England	Same as those of England. The legislation is national. (i.e. England but each of the Borough Councils/Authorities within London are responsible for local interpretation and implementation within their jurisdiction.)
	8	Frankfurt	Local City Pollution Control Committee (City Council)	Nil	Approval sought for avoiding "the possibility of light emissions" at the design stage. Local city council in line with the national guidelines
Asia Pacific	9	Yangtze River Delta, PRC	Nil	Nil	Nil
	10	State of New South Wales, Australia	Nil	Nil	Nil
North America	11	State of California, USA	Nil	Nil	Nil
	12	Province of Ontario, Canada	Nil	Nil	Nil
Europe	13	England, UK, European Union	Local Environmental Health Department Local District or Borough Council	1. Offender of statutory nuisance is subject to imprisonment for a term not exceeding 12 months; or a fine not exceeding 50,000(HK$588,450) 2. A planning breach in itself is not illegal and the Local District or Borough Council may permit a retrospective application. However, if the breach involves a previously rejected development or the retrospective application fails, the Local District or Borough Council may issue an enforcement notice. It is illegal to disobey an enforcement notice. If the Local District or Borough Council decides to take the offender to court, the offender may have to pay a fine.	New buildings or major changes to existing buildings including changes to out door lighting fixtures require planning permission from the local planning authority.
	14	European Union (see Note 1)	See Note 1	See Note 1	Approval sought for avoiding "the possibility of light emissions" at the design stage.

Note: 1. For EU, there are some areas such as Canary Islands in Spain, Czechia, Lombardy region in Italy, UK, Germany, Slovenia and Croatia having national lighting pollution laws to control on obtrusive light emission and energy consumption of outdoor light sources.

Table 5.10 – Parameters in Voluntary guidelines / reference standards on light nuisance identified in the selected metropolises and economies

Metropolis/ Economy	Voluntary guidelines / standards	Zoning	Curfew	Light trespass on residents	Glare on residents	Glare on road users	Sky glow (See Note 1)	Luminaire classification based on intensity distribution
Shanghai	Yes[46]	2 zones for assessing impacts on residential premises	23:00 for all zones	Vertical illuminance on windows/façade of residential premises	(iv) Intensity of bright luminaires in the direction of residents (v) Average building façade luminance Average sign luminance	$L \cdot A^{0.5}$ used to assess glare effects on pedestrians and cyclists	Upward light ratio (ULR)	Nil
Tokyo	Yes	4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	23:00 for all zones (as recommended by CIE)	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance	Threshold increment	Upward light ratio (ULR)	Nil
Singapore	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Sydney	Yes	3 zones for assessing impacts on residents and road users in residential areas	23:00 for all zones	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance	Threshold increment	Nil	Classification based on intensity distribution for glare control and UWLR
New York City	Yes	Nil	Nil	Illuminance on a plane perpendicular to the line of sight to the luminaire	Illuminance on a plane perpendicular to the line of sight to the luminaire	Nil	Upward light ratio (ULR)	Nil
Los Angeles	Yes	Nil	Nil	Illuminance on a plane perpendicular to the line of sight to the luminaire	Illuminance on a plane perpendicular to the line of sight to the luminaire	Nil	Upward light ratio (ULR)	IESNA TM-15-07 defines a new luminaire classification system for BUG rating
London	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Frankfurt	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil

[46] In Shanghai, the Environmental Protection Regulation (《上海市环境保护条例》) in the clause concerning outdoor lighting refers to Shanghai Municipal Standard 《城市环境（装饰）照明规范》DB31/T316-2004 where parameters are used to persuade the offender to reduce the relevant light nuisance.

Table 5.10 – Parameters in Voluntary guidelines / reference standards on light nuisance identified in the selected metropolises and economies

Metropolis/ Economy	Voluntary guidelines / standards	Zoning	Curfew	Light trespass on residents	Glare on residents	Glare on road users	Sky glow (See Note 1)	Luminaire classification based on intensity distribution
Yangtze River Delta	Yes	Nil	Nil	Nil	Nil	Nil	Nil	Nil
New South Wales	Yes	3 zones for assessing impacts on residents and road users in residential areas	23:00 for all zones	Vertical illuminance on windows/façade of residential premises	(i) Intensity of bright luminaires in the direction of residents (ii) Average building façade luminance (iii) Average sign luminance	Threshold increment	Upward waste light ratio (UWLR)	Classification based on intensity distribution for glare control and UWLR
California	Yes	Nil	Nil	Illuminance on a plane perpendicular to the line of sight to the luminaire	Illuminance on a plane perpendicular to the line of sight to the luminaire	Nil	Upward light ratio (ULR)	IESNA TM-15-07 defines a new luminaire classification system for BUG rating
Ontario	Yes	Nil	Nil	Illuminance on a plane perpendicular to the line of sight to the luminaire	Illuminance on a plane perpendicular to the line of sight to the luminaire	Nil	Upward light ratio (ULR)	IESNA TM-15-07 defines a new luminaire classification system for BUG rating
England	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil
European Union	No	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Note:
1. Sky glow is also parameter in reference standards for Mandatory regulations on light pollution identified in the selected metropolises and economies.

Table 5.11 – Parameters in Voluntary guidelines / reference standards on energy efficiency identified in the selected metropolises and economies

Metropolis/ Economy	Voluntary guidelines / standards	Zoning	Cut-off / shielding requirements of outdoor luminaires	Wattage / LPD limits	Automatic switching off requirements
Shanghai	No	Nil	Nil	Nil	Nil
Tokyo	Yes	4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	Nil	Nil	Nil
Singapore	No	Nil	Nil	Nil	Nil
Sydney	No	Nil	Nil	Nil	Nil
New York City	Yes	Nil	Nil	Nil	Nil
Los Angeles	Yes	Nil	Nil	Nil	Nil
London	Yes	ILE Guidance Notes recommend the use of 4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	Nil	Nil	Nil
Frankfurt	No	Nil	Nil	Nil	Nil
Yangtze River Delta	Yes	Nil	Nil	Nil	Nil
New South Wales	No	Nil	Nil	Nil	Nil
California	Yes	Nil	Nil	Nil	Nil
Ontario	Yes	Nil	Nil	Nil	Nil
England	Yes	ILE Guidance Notes recommend the use of 4 zones for assessing impacts on residents, road users and astronomical observers (CIE-150:2003)	Nil	Nil	Nil
European Union	No	Nil	Nil	Nil	Nil

6 DISCUSSIONS ON THE RECOMMENDED APPROACHES FOR ADDRESSING EXTERNAL LIGHTING PROBLEMS AND IMPACTS IN HONG KONG

6.1 Introduction

6.1.1 In this chapter, the findings and results in earlier chapters are further evaluated with the aim to providing grounds for the recommended approaches to deal with issues on external lighting in Hong Kong. The subsequent sections will address the key issues of:

(i) the current situation of external lighting in Hong Kong;

(ii) the approaches available.

6.2 Review of current situation of external lighting in Hong Kong

6.2.1 In Hong Kong, there is currently no regulation or guideline concerning light nuisance and energy wastage caused by external lighting installations. Complaints against external lighting installations such as advertising signs are dealt with by relevant Government department(s) including the Buildings Department, the Fire Services Department, the Marine Department, the Hong Kong Police Force, the Civil Aviation Department, and the Food and Environmental Hygiene Department, depending on the nature of the complaints.

6.2.2 Complaints could be addressed to Government departments, "local elected officials" (such as District Council or Legislative Council members) or publicized in the news media. Government departments, District Council or Legislative Council members can try to solve the problem of glare or excessive brightness of signs through persuasion or public pressure. In some cases, companies, having strong awareness of their social responsibility and intention to keep their good relationship with the community, are willing to take improvement measures to reduce glare or excessive brightness problems.

6.3 Discussions on pros and cons of various approaches in selected places

6.3.1 Legislative control on light nuisance

6.3.1.1 In the 8 Metropolises and 6 Economies, Sydney, Shanghai, England and Germany have mandatory regulations on light nuisance. The exterior lighting strategy under the Environment Planning & Assessment (Amendment) Act 1997 covers the city of Sydney, the legislation in England covers London and the legislation in Germany covers Frankfurt. These legislations and the strategy do not prescribe limiting values on light trespass or glare level to specify what situation shall constitute statutory light nuisance. Supplementary guidelines may be referred to by the enforcing authorities. In October 2005, Shanghai added a clause in the Shanghai Environmental Protection Regulation for the control of nuisance from outdoor lighting. The clause empowers City Appearance and Environmental Department to order improvement works to external lighting installations which fail to comply with the local technical standard for external lighting.

6.3.1.2 The pros and cons of using a legislative approach to control light nuisance are:

Pros:

- Legal sanction could help deter owners and users of lighting installations from creating light nuisance.
- Authorities have legal power to investigate into light nuisance cases, order for improvements, and make prosecution where appropriate.

Cons:

- It is usually difficult to prescribe concrete objective parameters for the authorities to determine what situation constitutes a light nuisance. The light nuisance may also be attributed to multiple light sources..

6.3.2 Legislative control on lighting energy

6.3.2.1 The States of New York and California have mandatory Building Energy Codes for regulating outdoor lighting. The New York State Energy Conservation Construction Code is applicable to New York City and the California Energy Commission Title 24 Code is applicable to Los Angeles. The province of Ontario in Canada has a Building Code with regulations on the energy consumption by external lighting associated with buildings. Apart from these metropolises/economies in North America, there is no legislative control on energy consumption of external lighting in the other studied metropolises/economies including Shanghai, Tokyo, Singapore, Sydney, London, Frankfurt, Yangtze River Delta in PRC, State of New South Wales (NSW) in Australia, England in UK and European Union.

6.3.2.2 The pros and cons of legislative control on lighting energy are:

Pros:

- Objective criteria can be set to ensure that the design of new external lighting complies with energy consumption limits.

Cons:

- The requirements may increase the installation costs of external lighting.
- Controlling lighting energy will not address light nuisance problems as energy efficient lighting that is poorly designed may still cause light nuisance.

6.3.3 Voluntary guideline to address light nuisance

6.3.3.1 From table 5.4, seven (7) (i.e. all selected metropolises except Singapore) of the eight (8) metropolises studied and four (4) (i.e. New South Wales, California, Ontario and England) of the 6 economies studied have some form of voluntary guidelines on the assessment of light nuisance. These guidelines are in the form of national standards, local standards, or institutional guidelines. The guidelines are implemented through education and promotion activities to enhance awareness of interested stakeholders and the public on possible light nuisance of new and existing installations.

6.3.3.2 The pros and cons of using voluntary guidelines to address light nuisance problems are:

Pros:

- Defines parameters for addressing light nuisance and gives reference limiting values to balance the conflicting requirements of human activity needs and impacts of light nuisance.
- Gives a reference for outdoor lighting design for reducing the impacts on residents, road users and astronomical observers.

Cons:

- Some of the recommendations are unclear and subject to interpretation. For example, the lighting zoning classification system gives only vague descriptions and the classifications may be difficult to be set for districts with mixed land use and different stakeholders' interests.
- Some of the recommended parameters are not measurable on site (e.g. luminous intensity of bright luminaires, upward light ratio, threshold increment, etc.). Vertical illuminance on windows can be measured but the effect is a total effect from all surrounding light sources.
- Effectiveness of the guidelines may be questionable and depends on the voluntary compliance of the lighting designers, owners and users.

6.4 Options for Hong Kong

6.4.1 Non-mandatory/Voluntary Approach – Guidelines

6.4.1.1 Guidelines on reduction of light nuisance and energy consumption of external lighting installations could be issued for compliance on a voluntary basis. Whether these guidelines will be followed depends on the financial implications of the recommendations and the user awareness of environmental and social responsibilities.

6.4.1.2 This approach (i.e. the issuance of guidelines, code of practice and practice notes to professionals involved in building design, operation and maintenance) has the advantage that it can be implemented very quickly, but may not be effective. The guidelines will give clear guides to building designers and owners on what are the recommended practices. Designer will take into account the guidelines in the design for new buildings and alteration and addition works for existing buildings. The stakeholders are encouraged to follow the proposed guidelines through education and publicity, or persuasion when the recommendations in the guidelines are not followed. Education and publicity campaigns are effective measures as some past examples show that reputable companies/ organizations would respond to complaints against light nuisance or energy wastage of their external lighting installations and carried out various mitigation measures.

6.4.1.3 The main disadvantage of this approach is that the government has no authority to control the use of external lighting in private premises and to rectify undesirable existing external lightings. For some private property owners and building managers, bad publicity due to any adverse effect of artificial light, including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste in their buildings could reduce the building's market value, more so if there are litigations against the lighting nuisance.

6.4.2 Expansion of the Related Existing Regulation - To make legislative amendments specifically on advertising sign and external luminaries control to existing regulations

6.4.2.1 Regulatory controls through either provisions of the existing regulations or a new regulation on light nuisance would give the authority statutory power. However, there are potential constraints since the desired changes intended to bring about external lighting controls can only be implemented if they are within the scope of the existing regulations. A more in-depth study of the relevant regulations is required to see if it is within the ambit of the law to increase the statutory power of the designated authority.

6.4.2.2 This approach may be powerful in enforcement but requires efforts in coordination with the current relevant authorities in the future.

6.4.3 Mandatory Approach – New Legislation

6.4.3.1 It is possible that a new ordinance on light pollution be drafted. The regulation may make reference to standards to define parameters for controlling external lighting installation as well as external lighting design, operation and maintenance requirements. The penalties for non-compliance also need to be specified. The implementation can be by phases. Relevant government departments can set up a team responsible for updating the standards, vetting applications for new lighting installations and enforcing the standards. The drawback for such an approach is the long lead time required to come up with the legislation, and the associated problem of manpower and resources to administer the legislation to ensure compliance. The requirements in the legislation need to strike a good balance and take account of the possible benefits and adverse impacts from external lighting.

6.4.4 The recommended approach for adoption in Hong Kong

6.4.4.1 Since mandatory outdoor lighting regulations are still not widely adopted in the selected metropolises (only Shanghai, Sydney, London and Frankfurt) and economies (only UK), moreover, by visual observation of the situation of external lightings in Hong Kong, the extent of light nuisance and energy wastage are generally considered to be not that significant except for some isolated spots, such as areas in some districts with high ambient light level and with high density of external lighting installations including advertising signs and with high night time brightness for residents and visitors to enjoy night time shopping and recreation, it is not recommended to adopt right away in Hong Kong mandatory control over light nuisance and energy consumption caused by outdoor lighting. More reasons are as follows:-

1. For the few metropolises/economies with existing mandatory legislative control over external lighting, little enforcement experience has been gained since the legislative control was implemented only in recent years.
2. The authorities in these regimes may make reference to parameters on lighting levels recommended by independent professional institutions to assess whether there are possibly light nuisances when determining the enforcement actions to be taken. However, some of these recommended parameters for nuisance assessment (e.g. Luminous intensity of bright luminaires, Upper light ratio, Threshold increment, etc.) are not directly measurable on site. Some of the recommended parameters (e.g. Vertical illuminance on windows) can be measured but the measurement obtained is the total effect from all surrounding light sources. There is a possible situation that each individual light source can meet the requirement in respect of vertical illuminance on windows but the total effect from all surrounding light sources will fail to comply with the requirement. It is sometimes difficult in enforcing the requirements to control light nuisance.
3. External lighting serves different business and operational needs. The diverse interests of the various stakeholders should be balanced carefully should legislative control be considered.

6.4.4.2 It is recommended that as the first stage to deal with the problems due to external lighting, a set of guidelines with a view to limiting the impacts of outdoor lighting on the general public (the guidelines) could be developed and voluntary compliance solicited through publicity and education. The following 2-stage approach is recommended.

1. Development of a set of guidelines for control over external lighting in respect of light nuisance and energy efficiency;
2. Review of the external lighting guidelines and consideration of implementing of mandatory control of outdoor lighting

6.4.5 Development of a set of guidelines for control of outdoor lighting with respect to light nuisance and energy efficiency

6.4.5.1 The government should consider issuing external lighting guidelines for voluntary adoption by stakeholders. The external lighting guidelines could contain parameters with a view to limiting the adverse effects of external lighting on residents, road users and astronomical observers and limiting the energy consumption of external lighting. The guidelines could consider suggesting a zoning system for the control of external lighting and recommending the curfew hour as well as a set of limiting values on light trespass, glare and sky glow for each lighting zone. The lighting zone system, curfew hours and limiting values on light nuisance are suggested in section 7.2 to 7.6. Recommendations concerning lighting energy efficiency are given in section 7.8.

6.4.5.2 With the set of curfew hours and limiting values, if the lighting installation subject to complaint is found to exceed the recommended limits and the owner(s) of the lighting installation can be identified by pressure groups or Environmental Protection Department (EPD) of HKSAR, recommendations can be given to the owner(s) to improve the lighting installations by EPD. The Government should also publicize the requirements through education and publicity campaigns. Education and publicity campaigns are effective measures as some past examples show that reputable companies/organizations would respond to complaints against light nuisance and energy wastage caused by their external lighting installations through the implementation of various mitigation measures. For new lighting installations, designers or contractors can also make reference to the recommended limits when designing or installing their lighting devices.

6.4.6 Review of the outdoor lighting guidelines and consideration of implementing of mandatory control of outdoor lighting

6.4.6.1 A review should be conducted after the voluntary external lighting guidelines have been implemented for 3 years. The review should cover the experience in implementing the voluntary external lighting guidelines and the effectiveness of the guidelines in reducing the adverse impacts of external lighting installations. Overseas experience concerning outdoor lighting control should also be reviewed again to keep our reference materials up-to-date. The government can consider conducting public consultations to collect opinion of the general public and stakeholders on the need for mandatory control on external lighting. With all this information, the government can consider whether to further adopt legislative

control on external lighting by analyzing the pros and cons of and the acceptance of the stakeholders and the general public on legislative control.

6.4.6.2 The following approach may be considered for implementing the control on external lighting installations if the mandatory control of external lighting installation is considered appropriate and effective:

(i) The external lighting guidelines are to be reviewed and revised if necessary based on the implementation experience gained in the 3 years of implementation and the opinion of stakeholders and the public.

(ii) For existing lighting installations, investigations into possible non-compliance with the legal requirements are to be initiated by complaints and should be conducted by relevant Government department(s) (such as Environmental Protection Department (EPD) taking a coordinating role to consolidate the findings of other government departments). If non-compliance is found, the owner of the lighting installation should be given a reasonable period to rectify the problem. If the owner fails to rectify the problem after the given period, the lighting installation should be banned from being used.

(iii) For new external lighting installations or changes in existing as-built installations, the Government can consider imposing an approval requirement based on a light nuisance and energy impact assessment with regard to light trespass, glare and energy efficiency of the proposed lighting installations. Designers or contractors are required to submit an assessment to an approval authority on the possible light nuisance and energy efficiency of their new lighting installation before commencement of the installation works. If the assessment concludes that the lighting installation will cause serious adverse impacts and no effective mitigation measure is available to reduce the impacts to acceptable level, the installation works should not be implemented. After installation, the lighting system should be further assessed with regard to the light nuisance and energy criteria before approval for use. The assessments of external lighting impacts (before and after the installation works) should be carried out by registered professional engineers and submitted to the relevant authority for consideration.

7 The recommended practice for measuring and assessing the impacts of external lighting in Hong Kong

7.1 Introduction

7.1.1 As mentioned in Chapter 6, we recommend that a set of outdoor lighting guidelines should be issued for public reference. These voluntary guidelines should include recommended practices for minimizing light nuisance and preventing energy wastage of outdoor lighting.

7.2 Lighting environmental zoning

7.2.1 In 7 (i.e. Shanghai, Tokyo, Sydney, New York City, Los Angeles, London & Frankfurt) out of the 8 selected metropolises and 4 (i.e. Yangtze River Delta, New South Wales, California & England) of the 6 selected economies, a lighting environmental zoning system are in place to divide different lighting environment for different levels of commercial and recreational activities to control outdoor lighting. Since different districts/areas have different population densities and different levels of commercial and recreational activities which require different lighting conditions at night, a lighting environmental zoning concept, if adopted for reference in Hong Kong, should be carefully applied taking into account local context as Hong Kong is a high densely populated city with mixed land use and different social activities at night.

7.2.2 Generally speaking, the zoning system divides a city into different types of areas (i.e. different zones). Using a lighting zoning system can provide benefits to different sectors of the community. Firstly, it allows sufficient brightness at night in areas (zones) with commercial and recreational activities at night for those who desire to enjoy night shopping and recreational activities. Secondly, it suggests lower brightness at night in residential areas for residents to enjoy good quality leisure time and rest without being affected by excessive light. Thirdly, the system also classifies suitable areas of a city as intrinsically dark areas for astronomical observers to conduct astronomical observations with little interference from the urban lighting. However, in Hong Kong, the limitations and practicability of a zoning system include difficulty in classifying zones between medium district brightness and high district brightness. The classification is not just a technical issue.

7.2.3 In the California lighting zoning system, a location has a default classification of rural or urban area based on census population data and boundaries of government designated parks. Then the local authorities can move an area (with no size limit) to a higher or lower lighting zone by considering the special characteristics of that area. A preliminary, broadly classified zoning based on population or residential density is given in Table 7.1. This suggested preliminary lighting zone classification has made reference to the Hong Kong Metroplan Residential Zones, New Towns Residential Density Zones and Rural Area Residential Density Zones for consideration.

Table 7.1. Recommendation of lighting environmental zones

Zone	Lighting Environment	Provision of areas with different ambient brightness for different nighttime activities	Suggested preliminary classification for consideration
EZ1	Intrinsically dark	For astronomical observation.	Country parks and designated areas for astronomical observations
EZ2	Low district brightness	For people who want to have a rural living condition including having a low nighttime ambient brightness.	Rural Residential Density Zones RR2, RR3, RR4, RR5, Village (with New Territories Exempted Houses); Metroplan Residential Zone 3; and New Towns Residential Density Zones R3 & R4 (Excluding areas already classified as country parks which is suggested to belong to zone E1 by default)
EZ3	Medium district brightness	For residential areas where people would enjoy the convenience of commercial activities nearby (e.g. the convenience of buying everyday needed items without traveling long distance). Even for a little commercial activity at night, such as a convenience store, the area will need to be brighter than a solely residential area, i.e. the area would have medium ambient brightness.	Rural Residential Density Zone RR1; Metroplan Residential Zone 2; and New Towns Residential Density Zones R2
EZ4	High district brightness	For areas with high level of commercial and recreational activities at night. These areas are with high nighttime brightness for residents and visitors to enjoy nighttime shopping and recreation.	Metroplan Residential Zone 1; and New Towns Residential Density Zones R1

7.2.4 A 4-zone lighting zoning system similar to the CIE lighting environmental zoning system could be considered, with adaptations, for adoption in Hong Kong. However, practical issues relating to implementing the zoning concept in Hong Kong should be taken into consideration. Building mix and building density make it difficult to classify zones. Zoning classification is not just a technical issue. It is also a social issue and may arouse disputes among stakeholders with differing interests or concerns. An alternative to be considered is to only classify the geographic areas broadly into the low brightness and high brightness zone.

7.2.5 The suggested curfew times and reference limits for quantitative assessment of lighting impacts in the subsequent sections are based on the assumption that the 4-zone lighting environmental system is adopted. The respective suggestions and reference limits will need to be reviewed and refined in case a different lighting environmental system is adopted to suit Hong Kong's context.

7.3 Establishment of curfew hour

7.3.1 Curfew hour[47] is recommended in many guidelines and also enforced in some external lighting laws. 5 (i.e. Shanghai, Tokyo, Sydney, London and Frankfurt) of the 8 selected metropolises and 2 (i.e. New South Wales & England) of the selected economies have guidelines on recommended curfew hours of external lighting. This will minimize light nuisance and reduce energy wastage at night. Education and publicity could be effective as past examples show that owners of external lighting installations responded to complaints by rectifying light nuisance problem caused by their lighting installations. When there are stated guidelines, civic-minded owners would follow the guidelines.

7.3.2 In Hong Kong, it is also considered to be suitable to establish curfew hours which should be different in different lighting zones. Interest groups on environmental issues have expressed their concern from time to time that lighting devices in many locations in Hong Kong are still operating unnecessarily during very late hours at night. With curfew hours, commercial and/or recreational activities can still be carried out during the early part of the night and residents can enjoy a darker environment for good quality sleep during the later part of the night. If owners of lighting devices can follow the guideline on curfew hour, unnecessary waste of energy can also be avoided as some non-essential lighting devices will be turned off after the curfew hour.

7.3.3 A preliminary recommendation of curfew hours for the 4 suggested lighting environmental zones is given in Table 7.2.

Table 7.2. Recommended curfew hours for the 4 suggested lighting zones

Lighting Environmental Zone	EZ1	EZ2	EZ3	EZ4
Curfew hour [1)]	21:00	22:00	23:00 [2)]	24:00 [2)]

Notes:

1) The curfew hour is the time when all non-essential lights are recommended to be switched off. All non-essential lights should be kept off after the curfew hour until dawn of the next day. A basic definition of "non-essential light" is lighting whose primary function is not for the safety of people and vehicle traffic during night time hours.

2) Exemptions are to be given to lighting installations for business needs, shops which require night-time operation such as signs of 24 hour stores.

7.3.4 However, it may be difficult to define "non-essential lights" as some lightings are used for business purpose or security and safety reasons. It may also be difficult to reach a consensus on the appropriate definition of "non-essential lights".

[47] The curfew hour is the time when all non-essential lights are recommended to be switched off.

7.4 Recommended parameters and limiting values for quantitatively assessing the effects on residents

7.4.1 Light trespass

7.4.1.1 In 7 (i.e. Shanghai, Tokyo, Sydney, New York City, Los Angeles, London, Frankfurt) out of the 8 selected metropolises and 5 (i.e. Yangtze River Delta, New South Wales, California, Ontario and England) of the 6 selected economies, the vertical illuminance on the windows/façade of residential units or the illuminance in a plane perpendicular to residents' eyes is used to measure and assess the effect of light trespass on residents. The illuminance is the summation of the light from all light sources that emit light towards the resident's premises. As the vertical illuminance on windows or property boundaries such as balconies is commonly used as a parameter to measure and assess light trespass, it is also recommended to use vertical illuminance at windows/façade/property boundary to assess light trespass in Hong Kong. In order to simplify the measurement or calculation, the vertical illuminance at the centre of the window or the centre of a balcony opening can be used.

7.4.1.2 As zone EZ1 is intrinsically dark area suitable for astronomical observations, recommendation of CIE could be adopted. For zone EZ2 & EZ3, the recommendations of CIE could be adopted to low and medium district brightness in Hong Kong respectively. For zone EZ4, it is necessary to adopt a limit higher than those used in other guidelines because Hong Kong has higher population density in residential areas so that interior lightings emitted outdoors create a higher environmental brightness than corresponding zones in other metropolises. Hong Kong also has more commercial and recreational activities at night in certain districts compared with other cities. Based on the highest limiting values found in the current study (i.e. the values used in Shanghai) and taken account of the density of buildings and levels of commercial activity at night in Hong Kong, moderately higher limiting values than those used in Shanghai could be considered to be adopted in Hong Kong at initial stage of implementation. The recommended limiting values of light trespass as assessed by the vertical illuminance at centre of windows/façade openings of residential units are given in Table 7.3.

Table7.3. Recommended parameter and limits for assessing light trespass

Light Technical Parameter	Application Conditions	Lighting Environmental Zones and Recommended Limits			
		EZ1	EZ2	EZ3	EZ4
Vertical illuminance at centre of window (E_v) [1)]	Pre-curfew	2 lx (CIE)	5 lx (CIE)	10 lx (CIE)	50 lx (Shanghai)
	Post-curfew	0 lx [2)] (CIE)	1 lx (CIE)	2 lx (CIE)	25 lx (Shanghai)

Notes:

1) The values are the summation of light from all lighting installations.

2) If there is public (road) lighting then this limiting value should be raised by 1 lx (*where the unit, "lx", represents light intensity per unit area*).

7.4.1.3 The suggested limiting values given in Table 7.3 may not be suitable to be turned into mandatory requirements to control existing outdoor lighting installations as vertical illuminance is the summation of light from all light sources shining at the resident's premises. A possible situation may happen that individual light source can meet the requirement in respect of vertical illuminance on windows but the total effect from all surrounding light sources will fail to comply with the requirement. It is sometimes difficult to enforce the requirements on light trespass to control light nuisance. Even if the vertical illuminance of a particular location is found to exceed the limiting value, it is difficult to advise which particular lighting source(s) in the surrounding areas should be made dimmer or removed. The vertical illuminance on windows/façade openings is used to assess the level of light trespass affecting the residents. When implementing new lighting installations, designers or contractors can take account of the vertical illuminance of surrounding premises and the recommended limiting values to adopt lighting devices of suitable light intensities and prevent excessive light trespass to the neighborhood.

7.4.2 Glare from bright light sources, building facades and signs

7.4.2.1 In 7 (i.e. Shanghai, Tokyo, Sydney, New York City, Los Angeles, London, Frankfurt) out of the 8 selected metropolises and 5 (i.e. Yangtze River Delta, New South Wales, California, Ontario and England) of the 6 selected economies, the recommended practice for assessing glare from bright light sources is based on the intensity of bright luminaires in the direction of residents. Furthermore, 4 metropolises and 2 economies have specifications to limit the nuisance from bright signs and brightly-lit building façade based on average luminances. As these parameters are also recommended by CIE, the following three parameters are recommended for use in assessing glare due to direct view of bright light sources, building facades, signs (including permanent external video structures and flashing and dynamic lighting such as lighting with colour change):

(i) Luminous intensity emitted by luminaires (I_d) in the directions where views of the bright surfaces of the luminaires are likely to be troublesome to residents, or from the positions where such views are likely to be maintained, i.e. not from the positions where momentary or short-term viewing is involved.

(ii) Building façade luminance (L_b) which can be taken as average luminance or the product of the average illuminance and reflectance factor divided by π.

(iii) Sign luminance (L_s) which is taken, for illuminated signs, as the average luminance or the product of the design average illuminance and reflectance factor divided by π, or for self-luminous signs, its average luminance.

Table 7.4 gives the suggested limiting values for the three parameters. All these limits are the same as the CIE recommendations.

Table 7.4. Recommended parameters and limits for assessing glare impact on residents from bright luminaires, building facades and signs (including video walls and the distracting effect of flashing and dynamic lighting such as lighting with colour change).

Light Technical Parameter	Application Conditions	Lighting Environmental Zones and Recommended Limits (CIE)			
		EZ1	EZ2	EZ3	EZ4
Luminous intensity emitted by luminaires (I_d) in directions towards residents [1)]	Pre-curfew	2500 cd	7500 cd	10000 cd	25000 cd
	Post-curfew	0 cd	500 cd	1000 cd	2500 cd
Building façade luminance (L_b)	Pre-curfew	0 cd/m^2	5 cd/m^2	10 cd/m^2	25 cd/m^2
	Post-curfew	0 cd/m^2	5 cd/m^2	10 cd/m^2	25 cd/m^2
Sign luminance (L_s) [2)]	Pre-curfew	50 cd/m^2	400 cd/m^2	800 cd/m^2	1000 cd/m^2
	Post-curfew	0 cd/m^2	400 cd/m^2	800 cd/m^2	1000 cd/m^2

1) If the luminaires are **flashing**, the luminous intensity should be half of the given limits.

2) Signs include video walls but exclude signs for traffic control. The use of signs incorporating lighting which is **cyclic or flashing** in nature is not allowed in zones EZ1 and EZ2. In any zones, such signs should not be positioned close to windows of habitable rooms.

7.5 Recommended parameter and limiting values for assessing the effects on road users

7.5.1 The threshold increment *TI* is the recommended parameter to assess the effect of non-road lighting outdoor luminaires on road users in 3 (i.e. Shanghai, Tokyo and Sydney) of the selected metropolises and 3 (i.e. Yangtze River Delta, New South Wales and England) of the selected economies. In Hong Kong, threshold increment *TI* is used for the assessment of glare due to road lighting according to lighting classes of roads. In the Public Lighting Design Manual of Highways Department, it is also mentioned that the undesirable effects of light pollution should be minimized making reference to the ILE publication – Guidance Notes for the Reduction of Light Pollution (Obtrusive Light), which recommends the use of CIE guidelines. Hence, it is considered that *TI* is also a suitable parameter for assessing the effect of glare on road users caused by other types of external lighting (i.e. external lighting other than road lighting). Since the Highways Department specifies a *TI* of 20% for road lighting class L5 and 15% for road lighting classes L1-L4, the same *TI* limits should be used for assessing glare from outdoor lighting installations which are not road lighting. The recommended limiting values are given in Table 7.5.

Table 7.5. Recommended parameters and limits for assessing glare impact on road users due to external lighting other than road lighting

Light Technical Parameter	Application Conditions	Recommended Limits [1]			
		Road classification [2]			
		No road lighting	L5	L4/L3	L2/L1
Threshold increment (*TI*)	Limits apply at all times	20% based on adaptation luminance of 0.1 cd/m^2	20% based on adaptation luminance of 1 cd/m^2	15% based on adaptation luminance of 2 cd/m^2	15% based on adaptation luminance of 5 cd/m^2

1) Limits apply where road users are subject to a reduction in the ability to see essential information. Values given are from relevant positions and for viewing directions in the path of travel.

2) Road classifications and minimum maintained average road surface Road lighting classes luminance as given in Public Lighting Design Manual of Highways Department (HyD) and summarized as follows:-

Road lighting class HKSAR HyD	Minimum maintained road surface luminance (cd/m^2)
L1	2.0
L2	1.5
L3	1.0
L4	0.75
L5	0.5

7.6 Recommended parameter and limiting values for assessing the effects of outdoor lighting on astronomical observation

7.6.1 In 6 (i.e. Shanghai, Tokyo, Sydney, New York City, Los Angeles and London) out of the 8 selected metropolises and 5 (i.e. Yangtze River Delta, New South Wales, California, Ontario and England) of the 6 selected economies, the recommended parameter for assessing sky glow effect from bright light sources is the upward light ratio (ULR) or the upward waste light ratio which are essentially the same.

7.6.2 The ULR is defined as the proportion of the flux of a luminaire that is emitted, at and above the horizontal level of the installed position in which the luminaire is mounted. In calculating the ULR, light emitted in the critical zone just below the horizontal level and light reflected upward are not included, but these both also contribute to sky glow. ULR cannot be measured on site. Assessment of ULR can only be made by calculations, aided by computer software if necessary. The calculation of ULR requires the availability of photometric data of the luminaires, and is affected by the locations and aiming angles of the luminaires.

7.6.3 The ULR could be considered to be adopted in Hong Kong. According to the recommended limits used in the metropolises and economies under study, an ULR of not more than 25% is recommended in high brightness zone of lighting environmental zone such as commercial centres. Most astronomical observations will not be conducted in the brightness zones EZ2, EZ3 & EZ4. In addition, many existing floodlights for signs and for building facades in residential and commercial areas in Hong Kong are installed such that the lights are aiming at a direction pointing upwards for specific needs. The ULR limits could be applied to low to high brightness zones in Hong Kong. As more astronomical observations and activities will be carried out in lighting environmental zone EZ1 (intrinsically dark) rather than other zones, a limit of 0% ULR is proposed for lighting environmental zone EZ1 (Table 7.6).

Table 7.6. Recommended parameter and limit for assessing lighting installations for reducing sky glow effect.

Light technical parameter	Proposed limit	Application conditions	Applicable lighting environmental zone
Upward light ratio (ULR)	0%	Limits apply all times	EZ1

7.7 Recommended practice for luminaire classification

7.7.1 Only in 1 (i.e. Los Angeles) of the 8 selected metropolises and 1 (i.e. California) of the 6 economies have specifications requiring the use of cut-off luminaires when the lamp power exceeds a certain value. Since this approach is not commonly adopted and that there will be implication to lighting design (as part of the light is cut off, more luminaires may be required and higher installation cost involved), it is not recommended to adopt cut-off requirements for outdoor luminaires in Hong Kong.

7.8 Recommended parameter and limiting values for assessing energy efficiency of external lighting

7.8.1 The lighting power density (LPD) in W/m^2 is a common parameter used to assess lighting energy efficiency of an illuminated area. LPD is adopted in 2 (i.e. New York City & Los Angeles) of the 8 selected metropolises and 3 (i.e. Yangtze River Delta, California & Ontario) of the 6 economies. The parameter is not widely adopted currently. In all areas with assessment of outdoor lighting energy efficiency, LPD is the main parameter used for assessment. Therefore, LPD could be considered to adopt for assessing the energy efficiency of external lighting.

7.8.2 Initially, based on the experience of the areas under study, the suggested limits of LPD for building facades are given in Table 7.7 with reference to the limiting values adopted by China JGJ/T 163-2008, the Beijing Municipal Standard DB11/T 388.4-2006 and California Building Energy Efficiency Standard. A single upper limit (instead of specifying values based on façade reflectance) is suggested for each lighting environmental zone for simplicity.

Table 7.7. Recommended limiting values of light power density for assessing energy efficiency of lighting for building façade.

Type of lighting	Lighting Environmental Zones and recommended limiting values of Lighting Power Density (W/m^2)			
	EZ1	EZ2	EZ3	EZ4
Building façade lighting [1)]	0	7	9	14

1. Only the illuminated area of the building façade shall be used for calculating the LPD.

7.8.3 Initially, based on the experience of the areas under study, the suggested limits of LPD for externally and internally illuminated signs are given in Table 7.8 for reference for all zones. The LPD values for externally and internally illuminated signs are recommended to be about 26W/m^2 and 130W/m^2 respectively based on the California 2008 Building Energy Efficiency Standards (CBEES). CBEES does not mention the lighting zones in which the recommended values should be applied.

7.8.4 However, the CBEES may not be directly applied to Hong Kong. The recommended LPD limits for externally and internally illuminated signs should take into account the local situations, including our more densely populated urban area, higher building densities, higher ambient light level and different business and social background.

Table 7.8. Recommended limiting values of light power density for assessing energy efficiency of lighting for external & internally illuminated signs.

Type of lighting	Lighting Environmental Zones and recommended limiting values of Lighting Power Density (W/m^2)			
	EZ1	EZ2	EZ3	EZ4
Externally illuminated signs [1)]	26			
Internally illuminated signs [2)]	130			

1. Only the illuminated area of the sign shall be used for calculating the LPD.
2. Only the luminous area of the sign shall be counted for calculation of LPD; for double-faced signs, only the area of a single face shall be counted.