



House of Commons
Science and Technology
Committee

Light Pollution and Astronomy

Seventh Report of Session 2002–03



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Volume I

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The Science and Technology Committee

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Summary

The majority of professional astronomy now takes place outside of the United Kingdom. This is due to the poor and unpredictable weather conditions of the British Isles, their hemispherical position and to the continuing encroachment of light pollution on British skies. However, astronomy remains a growth subject of academic study, as demonstrated by the increase in the number of students at GCSE, undergraduate and postgraduate level.

This Report emphasises the importance of the amateur astronomy community in the UK. Whilst many observe the stars for purely aesthetic pleasure, there is a thriving community of amateurs who provide important observational data to grateful professional astronomers. Amateur astronomical societies, along with professional astronomers based in the UK, are also instrumental in introducing young and future scientists to astronomy and physics through open days at observatories and by bringing mobile planetaria to schools and groups.

Most importantly of all, amateur societies have been attempting for over ten years to educate local authorities, government, lighting retailers and the general public about the problems caused by light pollution. Light pollution has grown to such an extent that it threatens the remaining dark skies in the rural areas of the UK. Astronomers have been joined by the Campaign to Protect Rural England in an attempt to persuade government that education and exhortation alone are not enough to stem the swathe of light ruining the night sky for everyone. We agree.

This Report provides recommendations on how light pollution can be controlled without reducing the levels of light needed for safe illumination of urban and rural environments.

1 Introduction

1. In February 2003 we decided to conduct an inquiry to examine the effectiveness of measures taken to reduce the impact of light pollution on astronomy and to consider what further steps, if any, were required. The inquiry was announced on 4 February with the following terms of reference:

- What has been the impact of light pollution on UK astronomy?
- Are current planning guidelines strong enough to protect against light pollution?
- Are planning guidelines being applied and enforced effectively?
- Is light measurable in such a way as to make legally enforceable regulatory controls feasible?
- Are further controls on the design of lighting necessary?

2. The purpose of the inquiry was to establish whether astronomy had been affected by light pollution to such a degree that appropriate legislative action needed to be taken by the Government. Our recommendations apply principally to the UK Government.

3. We received over 120 submissions to this inquiry. We held two oral evidence sessions on 9 June and 14 July with five sets of witnesses from the amateur and professional astronomy societies, the Institution of Lighting Engineers, the Highways Agency, the Campaign to Protect Rural England, a Local Authority, the Particle Physics and Astronomy Research Council and the Government.

4. The Committee made one visit in relation to this inquiry, to Greenwich in the late evening hours of 4 June. We met representatives from local amateur societies, Mr Bob Mizon and Dr Chris Baddiley, Campaign for Dark Skies, Dr Helen Walker, Royal Astronomical Society, and Dr Robin Catchpole and Dr Robert Massey of the Royal Observatory Greenwich. We were most grateful to the Royal Observatory for kindly allowing us to visit, and for the use of the telescope and planetarium. Mr Tom Harris MP made a visit in a representative capacity to the School of Physics and Astronomy at the University of St Andrews and met Dr Ron Hilditch.

5. We are grateful to all those who have submitted evidence to and assisted in the inquiry, with special thanks to the Vectis Astronomical Society and Mr Nigel Pollard of NEP Lighting Consultancy.

2 Background

The appeal of astronomy

6. From the evidence we have received it is obvious that the science of astronomy holds a fascination for thousands of people in the UK. Many witnesses spoke of awe-inspiring observations in their childhood sparking off a lifetime of scientific study, with travels around the country or world in search of clearer skies, or the simple pleasure of studying the stars with a telescope from their back gardens. Advances in technology have given amateurs access to high quality telescopes similar to those used by professionals, which has further encouraged enthusiastic participation by local astronomical societies.

7. The Campaign for Dark Skies, a section of the British Astronomical Association, has coined the phrase that the night sky is a site of special scientific interest and an area of outstanding natural beauty – a phrase that has struck a chord with many of its supporters. Many memoranda used emotive language and imagery to illustrate their frustration at the erosion of the night sky by the effects of light pollution. Professor Sir Martin Rees, the Astronomer Royal, explained the special appeal of astronomy: “the night sky is one part of our environment we have shared with all cultures in all periods of human history.”¹ Five thousand years ago the Sumerians and Egyptians had already established a tracery of symbols, creatures and gods in the sky that were to develop into the eighty-eight mapped constellations of the modern night sky.² Professor Mark Bailey of the Armagh Observatory warned of the danger of losing sight of the night sky:

“Astronomy is the oldest science, with roots extending more than five thousand years to the building of Newgrange, Stonehenge and similar structures. It is a key part of mankind’s cultural inheritance which attracts people towards science and into a scientific way of thinking. Concepts and ideas derived from astronomical theories and observations are often found in fields far removed from science [...] the ‘inspiration’ of astronomy extends into many areas of our lives, including philosophy and religion, and provides us with a unique, and rapidly changing, perspective on our universe [...] To draw a veil across this aspect of humanity’s cultural heritage [...] is to deprive us of a source of inspiration that has operated for thousands of years.”³

How are astronomical observations affected?

8. Light pollution affects not just astronomers, but the general public and the environment. Indeed, the Committee received memoranda from people suffering from light pollution who had no direct interest in astronomy.⁴

9. Although a fuller description of the types of light pollution is given later in the Report, essentially, lighting spilling over into an astronomer’s garden from another property or

1 Q 64

2 Bob Mizon *Light Pollution, Responses and Remedies*, Springer-Verlag (London, 2001) p 25.

3 Ev 44

4 Ev 215, 55

from street lighting can prevent a view of the night sky. Astronomers' eyes need to adapt to the dark, but the sensitive receptors in the eyes will cause the iris to contract if lights suddenly come on, causing a delay of twenty minutes to regain dark adaptation.⁵ Over-sensitive security lights switching on and off all night would ruin an evening's observation. Light pollution can also be seen as the visible orange glow seen over towns and cities which creates a veil over the night sky so that interesting stars and the Milky Way are invisible to the naked eye or telescope.

Professional Astronomy in the UK

Facilities

10. There are currently no world-class optical telescope facilities in the United Kingdom. Light pollution makes this impossible. For example, the Royal Observatory at Greenwich relocated in 1954 to Herstmonceux in Sussex, and then Cambridge, to escape the light pollution in London.⁶ The Isaac Newton telescope was relocated from Sussex to La Palma in the Canary Islands in 1984.⁷

11. The Science Budget currently provides £54 million per annum for astronomy, through PPARC. The tables below show facilities currently funded by the Government. The Government states that there are no optical telescopes in the UK funded by the Science Budget "carrying out leading-edge professional research".⁸

5 Ev 115. For a more detailed description of the workings of the eye, see *Light Pollution: Responses and Remedies*, p 3.

6 Ev 197

7 Ev 176

8 Ev 223

Table 1 – Operational telescopes currently funded by PPARC

Telescope	Location	Wavelength(s)
Anglo–Australian Telescope (AAT)	Australia	Optical/Near Infrared
Carlsberg Meridian Telescope (CMT)	La Palma	Optical
Isaac Newton Telescope (INT)	La Palma	Optical
Jacobus Kapetyn Telescope (JKT)	La Palma	Optical
James Clerk Maxwell Telescope (JCMT)	Hawaii	Sub–millimetre
Gemini	Hawaii and Chile	Optical/Near & Mid Infrared
MERLIN	England	Radio
UK Schmidt Telescope (UKST)	Australia	Optical
UK Infra Red Telescope (UKIRT)	Hawaii	Infrared
William Herschel Telescope (WHT)	La Palma	Optical/Near Infrared

Source: Office of Science and Technology

Table 2 – Telescopes currently under construction

Telescope	Location	Wavelength(s)
Atacama Large Millimetre Array (ALMA)	Chile	Millimetre/Sub–millimetre
Liverpool Telescope (LT)	La Palma	Optical/Near Infrared
Visible and Infrared Telescope for Astronomy (VISTA)	Chile	Optical/Infrared

Source: Office of Science and Technology

12. Light pollution is not the only reason for the lack of professional observational facilities in the UK. First class ground–based optical, InfraRed or millimetre wavelength telescopes need to be built where the local atmosphere is free of dust, water vapour, air–borne pollutants and light pollution.⁹ Facilities are also necessary in both hemispheres. These telescopes are multi–million pound facilities, each telescope costing roughly £70 million apiece,¹⁰ and costing thousands of pounds per night to operate, which is why it is essential that they have access to good clear skies. Irrespective of light pollution, the British Isles simply do not have the weather and atmospheric conditions to make the siting of a world–class multi–million pound astronomical facility feasible. The UK could not afford to build

9 Ev 223

10 Q 211

its own telescopes in isolation – most facilities have been built in collaboration with one or more partners.¹¹

13. Despite world-class astronomical observation being based outside the United Kingdom, the UK supports and participates in the best international facilities, through its membership of the European Space Agency, the European Southern Observatory, and its partnership in the facilities based in Mauna Kea, Hawaii; Cerro Pachon and Paranal, Chile; La Palma, Canary Islands; and in Australia.¹² Funding from the Particle Physics and Astronomy Research Council (PPARC) enables the UK research community to have access to and participate in research at these facilities.¹³ Professor Ian Halliday, Chief Executive of PPARC, told the Committee: “Apart from the Americans, British astronomy is the best in the world. We have access to facilities which are second to none.”¹⁴ Professor Sir Martin Rees told the Committee: “there is a very strong and broad programme as measured by all of the scientific indicators of citations and publications.”¹⁵

Radioastronomy

14. The Science Budget also funds the UK-based MERLIN telescope at Jodrell Bank, Cheshire, which carries out radioastronomy. Radioastronomy is largely unaffected by atmospheric conditions and light pollution, and so can operate in the UK. It involves listening to the radio signals emitted by astronomical sources and needs radio silence. Despite strict controls maintained by the Radiocommunications Agency (soon to be part of the Office of Communications under the Communications Act 2003) around the sites of the radio dishes, radio astronomy is being threatened by growing demands on wavelength access from the telecommunications industry and from satellite-based developments which do not respect international boundaries.¹⁶ A number of memoranda submitted to the Committee raised concerns over the threat to radioastronomy. Although radioastronomy is not within the remit of this current inquiry, we may return to this subject at a future date.

Professional Astronomers in the UK

15. Professor Paul Murdin of the Royal Astronomical Society (RAS) told us that there were roughly 200–300 tenured academics in astronomy in the UK, and several thousand who make a living from astronomy, including PhD students.¹⁷ He confirmed that not all professionals worked exclusively on overseas world-class facilities; many were training students. He said:

“there is more to professional astronomy than using the very largest telescopes. There are also people who use moderate-sized telescopes from night to night, from hour to hour and from week to week [...] for professional purposes, there is also a requirement

11 Ev 204, Ev 223

12 Ev 204

13 Ev 203

14 Q 221

15 Q 66

16 Ev 204

17 Q 20

for access to smaller telescopes within the UK and those telescopes are inhibited by light pollution.”¹⁸

16. At St Andrews University the telescopes are used almost exclusively by undergraduates as post-graduates tend to use facilities abroad. Some joint research projects were carried out with telescopes abroad. For example, St Andrews is being used in conjunction with the Hubble Space Telescope.

Amateur Astronomy in the UK

Research undertaken by amateur astronomers

17. As well as receiving many memoranda from local astronomical societies and individual astronomers, we received evidence from the two largest amateur astronomy groups, the Society for Popular Astronomy (SPA) and the British Astronomy Association (BAA).¹⁹ Also, the RAS counts about 30% of its approximately 3,000 members as amateurs.²⁰ Mr Guy Hurst, President of the BAA, told the Committee that they also had approximately 3,000 members. Of this number, he estimated that 2,000 members observed once a week, whilst 200–300 observed 120 nights of the year.²¹ He commented that this enthusiasm “astonishes our overseas’ colleagues, who have better conditions but do not observe anywhere near as much as in this country.”²²

18. Much of the evidence to the Committee commented on the unique nature of astronomy’s very close links between amateur and professional astronomers. Dr Helen Walker, of the Central Laboratory of the Research Councils, and representing the RAS, told the Committee: “professional astronomers, unlike a lot of other sciences, rely on the work of amateurs to support them. We rely on amateur astronomers to spot comets, supernovae and gamma ray bursters.”²³ Professor Murdin told us of the RAS’s organisation called PROAM which is a collaboration between professional and amateur astronomers, which organises programmes of work.²⁴ Mr Hurst of the BAA told the Committee:

“Often professionals ask me to get a group of people together to observe a particular global star [...] for a week, maybe, just to run it concurrently with a satellite programme that the professionals are running, and virtually every week there is a PROAM project in process.”²⁵

18 Q 5

19 Ev 160, 109

20 Q 16

21 Qq 15–18

22 Q 15

23 Q 4

24 Q 16

25 Q 16

19. We received evidence showing specific examples of how amateurs contribute to the professional research community:

- Croydon Astronomical Society members work on the hunt for near earth objects and asteroids and discovering comets;²⁶
- Mr Michael Gainsford makes astronomical observations on variable stars and comets used by professional astronomers;²⁷
- Members of the Cotswold Astronomical Society’s research programmes include asteroid and neo astrometry and supernova patrols;²⁸
- Hampshire Astronomical Group contribute to databases used by the professional community for further research – most recently the Group’s observatory has been used for confirmation observations of discoveries of exploding stars in distant galaxies;²⁹ and
- Mr Roger Dymock assists professionals to define the orbits of Near Earth Asteroids.³⁰

20. Dr Darren Baskill, of the University of Leicester, told the Committee that whilst professional astronomers carry out detailed studies of individual objects, amateurs monitored the whole sky. His PhD thesis, based on the X-ray emissions from stars, contained tens of thousands of optical observations made by amateur astronomers world-wide. He said:

“it is not unusual for an amateur astronomer to detect a star to suddenly brighten, inform a UK professional astronomer, who can then co-ordinate telescopes world-wide (both ground based and space-borne) to observe that star in detail. Such observations by amateurs have even caused the NASA Hubble Space Telescope to interrupt an observation, and to rapidly observe a brightening star, in order to detail unusual or rare behaviour.”³¹

21. Professor Halliday seemed less convinced about the value of observations to the professional community but acknowledged: “It is useful, it is serendipitous; they find comets, they do all sorts of things. [...] It is a real resource in the UK science structure that we have these extremely enthusiastic people putting in a huge effort.”³² However, he admitted “I have a hidden constituency, which I was not really aware of”.³³

22. Dr Walker from the RAS told the Committee that professional astronomers simply do not have the opportunity or funding to spend much time on the world class facilities abroad:

26 Ev 143

27 Ev 35

28 Ev 93

29 Ev 96

30 Ev 104

31 Ev 129

32 Qq 200–201

33 Q 200

“when I went out to Australia the stars I was studying faded and when they faded not even the Anglo–Australian telescope could observe them. So we had a group of New Zealand amateurs monitoring all the stars we might possibly want to look at, and they would tell us if one of these stars was going to fade because we would have to reorganise our programme [...] Variable stars are something professional astronomers cannot follow [...] there is no way we are going to just scan the skies night after night on the off chance there might be a comet, a supernova, or something else, we have to rely on the amateurs to tell us there is something new.”³⁴

23. We conclude that there is convincing evidence that many professional astronomers benefit from the valuable input made to professional astronomy by the observations of amateurs.

Work with the wider community

24. Although some remain unconvinced that amateur astronomers carry out *essential* ‘back-up’ research for professionals, it is generally acknowledged that the amateur astronomy community also plays a valuable role in showing the wider public the wonders of the night sky. Most local astronomical societies hold open–days (and evenings) when members of the public are invited in to use the observatories or telescopes. Professional and amateur astronomers visit schools, groups and societies, sometimes using planetaria to demonstrate how the Earth is placed in the universe. Professor Murdin of the RAS said: “the queues at the University of Cambridge to line up to put their eyeballs to the eyepiece to experience it for themselves rather than watch it projected on the screen are quite extraordinary. People want that first–hand experience.”³⁵

25. Dr Walker said “a lot of people come to science – not just astronomy – because they have seen the night sky, they have been to amateur observatories and they have been to public viewing evenings at public observatories [...] there is a lot of excitement there and it fuels all the way through the system because people can actually do astronomy in the UK.” Dr Chris Baddiley of the BAA’s Campaign for Dark Skies (CfDS) told us that “I, like many of my colleagues in astronomical societies, go up and down the country giving lectures in our spare time. We are also involved in things like National Science Week where there is an encouragement to get school children particularly interested in sciences, and astronomy is an excellent way.”³⁶ We received evidence that teachers were keen to learn more about astronomy to assist them in the teaching of the national curriculum.³⁷

26. Professor Halliday told us “[amateurs] play a serious role in the dynamic of producing astronomy students, producing people who want to do PhDs.”³⁸ Professor John Brown, the Astronomer Royal for Scotland told us “[PPARC] are not relying heavily on the amateurs to provide research analysis but they are using amateurs to inspire school kids to help not

34 Q 13

35 Q 33

36 Q 31

37 Ev 53

38 Q 200

only astronomy but the technological careers that this country needs more of, the good, high-tech people, and astronomy is a way into that.”³⁹

27. We believe that amateur and professional astronomers have played a valuable role in the introduction of young people into science. As Sir Patrick Moore commented “the amateur [astronomer] of today is the professional researcher of tomorrow”.⁴⁰

The study of Astronomy in the UK

The National Curriculum to GCSE level

28. The Government has acknowledged that pupils need encouraging to study science. Evidence received from witnesses suggests that astronomy is a successful and long lasting means by which school pupils can be “turned onto” science. Mr Bob Mizon of the Campaign for Dark Skies told us “teachers tell me over and over again that there are two things in primary science that light up the eyes of little children, they are Space and dinosaurs.”⁴¹

29. The National Curriculum, at Key Stages 2 (7–11 year olds), 3 (11–14 year olds) and 4 (14–16 year olds) requires school pupils to learn about the sun, earth, moon and the solar system. The Government memorandum states that pupils are “encouraged to supplement their learning with activities such as visits to a planetarium, observing the night sky, and using online resources, including webcam pictures and satellite images of astronomical phenomena.” On the effect that light pollution has on school pupils observing the night sky “the Government has no information on the extent to which this is the case.”⁴² Whilst planetaria do indeed engage children’s interest, as Mr Bob Mizon of the Campaign for Dark Skies told us “sitting inside a plastic dome with little dots on the ceiling is nothing like sitting below the real night sky”.⁴³

30. The DfES estimate that approximately 480 students sat astronomy at GCSE level in June 2003. This shows an increase in numbers on the previous two years. We were also told by DfES that of the twenty four Science Specialist Colleges which came on stream in September 2002, only one planned to offer GCSE in Astronomy. However, of the fifty seven new Science Colleges to be operational from September 2003, three are planning to offer GCSE in Astronomy and one is offering Astronomy at AS level.⁴⁴

31. Astronomy at GCSE level is currently only offered by Edexcel. Section 4.30 of the GCSE syllabus for Astronomy states that:

It is necessary to “Describe the appearance of the Milky Way as seen with the naked eye, with binoculars and with a small telescope”.

39 Q 65

40 Ev 59

41 Q 31

42 Ev 224

43 Q 31

44 Ev 233

However, the Milky Way is only visible from approximately 30% of the country on a clear night.

32. The Minister for School Standards, Mr David Miliband MP, has told us on a previous occasion that science “does not mean that science teaching and science classes are restricted to giving them the facts.”⁴⁵ In this inquiry, Mr Miliband told us “In science, practical work has a particular meaning and it is important to supplement the more traditional book or lecture based methods [...] if we cannot give young people access to the night sky because of where they live, we have to find other ways of giving them practical engagement with the subject.”⁴⁶ We were told by the Minister that the Government had put funding into “the two Australian telescopes to allow every school in the country to buy time through these telescopes and down the internet and to book half an hour at a time to study the stars through this Australian telescope [...] I am told authoritatively that there is great viewing of the Milky Way through this Australian telescope”.⁴⁷ We were surprised that the Minister for School Standards did not see the irony of his own words. Schools are now obliged to buy time to enable their pupils to view stars in the southern hemisphere, when the UK’s own night skies should be there for all to view for free. **Astronomy in the UK plays a valuable part in supporting the work of professionals, engaging young people in science, and producing astronomers and physicists through UK universities. It is not good enough that PPARC and the Department for Education and Skills had to pay for young people in schools to “book time” on overseas telescopes to see the night sky as it should be.**

33. Whilst the development of new technologies is welcome, as Professor Murdin commented, “we would not ask that question for sport, would we. We would not say, ‘is it okay for children to watch sport on a Saturday afternoon on the TV and not play it themselves’. Education is about experiencing things for yourself, not through somebody else’s experience of it.”⁴⁸ Viewing foreign skies through the internet should be used in tandem with practical observations of the stars in this country. Professor Sir Martin Rees told the Committee that the technical advances in the production of small telescopes allowed the viewer to see more varied objects whilst being within the affordable reach of schools as teaching aids.⁴⁹ **Pupils should be able to study the night sky at school primarily with the naked eye or through a telescope rather than via a computer and the internet.**

34. Many professional astronomers, physicists and teachers have written to us describing how the inspiring nature of the stars and the night sky led them to a career in science. Professor Halliday himself told us that “I was brought into science as a 15 or 16 year old first of all by being taken out to see the Northern Lights in Scotland by my father, expressing interest, then getting engaged with a local society which was interested and is still there.”⁵⁰ Professor Halliday told us of the growing partnership between PPARC, DfES

45 Science and Technology Committee, Session 2002-03, *Science and Technology from 14 to 19: The Government’s Response*, Minutes of Evidence, HC 1273-i, Q 58

46 Q 199

47 Q 181 and Q 183

48 Q 32

49 Q 64

50 Q 200

and the increasing use of professional astronomers to engage local schools in astronomy: “We have an invitation from Charles Clarke to try to use space in a similar way, to get visibility in schools for things happening now in science.”⁵¹ **There seems to be an acknowledgement within Government that Space is a good way to engage young scientists, but there is little real support for schools to use observing facilities in this country. The Department for Education and Skills should be supporting efforts to make the night sky available to all. We regret that it is not doing so at present.**

Undergraduate and Postgraduate study of astronomy

35. There are currently around fifty universities in the UK offering significant modules in astronomy at undergraduate level. About twenty-five of these universities offer postgraduate courses.⁵² There are approximately three hundred PhD astronomy students funded by PPARC, and many more funded by the universities.⁵³ Professor Murdin described astronomy as “one of the growth areas of physical science education in universities attracting large numbers of people who are, incidentally, learning about electronics [...] going on to be electronic engineers [...] being attracted into science by studying astronomy.”⁵⁴ Students tended to major in mainstream subjects such as physics, mathematics or electronic engineering, and then bolt on modules in astronomy.

36. Professor Murdin believed that astronomy could be the saviour of physics “[physics enrolment in universities] has been declining for a long time, it has plateaued now but the astronomy education in universities is rising by ten per cent a year.”⁵⁵ There had been a time when one university every year was adding astronomy into its physics teaching because of its attraction to students.⁵⁶ Professor Sir Martin Rees agreed “Astronomy is a prime value subject at a number of universities [...] it has certainly proved to be a great enhancement to physics.”⁵⁷ Professor Murdin also confirmed that there were a large number of overseas postgraduate students coming to the UK to study astronomy.⁵⁸ Professor Halliday of PPARC confirmed that the number of astronomy courses is growing much faster in comparison to courses in more applicable physics.⁵⁹

37. There are approximately 33 observatories attached to universities. These observatories are where the majority of observing is done.⁶⁰ Training is carried out on easily observed astronomical objects, theoretically or by use of sites overseas.⁶¹ However, Professor Murdin said “it is not practical to take students to Hawaii for a weekend trip to teach them how to use the telescopes.”⁶² Dr Ron Hilditch of St Andrews University told a Member of

51 Q 200

52 Q 1

53 Q 205

54 Q 7

55 Q 9

56 Q 10

57 Q 63

58 Q 12

59 Q 202

60 Ev 234

61 Ev 176

62 Q 5

the Committee that optical telescopes were an important element in attracting students to study astronomy as they were keen to gain practical observational experience. The university observatories are not subject to special protection from the encroachment of light, and many local authorities are unaware of the observatories' existence.⁶³ Even if local authorities are sympathetic, observatories can suffer from light coming from a source some miles away. For example, St Andrews University Observatory is affected by the lights of Dundee; some ten miles away.⁶⁴

38. PPARC do give grants to universities to keep the facilities working – even though the observatories are not producing “cutting edge research” – with the stipulation that the observatories are involved with schools in the neighbourhood.⁶⁵ Professor John Brown said of the PPARC funding of schools and universities: “they funded [Glasgow University] to set up some equipment and train the Paisley Observatory and Coates Observatory Astronomical Societies to use it.”⁶⁶ However, significant investment by PPARC into the university facilities is not made due to the effect of light pollution in the UK,⁶⁷ and also due to the fact that PPARC does not consider it productive to invest in instruments, usually built in the 19th century, which are not capable of producing competitive research. They are supported for educational and teaching purposes only, and not research.⁶⁸

39. As the Report later discusses, the Government and PPARC support the protection of the dark skies around the multi-million UK-funded international facilities, but when asked if PPARC supported efforts to mitigate light pollution affecting observatories and societies in the UK, Professor Halliday replied “No, I am afraid we pass the buck.”⁶⁹

40. We regret that PPARC and the Government have adopted a defeatist attitude towards light pollution and astronomy in the UK. There are substantial numbers of amateur astronomers, astronomy undergraduates and postgraduates and professional astronomers observing in the UK. Amateur and professional astronomers have undertaken a dual role of showing and explaining the night sky to students, pupils and the general public, whilst campaigning for the last ten years to prevent further degradation of the night sky. It is time they receive support from PPARC and the Government.

41. Dr Helen Walker told us that current developments in professional astronomy meant that “The UK is in an excellent position to blow the children’s minds with the work we are doing”.⁷⁰ The extensive media coverage this year of Beagle 2, the Annular eclipse and the close approach of Mars to Earth in August is an indication of the wide appeal of astronomy to the general public. **There is a real opportunity of using the enthusiastic astronomy community to increase the numbers of school pupils taking astronomy and continuing into physics. PPARC and DfES together should bring to bear more pressure on ODPM**

63 Q 48

64 Ev 177

65 Q 207

66 Q 65

67 Q 212

68 Qq 212, 217

69 Q 216

70 Q 37

and DEFRA to find a way to protect the skies, particularly around those observatories who work with local schools.

The extent and nature of light pollution

The properties of light

The joint Countryside Commission and Department of the Environment's Guidance *Lighting in the Countryside: Towards Good Practice* (1997), describes the properties of light as:

"Light is a type of radiation and forms part of the electromagnetic spectrum visible to the eye. It is measured in lumens (lm). A modern electric light takes in energy in watts, and its efficiency can be measured in lumens per watt (lm/w). The amount of light falling on a surface is known as the illuminance and is measured in lumens per square metre or lux. This is easy to calculate and measure and is therefore widely used. The illuminance of direct sunlight is approximately one hundred thousand lux, but normal daylight, which is filtered through a cloudy sky is between five thousand and ten thousand lux, while moonlight is as little as 0.25 lux.

Luminance, or brightness [...] is directional and is measured in candelas per square metre (cd/m²).

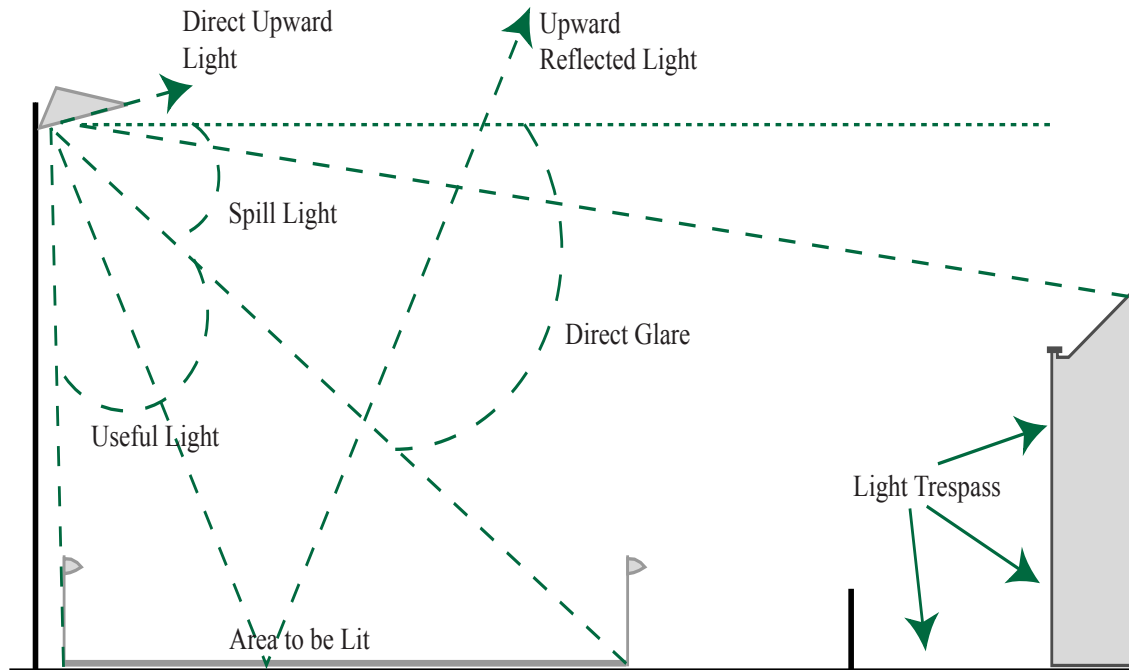
The other term commonly used by lighting engineers is luminous intensity. This refers to the strength of light in a given direction and is measured in candelas (cd). However, in reality, a source's luminous intensity is seen by the eye relative to the brightness of its surroundings, and this is not easy to measure."

What is light pollution?

42. It is generally acknowledged that there are three types of light pollution: sky glow, which has principally contributed to professional astronomy being undertaken abroad; glare, and light trespass which have the most adverse effect on the amateur and professional astronomers based in the UK. However, there is no legal or official definition of "light pollution". The Government's guidance *Lighting in the Countryside Towards Good Practice* (1997), a joint Countryside Commission and Department of the Environment publication, described light pollution as a "very general term which refers to effect of over-lighting resulting from poorly designed lighting schemes and excessive levels of light."⁷¹ The guidance was produced as a response to the concerns raised in the 1995 White Paper: *Rural England – A Nation Committed to A Living Countryside* which stated that the intrusiveness of lighting in the countryside should be kept to a minimum. *Lighting in the Countryside* sought to mitigate "excessive" "unnecessary" and "obtrusive" lighting. The Institution of Lighting Engineers (ILE) said in its memorandum "lighting in itself is not a problem; it only becomes a problem where it is excessive, poorly designed, badly installed or poorly maintained."⁷² The issue is not aided by the uncertainty over which Government department has lead responsibility for the problem of light pollution. Several departments are involved: Transport (street lighting is a main cause of light pollution), DEFRA (the Department has published the main government guidance on the matter and would implement a statutory nuisance on light) and ODPM (planning is currently the only control over lighting).

71 Department of Environment and Countryside Commission, *Lighting in the Countryside: towards good practice*, 1997, p 17

72 Ev 185



Source: Institution of Lighting Engineers, *Guidance notes for the reduction of light pollution*, 2000

Sky glow

43. Sky glow is the orange glow seen over towns and cities. It is caused by light travelling through the atmosphere being refracted or scattered by water droplets or particles (aerosols) caused by dust, pollen, bacteria, spores, salt from sea spray, mineral particles lifted from deserts and waste products from industry. It is therefore worse in heavily polluted areas, and will always exist to some extent when the air quality is poor. The glow over urban areas is not always localised and can be seen from many miles around, often spreading into dark rural areas. This brightness of the sky obscures distant stars, especially those low in the sky or just above the horizon, making them invisible to the naked eye.⁷³

44. The orange colour of the glow is due to low-pressure sodium street lighting units that were the most common type of lighting installed in the past.⁷⁴ The light is radiated directly upwards from the light fitting (luminaire) and light is also reflected back off whatever is being lit – the road, pavement, or building etc.⁷⁵ Even lighting traversing a path at a shallow level above horizontal level will cause sky glow as the light shining will be refracted against particles and droplets in the atmosphere. An element of sky glow is also attributable to radiation from celestial sources and luminescent processes in the Earth's upper atmosphere.⁷⁶

73 Ev 181

74 Ev 224

75 Ev 181

76 International Commission for Illumination, *Guide on the limitation of the effects of obtrusive light from outdoor lighting installations*, CIE 150: 2003, p 2

Glare

45. “Glare” consists of light shining into the eye, preventing the person from seeing the illuminated scene properly – for example a car with headlights on full beam will dazzle a driver or pedestrian moving the other way. Similarly, an over-powerful security light or floodlighting will dazzle and cause a temporary, sometimes painful contraction of the muscles controlling the iris, making it difficult to see into the areas surrounding the light. The effect can cause momentary blindness and bring safety risks for drivers moving rapidly from dark areas to relatively bright ones.⁷⁷

Light Trespass

46. Light trespass is defined as light that shines from one property into another where it is not wanted. It is also referred to as “light spill”. Security lights are the most common culprit.

47. The Department for the Environment, Food and Rural Affairs is currently considering the responses to its consultation “*Living Places – Powers, Rights, Responsibilities*”. This consultation paper was published at the same time as the Office of the Deputy Prime Minister published “*Living Places: Cleaner, Safer, Greener*”.⁷⁸ The DEFRA consultation sought opinions on how council powers could be revised to manage public spaces. This included whether new regulations for the positioning of external lighting (other than street lights) and powers to extend the statutory nuisance regime to include lighting were necessary.⁷⁹

Who and what does light pollution affect?

Astronomers

48. Our inquiry has concentrated on astronomy. Light pollution has forced astronomers to move to areas with dark skies,⁸⁰ or to travel great distances to find dark areas, or to be content with a severely reduced number of stars visible. Skyglow, light trespass and glare have all contributed to light pollution. The reduction of stars visible affects the observations of amateurs, professionals, students and pupils of astronomy in the UK: only a privileged few will have the advantage or opportunity of accessing an overseas world-class telescope first hand.

49. The majority of the evidence we received was from astronomers who regularly observed from their own back gardens. They explained their frustration at having observing conditions ruined by a neighbour’s security lights or from glare from streetlights and floodlights. Observatories also complained of the effect of this localised light pollution. The Rt. Hon. Keith Hill, MP, Minister of State, Housing and Planning, Office of the Deputy Prime Minister, told us “I am permanently blasted out of my chair in my

77 *Lighting in the Countryside*, p 20

78 Eleventh Report of the Office of the Deputy Prime Minister: Housing, Planning, Local Government and Regions Committee, Session 2002-03, *Living places: cleaner, safer, greener*, HC 673-I.

79 Ev 222 and ODPM Committee, *Living Places: cleaner, safer, greener*.

80 Ev 66, 153

conservatory by the totally inexplicable but extremely effective security light which a neighbour has across our back garden fence.”⁸¹ In spite of his first hand experience of the unpleasantness of light trespass, Mr Hill’s understanding of the nature of light pollution is flawed. He told us “We are talking about different issues when it comes to light as a nuisance from the issue of light pollution in general.”⁸² The remedies for the different types of light pollution may differ, but light trespass, glare and sky glow are all caused by an unnecessary misuse of light. This confusion is indicative of the Government’s disjointed treatment of the problem of light pollution.

50. Whilst there are different types of light pollution and different ways to tackle them, the problem for each type of light pollution is the same: inappropriateness of the direction and power of light. Astronomers in particular are affected by all three types of light pollution: the majority of the population, be they the general public, school pupils, postgraduates, professional or amateur astronomers, are prevented from seeing the night sky in its entirety by light pollution. We hope that this Report will inform the Office of the Deputy Prime Minister of the effects of light pollution on astronomy.

The general public

51. The loss of the dark night sky and stars has been noticed by ordinary citizens who wish to be able to see the stars, without the orange glow. The BAA conducted a survey in 1991 which concluded that more than 90% of those who wished to see the night sky were prevented in doing so to some extent by light pollution.⁸³ We received evidence from members of the public who are not astronomers, and yet have suffered a great deal from the nuisance caused by inappropriate floodlighting and over-powerful industrial or domestic security lighting.⁸⁴ Security lighting shining through windows and curtains can cause great distress and have adverse effects on health and well being by disturbing sleep patterns and causing stress. A 1993 survey by the Chartered Institute of Environmental Health indicated that 80% of local authorities had received complaints about light pollution. When a similar survey was conducted in 1996 the level of complaints was found to have risen by 44%. The main sources of complaints were domestic security lighting (55%), sports facilities (21%) and industrial and commercial premises (19%).⁸⁵

Wildlife

52. *Lighting in the Countryside* discussed the effects of light pollution on wildlife, and concluded that there could be adverse ecological effects on:

- Insect populations, particularly moths and glow worms. A high general level of illumination may cause night-flying insects to cease flying and settle; while individual lights may mislead the insects' flight, causing them to fly in spirals.

81 Q 164

82 Q 164

83 Ev 110

84 Ev 55, 61, 62, 214

85 *Lighting in the Countryside*, p 20

- Nocturnal mammals are likely to be disturbed by the presence of bright illumination and could be deterred from using established foraging areas.⁸⁶ The International Commission on Illumination (CIE) advises that livestock can be adversely affected by inappropriate outdoor lighting, leading to decreases in production capacity due to the disruption of the animals' metabolic functions.⁸⁷
- For plants, the main effects are that some short-day plants will not flower if the night is shorter than the critical length, while others will flower prematurely as a result of exposure to the photoperiod required for flowering. In addition, low pressure sodium lamps have been shown to disrupt the photoperiodic regulation of plant growth and development. For example, Rice ear formation is delayed by night-time light.⁸⁸
- Birds can have their behavioural patterns significantly damaged. *Lighting in the Countryside* says:

“The attraction of birds to lights has been known for a long time. A close correlation has been demonstrated between commencement of dawn singing in thrushes and critical light intensity at sunrise, suggesting that artificial lighting may modify the timing of natural behaviour patterns. Reproduction in birds is photoperiodically controlled, and artificial increase of day length can induce hormonal, physiological and behavioural changes, initiating breeding. Around sixty species of wild birds have been brought into breeding condition prematurely by exposure to artificially long days in winter. In addition, bright lights such as those on telecommunication towers, lighthouses and other tall structures may attract and disorientate birds, especially on moonless nights, resulting in mortalities. Nocturnal species, many of which are already under threat, are particularly likely to be disturbed by the presence of bright illumination.”⁸⁹

53. We were told that the Empire State Building turns its lights off once a year to prevent the deaths of migrating birds.⁹⁰ We have not looked in detail at the environmental impact of light pollution but the action we recommend later in the report would have significant beneficial effects on many aspects of the natural environment.

The environment

54. The Committee has received evidence on the significant amount of energy wastage that occurs from inappropriate lighting. Examples include: all night (and sometimes daytime) floodlighting of buildings, all night and over-powerful domestic security lighting, the lighting of empty car parks, as well as inefficient street lighting which throws light upwards into the sky rather than downwards onto the road or pavement it is supposed to illuminate. There is no doubt that the production of electricity using fossil fuels causes continued pollution of the atmosphere, which in turn creates greater sky glow.

86 *Lighting in the Countryside*, p 22

87 CIE 150:2003, p 6

88 CIE 150:2003, p 6

89 *Lighting in the Countryside*, p 23

90 Ev 119

55. Following the Kyoto Protocol of 1997, the UK's target for the reduction of greenhouse gases (including CO₂) was a 12.5% decrease in 1990 levels by 2010. In our Report *Towards a non-carbon fuel economy: research, development and demonstration*, we concluded that this target was unachievable if current policies and market conditions remained in place.⁹¹ Both the Performance and Innovation Unit Report *The Energy Review*, and the Energy Research Review Group recommended that energy efficiency had a vital role to play in reducing the UK's carbon emissions. The PIU called for a 20% improvement in domestic energy efficiency by 2010.⁹² The Energy White Paper said that improving energy efficiency is "the cheapest, cleanest and safest way of addressing our energy policy objectives."⁹³ **Reducing the amount of electricity used to provide safe and effective levels of lighting for homes, streets and public buildings must be a priority for the Government.**

56. We deal later with how much energy could be saved if unnecessary lighting were switched off and street lighting changed.

57. The adverse effects of light pollution on energy consumption are both undisputed and a source of much disquiet and annoyance for large parts of the population. The Government fails to take the issue seriously and does not consider light pollution in its full context – with its effect on everyone.

Evidence of deterioration

Anecdotal evidence from astronomers

58. We have received many memoranda from professional and amateur astronomers around the country giving anecdotal evidence of the steady increase in light pollution. Most individuals had been observing between twenty and fifty years and described the decreasing visibility of stars over the years as disastrous, particularly since the 1960s. This decade coincides with the installation of street lighting consisting of low-pressure sodium lights, high pressure mercury or tungsten light sources which are difficult to control optically, resulting in unacceptable high levels of light pollution.⁹⁴ The increase in levels of air pollution and the decrease in air quality in general will have also exacerbated skyglow.

59. Astronomers measure the brightness of stars in stellar magnitudes. This is a logarithmic scale reflecting the way the eye reacts to light. The scale runs from negative to positive, with the brightest stars having magnitude -1 .⁹⁵ A star of $+6$ magnitude will be one hundred times fainter than a star of magnitude $+1$. The brightest star in the night sky is Sirius, which is of -1.4 magnitude.⁹⁶ In a pristine clear night sky, from a dark site, stars of the sixth magnitude should be visible with the naked eye: one should be able to see the Milky Way and Andromeda Spiral Galaxy.⁹⁷ However, due to urban skyglow, only stars

91 Fourth Report of the Science and Technology Committee, Session 2002–03, *Towards a non-carbon fuel economy: research, development and demonstration*, HC 55, para 216

92 Performance and Innovation Unit, *The Energy Review*, February 2002, paras 9.12, 7.63

93 Department of Trade and Industry, *Our energy future—creating a low carbon future*, Cm 5761, February 2003, para 3.47

94 Ev 53, 182

95 Ev 179

96 The scale continues as follows: a star of $+5$ magnitude is 2.512 times brighter (2.512 being the fifth root of 100) than a star of magnitude $+6$, and so on. *Light Pollution, Responses and Remedies*, p 23

97 Ev 47

brighter than the +1 magnitude are visible in urban areas, and there are only sixteen stars in the whole sky brighter than +1 magnitude.⁹⁸ The Milky Way is no longer visible once the faintest star visible is of magnitude +4.⁹⁹

60. The following table shows the number of stars that should be visible in one third of the total night sky, per limiting magnitude (or faintest star visible).

Limiting Magnitude	2	3	4	5	6	7
Number of Stars visible	<25	<50	<250	800	2500	7000

Source: IDA

61. Star maps, showing which stars are visible in the various magnitudes, can be found in the written evidence.¹⁰⁰ The following data is taken from evidence submitted by astronomers; showing how light pollution has affected observations various parts of the country:

- Forty years ago the Milky Way was visible from Liverpool; now only stars of the third magnitude are visible.¹⁰¹
- Thirty years ago, the Milky Way was visible in Finchley; now only stars of the third magnitude are visible.¹⁰²
- In 1976 it was possible to see the Milky Way regularly from Bexleyheath; now it is only visible on a very few nights a year.¹⁰³
- Twenty five years ago, the Milky Way was visible from Bristol.¹⁰⁴
- Only stars of the fifth magnitude are now visible in Maidenhead.¹⁰⁵
- Only stars of the fourth magnitude are now visible in Darlington.¹⁰⁶
- In the 1950's stars of the sixth magnitude were visible in Brightlingsea, Essex; now only third magnitude is visible.¹⁰⁷
- In Berkshire, in the 1960's sixth magnitude stars were visible; in the 1970's 5.5 magnitude; and in the 1980's and 1990's stars of the fifth magnitude were visible.¹⁰⁸

98 Ev 179

99 *Light Pollution, Responses and Remedies* p 34

100 Ev 206

101 Ev 158

102 Ev 67

103 Ev 64

104 Ev 63

105 Ev 79

106 Ev 83

107 Ev 99

108 Ev 112

- In the late 1980's it was still possible to see the Milky Way in South East England; now it is impossible.¹⁰⁹

62. Additionally, in response to our call for evidence, the Society for Popular Astronomy (SPA) held a survey amongst its members, 800 of whom responded. Included in the findings were:

- Nearly 80% could not see the Milky Way or could only see it on the best nights.
- 58% had to travel between 5 and 50 miles to find acceptable viewing conditions.
- 1 in 8 had to travel over 50 miles.¹¹⁰

The Campaign to Protect Rural England and British Astronomical Association's "Night Blight" joint campaign

63. The Campaign for Dark Skies (CfDS) is a section of the British Astronomical Association (BAA). It was created in 1990 by a group of astronomers "concerned about the erosion of the night sky by uncontrolled and ill directed lights of all kinds."¹¹¹ They wish to see the right amount of light and only where needed. The Campaign to Protect Rural England (CPRE) considers that the dark sky is one of the things which had defined the countryside. In 1994 CPRE and BAA had jointly produced a leaflet called *Starry Starry Night*, which tackled light pollution.

64. Following the receipt of pictures from the weather satellites owned by the US Air Force, the two organisations joined up again to produce *Night Blight!*, a campaign against light pollution. These two organisations should be commended for their work in bringing light pollution to the attention of the wider public. Scientists at the US National Oceanographic and Atmospheric Administration (NOAA) used the Operational Line Scanners aboard the weather satellites to measure the total brightness of artificial night time lights within small areas of the Earth's surface. *Night Blight* states "These maps provide an approximate but adequate overall measure of light pollution in each locality".¹¹² NOAA had been creating these maps since 1993, and so CPRE were able to compare the maps from 1993 and 2000. Whilst some areas had become darker (2%), the majority of the UK had become more brightly lit, with fewer areas of truly dark sky. CPRE banded the areas of lightness into colours, with navy being the darkest areas, and red being the brightest. In England, the darkest band fell from 15% in 1993 to 11% in 2000, whilst 26% had shifted up a brightness band between 1993 and 2000.¹¹³

65. *Night Blight* states that one's view on the ground will depend on whether there are any local bright lights to impede your view of the night sky. However, on a clear night, it should be possible to see the Milky Way in a deep blue banded area – but no chance of seeing the Milky Way on even the clearest night within the red and yellow bands where most of the

109 Ev 213

110 Ev 160

111 Ev 47

112 Campaign to Protect Rural England and the British Astronomical Association, *Night Blight!*, 2003

113 *Night Blight!*, p 7

population lives.¹¹⁴ CPRE and CfDS believe that these pictures prove the major growth in light pollution in recent years. Other satellite pictures have also been produced showing images of the light output of countries around the world, e.g. by Professor Woody Sullivan, Astronomy Department of the University of Washington.

66. When faced with the satellite pictures, the Rt. Hon. Keith Hill MP said: “in terms of light pollution, my own impression is that a certain amount of progress is being made. If you look at these dramatic satellite pictures of the expansion of areas, it seems to me that it is, as we say in the trade – us New Labour types, do we not? – a matter of the red light joining up in the urban and suburban partnership, spreading over into rural areas”.¹¹⁵ The thrust of the Minister’s argument seemed to be that as urban areas had borne the brunt of the increase in light pollution, the satellite pictures were not to be regarded as an indication that light pollution was getting worse.

67. It is reassuring that Lord Rooker, Minister of State for Regeneration and Regional Development, ODPM, during a debate on light pollution in the House of Lords on 19 June 2003, stated on the subject of the satellite pictures: “There has been an increase in light pollution: there is no question about that. The issue is what we do about it [...] we need positive solutions to the issue [...] There is a lot to do, as the recent satellite photographs show. There is no question about that.”¹¹⁶ **We are disappointed by the inconsistent approach by the Government on the issue of light pollution. We hope that the more realistic attitude adopted by Lord Rooker is the true reflection of the Government’s approach. The Government should not dismiss the compelling evidence of the satellite images of the United Kingdom, which clearly show an increase in light pollution in both rural and urban areas.**

Not just a UK problem

68. After the Netherlands, the UK is the most light polluted country in Europe. Light pollution is a global problem. Astronomers worldwide have raised concerns over the impact of light pollution. The International Dark Skies Association was set up in the USA in 1988 to tackle light pollution. It now has over ten thousand members in many countries.¹¹⁷ To date, together with the UK and the USA, there are organisations in the following countries who are working to counter the effect of light pollution: Australia; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Italy; Japan; Malta; Slovenia; South Africa; and Switzerland.¹¹⁸ The International Astronomical Union (IAU) has passed resolutions at eight general assemblies on the issues of light pollution. In 1999, the IAU and the United Nations Special Environment Symposium “Preserving the Astronomical Sky” made recommendations to member states.¹¹⁹ In September 2002, the Second European Symposium on the Protection of the Night Sky took place in Lucerne, Switzerland.

¹¹⁴ *Night Blight!*, p 7

¹¹⁵ Q 155

¹¹⁶ HL Debate 19 June 2003, col. 954

¹¹⁷ Ev 41

¹¹⁸ See *Light Pollution, Responses and Remedies* for details, p 169.

¹¹⁹ Ev 175

69. Should the Government decide to take action against light pollution, it would not be the first government to do so. The following countries, states, regions or cities have enacted legislation to control light pollution: the Czech Republic; Lombardy, Italy; Catalonia, Spain; Canary Islands, Spain; Maine, USA; Arizona, USA; Bisei, Japan; and Calgary, Canada. It is clear that some Governments are taking the threat of light pollution, to both the astronomer, the ordinary citizen, and the environment, seriously. Details of how each country or region controls light pollution can be found in an annex to this Report.¹²⁰

70. Those who have spent a lifetime studying the night sky have charted its deterioration and have now joined forces with environmental campaigners, astronomers in other countries, and also with those members of the general public, increasing in numbers, who have experienced the adverse effects of the increasingly badly lit environment. We are in no doubt that light pollution is getting worse. We recommend that the Government acknowledge this fact and give a commitment to taking serious action to tackle this problem, as other governments have proved it is possible to do.

3 What causes light pollution?

The need for lighting

71. We have received evidence on the need for lighting for social, security and safety reasons. The main issues raised were:

- The need to prevent road accidents by providing good definition of the roads through street lighting.
- Providing light on roads, pavements and pathways promotes a feeling of safety and well being for pedestrians and road users. Sympathetic lighting can illuminate and enhance architectural features of towns for the enjoyment of citizens.
- Lighting deters and reduces crime.

72. Evidence received has shown that street lighting has been effective in reducing the number of road traffic accidents.¹²¹ It is somewhat beyond the remit of this inquiry to investigate whether lighting does engender a feeling of safety for pedestrians at night or whether lighting does indeed prevent crime. A number of memoranda questioned the accuracy of the Home Office survey which concluded that lighting does prevent crime.¹²² It is interesting that the Home Office-sponsored Crime Reduction Website warns that over powerful infra red sensor activate security lighting creates dark shadows which make it easier for criminals to enter a property unseen.¹²³ The UK's streets are now more brightly lit than ever, and yet crime levels have risen since the days when street lighting was turned off at night. There is a suggestion that whilst people may *feel* safer, in statistical terms they

¹²⁰ See Annex 1.

¹²¹ Ev 231, 81

¹²² Farrington and Welsh, *Effects of improved street lighting on crime: a systematic review*, Home Office Research Study 251 (2002).

¹²³ <http://www.crimereduction.gov.uk/burglary45.htm>

may not actually be any safer. The Government told us that they were due to highlight the role that good lighting may play in reducing crime in its good practice guidance on “planning out crime”, due to be published later in 2003.¹²⁴

73. Witnesses have submitted written papers to the Committee on the adverse effect of lighting on crime.¹²⁵ Other memoranda has commented that more lighting at night enables criminals to see what they are doing—for example, would graffiti artists be able to work in the dark? Without commenting on the validity of this evidence, the Committee notes that in the August 2003 electricity blackout in parts of North America, the feared crime wave did not materialise. Similarly, in 1998, Auckland was victim to a black out lasting several weeks. A police inspector was reported as saying “It’s almost a crime-free zone. The normal levels of muggings, violence, fights, burglary and robbery have just not happened.”¹²⁶

74. We consider that whilst the role of efficient and well positioned street lighting in reducing accidents has been proven, the evidence relating to the correlation between lighting and crime is not conclusive. This link is outwith the remit of our inquiry, but is an area that merits further research. We look forward to seeing what new evidence the Government has received on the role of lighting in the reduction of crime when its good practice guidance “planning out crime” is published later this year. However, we believe that the impact of lighting on crime should be only one of a number of factors that is considered in the determination of Government policy on lighting.

LIGHTING EQUIPMENT TYPES

Taken from *Lighting in the Countryside*:

Lamps: *Gas discharge lamps* can be split into two types. The first type produces ultra-violet radiation from the gas discharge which is converted into visible light through a reaction with a phosphor coating on the glass bulb. This type includes the tubular fluorescent lamp used in most commercial offices and the growing number of small 'energy saving' compact fluorescent lamps available for the home. The second type, which produces visible light directly, includes metal halide, high pressure sodium and low pressure sodium lamps. All gas discharge lamps require extra electrical components, both to switch on the light and throughout the period they are working. They have relatively high efficiencies and long lives, but varying colour appearance and rendering capabilities.

Luminaires: While it is possible to run most lamps in free air, it is normal practice to fit them into some type of *luminaire*. The luminaire can provide protection for the lamp against damage and/or the weather and may protect people in the vicinity against burning or electric shock. In the case of gas discharge lamps, the luminaire may act as a container for the lamp control gear, and most importantly, it may act as an optical device for controlling and directing light, helping to reduce the risk of light trespass.

The two types of luminaire commonly used in exterior lighting are the *fixed angle* and *variable angle* luminaires. The former is designed for use in a fixed orientation, such as on the top of a lamp post or built into the wall of a building, while the latter is fitted with a movable bracket, allowing the installer to direct the light beam to the direction required. In many cases it is the choice of luminaire which will determine the impact of the light. Luminaires which provide *full horizontal cut-off* (HCO) can minimise sky glow, and many have reflectors which control and direct the light beam with varying degrees of accuracy and effectiveness.

124 Ev 225

125 Ev 185, and P R Marchant, *The Claim that Brighter Lighting reduces Crime is Unfounded*, 2003 and LPA 88, Barry Clark, *Outdoor lighting and Crime*, 2002.

126 *Light pollution, Responses and Remedies*, p 59

Street lighting

75. The ILE told us that there is a predominance of low pressure sodium (LPS) lighting (sometimes referred to as SOX lighting) in the UK. This was installed in the 1970s as it was considered to be the most energy efficient at that time.¹²⁷ Its disadvantages are that the light is difficult to control because of the physical size of the luminaires and that it causes the unpleasant orange tinged glow. The ILE estimate that 45% of street lighting in England is of that type and consider that the figure is probably the same for Wales, Scotland and Northern Ireland.¹²⁸ Some astronomers told us they preferred LPS lighting as it is easier to filter out, but most astronomers, the ILE and the Highways Agency advocate the disuse of LPS lighting in favour of high pressure sodium (HPS) lighting (also called SON lighting). The Highways Agency told us that it “carefully considers the overall environmental impact, energy efficiency, maintenance and aesthetics of its lighting installations before implementing a scheme.”¹²⁹ HPS lamps can be more controlled and can direct the light downwards whilst spreading it along the road – enabling the maximising of spacing the light fittings. It is also possible to use other white coloured light sources to reduce lighting levels on small areas such as housing estates.¹³⁰

76. The shape of the lamp is also important – lamps with fully curved bowls tend to spill more light above the horizontal. Whilst the ILE recommends that all lights be designed so that there is no upwards light from them, it has concerns about Full Cut-Off lighting (FCO) being used for all lighting.¹³¹ ILE believes that FCO lighting is not suitable for all street lighting, and should be kept for dark rural areas and areas near observatories. For general street lighting they suggest:

“we would advocate the use of shallow bowl luminaires (less than 60mm projection) for traffic route lighting as these give many of the benefits of non cut-off lighting with few of the disadvantages of Full Cut-Off lighting.”¹³²

77. For lighting in residential areas the ILE suggests that FCO is not suitable, but that the low pressure sodium lighting should be replaced with high sodium pressure lighting. The ILE estimates that better controlled modern lighting, for example shallow bowl luminaires, could reduce the amount of light pollution from the replaced lights by up to 20% without any difference in running or maintenance cost to the old LPS systems.¹³³

78. Street lighting in the UK is under Highways Agency or local authority control, depending on the type of road, or under the control of the devolved legislatures.

127 Q 86

128 Q 90

129 Ev 231

130 Q 86

131 Q 87

132 Ev 195

133 Ev 182

Highways Agency controlled street lighting

79. The Highways Agency lights approximately 30% of its 9,380 km strategic motorway and trunk road network, using a variety of luminaires.¹³⁴ A road is only lit by the Agency if an economic assessment shows that lighting will reduce the number of accidents. The Agency told us that lighting can reduce the number of night time accidents by up to 30%.¹³⁵ Before lighting is installed or renewed, the Agency has to hold a full assessment of the environmental impact considerations in accordance with the Department for Transport's "New Approach to Appraisal" Document.¹³⁶

80. Approximately 35% (51,000) of luminaires under the Agency's control are LPS, and the remaining 65% (94,000) are HPS with 50% having FCO or flat glass diffuser luminaires. The Highways Agency intends gradually to replace all of its lights with more environmentally friendly lights – using both HPS and FCO lighting. The framework for replacement is over the next 10–15 years.¹³⁷ They acknowledge that the HPS lighting will not bring any energy savings, but will better control the level and spread of light.¹³⁸

81. The Agency told us that it supported a number of research projects into light pollution, and was running trials on the reduction of lighting levels on roundabouts.¹³⁹ The Agency was also able to work with the ILE, the devolved assemblies and local authorities on the issue of improving road effectiveness as it sat on the Department of Transport's Lighting Board. The 1998 White Paper "*A New deal for Transport – better for everyone*", states that "where lighting is essential, it should be designed in such a way that nuisance is reduced and the effect on the night sky is minimised." It appears that Transport is one Department that is taking light pollution seriously and is implementing changes through the Highways Agency.

82. We welcome the fact that both the Department of Transport and the Highways Agency have given due consideration to the issue of light pollution. The Highways Agency has shown forward thinking in its gradual replacement of luminaires, and in giving environmental considerations top priority. It should be congratulated for its work with the lighting industry and with the Department for Transport's Lighting Board, to improve the efficiency of lighting throughout the UK. It should continue to work with local authorities to "spread the word" about light pollution and the benefits of High Pressure Sodium lighting. We look forward to viewing the results of various research projects into the effect of light pollution that the Agency has contributed to.

Street lighting under local authority control

83. Whilst the Highways Agency has control of approximately 145,000 street lights, roughly 4,355,000 lights are under local authority control. Much of this lighting is LPS,

134 Ev 231

135 Ev 231

136 Department for Transport, *A new deal for transport: better for everyone*, Cm 3950, July 1998

137 Qq 107–108

138 Q 113

139 Ev 231

over 30 years old and in need of replacing.¹⁴⁰ The Fifth Report of the Transport Committee of Session 2002–2003 (HC 407–1) stated that there had been uncertainty over the true extent of the maintenance backlog. Local authorities had been asked by the Department of Transport to determine the condition of their lighting by July 2003.¹⁴¹

84. The Government is currently making available £300 million in PFI credits for local authorities outside of London to invest in street lighting over the next three years, and £80 million to local authorities within London.¹⁴² When asked whether local authorities were receiving guidance from Government on the type of lighting they should be installing, the Minister for Housing and Planning replied:

“There is central government guidance in a succession of documents on the issue of light pollution, which we certainly expect local authorities to take cognisance of in their street lighting renewal programmes.”¹⁴³

85. ODPM later clarified that these documents were the Department of the Environment’s ‘Lighting in the Countryside’ and Department of Transport’s ‘Road Lighting and the Environment’, and that table 8.4 of ‘Lighting in the Countryside’ highlights other guidance available for lighting roads and pathways, including Department of Transport’s Design Manual for Roads and Bridges Vol. 10 and British Standard 5489, ‘General Principles of Road Lighting’, 1992.

86. These guidelines are too diffuse to be of any real significance or help to a local authority. The Transport White Paper says “where lighting is essential, it should be designed in such a way that nuisance is reduced and the effect on the night sky in the countryside is minimised.” It does not tell a local authority how this could be done.¹⁴⁴ BS 5489 says “in some cases artificial lighting can be obtrusive at night. This applies especially to rural and open spaces where the lighting can be seen as an intrusion into an otherwise darkened environment. In addition light above the horizontal should be minimised as it is wasteful and increases sky glow.” It then draws attention to the IAU/CIE publication providing information on lighting in the vicinity of astronomical observatories.¹⁴⁵ Again, there is no real Government guidance of the type and design of light that should be used on streets and roads. ‘Lighting in the Countryside’ gives options available but the document is clearly labelled “The content of the Guide should not be taken to be a definitive statement of Government policy [...] Although this report was commissioned by the Office, the findings and recommendations are those of the authors and do not necessarily represent the views of the Office of the Deputy Prime Minister.”

87. Street lighting that is being replaced by local authorities now will have a life expectancy of between twenty five to thirty years. If a local authority installs the ‘wrong’ type of luminaire, the Government will have lost an ideal opportunity to modernise street lighting, improve efficiency and reduce light pollution.

140 Q 120

141 Fifth Report from the Transport Committee, Session 2002-03, *Local Roads and Pathways*, HC 407-1, para 56

142 Q 159

143 Q 159

144 Ev 224

145 Ev 225

88. The Government must act now to ensure that every local authority about to invest in new street lighting is well informed of the properties of modern luminaires and the issues of light pollution. If the Highways Agency, backed by the Department of Transport, has taken a policy decision to use high pressure sodium lighting, with full cut off and shallow bowl luminaires in its own replacement of street lighting, then the Government should issue clear guidance to local authorities that these types of lighting are believed to be the most suitable lights available at this time. British Standards codes of practice and guidance should be updated accordingly.

89. Firm guidance and direction must come from the Government on this issue. Relying on piecemeal guidance, published some years ago, to inform important local decisions such as the replacement of the street lighting systems is not an acceptable attitude from the Government which is spending £380 million on this project.

90. Local authorities which have not already invested in new lighting must be strongly advised to install High Pressure Sodium lighting, the design of which should be shallow bowl or fully cut off lighting as appropriate. Local authorities should also be required to follow ILE and CIE guidelines when deciding where to install Full Cut Off lighting, with an obligation to protect observatories, dark rural areas and parkland within their jurisdiction.

Energy savings of street lighting

91. Although BAA and CPRE have both submitted evidence that the changeover to FCO luminaires would create energy savings, the ILE do not fully support this idea. BAA suggests that the total amount of wasted light (pointing above the horizontal rather than onto the street) from street lights amounts to 0.33 of a gigawatt a year.¹⁴⁶ Whilst the ILE do not dispute that this amount of light is wasted through inefficient lighting systems, they question the energy savings that could be brought about by the installation of FCO luminaires. Instead, the ILE suggest that the modernising of street lighting alone will bring about greater energy efficiency due to the advances of lighting technology in the last 30 years, but that even controlling lighting levels and better maintenance will not bring the energy savings suggested by the BAA.¹⁴⁷ **We remain unconvinced that modernising street lighting alone will bring significant energy savings, but with pressure from Government, the lighting industry will respond to the need to provide more energy efficient and less light polluting luminaires. Whilst energy saving targets are important, the Highways Agency and local authorities must ensure that luminaires under their control only direct light where it is needed in order to start a trend in the reduction of light pollution.**

The other main causes

92. The other types of lighting which have been described as the most obtrusive by the evidence we have received are listed below.

146 Qq 27–28

147 Ev 195

Domestic and industrial security lighting

93. In most cases, no planning permission is necessary for domestic or industrial security lighting. Only free standing structures carrying lighting fixtures are deemed ‘development’ under the Town and Country Planning Act 1990, and therefore subject to possible planning conditions. Individuals and small businesses are able to buy over-powerful security lighting, install it incorrectly and shine 500 watts through their neighbour’s windows, or into their neighbour’s gardens without any control. Sales of 500w lights rocketed in the 1980s and 1990s.¹⁴⁸ These lights were nicknamed ‘rottweiler’ lights by Libby Purves, and can make astronomical observations difficult from hundreds of metres away.¹⁴⁹ The Institution of Lighting Engineers (ILE) produced a leaflet entitled “*Domestic Security Lighting, Friend or Foe*” in recognition of the growing problems caused by this lighting. This leaflet advises those buying security lights:

“Because of price and ease of installation, many people install tungsten halogen floodlights. These units can provide satisfactory security lighting if correctly installed and aimed, however it is rarely necessary to use a lamp of greater than 2,000 lumens (150w) in such fittings. The use of a higher power only causes more glare and darker shadows [offering] a convenient hiding place for criminals.”¹⁵⁰

94. Rather than the 500w tungsten halogen lights, particularly those with Passive Infra Red (PIR) sensors which detect movement and mean the light flicks on and off all night, the ILE recommend low wattage compact fluorescent lamps (9/11w and 600–900 lumens) which give off gentle, soft illumination and can be left running all night if required. According to the ILE, security lighting is the area of lighting in which there are true energy savings to be made, if the public could be persuaded to use alternatives to the 500w lights.¹⁵¹ The BAA estimate that a one kilowatt light left on for twelve hours every night will result in CO₂ emissions from power stations of 3.5 tonnes a year, whereas a 100w light left on for the same time will produce 0.35 of a tonne per year of CO₂ emissions.¹⁵² **It is clear that there are significant potential energy savings to be made in the area of security lighting by reducing the amount of light pollution emitted from them.**

95. We asked B&Q and Homebase to give details of their light pollution policies. Only B&Q replied; however, CPRE report that Homebase did stock a ‘Dark Sky Friendly product’ and Focus Do it All stocked mostly 150w lights.¹⁵³ B&Q’s memorandum to the Committee states that they are keen to contribute towards the reduction of light pollution and have been promoting a range of lighting specifically designed to reduce stray light. B&Q’s annual turnover of security lights is £12.5 million, and £2 million of this is made up of 500w security lights. They stated that they were reconsidering the price architecture of 500w lights as these lights are £1 cheaper than 150w lights. B&Q consider they fully discharge their responsibility as the majority of B&Q floodlights are fitted with an anti light

148 *Light Pollution, Responses and Remedies*, p 49

149 *Light pollution, Responses and Remedies*, p 80

150 Institution of Lighting Engineers, *Domestic Security Lighting, Friend or Foe*, 2000.

151 Ev 195

152 Q 29, Ev 115

153 *Night Blight!*, p 21

pollution bracket preventing the customer angling the light upwards, and instructions with information about light pollution are included in the packaging of all security lights.¹⁵⁴

96. Based on B&Q figures alone, and estimating that the average 500w light costs £10 or less, at least 200,000 500w lights are being sold and installed every year, and the overwhelming majority of these lights are far too bright for their purpose. We have received evidence that despite the best efforts at negotiation, many householders, astronomers or not, are unable to persuade their neighbours to reduce the power of the lighting or to re-position it.¹⁵⁵ **Whilst it is possible to angle 500w security lights correctly, we consider that for normal domestic purposes, they are energy-inefficient and liable to cause a nuisance.**

97. The Government in its memorandum indicated that it was not in favour of controlling the designs of lighting available to the public.¹⁵⁶ However, when questioned on this subject the Minister for Housing and Planning told us that the Government had looked at the issue of only permitting the use of approved lighting devices which will not cause pollution:

“we are looking very specifically at the question of the power of certain forms of lighting used on the exterior of households and we are giving very serious consideration to taking action to prevent.”¹⁵⁷

98. **Whilst it is commendable that retailers have considered the issue of light pollution, leaflets inside the packaging of security lights will not alert customers to the benefits of a less powerful light before they decide which security light to buy. Providing the Institution of Lighting Engineer’s Guidance on security lighting, or a version thereof, alongside the displays of security lighting would greatly assist the customer. However, it will not prevent incorrect installation of lights. Only legislation either banning the sale of 500w lights as security lighting, or the designation of light as a potential statutory nuisance will ensure that householders suffering from their neighbour’s overspill of light have a remedy: we favour the control of obtrusive light through statutory nuisance legislation.**¹⁵⁸

Floodlighting of sports facilities

99. The floodlighting of stadia, golf driving ranges, football pitches, and tennis courts can cause light pollution for miles around. Sport facilities are important amenities to communities, and floodlighting of facilities enables them to be accessed by a greater number of people at hours convenient to the modern workforce. However, the lights must be properly installed and positioned so that the beams do not cause glare or nuisance to others. Planning Policy Guidance Note 17 (PPG17): Planning for Open Space, Sport and Recreation, suggests that local authorities should take into account the visual impact of the lighting towers during the daytime. Planning permission is required for floodlighting of this nature, and so the positioning and strength of new floodlights can be controlled by

154 Ev 227

155 Ev 116, 215

156 EV 226

157 Q 169

158 See paragraphs 137-146.

local authorities should they wish to do so – unfortunately they often do not. We received evidence from the ILE that many sports facilities had recently received lottery grants to install floodlights, leading to a number of complaints from people living in the surrounding area whose properties were lit up by cheap, badly installed floodlights.¹⁵⁹

Car parks

100. Witnesses were particularly annoyed with the tendency of companies, particularly supermarkets to keep empty, locked car parks illuminated all night. Unfortunately many car parks are lit by globe lighting chosen for its daytime appearance rather than its efficiency. Witnesses considered this all-night lighting to serve no purpose and to be both wasteful and a nuisance. The ILE told us “[globe luminaires] much loved by planners and architects, are some of the worse for causing light pollution and in many cases actually emit more light upwards than downwards.”¹⁶⁰ It is possible to modify globe lighting to cause less light pollution, and astronomers have reported that some companies have responded well to requests to turn off lighting at night or to modify existing lighting.¹⁶¹ The only way to ensure that any lighting scheme of this nature is properly controlled is to ensure that planning conditions on the style and type of lighting to be used in a development are imposed before planning permission is granted.

Floodlighting of buildings and monuments

101. Four hundred churches received grants from the Millennium Commission towards floodlighting projects across England.¹⁶² Unfortunately, like that used on many other buildings, poorly designed floodlighting is usually positioned on the ground shining upwards into the sky, missing most of the building it is meant to be illuminating. Lighting structures and installations of this kind may require planning permission if they are substantial, or alter the building’s external *daytime* appearance, or if they are new developments in their own right. The case of *Kensington and Chelsea Borough Council v CG Hotels and Another* shows how a local authority failed to force the removal of ground and first floor floodlights shining on a hotel, as the judge decided that the installations were invisible during daylight hours, and the lighting was a consequence of electricity passing through the apparatus, rather than the apparatus itself.¹⁶³ As it was not a listed building, planning conditions or controls on lighting would not have applied in this case, but a statutory nuisance of lighting could have applied if the hotel were causing a nuisance to its neighbours.

102. Whilst we agree with the Commission for Architecture and the Built Environment that sympathetic and well positioned lighting can add to the public enjoyment of towns

159 Q 95

160 Ev 182

161 *Light pollution, Responses and Remedies*, p 75

162 *Night Blight!*, p 15

163 Ev 87

and cities; it is a questionable use of money to floodlight buildings all night long.¹⁶⁴ For example, the Palace of Westminster is only floodlit until midnight.¹⁶⁵

103. Those responsible for floodlighting buildings and sports facilities and those companies lighting car parks should consider whether there is any need for lighting after 11pm or midnight. We recommend that, when giving planning permission to plans for new buildings with floodlighting, new floodlighting systems or new car parks, local authorities should impose conditions relating to the type of lights that are appropriate, how they should be positioned and the timing of the lighting to ensure it is not obtrusive to those around it and that it does not contribute to energy wastage.

Shining examples (and otherwise)

104. The central pages of this Report show photographs of lighting submitted by witnesses. Some are examples of skyglow and of badly installed or positioned lighting that has caused glare and nuisance. Other photographs show correctly positioned street lighting and security lighting.

4 Can and should light pollution be subject to legislative control?

Current Government guidance on light pollution

105. This Report has illustrated how astronomers and environmental campaigners have raised the problem of the growth of light pollution and its effects on us all. According to the evidence received, the situation has worsened substantially over the last thirty years. When asked what was being done to mitigate this growing problem, the Government told us that their strategy for tackling light pollution consisted of:

“raising awareness by those who buy and procure external lighting of the consequences of badly installed lighting; providing guidance on how those problems might be mitigated; providing advice, and by encouraging more effective use of existing planning powers.”¹⁶⁶

106. Annex Two shows a list of documents, Government and non-Government, which provide guidance on the issue of lighting and light pollution. The ILE, the Society of Light and Lighting (CIBSE), and the International Commission on Illumination (CIE) have produced the most prolific amount of lighting guidance. The ILE “Guidance Notes for the Reduction of Light Pollution” has been used, copied and adapted by organisations and countries around the world.¹⁶⁷

164 Ev 127

165 Ev 222

166 Ev 224

167 Ev 180

107. The most comprehensive Government document on the issues of lighting is “Lighting in the Countryside”, referred to earlier in the Report in the sections on street lighting. The Government claim that their policy of raising awareness was affirmed by the publication of this document which aimed to:

“minimise the intrusiveness of lighting in the countryside. It is designed to provide practical advice to local authorities, developers, professionals and members of the public on: lighting design, products and standards; the effects of lighting on people, wildlife and countryside character; preparing and assessing the impacts of lighting schemes; how the planning system can best promote good lighting practice; and good practice for lighting schemes associated with particular types of development.”¹⁶⁸

108. Whilst this document is useful in both urban and rural contexts, the title might discourage an urban local authority from referring to it. We note that the document is now out of print and only available online.¹⁶⁹ The DEFRA consultation “Living Places – Powers, Rights, Responsibilities”, which is currently under consideration by the Government, asked local authorities, householders and building developers whether they considered that the guidance in “Lighting in the Countryside needed updating. **We recommend that the Government update “Lighting in the Countryside” to take into account its relevance to urban authorities and, bearing in mind the imminent investment by local authorities into street light replacement, republish and circulate the document accordingly.**

109. The “Lighting in the Countryside” guidance, together with the Department of Transport documents and British Standards guidance constitute the Government’s efforts to raise awareness of the issue of light pollution and give advice. Whilst it is possible that these documents might reach the right people within local authorities, we fail to see how the Government is taking steps to raise awareness of the issue of light pollution amongst the ‘rottweiler’ security light buying general public.

110. The only controls over light pollution are by use of the planning system. “Lighting in the Countryside” advises local authorities to consider “including a policy in relation to lighting in their development plans, and for supplementary planning guidance to elucidate those policies”. The Government is unaware how many local authorities have followed this advice.¹⁷⁰ In addition, three Planning Policy Guidance Notes (PPGs) deal with lighting, whilst another two PPGs mention lighting in brief.

Planning Guidance

PPG 12 Development Plans

111. PPG 12 recommends subjects that ought to be included in Structure Plans and Development Plans. Local authorities are required to have regard to “social economic and environmental considerations.” Environmental considerations are to be taken into account “comprehensively and consistently”. Light pollution is listed as one of the environmental

168 Ev 224

169 <http://www.odpm.gov.uk>

170 Ev 225

considerations that ought to be taken into account, though it is not explained how this should be done. The reader is referred to PPG23 for further guidance.

PPG 23 Planning and Pollution Control

112. Local authorities are advised that the factors which planning authorities should take into account in preparing local plan policies will include “the possible impact of potentially polluting development on land use, including the effects on health, the natural environment, or general amenity resulting from releases [of] light”. There is no guidance on how this should be done in PPG 23.

PPG 17 Planning for Open Space, Sport and Recreation

113. PPG 17 recommends that planning authorities ensure that local amenity is protected when considering applications for floodlighting on sports grounds. It refers to the impact of the daytime appearance on the surrounding countryside.

Others

114. Two other PPGs refer to lighting: PPG15 “Planning and Historic Environment” discusses the need for consent for the floodlighting of historic buildings; and PPG19 “Outdoor Advertising Control” where local planning authorities should have regard to the effect of advertising on the appearance of buildings.

115. The Minister for Housing and Planning told us: “Planning guidance is already entirely clear at the moment in terms of our encouragement of down lighting. Full Cut-Off and Full Cut-Off in certain circumstances, good shaded lighting in other circumstances. Guidance is absolutely clear-cut about that.”¹⁷¹We were extremely surprised by this answer. We are not aware of any Government planning guidance that tells local planning authorities when to use Full Cut-Off lighting and when to use partially cut off lighting.

116. Planning guidance on light pollution to local authorities lacks coherence and force. Light pollution is not tackled head on in any PPG. The response from the local authorities to those seeking protection from light nuisance is uneven and usually unhelpful.

How local authorities can use the current guidance to prevent light pollution

117. Local planning authorities may control light pollution by either rejecting an application for planning permission on amenity or environmental grounds; or may grant permission subject to conditions or a legal agreement. Local authorities may include policies on lighting in their local development plans (as is suggested in PPG12) and refuse an application based on those policies. CPRE provided examples in “Night Blight” of local authorities which had implemented policies within their local plans. Two local authorities submitted details to us of their local Plans. Canterbury City Council and Huntingdonshire

District Council (DC) both had Supplementary Planning Guidance (SPG) on the subject of light pollution. Canterbury has included the policy as a direct response to the joint BAA/CPRE campaign to raise awareness of the issue of light pollution.¹⁷²

118. Mr Peter Lummis, Lighting Engineer, at Huntingdonshire DC told us how successful Huntingdonshire had been in implementing their SPG. There can be no doubt that this is due to the enormous enthusiasm for and knowledge of the subject shown by Mr Lummis, and the good communication that exists between the Lighting and the Planning Departments in Huntingdonshire DC. There, planning applications with lighting schemes are passed to the Lighting Engineer for examination. More detail may be requested by the local authority – particularly regarding lighting levels at the boundary of the site and beyond the boundary. Huntingdonshire also has in its lighting guidance permissible levels of lighting according to the zone the premises is located in – this has been taken from ILE guidance.¹⁷³

119. Mr Coatham of the ILE told us that local authorities should require applicants “when they are submitting designs for planning approval, to carry out an impact assessment on the lighting and that impact assessment should include what the amount of light going upwards is [...] they should also be required to do an impact assessment of the light falling onto properties around.”¹⁷⁴ Planning conditions can then be attached to the planning permission.

120. Mr Lummis told us that once the building has been completed he visits the site with the enforcement officer and a lux meter and confirms whether or not the conditions have been fully discharged before full planning permission is granted.¹⁷⁵ Although negotiations were necessary as applicants often submitted initial applications with unsuitable lighting, Mr Lummis told us he could not think of any case where negotiation and practical discussion had not come up with a suitable solution.¹⁷⁶

121. When asked why all local authorities did not have the same attitude towards lighting as Huntingdonshire, Mr Lummis replied that at Huntingdon, lighting engineers worked closely with the planning department and so could be more closely involved with planning decisions. Funding is designated to ensure that planning departments have use of lighting engineer expertise.

122. The Rt Hon Keith Hill MP said “on the whole the local authorities are not doing as badly as the most pessimistic observers might expect. Something like 35 per cent of local authorities have light pollution controls in their planning guidance. The evidence from the CPRE report is that a further 26 per cent of authorities are actively involved in bringing forward light pollution controls in their planning guidance, others are contemplating it.”¹⁷⁷ This still left 35 per cent of the local authorities CPRE contacted with no light pollution policies of any kind and no plans to introduce them.¹⁷⁸ CPRE contacted 49 English

172 Ev 230

173 Institution for Lighting Engineers, *Guidelines for the Reduction of Light Pollution*, 2000

174 Q 95

175 Q 127

176 Q 130

177 Q 154

178 Night Blight!, p 24

planning authorities, and so there is no definitive figure for the number of UK authorities with light pollution policies. There is no guarantee that these authorities will create policies in the near future, and may continue giving consent to planning applications with the worst type and positioning of luminaires. Mr Lummis told us: “Unless the planners themselves are either encouraged one way or formally forced by law to do it, there are always going to be some who are going to resist and do it their own way.”¹⁷⁹

123. There are too many local planning authorities which have not taken the issue of light pollution seriously and have not included light pollution in their local plans. The Government must take steps to rectify this. It should have a clear policy on when Full Cut Off lighting should be used, and we recommend that this policy is communicated to local authorities.

The need for a new PPG on light pollution

124. Many local authorities may not be aware of the issues of light pollution and may have overlooked “Lighting in the Countryside” if their area is an urban or suburban one. In order to bring light pollution to the attention of all local planning authorities, a separate PPG on light pollution should be created, giving local authorities clear guidance on what considerations should be given to every planning application containing a significant lighting scheme. It would also communicate the Government’s policy on FCO lighting to local authorities.

125. Every local planning authority should be obliged to create Supplementary Planning Guidance (SPG) on Light Pollution. It should be subject to public consultation as it is drawn up – particularly with local astronomy societies. The SPG should give Planning Officers the necessary powers to request information on lighting schemes, and Planning Departments will be able to reject schemes which are non-compliant with the SPG.

126. Before planning permission is granted a local authority should require the following details (together with any other lighting conditions that are appropriate):

- The height, type, shape and luminance output expected of the luminaires.
- The minimum level of light required to perform the lighting task.
- An impact assessment of the lighting.
- Whether the light fitting minimises the amount of light spill above the horizontal, and whether it lights areas outside the boundaries of the property it is meant to illuminate. (For example, applications to install globe or sphere lighting should be rejected unless the light is shielded and directed downwards.)
- Whether the lighting scheme in an area near to an astronomical observatory or nature conservation area that needs protecting. If so, local environmental groups or the observatory should be consulted before planning permission is granted.

- Will the lighting be on all night or will it be timed to go off at say, 11pm or midnight?
- If a lighting scheme was installed before the local policy on lighting was implemented, it must be resubmitted for planning permission upon replacement.
- In areas of doubt, the planning permission should be subject to tests on the lighting levels with the requirement that the lighting installations be changed if they are not satisfactory.

127. The Government should create a new Planning Policy Guidance (PPG) on Light Pollution as soon as possible and ensure that all local authorities are made aware of their obligation to include lighting in their local development plans. Local authorities must be obliged to request lighting schemes from those seeking planning permission for new developments, or changes to existing schemes. Lighting schemes must only include lights that do not shine above the horizontal. The new PPG should refer local authorities to the Institution of Lighting Engineers “Guidelines for the Reduction of Light Pollution” and the Department for the Environment’s “Lighting in the Countryside” and publications by the International Commission on Illumination for further guidance.

The shortfalls of current planning guidance and implementation

128. We have received many memoranda from individuals, astronomers or not, who list examples of bad planning decisions, disinterest from local authorities, or lack of awareness from planning departments of the issues of light pollution.¹⁸⁰ We have also received examples of local authorities improving street lighting schemes, only for the effect to be mitigated by bad light spill from neighbouring sports facilities.¹⁸¹ One memorandum stated of the attitude of local authorities to repeated enquiries concerning badly sited and designed lighting: “so many of us feel we are banging our collective heads against a brick wall”.¹⁸² Mr Mizon of CfDS said “the majority of the correspondence I receive as Co-ordinator of the Campaign for Dark Skies is from people who quite simply say that their councils say they cannot do anything or they will not do anything.”¹⁸³

129. The three major drawbacks of current guidelines are that:

- The most conscientious planning authority can do nothing about light polluting fixtures installed before the local authority implemented its light pollution policies. If a company or individual have fulfilled the planning conditions, the local authority has no powers of enforcement. Peter Lummis of Huntingdonshire DC told us “that is the where the big difficulty is for us as a local authority”.¹⁸⁴ Local authorities can only wait until lighting is replaced and a new planning application is submitted.

180 Ev 43, 54, 55, 57, 62, 63, 64, 72, 92, 94, 132, 139, 163, 199, 212

181 Ev 52, 76

182 Ev 66

183 Q 23

184 Q 132

- Many types of “problem” exterior lighting – mainly security and floodlighting – are not considered to be development and so are not subject to planning permission. Local authorities have no powers of control.
- Light pollution, like noise pollution, travels. A local authority only has powers of enforcement over buildings and structures within its area. Many people suffer from glare and light spill from buildings or sports facilities in neighbouring districts outside the jurisdiction of the local authority in which they live.

130. Whilst it has been possible for amateur astronomers and local authorities to approach individuals and organisations with light polluting luminaires and persuade them to alter, change or adapt the fittings, this is not always the case. Mr Lummis said “some people are very ignorant and they will not work by negotiation unfortunately; some people only respond to “Thou shalt” rather than “Would you mind sorting this out with us?”.¹⁸⁵

131. When asked how Huntingdonshire District Council deals with neighbouring councils without lighting policies, Mr Lummis replied “We would have officers who would try to work and encourage other authorities to take the same steps and the same attitude as we have. We would always try to do that. It is difficult.”¹⁸⁶ When asked if there was good co-operation between adjacent local authorities, he replied “Not as much as there ought to be, perhaps.”¹⁸⁷

132. Also, observatories, especially those used by universities funded through the Science Budget and those offering practical observation experience to schools, have no special protection, despite their valuable purpose. For example, St Andrews University has benefited from negotiating with the local Town Council for the introduction of cut-off lighting, but the observatory is still affected by the skyglow from Dundee. Dr Hilditch of St Andrews University believed that the observatory is also likely to be affected by a new housing development less than a mile away whose lighting schemes have not been made subject to planning controls. Likewise, the Royal Astronomical Society told us that Cambridge University had repeated battles on light pollution issues each time new developments were at the planning stage.¹⁸⁸

133. The Government should afford special protection to observatories, for the same reasons that the UK Government supports the protection of UK funded observatories in the Canary Islands. Local authorities should be obliged to consult on planning applications for developments in the vicinity of observatories, which should be able to object if the development is likely to affect their observations. Observatories would be able to register with their local authority for protection, showing their active membership or links with local schools as evidence of their importance to the community.

134. In essence, the Government’s current position is that sufficient guidance on lighting exists in the public domain, no further controls on the types of lighting systems available

185 Q 140

186 Q 141

187 Q 142

188 Ev 176

are necessary, and local authorities can control light pollution through planning controls as they currently exist. We disagree.

135. The Campaign for Dark Skies (CfDS) was set up in 1989 to tackle light pollution. It now has 120 officers throughout the country. Members have spent the last fourteen years attempting to stem the increase of light pollution. Unlike the Government, CfDS has been waging an active campaign in the field to educate local authorities, organisations and individuals on the disadvantages of light pollution in general, how it can be alleviated and how controls could be included into local plans and implemented effectively.¹⁸⁹ And yet light pollution is getting worse. Bob Mizon, Director of CfDS made a significant analogy when he said of 500w security lights “They are the new leylandii”.¹⁹⁰

136. Legislation combating the nuisance of Leylandii has gained Government support.¹⁹¹ However, when asked whether light pollution ought to be accorded the same Government support, the Rt Hon Keith Hill MP said: “Candidly the answer is no [...] the point about Leylandii is that I am very keen about that legislation but it is a very definable and a very specific nuisance which has highly specific anti-social effects. With the best will in the world, I do not think that the same arguments could be deployed about light pollution.”¹⁹² **We disagree that light pollution is less serious than the issue of Leylandii. Light pollution is not only detrimental to the science of astronomy, but it is wasteful of energy and causes distress to many individuals.**

The case for a Statutory Nuisance of Light

137. Together with our suggested new PPG on Light Pollution, making light a statutory nuisance would enable local authorities to tackle lighting that has previously been impossible for them to control. Light was omitted as a statutory nuisance from the Environmental Protection Act 1990, whereas nuisances such as noise, smoke, fumes, gases, dust, steam, smell, and animals were included. It is difficult to understand why this omission took place. An individual can suffer from the effects of intrusive light from his neighbour in the same way that he might suffer from noise or smell pollution. The Act gives local authorities the power to serve an abatement notice on the offender requiring the offender to take steps necessary to remove the cause of the nuisance and prevent its reoccurrence. Under the serving of such an order, light spill from floodlighting, street lighting or from security lighting would be remedied by simple adjustments or by adding baffles, louvres and other shieldings to obtrusive lights.

138. Light, like noise, dust and smoke can travel great distances. The Environmental Protection Act 1990 also enables local authorities to take action where the nuisance has occurred within the area of the local authority but was caused by an act or default taking place outside the area. If light were made a statutory nuisance, a conscientious local authority would be able to protect its own ratepayers from the lightspill caused by buildings, roads and facilities in a neighbouring, light polluting local authority.

189 Q 41

190 Q 38

191 High Hedges (No. 2) Bill, [Bill 28 (2002-03)]

192 Q 163

139. We do not expect the creation of light as a statutory nuisance to open the floodgates of complaints. We do, however, consider that light can be prejudicial to health and can cause great distress. Those that have suffered the unwanted effects of light pollution in the past will finally have a remedy. We expect that the creation of light as a nuisance would bring about a greater general awareness of the correct installation and siting of light fittings. There would be a greater obligation on retailers to ensure that security lights are sold that are suitable for the size and location of house and property.

140. The Government has already confirmed that it has given serious consideration to the issue of light pollution and statutory nuisance, and DEFRA is now considering the responses to its consultation “Living Places – Powers, Rights, Responsibilities”. This paper sought opinions as to whether the Government “should introduce new regulations for positioning of external lighting (other than street lighting) and the powers to extend the statutory nuisance regime to include lighting.” We were interested to note that the Local Government Association was not consulted on this matter.¹⁹³ From the Government evidence it would appear that although the Government is open to the possibility to light being made a statutory nuisance, the main issue of contention is the measurement of light.¹⁹⁴

Can light pollution be subject to statutory enforcement?

141. The Government told us that “It is extremely difficult to design a feasible means of assessing external light for statutory planning control purposes.”¹⁹⁵ However, if light from a property or structure falls across a property boundary onto another premises so as to cause a nuisance, this light can be measured. Evidence from the ILE and Mr Peter Lummis, lighting engineer for Huntingdonshire District Council, confirmed that it is possible to do this.¹⁹⁶ The CIE has also recently published guidance on how such measurements could be made to assess and control levels of illumination in cases of obtrusive outdoor lighting.¹⁹⁷ The CIE described how it was possible to calculate, using computer programming, the intensity of a proposed light fitting and the area which will be illuminated by it.¹⁹⁸ Once the light fitting has been installed, light trespass onto a boundary, through a window, can be measured using a lux meter. Mr Lummis also gave the example of how he had assessed how much light fell from a floodlighting structure onto a neighbouring chicken farm. Once light levels were assessed, the floodlights were altered and the levels re-measured.¹⁹⁹

142. Should it be impossible to measure an obtrusive light source, DEFRA confirmed that subjective judgments, as is the case for the nuisance of smell, could also be used without the need for scientific measurements. There have been two judgments already based on the subjective opinion of the Judge.²⁰⁰ We seen no reason why Environmental Health Officers,

193 Ev 68

194 Ev 222

195 Ev 226

196 Qq 95, 136

197 CIE 150:2003, p V

198 CIE 150:2003, p 20

199 Q 136

200 *Bonwick v Brighton and Hove Council*, August 2000, and *Stonehaven and District Angling Association v Stonehaven Tennis Club*.

with the relevant training, should not be able to assess light spill and make a subjective judgment on a case by case basis. Dr Martin Williams, Head of Air and Environmental Quality Division, DEFRA confirmed that:

“You are right to imply that there are existing nuisances classified as statutory nuisances which do not necessarily have a particularly scientific method of measurement when they are judged and assessed by environmental health officers. In that regard, you can mount a very credible argument that light could be handled in that way.”²⁰¹

143. An acceptable level of light for different situations would have to be agreed, but we are confident that this can be achieved through consultation with local authorities, interested parties and the Institution of Lighting Engineers. Mr Williams confirmed that “the relevant point is that one has to go through the whole process of agreeing the methods for assessing light as a nuisance. That may not necessarily mean some very sophisticated and lengthy and involved scientific method.”²⁰²

144. Whilst we have received several memoranda containing suggestions for the measurement of skyglow – including star counts and the use of photographic equipment – PPARC, the Government and the ILE all agree that it would be difficult to accurately measure sky glow over a town, city or area of countryside.²⁰³ However, Mr David Coatham of the ILE confirmed that it was possible to measure the amount of light being shone above the horizontal for planning and enforcement purposes:

“Whilst the level of skyglow cannot simply be measured, an assessment of the level of light going directly upwards from the luminaires can be calculated from the photometric data for the specific luminaire at its specified mounting angle. This can be used to give an indication of the level of direct light sent up in to the sky and would allow maximum values to be set.”²⁰⁴

145. We conclude that the problem of light pollution can be alleviated without the need for scientific measurement of sky glow. Sky glow is just one of three types of light pollution, the cause of which is well known, and is clearly visible – particles in the air and light shining above the horizontal. Light shining above the horizontal should be tackled directly by controls on the direction, position and type and duration of lighting, guidance on which should be included in the PPG on light pollution we have recommended.

146. Smell is currently assessed on the subjective judgment of the Environmental Health Officer – light can be assessed the same way, and there is legal precedent to show that this judgment can be made. The Government seems to be using the argument that measurement of all light pollution is impossible as a reason to do nothing about it. In the mean time, light pollution is getting worse. **Light trespass and glare affects astronomers, but it can also affect us all. We are persuaded by the evidence that light trespass is**

201 Q177

202 Q177

203 Ev 184, Q 212, Ev 226

204 Ev 195

measurable and controllable. We recommend that obtrusive light should be made a statutory nuisance.

How other jurisdictions have legislated against light pollution

147. As previously discussed, other countries have produced legislation to counter the effects of light pollution. Only one country, the Czech Republic, has enacted national legislation. Each country has tackled the issue by controlling the type and position of light source and fitting that may be installed, rather than just measuring the emission.

148. For example, in the United States of America several states (Connecticut, Pennsylvania, Maine, Texas, Colorado, Massachusetts, Maryland and Georgia) have legislation of various degrees of severity requiring state-funded lighting to be fitted with FCO lighting if the lighting units have an output of greater than 1,800 lumens (a 125w bulb). Arizona has required that all outdoor lighting fixtures must be fully or partly shielded with FCO lighting if the lights are more than 150w. Non-conforming lights can be used if they shut off automatically between midnight and dawn. New Mexico requires that all new outdoor lighting should be shielded below the horizontal level or shut off after 11pm. Non-conforming lighting must be replaced with conforming fixtures once they wear out.

149. The Czech Republic's "Protection of the Atmosphere" Act 2002 defines light pollution as any form of illumination by artificial light which is dispersed outside the areas in which it is intended, particularly in cases when the light is above horizontal level. Powers have been given to local authorities to specify and implement regulations to ensure that light pollution does not occur within their municipality, and they have been given the power to impose fines if these regulations are breached. It does not specify how pollution is to be measured or prevented, further than the definition of light pollution itself. However, an amendment is currently going through the Czech Parliament which will provide greater detail on this.

150. Bisei in Japan and the Canary Islands have both implemented legislation to protect world-class observatories in these areas, and in both areas the restrictions are quite severe. For example, in Bisei all outdoor lights (apart from safety lights) must be turned off after 10pm, and both indoor and outdoor lights must be shaded to prevent light going above the horizontal. Bisei has adopted the IAU guidance which suggests that the brightness of the night sky should not exceed 10% of the natural condition. The Japanese National Government have developed guidelines, and planning guidance referring to international examples and aiming to reduce light pollution.

151. Lombardy passed the regional law, The Light Pollution Act 2000 in order to reduce light pollution and the energy consumptions deriving from it, and to protect professional astronomical observatories and non-professional observatories carrying out scientific research or work aimed at the popularisation of astronomy. Under the law, regional and provincial administrations, municipalities, astronomical observatories, manufacturers, importers and suppliers of lighting installations, project technicians and installators were all given directives to comply with. The municipalities were responsible for adopting lighting plans and their enforcement. The Act defined the types, position and power of

lights permissible and gave municipalities the power to apply administrative endorsements to those who failed to comply with the law.

152. In La Palma, as well as restrictions on the types of lighting permissible, ornamental floodlighting, the floodlighting of sports facilities and advertisements must be turned off after midnight. Each zone on the island has a total limit on the amount of light emission permissible. The observatory in La Palma is protected by the Astrophysics Institute's Office for the Protection of the Quality of the Canarian Sky. Professor Murdin told us that the technique for monitoring the light emissions was "repeated photographs of the landscape around the observatories and repeated measurement of the flux of light from artificial sources that comes from the telescope."²⁰⁵ There are similar restrictions around the Anglo-Australian telescope in Australia and the International Observatory in Chile which is monitored by the Office for the Protection of the Skies of Northern Chile.²⁰⁶ Both the Government and PPARC have voiced their support for these restrictive measures around the world-class observatories overseas in which the UK Government has heavily invested.²⁰⁷

153. Other countries have used restrictions on the type and duration of lighting permissible in an attempt to control light pollution. Measurement of light emission is only used in the most heavily regulated areas. We believe that the Government should monitor the situation in the UK carefully over the next five to ten years. Should the creation of a statutory nuisance of light, a separate PPG for light pollution and enhanced guidance to local authorities on the issue of light pollution not produce a reduction of the current levels of skyglow, the Government must consider adopting similar legislation to other countries, to control the types of outside lighting used, and to ensure that no outdoor lighting shines above the horizontal. The Government must recognise, as other countries have, that the night sky needs protecting.

Conclusion

154. A memorandum to us asked would people accept the daytime blue sky being turned orange by pollution?²⁰⁸ Many people in the United Kingdom may have been unaware of the increase in light pollution. For some time now people living in urban areas have been amazed by the "difference" of the rural night sky to that viewed from towns or cities. However, evidence has shown that uncontrolled light pollution is now reaching the previously dark remote areas of countryside.

155. People have a right to feel safe and secure in their homes, to travel safely on the roads at night and to enjoy the amenities of the towns and cities where they live. Homes, streets, sports facilities, and historic buildings can all be lit effectively without the need to light up the night sky. Any light spilling above the horizontal is causing sky glow and light trespass and is preventing astronomical observations. It is also wasting energy and causing distress to an increasing number of people.

205 Q 62

206 Ev 178

207 Ev 204, 223

208 Ev 54

156. We consider that the astronomical community in this country is a particularly strong one and that it should be encouraged by the Government. Amateur astronomers not only support major professional projects through day to day observations, but also donate much of their time to introducing the general public and young people to the night sky, astronomy and through that initial interest, very often into a physics career.

157. We have prepared this Report to emphasise the importance of protecting astronomy as a science in this country. If we are to invest heavily in observatories abroad, we must also invest in the young scientists of today who will work in La Palma, Hawaii, Australia and Chile in the future. It is worth protecting the night sky for the use of astronomy pupils and students, amateurs and professional astronomers alone. However, Professor Sir Martin Rees provided an analogy when he pointed out that we may not all be ornithologists but we would miss the song birds in our gardens.²⁰⁹

158. The Government may not consider the effect of light pollution on astronomy in the UK to be a pressing issue, but amateur astronomers have taken on the issue on behalf of those who mourn the loss of the night sky, not only astronomers but also the general public, and those affected by the unwelcome intrusion of light. If the Government accepts this Report's recommendations it will start the process of reducing light pollution. In 20 years time it might then be possible for young people studying astronomy to see the Milky Way in the UK night skies once more.

Conclusions and recommendations

Amateur Astronomy in the UK

1. We conclude that there is convincing evidence that many professional astronomers benefit from the valuable input made to professional astronomy by the observations of amateurs. (Paragraph 23)
2. We believe that amateur and professional astronomers have played a valuable role in the introduction of young people into science. As Sir Patrick Moore commented “the amateur [astronomer] of today is the professional researcher of tomorrow”. (Paragraph 27)

The study of Astronomy in the UK

3. Astronomy in the UK plays a valuable part in supporting the work of professionals, engaging young people in science, and producing astronomers and physicists through UK universities. It is not good enough that PPARC and the Department for Education and Skills had to pay for young people in schools to “book time” on overseas telescopes to see the night sky as it should be. (Paragraph 32)
4. Pupils should be able to study the night sky at school primarily with the naked eye or through a telescope rather than via a computer and the internet. (Paragraph 33)
5. There seems to be an acknowledgement within Government that Space is a good way to engage young scientists, but there is little real support for schools to use observing facilities in this country. The Department for Education and Skills should be supporting efforts to make the night sky available to all. We regret that it is not doing so at present. (Paragraph 34)
6. We regret that PPARC and the Government have adopted a defeatist attitude towards light pollution and astronomy in the UK. There are substantial numbers of amateur astronomers, astronomy undergraduates and postgraduates and professional astronomers observing in the UK. Amateur and professional astronomers have undertaken a dual role of showing and explaining the night sky to students, pupils and the general public, whilst campaigning for the last ten years to prevent further degradation of the night sky. It is time they receive support from PPARC and the Government. (Paragraph 40)
7. There is a real opportunity of using the enthusiastic astronomy community to increase the numbers of school pupils taking astronomy and continuing into physics. PPARC and DfES together should bring to bear more pressure on ODPM and DEFRA to find a way to protect the skies, particularly around those observatories who work with local schools. (Paragraph 41)

What is light pollution

8. Reducing the amount of electricity used to provide safe and effective levels of lighting for homes, streets and public buildings must be a priority for the Government. (Paragraph 55)
9. The adverse effects of light pollution on energy consumption are both undisputed and a source of much disquiet and annoyance for large parts of the population. The Government fails to take the issue seriously and does not consider light pollution in its full context – with its effect on everyone. (Paragraph 57)

Evidence of deterioration

10. We are disappointed by the inconsistent approach by the Government on the issue of light pollution. We hope that the more realistic attitude adopted by Lord Rooker is the true reflection of the Government's approach. The Government should not dismiss the compelling evidence of the satellite images of the United Kingdom, which clearly show an increase in light pollution in both rural and urban areas. (Paragraph 67)

Not just a UK problem

11. Those who have spent a lifetime studying the night sky have charted its deterioration and have now joined forces with environmental campaigners, astronomers in other countries, and also with those members of the general public, increasing in numbers, who have experienced the adverse effects of the increasingly badly lit environment. We are in no doubt that light pollution is getting worse. We recommend that the Government acknowledge this fact and give a commitment to taking serious action to tackle this problem, as other governments have proved it is possible to do. (Paragraph 70)

The need for lighting

12. We consider that whilst the role of efficient and well positioned street lighting in reducing accidents has been proven, the evidence relating to the correlation between lighting and crime is not conclusive. This link is outwith the remit of our inquiry, but is an area that merits further research. We look forward to seeing what new evidence the Government has received on the role of lighting in the reduction of crime when its good practice guidance “planning out crime” is published later this year. However, we believe that the impact of lighting on crime should be only one of a number of factors that is considered in the determination of Government policy on lighting. (Paragraph 74)

Street lighting

13. We welcome the fact that both the Department of Transport and the Highways Agency have given due consideration to the issue of light pollution. The Highways Agency has shown forward thinking in its gradual replacement of luminaires, and in

giving environmental considerations top priority. It should be congratulated for its work with the lighting industry and with the Department for Transport's Lighting Board, to improve the efficiency of lighting throughout the UK. It should continue to work with local authorities to "spread the word" about light pollution and the benefits of High Pressure Sodium lighting. We look forward to viewing the results of various research projects into the effect of light pollution that the Agency has contributed to. (Paragraph 82)

14. The Government must act now to ensure that every local authority about to invest in new street lighting is well informed of the properties of modern luminaires and the issues of light pollution. If the Highways Agency, backed by the Department of Transport, has taken a policy decision to use high pressure sodium lighting, with full cut off and shallow bowl luminaires in its own replacement of street lighting, then the Government should issue clear guidance to local authorities that these types of lighting are believed to be the most suitable lights available at this time. British Standards codes of practice and guidance should be updated accordingly. (Paragraph 88)
15. Firm guidance and direction must come from the Government on this issue. Relying on piecemeal guidance, published some years ago, to inform important local decisions such as the replacement of the street lighting systems is not an acceptable attitude from the Government which is spending £380 million on this project. (Paragraph 89)
16. Local authorities which have not already invested in new lighting must be strongly advised to install High Pressure Sodium lighting, the design of which should be shallow bowl or fully cut off lighting as appropriate. Local authorities should also be required to follow ILE and CIE guidelines when deciding where to install Full Cut Off lighting, with an obligation to protect observatories, dark rural areas and parkland within their jurisdiction. (Paragraph 90)
17. We remain unconvinced that modernising street lighting alone will bring significant energy savings, but with pressure from Government, the lighting industry will respond to the need to provide more energy efficient and less light polluting luminaires. Whilst energy saving targets are important, the Highways Agency and local authorities must ensure that luminaires under their control only direct light where it is needed in order to start a trend in the reduction of light pollution. (Paragraph 91)

Other main causes

18. It is clear that there are significant potential energy savings to be made in the area of security lighting by reducing the amount of light pollution emitted from them. (Paragraph 94)
19. Whilst it is possible to angle 500w security lights correctly, we consider that for normal domestic purposes, they are energy-inefficient and liable to cause a nuisance. (Paragraph 96)

20. Whilst it is commendable that retailers have considered the issue of light pollution, leaflets inside the packaging of security lights will not alert customers to the benefits of a less powerful light before they decide which security light to buy. Providing the Institution of Lighting Engineer's Guidance on security lighting, or a version thereof, alongside the displays of security lighting would greatly assist the customer. However, it will not prevent incorrect installation of lights. Only legislation either banning the sale of 500w lights as security lighting, or the designation of light as a potential statutory nuisance will ensure that householders suffering from their neighbour's overspill of light have a remedy: we favour the control of obtrusive light through statutory nuisance legislation. (Paragraph 98)
21. Those responsible for floodlighting buildings and sports facilities and those companies lighting car parks should consider whether there is any need for lighting after 11pm or midnight. We recommend that, when giving planning permission to plans for new buildings with floodlighting, new floodlighting systems or new car parks, local authorities should impose conditions relating to the type of lights that are appropriate, how they should be positioned and the timing of the lighting to ensure it is not obtrusive to those around it and that it does not contribute to energy wastage. (Paragraph 103)

Current government guidance on light pollution

22. We recommend that the Government update "Lighting in the Countryside" to take into account its relevance to urban authorities and, bearing in mind the imminent investment by local authorities into street light replacement, republish and circulate the document accordingly. (Paragraph 108)

Planning guidance

23. Planning guidance on light pollution to local authorities lacks coherence and force. Light pollution is not tackled head on in any PPG. The response from the local authorities to those seeking protection from light nuisance is uneven and usually unhelpful. (Paragraph 116)

How local governments can use the current guidance to prevent light pollution

24. There are too many local planning authorities which have not taken the issue of light pollution seriously and have not included light pollution in their local plans. The Government must take steps to rectify this. It should have a clear policy on when Full Cut Off lighting should be used, and we recommend that this policy is communicated to local authorities. (Paragraph 123)

The need for a new PPG on light pollution

25. The Government should create a new Planning Policy Guidance (PPG) on Light Pollution as soon as possible and ensure that all local authorities are made aware of their obligation to include lighting in their local development plans. Local authorities

must be obliged to request lighting schemes from those seeking planning permission for new developments, or changes to existing schemes. Lighting schemes must only include lights that do not shine above the horizontal. The new PPG should refer local authorities to the Institution of Lighting Engineers “Guidelines for the Reduction of Light Pollution” and the Department for the Environment’s “Lighting in the Countryside” and publications by the International Commission on Illumination for further guidance. (Paragraph 127)

The shortfalls on current planning guidance and implementation

26. The Government should afford special protection to observatories, for the same reasons that the UK Government supports the protection of UK funded observatories in the Canary Islands. Local authorities should be obliged to consult on planning applications for developments in the vicinity of observatories, which should be able to object if the development is likely to affect their observations. Observatories would be able to register with their local authority for protection, showing their active membership or links with local schools as evidence of their importance to the community. (Paragraph 133)
27. We disagree that light pollution is less serious than the issue of Leylandii. Light pollution is not only detrimental to the science of astronomy, but it is wasteful of energy and causes distress to many individuals. (Paragraph 136)

Can light pollution be subject to statutory enforcement?

28. We conclude that the problem of light pollution can be alleviated without the need for scientific measurement of sky glow. Sky glow is just one of three types of light pollution, the cause of which is well known, and is clearly visible – particles in the air and light shining above the horizontal. Light shining above the horizontal should be tackled directly by controls on the direction, position and type and duration of lighting, guidance on which should be included in the PPG on light pollution we have recommended. (Paragraph 145)
29. Light trespass and glare affects astronomers, but it can also affect us all. We are persuaded by the evidence that light trespass is measurable and controllable. We recommend that obtrusive light should be made a statutory nuisance. (Paragraph 146)

How other jurisdictions have legislated against light pollution

30. Other countries have used restrictions on the type and duration of lighting permissible in an attempt to control light pollution. Measurement of light emission is only used in the most heavily regulated areas. We believe that the Government should monitor the situation in the UK carefully over the next five to ten years. Should the creation of a statutory nuisance of light, a separate PPG for light pollution and enhanced guidance to local authorities on the issue of light pollution not produce a reduction of the current levels of skyglow, the Government must consider adopting similar legislation to other countries, to control the types of outside lighting

used, and to ensure that no outdoor lighting shines above the horizontal. The Government must recognise, as other countries have, that the night sky needs protecting. (Paragraph 153)

Conclusion

31. We consider that the astronomical community in this country is a particularly strong one and that it should be encouraged by the Government. Amateur astronomers not only support major professional projects through day to day observations, but also donate much of their time to introducing the general public and young people to the night sky, astronomy and through that initial interest, very often into a physics career. (Paragraph 156)
32. If we are to invest heavily in observatories abroad, we must also invest in the young scientists of today who will work in La Palma, Hawaii, Australia and Chile in the future. It is worth protecting the night sky for the use of astronomy pupils and students, amateurs and professional astronomers alone. However, Professor Sir Martin Rees provided an analogy when he pointed out that we may not all be ornithologists but we would miss the song birds in our gardens. (Paragraph 157)
33. The Government may not consider the effect of light pollution on astronomy in the UK to be a pressing issue, but amateur astronomers have taken on the issue on behalf of those who mourn the loss of the night sky, not only astronomers but also the general public, and those affected by the unwelcome intrusion of light. If the Government accepts this Report's recommendations it will start the process of reducing light pollution. In 20 years time it might then be possible for young people studying astronomy to see the Milky Way in the UK night skies once more. (Paragraph 158)

Annex 1

Information on the control of light pollution in other jurisdictions²¹⁰

Czech Republic

The Clean Air Protection and Amendment of Some Other Acts (the Clean Air Act), 14 February 2002, made the Czech Republic the first Parliament to enact national legislation to tackle light pollution.

This Act regulates measures which will lead to a reduction of light pollution of the air. Light pollution is defined as “any form of illumination by artificial light, which is dispersed outside the areas to which intended, particularly in cases when directed over the horizon level.”

The Act affects anybody whose activities are performed within premises and places specified by the implementation regulations. These persons shall be obliged to perform the orders of the relevant municipal authority, and in compliance with it, to take measures to prevent the occurrence of lighting pollution of air. The Act does not specify how the pollution is to be measured or prevented, but leaves this to the judgment of local authorities.

Under the Act, the municipal authority issues regulations, specifies measures or obligations for the prevention or mitigation of light pollution occurrence. The authority then has to ensure adherence to these measures and is empowered to impose fines for any failure to meet these obligations. Fines can be from CZK 500 to CZK 150,000, and may be imposed by the municipal authorities upon a person, who is in breach of at least one of the obligations laid down by an authority.

An amendment to this Act will be considered in the autumn of 2003 by the Czech Parliament. It is intended to provide further guidance to local authorities on the means by which pollution should be prevented and measured.

Lombardy

The Light Pollution Act enforced in the regional territory of Lombardy was passed in March 2000. It aimed to reduce light pollution, the energy consumptions deriving from it and to protect the activities of both professional astronomical observatories and observatories carrying out scientific work or the popularisation of astronomy. All installations of artificial outdoor lighting must conform with the anti-light pollution rules

²¹⁰ The information was provided by the Foreign and Commonwealth Office Science and Technology Network.

within time limits or face administrative endorsements of up to 1050 euros. A lighting system was considered light polluting if light was dispersed outside the areas to which it was functionally dedicated and if directed above the line of the horizon. The municipal authorities were made responsible for ensuring that the Act was complied with. Authorities were required to adopt lighting plans within three years of the legislation, and to guarantee the plans application and observation. Control of lighting by the authorities included measurement of luminance. The manufacturers, importers and suppliers of lighting products were made responsible for ensuring that products conformed with the law, and that recommendations were provided with the product to ensure correct positioning and use.

Other Italian regions have also enforced similar legislation. Seven proposals for legislation at national level have been submitted to the Italian Parliament between 1996 and 2001, but to date none have been approved.

United States of America

Several states, and many municipalities, have adopted legislation designed to limit light pollution from streetlights and other fixtures. Among the rationales for such measures has been energy conservation, the reduction of glare and its resulting traffic hazards, and a desire to allow people a better view of the night sky.

Connecticut

The law requires that a roadway lighting system funded by the state (1) be designed to maximise energy conservation and minimise glare and light spilling onto adjoining properties and (2) provide the minimum amount of lighting needed for its purpose. State funds can be used only if the Department of Transportation determines that the lighting needs cannot be met by other means such as reducing the speed limit in the area or installing passive lighting. The latter approach includes reflectorized roadway markings, lines, warnings, and informational signs.

Lights with a capacity of 1,800 lumens (the light produced by a 125 watt bulb) or more on the states secondary and special service highways must be designed to prevent light going above the lamp, (i.e., be equipped with a full cut-off luminaire). This requirement does not apply if it would compromise the highways safety, increase the lighting's cost, or violate federal law.

The transportation commissioner can waive the requirement if he determines it is necessary. Waiver requests must describe the lighting plan and the efforts the applicant has made to comply with the requirement and include other information the commissioner requires. In reviewing the request, the commissioner must consider design safety, costs, and other factors he considers appropriate.

These provisions do not apply if the Office of Policy and Management (1) analyses the lifetime cost of fixtures that meet these requirements and fixtures that do not and (2) certifies that the fixtures that meet the requirements are not cost effective and are not the best alternative. The law does not apply to lighting meant to be used for less than seven days (CGS § 13a-110).

Maine

Maine's law applies to all state-funded lighting fixtures. It bars the use of state funds to install or replace outdoor fixtures that exceed the minimum lighting level recommended for the application by the Illuminating Engineering Society of America or the U.S. Department of Transportation. As in Connecticut, fixtures with a rated output of 1,800 lumens must be designed so that no light goes above the lamp. In the case of highways, lighting is only allowed when non-lighting measures cannot achieve the desired result. In addition, the Highway Commissioner must consider the minimisation of glare and light trespass (light shining on neighbouring properties).

The only exceptions to these requirements are when (1) federal law has conflicting requirements or (2) the director of the Bureau of Public Improvements determines that there is a compelling safety interest that cannot be met while complying with the state law (5 Me. Rev. Stat. Ann. § 1769, 2.23 Me. Rev. Stat. Ann. § 707)

Pennsylvania

The law applies to all state-funded lighting fixtures mandating full cut off lighting for lighting units with greater than 1,800 lumens output. Lighting fixtures should be based on the minimum lighting level recommended for the application by the Illuminating Engineering Society of America or the U.S. Department of Transportation. Generally adequate consideration to light pollution and light trespass is mandatory.

Exceptions are when (1) federal law has conflicting requirements, (2) fire, police, rescue or repair personnel need light for temporary emergencies or repairs, (3) special requirements (i.e. sport facilities, historic considerations) exist, (4) substantial night time pedestrian traffic or (5) compelling safety interests mandate it.

Arizona

Arizona has recently passed Senate Bill 1218 (12th May 2003) which strengthens an earlier effort (1996, Laws 1986, Chapter 236). The law is mainly concerned with the shielding of almost all outdoor light sources. The law requires that all outdoor light fixtures (other than airport navigational lights) be fully or partially shielded. Fully shielded means that no light goes above the bottom of the lamp; partially shielded means that the shield extends at least halfway down the lamp. This requirement does not apply to incandescent lights of 150 watts or less and other sources of 70 watts or less. Streetlights are exempt from this requirement if the shielding is not available from the manufacturer.

Unlike the laws in Connecticut, this requirement applies to all lighting, rather than just that funded by the state. Nonconforming lights can be used if they automatically shut off between midnight and dawn. Arizona has prohibited the installation of new mercury vapour lamps since 1991. Counties and municipalities can adopt more stringent standards. (Ariz. Rev. Stat. § 49-1101 *et seq.*)

New Mexico

The law requires that new outdoor night lighting, with certain exceptions, be shielded below horizon level or shut off after 11 p.m. It requires that nonconforming existing

fixtures be replaced with conforming fixtures when they become inoperable. Agricultural, industrial, and mining or oil and gas facilities, and billboard lighting on interstates and federal primary highways are exempt from these requirements. Public utilities can adjust rates to recover the replacement costs (N.M. Stat. Ann. § 74–12–1 through 74–12–10).

Texas

The law bars state funds being used to install, replace, or operate outdoor lighting fixtures unless:

1. any new or replacement fixtures with a capacity above 1,800 lumens has a cut-off luminaire (this standard is somewhat more lenient than Connecticut's);
2. any new or existing lamp provides no more than the minimum lighting needed for the intended purpose, considering nationally recognised standards;
3. for state highway lighting, the use of passive measures cannot eliminate the need for the lighting; and
4. energy conservation, glare reduction, minimisation of light pollution, and preservation of the natural night environment has been fully considered.

The requirements do not apply to temporary lighting and lighting used solely to enhance the aesthetic beauty of an object. Nor do they apply when compliance would violate federal law or when there is a compelling safety interest that cannot be met by other means (Tex. Health and Safety Code Ann. § 421.001 *et seq.*).

Furthermore the 2001 Texas law (HB164) deals specifically with the "protection of professional observatories from skyglow". This law allows county commissioners near 3 Texas observatories to regulate outdoor lighting that is located in unincorporated areas (outside city limits).

Colorado

House bill 01–1160 is a bill concerning the energy-efficient standards for certain new outdoor lighting fixtures funded by the state. It is very similar to the Pennsylvania legislation in terms of requirements and exemptions.

California

SB 5X Outdoor Lighting Standards: In April of 2001, in response to the California energy crisis, the California Legislature and Governor Davis passed and signed Senate Bill 5X (Sher, Chapter 7, 1st Extraordinary Session, Statutes of 2001), part of which requires the California Energy Commission to adopt energy efficiency standards for outdoor lighting.

The Commission intends to develop and adopt lighting standards for all outdoor lighting applications, including all non-conditioned areas that are not already subject to existing California Standards. Such lighting includes but is not limited to lighting in unconditioned buildings, lighting that is mounted on the exterior of buildings, lighting that is exterior to buildings but controlled from the electrical panel of the building, and lighting that is not controlled from a building. Examples of outdoor lighting include lighting in unconditioned

warehouses and other unconditioned building spaces, lighting for parking lots, signage and advertising, car lots, and service stations, street and highway lighting and other outdoor lighting systems.

The 2005 Building Energy Efficiency Standards—(Including SB 5X Outdoor Lighting Standards) is the formal rulemaking phase of the project to develop the 2005 Building Energy Efficiency Standards in response to AB 970 (statutes of 2000) and SB 5X (statutes of 2001; outdoor lighting building standards). The updated standards (express terms) are proposed to be adopted by the Commission in the fall of 2003 and take effect in 2005.

Other States

In addition Maryland has proposed the Maryland Outdoor Lighting Study Bill to enact a lighting taskforce in the state and Georgia has proposed legislation to enact special lighting controls on 'dark sky preserves' in the state.

Massachusetts state legislature is considering a bill directing cities and towns to construct or revise ordinances to directing the state to adopt full-cut-off fixtures for state-funded outdoor lighting. This bill has wording very similar to that on a bill passed into law by the State of Maine's legislature, in which all state-funded new and replacement outdoor lighting must be fully-shielded fixtures so that no light is emitted above the horizontal.

Spain

Two of Spain's seventeen regional governments—Catalonia and the Canary Islands—have enacted legislation to tackle light pollution, but there is no national legislation.

Canary Islands

Legislation was introduced to protect and optimise conditions around the Astrophysics Institute's observatories. The general concept of light pollution was introduced via legislation in 1988, with more detail added in 1992. The Astrophysics Institute's Office for the Protection of the Quality of the Sky aims to ensure the law is respected.

Catalonia

The legislation was introduced with general environmental protection aims, and to meet energy efficiency criteria. The law dates from 2001.

In both regions, laws rely more on type and position of light source rather than measurement of emissions. Infringement is punishable by administrative fine (which in the case of Catalonia can range from 150 Euros up to 30,000 Euros).

Bisei, Japan

The Optical Environmental Disruption (Light Pollution) Prevention Ordinance in Bisei, enacted on 22 November 1989, was the first regulation in Japan to deal with light pollution.

The ordinance was motivated by plans to establish the Bisei Astronomical Observatory (BAO), one of the largest public observatories in Japan. The main purpose of the ordinance is to advocate the prevention of light pollution by the Town of Bisei, its citizens and private firms, while guaranteeing a level of lighting necessary for daily life.

The main points covered by the ordinance are:

- Adequate but minimum lighting - citizens should try to keep outdoor lighting to a minimum, whilst ensuring it is still adequate. All outdoor lights should be turned off after 10:00pm, except particularly important lights, including safety lights.
- Cooperation with astronomical observation - citizens are asked to comply with extra restrictions on the use of outdoor lighting when there are academically important astronomical observations being undertaken in the town or neighbouring regions.
- Subsidies for light pollution preventive measures - notably, the Town will provide subsidies amounting to up to 2/3 of the total expenses incurred for installing, remodelling or exchanging lighting or other apparatus which result in a reduction in light pollution.

Bisei uses the International Astronomical Union (IAU) guidance that the brightness of the night sky should not exceed 10% of the natural condition, and has therefore set itself the goal of keeping the night sky brightness within 10% of the natural condition. But the implementation of the ordinance does not rely on the measurement of light, but on compliance with various specified standards for outside lighting, outlined below:

- Shading of the outdoor lights - outdoor lighting should not emit light higher than a horizontal level. In case of lighting on buildings or signboards, light sources should be installed at the top.
- Light sources - the use of low-pressure sodium lamps for outdoor lighting is recommended. These are less harmful to astronomical observation. Since low-pressure sodium lamps use a smaller volume of electric power, they are also more energy efficient.
- Use of floodlight projectors - Where search lights, spotlights or lasers are continuously used outdoors, it is forbidden to use appliances which project light higher than a horizontal level.
- Shading of indoor lights - business establishments consuming a large quantity of light are advised to keep light from leaking outside by using curtains and blinds, etc.

Action taken by other local Japanese governments

Following Bisei town's example, 6 other administrative districts in Japan have launched similar ordinances on light pollution:

Matsuyama city, Ehime Prefecture

Takayama village, Gunma Prefecture

Hirakata city, Osaka Prefecture

Okayama Prefecture

Saga Prefecture

Kumamoto Prefecture

These new ordinances are based on that enacted by Bisei and thus rely on controlling the type of lights installed rather than measurements of light emitted.

Action taken by central government (Ministry of the Environment)

Most of the activity to control light pollution in Japan has been initiated and enforced at the local level. But the Central Government, through the Japanese Ministry of the Environment has also produced various documents aimed at promoting the prevention of light pollution:

- **Development of Guidelines:**The Ministry of the Environment published its first guidelines on the prevention of light pollution in March 1998. These guidelines outline the problems caused by light pollution and stipulate measures for minimising light pollution, particularly when installing outdoor lighting facilities.
- **Manual for planning the lighting of an environment:** In June 2000, the Japanese government produced a manual to be used as part of the planning process for lighting a local area, aimed at minimising light pollution while ensuring a level of lighting necessary for daily life.
- **Guidebook:** In September 2001, the Ministry issued a more detailed guidebook on light pollution legislation. In addition to again outlining the problems caused by light pollution and possible countermeasures, the guidebook also reviews existing ordinances and legislation in Japan and elsewhere in the world (including Lombardy City, Italy and Arizona) and on the basis of this provides advice on activities which might be initiated for controlling light pollution.

Calgary, Canada

The “Enviro Smart Streetlights” Retrofit Project

The project aims to replace street lighting to full cut off lighting. The principal driver of the project was to reduce energy consumption and save money. The environmental benefits such as reducing light pollution, CO2 emissions reduction, etc, although very important, were secondary.

The Roads Business Unit was looking for efficiencies in the streetlight system when the asset was transferred from the utility to the City in 1998. The City considered it was excessively lit and, following electricity prices increases in 2001 and in the light of the Kyoto Accord initiative, it was considered the right time to implement this project. The

initiative originated at Business Unit Level and was approved by a Committee of the City Council.

- The City is retrofitting the following road lighting systems to meet minimum IES levels:
Residential local roads: 200W and 150W dropped lens cobraheads to 100W, flat lens fixtures.
- Collector roads: 250W and 200W dropped lens cobraheads to 150W, flat lens fixtures.
- Many other municipalities are already at minimum light levels based on the wattage of the fixture and height and distance apart on their light poles. Calgary was over-lit and based on light analysis, the Council determined that lower wattages could be retrofit at the same locations without adding poles to meet minimum recommended light levels established by IES. Each municipality must do the engineering analysis to determine if a fixture retrofit is feasible or not. It was considered that replacing or adding poles would greatly add to costs and would not provide a reasonable payback.

Currently, in the NW areas of Calgary, 10,400 lights have been refitted, and in the North East areas 8,000 lights have been refitted. The remaining quadrants are being designed, but the total City wide figure for replacement is estimated to be 33,000 fixtures.

It has been estimated that the retrofit project will pay for itself in energy savings within three and a half to four years.

Annex 2

List of major documents providing guidance to the public on light pollution

Government documents

1. Countryside Commission and Department of the Environment, *Lighting in the Countryside: Towards Good Practice*, 1997
2. Rural White Paper; *Rural England—A Nation Committed to a Living Countryside*, 1995
3. Department of Transport White Paper; *A New Deal for Transport; better for everyone*, CM 3950, July 1998
4. Department of Transport, *Road Lighting and the Environment*, 1993
5. British Standards, BS5489, Road Lighting
6. Planning Policy Guidance: PPG 12,17,23

Non-Government documents

1. Institution of Lighting Engineers (ILE): *Domestic Security Lighting, Friend or Foe; A Practical Guide to the Development of a Public Lighting Policy for Local Authorities (TR24); Brightness of Illuminated Advertisements (TR5); Guidance Notes for the Reduction of Light Pollution.*
2. Society of Light and Lighting (CIBSE): *Code for interior lighting (LC1); The industrial environment (LG1); Sports (LG4); The Exterior Environment (LG6).*
3. ILE and CIBSE jointly, *Lighting the Environment – a guide to good urban lighting.*

International Documents

Commission Internationale de L'éclairage (International Commission on Illumination) (CIE): The CIE have published many guides on lighting, including: *Guide for floodlighting (94–1993); Recommendations for the lighting of roads for motor and pedestrian traffic (115–1995); Guide for minimizing skyglow (126–1997); Guide for lighting exterior work areas (129–1998); Design Methods for the lighting of Roads (132–1999); Guide to the lighting of urban areas (136–2000); Guide on the limitation of the effects of obtrusive light from outdoor lighting installations (150–2003).*

Joint Publication of CIE and the International Astronomical Union: *Guidelines for minimizing Urban Sky Glow near Astronomical Observatories (01–1980).*

Formal minutes

Monday 15 September

Members present:

Dr Ian Gibson, in the Chair

Mr Tom Harris
Mr David Heath
Dr Brian Iddon

Mr Robert Key
Mr Tony McWalter
Geraldine Smith

The Committee deliberated.

Draft Report (Light Pollution and Astronomy), proposed by the Chairman, brought up and read.

Paragraphs 1 to 158 read and agreed to.

Resolved, That the Report be the Seventh Report of the Committee to the House.

Ordered, That the Chairman do make the Report to the House.

Ordered, That the provisions of Standing Order No. 134 (Select Committees (reports)) be applied to the Report.

Ordered, That the Appendices to the Minutes of Evidence taken before the Committee be reported to the House.

[Adjourned till Monday 20 October at 3.00pm.]

Witnesses

Monday 9 June 2003

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Professor Paul Murdin, Royal Astronomical Society, **Mr Guy Hurst**, The British Astronomical Association, **Mr Bob Mizon** and **Dr Chris Baddiley**, Campaign for Dark Skies

Ev 1

Professor Sir Martin Rees, The Astronomer Royal, **Professor John C Brown**, The Astronomer Royal for Scotland

Ev 9

Monday 14 July 2003

Mr David Coatham, Institution of Lighting Engineers, **Ms G Clarke**, Highways Agency, **Mr N Sinden**, Head of Policy and **Mr T Oliver**, Head of Rural Policy, Campaign to Protect Rural England

Ev 15

Mr P Lummis, Lighting Engineer, Huntingdonshire District Council

Ev 21

Rt Hon Keith Hill MP, Minister of State, Housing and Planning, Office of the Deputy Prime Minister, **Mr David Miliband MP**, Minister for School Standards, Department for Education and Skills, **Dr Martin Williams**, Head of Air and Environmental Quality Division, Department for Environment, Food and Rural Affairs, **Professor Ian Halliday**, Chief Executive, Particle Physics and Astronomy Research Council

Ev 25

List of written evidence

1	Mr Michael Gainsford, Member of the British Astronomical Association	Ev 35
2	Mr Ian Coulson	Ev 36
3	Mr Colin Henshaw	Ev 37
4	Mr Graham L Boots, Curator to the Worthing Astronomical Association	Ev 38
5	Mr G F Johnstone	Ev 38
6	Mr Maurice Gavin	Ev 39
7	Mr Gerald White, The Norman Lockyer Observatory	Ev 39
8	International Dark-Sky Association (IDA)	Ev 41
9	Shropshire Astronomical Society	Ev 42
10	Armagh Observatory	Ev 43
11	Rosemary Pears, Secretary, Vectis Astronomical Society and Isle of Wight Observatory	Ev 46
12	Mr Michael Gregory	Ev 46
13	British Astronomical Association's Campaign for Dark Skies	Ev 47, Ev 51, Ev 196
14	Astronomical Society of Glasgow	Ev 52
15	Mr Martin Male	Ev 53
16	Professor John C Brown DSc FRSE FInstP, Astronomer Royal for Scotland	Ev 54
17	Mr and Mrs D Waddell	Ev 55
18	Mr J A G Ball	Ev 56
19	Members of the Hinckley & District Astronomical Society	Ev 57
20	Sir Patrick Moore CBE FRS	Ev 58
21	Pollution & Public Health Project Group, Ealing	Ev 59
22	Mr Nigel Pollard, NEP Lighting Consultancy	Ev 61
23	Steve Allmand	Ev 62
24	Wessex Astronomical Society	Ev 62
25	Mr Mike Newman	Ev 63
26	Mr J S Smith	Ev 64
27	Mr Kenneth R Whayman	Ev 64
28	Mr A N Hasluem	Ev 66
29	Michael Milne	Ev 67
30	Mr D G Daniels	Ev 67
31	Local Government Association	Ev 68
32	The Norfolk Society	Ev 68
33	Mr Tony Chandler	Ev 73
34	Dr Fiona Vincent	Ev 76
35	Orpington Astronomical Society	Ev 76
36	Mr Clive D Beech	Ev 77
37	D A Coleman	Ev 78
38	G S Hawkins	Ev 79
39	The Hill Rise Observatory	Ev 79
40	A Menarry	Ev 83
41	Mr Martin Morgan-Taylor and Professor David Hughes	Ev 84

42	The Highlands Astronomical Society	Ev 91
43	The Cotswold Astronomical Society	Ev 93
44	Dr F W Thompson	Ev 95
45	JJ Temple	Ev 95
46	The Hampshire Astronomical Group	Ev 96
47	R W Middleton	Ev 99
48	T R Scarborough	Ev 99
49	Mr P J Fay	Ev 100
50	Peter G Carson MCIOB	Ev 101
51	John Vetterlein	Ev 101
52	R Dymock	Ev 104
53	Mr Colin C Knoppitt	Ev 104
54	Michael Morris Franks	Ev 108
55	A T Storey	Ev 109
56	The British Astronomical Association	Ev 109
57	The Orwell Astronomical Association (Ipswich)	Ev 111
58	Michael O’Gara	Ev 112
59	The Herschel Astronomical Society	Ev 112
60	Dr CJ Baddiley, BSc DIC OhD MinstP ChPhys FRAS	Ev 113
61	The Commission for Architecture and the Built Environment (CABE)	Ev 127
62	Dr Darren Baskill	Ev 129, Ev 192
63	David T Hayes	Ev 131
64	Dr D McNally	Ev 135
65	D J Reynolds	Ev 138
66	Matthew N Dugas	Ev 140
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70	Keith Venables	Ev 145
71	Martin T Brown	Ev 148
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75	Lembit Öpik MP	Ev 158
76	Mr Rob Johnson	Ev 158
77	R H Peeling	Ev 160
78	The Society for Popular Astronomy	Ev 160
79	The Mexborough and Swinton Astronomical Society	Ev 162
80	SIGMA, Moray’s Astronomy Club	Ev 164
81	The Macclesfield Astronomical Society	Ev 165
82	The Campaign to Protect Rural England (CPRE)	Ev 171, Ev 193
83	The Royal Astronomical Society	Ev 175, Ev 234
84	Institution of Lighting Engineers (ILE)	Ev 180, Ev 195
85	Dr P R Marchant	Ev 185
86	Andrew Briggs	Ev 188

87	Dr Barry Clark	Ev 188
88	The Royal Society of Edinburgh	Ev 189
89	Kevin Miles	Ev 190
90	Mr James Reed	Ev 190
91	County Surveyors Society	Ev 190
92	Mervyn Pitchers	Ev 191
93	Mr Michael John Dagleish	Ev 191
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95	Nonsuch Watch	Ev 199
96	Dr George Sudbury	Ev 199
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116	H P Webber, Director, Parliamentary Estates	Ev 221
117	The Office of Science and Technology, Department for Education and Skills, Office of the Deputy Prime Minister, Department for Transport and the Department for Environment, Food and Rural Affairs	Ev 222
118	B & Q	Ev 226
119	Professor Sir Martin Rees, Astronomer Royal	Ev 227
120	The Chartered Institute of Environmental Health	Ev 228
121	Robert Ince	Ev 229
122	Canterbury City Council	Ev 229
123	The Highways Agency	Ev 231
124	Huntingdonshire District Council	Ev 232
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126	Qualification and Curriculum Authority	Ev 233

Reports from the Science and Technology Committee since 2001

The following Reports have been produced by the Committee since the start of the present Parliament. The reference number of the Government's response to the Report is printed in brackets after the HC printing number.

Session 2002–03

First Report	The Work of the Particle Physics and Astronomy Research Council	HC 161 (HC 507)
Second Report	Annual Report 2002	HC 260
Third Report	The Work of the Medical Research Council	HC 132 (CM 5834)
Fourth Report	Towards a Non-Carbon Fuel Economy: Research, Development and Demonstration	HC 55-I (HC 745)
Fifth Report	The Work of the Natural Environment Research Council	HC 674
Sixth Report	UK Science and Europe; Value for Money?	HC 386-I
First Special Report	Government Response to the Science and Technology Committee's Fifth Report, Session 2001-02, Government Funding of the Scientific Learned Societies	HC 53
Second Special Report	Government Response to the Science and Technology Committee's Sixth Report, Session 2001-02, the National Endowment for Science, Technology and the Arts: A Follow-up	HC 276
Third Special Report	Government Response to the Committee's Seventh Report, Session 2001-02, The Office of Science and Technology: Scrutiny Report	HC 293
Fourth Special Report	Government Response to the Committee's Eighth Report, Session 2001-02, Short-term Contracts in Science and Engineering	HC 442
Fifth Special Report	Government Response to the Committee's First Report, The Work of the Particle Physics and Astronomy Research Council	HC 507
Sixth Special Report	Government Response to the Committee's Fourth Report, Towards a Non-Carbon Fuel Economy: Research, Development and Demonstration	HC 745

Session 2001–02

First Report	Cancer Research – A Follow-Up	HC 444
Second Report	The Research Assessment Exercise	HC 507 (HC 995)
Third Report	Science Education from 14 to 19	HC 508-I (HC 1204)
Fourth Report	Developments in Human Genetics and Embryology	HC 791
Fifth Report	Government Funding of the Scientific Learned Societies	HC 774-I

Sixth Report	National Endowment for Science, Technology and the Arts: A Follow-Up	HC 1064
Seventh Report	The Office of Science and Technology: Scrutiny Report 2002	HC 860
Eight Report	Short-Term Research Contracts in Science and Engineering	HC 1046
First Special Report	The Government's Response to the Science and Technology Committee's Fourth Report, Session 2000-01, on The Scientific Advisory System	HC 360
Second Special Report	The Government's Response to the Science and Technology Committee's Sixth Report, Session 2000-01, Are We Realising Our Potential?	HC 361
Third Special Report	The Government's Response to the Science and Technology Committee's Seventh Report, Session 2000-01, on Wave and Tidal Energy	HC 377
Fourth Special Report	Government Response to the Committee's Third Report of Session 2000-01, on Scientific Advisory System: Scientific Advice on Climate Change	HC 493