Resources, Conservation and Recycling xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Resources, Conservation and Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Complying with voluntary energy conservation agreements (II): Lighting in Hong Kong's shopping malls

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ARTICLE INFO

Article history:
Received 21 May 2016
Received in revised form 25 October 2016
Accepted 25 October 2016
Available online xxx

Keywords:
Voluntary agreements
Energy conservation
Lighting
Shopping malls

ABSTRACT

Voluntary agreements have the potential to complement mandatory policies for achieving energy conservation and environmental goals. Through examining three voluntary agreements for indoor and outdoor lighting in Hong Kong's shopping malls, we aim to understand the compliance decisions and explore how to select more effective voluntary agreements. A field survey was conducted to solicit empirical data on shopping mall visitors' responses to unsatisfactory lighting conditions and advertising effect of outdoor lighting. It is found that visitors are unlikely to leave due to unsatisfactory indoor lighting conditions, while the advertising effect of outdoor lighting is significant in attracting visitors' attention, particularly tourists. This implies voluntary agreements focusing on reducing excessive indoor lighting, or "De-lamp", would receive more support. The prevalent compliance with the Earth Hour is mainly due to the public image penalty on non-compliance and the minimal compliance cost of losing the advertising effect for only one hour in a year. The Voluntary Charter Scheme on Outdoor Lighting Reduction, however, would suffer non-compliance with the significant advertising effects of outdoor lighting. The research suggests prioritising "De-lamp" in promotion. Overall, we are cautiously pessimistic on the effectiveness of voluntary agreements for significant energy conservation, given visitors' lacking of a green preference.

1. Introduction

In comparison to mandatory policies that tend to put regulators and those under regulation in more confrontational positions, voluntary agreements call for more collaboration. Enterprises are encouraged to enter the agreements promising to improve their performance in the particular aspect, with no formal penalty given for non-compliance. Lighting is responsible for a significant proportion of energy consumption, for example, 13% and 11% of electricity consumption in Hong Kong and the United States respectively (Electric and Mechanical Services Department, 2015; U.S. Energy Information Adminstration, 2015). Lighting can be classified as outdoor and indoor, according to their location, each with their own significance for energy conservation.

The excessive use of artificial outdoor lighting could cause light pollution, bringing adverse impact to human, ecosystem and wildlife, besides wasting energy (International Dark-Sky Association, 2015). It is recognised as a nuisance to human during night time, particularly in developed urban areas (Hong Kong Night Sky Brightness Monitoring Network, 2015; Task Force on External Lighting, 2015). Excessive lighting at night could bring adverse impact to human health, disturbing human circadian clock, movement pattern and brain activity, causing physiological and psychological effects (Chepesiuk, 2009; Falchi et al., 2011; Health Council of the Nethelands, 2000; Stevens and Zhu, 2015). Medical research have shown evidence that circadian disturbance could alter melatonin-synthesis, inducing breast cancer (Dickerman and Liu, 2012; Falchi et al., 2011; Pauley, 2004; Stevens, 2009). Other human activity is also impaired by light pollution such as visual astronomy and recreational or even literature creation indirectly with the loss of darkness (Falchi et al., 2001; Health Council of the Nethelands, 2000; Hong Kong Night Sky Brightness Monitoring Network, 2015). While it is commonly agreed there is a need to control the outdoor lighting, it could induce a significant cost to the commercial sector, such as the loss of customers and impairing the city's image (Task Force on External Lighting, 2015), yet few studies have been done to examine the potential cost the "polluters" could bear for reducing their outdoor lighting usage.

In indoor environment, personal comfort could be affected by lighting, though there is no clear delineation of its importance (Frontczak and Wargocki, 2011) and the comfortable lighting

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http://dx.doi.org/10.1016/j.resconrec.2016.10.013
0921-3449/

condition varies for different persons (Levin, 1995). The influence of indoor lighting on shopping behaviour, however, has been widely examined with reference to the Stimulus-Organism-Response framework proposed by Mehrabian and Russell (1974), after Kotler (1973) proposed the influence of "atmosphere" on consumer behaviour, and is commonly recognised lighting could influence the perceived quality of shops, giving an arousal impact on customer behaviour (Park and Farr 2007a; Quartier et al., 2009; Summers and Hebert, 2001; Turley and Milliman, 2000). There are also researches on the influence of lighting on human comfort and the impact of the colour of lighting (Babin et al., 2003; Crowley, 1993; Park and Farr 2007a, 2007b). However, few studies have been done on the reaction toward unsatisfactory lighting conditions in indoor public space.

Shopping malls in Hong Kong are chosen as the subject of study. Being an attractive shopping paradise (Choi et al., 1999; Heung and Qu, 1998), with shopping activities of tourists as a critical component in her economy (Census and Statistics Department, 2011; Hong Kong Economy, 2007), Hong Kong is ideal for studying the topic. Hong Kong's light pollution has also attracted wide attention in media reporting for being ranked the worst in the world (Cheung, 2013). The night-time urban sky in Hong Kong is 100 times brighter than the darkest site and 82 times brighter than the dark site standard established by the International Astronomical Union (IAU) (Pun and So, 2012; Pun et al., 2014). The retail sector is a significant consumer of electricity in Hong Kong, consuming 16.6% of the total electricity of the city in 2013 (Electric and Mechanical Services Department, 2015), while shopping malls are clusters ideal for conducting the study. Shopping malls have also been blamed for wasteful energy practises such as keeping lights on overnight and the overuse of spotlights and floodlights, contributing to the light pollution problem. Lighting also consumes a significant amount of electricity for the retail sector: 25.2% in 2013 (Electric and Mechanical Services Department, 2015).

Three voluntary agreements with different focuses and durations of commitment are studied to examine how the design of voluntary agreement could potentially influence their rate of compliance. The first event, Earth Hour, organised by the World Wide Fund for Nature, is held every year on the last Saturday of March, requiring the participants, including individual households, business and governments, a once-off action of turning off their lights for one hour at 8:30 p.m. local time (Earth Hour, 2015). The second voluntary agreement, Voluntary Charter Scheme on Outdoor Lighting Reduction, is pending for commencement regulating lighting installations outdoor for decorative and advertising purposes, which business owners should turn off such lights during the preset time: from 11 p.m. or mid-night to 7 a.m. (Task Force on External Lighting, 2015), after the introduction of voluntary guidelines on external lighting (Electric and Mechanical Services Department, 2012; Environment Bureau et al., 2012). The third voluntary agreement, "De-lamp", focuses on the reduction of indoor lighting, with reference to the reduction of lamps and switching off unused lights in Japan after the Tohoku Earthquake in 2011 (Kimura and Nishio, 2013). This agreement is not yet proposed in Hong Kong. The details of the three agreements are shown in Table 1.

Utilising the cost and benefit analysis based on the crime and punishment model this paper addresses the impact of customer reactions on enterprises' compliance with the voluntary agreements, from the perspective of lighting utilisation. In the first paper: *Complying with voluntary energy conservation agreements (I): Air conditioning in Hong Kong's shopping malls* the result shows the condition for a voluntary agreement to perform poorly with a case study of indoor air conditioning. This paper aims to study how the design of the agreement would possibly affect the decision making of the enterprises in complying with it by examining the difference in costs and benefits of compliance. Utilising an existing example and two proposed agreements, the model is tested and utilised to predict potential compliance conditions. The crime and punishment model is adopted in analysing the cost and benefits of (non-)compliance. The rest of the paper is organised as follows. Section 2 introduces data and methodology. Section 3 analyses data and reports our main research findings. Section 4 concludes the paper and discusses implications.

2. Data and methodology

2.1. Analytical framework

Same as the first paper discussing about air-conditioning in mall, this paper utilises the economic model of crime and punishment as the analytical framework to examine the feasibility of voluntary agreement as an alternative environmental policy instrument to tackle behaviour related issues. Under this framework crime is understood as a result of informed choice out of rationality from the economic perspective, as stated in Fielding et al. (2000). It is a decision between the criminal act and non-criminal act by considering the respective costs and gains. In the seminal work of Becker (1968) "if the expected utility (of a criminal act) to (a person) exceeds the utility he could get by using his time and other resources at other activities", the act would be performed out of rational choice:

$$Expected\ \ benefit\ \ from\ \ crime > Expected\ \ benefit\ \ from\ \ non-crime\ \ act$$

with a positive net return to the offender.

Under the economic approach, the net return of a criminal act equals to the expected return minus direct cost of the act, loss of income from legitimate work and expected penalty, which equals the product of probability of conviction and penalty per conviction (Ehrlich, 1996), and should be positive for the performance of a criminal act to be rational. The latter three components can be regarded as in general the cost of the criminal act, by considering the loss of income from legitimate act as part of the cost. The equation can therefore be rearranged to highlight the "cost" and "benefit" analysis, in which the benefit from the alternative action is regarded as the cost of the action, as shown below:

$$Expected\ benefit\ from\ \ crime > Expected\ \ cost\ \ ofcrime$$

The specific influential factors should be highlighted to provide a case-specific adaptation of the model (Clarke and Cornish, 1985). In this case, the crime is essentially the non-compliance with the voluntary agreement, while the offender would be the enterprise operating the shopping mall. Three factors would affect the decision of compliance: cost of compliance, rate of detection and voluntary penalty given by the civil society, in which the latter two are the indicators of the monitoring effectiveness. Effective monitoring would give a substantial penalty to the non-complying enterprises. The cost of compliance is equivalent to the benefit from crime, since it is the cost that can be evaded by not complying with the agreement, and it refers to the potential loss of visitors due to reduction in the arousal effect of lighting; while the cost of crime would be the voluntary penalty given by the public. Incorporating the factors into the equation, rational shopping mall managers will choose to participate and comply with a voluntary agreement when the following condition is met (Shimshack, 2014; Xu, 2011):

$$Cost\ \ of\ \ compliance(c) < Rate\ \ of\ \ detection(r) * voluntary\ \ penalty\ for\ noncompliance\,(p) + elec.saving$$

in which $r * P = Monitoring\ \ effectiveness$

This compliance condition is the reverse of the condition of crime in the previous equation, that the benefit of the non-crime act

Please cite this article in press as: Kwok, T.F., et al., Complying with voluntary energy conservation agreements (II): Lighting in Hong Kong's shopping malls. Resour Conserv Recy (2016), http://dx.doi.org/10.1016/j.resconrec.2016.10.013