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Contesting green technology in the city: techno-apartheid or equitable modernisation?

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ABSTRACT

In recent decades, heated debate around green technology and its equitable access has aroused the concern of international scholars. This paper provides a review on the exclusion of green technology referred to as 'green techno-apartheid' and examines selected key eco-cities (i.e. Masdar, Songdo IBD and Bangalore) considered in the 2013 United Nations Environment Programme (UNEP) Report on 'City-Level Decoupling' (2013). Metropolitan planning is a crucial instrument in addressing the challenges of urban social sustainability and is thus considered an important mechanism for developing a platform to approach issues of equitable access to green technology. The study reviews five metropolitan plans: the 'London Plan' (London, England), the 'Municipal Plan 2011 for Greater Copenhagen' (Copenhagen, Denmark), the 'Economically Strong and Sustainable Structural Vision: Amsterdam 2040' (Amsterdam, Netherlands), the 'Hong Kong 2030: Planning Vision and Strategy' (Hong Kong, China) and the 'Metropolitan Plan for Sydney 2036' (Sydney, Australia). The results of the study suggest that while all these plans focus on promoting green technology within a framework of ecological modernisation, they lack appropriate tools for achieving equitable modernisation and enhancing social equity. Consequently, it is essential that researchers and planners take further steps and develop effective instruments to improve equitable access to green technologies and achieve long-term urban social sustainability.

KEYWORDS

Green technology; equitable access; metropolitan planning strategies

Introduction

In recent decades, the number of individuals living in urban areas has increased. We have entered the urban age; cities now accommodate approximately 50% of the world's population (an increase from only 2% in 1800). Further, it is forecasted that approximately three-quarters of the earth's population (i.e. approximately 10 billion people) will live in cities by 2050 (United Nations Population Fund [UNFPA] 2007). Is has also been contended that urban land areas will triple from 2000 to 2030 (Seto, Güneralp, and Hutyra 2012). Consequently, the urban age has been referred to as a major contributor of environmental deterioration and has caused a loss of biodiversity and the destruction of the green infrastructure that plays an important role in safeguarding the environment and making it resilient to the effects of climate change (Baeumler, Ijjasz-Vasquez, and Mehndiratta 2012; Lye and Chen 2010; Seto, Güneralp, and Hutyra 2012). Thus, sustainable urban systems, principally in relation to the construction of eco-cities, need to be instituted (Florida 2011; Gleeson 2010; Harvey 2012; Heynen 2006; Kotkin 2010). In this context, social equity is considered a critical component of sustaining the urban environment. Recently, controversy has surrounded green technology and the

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issue of equitable access has aroused the concern of international scholars (Baum, O'Connor, and Stimson 2005; Caprotti and Romanowicz 2013; Moore 2009). Innovative technologies and design approaches have been integrated into the process of planning and developing modern cities; however, the United Nations Environment Programme (UNEP) Report on 'City-Level Decoupling' (2013, 46) raised the following question: 'Will they *(green technologies)* reinforce the stark techno-apartheid that is splintering cities around the world or will they create the basis for greater equity?'

Throughout time, Albrechts (2010) suggests that the practice of urban and regional planning has been central to the delivery of cities' responses to different issues such as environmental degradation. In this correlation, as suggested by Gleeson, Darbas, and Lawson (2004) and Davidson and Arman (2014), metropolitan planning strategy is a critical governance instrument for accomplishing urban sustainability. These scholars claim that this type of documents could provide strategic visions and guidelines for policy formulation at local levels; hence, it is anticipated that metropolitan plans can become key tools for change regarding the emergence of green technologies in planning process within recent years. Following the UNEP report (2013), this paper considers four issues to investigate the research question: *For whom are eco-cities being designed?* This paper begins by providing some background on the emerging debate of the importance of equity and the exclusion of green technology (i.e. 'green techno-apartheid') by investigating key eco-cities around the world; that is, Masdar, Songdo IBD and Bangalore. It then considers current metropolitan planning strategies (as tools for addressing the challenges of urban social sustainability) from the perspective of how they frame green technology (i.e. either within a strategy of ecological modernisation or equitable modernisation). Five key metropolitan planning strategies are reviewed: the 'London Plan' (London, England), the 'Municipal Plan 2011 for Greater Copenhagen' (Copenhagen, Denmark), the 'Economically Strong and Sustainable Structural Vision: Amsterdam 2040' (Amsterdam, Netherlands), the 'Hong Kong 2030: Planning Vision and Strategy' (Hong Kong, China) and the 'Metropolitan Plan for Sydney 2036' (Sydney, Australia). More specifically, this section seeks to elucidate emerging discourses on these plans with a focus on green technology and its equitable access. Finally, the conclusion for the paper is presented.

Methodology

This research adopted a comparative case study approach to review the metropolitan planning strategies of policy architects' in relation to equitable access to green technology. A selected number of case studies were examined to gain in-depth understanding into this emerging phenomenon and its complexity, natural setting and real life context (Punch 2005; Yin 1984). This comparative case study approach also allowed the issue to be examined in conjunction with a number of successive examples and enabled patterns of repetition to be identified in the case studies (Zartman 2005, 7). This method was relevant for this study, as it incorporate information to illustrate prominent aspects of the research phenomenon.

For the purposes of this study, the selection of case studies has been drawn upon the Arcadis Sustainable Cities Index 2015. This index is a global, leading sustainability index to develop an indicative ranking of 100 of the world's major cities (Arcadis 2015, 1). This Index is well acknowledged and supported by the key international organisation UN Habitat through their World Urban Campaign (World Urban Campaign 2016). The index was utilised to identify top performing global cities on sustainability to ascertain if equitable modernisation was yet incorporated into strategic visions and targets for intervening in and managing changes in urban areas as well as guidelines for policy formulation at local levels. Within this index (2015), the top five cities were identified as the European cities of Frankfurt, London, Copenhagen, Amsterdam and Rotterdam (Arcadis 2015). However, as no metropolitan plan for Frankfurt was available in English and both Amsterdam and Rotterdam are among Netherlands' largest cities, only three European cities (with strategic documents) were selected for investigation in this research; that is, London, Copenhagen and Amsterdam. Further, to provide an international perspective on the issue of green technology and its equitable access, the Asian city of Hong Kong (ranked 8th) and the Australian city of Sydney (ranked 11th) were also selected for investigation.

Urban sustainability

Over the last several decades, it is recognised that the idea of a 'sustainable urban environment' has been developed and evolved in urban policy discourse worldwide, particularly since the publication of the Brundtland Report in 1987 with a separate chapter on 'The Urban Challenge'. This idea proposes a desirable state in which economic and socio-politic systems are in equilibrium with natural systems. For this to occur, Satterthwaite (1997) and McManus (2005) indicate that cities should be governed in appropriate ways that enhance their capacity and adaptability to deliver sustainability. As a result, a significant number of new concepts have been progressed, ranging from broad ideas such as 'sustainable urbanism' and 'sustainable cities' (Haughton 1999; Haughton and Hunter 1994) to specific operational ideas such as 'compact cities', 'smart-growth cities' (Newman and Kenworthy 1989), 'city's nature and nature's city' (Swyngedouw 1996), 'urban ecology' (Collins et al. 2000) or 'new urbanism' (CNU 2000). It is noted that all these concepts provide ideological interpretations of sustainable development in urban settings with the strong focus on environmental sustainability. Additionally, these notions also demonstrate that '"the urban" is analytically meaningful in terms of human and ecological activity' (Davidson and Gleeson 2013, 59).

As sustainability is a contested concept, Davidson (2014) points out that different value sets could obtain different comprehensions about this term. In this circumstance, the political economy approach to the understandings of urban sustainability is initially useful since it provides a broader spectrum of interpretations of sustainability through categorising the ideologies of policy actors been neoliberal, liberal, social democratic to radical. With reference to the political economy approach to understandings of urban sustainability, competing visions of the processes of sustainable city building are suggested by Haughton (1999). Within this context, the free market city, which is also termed by Haughton (1999) as the 'externally dependent city', applies non-spatial views of economists. As a result, this model proposes solutions to urban environmental problems through the application of market mechanisms, which are claimed to have the capacities in rectifying market and regulatory failure (Haughton 1999). For the redesigning city model, the central focus is on redesigning the physical urban built environment for achieving greater resource efficiency. Moreover, this model also concentrates on improving individual components of physical infrastructure including green spaces, energy efficiency of buildings and public open spaces. Additionally, the redesigning city aims at reducing levels of car dependency of its residents through attempts to increase urban density around public transport nodes and advocate for mix land uses in the city (Haughton 1999). Turning to the self-reliant city, Roseland (1997) indicates that this model is developed with inspirations from a deep green perspective (Roseland 1997). In this correlation, two key focuses of this idea are a sensitive approach to nature such as smaller scale production, minimising urban impacts on natural assets of all kinds, and decentralised, grass-root politics. Through promoting the development of smaller decentralised communities, this model encourages a more nature-centred lifestyle by raising ecological consciousness through proximity (Haughton 1999). In consideration of the fair-share city, this model incorporates features from both the redesigning the city and the self-reliant city models, which include greater urban compaction, and improved use of market tools. However, the fair-share city also places a significant focus on the region in the form of more equitable trading relationships with other areas. In detail, this model

> envisages a world which is less an open market for exchange of global assets, and instead one where trading in environmental assets and capacities is permitted only where damage is not irreversible, and where adequate compensation mechanisms are put in place between exchanging areas. (Haughton 1999, 1894)

Fair-share city: equitable access

Urban conversations relating to social sustainability, a fair-share city as described by Haughton (1999), have traditionally been associated with equity concerns. This concept (derived from the theory of social justice) implies the necessity of fairness and impartiality in relation to the distribution of

resources and the entitlement of individuals to a sufficient quality of life (Burton 2000; Falk et al. 1993). Equity can also be demonstrated within horizontal and vertical dimensions. In relation to the former, horizontal equity represents a process of fairness or being impartially treated; for example, residents living in a certain area should have equal access to community resources and opportunities (Beder 1996). Similarly, Duclos (2006) noted that horizontal equity refers to a situation in which individuals, equal in all 'relevant respects' (such as income or assets), are treated similarly. Conversely, vertical equity ordinarily refers to the redistribution of resources in accordance with discrepancies in social circumstances. Vertical equity in resource distribution is a crucial condition for social cohesion and stability (Duclos 2006). However, in the majority of cities worldwide, both individuals and households experience inequitable access to resources and opportunities, as under contemporary social structures, the rich and the poor are concentrated in rich and poor environments, respectively (Baum and Gleeson 2010).

In recent years, it has been argued that current environmental circumstances are unsustainable and unjust and that current arrangements for urban life must be transformed (Wilson and Swyngedouw 2012). A variety of eco-urban projects have been developed to enhance urban sustainability (Caprotti, Springer, and Harmer 2015). It has been claimed that the establishment of eco-cities represents a shift towards *ecological modernisation*, the process in which environmental innovations are achieved through technological and economic developments (Caprotti, Springer, and Harmer 2015; Joss, Cowley and Tomozeiu 2013; Wu 2012). Similarly, Dryzek and Stevenson (2011) stated that economic progress and climate change alleviation could be reciprocally supportive; for example, the objective for decreasing greenhouse gas emissions could motivate the development of a more environmentally friendly and efficient economy in which green technologies become the main instruments of production. Further, these authors argued that modernisation should not only focus on addressing environmental degradation and increasing economic profit, but also 'serve human rights and needs' and reduce the inequalities that exist between wealthy and developing countries, concurring with Haughton (1999) the fair-share city. This process has been described as *equitable modernisation* and illustrated in Figure 1 (Dryzek and Stevenson 2011, 1869). However, it has been acknowledged that the majority of sustainable cities generally adopt 'an overwhelming economic-technological approach' and pay less attention to social equity aspects (Caprotti, Springer, and Harmer 2015b, 499; Cook and Swyngedouw 2012; Dempsey et al. 2011), limited to the redesign city model in Haughton (1999). These issues will be discussed further below in relation to the investigation of key eco-cities around the world.

Green technology and equitable access

In recent years, equitable access to green technology has become a prominent field of research, arousing the concern of international scholars (Baum, O'Connor, and Stimson 2005; Caprotti and

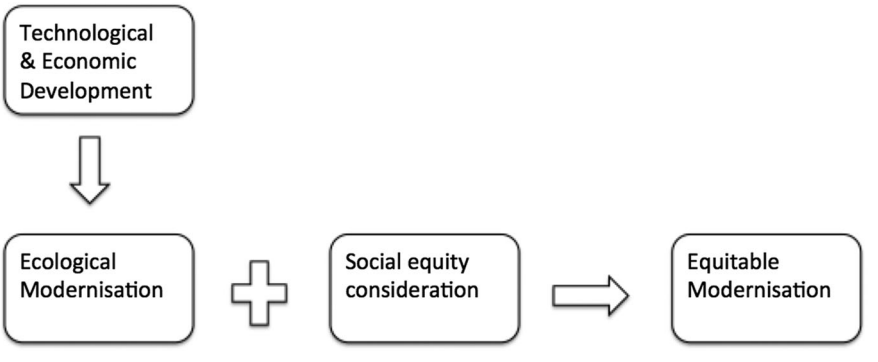

Figure 1. A summary of understandings about the concepts of ecological modernisation and equitable modernisation. Source: Adapted from Caprotti, Springer and Harmer (2015); Joss et al. (2013); Wu (2012); Dryzek and Stevenson (2011).

Romanowicz 2013; Moore 2009; UNEP 2012). Green technologies such as renewable energy or sustainable water management are generally viewed as important elements in the development of green cities, as they provide energy efficiency and produce less environmental effects (Kenworthy 2006). However, it has also been argued that the development of advanced technology, globalisation and economic restructuring has significantly contributed to a rising inequality across cities worldwide. This has resulted in a process referred to as 'techno-apartheid'. The globe has been categorised into 'slow' and 'fast' worlds, distinguishable by their levels of technological and scientific advancements (Friedmann 1995; Golding 1996; Knox 1995). Fast world cities are likely to have a higher degree of 'connectedness of individuals, groups and regions to the world of telematics' than slow world cities (Breathnach 2000, 477). Notably, Hoogvelt (1997) stated that this classification was primarily about social (rather than spatial) context and that features of both worlds could be investigated within all areas of the globe (Friedmann 1986; Graham and Marvin 1996; Sassen 1994). Thus, this process has partly led to social disparities and also exacerbated the impoverished living conditions of specific vulnerable groups and communities that cannot afford innovative technologies (Baum, O'Connor, and Stimson 2005; Dryzek and Stevenson 2011).

In this context, while critically analysing the design and planning process of eco-cities or sustainable cities, Caprotti and Romanowicz (2013) raised two important questions: (1) For whom are eco-cities being designed; and (2) Have social and class-based perspectives been included within the master plans of eco-cities worldwide? Caprotti and Romanowicz (2013) also stated that the process of designing, marketing or constructing individual components of eco-cities is principally the amalgamation of market-based and business-focused techniques; thus, environmental concerns or social equity are not priorities in the planning of sustainable cities.

In relation to the discourse about green technology and equitable access, it has been argued that while a wide range of industries have been attempting to adjust unsustainable technologies and sell environmental-friendly products, their targets are mainly embedded in neoliberal market mechanisms (Cook and Swyngedouw 2012). Thus, the development of green technology initiatives is not commonly aligned with considerations about issues relating to social justice and social inclusion (Cook and Swyngedouw 2012). Further, it has also been contended that green technologies are becoming commoditised and mobilised (Whitehead 2007). One example of this is Mexico's 'Green Mortgage' programme that offers low-income families an additional mortgage to cover the cost of eco-technologies such as low-energy bulbs, solar panels or water-saving appliances (World Habitat Awards 2012). This mortgage allows families to attain the goals of energy efficiency; however, it also involves an initial upfront cost to householders (Broto and Bulkeley 2013; Cook and Swyngedouw 2012). It is obvious that green technologies are more affordable for middle- or high-income classes of the society. However, in a democratic society, the equitable right to access green technologies (beneficial to social development) has an important role in the progression of sustainable cities. Thus, from a social equity perspective, it is essential that planners and developers create sustainable urban forms and infrastructures for cities to promote equitable access to environmental-friendly techniques for all residents (Broto and Bulkeley 2013; Cook and Swyngedouw 2012; UNEP 2013).

With the emergence of green technologies in recent years, UNEP's 'City-Level Decoupling' Report (2013) has identified 30 case studies of eco-cities worldwide obtaining innovative ideas in this field, which include Auroville, Bangalore, Masdar, Songdo IBD, San Francisco's 'Treasure Island', Vauban, Accra, Bangkok, Beijing, Mariannhill, Kampala, Orangi, Lagos, Lilongwe, Medellin, Finnish municipalities, Kitakyushu, City of Melbourne, Portland, San Jose, Singapore, Totness, Vaxjo, Buenos Aires, Cape Town, Chennai, Curitiba, Ho Chi Minh City, Linkoping and Seoul. For the purposes of this paper, three eco-cities selected for further discussion regarding the process of *green techno-apartheid* are Masdar, Songdo IBD and Bangalore. These cases were selected on the basis of relevance to the research, and which illustrate prominent features in the area of eco-city practices. For further clarification, in the report 'Eco-Cities – A Global Survey 2011' written by Joss, Tomozeiu, and Cowley (2011) that explores and documents different case studies of eco-city

from an international position, these scholars categorise listed eco-cities based on these following variables: (i) type of eco-city – new development, urban expansion and retro-fit development, (ii) development stage – planning phase, under construction and implemented. In this correlation, it is recognised that the three selected cities in this research reflect different types of eco-city (Masdar – new development, Songdo IBD – urban expansion and Bangalore – retro-fit development) and also at various development stages (Masdar and Songdo IBD – under construction, Bangalore – implemented).

The first eco-city, ***Masdar*** (located in Abu Dhabi and the largest of the seven emirates comprising the United Arab Emirates (UAE)) is widely considered one of the most ambitious eco-city projects in the world (Stilwell and Lindabury 2008; UNEP 2013). With $22 billion invested by the government of Abu Dhabi, Masdar is anticipated to become a zero carbon, zero car and zero waste city and will also promote the emirate's transition from being a technology 'consumer' to a technology 'producer' that uses the most advanced renewable energy and water-saving techniques (Ekblaw, Johnson, and Malyak 2009; Masdar City 2009; Rosenthal 2009; Stilwell and Lindabury 2008; UNEP 2013). In relation to this vision, it is forecasted that the city will accommodate approximately 50,000 permanent residents, 60,000 daily commuters and 1500 businesses that focus on manufacturing environmental-friendly products (Stilwell and Lindabury 2008; UNEP 2013). Despite the strategic aims reported above, there has been much debate about the likelihood of the city being constructed (UNEP 2013). Sceptics are concerned that Masdar is merely symbolic for Abu Dhabi and will actually be a city of luxury developments for the wealthy (UNEP 2013). Similarly, Ouroussoff (2010, 1) referred to Masdar as a gated community that represents 'the crystallization of another global phenomenon: the growing division of the world into refined, high-end enclaves and vast formless ghettos where issues like sustainability have little immediate relevance'. Thus, it may be that Masdar (a self-sufficient city with advanced technologies devised for 'high-function and low-consumption performance') will be beyond the reach of most of the world's residents (Ouroussoff 2010, 1).

The second eco-city, ***Songdo IBD*** is considered a flagship model for eco-cities in Korea. Developed in 2009, it is forecasted that this eco-city will be completed in 2015 (Joss, Tomozeiu, and Cowley 2011; Kamal-Chaoui et al. 2011; Nguyen and Davidson 2015; UNEP 2013). The total cost of this city is estimated to be approximately $35 billion; however, Songdo IBD is envisaged as a sustainable city under the aerotropolis model (i.e. 'the city is the airport') (Kasarda and Lindsay 2011). It will also be the business hub of Southeast Asia (Ekblaw, Johnson, and Malyak 2009; Gale International, n.d.). The city has incorporated various principles of transit-oriented development and new urbanism into its development and seeks to establish a high-tech, green urban environment that uses different aspects such as energy, water, transport and waste management (UNEP 2013; Vogl 2012). It is claimed that the application of advanced technologies and other environmental-friendly building materials/operators in accordance with the Leadership in Energy and Environmental Design (LEED) standard will contribute considerably to replicating the design; however, some modifications have been made to satisfy the different culture and lifestyles of the residents (Burnham 2011; UNEP 2013). Considerable progress has been made in technological developments; however, it has been argued that Songdo IBD will still not achieve equitable modernisation. Sceptics challenge the applicability of this city's model, as Songdo IBD will have no social housing for low-income classes and was not designed to comply with the demands of the poor or resolve issues relating to social inequalities (UNEP 2013). Thus, the process of *green techno-apartheid* is present in the development of Songdo IBD and appropriate alterations are required if sustainable development is to be achieved in the long-term.

The third eco-city, ***Bangalore*** (the third most populated city in India) is commonly considered the important economic and cultural centre of the nation (Map of Bangalore, n.d.). Generally, Bangalore is well known for being the Silicon Valley of India. It has a wide range of colleges, research institutes and technology industries, including different software companies and telecommunication organisations (Hon'ble High Court of Karnataka 2011; Map of Bangalore, n.d.; UNEP 2013). Presently, the city is experiencing rapid expansion especially in the field of Information Technology (IT) (Hon'ble High Court of Karnataka 2011; UNEP 2013). It has been contended that these changes

will foster the establishment of a cosmopolitan and educated class with new demands for housing that strongly focus on resource and energy intensive designs using imported materials (UNEP 2013). Several innovative models of green housing have been developed to satisfy the needs of Bangalore's residents (UNEP 2013). One prominent example is the 2003 launch of the *Towards Zero Carbon Development* (T-Zed) initiative that included the concept of providing sustainable living to citizens who could afford it (UNEP 2013). This programme seeks to transform sustainable housing into a commercial product and thus promotes the development of green housing industries in India. Like Masdar and Songdo IBD, Bangalore has experienced certain limitations that have prevented it from achieving equitable modernisation. Under this scheme, new dwellings are being constructed with luxurious facilities such as swimming pools and naturally ventilated squash courts that are only affordable to the higher classes (and not to low and middle income groups). Commentators have noted point T-Zed is a model of isolation and self-sufficiency that represents the aspirations of the wealthy rather than the aspirations of broader sectors of citizens in Bangalore for green housing (UNEP 2013). In conclusion, in relation the three eco-cities of Masdar, Songdo IBD and Bangalore, it is unfortunate that no progress in equitable access has been made in relation to green technologies.

Importance of metropolitan plans as a tool for implementing changes

For implementing changes regarding urban sustainability and equitable modernisation, it is accepted that city governments need to employ appropriate means and instruments. Albrechts (2010) indicates that cities are experiencing different challenges and opportunities such as environmental issues, financial crisis, globalisation or the emergence of technology. For responding to these issues, 'the call for change' has been assigned to urban and regional planning; and as suggested by Albrechts (2010, 1115), it is essential to establish new approaches to planning that can translate innovative concepts or ideas (such as changing the way resources are utilised, alternating the distribution of regulatory powers) into 'array of practice arenas, which in turn will transform these arenas themselves, rather than merely being absorbed within them'. In this correlation, Gleeson, Darbas, and Lawson (2004) and Davidson and Arman (2014) demonstrate that metropolitan planning is amongst key governance tools for accomplishing urban sustainability. These scholars claim that metropolitan plans should provide strategic visions and targets for intervening in and managing changes in urban areas as well as guidelines for policy formulation at local levels. Additionally, Gleeson, Darbas, and Lawson (2004, 363) suggest that these documents are able to reverse 'the ecologically unsustainable pattern of urban growth with integrated, collaborative and participatory policy formulation and decision-making processes'. Accordingly, it is expected that metropolitan plans can become critical mechanisms for facilitating the application of governance 'hypothesis' to the delivery of green technologies within planning process (Gleeson, Darbas, and Lawson 2004).

Review of current metropolitan planning policies

The above investigation of eco-cities (that have encountered the process of *green techno-apartheid*) showed that effective tools can enhance the equitable accessibility of innovative technologies and the development of democratic societies in which all individuals have similar rights to access technologies fundamental to the progression of sustainable cities. It is universally acknowledged that metropolitan planning strategies are important mechanisms for change and could lead to the attainment of urban sustainability in cities worldwide (Albrechts 2010; Davidson and Arman 2014). In this paper, the five metropolitan plans of London, Copenhagen, Amsterdam (Europe), Hong Kong (China, Asia) and Sydney (Australia) were selected for critical review to determine whether or not they incorporated any discussions of green technology and equitable access.

The first case study considers London. The leading global city, London was ranked first in the Global Power City Index (2014) for its comprehensive power in attracting individuals/business enterprises and managing its assets to ensure economic, environmental and social development

(Mori Memorial Foundation's Institute for Urban Strategies 2014). As a capital of culture, London also has one of the largest city airport systems and is among the most populous and most visited city in the world (Eurostat Statistics Explained 2015; London School of Economics and Political Science 2008). The 'London Plan' was published in March 2015 by the Greater London Authority with the aim of establishing an integrated economic, transport, social and environmental framework for the city's development for the next 20–25 years. In relation to the area of green technology, the plan presents strategies and policies that focus on three main sectors: green urban infrastructure, green housing design and construction and green energy technologies (Greater London Authority 2015).

In relation to green urban infrastructure, the plan encourages the creation, enhancement and protection of green infrastructure networks such as parks, street trees and green roofs to maintain an interrelationship between green and open spaces. Additionally, the plan also provides strategies for enhancing the operation of the Blue Ribbon Network, a strategic network of water spaces in London comprising the River Thames and related canals, docks, lakes and reservoirs. This network is anticipated to contribute significantly to the development and sustainability of London, as it prioritises the safe use of waters spaces for various purposes, including transport, tourism, drainage and flood management and heritage value (Greater London Authority 2015).

In relation to green housing design and construction, the 'London Plan' sets out different principles and policies to improve the environmental performances of new buildings (e.g. Codes for Sustainable Homes or Housing Design Guide) and has a strong focus on promoting the use of green materials and environmental-friendly design features such as green roofs or passive solar designs. Further, the plan also recommends that advanced technologies be used to create a Sustainable Urban Drainage System, an alternative platform for effectively managing runoff from buildings.

In relation to green energy technologies, the plan promotes the use of renewable energies, in particular those generated by waste or biomass. Further, the 'London Plan' also outlines plans for a Decentralised Energy Network that is projected to generate 25% of London's power and heat requirements via the uses of green energies and innovative, low carbon generation technologies such as electric and hydrogen fuel cell vehicles or advanced conversion technologies (e.g. 'anaerobic digestion, gasification and pyrolysis for the treatment of waste') (Greater London Authority 2015, 199).

The 'London Plan' outlines different strategies for promoting the application of green technologies and states:

- 'London is well positioned to accommodate expansion of the "green" business sector, with opportunities in renewable energy, low carbon technology, waste reduction and recycling'; and
- 'The Mayor is promoting a "Green Enterprise District" in the Thames Gateway stretching from the Lower Lee to London Riverside, a concept that could be extended to other parts of London' (Greater London Authority 2015, 176).

These statements suggest that under the 'London Plan', there will be a strong correlation between the development of green technology and the progress of green economic growth. Thus, it is argued that the metropolitan plan of London falls within an ecological modernisation framework. However, while green technologies are clearly considered crucial, if sustainable development is to be achieved, a lack of consideration has been given to issues of equitable access and enhancing social equity.

The second case study considers Copenhagen (Denmark). Named the European Green Capital and the most liveable city in the world in 2014 (European Commission, n.d.), Copenhagen aims to become the first carbon neutral city by 2025, a target that has a strong emphasis on growth, quality of life and employment (C40 Cities, n.d.; City of Copenhagen 2011). The 'Municipal Plan 2011 for Greater Copenhagen', published by the City of Copenhagen in 2011, sets out strategic visions for the city's future development. It is estimated that the population of Copenhagen will be more than six million people by 2025. The plan concentrates on optimising citizens' accessibility and mobility

while improving the quality of life of the homeless and creating better conditions for leisure and culture.

In relation to the field of green technology, this plan views technique, including green energy production and consumption, as efficient instruments for tackling climate change and improving environmental performance (City of Copenhagen 2011). The 'Municipal Plan 2011 for Greater Copenhagen' also focuses on enhancing the framework of green mobility to encourage the use of healthier means of transport such as walking, cycling or using public transport. The plan also gives priority to work on electric and hydrogen vehicles with the aim of reducing carbon emissions and moving towards sustainable development (City of Copenhagen 2011).

Accordingly, with a strong focus on the field of green technology and innovation, the plan states:

- 'Copenhagen should be a green growth lab, where enterprises from all over the world can develop, test and showcase the most up-to-date and inspiring environmental solutions and energy supply'; and
- 'During the period 2011–2015, employment in cleantech enterprises should grow by 20% in the capital region' (City of Copenhagen 2011, 25)

The plan prioritises the development of green technology for enterprises and innovation developments in Copenhagen and states that this will increase employment opportunities and economic benefits driven through the operation of a green growth lab. Thus, the importance of green technology is framed within ecological modernisation. However, like the 'London Plan', there is no discussion within the plan as to how these green technologies will be equally distributed to all residents to achieve urban social sustainability in Copenhagen.

The third case study considers Amsterdam, the capital city and the centre of culture and commerce in the Netherlands (I Amsterdam, n.d.). As an essential node in the global economic network, Amsterdam was named an alpha world city by the Globalization and World Cities Research Network in 2012. The 'Economically Strong and Sustainable Structural Vision: Amsterdam 2040' was developed in 2011 for the period of 2010 to 2040 and aims to make the city 'both economically strong and sustainable' (Department of Physical Planning 2011, 3). This plan sets out challenges, problems and opportunities in the Amsterdam metropolitan area and presents appropriate strategies for achieving the city's ambitions.

In relation to the field of green technology, the plan concentrates on promoting the development of sustainable energy sources, including solar and wind energy. Additionally, a certain amount of the city's budget has been allocated for investment in renewable energy generation across the region (Department of Physical Planning 2011). It is argued that a switch to green energy is essential, if Amsterdam is to move towards sustainability in the near future. The plan states:

- 'Economic development and sustainability have for many years no longer been regarded as each other's counterpoles, but quite the contrary: they are increasingly becoming extensions of one another'; and
- 'Investing in sustainability is therefore tantamount to investing in the economy' (Department of Physical Planning 2011, 6).

These two statements suggest that the promotion of renewable energy sources in Amsterdam is mainly for the purpose of economic development. Like the other two European cities, the metropolitan plan for the City of Amsterdam is situated within a framework of ecological modernisation, but does not consider whether all residents will have equitable access to these green energies in the long-term.

The fourth case study considers Hong Kong. Hong Kong was returned to the People's Republic of China in 1997 and developed into a Special Administrative Region under the concept of 'one country and two systems' (Hong Kong Special Administrative Region Government, n.d.). As the home of

approximately seven million people, Hong Kong had experienced rapid development in different areas, including physical, financial, political and social dimensions (Chan and Lee 2007). The city is generally considered to be the international business and financial hub of Asia and has a world-class transportation system and innovative telecommunication infrastructure (Genzberger 1994; The Government of Hong Kong Special Administrative Region, n.d.). The 'Hong Kong 2030: Planning Vision and Strategy' was produced by the Hong Kong Planning Department in 2007 and sets out long-term planning strategies that aim to achieve sustainable development and strengthen the implementation of government policies. With a vision for making Hong Kong a better place to live and work, the metropolitan plan responds to various economic, social and environmental demands within the city while maintaining the principles of sustainable development (Hong Kong Special Administrative Region Government 2007).

In relation to the area of green technology, the plan briefly acknowledges the importance of good urban infrastructure in achieving the goals of sustainable development. In this context, the 'efficient and green energy supply, sewage and waste treatment systems' are considered fundamental elements in delivering a high quality living environment (Hong Kong Special Administrative Region Government 2007, 33). The plan states:

- 'A quality living environment not only embraces social and environmental objectives but can help to attract and retain workers, especially the talented and skilled, needed to sustain our economic growth' (Hong Kong Special Administrative Region Government 2007, 166).

The plan also notes that good urban infrastructure has an important role in the effective operation of ecolodges for developing ecotourism. The metropolitan strategic document of Hong Kong states:

> Though common many parts of the world, ecotourism is still rather novel to Hong Kong, contributing a minor sector of the tourism industry … The operation of the ecolodges relies largely on environmentally friendly energy, water and waste systems, and could help open up a new market for such facilities. (Hong Kong Special Administrative Region Government 2007, 188)

Accordingly, it is apparent that in some instances, green infrastructure is being developed for the purpose of promoting economic growth, but it is also being represented as a process of ecological modernisation. Like the three European metropolitan plans, this plan does not mention that equitable access to green urban infrastructures will be necessary in the future.

The fifth case study considers Sydney, a global Australian city, characterised by high degrees of prosperity, diversity and competitiveness (Bryan et al. 2006). With its vibrant economy, energetic society, unique quality of life and world-famous attractions (e.g. the Sydney Opera House and Bondi Beach), Sydney is an optimal destination for businesses and attracts millions of visitors every year. The 'Metropolitan Plan for Sydney 2036', published by the Department of Planning and Environment in New South Wales in 2010, provides a general framework for the city's sustainable development for the next 20 years. This metropolitan plan identifies strategic directions and targets specific actions that incorporate infrastructure provisions and land use to promote the effective use of private and public resources (Department of Planning and Environment 2010).

In relation to the field of green technology, the plan includes Building Sustainability Index (BASIX) targets for promoting water and energy efficiency in new houses. Buildings in the city are designed to consume less potable water and release fewer greenhouse gas emissions (Department of Planning and Environment 2010). The plan states:

> BASIX delivers an overall positive return, with new BASIX certified dwellings generating a benefit to NSW of between $1.20 and $1.60 for every dollar spent complying with BASIX, most of which accrues directly to individual householders through lower energy and water bills. (Department of Planning and Environment 2010, 179)

In addition to the BASIX tool, Sydney's metropolitan plan also seeks to enhance the use of renewable energy to satisfy the demands of a growing population and address climate change. The plan states:

- 'Sustainable building design and construction is a key emerging industry for Sydney'; and
- 'The development and manufacture of renewable energy technologies is also recognised as a potential sunrise industry' (Department of Planning and Environment 2010, 145).

These statements show that the development of green technologies in Sydney has a crucial role in promoting green enterprises. Thus, the discussion around green technology in the 'Metropolitan Plan for Sydney 2036' is generally situated within an ecological modernisation framework and has strong links to technological advancements and economic benefits. However, the plan only mentions green technologies and fails to consider any need for equitable access to these instruments to promote social equity.

From the analysis of five metropolitan plans for London, Copenhagen, Amsterdam, Hong Kong and Sydney, it is apparent that while all these strategic documents position green technology within a framework of *ecological modernisation*, they do not incorporate any steps for *equitable modernisation* that are fundamental if the challenges of urban social sustainability are to be addressed.

Conclusion

The above analysis shows that within the discourse of urban social sustainability, equitable access to green technologies has become a prominent area of research, arousing the concern of international scholars. However, the development of these innovative technologies has not generally been aligned with considerations of social justice and social inclusion. Consequently, several cities around the world are experiencing a process of *green techno-apartheid* whereby access to green technologies is limited to wealthy residents. This was illustrated by the investigation of key eco-cities (i.e. Masdar, Songdo IB and Bangalore) chosen from the UNEP report (2013). As metropolitan planning strategies are considered important mechanisms for change, the paper adopted a case study approach and reviewed five metropolitan plans, including the 'London Plan' (London, England), the 'Municipal Plan 2011 for Greater Copenhagen' (Copenhagen, Denmark), the 'Economically Strong and Sustainable Structural Vision: Amsterdam 2040' (Amsterdam, Netherlands), the 'Hong Kong 2030: Planning Vision and Strategy' (Hong Kong, China) and the 'Metropolitan Plan for Sydney 2036' (Sydney, Australia). The key findings of the research showed that while each of these strategic plans focus on promoting green technology within a framework of *ecological modernisation*, they do not consider what tools are needed to attain *equitable modernisation* and enhance social equity.

Noticeably, in consideration of the question raised by the UNEP (2013): 'Will they (*green technologies*) reinforce the stark techno-apartheid that is splintering cities around the world or will they create the basis for greater equity?', it is apparent that although eco-cities are commonly positioned as progressive models for moving towards better urban futures, key findings of this paper reveal that the debate about green technology and equitable access is very under developed in the areas of public policy, particularly within metropolitan planning strategies. As urban future requires strong goals of achieving not only environmental sustainability but also social equity, it is key that metropolitan strategies and master plans include appropriate components that promote the development of more equitable cities. In this correlation, for the progression of a democratic society, it is suggested that city policy makers should incorporate issues of equitable distribution into their metropolitan plans, in which they align the development of different green services and technologies with strong considerations about social justice or social inclusion.

City policy makers, as Albrechts (2010) describes, are well placed to drive change, in turn, to enable the translation of concepts and ideas to break free from the processes of continuity. He points to, ' … Transformative practices focus on new concepts and new ways of thinking that change the

way resources are used, (re) distributed, and allocated, and the way the regulatory powers are exercised' (Albrechts 2010, 1116). The possibility of transformative policy is enabled or restricted by the underlying political economic course chosen by response frameworks – the fair-share city, a more progressive approach, breaking from the restraint of growth first (see Albrechts 2010) or the redesigning city model aligned to neoliberal urbanism (Hodson and Marvin 2010). Nevertheless, metropolitan planning strategies remain a critical tool for transforming practices to deliver on urban sustainability, and in this case the particular focus on equitable access to green technology. As this paper has illuminated if long-term urban social sustainability is to be achieved, more effective embedding of equitable access to green technologies into metropolitan planning strategies is urgently required.

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