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Cooling cities with green space: a policy analysis framework

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Abstract: The urban heat island effect, in which cities are hotter than surrounding rural areas, will be exacerbated by climate change impacts for many Australian cities. Heatwaves already kill more people than other natural disasters, and have significant impacts on productivity and liveability. Vegetation is one of the most effective mitigation options for the urban heat island effect. However, in many Australian cities, green space is under increasing pressure from urban densification and sprawl. To date, green space planning has a relatively weak role in urban planning, and the links between urban planning and provision of urban green space, and its broader urban liveability contributions, are largely missing. This paper provides an overview of the urban heat island effect, and urban greenery's role in its mitigation. Following this, it presents an analysis framework to assess the effectiveness of Australian policies in retaining and maximising urban greenery. The framework utilises research on sustainability transitions to structure the criteria for analysing policies. The framework focuses on policy processes and content to assess policy effectiveness and to define policy 'success'. We propose that a key component of policy effectiveness is gaining cross-organisational 'ownership' and agency for policy implementation from across multiple departments within the policy's jurisdiction. Reflecting urban greenery's multi-functionality, we propose that policy success is associated with it being integrated and embedded across departments within an organisation (for example transport, recreation, open space, strategic planning, assets management, etc.); and when a range of urban greenery's multiple contributions are actively and intentionally utilised.

Introduction

"Liveable cities are equitable, socially inclusive, affordable, accessible, healthy, safe and resilient"
(Commonwealth of Australia 2011).

Urban liveability is created and maintained by a combination of factors related to health and well-being, economic prosperity, social cohesion and the quality of the urban fabric. The concept of 'liveability', though subject to a variety of definitions, underpins urban policy for cities in Australia and internationally (Commonwealth of Australia 2011; Badland et al. 2014). Maintaining urban liveability requires addressing a range of environmental sustainability issues, including the urban heat island effect (Department of Infrastructure and Transport Major Cities Unit 2013). The urban heat island effect, in which urban areas are hotter than their surrounding rural areas (Oke 1982), exacerbates the impact of heatwaves. Heatwaves affect a city's liveability: the health and well-being of its residents and workers, economic activity and infrastructure (Loughnan et al. 2013). Heatwaves kill more people than any other type of natural disaster (Steffen et al. 2014), and can worsen social isolation and mental health issues (Department of Infrastructure and Transport Major Cities Unit 2013). With increasingly severe heatwaves caused by climate change, urban greenery will be of growing importance to maintaining a city's liveability, as one of the most effective ways to address and reduce the urban heat island effect (Fryd et al. 2011; Kleerekoper et al. 2012).

Australia is a highly urbanised nation; measures to maintain and increase liveability for its people will therefore need to address the urban context, including heat-related issues and the urban heat island effect. Public policy has an important role in addressing the urban heat island effect. Some Australian governments at local, state and federal levels have commenced policy development to address the urban heat island effect; efforts are still immature, lack consistency across jurisdictions and often lack application of research to inform evidence-based priorities (Jewell 2013).

The purpose of this paper is to present a policy analysis framework that specifically focuses on policy process and policy content. The aim of this research is to contribute to the current knowledge and understanding of policies for mitigating the urban heat island effect through the retention and maximisation of urban green space. We focus on Melbourne, one of Australia's major cities that has already suffered significant impacts from heatwaves exacerbated by the urban heat island effect (Steffen 2015).

We provide an overview of the urban heat island effect, and summarise the role of policy for urban green space. We argue that urban greenery policy can potentially play a significant role in the retention and maximisation of urban greenery, but is not yet prioritised in relation to broader urban policy and planning processes (Colding 2011). As such, urban greenery policy can be described as a sustainability innovation, and theories of sustainability transitions can be utilised in analysing the trajectories of policy development, adoption and implementation. The policy analysis framework draws on research into the public policy dimensions of sustainability transitions (Loorbach 2010; Rotmans et al. 2001), to identify the key criteria for analysis. This paper synthesises insights from research on the urban heat island

effect and its mitigation with urban greenery, with research on sustainability transitions and public policy analysis. As the research is still in progress, preliminary results are reported.

The urban heat island effect

Research has identified two distinct aspects to urban heating: surface heating and 'urban canopy level' ambient air heating. Surface heating, caused by short wave solar radiation being absorbed by unshaded ground surfaces or buildings, is the daytime element of the urban heat island effect. In contrast, air heating, whereby ground surfaces or buildings with higher temperatures heat the urban air canopy, is particularly related to the increased night-time temperatures in urban areas (Norton et al. 2013).

During heatwaves, the urban heat island effect further increases the temperatures experienced in urban areas. There is not a single, authoritative definition for a heatwave (McGregor et al. 2015), "because similar temperatures can have different impacts on communities at different times" (Victorian Auditor General 2014, p. 4), and because the same temperatures will affect people from various locations differently (McGregor et al. 2015); people can adapt to average temperatures of a location, so that the temperature threshold for declaration of a heatwave would be higher in Mildura, which has a warmer climate, than in Melbourne (Victorian Auditor General 2014). Higher night-time temperatures can also impact on people's recovery from high daytime temperatures (Norton et al. 2015).

Heatwaves affect a city's economic activity and productivity (Sweeney Research 2014), its infrastructures and delivery of public services, and the health and well-being of its inhabitants. During Melbourne's 2014 heatwave, public transport users were advised to leave work early to avoid potential problems with the train system at the end of the day (Carey 2014), and businesses reported a range of economic impacts, including reduced demand for their services, and increased costs of operating air conditioners (Sweeney Research 2014). The associated loss in revenue in the City of Melbourne was calculated to be \$37 million (Sweeney Research 2014). During Melbourne's 2009 heatwave, infrastructure suffered serious damage, with train tracks buckling, and electricity network blackouts leaving homes and businesses without power (Steffen et al. 2014).

Loughnan et al. (2013) calculated temperature thresholds at which excess heat-related illnesses and deaths occurred for all Australian capital cities. For Melbourne, the threshold temperature for heat health warnings was forecast maximum of 44 °C or a mean temperature (the arithmetic average of daily maximum and minimum temperatures) of 34 °C (Loughnan et al. 2013). Those particularly vulnerable to the health impacts of heatwaves are young children and babies, the elderly, those with pre-existing medical conditions, and socio-economically disadvantaged people, including those living in poor-quality housing, those without the financial capacity to pay for air conditioning, etc.

The urban heat island effect can be mitigated by a range of measures, focused on vegetation cover, water, built form and materials. Increasing vegetation cover is one of the most effective ways to mitigate the urban heat island effect (Kleerekoper et al. 2012). Increased vegetation, particularly trees and irrigated grass, significantly and measurably reduces land surface temperatures through evapotranspiration (Coutts and Harris 2013; Adams and Smith 2014). Coutts and Harris (2013) reported a 1 °C reduction in daytime surface temperature, with an increase in vegetation area of 10% for one municipality in Melbourne. Research has shown that even a small reduction in urban temperature (between 0.5 and 2 °C) can significantly reduce heat-related mortality; increasing vegetation coverage in Melbourne's central business district from 15% to 33% may reduce heat-related mortality by between 5% and 28% (Chen et al. 2014).

Water bodies cool by evaporation, and in the case of flowing water, by transporting heat out of an area. Water-sensitive urban design treatments can contribute to cooling effects, as well as providing water for street-side landscaping, itself a mitigating treatment (Coutts et al. 2010).

The orientation of streets, the height-to-width ratio of street 'canyons', the amount of 'skyview', the location of open spaces and the amount of shading can all impact the level of solar radiation absorbed by land and building surfaces. Urban density and orientation can also impact ambient air movement and the effects of cooling winds (Smith and Levermore 2008). Building design that incorporates passive design elements (e.g. orientation, eaves, etc.) and energy efficiency (e.g. double glazing, insulation, draught sealing) requires less artificial cooling, reducing the heat generated by machinery (Coutts et al. 2010). Provision of public transport can reduce private vehicle usage, which is a major source of heating in cities (Coutts et al. 2010). The colour, type and permeability of building and paving materials impact the amount of short wave solar radiation absorbed or reflected and long wave infrared thermal radiation

emitted. Different materials can exhibit temperature differences of 8°C to 10°C (Kleerekoper et al. 2012). Permeable surfaces are cooler than sealed surfaces, and can also allow water infiltration for associated landscaping.

Urban policy and planning for green space, and urban sustainability transitions

A city's vegetation – its urban green space – provides a wide range of benefits for the city's residents and workers, in addition to mitigating the urban heat island effect. Research has identified and quantified many of the benefits provided by urban green space. These include mental and physical health benefits; economic benefits (including increased economic activity associated with attractive urban landscapes and streetscapes); social benefits (including through social interaction); and environmental benefits (Fryd et al. 2011; Kabisch et al. 2015).

In Victoria, the contribution of urban green space to urban liveability has been recognised in a range of high-level assessments and strategic plans, including, for example State of the Environment Report (Victorian Commissioner for Environmental Sustainability 2013) and whole-of-water-cycle planning and management (Office of Living Victoria 2014). However, urban green space is under increasing pressure from urban expansion and urban densification (Pauleit et al. 2011; Lehmann 2015; City of Melbourne 2012b; Victorian Environmental Assessment Council 2011), and there is a trend for reduced private open space in new residential developments in Australia (Hall 2010). Climate change impacts may further threaten urban greenery's survival and resilience (Fryd et al. 2011); climate change models indicate that southern Australia will experience increased frequency and severity of droughts, extreme weather and wind (Steffen et al. 2014).

What is the role for public policy in the retention and expansion of urban greenery for mitigation of the urban heat island effect? An issue must meet four conditions to warrant inclusion in a government's 'policy agenda' (Althaus et al. 2013): agreement on a problem; the prospect of a solution; an appropriate issue for government expenditure; and a willingness to address the issue (from a political/ideological perspective). It could be argued that all four conditions are met in the case of urban green space and mitigation of the urban heat island effect. However, the status and relative immaturity of the body of policies for urban greenery and urban heat island effect suggest that their inclusion in urban planning could be understood as being in the early stages of a 'sustainability transition', as part of larger urban sustainability transformation processes. "Sustainability transitions are long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption" (Markard et al. 2012, p. 956). 'Sustainability transitions' can be observed in new approaches to the ways that cities plan and implement building and precinct design, stormwater management, transport, electricity production and waste treatment, etc.

Theories of sustainability transitions aim to explain the processes, pathways and actors that are involved. 'Transition management', the body of research focused on public policy and governance perspectives of sustainability transitions, identifies the key characteristics that underpin public policy for transitions: long-term thinking as a framework for shaping short-term policy; multi-domain, multi-actor and multi-level thinking; the importance of experimentation (learning-by-doing and doing-by-learning), and keeping a large number of options open (Rotmans et al. 2001). Loorbach (2010) described the transition management policy process as comprised of strategic, tactical, operational and reflexive steps. 'Strategic' relates to problem structuring establishment of the transition arena and envisioning; 'tactical' to the process of developing coalitions and transition agendas; 'operational' to mobilising actors and executing projects and experiments; and 'reflexive' to the evaluation, monitoring and learning from implementation and experience. Although these are listed sequentially, Rotmans and Loorbach (2009, p. 191) noted that "in the real world, the transition management activities are carried out partially and completely in sequence, in parallel, and in a random sequence". Transition management research can inform the development of a policy analysis framework for urban green space policies, that focuses on aspects of innovation, policy development and evolution, and normative goals of sustainability.

Policy analysis: practice and research approaches

Policy monitoring and evaluation is an important element of the 'policy cycle', to allow policy-makers to assess the effects of the policy and adjust it as appropriate; it usually focuses on assessing policy outputs, costs, etc. (Althaus et al. 2013; Dovers 2005). Policy research may take a larger focus, for example assessing environmental performance of a particular government over multiple terms in office (Coffey 2011); evaluating climate policies of a particular region (Huitema et al. 2011); or considering the emergence of green infrastructure in planning policies (Lennon 2013). There are several aspects of public policy that can be examined, including policy process and policy content, and multiple methodologies for policy research analysis (Vogel and Henstra 2015). A 'plethora' of evaluation criteria have emerged over recent years (Huitema et al. 2011, p. 182); many focus on cost-effectiveness and

efficiency. Policy effectiveness and policy success can be defined in a number of different ways and taking different perspectives: from input, to process, output, and ultimately outcome (Doick et al. 2009; Millar et al. 2001). Assessing outcomes provides a more direct indication of the achievement of policy aims or objectives; for example, an urban greenery output of 'number of trees planted' does not indicate whether the outcome of 'increased tree canopy coverage' has been achieved.

However, the challenges with measuring policy outcomes include attribution (demonstrating that a specific policy has led to a specific outcome (Maddison and Denniss 2009; Doick et al. 2009; Bovaird 2014)) and timeframes (policies may only produce 'subtle effects' with considerable time-lags (Conway and Urbani 2007; Vogel and Henstra 2015; Doick et al. 2009)). Utilising policy outputs as proxies for policy outcomes is still problematic, as they may not provide effective indicators or reflections of policy outcomes, or ultimately, policy 'success'.

Noting these and other issues, Vogel and Henstra (2015) developed a research framework for comparative policy analysis of climate adaptation policies that focused on two aspects of public policy: policy content and policy process. *Policy content* includes goals, targets, instruments and agents, and *policy process* spans agenda setting, policy formulation, decision-making, implementation and evaluation, involving different participants throughout. Based on these considerations, in the next section of this paper we propose a policy analysis framework for Australian policies for urban green space and urban heat island effect that integrates elements of policy research, with insights from theories of sustainability transitions.

Urban green space policy: a research framework for comparative policy analysis

We propose a policy analysis framework to examine the development of urban heat island and urban greenery policies and assess their success in retaining and maximising urban green space. This framework seeks to build an understanding of the process by which policy innovation for urban green space is developed, adopted and implemented, how the policies are framed, what status they are given within an organisation, and how their success is defined and evaluated by policy makers. The analysis framework (Table 1) synthesises insights from policy research (particularly Vogel and Henstra (2015)'s heuristic framework) and sustainability transitions research (particularly Loorbach (2010)'s four elements of the transition management cycle) to enable analysis of the content and process of urban greenery and urban heat island policies.

Table 1 Framework for policy analysis: transition management criteria for analysing policy process and content. Sources: Vogel and Henstra (2015), Loorbach (2010)

	Transition management cycle			
	Strategic: problem structuring establishment of the transition arena and envisioning	Tactical: developing coalitions and transition agendas	Operational: mobilising actors and executing projects and experiments	Reflexive: evaluation, monitoring and learning from implementation and experience
Policy content:				
Goals				
Targets				
Instruments				
Agents				
Policy process:				
Agenda setting				
Framing the problem				
Engaging stakeholders and the public				
Setting priorities				
Formulating policy options				
Generating political support				
Policy integration				

Analysis of the policy process includes examining how urban greenery policies are identified as part of the policy agenda, knowledge transfer and policy 'diffusion' (both within and between organisations and cities (Starke 2013)), policy learning (Ison and Collins 2008), and researching policy makers' own understandings and definitions of policy success. The analysis of the policy process will also consider the development of policy 'ownership' (who takes responsibility for implementing urban greenery policies, or as Hajer et al. (2015) expressed, inspiring and motivating agents of change to implement policy goals). We propose that these policy processes are important factors in the successful transition of policies (Loorbach 2010; Rotmans et al. 2001) from 'niche innovation' (whereby policies for urban greenery and urban heat island effect represent relatively new and as yet uncommon approaches to urban planning) (2020 Vision 2015) to being taken up widely within and across jurisdictions and achieving broad policy ownership. Policy content will be examined to identify the selection of policy instruments or mechanisms. Policy content analysis will also include analysis of the goals, targets and agents, assessed against transition management's strategic, tactical and operational criteria.

This policy analysis framework is intended to be applied to comparative policy analysis research between neighbouring jurisdictions, as well as between different levels of government. Comparative policy analysis can contribute to better understanding, for both practice-based policy makers and for policy researchers, of the factors and processes that underpin the policy responses and policy choices to similar challenges from different jurisdictions (Vogel and Henstra 2015). Data sources include the key policies for urban heat island mitigation and urban green space, supplemented by interviews with policy makers and desk-top study of supplementary strategies and plans. This paper presents preliminary results identifying examples of some of the key policies for urban heat island mitigation within metropolitan Melbourne. The research is still in progress, further research will apply the policy analysis framework to develop understandings of how policies are established and implemented, and the factors that lead to policy 'effectiveness' and policy 'success'.

Results

Policies to mitigate the urban heat island effect with green space should seek to retain existing green cover, to identify opportunities to increase green cover, and to ensure that other policies, strategies and regulations do not pose unreasonable barriers to the retention and establishment of green cover (Bosomworth et al. 2013). Australian governments at federal, state and local levels have acknowledged heatwaves and the urban heat island effect as a significant issue for some urban areas, as well as the role of vegetation in mitigating the urban heat island effect (for example, Department of Infrastructure and Transport Major Cities Unit 2013; Victorian Department of Transport Planning and Local Infrastructure 2014; City of Melbourne 2012b). The urban heat island effect is addressed by some jurisdictions as part of their climate change mitigation strategies, whilst others locate the issue as part of their climate change adaptation approaches. The range of policy areas that address the urban heat island effect, heatwaves, heatwave mitigation and urban green space is summarised in Table 2. Many councils have developed heatwave strategies, often through their health or community welfare departments, but these usually focus on addressing extreme events rather than aiming to reduce the severity of heatwaves by mitigating the urban heat island effect itself. The Australian Productivity Commission (2014) reported that expenditure on disaster mitigation (in this case mitigating the urban heat island effect to reduce the impacts of heatwaves) is more efficient than post-disaster recovery, reinforcing the case for development of effective mitigation policies.

City of Moreland is one of the first municipalities to specifically focus on developing an 'Urban Heat Island Action Plan'; the plan is currently being developed and is due for completion in 2016. Development of the plan is one of the five priority actions identified in Council's climate change mitigation strategy, 'Zero Carbon Evolution' (Moreland City Council 2014). Areas for action in Moreland's urban heat island plan will be prioritised based on combining data on lower socio-economic areas with localised heat maps: Loughnan et al. (2013) developed the approach to prioritising areas for mitigation actions, by synthesising vulnerability data (social factors, based on demographic data) and exposure data (physical factors, based on aerial thermal imagery and ground truthing/site inspections); Norton et al. (2013) expanded this approach by incorporating 'behavioural exposure', zones of high activity, into the prioritisation process. Moreland City Council's Open Space Strategy (Moreland City Council 2012a) and Street Landscape Strategy (Moreland City Council 2012b) also identify the urban heat island effect and climate change as 'emerging issues' likely to impact open space and vegetation. The role of open space and trees in mitigating the urban heat island effect is also highlighted.

Table 2. Australian governments' policies addressing the urban heat island effect and urban green space

Policy focus area	Federal	Victorian	Municipal
Cities, urban design and planning	National Urban Policy Green Star rating tool	Vic Planning Provisions Plan Melbourne: Metro Planning Strategy	Municipal Strat. Statement Council Plan Local Planning Policy
Health, emergency management	Dept of Health Plan, Aust. Emergency M'tment, Disaster Resilience Strategy	Public Health & Wellbeing Emergency Management Victorian Heatwave Plan	Municipal health & wellbeing Municipal Emergency M'tment Heatwave Strategy
Water, whole-of water cycle, stormwater management	Water Act 2007 National Water Initiative	State Environ Protection Policy Living Victoria, Living Melbourne	Integrated Water M'tment Plan Waterway management plans
Climate change: mitigation and adaptation	Emission Reduction Fund	Climate Change Act 2010 Victorian Climate Change Adaptation Plan	Mitigation Plan Adaptation Plan
Open space and recreation	20 Million Trees program	Metro. Open Space Strategy (in prep) Healthy Parks, Healthy People	Urban Forest Strategy Open space strategy Green Roofs & Walls Strategy Street Tree strategy
Ecology and biodiversity	Environment Protection & Biodiversity Conservation Act	Environment Protection Act Flora & Fauna Guarantee Act Environment Effects Act VEAC Metro Melbourne	Urban ecology strategies
Buildings	National Construction Code		Building regulations, permits

City of Melbourne has addressed the urban heat island effect in several of its key strategies, including the Urban Forest Strategy (City of Melbourne 2012b), the Climate Change Adaptation Plan (City of Melbourne 2009), the Open Space Strategy (City of Melbourne 2012a) and Total Watermark, its integrated water cycle management strategy (City of Melbourne 2014b). City of Melbourne, in partnership with neighbouring municipalities, has also recently developed the 'Growing Green Guide' technical guidelines for installation and maintenance of green roofs, walls and facades (State of Victoria 2014), and is actively investigating opportunities to 'green' the laneways in the central business district (City of Melbourne 2014a), through its 'Green Your Laneways' program. In 2014, City of Melbourne won an international 'City Climate Leadership Award' through the C40 cities network for its urban landscapes adaptation program. As the research is still in its early stages, the policy analysis framework has been applied to the policy content aspects of the Urban Forest Strategy (City of Melbourne 2012b) to demonstrate its application (Table 3). Applying the framework highlights key aspects of the strategy's strengths and weaknesses. In future stages of the research, data from semi-structured interviews with policy-makers will be collected to analyse the policy process aspects.

Increasingly, the effectiveness of urban greenery interventions will depend on incorporating consistent sources of water, including where possible stormwater retention/water-sensitive urban design elements (Norton et al. 2013). Policy-makers from both Moreland and Melbourne Councils have highlighted the importance of integrating water planning with urban heat island mitigation, as well as the opportunities presented by linking 'water sensitive urban design' treatments with urban green space establishment and maintenance.

Other policies such as Plan Melbourne, the metropolitan planning strategy (Victorian Department of Transport Planning and Local Infrastructure 2014) include specific sections on urban green space and urban heat island effect. However, as with cities globally (Mees and Driessen 2011; Colding 2011; Hansen and Pauleit 2014), urban green space competes with other urban land uses and socio-economic interests, and the inclusion of urban greenery policy in urban design and planning is still limited and without strong influence.

**Table 3 City of Melbourne’s Urban Forest Strategy (City of Melbourne 2012b):
Policy analysis framework (policy content aspects)**

	<i>Transition management cycle</i>			
	<i>Strategic: problem structuring establishment of the transition arena and envisioning</i>	<i>Tactical: developing coalitions and transition agendas</i>	<i>Operational: mobilising actors and executing projects and experiments</i>	<i>Reflexive: evaluation, monitoring and learning from implementation and experience</i>
<i>Policy content:</i>				
<i>Goals</i>	Resilient, healthy and diverse forest (p. 5)	Engage with the community (p. 37)	Manage existing landscapes and adapt landscape (p. 37)	<i>Not addressed by Strategy</i>
<i>Targets</i>	Increase canopy cover, species diversity; improve vegetation health, soil moisture, urban ecology; inform community (p. 7)	<i>Not addressed by Strategy</i>	Actions to increase canopy cover in private realm (p. 40)	<i>Not addressed by Strategy</i>
<i>Instruments</i>	Strategic framework; integration with Future Melbourne Plan, Council Plan (p. 8)	“Green governance” (p. 53); Community engagement programs (p. 56)	Integration with associated policies and deliverables (p. 8); Actions identified for all strategies (pp 40-51)	Monitoring as part of tree maintenance (p. 42); Information development (data collection priorities) (p. 57)
<i>Agents</i>	Lord Mayor’s and Councillors’ support and engagement (p. 7)	Community and inter-professional integration; inter-municipal integration (p. 53)	Intra-Council integration (p. 53)	<i>Not addressed by Strategy</i>

In terms of policy learning processes, Australian local governments have demonstrated their openness to collaboration and information-sharing for policy development through their membership of a range of alliances and regional groupings, including for example Victorian Climate Change Alliances (such as the South-East Councils’ Climate Change Alliance), and the National Growth Areas Alliance. The recent development of a guide for preparing municipal urban forest strategies (2020 Vision 2015), and the associated workshop for local government officers and councillors, is further demonstration of this commitment to sharing information and learning from each other’s experiences.

Conclusions

The policy analysis framework presented in this paper aims to provide a methodology with which to enable comparative policy analysis of urban greenery policies in Australian cities. Given the lack of standardised policy analysis methodologies (Vogel and Henstra 2015), the immature and inconsistent policy context for mitigating urban heat island with urban greenery, and the lack of research on urban greenery focusing on the urban heat island effect and qualitative research (Krajter Ostoić and Konijnendijk van den Bosch 2015), this policy framework has the potential to progress both research and practice-focused efforts. It can contribute to the development of understandings of policy ‘success’, and the relative contribution of policy content and the policy process to policy success.

As cities grow and increase in density, there is increasing pressure on urban green space; it is often seen as easily replaceable when it 'gets in the way' of new developments and new ('hard') infrastructure (Victorian Local Sustainability Accord 2011). Urban planners must juggle a range of often competing demands and issues in the planning and development of cities, including housing affordability, economic development, infrastructure provision, urban sprawl (Colding 2011), often with lack of guidance on strategic priorities, or implementation targets. In addition, urban planners may not consider that they can facilitate sustainability outcomes, or that they have the authority or agency to influence sustainability outcomes (Säynäjoki et al. 2014).

How policies are framed and how their contents are designed can themselves have impacts on the "mobilisation of new agents of change" (Hajer et al. 2015, p. 1652), as part of the adoption and implementation of innovative policy approaches. Although the policy process has been framed as a rational, evidence-based exercise (Althaus et al. 2013), others acknowledge the role of values in decision-making, and the limits of a rational approach (Colebatch 2006; Maddison and Denniss 2009). Head (2008) highlighted the different types of knowledge that contribute to policy and decision-making: political judgement, scientific research-based knowledge and practical implementation knowledge. Policies for sustainability transformation need to inspire and challenge both governments and communities, if they are to realise their transformative potential, and the policies' construction and dissemination (or content and process) are critical aspects (Hajer et al. 2015).

Designing and implementing policies to address the urban heat island effect with urban greenery faces significant challenges due to the complexity of competing demands for space and resources in urban areas, and complex governance arrangements for many cities (particularly for large cities that have multiple local governments covering the greater metropolitan area). Nonetheless, the necessity for addressing the urban heat island effect has been recognised by a number of governments, particularly at local levels. Comparative policy analysis can contribute to development of effective policies and facilitate policy learning processes, particularly at local levels where local governments face similar issues, constraints and physical conditions, and where local governments have already demonstrated willingness and commitment to collaboration and information sharing.

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