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The Green Economy, Sustainability Transitions and Transition Regions: A Case Study of Boston

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Abstract

This paper is focused upon exploring the development of the green economy in particular locations, with the aim of identifying why some cities and regions have been successful in engendering green growth. To date we have little idea where the green economy is developing, nor much insight, beyond anecdotal evidence, into why certain cities and regions appear to be more successful than others in this regard. We position our analysis within the context of research on socio-technical transitions that has theorised the potential shift to a more sustainable economy. We review the literature on sustainability transitions and the development of the multi-level perspective encompassing niches, regimes and landscapes. However, most research into socio-technical transitions has not given adequate consideration to the influence of places and spatial scale in these transition processes, and we therefore critique the socio-technical transitions literature from a geographical perspective. In this paper we are interested in four key questions: what role does the enabling and facilitative state play in these cities and regions? What new institutional forms and governance structures are being developed? How do actors in particular cities and regions construct their green vision, and how do they encourage other actors to buy-in to this vision? How are links across levels and spatial scales developed to connect niches with the regime? We address these through a focus upon the Boston city region in the USA, drawing upon both primary and secondary research material. We utilize this case study example to re-examine and re-theorize work on sustainability transitions from a spatial perspective.

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Introduction

There has been a growing recognition in recent years that green industries and technologies offer considerable economic development potential. As opposed to previous attitudes, which often saw environmental protection as antithetical to economic growth, policy makers around the world now see the green economy as a source of growth and jobs and the basis of a new round of capital accumulation (HM Government, 2008; UNEP 2011). This development was given added impetus by the global financial crisis and proposals for national stimulus measures or 'green new deals' to: transform and re-regulate the international financial sector; provide an opportunity for state intervention to redirect, or at least encourage, restructuring towards new economic forms - i.e. a 'green' or 'low carbon' economy; and to address issues of 'peak oil' or the 'energy crunch' associated with dependence on oil (Bowen et al. 2009). All of these measures, it was envisaged, would not only provide economic benefits, but also mitigate climate change through a reduction in carbon emissions. Such green economic development aims: "first to mitigate environmental damage from waste and resource over-exploitation; second, to moderate human contributions to climate change; and third, to manage the transition from fossil fuel to renewable energy" (Cooke, 2010: 833). Thus the green economy, involving a combination of new technologies and changing institutions, is increasingly becoming a mainstream source of policy responses and initiatives in the developed world (Barry and Paterson 2003; Barry and Doran 2006). In the UNEP (2011: 16) definition, "a green economy is low carbon, resource efficient, and socially inclusive [...where] growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services." This definition represents, as Bina (2013) argues, a continued commitment to business-as-usual, neoliberal economics and economic growth, reliant on technology, rather than shifting to a different paradigm promoting more holistic integration of social and environmental sustainability. While the green economy project is promised as a remedy to ecological crises, it is simultaneously "pro-growth, pro-jobs, and pro-poverty-reduction" (UNEP 2010: 6-7, in Shear 2014: 196). Whilst varying definitions and discourses of the green economy exist, it is much rarer that political appeals are made which encourage constraints on demand and consumption, given that the primary aim is economic growth, albeit green-tinged, and the socioeconomic paradigm is still that of consumption economies (Bina 2013).

Despite the contested nature of what actually constitutes the green economy, it is increasingly recognised that the complex and multi-sectoral nature of the green economy requires a coordinated response by governments in partnership with other regional actors. Those "countries where the green economy is currently the most developed are generally those where the public authorities (national or regional) adopt an active and dynamic approach to the long-term co-integration of environment policies and innovation policies, with the support of a global coalition of private stakeholders and institutions" (Hamdouch and Depret, 2010: 475). A

multi-level and multi-governance approach towards the integration of policy is therefore required to encourage the green economy to develop, involving government institutions working closely with other local actors (LGA, 2009). The governance forms associated with this integrative policy approach necessitates a rethink of traditional economic development policies as the green economy reconfigures established organisational boundaries. Governance moves from the level of individual actors “towards more socialised and systematic forms of collective co-ordination in networks. Coalitions, lobbies, public-private partnerships and social networks thus play a key role in the development of environmental innovations” (Hamdouch and Depret, 2010: 483). By adopting these policy approaches, nations, regions and cities have begun to position themselves as leaders in the new green economy and as destinations for new forms of investment, leading to competition between places for investment (Caprotti, 2012; Clean Edge, 2012). However, as with previous rounds of accumulation, the green economy will not develop evenly over space and we can expect that there will be winners and losers in this process.

Despite this growth of interest, we have relatively little understanding of how the shift to a green economy might occur and the extent to which it is already being developed on the ground. From a geographical perspective, our understanding of how these developments occur over space is limited. Nor do we have much purchase on the ways in which local and regional governments are promoting the development of the green economy, or the related institutional and governance shifts that are taking place. In this paper we address these research gaps by proposing a theoretical framework for research on the green economy and illustrate this by exploring a specific case study of such developments. In the next section of the paper we propose that socio-technical transitions research provides a useful framework to conceptualise the shift towards a green economy. However, one critique of this theoretical perspective is that it largely fails to account for the influence of space and place. Thus, in a subsequent section we explore the recent theoretical debates around incorporating space into socio-technical transitions research and put forward four research questions that arise from our analysis. Our aim here is to build upon the (limited) work that has already been undertaken on transitions from a geographical perspective, and to contribute to an understanding of how place specificity may lead to green economic development and act as a source for sustainability transitions. In addition, we explore the relational nature of these developments and the ways in which the actors involved transcend the purely local. Moreover, many contributions to the geography of transitions debate have largely proceeded in the absence of any clear empirical evidence from particular locations and they often take place at a fairly high level of abstraction (see for example Raven et al, 2012; Truffer and Coenen, 2012). We therefore draw upon recent research in a US context (Muro et al., 2011; Bureau of Labor Statistics, 2012; Pollack, 2012) as one example of the key national locations where green economy developments are taking place. More specifically, we investigate in some depth the development of the green economy in Boston, Massachusetts, drawing upon both primary and secondary research work, and use this case study to re-examine the theoretical debates in the light of our empirical findings.

Socio-technical transitions and the multi-level perspective

While policy makers and commentators increasingly agree that a green economy is desirable from both an environmental *and* an economic perspective, it is less clear exactly how the shift to a new green economy will take place, nor what form a so-called green economy should take. A useful perspective from which to address this is provided by research within social studies of technology, which has specifically explored sustainability transitions, the transformation of technological regimes and the role of innovation (Rip and Kemp, 1998; Smith, 2003; Geels, 2005). In particular, the multi-level perspective (MLP) of innovation is helpful in understanding the opportunities and constraints that a shift to a green economy may encounter. The MLP identifies three synergistic levels: the socio-technical *landscape*, which encompasses social values, cultural norms, the natural environment and the macro political economy etc.; a meso-level of socio-technical *regimes*, that include interconnected systems of existing technologies, institutions, rules, norms and practices (Berkhout et al. 2003); and a micro-level of protected *niches*, which act as test-beds for innovative ideas and technologies, and the potential emergence of new socio-technical constellations that challenge the existing regime (Späth and Rohracher, 2010).

In relation to the development of a green economy, one of the key tasks is to explore how new technologies, institutions and governance structures might supersede currently dominant socio-technical regimes and become mainstream. Regimes operate at the meso-level (such as fossil fuel-based energy systems) forming relatively stable configurations of institutions, techniques and artefacts, as well as rules, practices and networks that determine the 'normal' development and use of technologies (Rip and Kemp, 1998; Berkhout et al., 2003). Regimes are seen as largely physically and socially inert (Bulkeley et al., 2010), leading to path dependency and lock-in (Berkhout, 2002; Unruh, 2002; Genus and Coles, 2008). A key research focus in sustainability transitions research has been to explore how existing regimes can be challenged and, potentially, disrupted onto a different, more sustainable path (Smith, 2003). Regimes may be transformed by niche activities that focus on tensions that arise within regimes. These tensions may be the product of changing circumstances in the wider socio-technical landscape acting as a driver for regime transitions. For example, new imperatives, such as policy measures to address the impact of climate change and accelerated global warming, carbon reduction targets, and targets for energy generation from renewable technology sources, act as a challenge to existing technological regimes (Smith et al., 2010). Such changes may provide a window of opportunity for new socio-technical configurations to replace existing regimes (Truffer, 2008). In such cases, niche activities may break through to the mainstream if they successfully solve bottlenecks in the extant regime (Geels, 2005). Landscape and subsequent regime tensions may therefore create the space within which a green economy can develop successfully. More radical niches, and those less well aligned with the existing regime, may find it difficult to break through into the mainstream, although even then some aspects may be more compatible and more easily incorporated (Smith, 2003). In the latter case, actors in the extant regime may borrow convenient aspects of niche activity, but in the process lose the more radical, and transformative aspects. Indeed, in some cases, as Smith (2006) shows for the organic food industry, the mainstream technological regime may transform the niche rather

than the reverse¹. We should not, therefore, assume that any new regime will inevitably be more sustainable than that which it replaces².

The drivers of change within niches will be constituted by a set of actors, including green economy firms, and their related clusters of institutional support, such as government institutions, policy makers, industry associations and universities. Smith (2007: 447) suggests that these key actors are “pragmatic systems builders who make compromises and help translate some niche practices into forms amenable to actors in the regime”. This may enable incorporation into the existing regime or, more substantively, turn green business activities into the new mainstream regime (Meek et al., 2010). As we have already suggested, developing a new socio-technical regime may require new alliances (Keijzers, 2002) that supersede traditional competitive relations between private sector firms. One way in which such alliances seek to transform regimes may be through attempts to shift institutional arrangements, either in order to widen the niche (and their own markets) and/or to engender a more substantive regime change – see for example, Schaltegger and Wagner’s (2011) account of the German renewable energy market. This can be through a range of actions including the creation of new partnerships, shifting societal views on sustainability, introducing new norms, values and practices, as well as actively lobbying for regulatory change where this helps to foster the introduction of sustainable innovations. By these methods, niche actors aim to shift current standards, routines, norms and practices in order to create a regime that is more aligned to, and supportive of, their innovative behaviour and ultimately to contribute towards a sustainability transition in their particular sector (de Boer et al., 2009). Such efforts may be particularly effective if economic growth results in, for example, increased political influence and bargaining power by green businesses and their industry associations in order to lobby for regulatory change (Geels, 2010).

The green economy, transitions and space

In total, the socio-technical transitions literature constitutes a rich source of theoretical ideas about the processes of sustainability transitions. For a study of the green economy it provides a useful conceptual framework for the institutional and governance shifts that are involved, as well as for the development of innovative and entrepreneurial activities by firms engaged in the transition to sustainability. However, little attention has been paid to *where* niche development or transitions are taking place – the role of place and spatial scale involved in transitions is rarely examined or made explicit (Smith et al., 2010). As a consequence “spatial context is all too often treated as a passive background variable providing little causal explanation or theoretical purchase” (Coenen and Truffer, 2012: 369). In cases where space *has* been explicitly addressed, the main focus has been on national scale transitions (Hodson and Marvin, 2010). As Raven et al (2012) point out, the implicit (but erroneous) assumption is often made that the various levels of the MLP neatly equate to different spatial scales, such that the landscape operates at a global scale, the regime at a national scale and niches at more local scales. However, although the literature frequently refers to niches being at the local level and comprising protected spaces for the innovation process and sustainability transitions (Markard and Truffer, 2008), this does not necessarily correlate with specific locations, despite

the temptation to see these as one and the same. As Raven et al. (2012: 64) point out “theoretically...there is no reason to conflate the MLP levels with specific territorial boundaries. The MLP levels refer to processes with different temporal dimensions and modes of structuration that could each have a variety of spatial positioning and reach”.

Research which has focused on the role of space and place in transitions research proposes that the sub-national scale is important, and that cities and regions are key locations from which sustainability transitions may develop. Cities and regions thus offer an appropriate scale and entry point for investigating the interactions of niches, regimes and landscapes. They may provide ‘protected spaces’ for innovations where new socio-technical configurations can develop outside of the usual competitive pressures and act as a link between niches and regimes (Coenen, Raven and Verbong, 2010; Truffer and Coenen, 2012). Indeed, Healy and Morgan (2012: 9, emphasis in the original) make a case for seeing cities and regions as the source of niche innovations that will eventually transform regimes:

“the scope for unilateral action at the sub-national scale may be extremely modest, but it is not unimportant. On the contrary, a whole series of eco-innovations are being trialled at the sub-national level all over the world...In such cases...these cities and regions are acting like *living laboratories* of learning and innovation, localized spaces of eco-innovation in effect...Where these localized and collective learning experiments are successful, they can be scaled up and diffused nationally and internationally”.

Cooke (2009) defines such locations as ‘transition regions’, acting as a beacon or lighthouse for other regions and countries. Such transition regions constitute sub-national administrative areas with policies and support mechanisms in place to support green industries, especially for regional innovation processes. These regions will have clusters of related green industries and a platform of related sectors and sub-sectors. Cooke sees green businesses and entrepreneurs as key actors within the regions, in that they act as ‘carriers’ of innovation through market re-alignment, spin-off activity or inter-sectoral migratory practices. Together with a range of other actors from the public and private sector, they act to convene and coordinate regional niche activities. In this way they support the implementation, development and demonstration of both new technologies and social practices (Cooke, 2010; McCauley and Stephens, 2012).

However, what is important in theoretical terms about the city and regional scales is not just that they provide opportunities for niche experimentation. They also “bridge the niche-regime divide and provide ‘social contexts’ (actor networks, institutions, complementary technological structures) ‘to integrate’ and implement socio-technical configurations which differ from the dominant regime and may be important for long-term transition processes” and regime change (Späth and Rohracher, 2012: 475). Similarly, Geels and Raven (2006) distinguish between ‘local experiments’ in local networks in specific geographical places and a ‘global niche level’ that is an emerging institutional environment of shared rules which transcends particular places. Moving from one to the other is a far from linear process and takes much effort on the part of the actors involved (Raven et al., 2011). In moving beyond a view of cities and regions as simply places for experimentation and demonstration, we therefore need to link together the niche

with the regime and landscape. Of particular importance is how actors adapt, or adopt, landscape and regime factors and how these come to be configured locally (Truffer and Coenen, 2012). In MLP terms, while socio-technical landscapes provide the broad context of opportunities and constraints for green business developments and their supporting institutions, they do not (despite sometimes being seen as ‘external pressures’) determine outcomes or mechanically impact niches and regimes (Hodson and Marvin, 2010). Actors within a locality need to perceive and translate these external landscape developments in order to have purchase (Geels and Schot, 2007). The role of purposive actors and institutions is therefore important in this process, not just within the local area, but also to help transcend the city and regional scale. As Späth and Rohracher (2010: 456) comment:

“what seems to be more important for multi-level transitions is that discourses are interlinked in different ways across different geographical scales and levels of structuration. ‘Guiding visions’ or ‘Leitbilder’...play an important role as they travel across spheres and levels and are used intentionally to co-shape socio-technical change in a multi-level, multi-actor process. Actors purposefully link up with national and international discourses and translate them into regional contexts. Moreover, they align actors *across governance levels* to increase authority and resources for the promotion of their visions” (emphasis in the original).

Taken together, this body of research suggests that the development of the green economy will be unevenly distributed in space and that sustainability transitions will depend on the interplay of actors, networks and institutions available in some places and not others. The incorporation of space and place into MLP research helps to explain why it is that niches emerge in certain localities rather than others (Raven et al., 2012). Some regions or places may offer greater opportunities both for niches to develop and operate, and for the formation and development of green economy activities. Even so, exactly why this should be the case is currently not entirely clear. Cohen and Winn (2007) argue that green entrepreneurial activity may create new markets and opportunities for other green businesses to develop, thus those areas with green clusters could act as a catalyst and support for further development. This, however, is somewhat of a circular argument and fails to explain the initial development of green business activities. Meek et al. (2010) suggest that social norms within an area may play a role, with those areas where the prevalent norms value sustainability and the environment more likely to give rise to green business activities. Similarly Cohen (2006) suggests that certain locations will have the networks, institutions, capital, talent, culture and support services to encourage and support green business³. Again, exactly *why* certain locations should have this favourable confluence of institutions and structures is unclear.

Thus far we have argued that the MLP within socio-technical transitions theory provides an appropriate conceptual basis to investigate the development of the green economy. One advantage of utilising socio-technical transitions research is that it assists in focusing attention upon those networks and institutional structures that help to support the green economy and alternative sustainable practices (Smith, 2003). This enables us to connect the activities of individuals, firms and policy makers to wider economic and social structures, and indicates that

broader changes are necessary to develop a green economy beyond the formation and expansion of new firms and economic sectors advocated by national government initiatives (see for example Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2008; HM Government, 2008). A key component of developing the green economy is an enabling/facilitative state, with alliances committed to sustainability. Without these, developing the relevant collaborative governance arrangements, such as commercializing knowledge, cultivating clusters, creating supply chains and developing new skill sets that will lead to green economic development, is problematic (Healy and Morgan (2012)). However, while we have indicated that new alliances and institutional arrangements are needed for transitions, we have only limited knowledge of how these are developing, the form that they are taking, and where they are taking place.

We have argued that there may be a key set of actors or ‘green system builders’ driving the process, operating at a niche level at the city and regional scale who attempt to shift institutional arrangements and regime norms to the benefit of their own sectors, interests and localities. However, four key questions arise from the need to incorporate an analysis of space within the MLP. What role does the enabling and facilitative state play in these cities and regions? What new institutional forms and governance structures are being developed? How do actors in particular cities and regions construct their green vision, and how do they encourage other actors to buy-in to this vision? How are links across levels and spatial scales developed to connect niches with the regime? In order to address these questions, we believe it is essential to conduct detailed studies of green economy developments in particular cities and regions to examine the role of international, national and local policies, businesses, institutions, support structures, and government agencies. This would assist in identifying particular spaces and places which are the ‘hot spots’ of the green economy and help to understand the processes at work within these. In the remainder of this paper, we offer an exploratory analysis of these issues and respond to our four questions through an empirically-based examination of one particular place engaged in enacting sustainability transitions – the green economy of the Boston city-region in the USA. Before we move on to providing a detailed analysis of this location, in the next section we provide some context and a justification for the choice of this case study.

The Geography of the US Green Economy

For the most part, exploring the geography of the green economy is an exercise fraught with problems given the lack of available definitions and data – for example, green jobs do not form a specific sector under current industrial classifications and may be found across many sectors (Bureau of Labor Statistics, 2012). As an initial step in identifying green economy ‘hot spots’ or transition regions for empirical study, we draw upon the study by Muro et al. (2011) for the Brookings Institution⁴ which maps out where such activity is taking place in the USA, before turning to a more detailed analysis of Boston, Massachusetts as an example of a city positioning itself at the forefront of the green economy. We recognise, of course, that the USA is far from being the only key location for the development of the green economy and that there are other equally important locations in Europe and, increasingly, in China, which is now the world’s

leading exporter of wind and solar technologies (see Cooke, 2011; Jacobs, 2012). However, the Brookings Institution research provides a unique data set which identifies the key locations for the green economy in one nation state unmatched by any comparable study elsewhere to date. Given that it is based upon the compilation of an establishment-level database⁵ for the whole of the USA, this helps to justify the subsequent choice of Boston as a location to investigate in more depth with some objectivity.

As Muro et al. (2011: 7) state, a comprehensive national database for the USA on the spatial geography of the green economy does not exist and thus their work initially concentrated upon compiling these data. They define the green economy as comprising the following sectors⁶: agricultural and natural resources conservation; education and compliance; energy and resource efficiency; greenhouse gas reduction, environmental management and recycling; and renewable energy. Figure 1 illustrates the location of the green economy by job totals in US metropolitan areas based on this Brookings Institution survey definition (Muro et al., 2011). The report indicates that the US green economy is predominantly located in metropolitan areas – which accounted for 84% of total green industry jobs in 2010 – and that those areas where firms are clustered together experienced faster job growth. This then gives some empirical weight to the assertion by socio-technical transitions theorists in the previous sections of the paper that cities and regions represent key locations for the green economy.

(Figure 1 about here)

In the following section we focus upon Boston's importance as a green economy hot spot and explore the institutional forms, structures and policies that help to explain why Boston's socio-economic context supports and encourages the green economy. The data used in this section of the article come from multiple sources, including those compiled by the Boston Foundation, Pioneer Institute, other secondary source material from local institutions, interviews with key public and private actors in the city-region and archival data. Our justification for the choice of Boston is that it is one of the key US metro areas identified by the Brookings Institution as having particularly strong clustering activities in some green economy sectors (see Figure 2). In more practical terms, it is also an area with which one of the authors is familiar and where empirical research had been conducted and a network of key informants was in existence.

(Figure 2 about here)

The Boston Green Economy

Boston – a green economy hotspot?

The Boston city-region is one of the USA's green economy 'hot spots' according to the Brookings Institution, whose report ranks it eighth out of the top 100 metropolitan regions in terms of overall size (41,825 jobs) constituting 1.7% of all jobs in the metro area (Muro et al., 2011). While other metro areas rank higher in the Brookings report in terms of total employment, Boston is one of the US metro regions that possess strong industry clusters.⁷

Boston is particularly important for clean energy-related sectors, with around 30 percent of establishments in sectors such as fuel cells, green architecture and construction, solar photovoltaics (PV), professional energy services and energy saving consumer products (see Figure 2). Muro et al's (2011) assessment of Boston as a leading green economy location is confirmed by other US studies - in 2011 the Economist's Intelligence Unit ranked Boston as the fifth greenest city in the US⁸ and, at state level, Massachusetts was ranked first for energy efficiency policies and programmes by the American Council for an Energy-Efficiency Economy in 2012.

A study by Clean Edge (2012) also focused upon metropolitan areas in the USA and ranked these based on 24 indicators across four categories: green buildings; advanced transportation; clean electricity and carbon management; clean-tech investment, innovation and workforce in order to construct the US Metro Clean Tech Index⁹. The indicators cover a broader range of activities than the Brookings Institution, including green building deployment, clean vehicles in use, advanced transportation infrastructure, public transportation usage, regional electricity mix, GHG emissions, venture capital investment and clean energy patents. The Index ranked Boston ninth out of the USA's largest 50 metro regions, with particular strengths in buildings, transportation, and electricity, as well as leadership in clean energy technology development and venture capital activity (Clean Edge, 2012). Indeed, the Index positions Boston third amongst US metro regions for venture capital invested in the green economy (measured by dollars per capita) after San Francisco and San Jose, and among the top five for clean energy patent activity. In particular, Boston has considerable strengths in research and development for the green economy and is home to the largest concentration of university-developed green technologies, reflecting the importance of Harvard, Massachusetts Institute of Technology (MIT) and the University of Massachusetts within the regional economy (Gibbs and Krueger, 2007). MIT in particular has been a key source of spin-out companies and has been ranked first in a list of US clean tech universities¹⁰:

“that's one of the big draws of Massachusetts and companies that really want to be here, they want to be here for that reason, to tap into MIT, to be able to tap into Harvard and to be able to extract that labour. So I would say that's the dominant reason why companies want to be here” (Interview, public sector economic development professional).

The Enabling and Facilitative State

In addition to the role played by the creation of new and spin-out companies, and the strengths of local universities, the development of Boston as a green economy hot spot owes much to the longstanding engagement by state and city organisations, firms and institutions with a broader environmental agenda. Thus “companies often need a test market for prototypes of new innovations, and the New England area provides a great test environment, highly supportive to the cause through its green policies” (American Business Journal, 2011: 50). In 2000, Boston City Government began its climate action programme when it joined ICLEI¹¹'s Cities for Climate Protection Campaign. The state government has also played a key role in creating a supportive

policy on climate change which has encouraged the green economy (see also Lovell, Bulkeley and Owens (2009) on the convergence of climate and energy policies in the UK):

“Massachusetts is now clearly at the front of greenhouse gas emissions reductions. There’s a brand new law that got passed...about regulating greenhouse gases to a certain standard by certain dates and it’s very, very rigorous...we are really setting a very high standard on greenhouse gas reductions, again driven by the governor and driven by policy makers at the state level” (Interview, private sector company executive).

In 2007, Massachusetts joined the Regional Greenhouse Gas Initiative (RGGI), which aimed to reduce carbon emissions by auctioning carbon through a cap and trade programme for power plant emissions. RGGI is an initiative by a number of north eastern US states aimed at overcoming the inertia in Federal climate change policy¹² which is seen locally as detrimental to future economic development – “the lack of Federal guidance and Federal funding support has hurt not only Massachusetts and not only this region, but the entire country in many respects” (Interview, private sector company executive). In 2008, the state introduced the Global Warming Solutions Act, one of the strictest greenhouse gas (GHG) reduction laws in the US. It requires an 80% reduction in GHGs by 2050 over a baseline of 1990. In 2010, the 2020 greenhouse gas limit was set at 25 percent below the 1990 baseline, while at the same time the state government outlined a range of policies designed to enable Massachusetts to attain this goal and to ensure that Boston green economy companies benefitted from these policies¹³. In 2007, Boston was the first city in the US to mandate green construction standards in municipal zoning regulations, whereby all large-scale building projects (over 50,000ft²)¹⁴, must meet LEED¹⁵ standards, including minimum requirements for energy savings, water efficiency and CO₂ emissions reduction. Other measures noted included “some very aggressive energy efficiency strategies at the city level...stringent green building requirements for both public buildings and the private sector. There are also requirements that housing must be built with roofs that have the ability to easily incorporate solar power and solar thermal systems in the future” (American Business Journal, 2011: 50). Through these initiatives, both the state and city are seeking to ensure that greenhouse gas reduction policies are closely linked with economic development policies that will position the city-region as a leading area for the green economy:

“Massachusetts has shown impressive leadership and foresight in putting together the state’s Clean Energy and Climate Plan for 2020 and adopting innovative policies such as the Green Communities Act and the Global Warming Solutions Act that are stimulating great economic development and helping to grow the clean-tech cluster. Supporting alternative and renewable energy initiatives will not only yield environmental benefits, it will drive long-term sustainable economic growth and has the potential to create thousands of jobs¹⁶.”

New Institutional and Governance Structures

However, support for the green economy in the Boston region is not simply a public sector-led initiative – the Massachusetts Clean Economy Network¹⁷ is an industry-led grouping that has lobbied for changes in Federal law on climate and energy policies including a very public full-page advertisement in the local newspaper the *Boston Globe* in 2010 which directly targeted the state’s Senator, and very publicly included the logos of the Network’s members as signatories (see Figure 3). Together with Ceres¹⁸ and the New England Clean Energy Council, the Network of over fifty businesses subsequently (unsuccessfully) lobbied Scott Brown (then a Republican Senator for Massachusetts) to support a Federal clean energy and climate plan that included a price on carbon pollution. During interviews, private sector respondents placed importance upon their engagement with state and city level representatives on environmental issues:

“Our company feels we’re part of the community. We do a lot of work in these communities. A lot of us live in this area, so there’s a real commitment to make sure that those kinds of conversations happen on a regional level.” (Interview, private sector company executive)

(Figure 3 about here)

The state and city have also developed a range of institutional forms that seek to encourage the development of green businesses, involving partnerships across the private and public sectors. Much of this has been attributed to the leadership provided by the city government and notably the long-time former Mayor of Boston, Tom Menino¹⁹, described as “one of the greenest municipal leaders across the US” whereby “many of Boston’s innovative policies are attributed to the mayor’s true belief in green policy” (American Business Journal, 2011: 52). As one respondent commented:

“In this state in particular I think the political leaders pride themselves on being at the forefront of a lot of these environmental issues.” (Interview, private sector company executive).

These initiatives include, first, the Green Ribbon Commission, which involves business, civic and institutional leaders supporting the Mayor of Boston’s Climate Action Plan and providing advice to the City on the design and implementation of the Plan. Commission members also work as advocates for clean energy and efficiency practices and technologies with their industry peers. Second, the New England Energy Council (NEEC) involves a collaborative effort by venture capitalists, major financial institutions, green economy industries and associations, and local colleges and universities, with the aim of establishing Boston as a world-class leader in the green economy through providing training, education, and policy assistance to industry. Third, the Massachusetts Clean Energy Centre (MassCEC) was created in Boston through the state Green Jobs Act of 2008. MassCEC is focused on jobs in the green economy (especially clean energy technologies) and links academic research with entrepreneurs and the workforce in order to accelerate the development of green economy industries in Boston and the rest of Massachusetts. The organisation invests in early stage green economy entrepreneurs to

develop their ideas and to start up in business. MassCEC specifically supports renewable energy projects and provides municipalities, homeowners and businesses with assistance and finance for wind and solar energy projects, as well as developing programmes to ensure the availability of a local green economy workforce²⁰. Both the NECC and MassCEC's have encouraged new entrepreneurial start-ups, with moves to provide incubator space for new green economy companies:

“in the Cambridge-Boston area there are a lot of incubator facilities...which is where start-up companies...can share space, share equipment, receive many types of counselling or help with their business plans and help them grow and get them ready to go out on their own, so I think those types of centres are important.” (Interview, public sector economic development professional).

In 2011, a specific incubator space for early stage green economy start ups – Greentown Labs – was established on a former brownfield site in South Boston's waterfront area, newly renamed the Innovation District. Incubator occupants included wind and solar power developers, a home energy management system venture, various energy efficiency start ups, and a green trade association.²¹ The success of Greentown Labs subsequently led to a move to larger premises in Somerville, a short distance away from Harvard University. In total, then, there are a set of interrelated initiatives, actors, policies and networks seeking to promote and encourage the green economy in the Boston city-region. In the next section, we turn to a consideration of how these empirical observations help us to think through some of the issues involved in incorporating space into socio-technical transitions research.

Linking theory to practice in the Boston case study

This case study example of Boston is useful to illustrate how we can begin to understand the spatial development of the green economy from a socio-technical transitions perspective, and how the specificities of place play a role in affecting outcomes. From our analysis Boston emerges as a key location for the development of the green economy in the USA, led by both private and public sector initiatives, which gives some weight to the argument that the sub-national scale is an important source of innovation for sustainability transitions as the STS literature would suggest. Certainly in Geels and Raven's (2006) term, the city-region has been the site of many 'local experiments', involving a variety of local networks. Thus Boston has experienced a number of institutional responses by both state and city government involving the creation of new partnerships across the private and public sectors (e.g. MassCEC), as well as new alliances of firms (e.g. NEEC, Clean Economy Network), to encourage innovation and new firm formation in green economy sectors. Here, we can see the operation of Healy and Morgan's (2012) enabling (or facilitative) state helping to cultivate clusters of green economy activity. It is also possible to identify the importance of the social context of actor networks, institutions and complementary technological structures, together with the 'guiding visions' of leading political figures, such as Boston's Mayor and the Massachusetts State Governor, in creating a green industry hot spot or transition region (Späth and Rohracher, 2012). However, state actors and others have constructed a particular definition of the green economy based on

clean tech and energy sectors, which may exclude other types of green economy sectors from developing. This particular construction of the green economy is also reliant upon market-based instruments, such as RGGI's cap and trade. Moreover, clean tech energy development is not synonymous with the green economy – thus we should be aware that the pursuit of particular definitions and discourses of what constitutes a 'green economy' by particular sets of actors will lead to different outcomes in different places. In addition, the growth of the green economy in Boston should not be overstated – the sector currently only accounts for 1.7% of total jobs in the area (Muro et al., 2011).

These visions of the green economy as the basis for future economic development in Boston have not emerged *de novo*. Rather, Boston's green economy builds upon the city-region's existing strengths, notably its strong venture capital industry, the research strengths and spin-off potential of Boston's universities. As Cooke (2011: 143), drawing on research in evolutionary economic geography, suggests 'related variety' amongst industries can lead to knowledge spillover to enhance the green industry potential of a region through "geographically proximate concentrations and interactions amongst small, fast-moving systems of innovators and their networks." This then helps to understand why the green economy has developed in this particular city-region – the legacy of past efforts and a long term commitment to addressing environmental issues in Boston certainly creates a supportive environment for innovation and new firm formation, which appear to outweigh some of the disadvantages of a Boston location for firms that are related to cost and housing availability (see Gibbs and Krueger, 2012). However, Gibbs and Krueger's (2012) discussion of the pressures facing Boston highlight how particular spaces are themselves affected by the processes of transition. Specifically, demand for land is creating pressures for housing, problems of housing affordability, the loss of habitats and agricultural land, and the relocation of businesses out of the city leading to urban sprawl. For example, the Greentown Labs described above have relocated away from the waterfront to an out of town location, albeit closer to Harvard. These processes are affecting how Boston is perceived and threatening the future growth of green economy businesses in the area.

However, the Boston case study also emphasises that we need to look beyond purely local experiments to the kinds of broader relational networks outlined in earlier work by Späth and Rohrer (2010, 2012), Truffer and Coenen (2012) and Raven et al. (2012). This points to the effectiveness of a multi-level perspective to analyse such phenomena, but also indicates the need to incorporate space and place into our analyses. The Boston study has shown that new alliances of firms have developed in the Boston city-region and that part of their agenda is to try and shift institutional arrangements towards a more favourable set of conditions in which to operate, as well as creating a local niche of green economy firms and spin-off companies through financial and R&D support, in addition to the provision of incubator space. In particular, efforts have been focused on developing clean technology sectors, especially in the energy sector, in order to reduce carbon emissions. This has been supported by state level initiatives on climate change to introduce stringent greenhouse gas emission targets, both through state level legislation and through participation in a wider North Eastern US states cap and trade initiative for power plants. In this instance, the niche of clean technology industries

and its associated network of institutional support have challenged the established regime of energy supply. While some of this networking activity may be focused upon the city-region (e.g. through the kinds of partnerships and dialogue with state and city governments, investors and universities we have outlined), it can also transcend these boundaries. In this manner a focus upon city-region activities provides an entry point into theorising the link between the niche and regime levels of the MLP (Späth and Rohracher (2012)). Niches may not be strictly limited to a local geographical scale, but can comprise important extra-local links as well. Thus, many of our respondents expressed frustration with the lack of Federal legislation and action on climate change policy which they believed is detrimental not only for environmental policy, but also in terms of creating certainty and stability for the green economy. As such, actors within Boston are trying to change the mainstream regime through policies, laws and lobbying at the city, regional and Federal level, in a two-way process of negotiation. Certainly, this is not a straightforward linear process of translation from the niche to the regime, but one involving 'complexity and chaos' and the alignment of processes at the multiple levels of niche, regime and landscape (Lovell, 2007; Schot and Geels, 2008). Translating local experiments into generic lessons and vice versa is difficult, requires negotiation and struggle, and a greater understanding of agency (Raven et al., 2011).

We think that two specific examples stand out here, as instances of attempts to alter the current State level energy regime which is dominated by fossil fuel-based electricity generation (63% comes from natural gas, 12% from coal (albeit decreasing rapidly) and 9.3% from renewable sources²²) and to create conditions conducive to the mainstreaming of local green economy niche activities in clean energy sectors. First, there is the case of REGGI where the Massachusetts state government, in conjunction with other North East states, has bypassed the Federal government, as well as introducing its own state-level Global Warming Solutions Act in 2008²³. This accords with Cooke's (2011: 110) suggestion that where there are laggard national regimes "a region may anticipate its slow-moving institutions and begin swiftly eco-innovating independently, expressing local collective demand or proto-market building by ecologically conscious or interested firms or organisations." A second example is the lobbying and promotional activities of the Boston Clean Economy Network, which reveals actors operating across scales as they attempted to change institutional arrangements at the national Federal level, by targeting the voting behavior of locally elected senators. Such attempts (albeit unsuccessful in the latter case) can be seen as an attempt by local actors to upscale green economy activities to a much wider arena, driven by a mix of environmental concern and perceived economic (self) interest and are important "for the process of building up credibility and authority for an alternative configuration" (Späth and Rohracher, 2012: 463). Boston would therefore appear to have its own set of green system builders, attempting (in some cases) to dislodge and replace the dominant regime. While they remain within a clean technology niche, operating below the surface of incumbent regimes, they are also connected to, and at times operate within, fairly elite political and economic structures facilitated by city and state political initiatives, and policies that provide the opportunity to challenge the incumbent regime.

Conclusions

Our argument in this paper is that sustainability transitions theory is a useful concept that focuses attention on the networks and institutional structures that help to support the transition towards the green economy. It helps to elucidate the ways in which the activities of individuals, firms and policy makers interconnect with each other, and with wider economic and social structures. Moreover, through using this case study of Boston we have contributed to the growing interest in introducing space into transitions research which, to date, has involved only a limited number of empirical studies. Indeed, a central critique of the MLP framework has been “that it describes the transformation of socio-technical systems without sufficient attention to the actual places and contexts in which transitions unfold and, therefore, that it remains an abstracted model of transition without providing guidance for sufficiently understanding or promoting transitions on the ground” (McCauley and Stephens, 2012: 217). Rather than seeing space and place as passive backdrops to the transition process, we have argued that incorporating spatial specificity is a core component of any causal explanation. In the case of Boston, we can see how the green economy has developed out of existing strengths and networks in related activities, in addition to a commitment to a longstanding environmental leadership. We could also add to this the local fears of policy makers and business leaders over a growing lack of competitiveness and job loss in the Boston and Massachusetts economies and a desire to shift the basis of the local economy into new and growing areas, such as green business (Gibbs and Kruger, 2012; Pioneer Institute, 2013). Adopting a sustainable transitions approach therefore helps to explain spatial heterogeneity and asymmetry in the development of the green economy. In particular, it points to the need to consider the roles that historical context and (in this case) supportive state and municipal policies may play in encouraging its development (see Pollack (2012) for a further analysis of this in the US context). The sustainable transitions approach is therefore useful in that it allows us to more systematically identify the pre-requisites of green growth and to analyse how these may be mobilised (successfully or not) in attempts to upscale from niches to the regime and to align actors across levels. Given the present focus by national and local policy makers upon engendering green growth, then this also has practical application beyond academic and theoretical interest. What remains problematic, however, are the varying definitions of what actually constitutes ‘the green economy’.

It is only through case studies such as this that we can further understand the complexities and variations that are present in the interpretations and discourses that emerge in specific places. In addition, by exploring the processes of transition in particular places, we can not only explore how specific places aim to affect, or bring about, transitions, but also how the processes of transition can in turn affect those places. Increasingly this lack of spatial context has come to be recognised as an important shortcoming in socio-technical transitions research, where an inattention to space hinders it from adequately capturing the evolution and development of networks of institutions, entrepreneurs and innovations into stable forms that can challenge and replace existing regimes. The incorporation of “a spatial context will force it to address the question how and why experiments are performing differently in different geographical settings

and, consequently, what the governance challenges are for translating localities into generalities and backwards and ultimately upscaling into mainstream regime practice” (Coenen, Raven and Verbong, 2010: 296-7). A better understanding of spatial context will therefore help to provide an explanation of the heterogeneity and asymmetry of socio-technical systems (Raven et al, 2012), as well as the spatially uneven nature of pathways to sustainability transitions (Coenen and Truffer, 2012).

As well as indicating the advantages incorporating space and place brings to our understanding of transitions, we believe that this paper points to the need for future research to focus on conducting empirical research in a variety of settings. While the focus here has been upon Boston and the US, it is obvious that different configurations of niche, regime and landscape will give rise to different outcomes. Empirical research can also help to address the criticism of socio-technical transitions research that it lacks any real sense of the politics and power relations involved between the different actors and institutions that may facilitate or hinder transitions. Certainly “changes to the socio-technical landscape of politics, institutions, the economy and social values” (Smith, 2003: 131), are unlikely to proceed (if at all) without parallel political actions. A focus upon system building activities (in this case by actors within the Boston city-region) helps to address this gap in transitions research. We can therefore see transitions as not inevitable, but the outcome (or not) of struggle, agency and power relations, something which may be hidden by approaches that have focused upon past niche developments to extrapolate from historical studies²⁴ (Smith, 2004; Shove and Walker, 2007). The question of whether socio-technical regimes can be guided intentionally towards more sustainable outcomes remains an open question in much MLP research (Späth and Rohracher, 2010). Certainly niches are important sources of innovation that may offer solutions for tensions in existing socio-technical regimes, but the “adaptation process is confined by structures within the existing, mainstream regime” (Smith, 2006: 453). Indeed, it may be that existing socio-technical regimes limit space for alternative approaches (Shove, 1998), requiring actors to attempt to transcend these, as with the coalition activities of Boston green economy firms. Some (if not many) of the alternatives being promoted by niche actors may fail to achieve the breakthrough into the regime – those that continue to develop could be thought of as ‘embryonic niches’, which exist alongside the regime and landscape and which may be taken up at a later date. The public policy agenda related to this involves a combination of action by green businesses and their support organisations, as well as state actions to ensure supportive institutional structures and forms are in place (Gibbs, 2002; Raven et al., 2011). Many of those working in the socio-technical transitions framework are agreed that intervention in the pursuit of sustainability can be effective. A key aspect of the state in promoting the green economy is its enabling and supporting role encouraging innovation and the development of new sectors (Barry and Doran, 2006), and our Boston case study helps to illustrate how this can occur. In total we have shown how the incorporation of scale and a geographical perspective can help us to gain a better theoretical purchase on socio-technical transitions research through taking a relational perspective, such that detailed study of particular places such as Boston can help us begin to better understand the geography of transitions and the potential for purposive action to encourage such sustainability transitions (Coenen and Truffer, 2012).

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References

American Business Journal (2011) Green Tech Boston: Investigating investment in Boston's Innovation District, *American Business Journal*, April/May, 46-52.

Barry, J and Paterson, M (2003) The British state and the environment: New Labour's ecological modernisation strategy, *International Journal of Environment and Sustainable Development*, 2(3), 237-249.

Barry, J and Doran, P (2006) Refining green political economy: From ecological modernisation to economic security and sufficiency, *Analyse and Kritik*, 28, 250-275.

Berkhout, F., (2002) Technological regimes, path dependency and the environment, *Global Environmental Change*, 12(1), 1-4.

Berkhout, F, Smith, A and Stirling, A (2003) Socio-technological regimes and transition contexts, SPRU, University of Sussex.

Bina O, 2013, The green economy and sustainable development: an uneasy balance? *Environment and Planning C: Government and Policy*, 31, 1023–1047

Bowen, A, Fankhauser, S, Stern, N and Zenghelis, D (2009) *An Outline of the Case for a Green Stimulus*, Policy Brief, Grantham Research Institute on Climate Change and the Environment/Centre for Climate Change Economics and Policy.

Bulkeley, H., Castan-Broto, V., and Maasen, A., (2010) Governing Urban Low Carbon Transitions, in H., Bulkeley, V., Castan-Broto, S., Marvin and M., Hodson (Eds) *Cities and Low Carbon Transitions*, 29-31, London: Routledge.

Bureau of Labor Statistics (2012) *Green Goods and Services survey program*, Available at www.bls.gov/ggs.

Caprotti, F (2012) The cultural economy of cleantech: Environmental discourse and the emergence of a new technology sector, *Transactions of the Institute of British Geographers*, 37(3), 370-385.

Clean Edge (2012) *US Metro Clean Tech Index*, Executive Summary, Available at www.cleandedge.com.

Coenen, L, Raven, R and Verbong, G (2010) Local niche experimentation in energy transitions: A theoretical and empirical exploration of proximity advantages and disadvantages, *Technology in Society*, 32, 295-302.

Coenen, L and Truffer, B (2012) Places and spaces of sustainability transitions: Geographical contributions to an emerging research and policy field, *European Planning Studies*, 20(3), 367-374.

Cohen, B. (2006) Sustainable valley entrepreneurial ecosystems', *Business Strategy and the Environment* 15.1: 1-14.

Cohen, B and Winn, M J (2007) Market imperfections, opportunity and sustainable entrepreneurship, *Journal of Business Venturing*, 22, 29-49.

Cooke, P (2009) Transition regions: Green innovation and regional development, Paper presented to the DRUID conference, Copenhagen Business School, Fredriksberg, Denmark.

Cooke, P (2010) Regional innovation systems: Development opportunities from the 'green turn', *Technology Analysis and Strategic Management*, 22(7), 831-844.

Cooke, P (2011) Transition regions: Regional-national eco-innovation systems and strategies, *Progress in Planning*, 76, 105-146.

de Boer S, Hekkert, M and Woolthuis, R K (2009) *Strategies of sustainable entrepreneurs to influence the innovation system*, DIME Working Paper.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2008) *Ecological Industrial Policy: Sustainable Policy for Innovation, Growth and Employment*, Berlin: BMU.

Geels, F W (2005) *Technological Transitions and System Innovations: A Co-evolutionary and Socio-technical Analysis*, Cheltenham: Edward Elgar.

Geels, F (2010) Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective, *Research Policy*, 39, 495-510.

Geels, F and Raven, R (2006) Non-linearity and expectations in niche-development trajectories: Ups and downs in Dutch biogas development (1973-2003), *Technology Analysis and Strategic Management*, 18(3/4), 375-392.

Geels, F and Schot, J (2007) Typology of socio-technical transition pathways, *Research Policy*, 36, 399-417.

Genus, A. and Coles, A.M., (2008) Rethinking the multi-level perspective of technological transitions, *Research Policy*, 37(9), 1436-1445.

Gibbs, D (2002) *Local Economic Development and the Environment*, London, Routledge.

Gibbs, D (2006) Prospects for an environmental economic geography: Linking ecological modernisation and regulationist approaches, *Economic Geography*, 82(2), 193-215.

Gibbs, D and Krueger, R (2007) Containing the contradictions of rapid development? New economy spaces and sustainable urban development in R Krueger and D Gibbs (eds.) *The Sustainable Development Paradox: Urban Political Economy in the United States and Europe*, New York: Guilford, 95-122.

Gibbs, D and Krueger, R (2012) Fractures in meta-narratives of development: An interpretive institutionalist account of land use development in the Boston city region, *International Journal of Urban and Regional Research*, 36(2), 363-380.

HM Government (2008) *Building A Low Carbon Economy: Unlocking Innovation and Skills*, London: DEFRA.

Hammdouch, A and Depret, M-H (2010) Policy integration strategy and the development of the 'green economy': foundations and implementation patterns, *Journal of Environmental Planning and Management*, 53(4), 473-490.

Healy, A and Morgan, K (2012) Spaces of innovation: Learning, proximity and the ecological turn, *Regional Studies*,

Hodson, M and Marvin, S (2010) Can cities shape socio-technical transitions and how would we know if they were? *Research Policy*, 39, 477-485.

Jacobs, M (2012) Green Growth: Economic Theory and Political Discourse, *Centre for Climate Change Economics and Policy Working Paper No. 18/Grantham Research Institute on Climate Change and the Environment Working Paper No. 92*, London: LSE.

Keijzers, G (2002) The transition to the sustainable enterprise, *Journal of Cleaner Production*, 10, 349-359.

Local Government Association (2009) *Creating Green Jobs: Developing Local Low-Carbon Economies*, London: LGA.

Lovell, H (2007) The governance of innovation in socio-technical systems: The difficulty of strategic niche management in practice, *Science and Public Policy*, 34, 35-44.

Lovell, H, Bulkeley, H and Owens, S (2009) Converging agendas? Energy and climate change policies in the UK, *Environment and Planning C*, 27(1), 90-109.

Markard, J and Truffer, B (2008) Technological innovation systems and the multi-level perspective: Towards an integrated framework, *Research Policy*, 37, 596-615.

McCauley, S M and Stephens, J C (2012) Green energy clusters and socio-technical transitions: Analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA, *Sustainability Science*, 7, 213-225.

Meek, W R, Pacheco, D F and York, J G (2010) The impact of social norms on entrepreneurial action: Evidence from the environmental entrepreneurship context, *Journal of Business Venturing*, 25, 493-509.

Muro, M, Rothwell, J and Saha, D (2011) *Sizing the Green Economy: A National and Regional Green Jobs Assessment*, Washington DC: Brookings Institution.

Pioneer Institute (2013) *Massachusetts' New Economy*, Boston: Pioneer Institute.

Pollack, E (2012) *Counting up to Green: Assessing the Green Economy and its Implications for Growth and Equity*, Economic Policy Institute Briefing Paper #349, Washington DC: EPI.

Raven, R, Schot, J and Berkhout, F (2012) Space and scale in socio-technical transitions, *Environmental Innovation and Societal Transitions*, 4, 63-78.

Raven, R, Verbong, G, Schilpzand, W and Witkamp, M (2011) Translation mechanisms in socio-technical niches: A case study of Dutch river management, *Technology Analysis and Strategic Management*, 23(10), 1063-1078.

Rip, A and Kemp, R (1998) Technological change in S Rayner and E Malone (eds.) *Human Choices and Climate Change*, Volume 2, Columbus, OH: Batelle, 327-399.

Schaltegger, S and Wagner, M (2011) Sustainable entrepreneurship and sustainability innovation: Categories and innovations, *Business Strategy and the Environment*, 20, 222-237.

Shear, B.W. (2014) Making the green economy: politics, desire, and economic possibility, *Journal of Political Ecology*, 21, pp. 193-209.

Schot, J and Geels, F (2008) Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy, *Technology Analysis and Strategic Management*, 20(5), 537-554.

Shove, E (1998) Gaps, barriers and conceptual chasms: Theories of technology transfer and energy in buildings, *Energy Policy*, 26(15), 1105-1112.

Shove, E and Walker, G (2007) Caution! Transitions ahead: politics, practice, and sustainable transition management, *Environment and Planning A*, 39, 763-770.

Smith, A (2003) Transforming technological regimes for sustainable development: a role for alternative technology niches? *Science and Public Policy*, 30(2), 127-135.

Smith, A (2004) Alternative technology niches and sustainable development, *Innovation: Management, Policy and Practice*, 6, 220-235.

Smith, A (2006) Green niches in sustainable development: the case of organic food in the United Kingdom, *Environment and Planning C*, 24, 439-458.

Smith, A (2007) Translating sustainabilities between green niches and socio-technical regimes, *Technology Analysis and Strategic Management*, 19(4), 427-450.

Smith, A, Voß, J-P and Grin, J (2010) Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges, *Research Policy*, 39, 435-448.

Späth, P and Rohracher, H (2010) 'Energy regions': The transformative power of regional discourses on socio-technical futures, *Research Policy*, 39, 449-458.

Späth, P and Rohracher, H (2012) Local demonstrations for global transitions – dynamics across governance levels fostering socio-technical regime change towards sustainability, *European Planning Studies*, 20(3), 461-479.

Truffer, B (2008) Society, technology, and region: Contributions from the social study of technology to economic geography, *Environment and Planning A*, 40, 966-985.

Truffer, B and Coenen, L (2012) Environmental innovation and sustainability transitions in regional studies, *Regional Studies*, 46(1), 1-21.

United Nations Environment Programme (2011) *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication – A Synthesis for Policy Makers*, www.unep.org/greeneconomy.

Unruh, G (2002) Escaping carbon lock in, *Energy Policy*, 30(4), 317-325.

Walker, G and Shove, E (2007) Ambivalence, Sustainability and the Governance of Socio-Technical Transitions, *Journal of Environmental Policy and Planning* 9.3: 213-25.

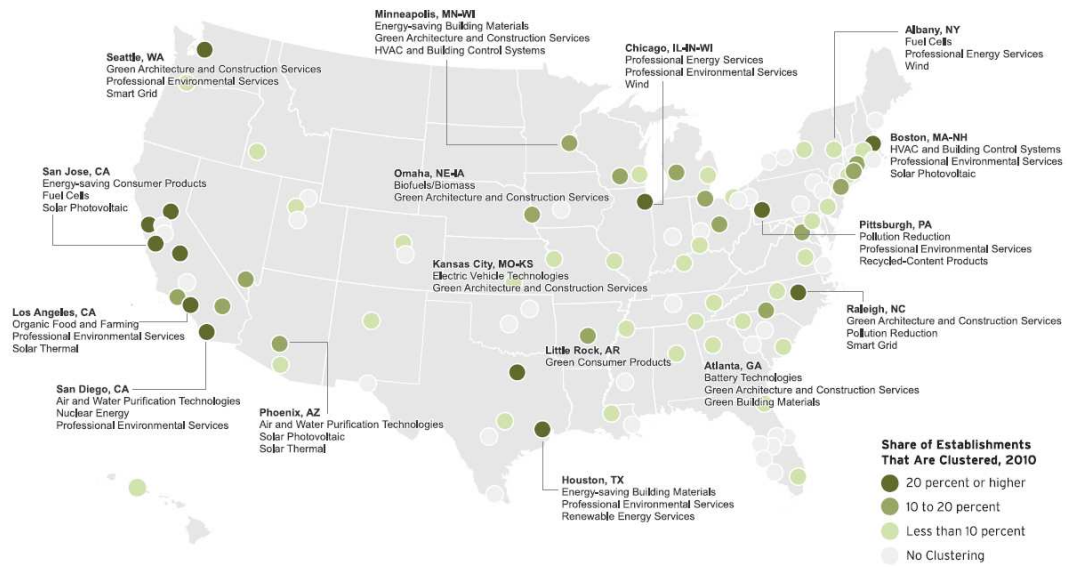
AGGREGATE CLEAN ECONOMY

Aggregate Clean Economy

Jobs 2010



Figure 1. Aggregate Clean Economy by Metropolitan Area by Job Numbers.



Source: Brookings-Battelle Clean Economy Database
 An establishment in a given segment is defined to be in a cluster if other establishments in the same county comprised at least one percent of all U.S. employment for the given segment.

Figure 2: Metro Area Establishment Clustering in the US, 2010.

Massachusetts Businesses Support a Clean Energy Climate Plan

For decades, Congress has punted on energy policy reform while China and other nations have raced ahead to develop clean energy sectors. The U.S. can no longer afford to squander the opportunity to align public and private interests in building a clean energy economy here at home. The time for half-measures and temporary band-aids is over.

Senator Brown: You have the opportunity to bring bipartisan leadership to a clean energy climate plan that will create jobs and accelerate the clean energy sector in Massachusetts, New England and beyond.

“Reducing carbon dioxide emissions in Massachusetts has long been a priority of mine.”

Source: State Senator Scott Brown Press Release, “Brown Announces Approval of Greenhouse Gas Emissions Bill,” January 9, 2008.

“We have great technology, we have great ideas, but we don’t have the funds... We’re not providing a level playing field for these Massachusetts green companies to really get cracking. And it’s unfortunate.”

Source: Senator Scott Brown on the Howie Carr Show, June 10, 2010.

Senator Brown: We agree that Massachusetts’ universities and businesses have the technologies and entrepreneurial know-how to thrive in the new energy economy. However, providing a level playing field for Massachusetts companies to raise capital, grow their operations, create thousands of jobs, and serve regional and global markets requires long term, consistent climate and energy policies that include a price on carbon pollution. We need your support in Washington, D.C. to pass a comprehensive energy and climate plan this year.

Massachusetts businesses are ready to lead if Washington will act.



To learn more about business support for a clean energy climate plan, visit

wecanlead.org

Paid for by the Clean Economy Network

Figure 3: Advertisement in the *Boston Globe* by Massachusetts Clean Economy Network, 2010.

Endnotes

¹ In this example Smith (2006) argues that the mainstream industry has co-opted some aspects of niche practices, such as organic standards, but sells imported organic food from around the world, packaged, processed and sold in the mainstream food socio-technical regime.

² The increasing use of fracking for gas, especially in the USA, appears to be creating a new regime of energy production, albeit aligned to the existing carbon-based regime. The environmental impacts of this, both through increased carbon emissions and more localised concerns over water table pollution, are considerable.

³ Cohen's focus is on Victoria in British Columbia, although he identifies the Pacific Northwest more generically as a location where the culture would be supportive.

⁴ The Brookings Institution is a nonprofit public policy organization based in Washington, DC (see www.brookings.edu for details).

⁵ Details of the methodology used to construct the data base are given on the Brookings Institution website (www.brookings.edu).

⁶ Note that Muro et al (2011: 14) use the term clean economy rather than green economy. This is defined as “economic activity – measured in terms of establishments and the jobs associated with them – that produces goods and services with an environmental benefit or adds value to such products using skills or technologies that are uniquely applied to those products”

⁷ Muro et al (2011: 30) define clusters on the basis that “an establishment had to be located in the same county as at least 1 percent of national jobs in its segment to be considered clustered.”

⁸ <https://www.cityofboston.gov/news/Default.aspx?id=5175>, Accessed 28.4.14).

⁹ While different analysts use differing terms - ‘green’, ‘clean’ and ‘clean energy’ - their definitions of these are broadly similar (Pollack, 2012).

¹⁰ www.energyboom.com/emerging/top-10-cleantech-universities-america.

¹¹ ICLEI was the International Council for Local Environmental Initiatives and changed its name in 2003 to ICLEI - Local Governments for Sustainability.

¹² Massachusetts was involved in the initiation of RGGI in 2005, but only joined in 2007. Former Governor Mitt Romney objected to the lack of opt out options and this position only altered with the election of a new Governor, Deval Patrick.

¹³ Compared, for example, to President Obama's target for the US of (in the range of) 17% reductions over 2005 figures by 2020 following the UN Copenhagen Accord.

¹⁴ 4645m².

¹⁵ Leadership in Energy and Environmental Design (LEED) is a US certification scheme for green buildings (see <https://new.usgbc.org/leed> for details, Accessed 28.11.12).

¹⁶ www.pbln.org/massachusetts-must-continue-its-leadership-in-building-a-clean-energy-economy-pbln-goes-to-the-state-house/ (Accessed 31.10.12).

¹⁷ This is the Boston chapter of the national advocacy organisation.

¹⁸ Ceres is a North American coalition of investors, environmental and public interest organizations, including many large corporations, see www.ceres.org.

¹⁹ Tom Menino was Boston's longest serving mayor from 1993-2014.

²⁰ www.masscec.com/index.cfm/page/About-MassCEC/pid/11193 (Accessed 31.10.12).

²¹ www.greentechboston.org (Accessed 31.10.12).

²² US Energy Information Administration, <http://www.eia.gov/state/?sid=MA> (Accessed 8.4.14).

²³ www.mass.gov/dep/air/climate/gwsa.htm (Accessed 21.1.13).

²⁴ Smith (2004) makes this same point through a comparison with the Alternative Technology movement in the UK. This movement had a keen awareness of the need to consider political and economic power structures.