The Imaginaries and Governance of 'Biofueled Futures'

Ponte, Stefano; Birch, Kean

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Guest editorial

The imaginaries and governance of 'biofueled futures'

Since the 1990s governments in both the Global North and the Global South have been heavily promoting liquid biofuels and enacting policies as a result of concerns related to climate change mitigation, energy security, and rural development. Policy discourses about future technological pathways and landscapes have also been based on framing the lack of energy as an impediment to development and growth (Smith, 2010; Wilkinson and Herrera, 2010). Liquid biofuels have been portrayed as an attractive technological pathway because they can address disparate problems at once without fundamentally altering prevailing energy consumption practices (Smith, 2010; White and Dasgupta, 2010). They are already a major 'renewable' energy source in the United States, Brazil, and the European Union where they are presented as a way to sustainably transition away from fossil fuels in the future (Birch and Calvert, forthcoming).

While biofuels come in many forms, the focus of this theme issue is on liquid biofuels. Liquid biofuels are important because of their use in transportation as 'drop-in' fuels that are immediately compatible with an existing transportation infrastructure built around internal combustion engines. This promotion of drop-in biofuels has been particularly the case in capital-intensive industries, such as aviation, where finding alternatives to fossil fuels is difficult given large-scale investments in infrastructure and the time needed to bring about technological change and embed sustainable energy management systems.

In this theme issue, we examine how the biofuel sector (and those supporting it) aligned the future visions or promises of liquid biofuels within prevailing forms and practices of governance. We use the concept of 'imaginaries' to denote these future visions and promises, building on the work of Jasanoff (2004), Jessop (2005; 2009), Jasanoff and Kim (2009), Birch et al (2010; forthcoming), Fairclough (2010), Levidow et al (2012), and others. The concept of imaginaries is helpful in this regard because it explicitly concerns the enrolment of imaginings of the future in the forms and practices of governance in the present. Imaginaries (eg, visions and narratives) come to define what "could or should be" (Fairclough, 2010, page 266)—*and* what cannot or should not be—and, in this way, they shape future objectives, strategies, and realities (Levidow et al, 2012). As we highlight in this theme issue, these imaginaries are spatially bounded as much as they are future oriented; they are centred on specific geographical spaces, places and territories and concern the construction of economic (Jessop, 2005) and social (Jasanoff and Kim, 2009) orders. What makes them such a useful concept in this context is that imaginaries contribute to an understanding of the diversity and variety between places; they help to show what underpins geographical specificity and what this means for the development of socio–techno–economic pathways.

The papers included in this theme issue all revolve around understanding how (different) imaginaries of *biofueled futures* have been created, how they have changed as events unfolded over time, and how they are enrolled in the governance of biofuels development. What brings the contributions together is their focus on how these imaginaries represent biofuels as appropriate, attractive, and sustainable technologies within specific, geographically situated governance practices that, therefore, are meant to deliver on such imaginaries and maintain them accordingly. Thus, the contributors share an interest in explaining how policy and governance mechanisms that have been rolled out are shaped and sustained by specific biofueled futures, whose contours are constantly evolving. The papers engage with these

processes in systematically important countries and regions for biofuel production and consumption (eg, Brazil, the USA, the UK, and the EU more generally) but also in emerging economies that are the testing ground for 'poverty' and 'equity' justifications for developing future biofuel sectors (South Africa, India).

In the rest of this introduction we discuss what we mean by 'biofuels', then we develop the links between imaginaries and governance of biofuels, and lastly we discuss the specific contributions that the papers included in this collection make. Early versions of these papers were first presented at a special panel on "Biofuels, food and the bio-based economy" at the 2012 AAG Annual Meeting in New York, organized by the theme issue editors.

Liquid biofuels: a primer

Biofuels are fuels generated from specific kinds of biomass, including agricultural crops, for use in transport, energy production, or for domestic uses (eg, heating, cooking). Biofuels take various forms: solid (eg, wood), gas (eg, methane), and liquid (eg, ethanol). Our focus in this theme issue is liquid biofuels. What distinguishes liquid biofuels from other forms of biofuel is the (technological) promise they hold as a (renewable) replacement for hydrocarbon energy (eg, petroleum), especially in transport. For ease, throughout the rest of the introduction we use the term 'biofuel' to refer to liquid biofuels unless stated otherwise.

Currently, ethanol accounts for over 90% of liquid biofuel production globally. It is produced by fermenting and distilling sugars from starchy plants (such as sugarcane, sorghum, wheat, and corn) into alcohol. Ethanol can be used in low percentage mixes in regular engines without modification. Biodiesel is another biofuel, one produced from oily crops or plants (eg, soya, palm, sunflower, and jatropha) and from animal fats and waste cooking oil through the process of transesterification. Some kinds of biodiesel can be used in high-proportion mixes or even unblended in modified diesel engines. Environmental assessments have shown that these so-called 'first-generation' biofuels, which use feedstock that can also be used for human consumption, have a varied record in terms of environmental and social impacts (see Clancy, 2013; Malca and Freire, 2011; Pimentel, 2012).

As a result of this mixed record, there are a number of so-called 'next-generation' biofuels under development. Some of these are expected to be produced from new and improved thermochemical or biochemical processes applied to forestry byproducts, crop residues, domestic and industrial waste, and algae feedstock. Next-generation biofuels have, in some cases, yielded more desirable environmental impact profiles (Jørgensen et al, 2012), but often with the assumption that there are no substantial competing uses of the biological material and/or without assessing the wider effects of direct and indirect land use change.

From the turn of the 21st century to around 2006/07, all the main biofuel producer countries/regions (including Brazil, the USA, and the EU) have enacted policies that effectively created (or reenergized, in the case of Brazil) an industry. The EU and US set minimum mandates on the use of biofuels and provided a range of subsidies, research funding, and investment facilities to farmers, processors, blenders, biotech companies, and universities. Early Brazilian government support of the 1970s and 1980s had waned by the end of the century, but was revitalized in the 2000s. Agricultural lobbies (eg, US corn, German rapeseed farmers), climate change activists seeking non-fossil-fuel alternatives, and government departments concerned with energy and security provided a unique combination of interests that pushed biofuel-friendly policies in a generally favourable political environment (Dauvergne and Neville, 2009; Gillon, 2010; Lehrer, 2010).

However, increasing food prices and the related food riots starting in 2006/07 dramatically altered this picture. Biofuel production has been identified as a major cause of increasing food prices because it takes land and water away from food production. Many studies highlighted deeply problematic aspects of land investments, including shady deals, little benefit for local

communities, lack of participation in decision-making at the local level, and environmental degradation (see, among many others, Borras et al, 2010; Clancy, 2013; Matondi et al, 2011; Vermeulen and Cotula, 2010). Doubts have also been cast on the impact of biofuel production on greenhouse gas (GHG) emissions (Pimentel et al, 2010). Some feedstock–location combinations are deemed to be especially problematic in terms of GHG balance (eg, corn in the US) or in terms of deforestation (eg, palm oil in Southeast Asia). A wider methodological debate is also raging on how to take account of crop residues and indirect land-use change in the calculation of energy balance sheets and GHG emissions (see Smith, 2010).

Pro-biofuel analysts have responded to these arguments by claiming that there is marginal land available for biofuel production and that with modern farm management and improved technology it is possible to produce a meaningful proportion of fuels for transport from biological resources without adversely affecting food supply (Cortez et al, 2010). Critics reply that land is often not actually 'available' even when labeled as such, that in marginal lands yields are much lower, and that faith in technology is misplaced (Levidow, 2013; Levidow and Paul, 2010, 2011; Smith, 2010).

As criticism of biofuels grew, the EU enacted demands for sustainability standards for the production, trade, and use of biofuels in member countries (Levidow, 2013; Ponte, 2013; Schleifer, 2013). The US fine-tuned its subsidies and regulation to increase support of next-generation biofuels. And Brazil increased its public relations effort aimed at showing that sugarcane-based ethanol production in the country has indeed a positive impact on GHG emission reductions. At the same time, the biotech industry saw these developments as a window of opportunity to gain public support (and research funding, investment, financing) for 'cleaner' and less land-dependent versions of biofuel production, based on new and improved transformation processes of cellulosic material and other waste and on the development of algae feedstocks.

Imaginaries and governance

The imaginaries created by often competing social actors represent powerful influences on the direction that the liquid biofuel industry is taking. The most critical voices against biofuels have raised concerns about the distorting socioeconomic and ecological effects of state subsidies, corporate monopolies, and intensive monocultural farming (eg, Collazos, 2009; Magdoff, 2008). Biofuel advocates have provided specific suggestions in response to the diverse problems that have arisen arising from the implementation of first-generation biofuels, whether these are technoscientific (Robertson et al, 2008) and/or political–economic (eg, Matthews, 2009). Unusually, some advocates raise similar concerns to the critics, but often point to different outcomes—namely, market inefficiencies from subsidies, innovation inefficiencies from corporate monopolies, and population pressure on agricultural productivity (eg, Cockerill and Martin, 2008; Hahn-Hagerdal et al, 2008; Jenkins, 2008; Matthews, 2009). However, the idea that the best route to biofueled futures is through the creation of a "competitive market-based sector" (Puddister et al, 2011, page 469) has come to dominate policy making in the USA, EU, and Brazil. What matters here is the underlying contradiction in these market-based perspectives between the discursive construction of nature as scarce or inefficient, *and*, at the same time, as bountiful, abundant, and renewable (see also Levidow et al, 2012).

Future visions and imaginaries have helped to drive forward new investments by naturalizing market-based solutions derived from technoscience to resolve imminent or critical social problems arising from biofuel production. The enrolment of technoscience can be seen as part of a broader shift from an *ecological* fix associated with first-generation biofuels to a *technological* fix offered by next-generation biofuels derived from modern biotechnological knowledge. Although the application of modern biotechnology to

agriculture has been a strongly contested political terrain, evident in protests against GMOs, it is now being represented as an essential tool for any transition to a greener and more sustainable 'bioeconomy' (eg, Frow et al, 2009; McCormick and Kautto, 2013; Staffas et al, 2013).[1] Another side of this imaginary is the need to build new (or reconfigure old) infrastructures and value chains in order to ensure the capture of economic value from existing and future biofuels. In this case, imaginaries are dominated by the idea of a multipurpose biorefinery (O'Connell and Haritos, 2010), although these biorefineries are dependent on the development and deployment of multiple technoscientific pathways—eg, heat generation, by-products, and fuel conversion (Sims et al, 2010). Within this imaginary it is not clear how significant biotechnology will actually be in stimulating the transition to more sustainable liquid biofuels. The reconfiguration of existing fuel and food value chains could be dramatic, with the potential of quite literally creating new socioecological landscapes around us. These are likely to entail not only nature's recalcitrance (Birch et al, 2010; Castree, 2008a; 2008b), but also human protest and resistance to the visions of the future offered by different social actors.

The expectation that more sustainable biofuels are just around the corner has stimulated the reworking of governance in terms of the development of mandates, targets, and sustainability criteria that enable judgments about the environmental value of both first-generation and next-generation biofuels. It has also fostered new forms of regulation that incorporate market mechanisms or public–private partnering in the configuration of energy flows and economic value. And, in turn, it has also stimulated new, even more 'improved', visions and imaginaries of next-generation biofuels that help to facilitate investment.

The governance of biofuels is changing in light of this push for more sustainable biofuels. Over the past few years it has rested on a range of incentives from renewable fuel mandates and targets to direct subsidies that are meant to stimulate the development of first-generation ethanol and biodiesel as well as next-generation biofuels (Charles et al, 2007; Frow et al, 2009; Mabee, 2007). In this context, next-generation biofuels represent a technofix, a solution to the problems with earlier biofuels that have necessitated new forms of political–economic governance (including massive research support for next-generation biofuels). A helpful example of this point is the governance of biofuels in the USA. Tyner (2010a; 2010b) argues that there are significant uncertainties around the promotion of cellulosic biofuels that relate to the needs of companies for long-term feedstock planning, long-term assurances to support refinery building, and long-term mandates and subsidies that help reduce the cost of next-generation biofuels to achieve price competitiveness vis-à-vis gasoline. Consequently, state funding and intervention are tied, explicitly and implicitly, to any expansion of sustainable biofuels, since short-term market pressures are unlikely to resolve the uncertainties facing developers of next-generation biofuels.

Alongside political–economic governance, biofuels entail emerging forms of state and nonstate environmental oversight specifying sustainability criteria such as GHG emission reductions, biodiversity protection, and minimal impact on food security (Bailis and Baka, 2011; Londo and Deurwaarder, 2007; Ponte, 2013). Such technoscientific

[1] The 'bioeconomy'—or, sometimes, 'bio-based economy'—is a concept which refers to a (future) techno-economic transition in our economies (Birch et al, 2010; Hilgartner, 2007; Staffas et al, 2013). It denotes a shift away from economic dependence on fossil fuels and towards the use of biological material (eg, plants) as sources of energy (eg, biofuels), chemicals, and other inputs into production, as well as the production of bioproducts. While it is a relatively recent concept, arising in the mid-2000s from policy makers in the European Commission (EC) and Organisation for Economic Cooperation and Development (OECD), it has been taken up by the EC, OECD, and the US government as an important (and beneficial) solution to a range of societal and/or global challenges (eg, climate change) (see EC, 2012; White House, 2012). For a critical review of the various theoretical discussions around 'biovalue' and 'biocapital', see Birch and Tyfield (2013).

governance is varied—for example, the US and EU both stipulate GHG emission reduction thresholds but at different levels and for different facilities. While governance plays out differently in separate realms (eg, political–economic and technoscientific), the interplay of governance between realms is liable to promote particular and geographically specific development pathways (see Harvey and Pilgrim, 2011). For example, according to Tyner (2010a), the USA is likely to remain reliant on corn ethanol in the near future because of its particular volumetric mandate (eg, litres of biofuel production), while the EU is more technologically 'neutral' because of its calorific targets (eg, energy content of biofuel production). Hence, understanding the governance of biofuels means understanding how environmental value is married to other considerations around economic value.

Understanding the governance of biofuel production, consumption, and trade is therefore critical (Oosterveer and Mol, 2010). However, the configuration of biofuel energy flows and value chains depends on a complex array of market-based incentives and mechanisms that conserve some natures, destroy others, and create wholly new ones in the process (Castree, 2008a; 2008b; Gillon, 2010; Levidow et al, 2012). It is also being shaped by technical and narrow ways of assessing 'sustainability', focused mostly on GHG emissions instead of tackling broader socioecological risks and consequences.

Contributions to this theme issue

The contributions to this theme issue examine how 'biofueled futures' are being imagined, justified, enacted, legitimized, adjusted, and governed, and with what socioeconomic and environmental mechanisms and consequences. The first two papers focus on the role of specific, national discourses and imaginaries in shaping biofuel policy making and governance and the possible achievement of some futures over others. Les Levidow and Theo Papaioannou's (2014) contribution shows that technoscientific innovation has played a central role in shaping UK biofuel policy. When the government was adopting mandatory quotas for biofuels in 2007–08, technoscientific advances in the field of next-generation biofuels were framed as providing answers to controversies about environmental harm and land-use conflicts generated by first-generation biofuels. Levidow and Papaioannou argue that this future vision served as a technoeconomic imaginary—a feasible, desirable future which can potentially be transformed into practice. These imaginaries helped to stimulate the creation of mandatory markets for currently available biofuels, and provided support for the investment of greater research funding in next-generation biofuels. They stimulated institutional change that reinforces infrastructural dependence on liquid fuel for the internal combustion engine, thus facilitating one future, while marginalizing possible alternatives. Shishusri Pradhan and Shaun Ruysenaar's (2014) contribution shows that the global proliferation of biofuels has given momentum, meaning, and legitimacy to specific 'biofueled futures' within national policy frameworks in countries that historically have not been systemic players in the sector. In their comparative case study of India and South Africa, Pradhan and Ruysenaar show how biofuel policy objectives have been based more on mobilizing biofuel metaphors and imaginaries that have been adapted to fulfil local political needs, rather than on responding to market demand in the two countries. This has led to a scramble for biofuels embedded within policy processes dictated by powerful local vested interests. They explain how pro-poor narratives have augmented these interests and discuss the forms of knowledge, kinds of decision makers, and networks formed by actors involved in such processes. Ultimately, they are able to illustrate how local contestations both acquiesce but also react to, undermine, and perhaps reconfigure global biofuel imperatives.

The next two papers focus on how these imaginaries and future scenarios are based on very specific modes of scientific practice (mostly based on 'GHG science') at the expense of other, broader approaches to assessing socioecological impacts and risk. Sean Gillon's (2014)

contribution focuses on debates over regulatory science that legitimizes biofuel production in the USA. He examines the scientific practices and social processes that render carbon—in the form of GHG emissions—visible, countable, exchangeable, and governable. Gillon examines conflicts emerging between the dominant role of GHG science in biofuel policy and competing analyses that take a broader view of biofuels' socioecological risks and consequences. He draws attention to alternative, place-based approaches to integrating science and agriculture, represented by democratic, farmer-led institutions. His analysis of conflicting modes of scientific practice suggests the importance of considering multiple scientific approaches in addressing climate change. He argues that to complement climate mitigation strategies like biofuels, future governance approaches might build on institutions with the capacity to adapt to changing, site-specific socioecological circumstances. James Palmer's (2014) contribution examines political controversy surrounding biofuels at the European Union level, focusing on recent debates over the problem of biofuel-driven land-use change. To date, the European Commission's attempts to manage such land-use change have relied heavily on technical assessments of the GHG emissions that it might bring about, effectively ignoring a range of other possible social and environmental impacts. Within this context, Palmer assesses how the make-up of Brussels itself, as a specific bureaucratic setting, has been fundamentally constitutive both of the dominant political discourse through which biofuel-driven land-use change is interpreted, and of the techniques and mechanisms through which that discourse has been defended, and indeed reinforced, against challenge. The 'narrowing of vision' entailed in the institutional embedding of this discourse, moreover, has yielded undesirable political consequences by eliding the place-specific consequences and the ethical and moral dimensions of biofuel-driven land-use change.

The final contribution, by Stefano Ponte (2014), examines the formation, evolution, and governance of three national/regional biofuel value chains (in Brazil, the US, and the EU) and provides evidence to support a trend towards the increasing but still partial formation of a *global* biofuel value chain. He argues that, without government mandates, subsidies, and bankrolling of research, this industry would not exist. Without regulation demanding 'sustainability', the market for certified biofuels would have been much smaller or even nonexistent. At least in their formative phase, biofuel value chains were 'government driven' in the sense that regulatory choices, shaped by specific vested interests and imaginaries, directly shaped their structure and functionality. But, as the biofuel value chain becomes more global, a new set of key global drivers is emerging, including indirect value chain players such as sustainability standards makers and certifiers, social movements, and international nongovernmental organizations. Ponte's contribution suggests that this process of global industry formation is likely to involve adjustments in the scope, complexity, and reach of governance, further reimagination, and perhaps a reconfiguration of what 'biofueled futures' may look like.

Stefano Ponte
Department of Business and Politics, Copenhagen Business School
Kean Birch
Department of Social Science, University of York, Canada

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