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Policy-driven, narrative-based evidence gathering: UK priorities for decarbonisation through biomass

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Evidence-based policy-making has been a much-debated concept. This paper builds on various insights for a novel perspective: policy-driven, narrative-based evidence gathering. In a case study of UK priority setting for bioenergy innovation, documents and interviews were analysed to identify links between diagnoses of the problem, societal visions, policy narratives and evidence gathering. This process is illuminated by the theoretical concept of sociotechnical imaginaries—technoscientific projects which the state should promote for a feasible, desirable future. Results suggest that evidence has been selectively generated and gathered within a specific future vision, whereby bioenergy largely provides an input-substitute within the incumbent centralised infrastructure. Such evidence is attributed to an external expertise, thus helping to legitimise the policy framework. Evidence has helped to substantiate policy commitments to expand bioenergy. The dominant narrative has been reinforced by the government's multi-stakeholder consultation favouring the incumbent industry and by incentive structures for industry co-investment.

Keywords: evidence-based policy-making; UK; bioenergy; decarbonisation; decentralisation; anaerobic digestion.

1. Introduction

The role of expert knowledge in policy-making has been a long-standing focus of academic and policy debate, especially in the USA and Europe. More specifically, 'evidence' was given a sharper focus by the UK's New Labour government (1997–2007). Major policy documents signalled the importance of ensuring that 'policies are inclusive, fair and evidence based' (Cabinet Office 1999a, b).

The new approach soon became known as evidence-based policy-making (EBPM). Here evidence meant expert knowledge which could favour or justify specific policy choices. An initial focus was socio-economic issues, where evidence linked outcomes of earlier policies with implications for future policy.

In the run-up to the 1997 election Tony Blair, the Labour Party leader, had declared:

> What counts is what works (quoted in Robinson and Wells, 2007).

This inspired the establishment of 'What Works Centres' in various policy areas (e.g. the National Institute for Health and Care Excellence, Education Endowment Foundation, Centre for Local Economic Growth, Centre for Crime Reduction etc.) all aiming to obtain evidence for better policy decisions. For technoscientific issues such as product safety and future innovation, 'evidence' was more dependent on judgements about predictive uncertainties.

Responding to these policy changes, academic studies analysed the various roles of evidence. This could not entirely explain or determine policy but often provided legitimation. Conversely, evidence depends on policy assumptions and/or wider narratives (see Section 2).

Exploring and linking such perspectives, this paper starts from generic theoretical questions:

- How does evidence—its generation, selection and deployment—relate to policy?
- How does policy-making deal with diverse evidence favouring different narratives?

In what follows, those theoretical questions will be made more specific to a UK case study featuring controversy over ‘unsustainable biomass’:

- In promoting decarbonisation through biomass, how do UK policy narratives diagnose current problems, envisage societal futures and deploy evidence for these?
- How does policy-making relate to an evidence base for different biomass pathways towards decarbonisation?
- What roles are played by evidence gathering?

In answering those questions for the UK context, this paper will argue that UK policy-making has favoured a specific vision of future society from the incumbent industry, in conflict with an alternative vision from civil society organisations. The former, dominant vision seeks bioenergy expansion as an input-substitute within centralised energy systems; the latter, marginal vision, promotes biomass uses for eco-decentralisation. Each generates different evidence which plays an integral narrative role, while at the same time portraying such evidence as external knowledge, thus helping to legitimise its vision.

Gathered within the dominant narrative, moreover, some evidence has helped to substantiate policy commitments to expand bioenergy, alongside specific priorities for technoscientific innovation which could make bioenergy more sustainable. Meanwhile an earlier policy vision for decentralised bioenergy was kept marginal. The dominant narrative has been reinforced by the government’s multi-stakeholder consultation favouring incumbent industry and by incentive structures for industry co-investment, even co-decision on priorities. This analysis links and goes beyond theoretical insights from previous studies of how policy-making draws on expert knowledge (see Section 2).

This remainder of this paper is structured as follows: Section 2 briefly surveys the literature on various roles of expert knowledge in policy-making: evidence-based policy and/or policy-based evidence? Section 3 presents the research methods underpinning the case study on bioenergy. Section 4 compares input-substitution versus eco-localisation as divergent narratives for the roles of biomass in decarbonisation. Section 5 analyses how UK policy favours the former narrative by selectively generating and deploying evidence. Section 6 identifies specific bioenergy pathways illustrating tensions between future visions. Section 7 concludes by answering the above questions about the policy role of evidence in the specific UK case, as well as its wider implications for EBPM.

2. Analytical perspectives: Policy roles of evidence?

Since at least the 1980s academic studies have analysed how policy-making variously draws on social science, research results, expert knowledge and evidence. Those forms were not always distinguished by the studies, nor by the policy frameworks being analysed. Commentators noted the limitations of a knowledge-basis for policy. Rather than directly influence policy, social science may have a long-term enlightenment function by broadening perceptions about policy problems and appropriate solutions (Weiss 1979). Social science research:

> . . . influences conceptualizations of the issues with which they [policymakers] deal; affects those facets of the issue they consider inevitable and unchangeable and those they perceive as amenable to policy action; widens the range of options that they consider, and challenges taken-for-granted assumptions about appropriate goals and appropriate activities . . . ideas from research are picked up in diverse ways and percolate through to officeholders. (Weiss 1982: 622)

In a specific policy context the four Is (i.e. interests, ideology, information and institutions) are just as important (Weiss 1995). Policy relevance depends on transforming expert ideas into the kind of knowledge used by policy actors (Radaelli 1995). In this way:

> . . . the very process of producing expert knowledge – rather than the research findings themselves – bolsters [the government’s] policy preferences. (Boswell 2008: 480)

Evidence also has a potential substantiating role:

> Expert knowledge can lend authority to particular policy positions, helping to substantiate organizational preferences in cases of political contestation. (Boswell 2008: 471–2)

Knowledge claims are best conceptualised as ‘policy narratives’, promoting beliefs about policy problems and appropriate interventions.

> Narratives are likely to be more successful where they meet three criteria: they are cognitively plausible, dramatically or morally compelling and, importantly, they chime with perceived interests. (Boswell et al. 2011: 1)

Narrative meanings and their symbolic devices have been understood through interpretive policy analysis, applying methods of phenomenology and hermeneutics (Yanow 1999, 2007). While analogy makes an explicit comparison, metaphor is more subtle and ubiquitous: our conceptual system is fundamentally metaphorical:

> The essence of metaphor is understanding and experiencing one kind of thing in terms of another. (Lakoff and Johnson 1980: 1, 5)

A metaphorical understanding can be persuasive through a subtle narrative. Indeed, a metaphor is such a commonplace device 'that it slips right by us' (Stone 1998: 122–3). Quantification likewise has a narrative, it categorises things by asserting a likeness:

> ... on the basis of specific characteristics, while ignoring other characteristics. (Stone 1998: 165)

As a symbolic device, a metaphor or classification subtly conveys a specific narrative while also concealing it.

In academic literature, the 'lock-in' metaphor has sharpened debate on the theoretical concept of 'path dependence' (e.g. on institutional constraints, their drivers and scope for other pathways). Here 'lock-in' can denote 'a self-reinforcing internal mechanism', or else 'a temporary stabilisation of paths in-the-making', among other meanings (Garud et al. 2010). In the case study below, metaphors such as 'lock-in' and 'distributed' serve as narrative devices.

2.1 New Labour's EBPM: What roles?

When the New Labour government gave a high profile to EBPM, it was seen as central to a new governance agenda. It creates new conditions for ordered rule and collective action, moving away from the conventional 'command and control' style of policy and regulation (Hagendijk and Irwin 2006; Jordan et al. 2005; Bache 2003).

The concept was accepted at face value by some academics. For example, the EBPM approach:

> ... helps to make well-informed decisions about policies, programmes, and projects by putting the best available evidence at the heart of policy development and implementation. (Davies 2004: 3)

EBPM considers:

> ... all types of science and social science knowledge generated by a process of research and analysis, either within or without the policy-making institution. (Juntti et al. 2009: 208)

Policy-makers seek better quality evidence on which to base policy and regulatory design.

Within such perspectives, a main obstacle is 'a paucity of evidence on what works why, when and with whom' (e.g. in judging which policy instruments are most effective and whether they are complementary or conflicting); likewise inadequate or contested evidence about risk to health and the environment (Taylor et al. 2013: 492, Figure 2). Evidence must be relevant:

> No amount of evidence will have any impact unless it chimes with concerns and priorities of policy makers and politicians. (Riddel 2014: 11)

From those diagnoses of the problem, the solution lies in better, more relevant evidence to overcome controversy and thus guide 'better regulation'.

EBPM presumes an explanatory or causal role of evidence, but doubts were raised about its practical meaning. Evidence has been used strategically or symbolically to legitimise policy choices (Owens 2005; Radaelli 1995). Even when ostensibly science-based, policy decisions:

> ... have always been influenced by interests and values. (Lyall et al. 2009: 1)

In particular, UK Ministers' priorities have been driven by neoliberal political commitments, even if hidden by 'evidence-based' discourses (Campbell et al. 2007).

In those ways, evidence has been seen as simply one of many factors. According to Davies et al. (1999: 3):

> ... research evidence on what works has been just one, relatively minor, ingredient in the process from which policy decisions emerge.

Policy-making has at least seven influences: experience and expertise; judgement; resources; values; habits and tradition; lobbyists and pressure groups; pragmatics and contingencies (Davies 2004). Evidence is contingent, fallible and highly contested (Sanderson 2009; Little 2012), thus rarely pointing towards a single policy direction. So writers have proposed modest concepts such as 'evidence-inspired policy-making' and 'evidence-informed policy-making' (Nutley et al. 2007; Campbell et al. 2007; Duncan 2005). EBPM can serve many roles, for instance:

> ... as a mechanism for legitimating a policy by giving it an expert's authority. (Wells 2007: 27)

Although valid, these perspectives leave ambiguous and perhaps marginal any role for evidence.

Inverting the official model of EBPM, other perspectives emphasise epistemological and political influences on evidence. According to Little (2012: 3):

> ... issues such as the structure of power, the politics of influence and judgements about contextual constraints in any policy environment have direct bearing on whether policies that are actually pursued are grounded in evidence or whether the evidence is manufactured to suit the policy agenda.

The EU's biofuel target, for example, can be seen as 'policy-based evidence gathering' (i.e. a process whereby evidence is selected to support a previously determined policy) (Sharman and Holmes 2010). In the area of health inequalities, UK policy has influenced research through fundamental ideas about problem definitions (Smith 2014).

2.2 Narrative roles of technoscientific futures

Academic analyses also identified links between evidence and future societal visions (Boswell et al. 2011). Policy-making is not necessarily a logical problem-solving process (Jones 2009). Rather policy-making depends on narratives of future societal visions which simplify complex situations, thus:

> . . . reducing the room for manoeuvre or policy space of policy makers, that is, their ability to think about new alternatives or different approaches. (Sutton 1999: 11)

Narratives diagnose problems in ways which favour specific solutions and futures, as promoted by specific policy networks and/or groups (e.g. industry lobbies or civil society organisations). Social science too readily operates within the assumptions of the narrative being analysed. To avoid this constraint, it is necessary:

> . . . to include other available narrative discourses. (Fisher 2003: 174)

Future societal visions have been theorised as imaginaries, that is:

> . . . representations of how things might or could or should be. (Fairclough 2010: 266)

Such visions may be institutionalised and made routine as networks of practices:

> Imaginaries produced in discourse are an integral part of strategies; and if strategies are successful and become implemented, then associated imaginaries can become operationalised, transformed into practice, made real. (Fairclough 2010: 480)

As a concept more specific to a technology-related policy, sociotechnical imaginaries are:

> . . . collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects. (Jasanoff and Kim 2009: 120)

Such imaginaries either describe attainable futures or prescribe futures that states believe ought to be attained. This normative dimension influences state policies for science and technology (S&T). The concept can help to analyse how:

> . . . national S&T projects encode and reinforce particular conceptions of what a nation stands for. (Jasanoff and Kim 2009: 120)

Less instrumental than a policy agenda, an imaginary is:

> . . . an important cultural resource that enables new forms of life by projecting positive goals and seeking to attain them. (Jasanoff and Kim 2009: 122)

A sociotechnical imaginary includes several aspects: the purposes of S&T, the public good to be served, participation in steering etc. It means to resolve controversies about the pace or direction of R&D. In this way, sociotechnical imaginaries underlie policies:

> National policies for the innovation and regulation of science-based technologies are useful sites for examining imaginaries at work. Such policies balance distinctive national visions of desirable futures driven by science and technology against fears of either not realizing those futures or causing unintended harm in the pursuit of technological advances. S&T policies thus provide unique sites for exploring the role of political culture and practices in stabilizing particular imaginaries . . . (Jasanoff and Kim 2009: 121)

The concept 'sociotechnical imaginaries' can help illuminate the policy criteria for relevant evidence. The UK policy system has had a long-standing, deep policy commitment to technoscientific innovation, especially through the life sciences. This commitment has assumed that the UK science base will power industrial success and UK economic growth. These:

> . . . policy objectives drive the search for and interpretation of evidence. (Nuffield Council on Bioethics 2012: 122)

At the same time, R&D priorities and industrial success have been increasingly globalised (Nuffield Council on Bioethics 2012: 126–7).

Indeed, a 'diplomacy for science' has sought to extend international cooperation, with various aims, according to a scientists' report. Diplomacy can pursue:

> . . . top-down strategic priorities for research or bottom-up collaboration between individual scientists and researchers.

As one rationale for such diplomacy:

> Science provides a non-ideological environment for the participation and free exchange of ideas between people. (Royal Society 2010: 15)

The UK government created a Science and Innovation Network to globally market UK environmental technology and renewable-energy technology, especially by highlighting the threat of global warming. This initiative was criticised for seeking global political influence regardless of researchers' interests (Flink and Schreiterer 2010: 672). In seeking global influence, UK policy has diverse aims and beneficiaries, while concealing these tensions within an ambiguous language of common benefits.

Our case study also lies within policy tensions around renewable energy, which can power diverse societal futures. Many scientists and political activists worldwide have been promoting renewable energy for 'decentralisation of energy production and equalisation of access', potentially opening up opportunities for communities to assume control over their territories, resources and lives. For several decades, such community control was anticipated through a transition to renewable sources, yet its advocates have run up against a contrary agenda, often from the renewable energy sector itself (Abramsky 2010; Müller 2012).

Energy-localisation initiatives have arisen all over Europe, often succeeding despite the energy incumbents.

Danish social movements successfully promoted decentralised, small-scale forms of renewable energy (Østergaard 2010; Raven and Gregersen 2007). Berlin had a campaign for a 'social and ecological community-owned energy supplier' to take over the management of the city's power grid, though the initiative has not prevailed (Kunze and Becker 2014).

Indeed, decentralisation agendas have generally been kept marginal by energy incumbents, policy frameworks and support measures in many places, especially the UK:

> These [alternative] pathways focus . . . on reconfiguring local energy and transport systems. These alternative transition pathways receive less attention and resources, which shows that the dominant prognostic discourse privileges the interests of centralized incumbent actors rather than those of less organized and local actors. (Geels 2014: 32)

Why and how? Since the 1990s EU-wide policies have been liberalising the energy supply. Such changes have weakened government ownership or control over the sector (Faij 2006). As an extreme case, the UK electricity system was bought up by foreign-owned multinational companies (Meek 2012). Consequently, the UK's newly privatised industries favoured less capital-intensive improvements because they were forced to recoup investment over shorter time periods than their nationalised predecessors (Shackley and Green 2007).

After efforts at 'picking winners' had some failures (e.g. in a gasification project) (Piterou et al. 2008), UK policy shifted towards 'allowing the market to decide' innovation priorities, including low-carbon options. In effect this narrative:

> . . . privileges powerful regime actors with more capabilities, financial resources and established market positions. (Geels 2014: 34)

From an earlier focus on renewable energy, by 2007 government policy shifted towards seeking large-scale technical options:

> . . . which fit relatively well with the practices and interests of utilities and national governments. (ibid.)

In the government's future vision, carbon capture and storage (CCS) would reduce GHG emissions from coal and gas plants, thus greening their long-term prospects (Geels 2014: 31). This vision has been extended to bioenergy.

As a global trend, renewable energy likewise has been increasingly appropriated for large-scale centralised infrastructures, along lines similar to fossil fuels. Thus the key choices are less among different fuels than among different designs for energy systems. The issue is not what fuel to use but rather what society to build (Miller et al. 2013: 142).

Let us examine how such issues arise within UK priority setting for biomass uses and innovation towards decarbonisation. For this analysis, the paper links several concepts: a narrative (i.e. a diagnosis of the problem justifying specific solutions and means towards their fulfilment); a sociotechnical imaginary (i.e. a technoscientific project incorporating or expressing a narrative); and evidence gathering within or for a specific narrative. Linking those concepts, the subsequent sections will analyse priority setting for UK bioenergy.

3. Research methods

The research underpinning this paper was carried out during 2010–2 within a project that asked the question: what drives and selects UK bioenergy innovation pathways? The study investigated numerous state bodies whose roles have changed over the past decade, as briefly described here. A decade ago bioenergy was being promoted mainly by two government bodies: the Department of Trade and Industry (DTI) and the Department of the Environment, Farming and Rural Affairs (DEFRA). In 2009 bioenergy policy was transferred to the new Department of Energy and Climate Change (DECC), which acquired some former staff of both other ministries. Meanwhile the DTI was renamed the Department for Business and Industry (BIS). The Department for Transport (DfT) sets mandatory quotas for biofuels, while also justifying these *vis-à-vis* sustainability standards and future innovation for novel biofuels.

Public-sector funds for novel bioenergy technology have several sources. 'Strategic research' has been funded mainly through research councils, in particular, the Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC). The latter has co-funded the Energy Technologies Institute (ETI), which describes itself as:

> . . . a UK-based private company formed from global industries and the UK Government.

Near-market innovation has been funded mainly through government departments (e.g. via specific project grants or subsidy for renewable energy). Such priorities have been investigated through two main methods of data gathering: documents and interviews, which were analysed together.

The study analysed more than 30 documents from several bodies (especially government departments, research councils, research institutes and Parliamentary hearings). The sources include: government departments (e.g. DEFRA, DTI and DECC), expert reports that they have cited as evidence and generally funded (e.g. AEA Technology, National Non-Food Crops Centre, E4tech, Energy Research Partnership (ERP) and the Low Carbon Innovation Co-ordination Group (LCICG)), research councils (e.g. BBSRC/BBSRC Sustainable Bioenergy Centre, EPSRC and ETI), other state bodies

(Environmental Audit Committee (EAC), Renewable Fuel Agency (RFA), Committee on Climate Change (CCC) etc.) whose views elicited government responses, and industry organisations (e.g. Renewable Energy Association (REA), Anaerobic Digestion and Biogas Association (ADBA), Combined Heat and Power Association (CHPA).

From the document analysis, initial results indicated evidence gathering within different visions, leading to a more systematic search of documents over the past decade. This aimed to identify similar or different trends among relevant bodies and over time. Some UK academic studies suggested concepts for elaborating our questions (Bergman and Eyre 2011; Kearnes and Wienroth 2011; Russell 2010; Nuffield Council on Bioethics 2012).

The document analysis provided a sharper basis for interview questions, which investigated in depth the public policy process of gathering evidence and selecting priorities for bioenergy R&D. Face-to-face interviews were carried out with 22 key informants. These informants were chosen on the basis of their involvement in those bodies which had originated the policy documents (listed above and cited in the References section). Most interviewees had been involved in inter-departmental discussions, multi-stakeholder consultations and/or expert reports towards formulating what became the 2012 UK Bioenergy Strategy. Some were policy-makers in the sense that they designed and/or shaped frameworks eventually accepted by Ministers. Nearly all agreed to be interviewed, though often with long delays in making the arrangements.

For interview questions, our standard guide encompassed the following topics: the process and rationale of priority setting for sustainable bioenergy; environmental sustainability and economic benefits, especially of innovation; future vision for bioenergy and society; and roles of specific organisations in setting or influencing priorities. For example, interviewees were asked initially: 'What are UK innovation priorities for bioenergy? What has influenced them?'.

These themes structured the preliminary analysis of the interview comments, juxtaposed with policy and expert documents, in order to identify convergent and divergent views. The many interviewees involved in policy discussions had largely convergent views on innovation priorities, though some expressed doubts about policy assumptions. Their accounts overlapped in the sense that no civil servant or expert mentioned any policy debate about alternative frameworks such as decentralisation. As this near-silence indicates, priorities had been evaluated within the long-standing dominant framework of a centralised energy infrastructure. In contrast to most interviewees, non-governmental organisation (NGO) representatives emphasised doubts about sustainable biomass and its verification procedures, but they engaged little with innovation priorities (except UK WIN, 2010).

4. UK decarbonisation: Two divergent policy visions

Climate change has stimulated global debate and policy changes around a transition towards renewable energy. Such debate has focused on potential choices or mixes of renewable energy as various means to reduce greenhouse gas (GHG) emissions and lower dependence on fossil fuels. While societal conflicts have arisen over some forms of power (solar, wind, wave etc.), biomass was uniquely turned into a controversial case for what counts as a renewable, sustainable source.

In the 2007–8 biofuel controversy, especially in Europe, attention focused on the 'food versus fuel' conflict over land use in the global South, as well as environmental degradation there, especially from land clearances and plantations (Franco et al. 2010; Hansen 2014; Upham et al. 2011). Moreover, according to a paper published in *Science*:

> . . . when indirect land-use is taken into account, GHG emissions may actually be higher than those in fossil fuels. (Searchinger et al. 2008)

When governments further promoted bioenergy in general for decarbonisation, NGOs made similar criticisms of 'unsustainable biomass'. Partly in response, policy frameworks emphasised technoscientific innovation which could convert non-food biomass (Boucher 2012; Hansen 2014).

Amidst such Europe-wide controversy, the UK had a specific political context. For at least two decades the UK government has promoted renewable energy as essential for decarbonisation, fuel security and climate protection. In parallel the climate problem acquired new meanings through a specific governance relationship between the state and industry. As elaborated by the UK's New Labour government (1997–2010), various pro-industry policies address climate change, while transferring responsibility to business and consumers. Climate protection has been the narrative rationale for policies which prioritise other aims, especially economic growth and competitive advantage via low-carbon industry (Carvalho 2005). Thus renewable-energy priorities warrant critical analysis for their various aims and drivers.

Decarbonisation has been driven partly by EU obligations. Specifically, under the Renewable Energy Directive (European Commission 2009), EU member states must obtain 10% of their transport fuel from renewable sources by 2020: mainly meaning biofuels in practice. EU member states must obtain 15–20% of all their energy from renewable sources by 2020. The UK foresees the need to fulfil half its 15% target through bioenergy, from a low baseline of only 2% in 2011 (HM Government 2011: 3). The UK has more ambitious longer-term targets, beyond renewable energy *per se*: the Climate Change Act 2008 mandates GHG reductions of at least 34% by 2020 and 80% by 2050, relative to a 1990 baseline.

The government declared that a low-carbon society implies a social transformation in the way we live, as well as a technological revolution (DEFRA 2008: 2). Biomass conversion to energy would substitute for fossil fuels and thus reduce GHG emissions. Various policy incentives aim to expand biomass imports and technoscientific innovation (HM Government 2011). Such innovation has been promoted to make bioenergy environmentally sustainable (e.g. by using non-food crops or biowastes) (Thornley et al. 2009).

From our analysis of UK stakeholders, it became clear that they promote future biomass roles according to divergent policy visions, as follows:

- Centralised input-substitution: As the dominant vision from government and the incumbent industry, bioenergy would complement current centralised energy and transport infrastructures; bioenergy expansion would substitute for some fossils fuels.
- Eco-localisation: As a marginal vision from civil society groups, eco-localisation seeks to reduce energy demand and expand net-negative carbon activities, partly through community involvement; biomass usage would mainly recycle natural resources and sequester carbon.

Given that biomass is spatially distributed, this has been seen as potentially impeding a centralised vision—or as facilitating a decentralised one. The metaphor 'distributed' is given a different significance by the two visions, thus illustrating the narrative-dependent role of evidence. Each vision will be elaborated in a general way below, as reference points for UK bioenergy strategy.

4.1 Input-substitution vision of government and industry

UK governments have generally sought centralised energy systems, which were reinforced by the 1990s privatisation:

> The newly privatised industries favoured less capital-intensive developments since they were forced to recoup investment over shorter time periods than their nationalised predecessors (Shackley and Green 2007: 226–7).

In particular combined heat and power (CHP) and district heating systems are more capital-intensive, so requiring greater infrastructural investment, which did not materialise (Shackley and Green 2007: 226–7; Russell 2010).

UK industry has generally promoted a future vision of substituting renewable energy, while implying or assuming that energy infrastructure and end uses would continue largely as before. Centralisation is often presumed or even explicit as the default mode, complementing dominant policy assumptions (see Section 4). In this societal vision, localisation would be a contingent exception—necessary for some biomass conversion processes to be economically viable.

The REA represents a wide range of organisations servicing the wider energy industry as well as producing renewable energy in various forms (i.e. heat, electricity and biofuels). Among other renewable sources, it promotes biomass conversion to energy and materials, emphasising substitute inputs within current infrastructure. It advocates:

> . . . an important role for power stations using biomass from sustainably produced feedstocks.

It also advocates using biofuels for road transport, which:

> . . . need to peak in 2030 and remain a significant element until 2045. (REA 2011a)

In addition, farm slurry could be converted to biogas for CHP and then be sold for local industrial uses, but it mentions no wider role for CHP (REA 2010). Pyrolysis oils can substitute for diesel, likewise biomass for oil in producing plastics, likewise digestate for chemical fertiliser etc. (REA 2011b). To incentivise such input-substitution, the REA lobbies for R&D funds as well as operational subsidies. Supportive policies are advocated by the REA, as well as by its affiliates for specific pathways (e.g. biofuels, CHP, anaerobic digestion etc.)

Input-substitution is also emphasised as the role for technoscientific innovation. To clarify feasible pathways for the UK's 2050 target, a Bio-energy Technologies Review was carried out by the ERP (2011). It was co-chaired by DECC's chief scientist and co-sponsored by major actors in the energy field, especially the incumbent energy industry (e.g. fossil fuel suppliers, large energy producers, government departments, UK research councils etc.). Its study drew on discussions involving policy-makers, research managers and industrialists. The Bio-energy Technologies Review:

> . . . identifies critical gaps in innovation activities that will prevent key low-carbon technologies from reaching their full potential. (ERP 2011: 3)

In order to overcome those obstacles, long-term R&D investment and new large-scale infrastructure would be necessary to more efficiently substitute bioenergy for fossil fuels. Specific priorities should be: bioenergy with CO_2 capture and storage (CCS); 'drop-in' biofuels that could be substituted for conventional liquid fuels; biofuel production through development of large-scale biorefineries, whose scale-up would be financially too risky for the private sector (ERP 2011: 9).

Centralised energy systems are taken for granted by key actors. As a resource which is inherently distributed (i.e. diffusely located), biomass can pose obstacles for economically viable energy production. So biomass sources must be aggregated by centralising supply chains ETI 2010a). Capital-intensive projects such as CCS are envisaged as an economically viable way to centralise biomass collection and so compensate for its distributed character (ERP 2011; ETI 2010b).

4.2 Eco-localisation vision of civil society organisations

In contrast to that vision, structural changes in production–consumption patterns have been widely advocated as a means towards reducing energy demand, localising energy production and shifting to renewable energy sources (Abramsky 2010; Miller et al. 2013; North 2010). An eco-localisation vision for the UK was elaborated by Zero-Carbon Britain 2030 (henceforth ZCB2030). The report brought together numerous academics and other experts (CAT 2010), thus resulting from a broad collective effort. Quickly persuaded, political activists published a high-profile summary version for wide circulation and public events (CampaignCC 2012).

ZCB2030 plays on the metaphor of a computer starting up: 'Powering-up' means building a new zero-carbon, renewable energy infrastructure. Accordingly:

> . . . an integrated approach involves 'powering-down' (reducing energy wastage) and 'powering-up' (deploying renewable energies), combined with lifestyle and land use changes. (CAT 2010: 5)

Towards 'powering-down', the report elaborates means of localisation (e.g. decentralised energy production via micro-grids, localised supply chains, less need to transport energy or goods, energy-efficient structural changes in buildings etc.). Although small-scale renewables are generally more expensive:

> . . . they increase the total potential of sustainable generation; wherever deployed, they help increase efficiency and decrease demand. (CAT 2010: 16)

Recognising 'strong links between economic growth and growth in transport demand', the report provides evidence for the importance of reducing the demand for transport by various means, as well as replacing liquid fuel with electricity-powered transport, cycling and walking (CAT 2010: 105).

Biomass is given a modest role, mainly in recycling natural resources and thus reducing demand for extra resources and their transport. As a widespread problem, food waste sent to landfill generates methane emissions: instead the waste would be fed to non-ruminant livestock and digestate, all of which can. Other biowaste would be processed by anaerobic digestion (AD), producing stable compost and biogas which, in turn, can substitute for fossil fuels in agriculture:

> Recovered digestate from anaerobic digestion is particularly valuable as a fertiliser. (CAT 2010: 210, 207)

Woody biomass would also supply an expansion of CHP. This contributes to a distributed generation strategy (i.e. decentralising supply chains, while also maximally using available heat) (CAT 2010: 282). All these biomass uses are seen as ways to involve farmers, citizens and communities in shaping the future.

Moreover, biomass would serve sequestration processes in order to balance GHG emissions elsewhere and thus achieve overall zero carbon (CAT 2010: 188). In particular:

- Perennial woody plants would sequester carbon in the soil, thus providing a net-negative carbon sink, even if some plants are converted to bioenergy. This is 'the proven technology of land-based CCS using natural photosynthesis', unlike merely potential future technology (CAT 2010: 203).
- Non-food biomass such as lignocellulose would be converted to energy, but with two caveats: it could make great demands on water, and its viability will depend on future technological development (CAT 2010: 113–4).

On the basis of gathered evidence, it is predicted that jobs will be created within the agricultural sector through the twin drives of re-localising production and decarbonisation (CAT 2010: 73).

Community-building activity is also emphasised as a dual facilitator and societal benefit. A key activity is:

> . . . supporting local programmes which attempt to achieve specific behavioural objectives but also foster intrinsic, community-oriented values.

Strategies include:

> . . . social marketing, identity campaigning and community-led carbon management and energy reduction schemes. (CAT 2010: 29)

To substantiate its proposals, ZCB2030 cites various expert reports as scientific evidence for feasibly linking total decarbonisation with a better future society. For example, such evidence includes the major sources of GHG emissions, ways to reduce them, employment prospects, how to understand and change consumer behaviour etc. Thus evidence gathering lies within an eco-localisation narrative. This draws upon experiences of transition towns (Hopkins 2008) and proposals for a post-materialist 'conserver society' (Trainer 1995), whereby decentralisation serves community involvement and control over resources (North 2010).

Exemplifying the eco-localisation vision, some academic researchers emphasise the spatially distributed character of renewable energy sources as a basis for decentralised systems. Biomass could power small-scale CHP alongside community roles in district heating systems.

Micro-generation can be designed for a cultural–behavioural shift towards users' control and responsibility, linked with knowledge of renewable energy sources. This linkage offers greater opportunities to reduce energy usage and GHG emissions. Relevant technologies include biomass-fuelled boilers and micro-CHP (Bergman and Eyre 2011).

5. UK bioenergy priorities: Tensions around a centralised vision

How does UK policy relate to divergent stakeholder visions for biomass in decarbonisation?

UK policy once emphasised prospects for decentralised forms of renewable energy, but this narrative soon became marginal. Support measures have generally favoured bioenergy as input-substitutes within centralised systems: evidence gathering lies within this vision. But policy tensions arise around various aims.

5.1 Maximising 'renewable energy'

In UK policy documents, a decade ago, the distributed character of biomass offers an opportunity for localisation. For example the 2003 Energy White Paper emphasised greater use of biomass for CHP, especially for small-scale local uses:

> There will be much more local generation, in part from medium to small local/community power plant, fuelled by locally grown biomass . . . (DTI 2003: 18)

A follow-up report reiterated an energy-localisation perspective (although this would require changes to the infrastructure):

> . . . a combination of new and existing technologies are opening up new possibilities for carbon reduction by producing and using heat and electricity at a local level; that is, distributed or decentralised energy. (DTI 2007: 12)

According to evidence-based reports for the UK government, energy localisation can help to lower demand. For example, a more effective public engagement in energy efficiency and demand reduction may require a re-focus onto local scales, with a concomitant move away from the UK's centralised approach to delivery (Boardman et al. 2005; Shackley et al. 2002). The Sustainable Development Commission (2005) noted that, especially for reducing demand:

> A move towards local and micro-grids could stimulate new user/consumer identities.
>
> According to a statutory committee (CCC 2011a: 106) for renewable energy in general, UK strategy should attempt:
>
> . . . to ensure stronger local participation in projects, and sharing of benefits via local communities.

For bioenergy in particular:

> A further factor that is likely to increase the economic favourability of bioenergy is the decentralisation of power generation through micro-generation. (UKERC 2009: 3)

Decentralisation was advocated by some policy reports, scientists, lobby organisations and NGOs (Levidow, and Papaioannou 2013).

Nevertheless, this vision became marginal in later narratives and policy incentives. Apparently this happened without debate, thus leaving the incumbent infrastructure as the default mode:

> The UK energy system is highly centralised, so it's very much the way we normally work. Decentralisation would mean a change . . . (DECC interview, 14 August 2012; cf. Shackley and Green 2007)

Indeed, as a seminar participant mentioned, 'infrastructures are difficult to change'—more difficult than the technologies linked with them.

As another driver for priorities, the 2020 targets for renewable energy have subordinated the ambitious targets for GHG reductions. These two targets were always in tension: civil servants have different views about whether it is most important to deploy bioenergy now for the 2020 target or for the longer term for the 2050 target (i.e. for maximum GHG savings) (DECC interview, 18 March 2011) The former target soon prevailed:

> Given our budget constraints, priority has gone to pathways that can achieve the 2020 target. Bioenergy can be injected into national grids for gas or electricity . . . Large-scale production provides an economy of scale which helps to reduce GHG emissions as well as costs . . . (DECC interview, 14 August 2012)

Consequently, incentives have favoured large-scale supply chains and centralised systems for any processes maximising 'renewable energy' in time, regardless of whether these optimise GHG savings. Bioenergy is envisaged as a substitute input within the current delivery infrastructure.

As DEFRA had acknowledged in 2007, biofuels are the least cost-effective means to reduce GHG emissions, compared to other means or biomass uses. Yet biofuel expansion was justified by a narrative of technoscientific advance:

> It is likely that by 2020 second-generation biofuel technologies will be in place. This should make the production of biofuels from land much more efficient, with a reduced area needed to produce a given volume of biofuels. (DEFRA 2007a: 22, 36)

In this narrative, technoscientific advance will enhance the sustainability of current transport patterns and infrastructure, especially in time for the 2020 EU target on renewable energy. According to the BBSRC Chief Executive, sustainable biofuel:

> ...is one of the few alternative transport fuels that we could roll out quickly using current infrastructure. (BBSRC 2009)

Incumbent industry emphasised economic advantages, alongside the prospect of 'drop-in' biofuels which can directly substitute for petrol (ERP 2011: 9) (i.e. within the current infrastructure).

More generally:

> ...biomass is treated as a perfect substitute, in terms of energy content, for fossil fuels. (DECC 2011a: 78)

Input-substitution helps to protect the investment value of the current transport-energy infrastructure, as well as consumer freedom through private motor vehicles (ETI interview, 8 June 2012). Such narratives informed evidence gathering for the government's internal review, leading to its 2012 UK Bioenergy Strategy (DECC et al. 2012a).

This seeks the most cost-effective means to expand 'sustainable bioenergy'. It formulates several principles, as a basis 'to foster the development of sustainable bioenergy markets'. To minimise dependence on fossil fuels, bioenergy will substitute for fossil fuels and incidentally may generate co-products, in turn substituting for other carbon-intensive processes (e.g. chemical fertiliser) (DECC et al. 2012a: 65).

The document emphasises the importance of evidence:

> Developing a robust evidence base, while recognising risks and uncertainties, is fundamental in identifying low-risk pathways... (DECC et al. 2012a)

And it cites an external evidence base in expert reports and modelling:

> The analysis in the Bioenergy strategy is based on analysis commissioned by DECC and undertaken by AEA Technology, Forest Research and Oxford Economics.

Alternative options are also evaluated (DECC et al. 2012b: 10–2).

Such evidence gathering lies within a specific narrative. Those reports focus on biomass sources and their future availability as input-substitutes in centralised infrastructure; alternative, decentralised options remain marginal or absent. As mentioned above, the strategy document identifies medium-term 'low-risk bioenergy pathways'. These include: some conventional biofuels, CHP processes efficiently utilising recoverable wastes, and sustainable biomass for decarbonising power generation which currently uses coal as a feedstock (DECC et al. 2012a: 40, 8–9).

By substituting biomass for some coal, co-firing was meant to expand greatly, driven by the 2020 target for renewable energy and operational subsidy. Beyond domestic sources of biomass, large-scale imports became more explicit in the UK Renewable Energy Roadmap:

> The supply chain for biomass feedstocks is currently too immature and must expand to support the level of biomass electricity generation we envisage, given competing uses for the fuel. (HM Government 2011: 70)

Bio-electricity expansion depends on large-scale supply chains of woodchips from North America, thus provoking criticism of environmental harm (e.g. for turning biodiverse forests into monoculture plantations) (Ernsting 2012). Environmental concerns were acknowledged in the government's bioenergy strategy (DECC et al. 2012a: 16). Nevertheless biomass co-firing of coal plants was promoted to reduce GHG emissions, partly on the grounds that the plants will be decommissioned anyway by the 2020s. By contrast, new investment such as dedicated biomass plants may be retrospectively seen as sub-optimal for GHG savings or other benefits. Such a lock-in would be avoided by medium-term support for co-firing (DECC et al. 2012a: 36).

This policy narrative cautions against locking-in long-term sub-optimal trajectories, while downplaying medium-term options and effects. In particular, European Commission Directives have set deadlines for lower SO_2 emissions, so some UK coal plants would have to close by 2015. Biomass has lower SO_2 emissions than coal and a relatively low cost. So input-substitution extends a plant's lifespan, as promoted by the 'clean coal' agenda (Sloss 2010; Fernando 2012). The incumbent company can protect its infrastructural investment, centralised plant, market power and some coal combustion. All of this remains a default assumption, concealed by the 'lock-in' metaphor.

5.2 Marginalising community alternatives

As above, the UK Bioenergy Strategy cautions against locking-in pathways which may be seen later as sub-optimal (DECC et al. 2012a: 36). This undesirable prospect is framed narrowly. The UK strategy perpetuates a biomass-to-electricity-only pathway, yet policy documents do not call this a 'lock-in'. Environmentalists criticise current practices for wasting incidental heat: coal-fired plants lose an opportunity for energy localisation and GHG savings, among other benefits (World Wildlife Fund interview, 16 December 2011).

> If you want higher efficiency by using the heat, then you adopt a more localised structure of delivering and exploiting the indigenous resource (e.g. through CHP, authors' comment) (Greenpeace interview, 28 November 2011).

The Bioenergy Strategy relegates CHP to a minor outlet for some biomass sources. It mentions little evidence for CHP's benefits and wider potential, in contrast with previous policy documents. For at least the previous decade the UK government had advocated CHP for its environmental and community benefits (DEFRA 2007a:

7, 15), while also subsidising energy crops as feedstock (DEFRA 2004: 6, 7).

According to its proponents, support measures have been inadequate for significantly expanding CHP. For example, it takes five years to build a renewable CHP plant, yet in 2012 the Renewable Heat Incentive had no clear budget post-2015. According to the industry lobby, government policy has removed or weakened various incentives for bio-CHP (CHPA interview, 19 June 2012).

Despite the government's evidence about benefits and financial incentives, the UK has had little expansion of bio-CHP. As a major obstacle, CHP requires substantial capital investment in district heating systems but is financially risky. CHP has attracted little private-sector investment. The government's expert report mentions missing infrastructure for district heating, while relegating CHP to a marginal role in biomass usage (LCICG 2012: 12). CHP depends on community-sized plants and local decisions, by contrast with electricity sales to the national grid or biofuels to the liquid fuel market, which are more reliable outlets (DECC interview, 13 May 2011).

CHP has been widely promoted as complementing community and consumer involvement, yet some civil servants foresee public attitudes as awkward:

> People in the UK don't want to buy heat from CHP; they hate such local projects. (DECC participant in our seminar, 13 October 2011)

If, for example, householders are invited to install biomass boilers, then GHG savings will depend on behavioural change. Such responsibility may elicit complaints or recalcitrance. Moreover, if consumers know that a proportion of their grid energy comes from renewable energy, then some feel entitled to increase GHG emissions in their travel behaviour. Therefore, to avoid such problems, substituting renewable energy ideally:

> . . . should not require active behavioural changes from people or trigger undesirable behavioural changes. (DECC interview, 14 August 2012)

As a strategic advantage, then:

> Bioenergy will be invisible to consumers. (DECC participant in our seminar, 13 October 2011).

By emphasising the obstacles and difficulties of CHP, the policy narrative confirms a centralised infrastructure as more cost-effective for GHG savings. Policy-makers justify weak support for CHP by reference to its practical difficulties: In particular, 80% of UK heating comes from the national gas grid in the UK, where district heating has a poor reputation. Its expansion would require significant infrastructural investment and heat-pump installation in each building or household (DECC interview, 14 August 2012).

Analogous tensions arise over anaerobic digestion (AD), another available technology. For many years, this has been widely used to produce biofertiliser and biogas which, in turn, has multiple uses. Policy-makers have promoted AD as an environmentally sustainable process that could be further improved (DEFRA 2007a: 8). Localisation has been promoted via modest infrastructure development and new supply chains for AD (DEFRA 2007b).

From a localisation perspective, the AD industry sees the need and opportunity for community involvement:

> AD will be decentralised, given the costs of transporting the feedstock and digestates . . . AD needs partnerships, e.g. through community buy-in. (Anaerobic Digestion and Biogas Association interview, 10 July 2012)

Along those lines, government incentives have supported small-scale AD for on-farm biowaste conversion, but no wider role. In policy arguments for AD, its economic advantages emphasise:

> . . . promotion of a competitive domestic manufacturing base. (DEFRA and DECC 2011: 31)

This has favoured support measures for companies foreseen as exploiting the export market, especially through large-scale waste management, technological expertise, government subsidy and economies of scale. These linkages were highlighted by the UK's largest-ever AD plant, supplying biogas for grid-injection. The plant's operation perpetuates long-distance transport of food waste, indeed, dependence on its large-scale generation, despite a policy aim to reduce such waste. Here AD accommodates the input-substitute centralised model.

6. Technoscientific innovation in bioenergy

Many constraints on expanding bioenergy have been anticipated. On the one hand, future biomass supply may face high prices for imports. On the other hand, according to an expert study (Thornley et al. 2009: 5623), excessive increases:

> . . . could have counterproductive sustainability impacts in the absence of compensating technology developments or identification of additional resources.

Given those dual constraints, technoscientific innovation has been promoted as essential for bioenergy to become environmentally and economically more sustainable. Various means include, for example, cultivating plants on 'marginal land', using non-edible feedstock and more efficiently converting it to energy (DECC et al. 2012a: 6, 8). A reliable large-scale long-term supply of feedstock is deemed essential to attract investment for technoscientific innovation which can convert biomass more efficiently. Within that wider narrative, public-sector R&D seeks technoscientific innovation to broaden the range of biomass sources which can be sustainably produced and converted into bioenergy.

6.1 Evidence gathering for benefits

Facing controversy over 'unsustainable biomass' in 2009, some policy-makers had doubts about significantly expanding bioenergy:

> There was a feeling that bio-anything was a bit awkward.

But by 2010 bioenergy expansion and innovation were supported by the DTI and DECC's chief scientist (BBSRC interview, 5 April 2011). Indeed, the latter co-chaired the Bio-energy Technologies Review (ERP 2011). Various policy discussions generated support for the prospect that technoscientific innovation would provide second-generation bioenergy converting biowaste and/or crops grown on grown on land otherwise not used for agricultural purposes. Such bioenergy would sustainably substitute for fossil fuels and provide an essential contribution towards achieving the UK's statutory targets for GHG emissions. Within this narrative, future bioenergy models were elaborated in inter-departmental discussions and eventually published (DECC et al. 2012a, 2012b).

UK policy has sought to commercialise knowledge as intellectual property for export. This became a key rationale for technological innovation in the biofuel sector. UK producers:

> . . . will have the opportunity to compete in a global market if they can meet the European mandatory standards. (DECC 2009a: 111)

According to the government's technology assessment of advanced biofuels:

> Highest value to the UK is found in specific high tech component processes, which are more exportable, protectable through IP and well-aligned with the UK's academic and commercial strengths. (LCICG 2012: 25)

The same report likewise emphasised national economic benefits for other innovation pathways. In the government's Technology Innovation Needs Assessment (TINA) (LCICG 2012) for bioenergy, environmental and economic benefits together justify public-sector support. The pervasive term 'economic benefits to the UK' has two different components: reducing the costs to the UK of renewable energy and GHG reductions, while also capturing market value from innovation. Consequently, for each technological pathway, the report analyses the specific production stages where the UK may best gain a competitive advantage for exporting intellectual property and novel products, as a basis for R&D priorities (LCICG 2012: 5). Within this future vision, bioenergy innovation priorities have resulted partly from institutional arrangements and incentives for industry investment, especially through research councils and the ETI.

Research councils give higher priority to any proposal attracting 10% of its budget from the private sector. In this way, energy and biotech companies influence R&D priorities. Larger, long-established companies have greater expert capacity to engage with such arrangements and benefit from them (BBSRC interview, 5 April 2011).

As 'a business-led organisation', the government's Technology Strategy Board is governed mainly by industry representatives. It emphasises that bioenergy should create wealth (e.g. profit, patent licences, royalties, jobs etc.) (Technology Strategy Board interview, 15 June 2012). To do so government departments work with the Foreign Office on promoting UK trade:

> We may licence some of the fundamental underlying innovation or build companies which then operate around the world. (DECC interview, 1 April 2011)

For near-commercial scale-up, the ETI brings together several companies which thereby share the high costs and financial risks, and the government provides half the overall funds. Its innovation priorities are steered through co-funding between public and private sectors, mainly large incumbent companies in the oil and renewable sectors. Their representatives on ETI's Strategic Advisory Group discuss priorities, as a basis for ETI managers to judge which pathways have adequate industry support and warrant state funds. Its bioenergy investments generally foresee technoscientific innovation as saving GHG emissions within centralised infrastructure (ETI interview, 8 June 2012). ETI managers also contributed to the TINA Report, as well as the UK Bioenergy Strategy. These arrangements have reinforced the dominant policy vision in evidence gathering as well as priority setting.

6.2 Priority setting for innovation

As a long-standing UK aim, CCS has been developed mainly for gas and coal-fired plants, with potential adaptation to bioenergy such as by co-firing biomass. Otherwise, the 2050 targets for GHG savings would be much more costly to achieve. Thus 'the availability of CCS is key in the longer term' through linkages with other bioenergy technologies. But their costs and availability remain highly uncertain (DECC et al. 2012b: 8–9, 56).

As 'the key bioenergy hedging options against these inherent long-term uncertainties', the UK strategy identifies three technologies (biosynthetic gas, hydrogen and advanced biofuels) for converting non-food biomass (DECC et al. 2012a: 38). Those three options illustrate the dominant narrative within the UK Bioenergy Strategy, as follows (Levidow et al. 2013):

- *Biohydrogen:* Since the turn of the century, government policy has identified hydrogen fuel cells as the preferable alternative, even as the 'fuel of the future' (DECC et al. 2012a: 53; earlier sources cited in Berti and Levidow 2014: 137). Going beyond the internal combustion engine, hydrogen cells have been foreseen as even more environmentally sustainable if using biomass inputs for biohydrogen. But this pathway has gained much less R&D investment than biofuels. Evidence gathering has recently emphasised the technical difficulties of biohydrogen, which thus becomes one of many 'unproven technologies' (DECC et al. 2012b: 56). As an implicit extra reason, this pathway would require new infrastructure undermining the incumbent one.

- *Advanced biofuels*: These have been strongly promoted for several aims: to build on UK technoscientific strengths, to gain intellectual property from those strengths, to avoid the 'fuel versus food' conflict, to complement current fuel delivery for private motor vehicles, and to avoid locking-in conventional biofuels. Warnings against a policy lock-in came from Parliamentary Committees (EFRAC 2006: 45–46; EAC 2008: 3, 14; Berti and Levidow 2014); soon a lock-in was already happening (e.g. DEFRA interview, 22 May 2012). Whenever advanced biofuels materialise, they could intensify competition for biomass among potential uses and industrial sectors, according to an expert report for DECC (AEA Technolgy 2011: viii). Policy documents did not cite this warning, but did cite the same expert report for evidence favourable to government strategy, including biofuels (DECC et al. 2012a: 24, DECC et al. 2012b: 5). When reporting future plans to the European Commission, the UK quietly abandoned its earlier narrative that advanced biofuels would help fulfil the 2020 target for renewable energy (HM Government 2010); this delay substantiates Parliament's 2006 warning. UK policy reports did not acknowledge the change in expectations, much less a possible lock-in of conventional biofuels.
- *Gasification:* Providing biosynthetic gas, this technology has been promoted for its economic benefits and flexible links with several other pathways. In particular, biowaste-to-energy conversion would turn an environmental burden into an asset. Although gasification could complement localised systems, the technology has been envisaged mainly for centralised infrastructure. For example, large plants converting waste from a wide area would be distant from populations and so would have difficulty to use the waste heat (ETI interview, 8 June 2012).

As those examples illustrate, the dominant narrative informs evidence gathering for the prospects and benefits of 'sustainable bioenergy'. Through new institutional arrangements between state bodies and industry, they jointly shape innovation pathways (Levidow et al. 2014). Evidence plays a role in substantiating some pathways more than others, while also legitimising bioenergy promotion.

7. Conclusions

As surveyed above, EBPM has various theoretical interpretations, focusing on 'evidence' as an argumentative form of expert knowledge. Some commentators accept the prevalent diagnosis of the problem, that better evidence is necessary for government to choose the best policy. Yet sceptics see EBPM as exaggerating the policy role of evidence or even as disguising the policy basis of evidence, thus inverting their real, practical relationship (Sharman and Holmes 2010; Little, 2012). Indeed, evidence can serve as a policy narrative, promoting beliefs about policy problems and appropriate interventions (Boswell et al. 2011). As ubiquitous symbolic devices, metaphors convey subtle narratives while also concealing them, according to interpretive policy analysis (Lakoff and Johnson 1980; Stone 1998: 122–3). This paper has combined those insights for a novel perspective: policy-driven, narrative-based evidence gathering.

As shown above, UK decarbonisation agendas have had two divergent visions of future society around priority setting for biomass uses and innovation. The incumbent industry has sought bioenergy expansion as an input-substitute within centralised energy systems. From an earlier promotion of diverse trajectories, UK policy shifted towards large-scale techno-fixes compatible with long-term dependence on fossil fuels, thus reinforcing the state's dependence on incumbent companies (cf. Geels 2014). This dominant vision seeks a global competitive advantage for exporting technology, expertise, intellectual property etc. By contrast, a marginal vision from civil society organisations has promoted biomass uses for eco-decentralisation to contribute towards making the UK carbon-neutral.

Each future vision has its own narrative (i.e. a diagnosis of the problem justifying various solutions and means to realise them). In different ways, each vision proposes biomass uses which are currently available and/or can be developed through innovation. As a metaphor, 'distributed biomass' has been seen as potentially impeding a centralised vision but rather as facilitating a decentralised one, thus illustrating the narrative-dependent role of evidence.

Each vision serves as a sociotechnical imaginary—a feasible, desirable future dependent on technoscientific advance—which is potentially turned into reality. In UK policy contexts, imaginaries operate less as instrumental strategies than as cultural resources for divergent narratives for diagnosing problems and proposing solutions. Comparing the two overall narratives helps to analyse tensions and priorities within policy frameworks (cf. Fisher 2003: 174).

Evidence has been selectively generated and gathered within the dominant narrative, while being attributed to an external expertise, thus helping to legitimise the narrative. Some evidence has helped to substantiate policy commitments to technoscientific innovation which could make bioenergy more sustainable within a centralised infrastructure. Through evidence of future benefits, the dominant narrative conflates the public good with private interests.

It also conflates national advantage with competition among UK researchers for intellectual property and global collaboration: tensions arise between different benefits and units of competition.

The dominant narrative has been reinforced by several policy processes. Incumbent industry has been favoured by multi-stakeholder consultation processes, alongside incentive structures for industry co-investment. Going far beyond lobbyists and pressure groups (Davies 2004), such institutional arrangements jointly shape innovation pathways and evidence about their benefits. Ambitious 2050 targets for GHG savings have been subordinated to 2020 targets for renewable energy, in ways favouring large-scale expansion of bioenergy by the shorter deadline.

A policy narrative warns against locking-in sub-optimal pathways, framed narrowly: each available substitute (e.g. conventional biofuels or biomass-coal co-firing) becomes a temporary, transitional step towards more a sustainable future and thus not a lock-in (cf. Garud et al., 2010). The metaphor conveys a policy narrative about cautiously keeping future options open, yet conceals assumptions about the centralised infrastructure and political–economic power of the energy incumbents. Even if advanced biofuels eventually avoid a lock-in of conventional ones, the search for 'drop-in fuels' reinforces the internal combustion engine. This prospect lies outside the policy narrative of lock-in.

Despite earlier policy statements advocating small-scale decentralised bioenergy, difficulties have been recently emphasised by policy documents and civil servants. Such alternative pathways were quietly abandoned, downplayed or relegated to marginal contexts. The UK had no societal controversy to stimulate a policy debate.

In sum, the incumbents' narrative on sustainable bioenergy has informed evidence gathering in expert reports and policy processes. In the guise of evidence, moreover, the narrative naturalises and reinforces the state's institutional dependence on the energy incumbents. Thus, the stereotype of EBPM should be inverted as a novel perspective: policy-driven, narrative-based evidence gathering. This builds on earlier theoretical perspectives on how evidence plays legitimising roles, while promoting narratives about feasible desirable futures.

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