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UK bioenergy innovation priorities: Making expectations credible in state-industry arenas ☆

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ABSTRACT

The UK government has promoted bioenergy for several policy aims. Future expectations for bioenergy innovation encompass various pathways and their potential benefits. Some pathways have been relatively favoured by specific state-industry arrangements, which serve as 'arenas of expectations'. Through these arrangements, some expectations have been made more credible, thus justifying and directing resource allocation. Conversely, to incentivise private-sector investment, government has sought credibility for its commitment to bioenergy innovation. These dual efforts illustrate the reciprocal character of promise-requirement cycles, whereby promises are turned into requirements for state sponsors as well as for innovators.

Collective expectations have been shaped by close exchanges between state bodies, industry and experts. As promoters build collective expectations, their credibility has been linked with UK economic and environmental aims. When encountering technical difficulties or delays in earlier expectations, pathways and their benefits have been broadened, especially through new arenas—as grounds to allocate considerable state investment. Thus the concept 'arenas of expectations' helps to explain how some pathways gain favour as innovation priorities.

1. Introduction

Over the past decade, UK policy has given renewable energy an increasingly important role as both an environmental and economic imperative. Environmental aims include: reducing greenhouse gas (GHG) emissions, moving to a low-carbon economy and improving waste management. Renewable energy encompasses solar, wind and wave, which convert site-specific sources into electricity.

By contrast, bioenergy has diverse biomass sources and energy outputs. But it largely depends on traditional processes for converting biomass, especially from sources which have been criticised as environmentally unsustainable [1]. To increase bioenergy production, excessive increases in biomass imports 'could have counterproductive sustainability impacts in the absence of compensating technology developments or identification of additional resources', according to an expert study [2]. Along those lines, the UK government emphasises the need for technoscientific innovation to ensure expansion of 'sustainable bioenergy' [3]. Multiple innovation pathways have competed for public-sector funds, while also anticipating that biomass sources may become scarce, more expensive and/or controversial.

This paper analyses UK innovation policy on bioenergy through the following question: Given various state funding sources, how does each favour different expectations for benefits from bioenergy innovation, thus giving priority to some innovation pathways? Subsidiary questions include: How have future expectations mobilised resources for some innovation pathways more than others? How have some expectations been made more credible through institutional processes evaluating and prioritising them for public funds? In those processes, what have been the arrangements between the public and private sectors, i.e. between

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state and industry bodies? How have arenas and priorities undergone change? To provide answers, we analyse UK priority-setting for bioenergy innovation pathways.

The paper is structured into six sections. Section 2 surveys analytical perspectives on how technological expectations help to mobilise resources, especially through specific arenas. Empirical sections correspond to the different types of comparisons made here. Section 3 analyses how specific UK arenas have favoured some expectations, as a basis for some innovation priorities rather than others. Sections 4 and 5 analyse how some expectations have been made more credible than before through specific arenas, especially vis a vis previous difficulties for gasification. For algal bioenergy, Section 6 analyses how this overall pathway was made more credible in a specific arena; yet the significant funds were soon lost through a shift in government criteria. Drawing on those various comparisons among pathways and arenas, Section 7 summarises answers to the above questions; Table 1 summarises links between specific arenas, credible expectations and innovation priorities.

Table 1
Arenas of expectations for UK bioenergy innovation. The four agencies below have given significant funds to bioenergy innovation along different lines. Each column outlines a high-level aggregation through an 'arena of expectations' with distinctive ways to structure relations between selectors and enactors, to involve industry, to fund types or stages of innovation, and to set criteria for success. Funding priorities cannot be explained entirely by technical progress, as indicated in the 'promise-requirement' row.

Arena: selector and/or enactor	Research councils	Bioenergy capital grant scheme	Carbon Trust	Energy Technologies Institute (ETI)
Host/funder Bioenergy-specific unit?	BIS EPSRC Supergen Bioenergy since 2003 BBSRC BSBEC since 2009	DTI, then DECC since 2009 Bioenergy-only funding since its establishment in 2002	DTI, then DECC since 2009 Advanced Bioenergy Directed Research Accelerator since 2008	BIS + EPSRC All energy pathways, especially renewable forms, since 2009
Industry role	Industry co-funding or sponsorship, as an indicator of commercial prospects, is an advantage for a proposal in competing for RC funds. Researchers also compete against each other for such support.	Evaluates proposals from organisations, companies, public authorities, etc.	Projects often develop a partnership with industry (but not for algae programme).	Established a club membership, especially of large fossil-fuel companies, which have provided half the funds.
Innovation stages	EPSRC: 'strategic research', i.e. knowledge linking with commercial application. BBSRC: fundamental science underpinning later application	Conventional or novel technologies needing refinement or scale-up	Generally near-market or commercial use (except for Algae Biofuels Challenge programme)	Initial feasibility studies for the entire supply chain, towards upscaling demo projects, thus minimising risk for any single investor
Commercial expectations	R&D results will eventually find commercial application by companies via partnership and/or patent licensing.	5-year grant for energy production will facilitate commercial viability and stimulate demand for energy crops.	Funds will 'overcome technical barriers that are holding back next-generation' bioenergy, e.g. algae and pyrolysis.	Companies together 'identify key areas for strategic investment' via real-world systems, towards making them commercially viable.
Favoured path: example	Advanced biofuels via lab techniques towards facilitating the commercial stage	Minimal competition: numerous diverse proposals funded, sometimes via repeat grants	Algae Biofuels Challenge funding R&D (2008–11 only)	Gasification, esp. for converting bio-waste; and bioenergy-CCS for 'negative emissions'
Expectations of latter example	Advanced (ideally 'drop-in') biofuels lowering net GHG emissions from current transport infrastructure, as well as gaining export markets or intellectual property	Various innovations contributing to targets for renewable energy and GHG savings	Commercially viable algal biofuels by 2020, thus substituting for fossil fuels without demand for freshwater or land	New (or add-on) plants lowering GHG emissions of current infrastructure for fossil-fuel energy, as well as gaining export markets or patents
Promise-requirement cycle	2009 expectations for advanced biofuels by 2020 target were explicitly postponed, yet support was maintained via a promise to bypass the 'fuel vs food' controversy and bring economic benefits.	DECC had weak basis to evaluate promises or to impose requirements for technical progress via the BCGS, which was being phased out by 2013.	DECC criteria changed in 2010, diverging from original promises of the algae programme, leading to its termination in 2011.	Expectations to convert any biomass (especially waste) more efficiently via gasification became more important and credible, despite UK's earlier difficulties ('picking losers').
Contrast with other pathways or arenas	Much less funds were allocated to bio-hydrogen techniques and fuel-storage cells, which face many technical difficulties. Their application would undermine current infrastructure of large incumbent energy companies.	By 2013 the Scheme was deemed an ineffective way to select the best prospects for innovation.	Various public–private partnerships were funding other algal pathways for diverse high-value products, with energy as a by-product.	Policy language has emphasised decentralisation via bioenergy, but such pathways remain marginal in priorities, which favour large-scale centralised plants.

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