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Without SLO BECCS, fast net-zero looks unlikely

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Abstract

Bioenergy with Carbon Capture and Storage (BECCS) discussions have been dominated by global scale assessments with very limited exploration of how and where the technology could be deployed. A social license to operate (SLO) may not be achieved if key aspects of deployment and public concerns are not addressed, as has happened with onshore wind energy and fracking. There is a crucial role for the news media in this process because of its influence over the public debate and public attitudes. The fate of the public debate on BECCS has major implications for the delivery of net-zero emissions: time is very short for policymakers to find alternative strategies to meet carbon budgets if BECCS is rejected. Our news media analysis of the UK and California explores the ‘storylines’ which frame the public debate of BECCS. Results highlight: 1) an immature public debate, significantly lagging policy objectives; 2) a distinctive set of storylines specific to California and the UK; and 3) the absence of a location-specific discussion of BECCS, which we argue is critical to community-level support necessary for a SLO.

Key words: BECCS, social license to operate, public acceptance, negative emissions, net-zero, public debate

1. Introduction

BECCS is included in the majority of Intergovernmental Panel on Climate Change (IPCC) scenarios consistent with the Paris Agreement targets, with median BECCS deployment of somewhere between 3 Gt CO₂ and 7 Gt CO₂ needed per year by 2050 to achieve the 2 °C and 1.5 °C warming limits respectively [1]. To put this in context, it has been estimated that this magnitude of CO₂ recovery would require in the region of 380-700 million hectares of land globally to be dedicated to the supply of biomass [2], and an estimated 1,000-2,333 BECCS power stations sized at 500 MW each (using calculations from Donnison *et al.* [3]). However, few commercial operations exist globally and policymakers are favoring BECCS to meet net-zero targets whilst key questions remain unanswered, including those relating to costs, scalability, and the environmental impacts of these levels of land-use change [4]. The environmental and social impacts of BECCS deployment could be severe, with concerns raised over food security, land degradation, biodiversity loss, and water scarcity [5].

Knowledge gaps for BECCS are present at sub-global scales, where political decision-making and public attitudes will determine whether BECCS is deployed. There is already early evidence of friction between policymakers' ambitions for the technology and the public response: the UK government's plan to achieve a net-zero economy relies heavily upon the use of BECCS [6], whilst the recent UK Climate Assembly found limited support for the technology's role in meeting the net-zero target [7]. There will be pressure to bypass citizens due to the speed and scale at which BECCS is required in net-zero scenarios [8], however, the public see things expert

assessments miss, have a democratic right to be involved in the decision-making, and add legitimacy to the process [9]. Public awareness is currently low: just 5.7 % of people in the UK and 9.6 % in the US are familiar with Negative Emission Technologies (NETs) including BECCS [10]. Public concerns range from cost and safety of carbon storage to impacts on land-use and the environment [11,7]. Recent research has begun to show that the impacts of BECCS will be location-specific, with environmental, social, and economic trade-offs according to location, at the regional and national scales [3,12,13,14]. It is at these scales, and the community scale, where social challenges may arise which are not evident at the global-scale analysis; Wustenhagen *et al.* [15] distinguish social acceptance at the broad socio-political level from social acceptance at the community level, which is influenced by matters of justice and trust between local stakeholders. It is a mistake therefore to assume that national level social support or rejection of a particular technology will translate to a specific project at the community level. In the case of CCS, strong support has been found in some locations [16,17], likely because of familiarity with the technology and its perceived support for jobs and existing industry. In the case of BECCS it is not clear that there is public support at the national level [7,10] and understanding of local-level support is yet to be determined: a more thorough approach to public engagement of BECCS is urgently called for [8,18,19].

Public engagement at the community scale may be crucial in any successful BECCS policy [13,20]. Companies in the fossil fuel industry have sought ongoing community and stakeholder support of the necessity of resource extraction, a process known as a ‘social license to operate’ (SLO) [21]. This concept therefore moves beyond a snapshot of public opinion: to establish SLO for energy projects such as BECCS requires: i. addressing the specific project context; ii.

building relationships with stakeholders; iii. communicating with local people the benefits and impacts of the project; iv. understanding sustainability as a dominant concern within communities; and v. an adaptable approach when engaging with the community [21]. Recent energy technologies have both succeeded and failed to achieve a SLO based on these principles: in Poland, stakeholders and local politicians were fully engaged in the process of a successfully introduced fracking industry, whereas top-down approaches in Belarus and the UK both led to public backlash [22,23].

Just as the local context determines environmental and social impacts of BECCS, it is also critical to SLO: *“Local context is key. The legitimacy of a project hinges on whether people think a project will create more benefits than problems. And people’s perceptions emerge from a combination of local economics, demographics and social values”* (Andreas Goldthau, 2018 [24]). A recent study found that local opposition to renewable energy projects was not to the technologies per se but the “place-blind ways” in which they are sometimes deployed, and that failing to engage the local community in projects which deliver benefits elsewhere, whilst leading to costs locally, results in public resistance [13]. There is a risk that local communities would perceive BECCS power stations and associated bioenergy crop landscapes in this way. A SLO for BECCS is also not expected to form homogeneously, with the environmental and social circumstances of particular regions or nations being more supportive than others, as indicated by previous energy technology research [19,25]. Additionally, the dissemination of information is crucial to this process: the translation of scientific evidence was identified as critical to the early stages of SLO for CCS [17].

With key elements of the SLO forming around dissemination of information and engagement with the public we explored the status of the public debate on BECCS in the news media. News is an important source of public information on energy technology [27] and performs a key role in agenda-setting and influencing public attitudes regarding new technologies [28–30]. Whilst policymakers and industry may seek to avoid controversy, news media has an incentive in actively engaging with the arguments of industry and government critics [31]. News media can also be used as a tool of persuasion by different actors, and has previously undermined the legitimacy and deployment of new energy technology [32]. How issues are framed, and the choice of narratives or storylines, are the means by which news media communicate and give meaning to the public [28–31]. Storylines are argued to be the most powerful discursive tool available by prominent political scientist Maarten Hajer, who states that they are a “*generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to specific physical or social phenomena*” [33]. We used storylines as the basis of our analysis of the meaning and values ascribed to BECCS in the public debate, and the prospects for a SLO. In 2015 a newspaper media analysis looking at CCS and biomass individually found very little discussion of the two technologies combined, with limited evidence suggesting positive public perception of the technology for its role in combating climate change [34]. The two previous media analyses of BECCS focused on the narratives used by experts of BECCS, finding strong criticism of BECCS scenarios, as well as a ‘reluctant acceptance’ of the technology [35,36]. Haikola *et al.* [36] argue that the IPCC’s heavy reliance of BECCS in their scenarios has narrowed public debate on the full range of decarbonization options available, including deep mitigation and ‘de-growth’ pathways. Virtually no expert narratives of BECCS favor large-scale deployment [36], which appears problematic for the fate of the public debate of BECCS, and

prospects for SLO. We advance findings from Haikola *et al.* [36] by exploring the development of narratives or storylines within and across national contexts and their relationship with public debate and the SLO.

2. Materials and Methods

The objectives of our news media review were: 1) determine the maturity of the public debate of BECCS, indicated by the range of storylines identified, and whether any dominant storyline existed which might indicate a basis upon which SLO could be achieved [33]; 2) explore whether a SLO has better prospects to develop in some geographical contexts, and the factors contributing to this, and; 3) determine if the news media debate adequately discusses the location-specific social, economic, and environmental impact of BECCS deemed to be important for SLO. Our newspaper analysis was comparative, exploring storylines across two geographical locations where BECCS is being considered - the UK and California; previous comparative newspaper analyses of energy technologies in two countries have found contrasting news media frames which influence the public debate and opinion [25,27,29]. We chose these two geographies as they are the only two locations where, in addition to a legislated commitment to achieving net-zero emissions, a public debate on BECCS was evident in the newspapers. California and the UK also reflect contrasting energy portfolios and geographical contexts which are likely to result in different approaches to news media reporting. The news media continues to play an active role in both geographies: whilst UK newspaper circulation as hardcopy has halved in the decade since 2010, around half of adults still use newspapers or newspaper websites and apps [37]. In the USA, around half of adults also regularly use print newspapers and news websites [38], although in recent years, social media has begun to contribute to news sources. However, consumers see newspapers as more trustworthy, detailed, and helpful in understanding

current affairs, compared to social media [37]. Newspaper companies therefore still perform an influential role in the public debate in the UK and California, and are likely to influence news content of non-newspaper sources such as television and social media.

To conduct our newspaper media analysis we used Nexis, a database that includes national, regional and local newspaper sources. Each of these newspaper types is expected to approach energy technology differently, with a previous newspaper analysis finding regional and local newspapers giving extensive attention to bioenergy whilst very little came from national tabloids [27]. Regional and local newspapers are also more likely to pick up on local issues relevant to the SLO which could be missed by national newspapers. However, national media can perform an important role in drawing social attention to an energy technology upstream in its development process, with social control over the technology lessened by the time it is developed [39]. Given the limited media coverage of BECCS we decided to look at articles from the top ten circulating UK and Californian newspapers, acknowledging this would include both national and regional newspapers. Although the Californian newspapers were by nature regional to California they still covered national news topics. Additionally, we supplemented them with the results from three national US newspapers (this did not change the nature of the results, see supplementary information). We searched for keywords relating to BECCS in the selected newspapers during the study period 2001-2020 (See SI for further details of our methodology). Distinct BECCS storylines were identified within each set of results, based on Hajer's guidelines to look for often repeated figures of speech [33], noting the occurrence of a 'ritual' character, for example referring to BECCS as "no silver bullet". The degree to which each article discussed BECCS varied, with some providing as little as a sentence to the technology, and as a result, in

the case of several news articles no storylines were identified. Aware that journalistic culture and newspaper political leaning could influence the use of storylines we detailed the political leaning and ownership of the newspapers analyzed (SI Table 1), noting that the UK news media is further to the political right than the Californian news media. However, all storylines that we identified were found in multiple newspapers, suggesting that political leaning or journalistic culture were not important factors in our study.

3. Results

3.1 BECCS storylines in the UK

A total 96 UK newspaper articles were reviewed, of which 88 had storylines identified, with the first article published in 2012 and the majority published during 2018-2020 (Figure 1). Six distinct BECCS storylines were identified (Figure 2). The most prominently occurring described the technology as “no silver bullet” and “too good to be true”, rejecting the likelihood of BECCS to deliver on the huge scale proposed in IPCC models. This storyline was mentioned in 29 % of the UK newspaper articles and featured consistently through the study period (Figure 1). The second storyline emphasised the ‘danger’ or risk of BECCS. Some newspapers presented the ‘moral hazard’ of BECCS reducing incentives for immediate mitigation and then not working on the scale of the IPCC models, increasing the risk of future dangerous temperature increases. Dr Rachel Smolker of the organisation Biofuelwatch evoked this language, describing BECCS as “largely untested” and “very risky” (April 7th 2014, The Guardian). Risk was also used when describing the land-use consequences of BECCS deployment, with language used including “ecosystem collapse”, “severe biodiversity impacts” and “endangering food security”. The third storyline was of ‘cost’. In some newspapers, cost referred to the monetary cost of using the CCS

technology whilst elsewhere cost referred to the cost of climate change, which was believed to be much greater than the monetary cost of using BECCS technology to limit warming. The fourth storyline identified concerned the ‘transition’ that BECCS represents. Transition was mentioned in the context of BECCS representing a temporary bridge between fossil fuels and renewable energy, as opposed to a permanent use of BECCS. Fifth was the storyline of BECCS representing a continuation of the ‘status quo’: the preservation of existing consumption habits and energy demand, a feature which is criticised by some groups and seen as a strength by others. This storyline included the critique that BECCS is supported because it is ‘not disruptive’ to the current socio-economic system as opposed to the radical change that some see as necessary to achieve emissions reduction targets, reflecting a ‘post-normal’ critique based more on values than facts [35]. The sixth storyline described BECCS as a ‘necessity’ for meeting climate targets, featuring phrases such as “only solution” or “only chance”.

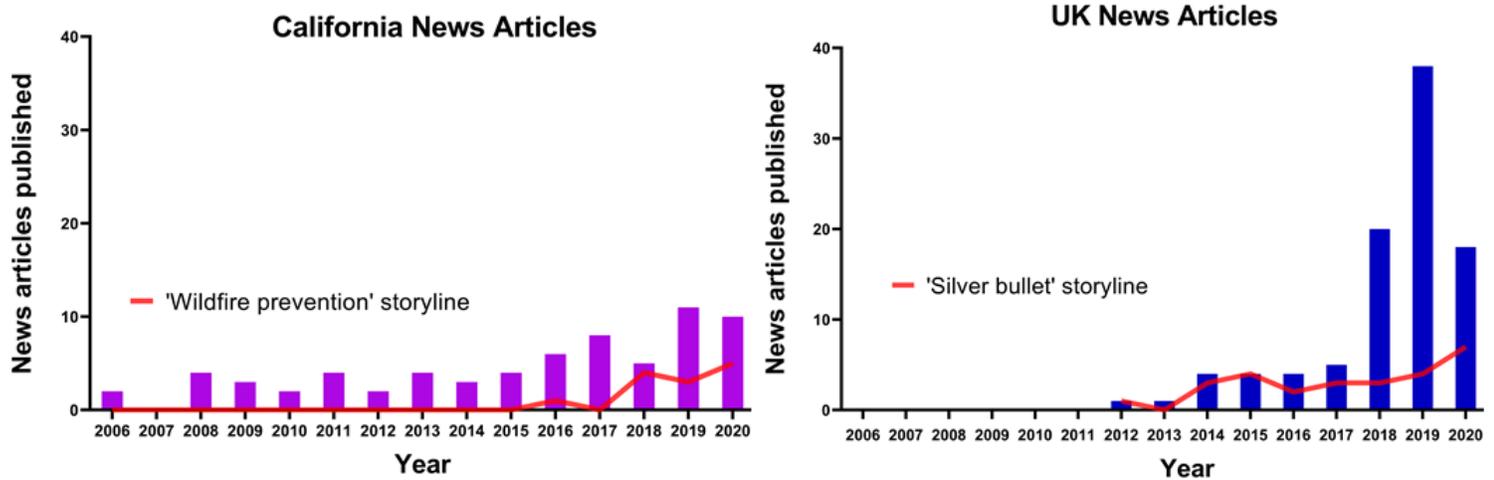


Figure 1. The number of newspaper articles published in each year of our period of analysis for California (left-hand pane) and the UK (right-hand pane). Note: the first Californian and UK newspaper articles were published in 2006 and 2012, respectively. The red line shows how many of these newspaper articles in each year featured the most prominent (frequently occurring)

Californian storyline (‘Wildfire prevention’) and UK storyline (‘Silver bullet’) during this time period. Note: no storylines was identified in 19 Californian/US and 8 UK newspaper articles.

3.2 BECCS Storylines in California

Our California review covered 68 newspaper articles, with storylines identified in 47. The first news article was published in 2006, followed by a gradual upward trend in newspaper articles throughout the study period (Figure 1). Four storylines were identified from the results (Figure 2). The most frequently occurring storyline linked BECCS to ‘wildfire prevention’, appearing first in a newspaper article in 2016, and then more frequently in the last few years as wildfire events have intensified in California, found in 33 % of all the articles since 2016. Newspaper articles cited the benefit of using woody biomass from the forested Sierra Nevada to meet the high feedstock demand of BECCS, helping achieve state ambitions of increased forest management, including removal of biomass to reduce wildfire risk. The second storyline related to CO₂ storage and land management, with ‘storage concern’ for terrestrial sequestration in California. It is important to note here that under a BECCS strategy in California CO₂ is expected to be stored onshore under land whereas in the UK it is expected to be stored offshore under the North Sea. The third storyline concerned CCS and its ability to prevent emissions. The ‘cleaning’ function of CCS was mentioned in combination with coal-fired power stations, with the phrases “clean-coal” and “CO₂ scrubbing” both used. This storyline, featuring during 2007-2010, has lost salience recently, with the closure of nearly all Californian coal-fired power stations. The fourth storyline identified concerned BECCS ‘making up’ the projected emission mitigation shortfall, as well as being used to ‘undo damage’ from historical emissions. This storyline describes

BECCS as a safety or ‘back-up’ option, as opposed to a necessary aspect of achieving net-zero targets, representing an example of a reluctant acceptance.

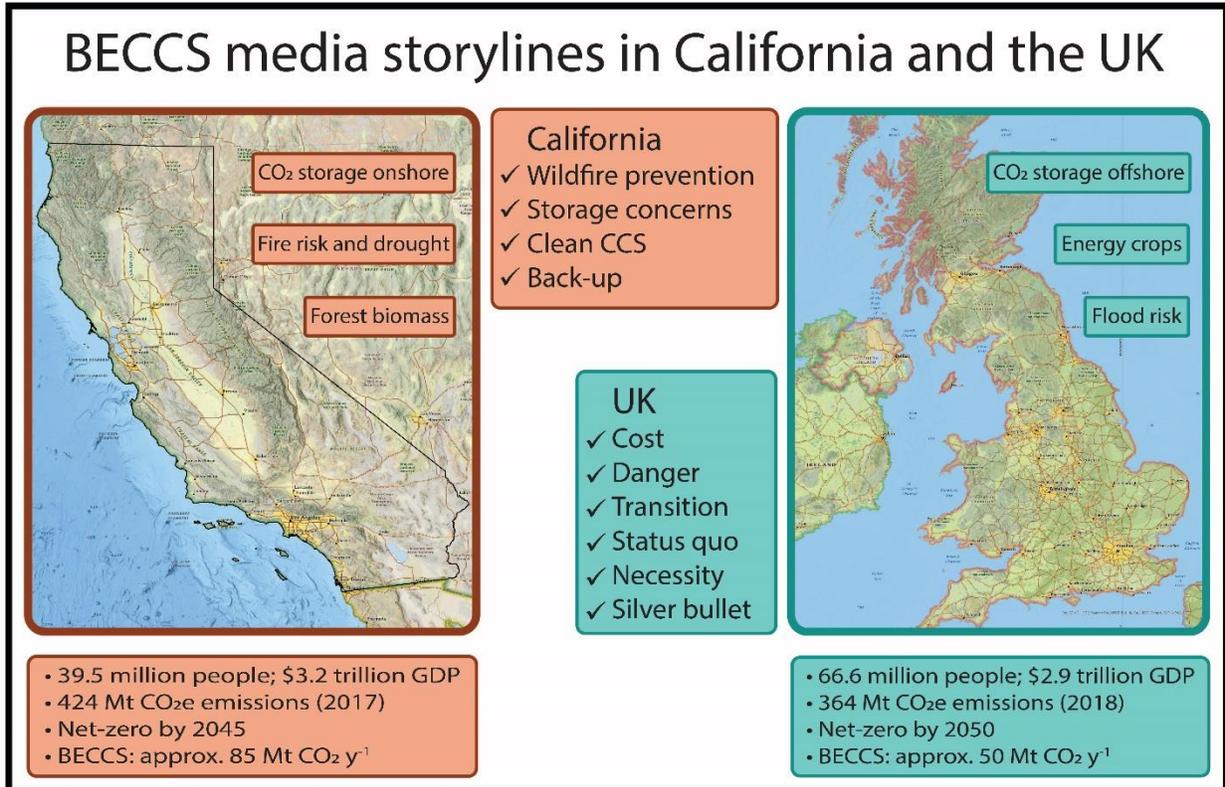


Figure 2. Ticked boxes represent the storylines identified in the newspaper articles of the top circulating newspapers in California and the UK. Data on population size, recent carbon dioxide emissions, net-zero targets, and potential ambitions for mid-century BECCS deployment (taken from Baker *et al.* [40] and CCC [6]) are also summarized. The UK and California represent two geographical locations with similar socio-economic contexts, net-zero ambitions, and public consumption of the news media, but with distinctly different geographies and energy systems.

4. Discussion

Our slender newspaper results stand in stark contrast to the extensive recent deliberations on BECCS in research and policy circles, including the recent policy proposals to deploy BECCS to achieve the UK net-zero target, raising concern that the BECCS policy debate may be accelerating away from public understanding or acceptance. The number of newspaper articles that we found was also notably smaller than the numbers of newspaper articles reviewed in previous news media analyses on energy storage, offshore wind energy, fracking, CCS, and bioenergy [25,27,29,30,41]. This gap between the public and policy debate on BECCS is important: a SLO takes time to form and requires continued active public engagement whilst attempting to rush this process to deliver BECCS carries risks. There is therefore a key role for the media in facilitating the public debate on BECCS.

A greater number of newspaper articles and storylines identified in the UK may indicate that the public debate is more developed than in California. However, it may be that BECCS is currently more discussed in national newspapers than regional newspapers, a trend likely to change once specific BECCS projects are proposed. The storylines of BECCS contrasted between the UK and California, with newspapers using different language to frame the debate in each location (Figure 2). Some of these differences between the UK and California may be the result of differences in journalistic culture (Table S1); in the UK, the center-left Guardian newspaper was particularly vocal of the ‘danger’ storyline. However, whilst it seems clear that journalistic culture and newspaper political leanings did shape the narratives and language around BECCS, all the storylines we identified were found across multiple newspapers.

Location-specific factors had some influence on how BECCS was framed differently in the news media, with the positive storyline of the role of BECCS in wildfire prevention as well as the storyline of the concerns over CO₂ storage unique to the Californian newspapers. Communities across California, and particularly those in the heavily forested Sierra Nevada, could benefit from a BECCS sector which reduces forest fuel-load by utilizing forest biomass, reducing fire risk [40] and dangerous air pollution, and this was reflected by the dominance of the wildfire prevention storyline (Figure 1). Recent wildfire events in California have resulted in tragic loss of life as well as billions of dollars in damage [42] and this storyline is therefore expected to be highly salient to forming a SLO for BECCS in California. The uniqueness of the CO₂ storage concern storyline to California is perhaps unsurprising: CCS technology has lower public support in the US, where storage would be onshore, than in the UK, where storage would be offshore [16]. Under a Californian BECCS scenario CO₂ will likely be stored terrestrially in the Central Valley [40] and it will be important to understand the local socio-economic factors which will shape attitudes towards BECCS in this region; the Central Valley has a history of oil and gas extraction and BECCS might be received positively for its perceived support to jobs and industry: high support has been identified for CCS in the industrial Teesside region of England, where it is perceived to support local industry [17]. In fact previous research has found a positive employment impact of BECCS, particularly to regions of traditional industry [14,43].

Surprisingly, however, the news media articles we reviewed did not present a positive BECCS storyline of jobs and industrial support, in either California or the UK. Whilst outside the scope of our formal analysis, we did find evidence of a jobs-focused storyline in the Yorkshire Post, a regional newspaper local to Drax, the power station which converted from coal to biomass

combustion and is now the first UK company to pursue BECCS. In an opinion piece written for the Yorkshire Post, Drax CEO Will Gardiner cites the positive regional impact of Drax's decarbonization from coal to biomass, hailing it a "just transition" as jobs were protected in Northern England, and the regional economy boosted, alongside emission reductions [44]. He identifies BECCS as the 'anchor' which would facilitate the continuation of this story of prosperity for the region.

Environmental concerns of BECCS featured in the newspaper articles we reviewed, particularly in the UK. This is important for the public debate and potential SLO for BECCS: environmental impact is heavily weighted in public perception studies [8], sustainability concerns of biomass have been controversial in recent years, and BECCS has increasingly been labelled as ecologically 'devastating' because of its potential environmental impact [45–47]. There will be sizeable environmental impacts of BECCS, driven by location [3,12]. However, environmental newspapers were generic and not tailored to specific locations or regions. We identify this as an important gap in the news media debate on BECCS; location-specific environmental and socio-economic factors will be critical to any successful SLO: they represent the costs and benefits experienced by the community where the technology is deployed which is crucial in determining local support or opposition [19,24,33].

Whilst currently lacking from the newspaper media, it is unclear how greater discussion of the location-specific environmental impacts of BECCS will shape public attitudes; the wildfire prevention storyline identified could become a dominant narrative to legitimize BECCS in

California, and there are several other location-specific environmental impacts of BECCS which could support a SLO. Biomass removal in Californian forests is expected to indirectly increase water availability [48] which will become increasingly important as the state experiences drier and longer fire seasons [49]. The absence of this impact from the Californian newspapers perhaps reflects an inability to explain a complex and indirect phenomenon in relatively short newspaper articles. However, it could become an important frame to justify BECCS to the public in drought-stricken California, given the likely controversy of additional water withdrawals required by BECCS power stations. In contrast to California, a UK BECCS strategy cannot rely on forest biomass resources and will necessitate either the conversion of marginal and agricultural land to dedicated bioenergy crops or the import of significant biomass resources [50]. UK land-use change to bioenergy crops could reduce the severity of flooding events, particularly if bioenergy crops are sited on the east coast of England where costly flooding incidents may be mitigated [3,51]. A flood mitigation storyline could be an important element of the public debate on BECCS if a SLO is to be achieved, particularly in the flood prone communities. Measuring and communicating these environmental and social impacts of BECCS is likely to become increasingly important for building a SLO, with climate change driving increased drought conditions and wildfires in California [49,52], and flooding events in the UK [53,54].

The limited evidence of location-specific factors of employment and environmental impact in our results reflects the immaturity of the present public debate of BECCS. There also appears a lack of resonance of sub-national issues in the national newspapers, supported by our findings from the local newspaper the Yorkshire Post and a previous newspaper analysis which found

notably greater coverage of CCS and bioenergy issues in local newspapers compared to national newspapers [34]. This likely reflects the fact that regional newspapers are in closer proximity to potential locations for - and local opposition to - energy infrastructure [34]. Until BECCS projects are proposed in specific locations the technology is unlikely to feature in local newspapers. This may happen soon and it will be important for researchers to facilitate public debate by providing information on the location-based BECCS impacts, an under-developed research area at present [3]. Policymaking developments are needed too: a recent biomass consultation in the UK featured mostly techno-economic questions with more limited coverage of socio-economic factors and no mention of SLO [55].

Whilst our reliance on national newspapers is currently justified by the lack of specific BECCS projects - with the exception of Drax and the Yorkshire Post - as projects are proposed it will be important to analyze how BECCS is portrayed in local newspapers. Indeed, repeating our analysis after specific BECCS projects have been proposed, incorporating both national newspapers and newspapers local to BECCS projects, could further elucidate the public debate and progression of SLO for BECCS. Our analysis only explored one area of the public debate on BECCS and a comprehensive media analysis of BECCS requires analysis other media sources including magazines, radio, television, and social media. Whilst we did conduct targeted searches on the social media platform Twitter, finding very limited results, the role of social media is likely to become an increasingly important part of the public debate on energy technology.

5. Conclusion

BECCS will need to be deployed very soon if it is to support net-zero targets by 2050; there is only one shot at getting BECCS deployment right and failure to achieve a SLO risks the technology being rejected by the public, as has happened with the development of genetically modified food crops, fracking, and onshore wind energy [23,56–59]. A crucial step in moving towards a SLO is to identify locations where the technology is expected to be most acceptable - where co-benefits to the local economy and environment can be delivered, and negative impacts minimized - and to communicate these details to local communities and tailor incentives appropriately. Engagement with the public and local communities is crucial and there are key roles for policy makers, researchers, industry, and the media in this process. If BECCS fails to achieve a SLO then net-zero targets will need to be met from the fast-diminishing list of alternative policy options.

Data and materials availability

The Nexis database was used to collect data for our analysis, with a full methodology provided in the supplementary materials. The complete data set can be provided upon request.

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Authors contributions

KT led data analysis and CD led manuscript writing. GT and CD conceived the project and all authors contributed to writing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Figures

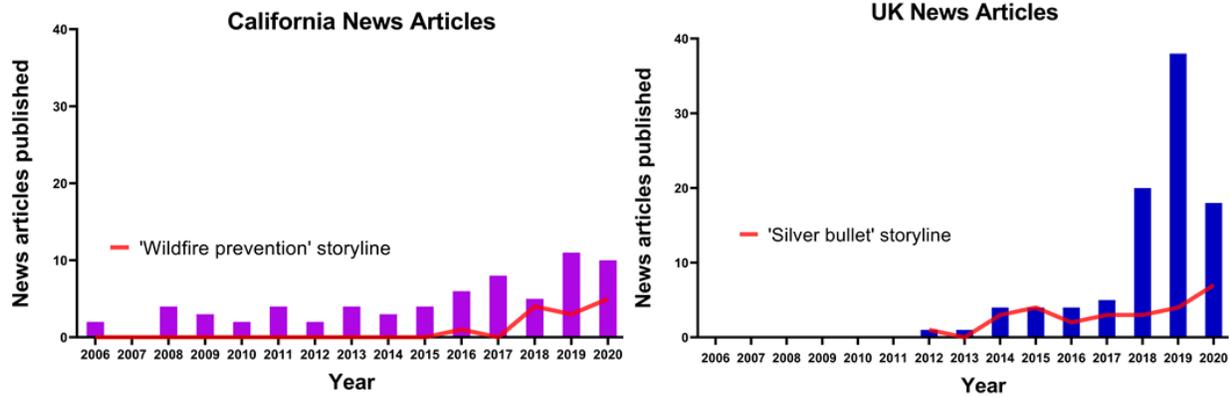


Figure 1

The number of newspaper articles published in each year of our period of analysis for California (left-hand pane) and the UK (right-hand pane). Note: the first Californian and UK newspaper articles were published in 2006 and 2012, respectively. The red line shows how many of these newspaper articles in each year featured the most prominent (frequently occurring) Californian storyline ('Wildfire prevention') and UK storyline ('Silver bullet') during this time period. Note: no storylines was identified in 19 Californian/US and 8 UK newspaper articles.

BECCS media storylines in California and the UK

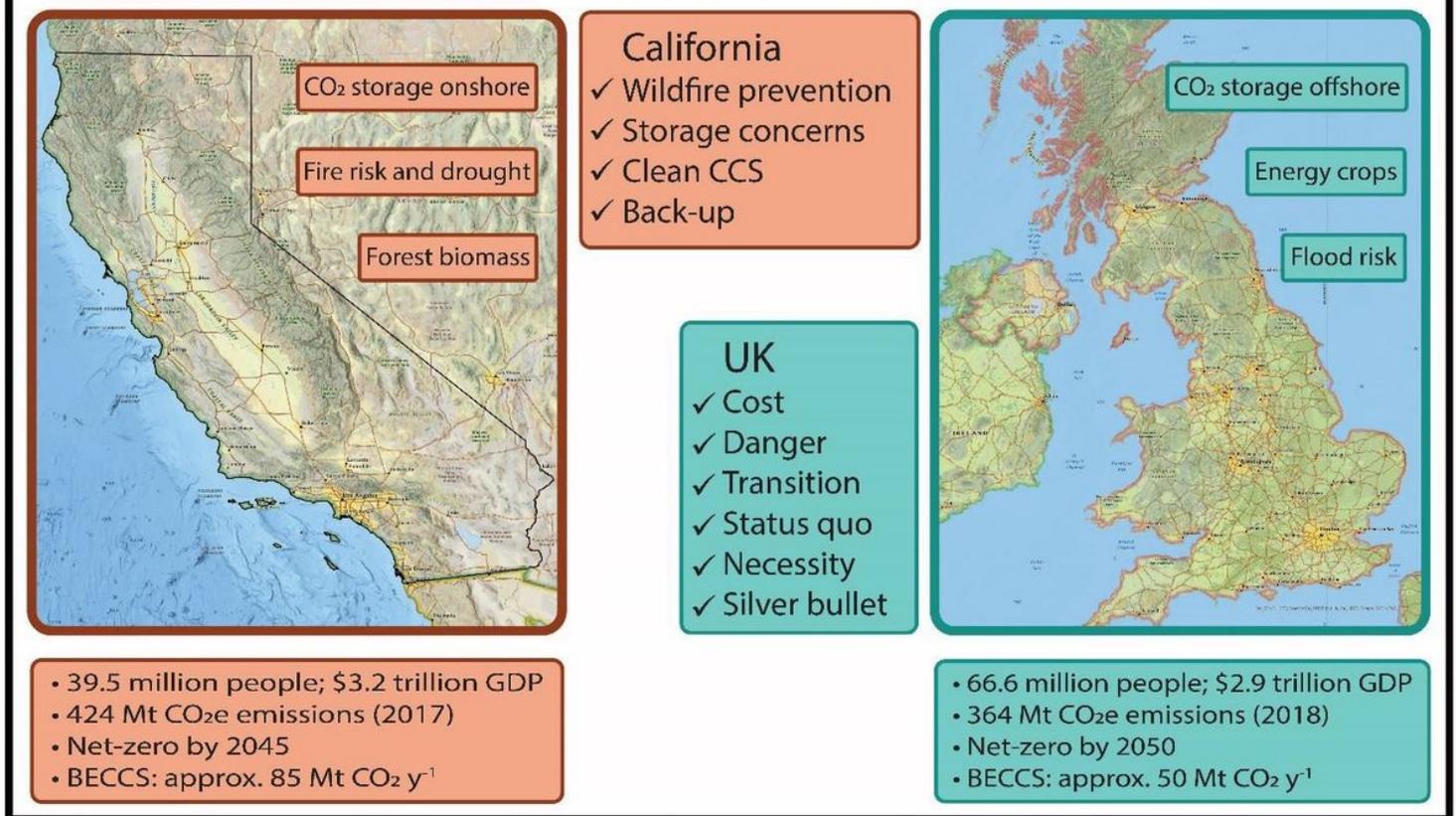


Figure 2

Ticked boxes represent the storylines identified in the newspaper articles of the top circulating newspapers in California and the UK. Data on population size, recent carbon dioxide emissions, net-zero targets, and potential ambitions for mid-century BECCS deployment (taken from Baker et al. [40] and CCC [6]) are also summarized. The UK and California represent two geographical locations with similar socio-economic contexts, net-zero ambitions, and public consumption of the news media, but with distinctly different geographies and energy systems

Supplementary Files

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