

Without SLO BECCS, fast net-zero looks unlikely

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12
13 **Abstract:** Given the importance of Bioenergy with Carbon Capture and Storage (BECCS) in
14 net-zero scenarios, it is crucial that policymakers understand how BECCS can achieve a Social
15 License to Operate (SLO). BECCS discussions have been dominated by global scale assessments
16 with very limited exploration of how and where the technology could be deployed at national
17 and local scales. Failure to address key aspects of BECCS deployment may lead to public
18 rejection, as has happened with previous technologies such as GM crops and onshore wind
19 energy. This has major implications for the delivery of net-zero emissions: time is very short for
20 policy makers to find alternative strategies to meet carbon budgets. We present the first media
21 analysis of its kind to consider BECCS, using two geographical locations - the UK and
22 California - to analyze the ‘storylines’ which frame the public discussion of BECCS. The results
23 highlight that successful policymaking will require engagement with local communities and
24 identification of relevant location-specific factors that determine the social and environmental
25 impact of BECCS.

26 **Main Text:** BECCS is included in the majority of Intergovernmental Panel on Climate Change
27 (IPCC) scenarios consistent with the Paris Agreement targets, with median BECCS deployment
28 of somewhere between 3 Gt CO₂ and 7 Gt CO₂ needed per year by 2050 to achieve a 2 °C and
29 1.5 °C warming limit respectively¹. To put this in context, it has been estimated that this
30 magnitude of CO₂ recovery would require in the region of 380-700 million hectares of land
31 globally to be dedicated to the supply of biomass², and an estimated 1,000-2,333 BECCS power
32 stations sized at 500 MW each (using calculations from Donnison et al.³). However, few
33 commercial operations exist globally and policy discussions are taking place whilst key
34 questions remain unanswered, including those relating to costs, environmental impacts, and
35 scalability⁴. There is early evidence of friction between policymakers' ambitions for the
36 technology and the public response: for example, the UK government's plan to achieve a net-
37 zero economy relies heavily upon the use of BECCS⁵, whilst the recent UK Climate Assembly
38 found limited support for the technology's role in meeting the net-zero target⁶. Public awareness
39 is also limited: just 5.7 % of people in the UK and 9.6 % in the US are familiar with Negative
40 Emission Technologies (NETs) including BECCS⁷. In addition, knowledge gaps of BECCS are
41 present at sub-global scales, where political decision-making and public attitudes may determine
42 whether BECCS is ever successful. Recent BECCS research has started to address gaps at the
43 regional and national scales, identifying location-specific environmental and social trade-offs
44 and opportunities of BECCS deployment^{3,8}. At the landscape and community scale, empirical
45 research on BECCS is lacking, although this is where social challenges may arise which are not
46 evident at the global-scale analysis, and where public engagement may be crucial in achieving
47 social legitimacy of BECCS^{9,10}.

48 Whilst public acceptance research of energy technologies is useful it is contingent on location,
49 scale, and timing of a project and a more holistic approach is called for in determining the social
50 impacts and responses to BECCS¹¹. A media analysis of BECCS is one means towards a deeper
51 understanding of the technology's emerging social impact. Until recently media discussion of
52 BECCS has been sparse, mainly driven by the commentaries of scientists and technical
53 specialists who highlight the risks of supporting a technology which has not been proven to work
54 at scale and whose consequences are still relatively unknown¹². A previous newspaper media
55 analysis of CCS and bioenergy technologies in four US states found very little discussion of the
56 two technologies combined - BECCS - with limited evidence suggesting positive public
57 perception of the technology for its role in combating climate change¹³. That study is now
58 somewhat dated, given the recent increase in public profile of BECCS in several regions of the
59 world. We use a comparative newspaper review to explore the most up-to-date portrayal of
60 BECCS across two geographical contexts currently considering the technology: the UK and
61 California. We examine the role that public engagement and provision of location-specific
62 information on the impacts of BECCS deployment have in shaping the portrayal of the
63 technology and in determining whether a 'social license to operate' (SLO) can be achieved.

64 **Social License to Operate (SLO)**

65 The term 'social license to operate' (SLO) refers to the ongoing community and stakeholder
66 support of an activity or technology, first emerging as a concept in the fossil fuel industry where
67 companies sought community and societal acceptance on the necessity of resource extraction¹⁴.
68 To establish SLO for energy projects requires: i. addressing the specific context; ii. building
69 relationships; iii. communicating with local people the benefits and impacts of the project; iv.
70 understanding sustainability as a dominant concern within communities; and v. an adaptable

71 approach when engaging with the community¹⁴. Recent energy technologies have both
72 succeeded and failed to achieve a SLO based on these principles: in Poland, stakeholders and
73 local politicians were fully engaged in the process of a successfully introduced fracking industry,
74 whereas a top-down approach in Belarus led to public backlash¹⁵. Geographical location is
75 important to SLO: *“Local context is key. The legitimacy of a project hinges on whether people*
76 *think a project will create more benefits than problems. And people’s perceptions emerge from a*
77 *combination of local economics, demographics and social values”*¹⁶. A recent study of
78 renewable energy expansion in the Imperial Valley of California found that local opposition was
79 not to technologies per se but the ‘place-blind ways’ in which they are sometimes deployed:
80 failing to engage the local community in projects which deliver benefits elsewhere, whilst
81 leading to costs locally, leads to resistance⁹. Dissemination of key information is also crucial to
82 SLO: in Sweden, the removal of forest stumps causes scarring of the forest floor but the practice
83 has gained social acceptance as a result of being framed as a necessary response to climate
84 change by maximizing biomass yield for renewable energy purposes, as well as being perceived
85 to offer economic benefits¹⁷.

86 **Public Image of BECCS**

87 BECCS has raised a range of concerns including land-use demand, public cost, environmental
88 impacts, and safety of carbon storage^{18,6}. Environmental and social impacts of BECCS will be
89 site-specific and also determined by the size of the power station³. Most research on public
90 attitudes to BECCS has focused on the UK^{7,18} and other geographical contexts need to be
91 explored to understand public perceptions for each location¹⁸. Public perception on BECCS has
92 changed as new information has emerged, with a ‘reluctant acceptance’ of BECCS found in one
93 survey once participants learnt that reliance upon intermittent wind and solar energy could

94 impact their lifestyle¹⁹. This reluctant acceptance could prove an important factor in shaping a
95 SLO for BECCS given the increasing likelihood that the technology will become necessary, as
96 palatable alternative options diminish.

97 **Newspaper Analysis: Storylines of BECCS**

98 A SLO would be expected to reflect a dominant or unifying storyline of why the technology is
99 necessary²⁰. We sought to determine the status of BECCS storylines by completing a
100 comparative newspaper analysis of the technology, using Hajer's discourse analysis to identify
101 'storylines': a "*generative sort of narrative that allows actors to draw upon various discursive*
102 *categories to give meaning to specific physical or social phenomena*"²⁰. By comparing
103 storylines across two geographical contexts, we could determine whether and how national and
104 regional context shaped storylines and the SLO. We chose California and the UK because these
105 are the only two locations where in addition to a commitment to net-zero a public debate on
106 BECCS is frequently present in newspapers: the medium we chose to analyse.

107 Using Nexis, a database that includes national, regional and local newspaper sources, we
108 identified the top circulating newspapers in the UK and California, searching for keywords
109 relating to BECCS (See supplementary materials for methodology). We identified distinct
110 BECCS storylines within each set of results based on Hajer's guidelines to look for often
111 repeated figures of speech²⁰, noting the occurrence of a 'ritual' character, for example referring
112 to BECCS as a 'silver bullet'.

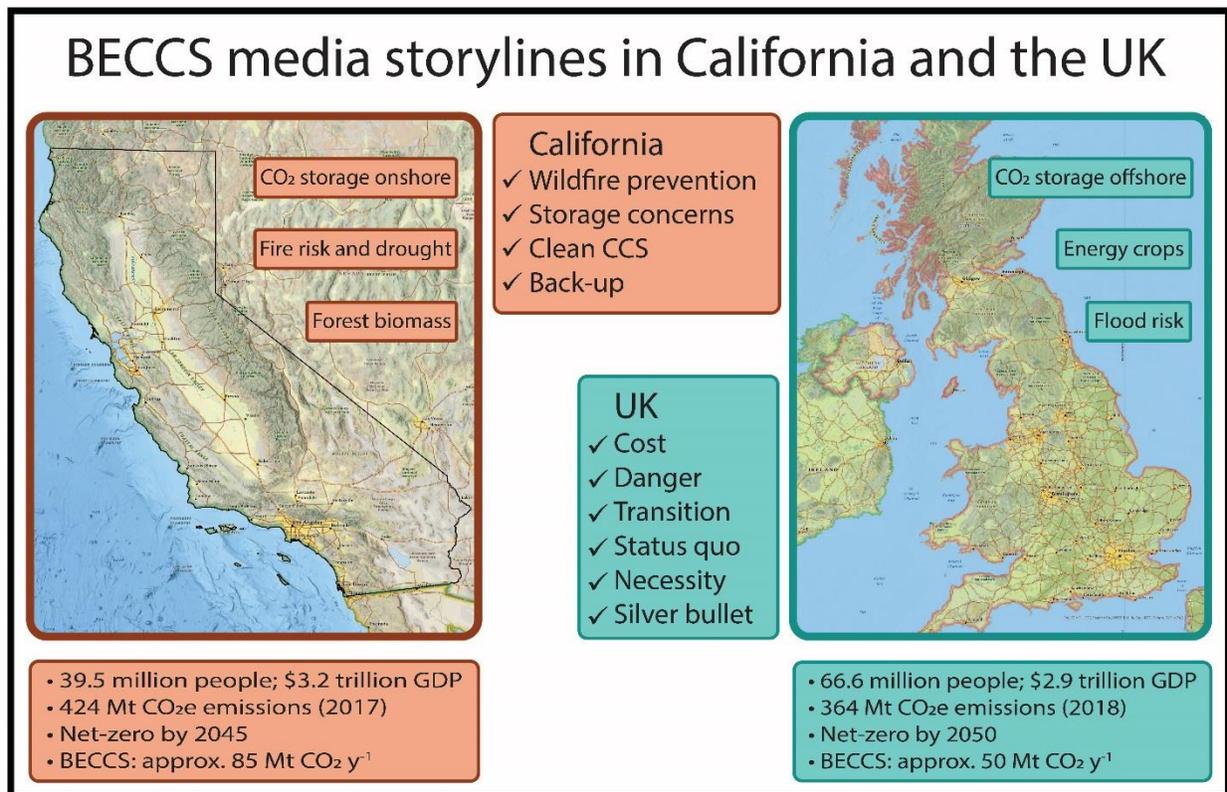
113 **BECCS Storylines in the UK and California**

114 Six BECCS storylines were identified in the UK (Fig. 1). The first emphasised 'cost'. In some
115 newspapers, cost referred to the monetary cost of using CCS technology whilst elsewhere cost

116 referred to the cost of climate change, which was believed to be much greater than the monetary
117 cost of using BECCS technology to limit warming. The second storyline identified was the
118 ‘danger’ that BECCS presents, featuring the phrase ‘moral hazard’: the risk that BECCS reduces
119 incentives for immediate mitigation, increasing the risk of future dangerous temperature
120 increases. The third concerned the ‘transition’ that BECCS represents. Transition was mentioned
121 in the context of BECCS being a temporary bridge between fossil fuels and renewable energy, as
122 opposed to the permanent future use of BECCS. Fourth was the storyline of BECCS representing
123 a continuation of the ‘status quo’: the preservation of existing consumption habits and energy
124 demand, a feature which is criticised by some groups and seen as a strength by others. This
125 storyline included the critique that BECCS is supported because it is ‘not disruptive’ to the
126 current socio-economic system as opposed to the radical change that some see as necessary to
127 achieve emissions reduction targets, reflecting a post-normal critique based more on values than
128 facts¹². The fifth storyline described BECCS as a ‘necessity’ for meeting climate targets,
129 featuring phrases such as ‘only solution’ or ‘only chance’. The sixth BECCS storyline described
130 the technology as a ‘silver bullet’ and ‘too good to be true’, rejecting the deliverability of
131 BECCS on the huge scale that is proposed in IPCC models.

132 Four storylines were identified in the Californian newspapers. The most prominent linked
133 BECCS to ‘wildfire prevention’. Newspaper articles cited the benefit of using forest biomass
134 from the Sierra Nevada to meet the high feedstock demand of BECCS, helping achieve state
135 ambitions to increase forest management, including removal of biomass to reduce wildfire risk.
136 The second storyline related to CO₂ storage and land management, with ‘storage concern’ for
137 terrestrial sequestration in California. It is important to note that in California, CO₂ is expected to
138 be stored onshore under land whereas in the UK it is expected to be stored offshore under the

139 North Sea. The third storyline concerned CCS and the ability of CCS to remove emissions. The
 140 ‘cleaning’ function of CCS was mentioned in combination with coal-fired power stations, with
 141 the phrases ‘clean-coal’ and ‘CO₂ scrubbing’ both used. The fourth storyline identified concerned
 142 BECCS ‘making up’ the projected emission mitigation shortfall, as well as being used to ‘undo
 143 damage’ from historical emissions. This storyline describes BECCS as a safety or ‘back-up’
 144 option, as opposed to a necessary aspect of achieving net-zero targets, representing an example
 145 of a reluctant acceptance.



146

147 **Fig. 1.** The UK and California represent two geographical locations with similar socio-economic
 148 contexts and net-zero ambitions but different geographies, which partly shape the different
 149 BECCS storylines that have developed in the newspapers of each political context, such as

150 relating to CO₂ storage concerns and wildfire mitigation in California. Ticked boxes represent
151 the storyline identified in the two geographies whilst data on population size, recent emissions,
152 policy on net-zero and ambition for BECCS are also summarized.

153 **Location is key in achieving social license to operate (SLO) BECCS**

154 Location-specific factors at the national and sub-national scale-shaped several of the BECCS
155 storylines in California, including the most prevalent one which emphasized the positive role
156 BECCS could take in wildfire mitigation, and also the concerns over terrestrial CO₂ storage.
157 Communities across California, and particularly those in the heavily forested Sierra Nevada,
158 could benefit from a BECCS sector which utilizes forest biomass, reducing potential fuel-load
159 and fire risk²¹ and this was reflected in our results. However, all other storylines, including all
160 those in the UK, were generic and did not appear shaped by location-specific factors. This is
161 somewhat surprising given the importance that location has in determining BECCS impacts^{3,8}
162 and considering the community-level opposition which can arise in response to energy
163 infrastructure developments⁹. Our findings also appears at odds with the importance of local
164 context, concerns of sustainability, and communicating impacts to local communities, in
165 achieving a SLO^{16,20}. The consequence of these three factors to the public debate and social
166 legitimacy of BECCS was reinforced by the findings of a recent public attitude survey⁷.

167 Location-specific storylines may be limited in our results as a result of the immaturity of the
168 present public debate of BECCS, as well as a lack of resonance of sub-national issues in the
169 national newspapers that were analyzed. This latter point is supported by a previous newspaper
170 analysis which found notably greater coverage of CCS and bioenergy issues in local newspapers
171 compared to national newspapers, likely reflecting the fact that regional newspapers are in closer

172 proximity to potential locations for - and local opposition to - energy infrastructure¹³. Whilst the
173 potential impact of BECCS on wildfires received newspaper attention, two other location-
174 specific impacts of BECCS did not appear in our results: water availability and flooding
175 mitigation. Biomass removal in Californian forests is expected to indirectly increase water
176 availability²² which will become increasingly important as the state experiences drier and longer
177 fire seasons²³. The absence of this impact from the Californian newspapers perhaps reflects an
178 inability to explain a complex and indirect phenomenon in relatively short newspaper articles. In
179 the UK, a BECCS strategy cannot not rely on forest biomass resources as in California and could
180 require converting marginal and agricultural land to dedicated bioenergy crops. This land-use
181 change is likely to reduce the severity of flooding events, particularly if bioenergy crops are sited
182 on the east coast of England where costly flooding incidents could be mitigated^{3,24}. However,
183 flood mitigation did not feature in the UK storylines.

184 As well as the possible tendency of national newspapers to give less attention to issues
185 surrounding BECCS, the absence of location-specific environmental and social impacts and
186 trade-offs of BECCS in our results likely also reflects inadequate research in this area³,
187 preventing communication of these factors with the media and local communities. Measuring
188 and communicating these environmental and social impacts of BECCS is likely to become
189 increasingly important for building a SLO, with climate change driving increased drought
190 conditions and wildfires in California^{23,25}, and flooding risks expected to increase in the UK^{26,27}.
191 Another important development is the emergence of a further storyline of BECCS labelling the
192 technology ecologically ‘devastating’ because of its high land-use impact²⁸. Although not
193 identified in our analysis, this emerging storyline could prove influential in public debate, raising
194 the importance of quantifying and communicating environmental impacts of BECCS.

195 A unifying storyline for SLO

196 As nations commit to net-zero targets but continue to fall short of necessary deep emission cuts a
197 ‘reluctant acceptance’ storyline could form because BECCS is perceived as unavoidable, even if
198 undesirable. Alternatively, BECCS could be successfully framed as a just means for developed
199 countries to clean up the pollution that they are responsible for, by returning their emissions to
200 the ground⁴. Our analysis shows that a crucial step in moving towards a SLO is to identify
201 locations where the technology is expected to be most acceptable - where co-benefits can be
202 delivered, and negative impacts minimized - and to communicate these details to local
203 communities. We have not yet reached the point at which location-specific impacts can be
204 quantified, and this level of detail has therefore not been provided to the public in recent surveys
205 of attitudes towards BECCS⁷. To gain SLO for BECCS requires more than seeking public
206 acceptance: a more holistic approach creating an opportunity for a broader dialogue around the
207 technology based on local, situated knowledge and expertise is required. The UK Climate
208 Assembly⁶ represented the kind of public engagement and involvement that will help determine
209 the social legitimacy of different policy solutions, including BECCS. It will be important to
210 understand perceptions of BECCS in other regions internationally too, although a lack of public
211 discussion may prevent similar analysis at present.

212 BECCS will need to be deployed very soon if it is to support net-zero targets by 2050 and earlier.
213 The race to achieve a SLO is therefore pressing and failure to engage the public early enough
214 risks a backlash and loss of trust, as illustrated by experience from other technologies which
215 were ultimately rejected by the public, for example, the development of genetically modified crops
216 for food production and onshore wind energy in the UK²⁹⁻³². Social barriers to negative emission
217 technologies are considered significant and a broader alliance is called on to achieve success in

218 delivering these technologies to reach net-zero³³. Researchers and policymakers can facilitate
219 this by providing location-specific impacts of BECCS deployment and ensuring that these details
220 enter the public debate, without delay. Locations identified as able to support co-benefits from
221 BECCS should be targeted as the most likely to achieve a SLO in the short time frame
222 remaining. If BECCS fails to achieve a SLO then net-zero targets will need to be met from the
223 fast-diminishing list of alternative policy options.

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298

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305 **Authors contributions:**

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

308 **Data and materials availability:**

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

Figures

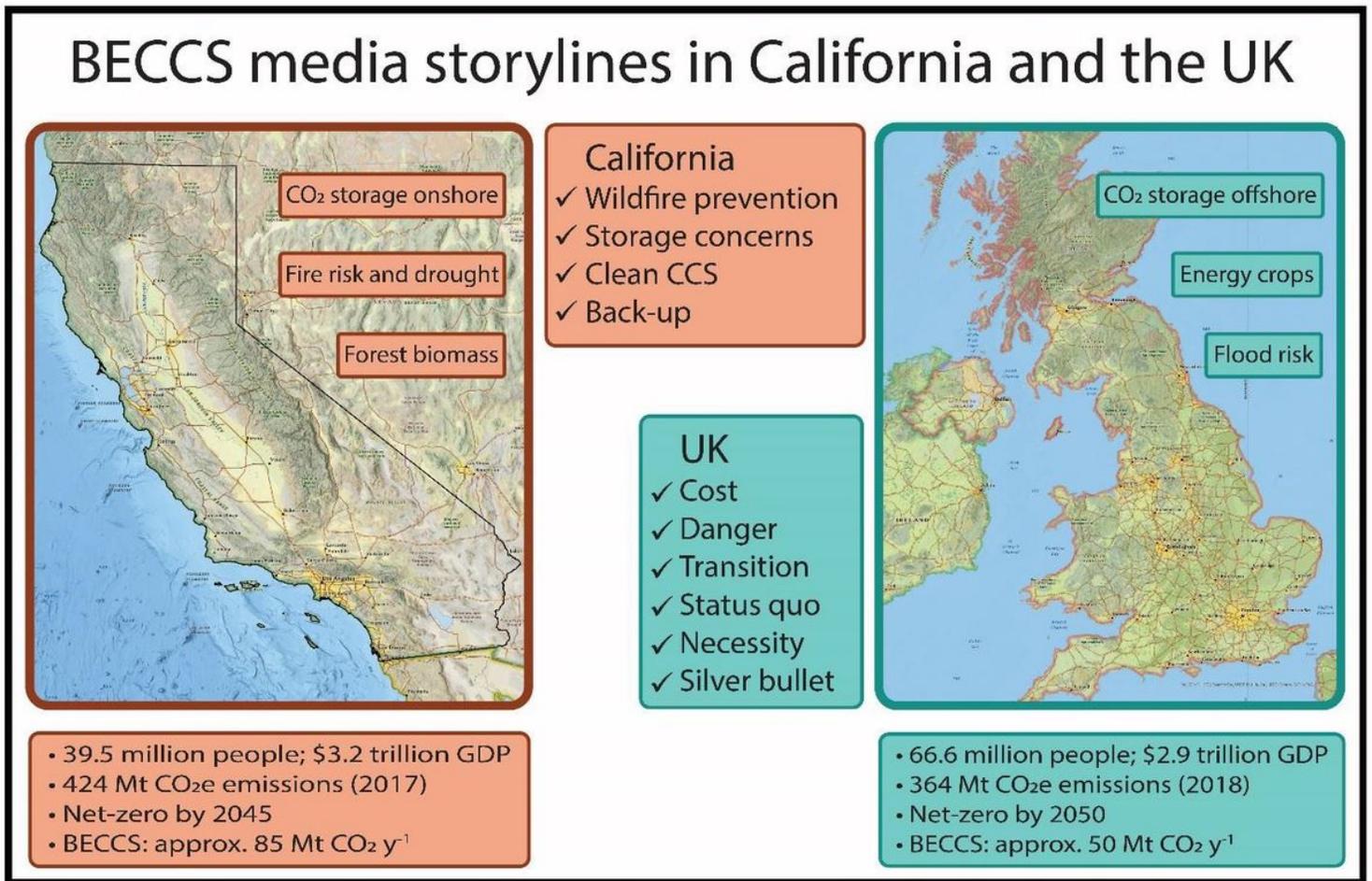


Figure 1

The UK and California represent two geographical locations with similar socio-economic contexts and net-zero ambitions but different geographies, which partly shape the different BECCS storylines that have developed in the newspapers of each political context, such as relating to CO₂ storage concerns and wildfire mitigation in California. Ticked boxes represent the storyline identified in the two geographies whilst data on population size, recent emissions, policy on net-zero and ambition for BECCS are also summarized.

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