UK farmers perceptions of Agrivoltaics.

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Abstract

Agrivoltaics (A.V) is thought to help work towards the global sustainable transition, as we endeavour to produce more 'green' electricity. A.V combines farming, 'agri', and solar photovoltaics, 'voltaics', in attempt to provide a land-use and resource efficient solution to meet both food demands and climate incentives. There has been many studies looking at the efficacy of A.V on farmland and how it benefits farmers through increased crop growth and income diversification. Yet, there hasn't been much consideration in literature to the fact that it may not be an upscaled solution in the UK, due to different place-based contexts such as climatic conditions and land quality grading. As a result, farmers are rightfully pragmatic, questioning its place in their farming business model. So, my research focuses on the agency of farmers, as a way to empower their decision-making in deciding to adopt new technologies. The research method comprises of interviewing UK farmers and land developers with various levels of A.V knowledge, as they are at the centre of decision-making in employing A.V on their land. The interviews allow for a discussion in terms of how they come to understand A. V's role in the UK, and their personal values, which are important to consider as they inform their decisions in accepting or rejecting A.V on an individual level. The major findings in this study show that we should not assume universal acceptance of such technologies. The rejection of such technology should not lead to farmer's being perceived as traditional, rather, we should endeavour to focus on how technologies come to be understood and accepted, and empower the farmer's decision making, rather than focusing on how A.V acts in a defined set of circumstances or contexts, as A.V literature often has referred to.

Contents

1. Key terms

Understanding - How technology and social organization are related, and how a given technology can be conceptualised and reimagined (Spijkerboer et al., 2022).

Identity - Identity shapes how technology is socially constructed and reimagined (Ulucanlar et al., 2013).

Acceptance - How likely a person or group is to accept a given technology (Taherdoost, 2018).

Political Ecologies – Social power relations and interactions with the land can shape each other, and outcomes of sustainable technology adoption (Roberts, 2020).

Instrumentalist – Views technology as inherently neutral and a solution to human's social and economic needs and desires (Fernandez, 2021).

Constructivist – Brings agency to the person choosing the technology and sketches the social construction of technology (Pinch and Bijker, 1984).

2. The list of tables and figures

3. Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where states otherwise by reference or acknowledgment, the work presented is entirely my own.

4. Introduction

Climate change as a result of industrialisation has been a major cornerstone in policymaking as we see increased issues arising every day from the present and predicted future impacts of a changing climate. To help combat this, there is a need to move from traditional fossil fuels such as oil and gas, to renewable sources to create a cleaner, greener, energy mix. The Climate Change Committee (CCC) provides a critical assessment of the transition the UK should take, including corporate behaviour change to ensure the UK meets its targets, signalling for low carbon investment, increase engagement and support for net-zero transition plans, and incentivizing companies when they reach target reductions (McCullough et al., 2022). So, the UK has set net zero 2050 targets, which incentivises clean energy production across the country (Burnett, Edwards and Watson, 2023). Traditionally, farming has been a driver of intensification and mechanisation of the land, leading to climate change impacts. Even still, a majority of farming activities are powered using fossil fuels, and being an intensive user of land, water and electricity resources, there is a focus on making this sector more sustainable. So, the CCC has again published a report on the land use policies for net zero in the UK, providing a list of potential drivers to reduce emissions. These include increased tree planting, encourage low carbon farming practices e.g., increased livestock health, and controlled fertilisers, restore peatlands, encourage bioenergy crops and reduce food waste and carbon intensive foods (Committee on Climate Change, 2020). Therefore, farming plays a key role in meeting net zero targets, and allows for resilient crop production, energy efficiency, and decreased reliance on traditional methods of energy.

Solar P.V energy has been a focus as the UKs energy transitions, with it being a reliable energy source and proved to be a feasible option in the UK. Solar power is well established and contributes 4.9% to the UK's energy mix (National Grid, 2023). Solar P.V uses semiconductors

to convert sunlight into electricity, and the most conventional form of P.V is ground-mount solar. Yet, new developments have emerged from P.V, with installation types such as floating solar (National Grid, 2023a). To combine this with existing agricultural activities, agrivoltaics (AV), can contribute to such a transition through being a new alternative and sustainable technology (Torma and Aschemann-Witzel, 2023). AV is the combination of solar and crop cultivation, e.g., through crops growing under raised solar panels (Hall, 2022). It holds many promises towards reaching these net-zero targets, and 'undoing' the impacts of previous farming techniques, through combining farming and electricity production. It reaps the benefits of multifunctional land use, where we must endeavour to feed the growing population whilst meeting the aforementioned targets (Gorjian et al., 2022).

To answer the title question, I want to explore A. V's application as an artefact, a material product that exists outside of social relations and exists in some form of protected space (Pinch and Bijker 1984). There is a lot of academic literature on how A.V is used as an artefact, through its multi-functional land use aspect, and how it works in very specific contexts, like in the USA, Netherlands and Denmark (Torma and Aschemann-Witzel, 2023). Throughout this thesis, this perspective of viewing A.V as an artefact, which exists outside of social relations, will be referred to as the **instrumentalist** take. The **instrumentalist** view represents the existing literature that narrowly explores A.V as something that should be upscaled, and in a way decentres the views of the farmers. We have yet to see how this technology could be adopted to the UK, and if it even *should* be used here. To justify whether it should be used in the UK, I will use a **sociological approach** to researching A.V, to analyse how such technologies come to be understood and therefore possibly adopted. This means to go beyond everyday understanding of particular situations, but venture into the experiences of farmers in a broader social context, with respect to the nuances of their livelihoods. This forms the justification of the route political ecologies**. Political ecology** aims to navigate the relations and injustices between nature (land use), society (farmers), and access to resources (capital), which shapes ecological change and

new environmental technology adoption (Roberts, 2020). Thus, the focus of this paper is to convey the under-explored aspects of the **critical, sociological approach to A.V.**

The idea of the technology itself has been around since 1980s, with Armin Zastrow and Adolf Goetzberger first proposing A.V as a way to maximise the utilization of the land (Goetzberger and Zastrow, 1982). Essentially, it isn't that novel of a technology, yet has only recently gotten traction in literature, in the past 5 years or so. As seen in Torma and Aschemann-Witzel's (2023) work, there are different A.V system designs, be it vertical (crops growing on either side of the panels), horizontal (crops growing underneath solar panels), and as cover installations for animal husbandry, or on top of greenhouses. Toledo and Scognamiglio (2021) state that through a variety of applications, there can be optimal designs of the installation depending on the place's climate, plant needs, farm workflow and general acceptance of the design. There is a possibility that agrivoltaics may be able to be used on degraded land, solving many issues surrounding land grade quality. An example from an A.V project in Jiangshan states that using A.V on degraded land can maximise land-use efficiency, as to aid ecological restoration and value of the land (Xiao et al., 2022).

Being in its infancy, I believe there should be further research on context-specific usefulness of A.V and how key stakeholders perceive such a proposal, to estimate how it can, or if it should, be adopted across the UK context (Weselek et al., 2019). If the aim is to upscale the technology, it must be established how these stakeholders, farmers, that exist on the frontlines of such decisions develop their opinions on A.V and what factors contribute to this. Therefore, I can establish potential barriers to the implementation of this key technology in order to seek how this technology can be best used for farmers individual contexts (Torma and Aschemann-Witzel, 2023). This is also important to consider as those who live in rural areas are those likely to be

directly affected by A.V in terms of economic opportunities and land development, hence farmers being the focus players of the research.

A.V has insofar been understood through studying the 'scientific' – the technological applications of the artefact in an instrumentalist way, yet it is to be explored what is underneath the umbrella of artefacts itself – the sociological. On the surface, agrivoltaics seems to a 'win win' situation, to combine 2 important mechanisms in order to secure UK's future energy and food security seems like a perfect combination. Yet, when viewing artefacts for themselves, this 'blackboxing' ignores the human relations that occur within the space they are developed or built. Through the lens of political ecologies, we can view A.V as a reimagination of futures and different contexts of places and spaces. The arduous task of mentally reconfiguring A.V to what may be applicable in the UK context acts as a representation of those farmers and shows how important it really is to unveil the social relations beneath the artefact (Harvey, 2018).

Through critically analysing the usefulness of A.V as a technology in the UK context, it is about deconstructing the promises that have so been proposed in the majority of literature revolving around the subject and reimagining the different contexts and realities in which it could work. Through researching A.V in a constructivist manner, we are then able to see the farmer's perspectives on A.V truly through a political ecologies' lens, rather than how their views imposed by scientists and policymakers. This research can contribute to such a gap in the field, which explores a variety of outcomes for A.V, and focuses on empowering farmer decision making, rather than blindly encouraging them to apply it. The topic was borne out of natural interest in how technologies come to shift and change when they first get some traction.

To guide the research process, important research questions and objectives will be established, with being at an early stage, there are no concrete research questions, yet, in a brief reading of

the topic as a whole, gaps have been presented and such questions will be used to guide the literature review: How does a farmers **identity** and values play into how they come to **understand** A.V's application on their land? How do they reimagine its place on their farm? And, how it could be **accepted** or implemented in the UK context? The three main theme's **identity, understanding and acceptance** come from sociotechnological literature and speak to how technology is adopted. Farmer identity shapes how technology is socially constructed and reimagined (Ulucanlar et al., 2013), the understanding of technology speaks to how technology and social organization are related, and how such a technology can be conceptualised and reimagined (Spijkerboer et al., 2022), the acceptance of a technology can simply be understood as how likely a person or group is to accept a given technology (Taherdoost, 2018).

To approach these suggested research 'questions,' I want to provide a background to the stance that I will take, and the objectives I want to achieve in researching. My research background is within the sociological arena, looking at social and political relations within the ecological and technological spheres, and so this naturally informs the critical sociological route I want to take. The background of this topic and literature available seems to ignore the views of the farmer, through the instrumentalist perspective, yet I want to use the sociological perspective to give light to how farmers can rightfully be pragmatic towards A.V in the UK context. This pragmatism falls under the knowledge they have acquired of A.V, and how they come to understand it. The understanding of such technologies is socially and politically constructed by their lived experience, and I aim to emphasize that their experiences may very well mean they are rightfully sceptical towards new technology. And so, their decisions towards adopting the technology must be empowered as to how they can make decisions which best fit their business model. Through this research I believe it will do so, by allowing them to have a voice in a space dominated by policymakers.

The objectives link to the research questions, in how I want to approach the results in a constructivist way, which ultimately all link back to technology pragmatism and act as an antithesis to existing literature goals, which will be explored in the next section. The literature review will discuss relevant topics within the themes of ‘identity’, ‘understanding’ and ‘acceptance’ and conclude the main findings within each section. This will inform the course of methodology as to how to approach an exposed research gap. The course of methodology interviewing farmers and land developers’ beliefs on A.V, their identity, government support, and their general stances around technology. The results from these interviews will then be linked back to the objectives, and how it may contradict or confirm existing literature results and contribute to further research on the sociology of technology in terms of A.V.

5. Literature review

The aim here is to investigate studies that arise from the research questions, to then use them to inform my own research design, to allow for relevant data to be analyse. The source of the studies was obtained through reputable academic sources, such as Google Scholar and Jstor. To explore concepts represented in these studies, I looked towards searching for more sociological focused papers, using terms/phrases such as “acceptance and diffusion of technology”, “sociology of science and technology” and “ecological politics” which all help to explore the research questions and objectives of the paper.

I will firstly discuss the previous studies surrounding A.V, which tend to lean towards the instrumentalist aspect of A.V in a set of defined circumstances, and very few actually look at UK contexts. These studies tend to comment on removing barriers to adoption, which configurations of A.V systems are the best (vertical/ cover installations/ crop/ grazing), and the electrical efficiency in comparison to ordinary P.V. These are important in informing people about how to use A.V, yet don’t discuss reasons why it may not work in all contexts, and they often seem to lack representation of farmers’ voices.

So, I will analyse why such trends exist in this literature using the sociology of technology concept. This concept speaks to understanding technology as socially complex, and interact with society, politics and economics. Such social systems impact a technology’s utility and potential uptake (Gunderson, 2016). This takes a constructivist, critical stance of A.V, and the ‘doing’ side of technology in places, which really exposes the research gap present in A.V literature, where few papers talk about the sociological aspect of adopting such a technology. In exposing the

research gap, I will refer to broader socio-technological articles to explore relevant concepts which can be used to criticise existing studies. To conclude the literature review, a summary will be provided to give an overview how the literature will inform my method of enquiry, and how themes can be related to the results of my research. Hopefully, the exposure of the research gap will prompt further investigation into the sociology of A.V adoption, and the importance of representation of farmers.

The **instrumentalist** perspective

This section outlines the results of the main studies that will be referred to, and analysed, throughout the literature review and in the results/discussion, as a key pointer for the instrumentalist perspective. The main points that arise from the studies will be placed here, with more critical analysis being found in the latter sections, in order to support or disprove theories/concepts that may arise whilst looking at the topic from the sociological lens. This section attempts to navigate the more instrumentalist perspectives on A.V, which is that these studies view A.V as something existing in a singular context, whose boundaries to acceptance need to be reduced in order to allow for the upscaling of the technology.

A study on agrivoltaics with livestock applications by Moore et al. (2021) in the US which consisted of 50 interviews with local Michigan stakeholders found that socio-psychological factors such as place identity and place attachment are central to understanding public support. Key factors which show highest support for A.V are economic benefits to local farmers (75% frequency of benefits), production of local food is beneficial to 'my' community (75%) and benefit local economy by creating new jobs and investment (73%). These factors are important

and link to the research question under ‘identity’, as they are likely to support A.V if it benefits their community.

Another non-UK based study by Torma and Aschemann-Witzel’s (2023) used 27 semistructured stakeholder interviews in Germany, Belgium and Denmark to study how agrivoltaics are perceived, and what the barriers and drivers to innovation adoption on different social acceptance levels. The main goal of this study was to inform policymakers’ decisions in boosting agrivoltaics nationally, helping researchers design their pilot studies and help developers design the best projects which lead to higher acceptance rates within stakeholder groups, that is, farmers (Torma and Aschemann-Witzel, 2023). Similar to the Moore et al. (2021) study, it speaks to barriers being something that must be overcome to boost A.V uptake, rather than analysing why the barriers exist in the first place, and if technology really is the focus of such a problem. The study by Torma and Aschemann-Witzel (2023) demonstrates more of an instrumentalist perspective of A.V, in that its main focus is to look at A.V in a defined context where it is seen to be viewed as a silver-bullet solution, one whose barriers must be removed in order to upscale.

Similar to Torma and Aschemann-Witzel’s (2023) study, Pascaris et al. (2022) seeks to investigate farmers adoption of A.V and barriers to it by using semi-structured interviews in the USA. Barriers to such adoption include (a) desired certainty of long-term land productivity, (b), market potential, (c) just compensation and (d) a need for an already flexible system to accommodate different scales, types of operations, and changing farm practices (Pascaris et al., 2022, p.1). They also interview agricultural sector experts, not necessarily farmers, to the perceptions on the benefits and barriers to this dual land-use system. Overall, results showed potential benefits for A.V, especially within a context whereby food system security is

imperative to meet demands for both sustainable energy and food production, as in the UK (Pascaris et al., 2022).

It is important to mention the diffusion of innovation theory, which was used by Torma and Aschemann-Witzel (2023), as it aids in understanding how such papers discuss how technologies can be interpreted, and how barriers that can arise may be reduced. The diffusion of innovation theory was coined by Rogers (2010). Here, Rogers defines innovation diffusion as a communicative endeavour and stated that early roots of technological diffusion are rooted in agriculture, hinting towards it being naturally innovative. Rogers (2010) introduces the pillars of innovation diffusion to expand upon this: relative advantage, compatibility, complexity, trialability and communicability. Relative advantage can be understood as the degree to which the technology has an advantage over existing ideas or technological arrangements. Compatibility is the degree to which the technology fits people's present needs, values and practices, which can be likened to how familiar they feel for the farmers. Complexity can be understood through the technologies ability to be understood, yet this attribute is more relevant in the next section as we discuss how such knowledge is produced. Trialability is the degree to which the innovation can be tried out. Trialability is especially relevant in the UK context whereby farms have yet to adopt this technology on their own esteem, and it is about talking to farmers and seeing what their opinions may be. This leads onto the next attribute, communicability, which is how the innovation becomes visible to others (Rogers, 2010). To create the perfect diffusion of a technology, it must have a greater relative advantage, compatibility, trialability, and communicability compared to other innovations.

Overall, the literature explored in this section display the barriers to adopting A.V, and their aim was to derive solutions which can reduce the barriers to allow for uptake of A.V in the respected area. The literature seeks to look at the barriers in a defined set of circumstances, and there is

not a lot of literature available to see how it may play out in the UK. This literature seems to undermine the agency, or the decision-making process made by farmers in implementing such technologies, as they are viewing their beliefs as 'barriers'.

Sociology of technology

To stick with the research questions and overarching research focus, key themes of identity, understanding, and acceptance, will guide the literature review. These themes were influenced by political ecology literatures that raise important points regarding social interactions with technology, e.g., Harvey (2018), Weselek et al. (2019), Roberts (2020), and Pinch and Bijker (1984), as well as personal intuition based on what I felt needed to be addressed more in A.V papers.

To allow for consistent referral throughout the text, I will carefully distinguish between each theme. It is important to mention that these themes have been slightly adapted from those in the key terms list, as a way to contextualise them within my research.

Identity – the farmer's social background, beliefs and expressions, and their resultant political or social values as a result. This theme also explores the stereotypes other stakeholders hold towards farmer's and their expectations of them.

Understanding – how a farmer can reimagine A.V on their farm, as a more mental activity. It is about how it is conceptualised by the farmer. This can also refer to their general technology reactions, as to how they may be more pragmatic towards them.

Acceptance – the decision-making process as to how A.V may be adopted by the farmer, which is influenced the mental activity of reimagining its configuration on the farm but is grounded more in 'real-life' economic factors that may influence their uptake, e.g., capital and business model configurations. This can be perceived as a more instrumentalist part of A.V, yet, is still necessary as to how these mental activities take place and move to a real-life setting.

This section aims to deconstruct the technological promises of A.V that were the focus of many A.V studies. It constructively uses theories and concepts to argue for a sociological outlook on A.V adoption, and how it can be understood and accepted. The objectives guide how I criticise existing studies, in a way that we should empower farmers decisions, allow them to be pragmatic, and show how A.V is very context specific, and doesn't always have to be used.

Identity – Farmer's perceptions of themselves and other stakeholder stereotypes

This section explores stereotypes that other stakeholders, e.g., government officials and land agents, have of farmers, and how this influences what is expected of farmers, with limited regard to farmer's agency. Along with this, farmer's personal identity within A.V and larger sociotechnological papers will be explored. Such lived experiences further press the idea that the social relations must be realised within technologies like A.V, as to provide more power and agency to those whose voices may be unheard against policymakers. Their identity reflects their lived experience and how they may come to understand and reject/accept technologies (Ulucanlar et al., 2013).

An example of being left out of UK policy, through post-brexit reduction in budget allocation and losing the EU's Common Agricultural Policy (CAP) which provided a lot of subsidy for farmers. Also, the UK have increased imported sources, mostly due to costs being lower, and UK weather being poor in recent years and impacting crop production (Bedford, 2024). Rather than direct payments from CAP, farmers now apply for subsidy through the new Environmental Land Management Scheme (ELMs), which only provide subsidy through the provision of providing public goods, ensuring local nature recovery and large-scale tree-planting and peatland restoration. There has also been a reduction in the Basic Payment Scheme (BPS) that means fewer farmers have access to BPS, other than those who meet the specific eligibility requirements (Marshall and Mills-Sheehy, 2021). Through these new incentives, harbour new feelings by farmers in response to the phasing out of CAP and BPS. They are concerned that the replacement through ELMS doesn't provide enough financial support in order to meet the environmental demands andare concerned that the government is being too vague regarding the BPS being phased out (Scott, 2024).

As farming was traditionally at the core of the intensification of the land, and thus climate change impacts, farmers are facing pressures by governments to reduce carbon emissions in line with SDGs as demonstrated by Burnett, Edwards and Watson (2023). Examples from Netherlands show that there is backlash through recurring protests over governments trying to close farms and reduce the number of animals on them. In Germany, a similar situation occurred whereby farmers dumped manure in the streets as a backlash against the German government planning to cut subsidies for diesel in farmyard vehicles (Niranjan, 2024). There are obvious efforts to engage in a carbon transition by creating such policies, but there must be ways for farmers to receive the correct governmental support in order for them to make that transition, and so they feel they are being misrepresented by policy-making decisions. The state withdrawal from the provision and management of public spaces caused economic and infrastructural decline in remote rural areas, cultivating the feeling of 'left behind' among their

inhabitants (Volonteurope 2016). In the UK, government economic restructuring of the rural has led to investment focus shifting from the rural to the urban, leaving the rural people marginalised (Cloke et al., 1995).

Often, a result of being left out of such decisions can sometimes leave them vulnerable to regressive political ideologies (Niranjan, 2024). Mamonova and Franquesa (2019), argues that the countryside not only provides the breeding ground for regressive political forces, but may also offer progressive alternatives in the form of emancipatory rural politics. Certainly, there is ample evidence that people's feelings of resentment indignation and of being 'left behind by progressive tides of cultural change which they do not share' (Inglehart and Norris 2016, p. 5) can act as crucial triggers of regressive ideologies (Mamonova and Franquesa, 2019). Varco (2023) assumes that farmers' main goal is to pursue a 'racially appropriate' way of life, grounded in self-sufficiency, luddite nostalgia and ethnic homogeneity (Varco, 2023).

There are ecological rationales as to justify xenophobic and/or authoritarian ways of thinking which appeals to the 'pristine' natural environment that is threatened by migrant bodies (Varco, 2023). Here, the places and spaces, and the narration of the 'border' as merely an ecological principle (Turner and Bailey, 2021) invoke Malthusian arguments around resource scarcity and ecosystem stress to antagonise population controls through discrimination, and not acknowledge that the problem is rather to do with resource misallocation, and nothing to do with race/gender/etc (Schultz, 2021). This is not to say all those who feel left behind will feed into regressive ideologies, however, it is important to show that it might perhaps turn into a negative form of hyper-independence, as a way to protect themselves.

In agricultural regions, neoliberal capitalism has caused what Harvey (2003) calls 'accumulation by dispossession' – concentration of land and property by large agricultural companies at the

expense of small-scale farmers. Many farmers found themselves trapped in a vicious cycle of 'scale enlargement, technologically driven intensification and tightening of the dependency relations with the food industries, banks, and retail chains' (van der Ploeg, 2013, p. 128). At such a time where they receive lack of support in competing against these market forces, it seems to make sense that they seek community and find themselves battling for their livelihoods and thus identity.

Here, we can mention the traditional values that farmers hold, that are often exploited and targeted by politicians. The central ethos in UK politics is the power of democracy and bringing 'power to the people' in a way to restore national sovereignty, at a time when we seem to feel so rejected as to the loss of imperial power, and the aim to restore independence through Brexit (Ranci'ere, 2013). Through this, there exists 'othering' of different cultures and races, as to draw particular images of people (Ranci'ere, 2013). With this literature, it is to be assumed that communities often want to stick to themselves, with self-reliance being in their culture, yet can only be expected when such stereotypes and expectations are placed upon them.

Much of the literature here paints farmers as quite isolated from policymaking decisions, and as a result of that, they react by wanting to be self-sufficient and serve the community as a priority. The literature states that sometimes this reaction can leave them vulnerable to oppressive ideologies, as a way to preserve the natural British rural feel, yet I believe this is a rather stereotypical stance. Instead, in my view, this reaction allows them to channel focus into the local economy and community, with self-preservation - not the total discrimination of other peoples.

Understanding - How do farmers conceptualise A.V and comprehend Technology as a whole

Through examining literature, it can be concluded that farmer's typically find it hard to imagine anything different from what they have traditionally used in their family for decades. Under this theme, many sub-themes arise that help give reasons as to how farmers come to understand technology. The theme of understanding speaks to how A.V can be conceptualised, and how it is important to bring the lived experiences and social realities into technological contexts, as to give power to stakeholder voices. To understand technology, we must acknowledge the fact that technologies that were previously black-boxed must be studied to decide their social relationships. To understand whether and how technology can succeed, we must begin to understand how such social relationships are formed. A lot of the studies surrounding technology 'expectations' has its focus within the social studies of science, technology, and society, through the lens of the mutual shaping of social and technology order, with an actor-oriented approach with critical, constructivist perspectives (Harvey, 2018). Such a constructivist stance is important to use in this research, as the mutual shaping of technology can be a mirror to the shaping of different attitudes to A.V, as the utility of it chops and changes as it evolves in the UK. Also, different actors may view A.V in different ways, impacting how the technology evolves.

Modern technology involves experts who 'do' technology and people, farmer's, who can use the technology. The old view that basic sciences generate all the knowledge which technologists then apply will simply not help in understanding contemporary technology (Pinch and Bijker, 1984). Through reading literature on this relationship, I believe a new rapport between farmer and technology experts is formed and gives more insight into how understanding of technology is constituted. Technologies are negotiable, who is the scientist, who is the technologist, what the technological and social relations are and who can participate in it (Pinch and Bijker 1984).

With this, it can be interpreted that the farmers themselves can be afforded the agency to become the experts, as to understand how the technology is used and applied to their space. For example, Mulkay (1979) states that it is difficult to show what counts as a working television set as everyone can have different interpretations as to what works for them. This is to say that anyone who has valid extensive knowledge of a technology can then be an expert, these farmers are not lay people who are deemed clueless to new technologies. It is about how they reimagine their land being used - "land serves not only as a means of production but also as a 'foundation, as a place and space providing a basis of operation'- space is required as an element of all production and human activity" (Marx, 1987). Different activities compete with each other for the use of space (Marx and Simpson, 1969), and this very well might include the land-use competition between energy and food production.

Farmers can understand the way A.V works by thinking "this is how land should look like, and this is how we would manage it". It is about envisioning futures. Technological innovation is inherently a future-oriented business which focuses on the creation of new capabilities (Harvey, 2018). Hence, the relationship between technological innovation and potential adoption is important, as the technology constantly innovates as it is reconfigured. Hence, adoption is not necessarily about adopting a technology in its current state, but as to how it is to be adapted to the needs of a context (Damanpour and Schneider, 2009).

Political life is figured as a battle for a kind of future, or rather, the future is the term of the battle itself (Varco 2023). Hence, why the concept of political ecologies is so important here; there are social relations within the adoption of technologies, and choosing to adopt a technology is political, as the values which undermine decision-making centre around what is best for the individual. This is inherently a political endeavour, as it centres around how we should organise ourselves for the best of society's interests (Neocleous, 2008). The future must

be considered heavily in technological spaces, often as the 'future is mobilised as making urgent and pressing demands on the present, often based in anticipatory fear' (Smith and Vasudevan, 2017, p.214). Expectations and visions are important for actors beyond scientists and engineers, but those who are directly affected at the micro-scale (Harvey, 2018, p.336). These visions are malleable and ever-changing as technologies are never one fixed entity that exists in one social context.

Technological expectations can be described as real-time representations of future technological situations. Terms such as technological 'promises' and 'visions' are commonly overlapped with 'expectations' yet highlight the normative character of technologies. Such, these envision a future of hopes of technological capabilities, as well as the fears and concerns around the risks of such technologies. The reorientation of futures is an integral part to human agency (Harvey, 2018). It is important to consider a variety of outcomes for one technology, and be pragmatic about its activity, as in a pragmatic way, farmers choose the technology rather than the technology choose them (Pinch and Bijker, 1984).

Visions, expectations and promises of technology are important factors in developing new technologies, with there existing a large shift in discussing future expectations of technology within this advanced state of industrial modernity. This is to say that there is now a strategic reasoning for technological change, rather than 'serendipitous innovation' (Harvey, 2018, p.286). This is to say, that technologies like A.V are purposefully made, largely due to scientific knowledge and technological development being central for societal development, through economic growth via competition. There are important accounts as to how expectations change over time, in relation to the 'real-time' factors. Expectations of technologies reflect current conceptions of the technology's utility; 'the tendency of every age to read the future as a fancier version of the present' (Harvey, 2018).

Expectations are ‘performative’ in the fact they attract the interest of necessary allies and brokering relationships between different actors and groups. Through this, technologies are constantly reimagined, shared and interpreted, forming a cluster of guided visions. Shared expectations increase the possibilities of success by enrolling a wide range of stakeholders, but it is important to consider that at early stages of technology development, expectations are at their most intense. This links to A.V in that land agents and those vouching for the technology may be consistently reimagining it and identifying new ways A.V can be used. The actual result will likely be very different to what was first imagined, and perhaps may not even be relevant anymore. Initial promises need to be high to attract attention from sponsors, and to stimulate agenda setting processes, be it technical or political, and to build a ‘protected space’, or niche, for the technology to exist in (Harvey 2018). There exists a freedom to explore and develop the technology, whilst understanding there is a societal obligation to deliver the best product in the end. We rely on the notion of path dependency to explain why some people resist new technologies, yet this fails to acknowledge that technologies change over time in a continual, practical state of reconfiguration whilst in use (Damanpour and Schneider, 2009).

Understanding innovations and their diffusion is much like studying the process of any form of change – the idea is communicated, the idea is seen as a new solution to a pressing problem, which is different from any ordinary practice, and stakeholders are eager to gain new information about the technology (Torma and Aschemann-Witzel, 2023). It is down to the individual farmers’ themselves to define the technology as innovative, and how they perceive it so will determine how it may be adopted (Rogers, 2010). For example, a farmer who has already used solar panels may believe that A.V is not so innovative, yet a farmer without that experience may look to A.V as something novel. Thus, choosing an innovation is something personal, and we must study it as such – to talk to the key stakeholders themselves. Here, a constructivist take is adopted, allowing us to understand how Rogers’ study might not encompass fully how farmers come to understand how their land would be envisioned, and how

their future economic state would be like. So, a constructivist take is important in my study, to see what constitutes the acceptance:

> *"Only when we fully comprehend the social meaning and social purpose will we be able to understand why certain technologies are chosen rather than others; why certain mental conceptions of the world take precedence over the others. It is the relation between the productive forces, social relations of production and mental conceptions of the world, all expressed within a single unique labour process."* (Harvey, 2018, p 102).

Thus, it can be assumed that technology can be understood through reimagining its present and future uses, leading to its definition in itself being 'slippery' as it is constantly reconfigured and adapted to fit certain contexts (Pinch and Bijker, 1984). This is relevant in the UK context as we have yet to see how it can be established on a larger scale. It is important to not blackbox technologies, and uncover the social relations inside of them, as to inform how they should or if they should be used.

Acceptance – Economic and business factors' impact on accepting A.V

The two previous sections were useful in helping to understand how farmers may come to conceptualise A.V on their land, and this section seeks to add onto this reimagination and discuss how it may come into fruition, with more 'grounded', 'real-life' factors, such as capital expenditure, the organisation of businesses, and the demands that actors in such a capitalist market face. As mentioned in the start of the literature review section, understanding the basis of acceptance of farmers is key to understand how this technology can perhaps be diffused on a

societal level (Torma and Aschemann-Witzel, 2023). To develop this, it is important to expand on the previously discussed approaches of technological pessimism, pragmatism, optimism and how this will impact uptake. Yet, the literature explored in this section exposes many problems within instrumentalist literature, in that it demonstrates technology as something that needs to be implemented and upscaled, rather than something that my simply fall in place for some stakeholders and may very well be rejected.

The study by Torma and Aschemann-Witzel (2023) shows that acceptance and diffusion can be understood through the characteristics of innovation diffusion which uses characteristics from Rogers' (2010) paper: relative advantage, compatibility, complexity, trialability and communicability (Rogers, 2010). The characteristics conceptualised here are inherent to the technology, and independent of context. Yet, this can be harmful as contexts differ, and context is imperative in examining how farmers can accept or reject this new technology. This again refers to the more instrumentalist take of A.V, which doesn't allow social relations to be explored. Farms in Kent would be very different to those in Cumbria. It is essentialist and generalised, and more descriptive of the use of A.V. There is an assumption here that scientific knowledge holds a privileged position in society – and his paper begs the question 'why haven't you done what the scientist has said?'. But Rogers' (2010) study can be used as a stepping stone to understand how technologies can diffuse and thus be accepted in farming communities.

To criticise Rogers (2010) further, they contradict themselves regarding the first attributes of relative advantage and compatibility, which to remind the reader mean how technology can be understood as the degree to which it has an advantage over existing ideas or technological arrangements and the degree to which the technology fits people's present needs, values and practices, which can be likened to how familiar they feel for the farmers, respectively (Rogers, 2010). Yet, here, it is contested as to how such innovations can protect the future as well as

addressing the present, as ultimately, the main goal is to use these innovations to preserve future generations. So, there exists a tension between relative advantage and compatibility.

Referring to Pascaris et al. (2022), whose paper displays support for solar power increases when energy and agricultural production is combined in an agrivoltaics system. 81.8% of respondents would be more likely to support solar when combined with agricultural production. Key points raised in the survey which increased respondents support for A.V were that they provide economic opportunities for farmers and the local communities, they aren't located on public property, they don't threaten local interests and they ensure equal economic benefits (Pascaris et al., 2022). Here, it is inferred that farmers are very positive about adopting a new technology due to its benefits, and hints to a changing social landscape as to how they come to accept new technologies. This displays a more technology optimism point of view, especially when the community themselves are reaping the benefits. This links to the 'identity' section, where selfpreservation of the rural community is key.

Reasons for the changes modes of production may be the fact it increases their competition in the marketplace, allowing them to access more resources to enhance their business model. Again, though, it is hard to understand how the reconfigurations of production take place in future markets, which is notoriously unstable - "Through one, or any combination of these responses, individual capitalists can hope to preserve or improve their competitive position. The strategy that is chosen will depend upon circumstances and possibilities as well as upon managerial predilections. The course of technological change under such conditions appears hard to predict." (Harvey, 2018, p.120). This then becomes the central source of tension, especially within the agricultural sector whereby there is a lack of government support. "What happens, for example, if the social cooperation required to operate a certain kind of production system is not forthcoming, or if the social capacity and desire to transform nature is not matched

by the means of production available? What happens when the result desired is not matched by the scientific understanding of the production process needed to produce that result? The potentiality exists for all kinds of oppositions and antagonisms between productive forces, social relations, and mental conceptions of the world. It is however, one thing to speak of potentiality and quite another to establish, as Marx seeks to do, the necessity of such contradictions within capitalism." (Harvey, 2018, p.120).

Overall, it is key to empower decisions made by farmers in order to benefit their businesses. As technology is slippery in its first emergence at a commercial scale, it may very well emerge to something quite different, or something that might not even be applicable in the UK context. Despite this, farmer priority is both their sustainability and also supporting their livelihoods by making market-oriented decisions to increase profit their business and income, especially in small scale farms (The National Farmer's Union, 2024). It is also important to deconstruct the promises of a given technology, for example A.V, can be seen as a 'silver-bullet' solution, which is to mean a quick technological solution to an environmental or economic problem (Campo, 2023). Yet, approaches to technology must be pragmatic, and to realise that in adopting a technology, a person has agency to do realise that technology may not be a solution to a complex problem (Hildebrand, 2023).

Summary:

Through reviewing literature based on these concepts, it is easy to see the human relations that occur within A.V spaces, which underpin the key concepts of political ecologies. There is a lack of evidence of UK farmers response to AV, with much of the studies coming from USA, Germany, Denmark, and Belgium. A lot of the literature focuses on the 'hard' science aspect,

and usability of it. Hence, the focus is to take a constructivist approach, in that we must seek out individual UK farmer's opinions to understand how they may come to accept, or not accept A.V, based on their values and/or understanding of A.V itself, or perhaps Technology as a whole. My research must not fall into the trap that instrumentalist studies like Rogers (2010) did, in that it lacks context and place-based relativity, and so this will be a crucial factor in going forward with this research, to take a more sociological approach. It is also important to consider that such a technology doesn't need to be adopted, and if the case is that it doesn't work for the business model of the farms, they must be empowered to making the decision that is best for themselves, especially during times of increasing price pressures.

Research questions:

The literature explored and the themes presented help shape the research questions going forward. For the 'Identity' theme, it is important to derive who key stakeholders believe A.V should benefit, as to inform their perspectives on community. 'Understanding' allows us to see how A.V is conceptualised in the UK, and how it could possibly evolve and perhaps be accepted.

Research Questions (RQ) and their justifications:

(1) Identity: How do UK farmers perceive the expectations placed upon them?

(2) Understanding: How do UK farmers come to understand A. V?

(3) Acceptance: Are UK farmers accepting of A.V on their land?

The literature explores themes of stakeholder stereotypes of farmers, and the resultant expectations of them being pressured to implement sustainable technologies, as explored in RQ.1. This appears to be a disproportionate request, and farmer's result in feeling left out of policy-making decisions that make sense to them. As a result, they may be quite 'tightly knit' with their own community, which can be viewed as being closed-off, or somewhat neglecting towards anything that doesn't follow their traditions or cultures. Yet, there are a variety of reasons for the farmers to do so, and there is much room for exploration in this question. I want to explore the antithesis to them being perceived as luddite, as they haven't been heavily researched before in the instrumentalist literatures. For RQ.2, there are the place-based contexts, and thus the definitions of A.V in the UK may change and adapt. It is to see how the technology can be reimagined and reconfigured as the knowledge of it spreads. For RQ.3, farmer's either have to have enough business capacity to invest in A.V or need subsidy/ government support towards new technologies, to get the 'ball-rolling' as such, yet the availability of these subsidies is limited. It is important here to empower farmer's business decisions, and this may well not include A.V, if the business model doesn't favour it.

6. Methodology

The methodology aims to provide a solid base of enquiry which allows the answering of the title question. Briefly, my method includes semi-structured interviews conducted via Teams with 9 participants, including 3 land developers and 6 farmers from around the UK, mainly in England. They have varying levels of awareness and understanding of A.V, and are mainly asked about A.V's viability in the UK context, with issues such as weather, subsidy, grid connections. We also discuss their values, familial farm history (if interviewees are farmers, not land agents) and goals as a farm business. The aim of this research is to understand whether and how UK farmers come to accept Agrivoltaics on their land.

To get to answering the research questions, it is necessary to establish the best route empirically to get the results I want, be it through quantitative or qualitative enquiry, and through which epistemological lens I view the research. Firstly, I will discuss the history of geographical methods, to justify the methodological choices I made. I will then relate this to the research questions above, and how I aim to answer these research questions through interviews and support my epistemological lens. Then, I will discuss how such interviewees were sampled, and any issues that arose in my fieldwork. The 'making sense of the data' section will show how I coded data to formulate a mappable network of themes that can be navigated in the results section, with the coding results table being in appendix 2 and discussed in the next chapter.

Why qualitative?

Domosh (1991) contends that the traditional methods of geographical enquiry, as acknowledged by the Royal Geographic Society, were more 'scientific', excluding more of the 'qualitative' and

‘subjective’ research that was traditionally conducted by early female travellers. The emergence of critical, humanistic geography in the 1970s challenged this prevailing paradigm in geographical research, alluding to the much-needed exploration of qualitative methods in order to understand people’s sense of place. Entrikin (1976) expands on this by stating that there is an emphasis needed on the understanding of the lives of individuals in the research process, and the intersubjective encounters between both researcher and the researched. In this, people are restored to the heart of geographical enquiry, whereby there is an understanding of the emotional, psychological, and existential attachment to spaces, places, and landscapes (Patricios and Tuan, 1979).

This turn in geography has been characterised by the adoption of qualitative methods in many different aspects of geography, with the most important for this research being the interface of human and physical geography, particularly resource management and public understanding of environmental issues (Harrison and Burgess, 1994). Qualitative methods do span a large range of empirical work with different philosophical and epistemological underpinnings, with a range of techniques. The key one for this research being in-depth, open-ended interviews with individuals, which can be conducted in a series of meetings (Limb and Dwyer, 2001). This is key in my research process, as it allows for back-and-forth discussion between the researcher (myself) and interviewee which explores a variety of issues, be it agency, government support, business models or capital costs, which are very important in relation to the research questions.

Qualitative methods are distinguishable from quantitative methods mainly because qualitative methods do not enter with the assumption that there is a pre-existing world that can be measured, but instead something that is dynamic and ever-changing through the combination of cultural, economic, social, and political processes (Limb and Dwyer, 2001). Characterized by in-depth, intensive approaches to seek subjective understandings of social reality. There is no

‘real’ world that exists independently of the relationships between researchers and their subjects (Smith, 1988). I interview a variety of farmers and explore the different experiences and views they use to construct how they come to understand and accept A.V, in an attempt to understand their social reality.

The choice to go with qualitative methods is shaped by the dimensions of the research questions. Qualitative methods recognise the importance of farmers’ perspectives on the practicalities on everyday life. It is important to adopt a strategy that recognises the diverse experiences of farmers that can be mapped, albeit sometimes quite messily. Much like the methods of Pascaris et al. (2022), different views were related to each other and realised to conclude that A.V is complex, relating to different aspects of sustainable energy and food production. Different themes can be related to each other, forming the ‘Bottom-Up’ route, in finding links between somewhat abstract concepts within a coding framework, to something that can be neatly mapped and communicated.

In challenging the ‘scientific’ status quo, it is unsurprising that qualitative methods allow the development of post-colonial and feminist knowledge, with these knowledges being rooted in a wide range of marginalised groups (Limb and Dwyer, 2001). Qualitative methods demonstrate the ability to explore the multiplicity of meanings, representations, and practices. It stems from a place where one is interested in how people see and make sense of the world as it is or has been, and how they ‘do’ things’; how they reproduce structures of the world around them. Technology means different things to different people, and to do this work is to empower farmers underrepresented views in comparison to that of the technology developer. To choose to do qualitative research is to engage in a particular kind of politics, which is relevant to A.V and its political ecologies, as politics involves decisions influenced by values and live experiences that can lead to such technologies being adopted (Limb and Dwyer, 2001).

To come to a certain research design is a result of a series of decisions that emerge from existing literature, what research questions I want to ask, the conceptual framework and what I want out of the research, whilst considering the pros and cons of different methods. Such research questions begin with how I observe what I have read, and what I feel is most important to focus on. Research questions are framed by what discourses there are to be identified, what patterns of activity can be determined, what beliefs or events and attitudes are shaping people's actions and who is being affected by the issue (Limb and Dwyer, 2001). The choice of research questions flows logically into the research method I'd need to enquire in the best way possible - a good research design requires the data generated to be interpreted well by the researcher.

Qualitative research often regards social life and the analysis of such as an ensemble of texts to be interpreted (Limb and Dwyer, 2001). When it comes to deciding a methodological approach, it is important to decide what it has to offer with regards to my research. In terms of interviews, I want to explore the ideas portrayed in the literature review as to how farmers come to decide how to adopt technologies. Here, we are essentially accessing the world based on how people think it is and has been, we are accessing a representation, be it an image, vision, or experience, of a text (the lived experience), through a text (a transcript), which ultimately is up to interpretation within itself (Limb and Dwyer, 2001). Here, it is interesting to see how a landscape, scene and experiences represent different things to different people, and even how some people's views are sometimes not represented at all.

This research constitutes the investigation and analysis of individual and collective social worlds, to gain more understanding of the society-space and people-place relationships. There is a deliberate shift to centralise marginalised voices. The marginalised voice can be understood as someone who is partially outside of mainstream institutions, cultures, practices, beliefs, and spaces (Parr, 1998), I deliberately intended to give these farmers voices towards the new technology, which they may not otherwise have, or to be crowded out by policymakers.

Sampling method

The chosen sampling technique was opportunistic, in that I sent emails and letters to farmers or land agents which already had some form of experience in interviews. For example, some were found through contacts at the university, who have interest in the topic. I found farmers through contacts with other research students who interviewed farmers for their different topics. I found that this was the easier sampling method due to the time constraints with the research, as I started it later in the year due to financial and personal life constraints. The timings were an issue due to difficulties in accessing relevant interviewees, my positionality may have had a part in this technique, in that being a young woman, it can be intimidating to travel to farms and ask farmers in person for their time in an interview. So, I had to wait a while for emails back, or responses to letters, or even through word-of-mouth recommendations. This constraint was managed by adapting to the small number of interviewees available, by making the interviews long and in-depth, to suffice the amount of information provided by many, shorter interviews, as perhaps originally planned.

This sampling approach may have led to a certain kind of person being interviewed, those who are already interested in being interviewed or know someone who works at the university may already have beliefs that may sway the direction of the hypotheses results. This may be that the interviewee's are already interested in technology and research & development, so may be more inclined to exploring the possibilities of A.V and the benefits of it. So, the voices of those who are against A.V, and their reasons why, might be left out.

Interview design

Throughout the research process, it is important to keep a research design timeline and research diary to keep tabs on whether I am falling behind or not, and to realise the realistic possibilities of how many people can be interviewed. It is also important to consider how much time transcribing can take, it is more important to do few, quality interviews which allow you to go in depth and develop a detailed analysis of genuine material, than to collect a large amount of data which you are only able to briefly interpret (Limb and Dwyer, 2001). To aid with decision making about what to include, it is focal to do some pilot interviews and log how that went in a research diary. For example, I practised my interview with a friend, which allowed me to have feedback on my technique, what issues arise and how long the interview might take. The research diary was useful here in keeping track of important decision-making regarding what is working or not in the interviews, be it timing, or if the questions were not getting the relevant information in relation to the objectives, which allowed me to make some adjustments before going ahead with the interviews. Yet, it is important to remain flexible, as unanticipated issues may still arise throughout the interview and coding process.

Due to interviewing people of varying levels of A.V knowledge, a short PowerPoint presentation was given at the start of each interview, providing picture examples of A.V in Europe and the USA, the drawbacks and benefits of such, and its progress in the UK. I felt a visual aid may help them understand A.V more, as when I first read about A.V, a picture allowed me to fully conceptualise the technology. This allows all interviewees to start on a similar level of knowledge, yet it is an extensive topic to cover in a short PowerPoint, so a land developer who works with A.V project may very well have more knowledge than someone who merely recognises the phrase. The decision to keep it short was so that it doesn't eat into any interview questions time, and there was an assumption that due to the sampling method being

opportunistic, they would already have a baseline knowledge of A.V, or at least be interested in it.

The style of in-depth interviews can range from formal to more casual, with myself picking the more casual and open-ended style. This allows for a lot of information to be generated in a short space of time, whilst covering a large range of issues and allowing for clarification of issues raised by the interviewee. The disadvantage with this style is that it relies on the interviewer having good interpersonal and listening skills. The most appropriate questions might not be asked, or the interviewees may not feel comfortable sharing some experiences, or even understand the question the interviewer is asking them. This might reflect the fact that there weren't enough interviewees to explore all the different perspectives possible, or rather the interviewees were only saying what they think the researcher might want to hear. It is also important to consider the practicalities when choosing a research method, given time and financial constraints. To tackle this, it comes with asking myself what is possible to achieve within the timeframe, and what I will or won't be able to say by the end of the project. Thus, I figured that a small amount of in depth- interviews, around an hour long each, would provide the most sufficient material given the constraints.

Interviewees – Why farmers and land agents?

Since the introduction chapter, it has been a main focus to give power and agency to the voices of farmers, who are an important stakeholder in A.V being adopted in the UK context. It is important to interview different types of farmers, as in those who are crop or dairy, as they perhaps have different imagined uses of A.V for their farms. It is also important to interview land agents, as they have a different outlook to farmers, and can often explore more of the

business and capital decisions made around land, especially because they work with a number of farms. These land agents may perhaps have negative stereotypical perspectives on farmers, as we understand through the 'identity' section in the literature review.

Different farmers have different business models, and therefore may be more inclined to engage with such technologies. They may also not find a use for it on their farm, for example, farms with low electricity usage e.g., dairy farms may find that it does not make sense to deliver the upfront capital for electricity returns, when they don't have high usage anyway. This also speaks to different regions and climatic factors, as hill farmers in the Lake District might find the configuration of A.V complicated compared to flat Norfolk land.

For land agents, their job may mean they are inclined to promote technologies due to company ethos and what their targets are. But they are interviewed outside of this restriction of work, and so can provide their own answers based on their everyday job experiences or how they form opinions on such technologies themselves. They may have to maintain a certain positionality on technologies due to the companies they work for, but it is important to note that they will of course have opinions outside of their workplace and were not pressured to answer in a way that protects the company, as confidentiality was ensured throughout.

The interviewees and their background are listed in **Table 1** and will be important to refer back to in the results and discussion section:

Interview	**Interviewee type**	**Interviewee background**
Interview 1	Land agent 1	Energy development manager for an energy company in Somerset
Interview 2	Crop farmer 1	Farm director in Preston
Interview 3	Integrated farmer 1	Crop farmer in Kent who has integrated sheep, cows, pigs, and goats.
Interview 4	Crop farmer 2	Top fruit farmer in Colchester
Interview 5	Land agent 2	Works with Cumbrian farmers
Interview 6	Land agent 3	Works in an international investment management business for energy production
Interview 7	Dairy and sheep farmer 1	Farms in the Lake District
Interview 8	Crop and sheep farmer 1	Regenerative famer with a diversified model; controls a large estate in Hull.
Interview 9	Land agent 4	Works for a firm in Chester, consisting of land agents who agree terms on behalf of farmers for new solar developments

Table 1. Interviewee type.

Ethics

In doing this research, it is important to consider the ethical implications, which can underpin the decision-making process. The most relevant ethical considerations are participation, consent, confidentiality, and making the participants feel like their time is well used. It is important to give the participants informed consent when approaching them and asking if they'd like to take part in the research. This means, to give them a detailed account of what the research aims to do, and how they are involved in it, how their data will remain confidential and whether they are happy with how their data might be used. In regard to participation, they were allowed to withdraw from the research within 2 weeks of the interview date, if they realised after that they did not want to be included. After that, the data was pooled and anonymised, so their answers could not be taken out. This was all detailed in a participant information sheet, which they signed as to understand and consent to their participation in the outcomes of the study.

It is important to recognise one's own positionality in this research and maintain reflexivity, due to a concern of misrepresenting the interviewees perspectives. I acknowledge that social systems can be misrepresented when constructing interviews - it is hard to convey the complex ethical, ideological, and methodological issues faced in such research. I attempt to uncover the tensions and contradictions faced in such research by doing the following. As Patton (2015, p.504) states, interviewing people can be stimulating and invigorating, and a chance for one person to peer into another person's world for a short while. Good interviews allow the expression of thoughts, feelings, knowledge, and experiences, to be taken through the process by the interviewer, perhaps opening them up to new ideas and previously unarticulated concerns through a sensitive and open conversation facilitated by the researcher (Limb and Dwyer, 2001).

There is an ethical dilemma in addressing the researcher as someone who becomes a collaborator in crafting narratives set in a world with varied interpretations depending on one's own perspective (Dyck, 1999). So, it is important to be reflexive and critical throughout the research process, and constantly reflect about why certain key research decisions were made. Yet, Thrift (1996) speaks of this constant self-analysis can verge on narcissism in academic texts and can appear somewhat patronising to the reader and their understanding of the methodology. To go about this, I try to reflect on my work more to improve the experience for the interviewee, rather than a reflection of my own self-interest in the study and its outcomes.

It is important to remain sensitive to different views in these interviews, my job as a researcher is to be open to their differences and embrace their lived experience as a lens into how they form their views around technology. My own positionality may reflect this, with being a female who isn't a farmer, it might be that sometimes I don't inherently understand their farming 'culture', but it means there is a genuine curiosity on my part. In being somewhat of an 'outsider' to the farming world, in that I am from an urban area, there is a social boundary and perhaps there exists a social position which marks whether someone belongs or not. In addressing the stereotypes and positionality I had, I was aware when drafting questions that I needed to ensure they focused on their experience and how they feel about the technology, or similar themes that may arise. I believe that my curiosity was evident in the interviews and encouraged the interviewee to be honest and open of their views. This also plays into the fact that some interviewees are more talkative and willing to share than others, being able to create some form of rapport. It is important to stay open-minded (Limb and Dwyer, 2001).

With qualitative research, I felt a faint insecurity when approaching people, farmers, arising from an anticipation that philosophical ideas may not interest them, and how bringing up such ideas will inevitably not work when interviewing them. At present, though, qualitative interview transcripts yield the largest data content held by human geographers. They are appealing due to

allowing a variety of voices to be heard and thus represented, especially in open-ended interviews, where there is an obvious space for interviewees to demonstrate for themselves how they view and experience the world. Burgess et al. (1988) states that interviewees somewhat can have a say in interpreting the data researchers use. There are obvious issues of plausibility, validity, and rigour, which will be explored in the latter analysis sections (Smith, 1981). Other than these issues, there were no other research problems that were raised throughout the process.

How to make sense of the data:

On top of re-reading transcripts, it is also important to relisten to the tapes, to seek out nuances in emphasis or hesitation, which can especially be relevant to interpreting ironic tones. These can also be labelled as discursive repertoires or dispositions, as an honest repertoire might give way to a vulnerable disposition. Also, perhaps their body language which you otherwise would've missed out on during conversation or relying wholly on the transcript. When transcribing, ironic tones were noted through apostrophes in Appendix 2 and can be understood as a vulnerable disposition towards governmental/ social issues, disguising a sensitive topic with humour can be a natural reaction in interviews around such sensitive or personal topics.

To make the raw data useful, it must be prescribed meaning in a relatively systematic fashion, which involves some form of 'coding'. Coding is intended to build up interpretation through stages of descriptive, analytical, and interpretive codes, which prevent the jumping to conclusions. Yet, there remains concern regarding key themes having simply just 'emerged' from the data, through misinterpreting the informant or reading into something that isn't there, so it is important to demonstrate the validity and rigour of the research by providing full information as to how the data was collected, coded, and interpreted (Baxter and Eyles, 1997).

So, moving from descriptive, interpretive and analytical codes, I labelled each quote ID into themes, as seen in Appendix 2 (Seale, 1998). Such codes and themes give way as to how these codes can be related to each other, and the main results were mapped in the results and discussion section.

Through reading the codes, I underwent an iterative process whereby similar concepts arise, and then can be labelled into themes as they continually appear in the coding results. Sub-themes were derived through interpreting the codes and relaying them to concepts in the literature review, which have been exemplified in previous studies like Pascaris et al. (2022) and Torma and Aschemann-Witzel (2023). The sub- themes derived can be related to each other and mapped to form answers to the research questions using support from concepts and theories. This will then help achieve the objectives noted in the introductory section. The sub-themes themselves and the justification of them can be seen in **Table 2**:

Sub-theme	**Justification**	**Theme they belong to**
Land use	Speaks to how farmer's use their land and the quality of the land	Understanding
UK evidence	The existing pilot studies, or existing policy, that helps farmers conceptualise A.V.	Understanding
Early adopters	Those who are the first to adopt a given technology	Understanding
Knowledge of A.V.	This speaks to the awareness by farmers, and also the definition of A.V itself	Understanding

Electrical connections	The electricity usage by farmers on their own land, and also how it could be potentially used in the grid	Understanding
Environmental impacts and place-based context	A.V climate benefits and the weather in the UK	Understanding
Community	Farmer's look to their community for support, and want technologies to be 'owned' and used by themselves	Identity
Farmer perceptions	Perspectives of farmers by themselves and land agents, and how they work with stereotypes in the literature	Identity
Expectations of the farmer	They are expected to implement technologies as a way to undo their past climate impacts via industrialisation	Identity
Capital Outlay	Upfront capital expenditure on A.V installations	Acceptance
Business model	Changing business models for income diversification, also how farmers have to meet targets by both government and customers	Acceptance

Competition	Competition with larger farms, and offshoring	Acceptance
Incentive	Available subsidies for technologies like A. V	Acceptance
Governance	Governmental support, policymaking and food system security	Acceptance
Feasibility	If it is viable in the UK context, does it need to be upscaled?	Acceptance

Table 2. Sub themes and their justifications.

Research Limitations

One of the limitations of this study was that there was a relatively small sample size. Given it was an investigation of farmers views, it would've been helpful to interview perhaps 10 more farmers. However, given the time constraints, the number of interviewees gave a huge amount of data, and with this being a one-year project, it would've been difficult to analyse that amount in the given time. If the project were to be longer, it would make sense, instead of emailing and sending letters, to potentially visit farms and ask them in person if I could interview them. This might have felt more personal to the farmers, and perhaps increase the number of interviewees. I would also attend farmer conventions and even farmers markets and engage in some conversations with the farmers also attending. I believe that meeting farmers where they are from and what they engage in is more personable and could entice them to do the interview more than simply sending an email or letter. This would further help any potential bias with recommended participants to the project. This is to say that through word of mouth, I was able to

get into contact with farmers that are already aware of Lancaster Environment Centre and the research that it conducts. Hence, they may have bias or prior interest in the research conducted, and so tailer their answers to fit what they see is most suitable for research. Such a bias can be overcome by visiting the places of farmers and meeting them naturally. This would've been the ideal solution, however due to time constraints, I instead had to reassure the participants of their confidentiality and reassure their lived experiences which may stray from what they believe to be unfamiliar in research.

Another limitation with bias is the fact I provided a short PowerPoint presentation at the start of the interview to introduce A.V/ get everyone on the same level of knowledge before the interview. There is a risk here in that they may be offended that I think they have limited knowledge of the topic, and they might believe my sources are not credible (as they haven't done the research themselves). There is also a risk that in the questions they may repeat what they saw in the PowerPoint because it is the most recent thing they saw, or in fact the only thing they know about the topic. If this was the case, I tried to tailor the questions to become something that references climate technology at large, rather than A.V specifically.

7. Results and discussion

To recap, there are 3 research questions I aim to answer, using the questions as sub-headings for each section:

1. **Identity -** How do UK farmers perceive the expectations placed upon them?
2. **Understanding** - How do UK farmers understand AV?
3. **Acceptance** - Are UK farmers accepting of A.V on their land?

I also want to refer back to the objectives in the introductory chapter, which informs how I want to approach the results in a constructivist manner, to stick with a sociological approach to A.V. I aim to highlight how farmers in the UK can be justifiably pragmatic about A.V. technologies. Their pragmatism is rooted in the knowledge they have acquired and their understanding of A.V., which is shaped by their social and political experiences, as through their identity. I emphasize that these experiences validate their pragmatic approach to new technology. Consequently, their decisions regarding technology adoption should be empowered to align with their business models. As a result, I believe this research will amplify their voices in a space largely dominated by policymakers.

There were many sub-themes that were raised from the interviews, which link to the literature explored in the first section, for example, policymaker expectations of the farmer, business model configuration, governance and food security. Some speak to the more instrumental side to A.V, as spoken in the introduction and literature review, with the use being justified through its protection against weather events, which of course are extremely place-based, and grid connectivity, and sustainability accreditation. Although, the instrumentalist perspective of A.V aid in forming the basis of the critical A.V stance in which my route focuses on. These topics,

although important to consider in the context of A.V, are not the focus of this research, whereby the key idea is that the farmers are allowed to be pragmatic in deciding technology that suits them and should be able to be empowered to explore the multitudes of benefits that can be available to them. Hence, the priority section is the 'understanding' theme. This critically looks at A.V, and using the political ecologies and sociological lens, the power relations that exist in adopting technologies. Using these concepts as a key figure in pointing to different context based solutions, A.V doesn't have to be the only solution available to them, despite it being painted in literature as something that should be upscaled and adopted by all farmers in literature by Torma and Aschemann-Witzel (2023), Moore et al. (2021), Pascaris et al. (2022), and Rogers (2010).

To help paint a bigger picture of the results, a code map has been provided in **figure 1**, to allow a visualisation of the sub-themes, codes and how they fit into the themes and thus research questions:

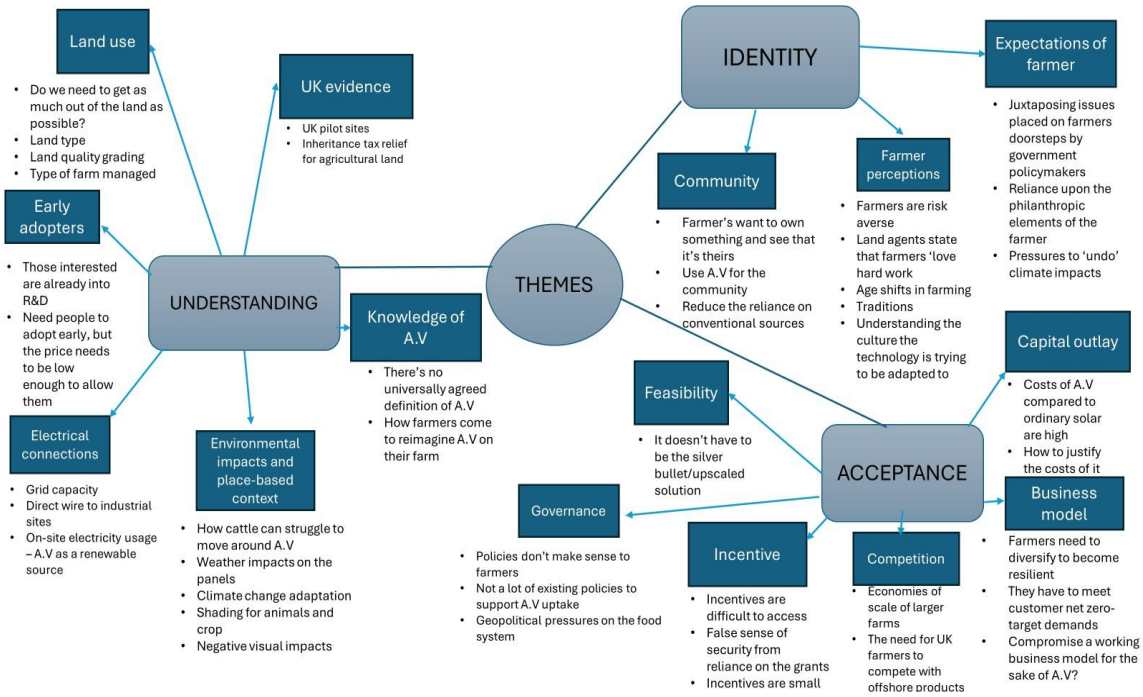

Figure 1. Thematic code map for the interview results.

I will firstly discuss farmer's identity and the social and political values which arise from this. Then, their understanding of technology and A.V as they reimagine and conceptualise it. The last section, acceptance, comes to realise how these decisions must be empowered rather than forced upon them, as to provide farmers with their agency which has been minimised through the lack of government representation of their voices.

Identity - How do UK farmers perceive the expectations placed upon them?

This theme explores the political and social realities of farmers livelihoods, and how this can then become useful in contributing to their understanding of A.V. It will be divided up into the main sub-themes and will refer to important interview codes that form the basis of the theme 'Identity'. Expectations of the farmer, speaks to their responsibilities imposed on them by government to become more sustainable, and the perceptions farmers themselves and land agents have of farmers, and how this may interact with stereotypes placed upon them in the literature review. Community is also an important aspect of their identity, as with feeling left behind by government decisions, they feel it is important for the community to benefit from A.V and have some form of ownership.

Expectations of the farmer

As stated in the literature review, the main priority for farmer's is to future-proof their business, as it is their livelihood, and they are already facing many pressures, which was a key problem for farmers in these interviews. In light of this, it is interesting to note that only once the

following concept was mentioned by land agent 3, yet I believe is an interesting outlook on A.V; philosophically, farmers were the pioneers in key stages of industrialisation and mechanisation of their business, speaking both to their innate innovative nature, but also how they face much of the blame for current and future outcomes of climate change. As mentioned by land agent 3 in an interview, farmers can face much of this blame due to "the intensification of agriculture [being] the main driver of biodiversity loss across the world". So, it makes sense in that way, that the government is trying to 'phase' the industry out, in claims that it damages the environment, yet, dairy and sheep farmer 1 acknowledged that they are "out every day, living [the realities of climate change]" and "seeing the effect… more than a lot of people living in towns", and so it is inferred that they have a connection and some form of responsibility to choose the more sustainable methods, but how can they be motivated to do so when they are shunned and looked down upon for every business decision they make. Indeed, this might be a generalisation and there very well may be farmer's out there who don't care as much about the environment as dairy and sheep farmer 1 states. Yet, I believe it must be emphasised that they must be empowered to make these diversifying business decisions on their own terms, and this very well may not look like A.V.

Integrated farmer 1 also speaks to the pressures that farmers face, in that the government are "relying on the philanthropic elements of the landowner or the farmer", and it is "quite a big ask" to do it all at one "cost". I believe this speaks to the pressures farmers face to be independent and self-sufficient, because they have to or else their businesses will not survive. The same farmer states that these issues are "juxtaposing" each other, which I interpret to mean, the pressures to supply food to the UK, whilst maintaining a farm that uses only sustainable electricity and all whilst doing it at the best costs for the farmer, is a tall order. This farmer also raises issues of the government importing food from other countries, which in combination with their comments on juxtaposition, can assume that the government are putting so many pressures on the UK farmers to meet food security and environmental goal demands, whilst not necessarily 'paying' them back with the onshore food production. As in the literature reviewed

for ‘identity’, farmers have found themselves trapped in the dependency of technologically driven intensification in relation to their industries and retail chains (van der Ploeg, 2013, p.128). As a result, this farmer states that farmers need to be “self-sufficient” as a community, as to be more resilient to changes in the climate in the future and food systems. Here, it can be assumed that in face of all these pressures, farmers internalise it and look inward to their community and each other for a safety-net. Dairy and sheep farmer 1 further emphasises this point, in that rural people are “self-sufficient anyway”. The tone here suggests a sort of reluctancy in such self-sufficiency, and perhaps it is something that they have to do as a result of pressures, rather than willingness to. This reaction seems to be typical of such situations, and it is only right that they seek community aid.

A frequent element in the interviews was that farmers are unfortunately used to those in government or companies with no background in farming telling them what to do, as dairy and sheep famer 1 stated they are “used to central government saying things that don’t make sense to them… kind of coming up with things and you just think, really, like, when was the last time you were on a farm?”. The sarcastic tone in this answer by dairy and farmer 1 speaks to the irony they feel towards government support, and that they perhaps feel left behind. In interpreting this, it seems that the government are not effective at communicating to farmer’s needs and base a lot of their policymaking on what they believe to work, rather than reaching out to farmers themselves. This supports the points raised in the literature review, as Niranjan (2024) suggests farmers are tasked with reducing their carbon emissions, but don’t receive much help to do so. To add onto this point, it is perhaps that the government are not providing any help at all, it is just not what the farmer’s feel is relevant for them.

Farmer perceptions

This section can be divided into the identity of farmers as they perceive themselves, and how land agents perceive farmers. It is important to distinguish these perceptions from that of government stakeholders, as they are often stereotypical, and with the course of methodology, I can only give evidence in regard to farmer and land agent perceptions. Land agent views are important here too, despite not being farmers themselves, they work closely with them throughout their career and can perhaps have different perspectives regarding business model configurations.

Crop farmer 1 stated that farmer's themselves are "risk averse", confirming the assumptions in the literature review that farmers somewhat are reluctant to adopt new technologies, due to luddite nostalgia, as exemplified in the literature review by Varco (2023). However, rather than this farmer painting themselves as luddite and traditional, which much of the literature suggests, the same farmer rightly state that they "like to see somebody else who has done it" and learn from that they have done. Here, it can be assumed that this farmer's perception of "risk averse" is simply that they would not uptake something if there isn't much evidence of it, and personally such an 'aversion' to risk is just a natural part of adopting new technologies – you cannot blindly accept them, there has to be an understanding of the workings and configurations of A.V, and how this could look on one's farm.

In discussing the identity of farmers with land agent 2, they stated that farmers "have always loved hard work", and that they may view A.V as "a lazy option", in reference to it "harvesting sunlight" and that farmers don't have to "go out and do anything". This perception may directly relate to the people this land agent may have worked with, and that they do like to see the

upfront results of their hard work. This land agent goes on to then say that in implementing A.V, you have to “take into account the culture to which it’s trying to be adapted to”. This can be assumed to mean that their hard-working culture may not align with the static, in-situ nature of A.V. I thought that this concept may be clearer in existing literature, yet the comment by this land agent seems to be a rare case. So, I think the contradiction of manual labour and an ‘in-situ’ technology like A.V could be researched more.

Dairy and sheep farmer 1 mentioned that they are also working with another student, who is looking into oral history testimonies about heat transitions. They speak to adapting energy transitions to the cultural context, akin to land agent 2. Here, the dairy and sheep farmer states that in rural Finland, the wood collection for the winter is important for the community feel and the culture, despite wood heating being unfavourable over electric heating. Despite being a different form of energy transition, I think it speaks to the cultural aspects of farming, and that there needs to be an understanding towards the cultural configurations.

Land agent 4 is the only interviewee to raise an interesting point regarding age shifts in farming, with the “average age of the farmer being late 50s/60s”, they seem to see this age as running their farms in a “traditional” way, which I assume to mean manual labour, rather than farming diversification through aspects like glamping, dog walking routes and education programmes. They state that the new generation is more welcoming to new technologies, as they are “operating everything off the phone already”, and that in “10/20 years’ time, this may become… more normal”. I thought that this aspect would be mentioned more, as it is clear that the younger generations have grew up with technology surrounding them, and therefore may be less sceptical towards A.V.

Community

Much like what was mentioned in the previous section by dairy and sheep farmer 1, the cultural and community aspect of farming is very important, and something that can bring the community together is a sense of ownership over the artefact, to understand something is theirs only and works for the benefit them can really speak to farmers. Land agent 2 likens this to the example of Vattenfall in Cumbria, and stated that village dwellers were initially sceptical of wind turbines, but when they were gifted one of the wind turbines and they each have a share of it, they can see it is theirs and that it is providing electricity for them, it then became a lot easier for them to get on board with wind turbines in their area. I think this is a key driver for the uptake of A.V, if landowners or farmers can implement A.V and see how it works for them, or even if they use it to provide to the local community, it will prove to be easier to implement, as seen in the literature review by Moore et al. (2021). Land agent 2 further testifies to this by stating that farmers are inherently focused on community, due to it naturally being a local enterprise through working with the land that is around them and can then facilitate the local areas through food production or environmental work, and that tapping into this sense of community will make a lot of sense for them.

Integrated farmer 1 is also very keen on the idea of community, with them already doing a lot of work for the community through their business anyway, stating that they are more inclined to channel something like A.V into the local area rather than selling it to the grid. They highlight the importance of being connected to the environment, and how this can help people care more about nature, which I think is what A.V is fundamentally about; the changing transition to more sustainable practices within farming, as supported by a study from Gomez-Casanovas et al. (2023). The feeling of community is particularly important to this farmer as they rightly acknowledge that at the moment, a lot of people are being pushed off the land.

Crop farmer 1 interestingly focuses more on a personal sense of ownership, rather than how A.V can come to be owned by a village. For example, they state that if you are generating your own electric and reducing reliance on more conventional sources, in conjunction with still growing produce, “you’re getting 2 gains from it”. They raise a key attractive aspect of A.V, in that essentially you are reliant on only your own source of electricity and can still continue to run your farming business rather than sacrifice a huge portion of it for a lone solar farm.

Understanding - How do UK farmers understand A. V?

This section explores how farmers conceptualise A.V and how they can imagine it would work on their land as a mental activity. This also includes how they form their beliefs towards Technology as a whole, which can then inform A.V acceptance.

Environmental Impacts and place-based context

The literature states that A.V is useful in environments with high sun exposure, which can be damaging to crops, this is so that the crops underneath the panels have a microclimate which allows for reduced evapotranspiration and thus water efficiency. Yet, in the UK, we have very dark winters where this benefit of A.V and crop shading is less important, but it still could be important to consider with climate change impacts. This was exemplified by almost all interviewees. The countries which have benefitted from A.V have a very different climate to us in the UK, and just because it works for them, doesn’t mean we have to implement it too. This is the case with new technologies, there is lots of hype around it, and everyone wants to get on

board and benefit, which speaks to a larger ‘problem’ in that technology doesn’t have to solve all (Pinch and Bijker, 1984).

In the UK, it could be useful to protect against weather. Land agent 1 spoke to crop protection against hail, as “hail bruises all the apples”. But I wonder if the few hailstorms we have throughout the year is enough to justify the implementation of A.V, yet some of the costs of such damage are high, as one this interviewee stated again, “he lost a quarter of a million in revenue, so even over 20 years, that’s a lot of money”. This again leads to the important place based context, in that some farms who are involved in cropping may see this as a huge benefit, and if the demands of their farm and their business model lines up with implementing A.V, it really could be a benefit to them. Agrivoltaics might also help new crops to be grown in the UK due to the microclimatic conditions, as the same interviewee stated, “protecting apples from hail”, “allowing a new crop to grow” and crop farmer 1 mentioned how it could “introduce alternative crops”.

Dairy and sheep farmer 1 discusses a rarely mentioned topic in the interviews, in that A.V could be very useful in climate change. This is to say, we are aware that with climate change, the intensification of sunlight is predicted to increase, and therefore the potential damage to exposed crops is increasing. So, this farmer states that “shade might become more important for animals” and crops in glass houses. I believe that this is a key point in raising support for A.V, as climate change realities become more present and the negative impacts of it are more frequent, we can use something like A.V to aid in the sheltering of animals and crops.

Land agent 1 carefully raises a surprisingly infrequent topic throughout the interviews, in that compared to ordinary solar P.V, which is often placed on roofs, A.V has a significantly higher increase in visual impact, due to being a “meter higher for the horticultural greenhouse effect”

and is assumed to have more of a “negative reaction”. Eye sores are a well-documented topic within the energy sphere, with earlier reactions to wind turbines being a well-known issue. When wind turbines first arose, there was a clear negative reaction to the visual impact they had, yet they are now a frequent part of energy mixes (Bartczak, Budziński and Gołębiowska, 2021), and so I assume that A.V could follow this same course.

Land agent 4 speaks to an important issue regarding the configuration of A.V itself, in the form of navigating machinery and large cattle around the panels. In order for machinery and big cattle to work, they need to be raised “6 metres high”, and how can that “not cause a massive visual impact”? This is an important problem regarding the actual configuration of A.V in the UK. If we were to implement this on dairy farms with cows, they are likely to bump into the structures, and if we are to implement it as a cover installation over crops, how can machinery be operated around it, as made apparent by land agent 4. Perhaps it is a case of it being quite inefficient to work alongside such things, but with the raised beams, it is clear that the costs of this would be massively increased compared to a low A.V grazing field, and people may not be willing to pay the initial capital costs.

Electrical connections

Many land agents raised concerns with the grid connectivity, surrounding the lack of grid availability in the UK, they speak to the industries taking a huge amount of grid capacity. A way for farmers to have A.V, whilst aware of the grid connection concerns, is that they use the A.V to provide electricity for their own farms, this would work with intensive farms who require electricity for storing, irrigation, machinery, huts, and other purposes. This will of course depend on their payback time, and they would need to see if it is worth investing in. Land agent

4 raises an interesting suggestion, stating that they could “dual wire to a nearby factory to give them green energy”. This could come with a “financial incentive to the landowners”, and I assume that the incentive for the factory would be a theoretically uninterrupted supply of green electricity for them to use. This could be a viable option in allowing for a profitable use of A.V and may incentivize more farmers to make that transition. This is also supported by dairy and sheep farmer 1, as they state grid capacity has been a big issue for them trying to implement A.V. Therefore, if we could skip the middleman, it may make sense to just straight wire it to a nearby industry complex.

Land use and farm type

The different types of farmlands may allow for different configurations of A.V, and A.V might be preferable on certain grades of land. Crop farmer 1 is a big energy user, as they have to cool, store and pack their produce, and they are interested in something that would directly reduce their outside energy consumption. I assume that A.V would be ideal for an intensive energy user like crop farmer 1, who looks to something like this to reduce their own reliance on outside sources. Dairy and sheep farmer 1 reinforces this idea, in that for high energy usage farms, A.V would make more sense as the payback time would be quicker. They also state that with farms with existing infrastructure e.g., large sheds, the economics of implementing A.V makes sense and can stack up easier, rather than raising something completely new.

With A.V being a combination of solar and farming, there is a compromise of either side to accommodate for the other. Granted, this compromise is quite small physically, with the direct land taken from A.V steel beams amounting to around 3% of a given land area, stating land agent 3. For a long time, the UK has already used solar and grazing land in conjunction with

each other. Land agent 3 speaks more to this, what would best fit A.V is already being done. Low grade 3 land has been and will be used for low yield crop grazing, as they deem it most appropriate of the UK. So, I assume that only low-grade land should be used for A.V, as to minimise the compromise for the most valuable agricultural land.

In relation to land use, land agent 3 is the only one in the interviews and even in A.V literature to raise a very important issue regarding maximising land use. They state, “is it really a significant benefit to get as much out of land as possible?... what is it that Agrivoltaics is trying to achieve?” It puts into question if it is really that beneficial to put something like this in place, or to just leave the land be, if we are taking the case argument as aiding biodiversity loss. So, it can be assumed that A.V and its use on the land is seen as a new kind of intensification, which can paradoxically oppose its intentions to start with.

Knowledge of A.V

One issue with A.V and how the knowledge of it is constituted, is that it does not have one set definition, or one set appearance. As mentioned in the previous sub-theme section, the UK has already grazed fields which have solar on for more than a decade, so it calls into question whether the concept of A.V itself is actually new, or necessary in the UK context. Land agent 3 supports this by stating, the coexistence of solar energy and plant cultivation dates back to the 1980s, yet the frequency of A.V literature has only accelerated in the past 5 years. Yet, it is still a relatively new innovation due to the terms of only recently accelerating in literature, and thus the knowledge of it being dispersed, as conveyed by land agent 3. This is an important part of my research, in that is it necessary to state what we have been doing in the UK for a decade or so, as something new and innovative, and perhaps it is more apt to collapse back into the ordinary definition of solar P.V, rather than create something new only as a market term. This

confirms a key point raised in the literature review, that technology expectations or promises must be deconstructed, as to reorientate human agency as a key part of choosing technology (Harvey, 2018).

A key part of how knowledge of A.V is constituted, is how the previous factors of farm type, environmental impacts, land use, and connections can inform them on how it may be imagined on their farm. This is evident in all of the farmer interviewees, as when they answer questions on A.V, they are constantly referring to their own farm as to how it would work in the future – it is about reimagining scenarios. This, mixed with their values in terms of identity and ownership, can inform how they come to understand it outside of its instrumental function. This is to say, when imagining such a technology on your farm, you have to think of the social relations on top of the obvious costs, e.g., how could this benefit my community? How could it reduce my electricity demand? A lot of it is about what it means to these people, and what does it signify?

This directly supports the literature explored in the understanding section, in that farmers are a key actor in reimagining futures with A.V; expectations and visions are important for actors beyond scientists and engineers, but those who are directly affected at the micro-scale (Harvey, 2018, p.336).

It is about what falls into place for your farm, but the context it might be placed is different. This also brings into question the actual definition of Agrivoltaics, for if it is used on a farm hut's roof, is that not just ordinary solar panels? The definition of A.V is not universally agreed, as crop farmer 1 and land agent 3 state, and it looks and is defined different for each country that uses it. In the UK, it might just be a case of collapsing back into the ordinary solar P.V definition, especially for farm roofs. Essentially, it is a marketing definition, and new technologies with such excitement like to be differentiated from the rest, despite its similarity to ordinary P.V, perhaps technology advocates get too excited and like to create new definitions.

This confirms what is stated in the literature review by Harvey (2018), that the main goal of the utility of technology, is to reimagine itself as a fancier version of the present, and that products like A.V might be purposefully made as a part of industrial modernity.

UK Evidence

There are examples in the UK of companies conducting 'pilots' of A.V farms, bringing solar developers, land developers and farmers together. This allows the solar developer to lease their land to the farmers who can then graze their land. Yet, all the land agents that were interviewed highlighted that it is hard to see how the costs of production from grazing sheep can cover the costs of leasing the solar land, especially with the current costs of solar panels and the steel beams involved in raising them – "almost double the cost of a standard solar farm", stating land agent 1. Developers are waiting for the cost to come down, which can only really happen if more people use the products. With this model, there seems to be too many players involved to make it economically viable, and thus feasible for any party to actually want to invest in it, as land agent 3 reinforces. The ultimate decision in A.V, regardless of how much it may benefit the environment in comparison to other sources of electricity, is how much the capital expenditure is, which was mentioned a lot throughout the interviews. This is a massive factor in decision making for farmers, they are businesses at the end of the day, and despite working with the land, and being linked to luddite, 'down-to-earth' perceptions as stated in the literature review by Varco (2023), they will not do something solely because of its environmental benefits. Like any business, they have targets and profits to meet.

Land agent 4 is the only one to raise a seemingly very important point about A.V on UK land, and that agricultural land benefits from 100% inheritance tax relief. They stated that if land was

solely to be used for solar, the land would be liable to be taxed if passed down generations, but if you can show that the land is also being used or agriculture in the case of A.V, and that agriculture is the main source of income from the land, it would be liable to inheritance tax relief. I believe that this is a huge driver for solar panel uptake, especially when used in conjunction with agricultural land as through A.V.

Early adopters

Land agent 1 states that those who are more likely to accept A.V on their land, are already heavily focused on research and development (R&D). This is to assume that they are keen of new technologies already, and so adopting new ones will not be as daunting as they are already knowledgeable about technologies as a whole. The same interviewee states that of course these new technologies do come with a risk, and that a typical reaction to new technologies is people just ignoring it, but those who think outside the box are more likely to see the benefits and perhaps uptake it. I believe that those who are already interested in R&D will be more likely to accept A.V, and if we are focusing on upscaling A.V in the UK, perhaps it is about getting these people on board with piloting schemes, to then reach to the masses.

Crop farmer 1 spoke about how A.V is to come to be accepted in the UK, stating that years ago, solar was very expensive and they have come down in price over time due to the demand. They called it a “chicken and egg situation”, whereby you have got to have the initial interest to invest in the technology and bring the prices down, so more people can access the technology. But if the technology was cheaper to begin with, more people would be interested. I think that this combined with the point made by land agent 1 conclude that those who are optimistic towards

new technologies are going to uptake the technology, causing the price to decrease and more people will be attracted to it.

Acceptance – Are UK farmers accepting of A.V on their land?

This section looks to move from the identity and understanding questions, to understand the scenarios in which it would work in the UK. This looks to the more economic and business side to A.V, as a key part in the decision-making process of adopting technologies. This section also highlights how it is important to reinforce how farmers can reasonably reject the technology, or perhaps how it can be collapsed into ordinary solar P.V use.

A key point that has guided the research was reinforced by land agent 3, in that A.V is a solution under certain circumstances, and it does not have to be a rolled-out solution in the UK. The same interviewee is the only one to correctly acknowledge that despite being a dual-land use solution, there is a compromise on either business model, in that you will have to drop 100% solar generation for part agriculture, or 100% agricultural land for part solar. The key points raised in literature and again here, is how to overcome this compromise in a way that allows them to both exist and optimize the land. And, if this even makes economical or environmental sense for us to co-exist the two in such a way?

Governance and incentive

The most common theme amongst the interviews is about government subsidy for farmers in order to get the ball rolling as such for A.V to be used in the UK. As Land agent 1 states, if A.V

was to be upscaled, government intervention is needed. There have been many subsidy schemes in the past for farming through basic payments schemes, especially post-World War 2, “the government incentivized farmers to increase numbers of animals because we were starving to death as a nation” and the food system was shocked, as one land developer said. It is interesting to see the parallels between that, albeit at a much grander scale, and current geopolitical conflicts e.g., Russia and Ukraine, whose impact has been felt in the UK, with food supply chains being disrupted and thus increase product prices. It is clear that the UK’s food system is not as stable as we thought, due to the amount of offshoring. Yet, there is no clear subsidy schemes that are accessible for farmers, even in the horticulture sector as a whole, which could support UK’s onshore food production. The same land developer touches on this again, stating that “Leaving the EU [we lost] the basic payment scheme, and the government are trying to replace it with ELMS. It should have been sorted, everything up and running. It’s not… the government is still very unclear about which way it’s going… farmers are finding it increasingly difficult to run the businesses as they’ve been kind of lured into this false sense of security that money will always be there”.

Dairy and sheep farmer 1 states that if A.V is to be useful in the UK energy mix, why is there no incentive for it? I assume that this means, if A.V was so important and to be upscaled, why is there not a plan in place for wide uptake of it, and so why should it be something that farmers consider? The same interviewee raises another important point regarding governance, in that farmers are “used to central government saying things that don’t make sense to them”, and that they question “when was the last time you were on a farm”, which I interpret to mean the government stakeholders are not understanding of how farming businesses are run, and if they do state something it isn’t what farmers want anyway. This leads to the farmers being skeptical of if they are actually in the government’s best interest. A message that has constantly been reinforced is that the UK food system is very fragile, integrated farmer 1 and land agent 2 both state that the food system has to change in order for the country to be self-sufficient. This is to

say, we need to use onshore farming products to build stability in the economic and food system.

This is reinforced by crop farmer 2, whereby the Welsh government implemented a rule whereby farmers have to dedicate 10% of their land to planting trees, with "no consideration [as to] how that will affect business". They also state that the government incentive payments are very little in comparison to the turnover, e.g., crop farmer 2 stated that last year they received a £3000 payment, and in comparison to their 1.1 million turnover, the "benefit to the fall is extremely small… and the government can go and shove its money as far as I'm concerned".

With the farming sector being such a small percentage of the economic sector, "2% of the working population", as stated by integrated farmer 1, who again speaks to them finding it hard to see why the government would prioritise that over banking sectors which frankly provide a lot more for the economy. With this, it is hard to see how the government would not only subsidise farming but subsidise a small sector of that – Agrivoltaics. This calls for farmer's to be left to fend for themselves in a way, and to invest in A.V themselves, whilst seeking out the knowledge of the technology on their own. This is simply the nature of the capitalist market, that farms with the economies of scale are able to implement A.V, and see how it works with their business model, whereas those farms who are failing, and perhaps need something like this the most to help with their electricity costs, will fall by the wayside.

Dairy and sheep farmer 1 raises a rarely mentioned issue in that in some cases, grants provided are used 'incorrectly'. They stated that farmers have "just gone for it [a solar panel grant] on a speculative basis", which I assume to mean that some farmers are applying to grants just because they are there, rather than applying for them because they have a genuine interest in implementing the granted technology. They said that it is "a bit of a waste", and "not actually

that useful". So, I can assume that these grants can sometimes be misused and perhaps lack the real focus that they were intended for. This again is reinforced by land agent 2, who states that some grants give farmers "no incentive to be good or bad", and that there is no "incentive to look at the business model". Thus, the incentive system must be reevaluated to ensure that the grants are used correctly. This was rarely mentioned in literature, and in the interviews themselves, yet it could be a useful comment on how incentives must be correctly applied for the benefits of farmers.

Integrated farmer 1 states that the government are focusing on "paying people not to farm". Here, there is a sense that they feel left behind in that cynically, they do want the government to help of course, but they don't understand what the government's plan for farmland in the long term is. This again speaks to the 'expectations of the farmer' sub-theme in the 'identity' section, in that sometimes they don't feel adequately communicated to. I interpret this to mean that this farmer feels often forgot about in policymaking, to assume that there is a lack of focus on the farming sector, which proves their disbelief in receiving incentives for schemes like A.V. Even then, dairy and sheep farmer 1 states that grants are of course useful, but they are such a small % of the overall cost of a solar system, that it doesn't really make sense. They say that the farms that are able to afford, say the remaining 75% of the solar installation post-grant, are the ones that do not need a grant anyway.

Capital outlay, business models, and competition

These 3 themes have been combined as they form a similar argument and may make more sense as one section for the reader. A common theme throughout these interviews were the fact that A.V has a high upfront cost, as land agent 1 states, the capital expenditure (CapEx) is currently

double that of a standard solar farm, and that solar developers are not going to want to invest in A.V due to this bottom line. Many of the farmers are aware of this CapEx cost yet focus on subsidy as a solution to cover the costs. The land agents, however, look to solutions of leasing the solar from landowners to allow for grazing underneath. Yet, land agent 1 states that this is not an "interesting commercial offer revenue" for landowners. So, the solution proposed by this land agent is that the CapEx will naturally come down, mostly due to steel beams and panel costs reducing, or selling the electricity to an onsite user and charging them more than a standard electricity provider. They also propose taking a cut of the crop revenue. Yet, land agent 3 states that if a farmer is successful in their product, they are not going to give up a share of their high value crop, similar to a solar investor, why would they sacrifice their returns on a set capacity to bring on a third-party farmer?

The land agents are heavily discussing the potential of A.V and what solutions can occur with CapEx, as mentioned in the literature review, expectations of the technology are at their highest right now, in order to attract the interest of necessary stakeholders. This exists in a form of protected space, or a niche, in that there is freedom to explore the possibilities of the technology and how it is to be the best product, and it changes through time and may result in being very different to what was first imagined, or may not even be relevant anymore (Harvey, 2018). This is a key point in this research, as the promises of A.V are at their highest right now, offering a lot of 'hype' around it, yet it is important to consider that what A.V might eventually look like in the UK could be very different to what was once imagined.

Grazing around solar P.V has already been done in the UK, and the idea itself of the land-use multifunctionality has existed for almost 2 decades, only recently gaining traction in the academic sphere. As with any technology, the ideas get shifted and the definitions of it are 'slippery' in its new stages, and so what means something to us, might mean something different to someone in the USA. Although, A.V is gaining more traction recently, and the more widely

accepted view of it, as in through the raised beams above crops, might be something we see in the UK in the next decade or so. This is supported the literature review, in that in early discussions of technology, and the reconfiguration of such, the definition of itself is 'slippery', as it is being adapted to different contexts (Harvey, 2018).

Crop farmer 1 states that a big part of wanting to adopt something like A.V would be the targets set by both government and companies, e.g., net zero 2050 by the government and a lot of their suppliers are coming in at 2035 as a target to have complete net zero production. Something like A.V on someone's farm can help them reach such targets, if they can demonstrate that A.V is being used to produce their own electricity. I believe this can be a big driver to implementing something like A.V, as reinforced by goals by the Committee on Climate Change (2020) and McCullough et al. (2022) in the introductory section.

Crop farmer 2 states that farms currently have the tendency to get bigger and bigger, and that smaller farms are falling by the wayside, unable to compete against these larger farms, and I believe they need to find a way to differentiate themselves from these farms and their produce, and perhaps A.V can aid this. Other than this farmer, competition between farms was not mentioned a lot during the interviews. Land agent 2 states that farming business models are needing to be reevaluated as a way to become more resilient to climate change shocks and generate a diversified income. This confirms what was stated in the literature review, in that individual capitalists hope to improve their competitive position, allowing them to access more resources to enhance their business model (Harvey, 2018, p.120).

Land agent 3 offers a contrasting viewpoint to the diversifying of business models, and suggests that if an existing business model is working for the farmer, why should they give that up for the sake of implementing A.V. I think this is a very important part of understanding the acceptance

of A.V, in that if something is already working for the farmers, they really do not have to give that share up. This relates to a quote stated in the literature review: “What happens, for example, if the social cooperation required to operate a certain kind of production system is not forthcoming, or if the social capacity and desire to transform nature is not matched by the means of production available? What happens when the result desired is not matched by the scientific understanding of the production process needed to produce that result? The potentiality exists for all kinds of oppositions and antagonisms between productive forces, social relations, and mental conceptions of the world. It is however, one thing to speak of potentiality and quite another to establish, as Marx seeks to do, the necessity of such contradictions within capitalism.” (2018, p.120). This, combined with the idea from land agent 3, affirm the idea that sometimes a new production system, or the desire to transform into a new system, is not necessary. Overall, technology doesn’t have to be the silver bullet solution, as displayed by Pinch and Bijker (1984) in the literature review sections.

8. Conclusion

The most important part of this research has been providing voices to the farmers, and their agency in deciding to implement technologies such as A.V. The focus must be on how farmers can be empowered to make decisions that benefit them, not just because policymakers say so. The existing literature on A.V acts as a good starting point in *how* it can be upscaled, but not necessarily *if* it should be upscaled. This is how my research differs from existing literature, as my research aims to give power to the farmers, rather than provide solutions as to how the technology can be upscaled.

There are various complexities for crop A.V regarding its efficacy due to shading and weather in the UK. This brings into question whether this method of using solar panels is a novel thing, with solar panel farms having been for grazing for a while already. There doesn't necessarily need to be a new term for this, so perhaps we collapse back into the old definition of solar panels, rather than using A.V. Yet, we may very well see the use of A.V in conjunction with crops, especially in regions like Kent, where the weather favours growth of fruits in particular. If A.V were to be upscaled and prioritised as part of the energy mix of the UK, we would need to see some investment to cover the initial installation costs, either through private companies working with landowners, or through governments providing incentives to farmers wanting to use A.V. Still, I expect the uptake of A.V to naturally take traction over the next 10-20 years, as more farmers become aware of it and the price of it comes down as more investment happens. I expect this research to add to existing literature, more so as a way to perhaps inform policy, in regard to how farmers can be approached to react to such a technology. I think the focus should now be on how to help farmers become more resilient and improve their stance as a business, and provide the necessary capital support for that, rather than implementing policies that do not make sense to them.

Despite the research providing a positive insight into new A.V stances, it has its limitations. The number of farmers and land agents interviewed were few, especially to gather a large consensus on the frequency of mentioned themes. Yet over 150 codes were produced, which provided more than enough information to analyse given the timings of the research. In future works, it would be interesting to see how focus groups with land agents and farmers may change the outcome of this research, as they are able to listen to each other's slightly different perspectives.

Each research question has been concluded using the results of the chosen method:

1) Identity- How do UK farmers perceive the expectations placed upon them?

The farmers interviewed are very keen to preserve their sense of community, for what I assume to mean an antagonism to how they feel neglected by government decision-making, or how the government simply misunderstands what the farmers actually want. I believe the feeling of neglect by the government is also heightened by the expectations placed upon them by policymakers, as they are disproportionately viewed to be a main driver of climate change and so are relied upon to be at the centre of the sustainable transition, despite not really being communicated to in a way that makes sense to them, or in a way where their business choices are understood. This has caused the farmers to be somewhat self-reliant, as a way to preserve their sense of community, and to keep their businesses and livelihoods a priority.

2) Understanding - How do UK farmers understand A.V?

A key to understanding A.V is how it is conceptualised by farmers and land agents, which ultimately stems from their knowledge of their own farming context. Farmers can be rightfully pragmatic about the technology as they reimagine how it can look on their farm, as to understand how a technology works, one must be informed about its purposes, and the informed person may not want to implement it. This directly refers back to what is stated in the literature review, that technology can be deconstructed, reimagined and reorientated as a key part of farmer agency in being pragmatic about this technology (Harvey, 2018). Here, it is important to reinforce the idea that we should choose the technology, rather than the technology choose us.

3) Acceptance – Are UK farmers accepting of A.V on their land?

A.V could be implemented in a set of circumstances where the business model falls into place to allow for it, and it shouldn't yet be forced to be upscaled. The decisions of farmers need to be empowered, which contrasts existing literature as it sees farmers' beliefs as a form of battle to get over to change their mind and make them uptake the technology. The concluding statement is that A.V is useful in a specific set of circumstances yet isn't to be seen as a 'silver-bullet' solution in the UK context, and rather it should be used as a way for farmers to improve their own business needs. This may naturally fall into place, as farmers suppliers are implementing net-zero targets, meaning that farms need to demonstrate a net-zero carbon footprint, which A.V can certainly help offset.

The results show conclusive results and demonstrate the efficacy of the chosen research method, as the themes from the interviews can be compared and contrasted with existing literature results. Overall, there are obvious disparities between the literature explored and the results. The literature paints A.V as an optimal, 'silver-bullet' solution in the land use for agriculture or energy use debate. It seems to ignore the fact that farmers can be pragmatic in these situations and are able to decide what is best for their business that they work with every day. It also seems

ironic that farmers are painted as being luddite if they do not accept such technologies, and that they have faced the pressure of being the main perpetrators of industrialisation and in turn climate change, and the ultimate result being that they have to adopt certain strategies to reverse their damage. The reality is that they are facing unjust prejudice, with major companies now doing much more environmental damage due to the sheer scale of their outreach in comparison to farms. Even then, A.V as a silver-bullet solution as an antagonism to the mechanisation and industrialisation of farmland demonstrates a contradiction in that it is also further intensifying the land for its resources by using technology. Albeit not as detrimental to the climate than coal mines, philosophically, this contradiction must be considered in literature.

In terms of policy implications, the result highlight clear issues between the UK government and its transparency with the farming community. This is to say that post-Brexit impacts are still being felt by farmers, although the phasing out of CAP and BPS are not a quick fix, it seems that farmers are being left in the dark about what subsidies are available, and that if they even are available, they are hard to get accepted onto. It seems that the government are struggling to provide a suitable replacement for CAP and BPS through ELMS, as far as farmers perceive it. the current policies seem to focus a lot on providing subsidy as long as the farmers are following guidelines on improving their environmental efforts, through peat restoration or reforesting. Farmers sometimes failed to see how this can benefit their business model, and state that they are sacrificing productive land for the sake of the regulations. A.V could be seen as a solution to this problem, as it provides a course of environmental management as well as keeping productive land in use. However, the subsidies for technologies like A.V are very unclear, and so policymakers must endeavour to focus on creating subsidies for A.V, or making existing ones clearer, if they are to increase their focus on environmental management as well as prioritising farmer benefits.

Further literature should be explored regarding if UK's market definition of A.V could collapse into ordinary definitions of solar, and we do not inherently need to adopt or define new technologies if what we have is working anyway, and the new technology is not providing any benefit for us as of yet. This is not to say it never will, but the capital costs need to come down in order for it to be adopted. With new technologies, there seems to be a cloud of optimism that surrounds them. They can be idolised even when there is limited evidence of them working. Of course, technology can help businesses become more efficient, yet they won't work for everyone. It is about deconstructing the promises of this technology, as much of the literature paints it out to be something that can be the silver bullet solution for the farming sector. This is not some anti-technology stance though; if it aligns with the business model, I am all for it; yet we cannot accept something simply because some scientists and academics said so. This research exploits the gap that exists in current literature trends regarding A.V, and hopefully informs others to focus on the sociological aspects of technology.

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10. Appendices

Appendix 1 - Interview Questions:

Context questions:

For farmers:

How long have you/your family been farmers?

What type of farm do you operate?

For developers:

What does your role look like?

What type of farm/land do you develop

Understanding - How do farmers understand the application of A.V on their land?

- Do you have Solar P.V on your land/farm? If so, why/ why not?
- What is your understanding so far of A.V?
- Could it be used in the UK context? In which ways?
- What would/does it look like on your farm? Consider land type and structure of buildings.

Values - Who do farmers think A.V should be for? -

Why are you a farmer? (allows to unpack issues more) - Do

you feel the government supports you?

- is this isolated to farmers, the countryside or your identity?

- How would you feel if A.V was placed on your land/farm?
  - Changing configurations of farm?
  - Upfront costs?
  - What kind of A.V would you use?
- Who do you think A.V should benefit? Wider UK context?

Acceptance – Under what conditions may farmers like to have A.V on their land?

- What are your priorities to focus on as you continue to farm?
- If your neighbours were to implement this on their own land, would you be more likely to follow suit?
- Would you have A.V on your land, if so, under what conditions?
  - Local economic benefits

- Local, community energy/ food/ job benefits
- Do you feel they need to be subsidised/ are the government doing enough to provide support in doing such tasks?

- What do you believe are the main barriers in adopting this technology?

Appendix 2 - Coding results

ID	Interview	Quotation Content	Descriptive codes	Interpretive codes	*Analytical codes*	*Themes*	Comments
1:1	Interview 1	So, I mean, we're hopeful it will be the UK's first sort of commercial park of it.	The first ones in the UK	Taking the first steps	*Investing in the new technology*	***Early adopters***	**This interviewee is a land developer**
1:2	Interview 1	It's up in Norfolk, it's on an Apple Farm. It's an orchard and the way it came about, so we look for sites for large scale solar, wind, battery developments, and we had this connection which had a large battery capacity attached to it. So, we approached a load of local landowners	Other land-uses like battery capacity	multiple land use, the battery capacity might allow for solar alongside it	*Dual-land use*	***Land use Place-based context UK evidence***	
1:3	Interview 1	So, we did a load of feasibility analysis on it, and we spoke with the landowner, and it became apparent that he's very big into R&D, which is great, but his biggest issue is weather protection against hail.	Landowner is keen on it	More likely to adopt the new technology, yet raises valid concerns around weather	*Weather issues*	***Early adopters Feasibility***	
1:4	Interview 1	So, that's the main reason that he's doing the project, but he's looking to work with us to compare a sort of a baseline case against the trees underneath the panels, looking to bring in a more shade tolerant apple to the UK. Uh, so that could appeal to some of his off takers. I mean, that's the predominant reason. There's a lot of other benefits which we want to quantify but we need to build a project to understand that in the UK. Uh, yeah, so that's the main context behind it, yeah.	Wanting to grow new crops	A new market available to allow for diversification of the crop, which helps with disease prevention	*New market crops*	***Business model Competition***	

1:5	Interview 1	Yeah, it's difficult at the moment, the big issue is CapEx [Capital Expenditure]. So, the cost of installing the equipment. So, our calculations, we see it's about double the cost of a standard solar farm. So, the big issue is that that from a private sector perspective as a developer are they're never gonna go out and look for any PV sites because most developers just care about the bottom line.	Cost issues	High capital costs preventing developers from investing	*Investors interested in other areas*	***Capital outlay Feasibility***	
1:6	Interview 1	So, if you're just installing a like for like we're gonna put in a taller system to allow crops to grow underneath, lease it from the landowner, export the electricity to the grid. Yeah, that's not gonna make an interesting commercial offer revenue for them. So, the ways in which we can swing it back into our favour, there's a few things we can do or hope that will happen. One is that the CapEx cost will come down. Most of that CapEx cost is the steel and the panels. Steel prices are gonna be the same for the ground mount system. It's just you've got twice as much.	Commercial issues	The amount of parties involved mean the economics don't add up for profit	*Waiting for costs to come down*	***Acceptance Electrical connections Feasibility Place-based context***	
1:9	Interview 1	The other ways we could make it work is if we sell the electricity to an onsite user and charge them more for the electricity than you would get from your standards electricity provider.	Charging them more for using A.V	This could work by using the idea that it is on their land, perhaps giving them more connection to it. But it would be hard to find someone willing to pay more just for that reason	*Selling higher to onsite users*	***Electrical connections Community***	
1:10	Interview 1	Umm, another way is taking a cut of the crop revenue. So, the crop revenue per acre is a lot more than the electricity yield per acre, it's probably 10 times more when we're talking about high value crops like apples or berries. So, if we could convince the landowner to share some of that revenue, that could help us skip closer towards a suitable project.	Developer asking landowner to trade their crop revenue for A.V electricity usage to allow for a project	Reducing their revenue in order to allow for A.V benefits, this could be useful in meeting carbon targets if they are willing to reduce their revenue	*Trading crop revenue for A.V*	***Electrical connections Community***	

1:11	Interview 1	I heard from solar Energy UK yesterday that DEFRA [UK government's Department for Environmental, Food and Rural Affairs] are consulting on Agri PV at the moment. They're doing a high level rapid review, it's called. They didn't consult solar Energy UK, which annoyed them slightly. Certainly, we didn't know about it, so I suspect they have targeted farmers that are more on the electricity side. Umm, so it is on their minds and solar energy UK have mentioned it to government, but it's been very much in the background.	Not a lot of information from the government, despite efforts from Solar Energy UK	This means it's perhaps going to be lost in policy for now, and so farmers are less aware that it is an option	*Lack of government acknowledgeme nt*	***Governance Incentive***	
1:12	Interview 1	So, hopefully the next few years will see some traction. I'm not sure about direct subsidy. I think they'd be reluctant to do that for the electricity side, but if we could see some subsidy to horticulture, to farmers, to encourage them to do fruit and veg, I think that's more likely. There's lots of benefits to that and that in turn could lead to more agrivoltaics interest. So, that's kind of where I see what needs to happen. We need to see a shift in those business models.	Rather than a direct subsidy for A.V, there should be a 'grander' subsidy for fruit and vegetable production in horticulture	More subsidies for wider farming might lend interest to farmers being able to invest in something like A.V	*Subsidy for farming at a larger scale*	***Business model Governance Incentive***	

1:13	Interview 1	Yeah, I think it will vary depending on what type of farmer they are. So, if you go and speak to a dairy farmer, agrivoltaics is just like it's a whole other step of farming, they haven't even got their heads around fruit farming. So that is just too much. So, that's been the general reaction from a sort of standard pasture farmer. I would say it's just, it's too much investment for them to think about. If you talk to existing fruit farmers, I think you have to kind of subcategorize it again. So, berry farmers, for example, they, I would say, lend themselves the most to all the points raised around the idea so far	Different types of farm's lend to different methods of farming, and so farmer knowledge is rather central to what type of farm they manage themselves	This means that certain farmers e.g., dairy farmers might be overwhelmed by A.V or any other new technologies, and so it might start from more R&D interested farmers which then can lead the way	*Different farms and different levels of acceptance*	***Acceptance Identity Place-based context***	
1:14	Interview 1	So, berry farmers, for example, they, I would say, lend themselves the most to all the points raised around the idea so far. So, we've gone out to, I believe most of the big berry farmers in the UK. Response has been to do with familiarity, that's probably what you find is in the early days of ground mount solar. You went up to people, it was like, oh, this is bizarre. Can't possibly get their heads around it. Now everyone's got one and all their neighbours have got one. It's like, yeah, I want a piece of the action	Similar to how other technologies have been adopted, and how they witness other people using it and want to do it themselves	A.V might just need a few early adopters to then get the movement rolling, allowing for more farmers to follow in their footsteps	*Technology adoption at the beginning stages*	***Acceptance Early adopters Place-based context***	
1:15	Interview 1	At the moment, the people that have responded to us are typically the ones that subscribe to European uh, like fruits at Vibe magazine or some other sort of farming magazine where they see these systems ads. They get with the idea, or they have to be particularly R&D focused. They must be quite an innovative farmer or have a lot of cash in their pockets, so they're willing to take risks, and that's probably true of any new tech industry. You know people like that, early adopters. So, I think that's a big problem. It's just landowner awareness and that's one thing that we've been really trying to work on in our advert.	Those interested in such developments are already R&D focused	Perhaps these people will take it up on their own esteem, and it might be a case of how these may influence the other farmers to adopt	*Those already interested in technology / R&D are quite keen*	***Early Adopters***	

1:16	Interview 1	Uh, but I think once people get more familiar, and we see that sort of business models work for this, I think landowners will take it up on their own esteem.	Seeing what type of business models work will then give farmers evidence so that they can take it up themselves	it is about building momentum and getting pilot sites out there, and provide evidence for the early adopting farmers	*Farmers want to see which business models work*	***Acceptance Early adopters***	
1:17	Interview 1	But I think if we want to see this, at the big utility scale level, you're going to need to see government intervention in either subsidy or relaxing the plotting rules. So, for example, ground mount solar is quite difficult to do in grade one land. If they, they might say, well actually agrivoltaics, yes, that's great because you carry on with the food production and that addresses that problem.	Changing policies regarding land type and which lands A.V might be most suitable for	Decrease barriers to plotting A.V sites, as long as it is used for dual food production, e.g., allow wide-scale use on lower grade lands. It also could be about subsidizing farmers to invest in new technologies/diversify their farm, in which they can prove are meeting targets regarding food production and net zero	*Decrease land plotting barriers and increase subsidy for horticulture*	***Governance Incentive***	
1:18	Interview 1	Yeah, that that's the main driver, to be honest. Yeah, it's just awareness. Yeah, absolutely. Familiarity with the tech, definitely.	Familiarity with A.V might allow for more understanding and thus acceptance	Once farmers become more familiar, they may take it up on their own esteem, this depends on how they come to understand A.V and how it fits within their model	*Familiarity with A.V*	***Acceptance***	
1:19	Interview 1	you couldn't have before that it's a no brainer. Uh, but the cooler climates like the UK and the Netherlands, Denmark and all those places, I think it will have a place, but it's, yeah, it's gonna be more niche. It's gonna be, yeah, not on the same scale, but I think it can, give it 10/20 years, I think a notable proportion of new projects will be agriPV. I think it will just almost be a prerequisite by then, wouldn't be surprised	Different climates allow for different applications for A.V, and UK's is tricky to currently navigate how it might reach the same scale as other countries like the Netherlands.	We need to get different types of A.V projects in the UK to see which ones work best, and then farmers can see what works best for their model and go from there	*Giving the UK time to see which A.V models work best*	***Feasibility Place-based context***	
1:20	Interview 1	I think the problem is uh, so grid connection doesn't really work, in the big scale. Because you're selling the electricity at a certain price, but your CapEx is twice as much. It just doesn't, yeah, add up? Uh, so yes, it kind of has to be private wire really feeding into someone's facility. The Norfolk one is grid connected, but the reason we're able to make that work is because we've got a massive, great big, profitable battery next door to it. So, it's a vehicle for us to test these things and not lose money on the project.	Grid connections and A.V doesn't work on the large scale, so it is best to use it privately, either on their own land or feeding it into a facility	Doesn't work on the large scale, but makes sense privately	*Private wire*	***Capital outlay Electrical connections Feasibility Place-based context***	

1:21	Interview 1	Yeah. Well, I think that's the first hurdle is the definition. We haven't got a universally agreed definition and the reason for that is because, uh, a lot of it, is in the States. They do like agriPV, but their version of Agri PV is a wildflower meadows pasture because a lot of their sites are semi-arid land. So, for them to have sheep and to have grass is like, whoa, that's such a crazy idea. Whereas over here pretty much all of our solar farms have that already. So, I think the UK will need to define our agriPV and I'm pretty sure they will just say it's horticulture not just sheep.	Different countries have different uses for A.V, and so different definitions. It is about pinning one down for the UK, especially because solar panel farms already have sheep grazing	A.V has existed in general terms in the UK for a while, but it is about defining A.V for ourselves, and what sets it apart from ordinary solar farms. It might be to do with horticulture and not just sheep grazing.	*Defining A.V for the UK*	***Knowledge of A.V***	
1:23	Interview 1	. Maybe that's maybe that's the criteria. And, I have seen this in some countries where they've brought in, I think like Italy for example, it's about calculating what the baseline is, what you're farming and then what by putting panels above it, what's the impact, what are you doing? If you've got a sheep farm, when you put panels above Sheep farm, is that Agri PV? I mean, it's a hard sell. So, whereas if you're protecting apples from hail or you're allowing a new crop to grow, I know like in Sicily they're looking to build an 80 MW agriPV plant on semi-arid land, to grow, I don't know what it is, but fruits you know, that's the purest form of agriPV. For me anyway, but yeah, so, be interesting to see how that goes.	How to come to the definition of A.V; calculating the baseline and finding the impact of the A.V. This would be easier to do for crops, as it would allow for new crops to grow and perhaps protect from the weather.	It is hard to calculate A.V in terms of how it's used in conjunction with sheep, and if that is a worthy use of the land. Perhaps it is better to use with fruit and veg crops.	*Using A.V for crops rather than sheep*	***Place-based context Knowledge of A.V***	

1:24	Interview 1	I think that they're in a slightly different position to the UK that most of their electricity is already low carbon because they have so much nuclear. But what we are seeing is a lot of fake agriPV projects we created over there just to get the solar farm in. They're building big barns with panels on the roof and saying it's an Agrivoltaics farm. And then they just don't. They just shut the door and don't grow anything underneath. There's a bit of that going on. Yeah. So, there's, you know, and in the [United] States, different states have got subsidies. So yeah, it's different approaches. Different country, different climate, different context. It is just,	Some people are saying they have A.V when they don't, depending on the definition, yet if you don't have anything agricultural working alongside it, it cannot be A.V.	It is not just solar panels on top of a hut that is in a farm, it must exist in conjunction with agricultural production	*Difficulties in defining A.V*	***Place-based context UK evidence Knowledge of A.V***	
1:25	Interview 1	Given that, it's quite a difficult business model, I don't think you'll see a lot of activity just yet, but I'm hoping some of the bigger companies are just willing to take the plunge and just get some demonstrators out there. So yeah, that's it really.	It is only really feasible to get the ball rolling if bigger companies invest in A.V sites	Once companies have A.V sites and we can see it works/ doesn't work, then we can go from there as to how farmers may adopt it and then what it could look like in the UK	*Company demonstrators that do the initial investments*	***Acceptance Business model Early adopters Feasibility***	
1:26	Interview 1	I would be keen to know. I'd be very interested to see public reaction to agriPV cause there's obviously an increase in visual impact. We're going probably a meter higher for the sort of horticultural greenhouse effect, uh, so we'll get a more negative reaction.	It looks different to ordinary solar P.V as it is raised higher, so there will be some visual impact	People don't ordinarily like visual impacts, as with any other technology e.g., wind or ordinary solar farm, so it will be the same for A.V as in any early stages of adoption	*Negative visual impact*	***Acceptance***	
1:27	Interview 1	he loses his crop on average once every two decades. So, if a hailstorm comes in, it just bruises all the apples. So even though it's very infrequent, uh, actually protecting that revenue over such a long period of time is actually quite substantial. You know, he was losing, I think he said the year that it happened, he lost quarter of £1,000,000 in revenue, so, even over 20 years, that's a lot of money.	A.V can protect crops against weather, and thus protect revenue	This could be a positive avenue for A.V and horticulture, as A.V can protect otherwise damaged crops	*Positive aspects of protecting against weather*	***Environmental impacts***	

1:28	Interview 1	Uh, but the panels, they're often transparent. So, I think every agriPV system I've seen is transparent panels, so we might see the price of those come down quicker. Maybe in correlation to the price drop with a standard panel, if the uptake in agrivoltaics happens across the globe,	As more solar panels roll out, their price will fall	Most solar panels are transparent, and its lucky that they are also clearly used in solar farms, so in correlation with usage and time, the cost will naturally fall as it is adopted	*Falling costs due to panel usage increasing*	***Capital outlay***	
1:29	Interview 1	So, I think it's probably very typical of normal new tech reaction is just people just ignoring it for the moment. It's quite risky, but there's a handful of landowners who were like, oh yeah, this will really benefit, and they think outside the box	It is like any other technology; in that it only takes a few landowners to be interested	From there, the knowledge and application of A.V will spread	*Diffusion of knowledge*	***Early adopters***	
1:30	Interview 1	I guess slightly controversial view about the land use argument is that, actually not having enough land is not the problem. It's just there are too many barriers up on the land that we have.	There is an argument that the UK doesn't have enough land for agricultural and energy use, but the interviewee is arguing that it is the barriers on the land we have that are preventing proper utilization	Barriers regarding land use need to be reduced so that things like A.V can be implemented	*Barriers to land use and maximising land efficiency*	***Land use***	
1:31	Interview 1	If you look at what we actually need to hit our net zero targets, to have all the fruit and veg that we want to eat in the UK, it's very doable, but it needs government intervention. It needs an overarching policy, and you raised a really good point about regional strategies. So, berries in Kent, potatoes in the lakes. I don't know. I don't know what they grow the lakes, but it's probably just sheep but if we want, we could overcome the land use issue by having an overarching policy. If you leave it down to the current planning stipulations, then yes, it's gonna get trickier.	To get A.V going, as an incentive to hit this net zero target, there must be an overarching policy that allows for deployment.	This can mean to reduce barriers to landuse and to incentivise growth of certain crops which can work well alongside A.V	*Crop type incentivisation and reducing land-use barriers*	***Governance Place-based context***	

2:1	Interview 2	It's my husband's family farm. And my father-inlaw started it in 1965. So, we had very small market garden areas, people would have like a couple of acres and some greenhouses and that sort of thing.	A farm that has been passed through generations	Shows the traditional aspect to farming in that it is often passed through generations and there aren't many other avenues to get into it	*Family farms*	***Identity***	**This interviewee is a crop farmer**
2:2	Interview 2	So that that's kind of what we do in the farming side of things and then we have some of the family who run another business, the sort of sales and distribution and marketing to all the supermarket customers. And we have like a salad factory and have quite a few growers who grow for us. So that's kind of how it how it all fits really.	A large, family run business with many aspects	Shows the business model and how they sell to supermarkets	*Supermarket clients*	***Business model***	
2:3	Interview 2	We kind of knew about it because we sort of have connections growing in Spain. So, we have seen some of that sort of side of things and we just see it as a sort of partnership between carrying on doing agriculture and there's sort of fit between them, you know, we would never see it as, sort of a, leave the field bare down to doing solar panels. We'd want it to fit with, not necessarily growing a crop underneath it, because obviously at the moment we grow quite a lot, and we're on peat soil, also, at the moment there's a lot going on in terms of sort of wet farming and then net zero and carbon issues. So, I know we've sort of thought around it.	They have an interest in A.V as they saw how it worked in Spain; they like how it is seen as an 'addon' to already existing agriculture that fits in with their farming methods.	They are keen on the technology but may not have full understanding of it, through the use of "we kind of knew about it", they seem interested to know more and how it would work in their business model	*Interest in A.V due to seeing it work in other countries*	***Business model***	
2:4	Interview 2	So, I know we've sort of thought around it. It might be something you could do whilst raising the water table and carbon having like a cover crop to protect the peat soil and then also have the benefit of a system. It maybe looks like the sheep version, but we wouldn't necessarily be grazing it because it would still be growing a crop as such, but it would be the carbon side of things rather than a typical crop and then there's also the opportunity possibly sort of glass house wise, solar panels on glass houses and things like that. But apart from that, we don't have great knowledge of it.	They have thought about how it would work with their farming system, and the benefits 'environmentally'.	They are interested about reducing their own carbon emissions, and how A.V could be used alongside their existing farm and how it may help alleviate existing issues	*How A.V works alongside existing systems*	***Environmental impact***	

2:5	Interview 2	Researcher: OK, so I assume you don't have any solar PV at the moment. Interviewee: No, no. Researcher: Ordinary solar PV, yeah. Interviewee: Not on the farm side of things, on our on factories and things, on the roof and things like that. But we don't actually farm wise, because we've always been looking at it trying to debate what to do and we're not a great fan, to be honest of, Well, I'm not a fan of solar panels on farm roofs.	They already have solar on their house, and are looking at A.V. They don't like the idea of solar on top of farm roofs though.	They already are interested in A.V, and have solar panels already, so they will have existing knowledge compared to the farmers that do not.	*Want more knowledge of A.V*	***Acceptance*** ***Place-based context***	
2:6	Interview 2	Because it's a great expense because we'd have to reroof the building and get them for the weight and things like that, and then also around us, we're in an area obviously with peat soil and it gets very dusty and we've always wondered about the maintenance, and it's a big thing to maintain them and get someone up onto a roof. So that's why we've kind of always wondered about more ground level for maintenance and you know keeping that efficiency and things like that.	They are concerned about roof-top maintenance and think that ground level solar would be easier to manage.	Seem more likely to be interested in a crop or sheep grazing usage rather than greenhousebased or on top of farm huts.	*Maintenance of different types of A.V configurations*	***Acceptance*** ***Capital outlay*** ***Place-based context***	
2:7	Interview 2	Yeah, yeah. I think it could be, yeah, but it's got to fit and and work well. I mean, we're quite big energy users. If you look at sort of things like looking in the pack houses, we've got packing coolers and refrigeration for our pack houses and our lettuce production, we've always wondered about doing something that connects into that and use it on site to reduce our energy consumption.	They are big energy users and have a keen interest in reducing their own electricity consumption.	If they were to have A.V it would be on their own site to reduce their reliance on the grid.	*They want A.V to help their own energy consumption*	***Acceptance*** ***Feasibility*** ***Land use*** ***Community*** ***Place-based context***	
2:8	Interview 2	We're a little bit, we're a bit sort of risk averse. I think as farmers, we like to see somebody else who's done it and then go and say, oh, that's what they've learned they would do it slightly different or that's a bad side of things. So yeah.	As a farmer she states that they are risk averse and want to see evidence of it working before they do something.	As a farmer she has great knowledge of her community, and naturally they are averting the risk of using A.V seemingly without any great load of evidence as to how it works in their farming model. But they want these early adopters to show how it may work and what may need to be changed	*Evidence from other farmers with similar models*	***Acceptance*** ***Identity*** ***UK evidence***	

2:9	Interview 2	Yeah. Yeah, it would be. We, we'd say it'd be more small scale like even for our own benefit first and then any extra would be for our local area or like that cause were not very close to the grid we're a couple of miles away from sort of where all the houses are in the village and things like that. So, if you work on to the grid, we're not the greatest in terms of sort of utility connections and things like that. So, it's a big outlay for that kind of side of things. Probably. Possibly if it was ours, it would be more local, first, I think.	They don't have any close grid connections, so that is another reason why they'd want it for their own farm.	She would like it on her own farm and then see how it could be used locally, rather than selling to the grid.	*Grid connectivity*	***Electrical connections Community***	
2:10	Interview 2	Then it actually says that it won't support anything that's on farmland as a scheme, so at the moment, not really. There's not a massive amount of out there.	Solar panel subsidies do not allow for usage on farmland, so for A.V.	There are not any incentives regarding solar on farmland, so A.V isn't really a viable option at the minute for those who would need subsidies.	*No subsidies for solar on farmland*	***Governance Incentive***	
2:11	Interview 2	So, a lot of it we only have a short window that you can do it. So, we don't qualify for them and things like that. And I know there's things like the SFI scheme, but that's coming in only if you've been claiming basic payments and we've never claimed basic payments. So, at the moment we can't go into that and I know that the farming solar innovation, or technology, because I know we looked into that case that was talking about solar panels cause we were looking at that but actually it specifically restricts you can't put it onto land, it's got to be attached to a building because we were looking at that thinking that might be a good fit and it would actually work and it works with our system and the field we think of is right next door to our pack house. But the actual wording in that it could have been looking at it in the ground documentation.	Subsidies have very specific requirements and are often hard to get, so there is not much out there at the minute for something like A.V.	Incentives for A.V fall under a larger issue of how difficult it is to get subsidies right now for horticulture.	*It is difficult to access subsidies*	***Governance Incentive***	
2:12	Interview 2	Yeah. Yeah. You know something like a scheme like that. If it was for a local, probably a bit more remote area than it was having an area farmland, it would help an individual community somewhere, so it's not just the farming side, it's the sort of the rural community element of it.	The interviewee emphasises the important of a scheme that would allow for A.V to be used to benefit local energy costs.	They highlight the importance of the rural community, and how that fits into schemes that could be rolled out, in order to not only help farmers out, but also how that trickles down to the community as a whole.	*The importance of supporting the local rural community*	***Identity Community***	

2:13	Interview 2	I think what pushes it is the cost of the energy at the moment, sort of we're off its contracts on the old price at the moment, but once the new price kind of kicks in once that's a bit more expensive, because I know we're looking at potentially if that increase, and what we're gonna have to spend is significant, it might be then worth it, there might be a business case then to going into something like this that reduces our energy consumption and the extra we would say	There are a variety of price pressures so they're looking at reducing electricity costs	As farmers face increasing price pressures, they would look at something like A.V to help reduce their electricity costs	*A.V as a solution to reducing electricity costs amidst increasing price pressures*	***Business model Capital outlay Feasibility***	
2:14	Interview 2	So, the potential benefits for that, it's just how are the sort of funders and finances and things like that would view it, we don't know because we haven't done that yet. But I know we've been doing at the moment, working out what the different increase in our annual spend on electricity's gonna be and see whether that actually then says the conversation needs to be had now about looking at something like that.	They would like to see what their electricity spend looks like so then they can see how A.V might play into it	A.V may be able to reduce price pressures, but it is important to consider the upfront costs of A.V, and the payback time of it over the period of years	*A.V payback times and initial costs*	***Business model Capital outlay***	
2:15	Interview 2	Because it's a big upfront cost and it's like stacking funding, if there was sort of a grant or whatever but not for all of it. We're not saying for all of it. Maybe half of it or something like that. It makes it a lot more attractive and affordable, and the figures stack up a lot more then, OK.	A grant would incentivise the use, even at half	As with anything, if it is partially subsidised it will be more attractive, but we need to see how it works without subsidizing	*Grant incentivisation*	***Capital outlay Incentive***	
2:16	Interview 2	Yeah, going forward, it's probably, at the moment there's a lot of talk with our customers because obviously the net zero governments targets 2050, the NFU 2040, and a lot of our suppliers have come out at 2035, that they're looking to only take produce from someone who can demonstrate complete net zero by 2035. So, it's those. Those time scales are getting closer and closer, so that's probably what we're all working on at the moment. Sustainability and that part of it. The A.V thing, it's 1 great big package and at the moment it's a lot.	Supermarket suppliers are facing targets of 2035 to be net zero, and they need to work towards these deadlines in order to keep them as customers.	A.V can be seen as a way to reach net zero if they supply to their own farm and demonstrate their energy usage coming from it. This could be an important route for A.V and how it plays into farmer's business models	*Future proofing business and keeping customers due to the net zero targets*	***Business model Expectations of the farmer Food security***	

2:17	Interview 2	I think obviously growing a crop and getting a fair price for it, cause obviously costs have gone up over the last couple of years. But beyond that, that side, normal trading type conditions, it's more the sustainability side and being able to, I think it's gonna have to be looking at would not necessarily gonna have to grow the same crops that we used to grow in the same way we may have to introduce alternative crops and do a bit of a balance.	The main aim of this farmer is to want to keep getting fair prices for their crop, and secondary to that, to look towards the sustainability side and perhaps introduce new crops into their mix	Obviously, farmers have targets to meet to keep their business afloat, and to make profits. Yet in order to meet the net zero targets they need to look at sustainable business, and perhaps that means introducing alternative crops through something like A.V.	*Alternative crops and getting a fair price*	***Business model Feasibility***	
2:18	Interview 2	Well, part of it, and I do see it part of the whole thing, because if you can generate your own electric, you're reducing your reliance on sort of more conventional energy sources and things. But if you can then use it in conjunction with your produce, you're getting 2 gains from it while still growing the crop, or you don't need as much water you know cause a big thing for these irrigating like celery and Chinese leaves, you have to irrigate them. Lettuce is not so bad. And it's a big cost and if the evapotranspiration isn't as high, we probably wouldn't have to apply as much water. So, then the cost of that crop a lot less.	Seems like a win-win situation as you are reducing your reliance on conventional energy sources, and are producing crops at the same time.	With A.V, not as much water is needed to irrigate the crops due to the microclimate, this is especially relevant for celery and chinse leaves. The crop cost can then reduce alongside irrigation costs reducing.	*Microclimatic conditions allowing for reduced irrigation costs and thus crop costs*	***Acceptance Feasibility Food security***	
2:19	Interview 2	it's just something that's of interest and yeah, and like I say, it's probably more of interest at sort of a field level rather than on buildings and things like that. For us, it's just a personal preference and that sort of thing really. Yeah.	They state that field level solar is out of personal interest.	They would prefer field rather than roofed solar, through something like A.V.	*Solar configuration preferences*	***Acceptance Understanding***	

2:20	Interview 2	Yeah, I think tradition is old fashioned. So that makes sense, years and years ago, they were really expensive. If they were on a building or on houses, they have come down in price over time and there are a lot less than the other way when they first came out. So, I guess over time it you know, but it is kind of that you've got a bit of a chicken and egg type of thing. You've gotta get people to use it and there be more demand for it, the cost goes down and then more people get it. So, it's just getting the ball rolling and perhaps there needs to be some kind of funding or joint ventures or something like that that makes it affordable then?	The prices of solar have come down, but they state that there needs to be a demand for the costs to go down.	There needs to be early adopters to get the ball rolling, then the costs come down, and then more people will adopt. Perhaps this could be through private companies as in interview 1 or through government incentives.	*There needs to be early adopters to allow for the price of A.V to go down*	***Early adopters Identity***	

3:1	Interview 3	So, I started farming in about 2006 on an arable farm and it was mainly arable up until about. I don't know 5-6 years ago and then well in about 10 years ago, I bought sheep and slowly we've been integrating them more and more into the arable system and more recently in the last 6-7 years we've gone down the region. I've grouped and integrating livestock across the farm, not just my sheep, but lots of others as well. Cows and pigs and goats, and so on. And then we've also done a bit of vegetable planting up as well. So, we've got a new entrant who's coming to farm, who wants to grow veg. So, he does that on a small scale on the farm, but it will scale up and then in terms of value added, we also now start milling our own flour. So, we mill our own wheat and turn into flour as well. So, that's the that's the broad-brush approach, I suppose, yeah.	The farm is quite diversified with arable and small-scale crop	This allows for diverse streams of income and gives insight into how they might adapt to using A.V	*Diversified farm*	***Place-based context***	**This interviewee is now a crop farmer, who transitioned from a family arable farm**
3:2	Interview 3	So, we've got P.V as in we've got solar panels on the roof of grain stores and that makes us neutral in terms of our electricity. So, we generate as much as we use throughout the year. We did want to put in a big PV site about 10 years ago, I think, and it got rejected by the local parish council. It was really badly handled by the company who were trying to put it in, and we didn't have much of a say in the matter as we should have done. And yeah, it was. It was a big mess, so that was kind of shelved. And I suppose as a result of that, we've kind of always thought, ohh we were, you know, other than on buildings, that's fine. No one can see that kind of thing, but umm, it's always been a bit irksome, to be honest	They already have solar P.V on their grain store roofs and neutralise their electricity usage. They wanted a big solar P.V site but it got rejected and was badly handled.	The local council handled the rejection of their P.V site badly a while ago, and it may have a negative impact on how this farmer perceives A.V in how it is to be adopted.	*Complications regarding landuse acceptance*	***Acceptance Governance Community***	

3:3	Interview 3	In A.V, I think. So, in terms of PV, there's a lot of P.V around us and people that I know, for example, who've grazed sheep under it, have had huge problems because you can't train a dog to round up sheep under panels because you know, they escape that way as well as that, you know, you can't circle them around them. So, they've lost or left sheep out there. You know all this kind of stuff, so it hasn't had a brilliant up taking in terms of grazing in amongst PV, but I can really see the benefits of AV being because it's higher up. You you're basically dealing on the ground with just a few sticks rather than great big barriers, so I could see that could be much more of a of an attractive proposition, particularly as it's flattish and so on	There are issues with solar P.V and grazing regarding rounding up the sheep using a dog, as they find it hard to navigate around the panels, but with A.V being raised higher, the dog may find it easier to navigate the sheep around	It will be easier for dogs to round the sheep under higher A.V installations than ordinary solar P.V farms, so perhaps it is just about how the configurations are.	*Solar configurations*	***Acceptance***	
3:4	Interview 3	But my concern would be with what happens in the winter months when you need as much light as possible, particularly in temperate climates? How much? How much would that hinder? Umm, the sun getting through to the plants when there isn't a lot of sun in the daylight, and I don't think there's been much research on that	In the UK, there is a lack of light in the winter and an issue regarding harnessing as much light as possible for the crops	This farmer raises an important issue regarding A.V in the UK, and how the crops already receive low amounts of sunlight in winter, and A.V would reduce that, but again it is about seeing which A.V configurations work in the UK	*Lack of sunlight for crops*	***Environmental impacts Place-based context***	
3:5	Interview 3	But I think AV could work if it was maybe over a couple of tram lines, or you know, something like a part of the field to see how that would work. I think the 3.2-meters between them is always gonna be problematic because all the arable kits are either on 3-meter or 4-meter parameters and so having it 3.2 is never going to fit in between. You know you're never gonna have a tram line or whatever it is that you've worked doing.	A sufficient space between the A.V systems will be better to allow more sunlight to reach the crops and to allow machinery through	A.V will have to have at least a certain amount of space between the panels to allow for maximalisation of sunlight and also to allow for machinery to be operated	*Space between panels*	***Feasibility Land use***	
3:6	Interview 3	So you know that imaginative ways of putting them on in situ would be great. And farmers are usually pretty imaginative when it comes to creating those spaces.	Farmers can have different ways of imagining the configurations of things	This leads to them being able to adapt A.V to how they best see fit for their own models	*Adapting A.V for their own farms*	***Identity***	

3:7	Interview 3	But as I say, I think you know, it might work better around headlands than it might in the middle of the field, but then having said that, if in the middle field and if our climate is changing the middle of field might need more protection from the sun in the height of summer when it's getting 40 degrees, then that would that would work, you know, so.SEP So, I could see that I could see that there's a mixture of pros and cons.	With climate change, there is a concern regarding the temperature increases	This means that A.V might work in a way to help with changing climatic conditions on farms, as it helps retain moisture in the crops	*Climate change*	***Environmental impacts***	
3:8	Interview 3	I think the government at the moment are really concentrating on SFI and getting that right. But I think as well that they're very much open to the idea of blended public private finance.	The government are interested in the blending of public-private finance	Rolling out A.V might mean a combination of both public and private sectors	*Combining public and private sectors*	***Governance Incentive***	
3:9	Interview 3	I'm sorry if you could get private finance to say right. I'll give you a grant to do it or we'll go 5050 or whatever it is. Then that would be great, but as you say, yeah, if there was a grant and the government were trying to roll this out, then that would be great. But I wonder, sort of cynically, what actually their plan is as far as farmland in the long term, because they're paying a lot to get people not to farm. So, this is this is not necessarily an answer to that. Because you could still farm underneath the AV unit and be absolutely fine, you know.	This farmer states that the government is trying to get less people to farm, so they're not sure where the grants would fall under in their plan	If the government is looking to encourage less people to farm and offshore produce, then it is safe to assume that there will be less subsidies available for agriculture	*Offshore produce*	***Governance Identity Incentive***	

3:10	Interview 3	I definitely would favour that [provide electricity to the community]. Yeah, we do a lot of work with the community and providing, you know we've got a 4G mast and you know, trying to help them to get 5G and if we could we have an EV charging points you know all that kind of stuff to the more you could do to help local community. I would definitely do that over and above something to the grid where it could go anywhere, and I suppose the other thing as well is that it is. I would say probably a lot more sustainable than coal or something like that. So, you know, again it would be a much, it would be great if it could you know how you can choose your electricity tariff according to how the electricity is produced. It would be great if there were more greenhouses for that kind of electricity being produced, I think.	This farmer does a lot of work with the community and so favours using A.V to help the local area	They are interested in how sustainable A.V can be for their community energy usage in comparison to the likes of coal. They speak about the grid allowing the electricity to go "anywhere", so there is a sense that they like the idea of owing it to the community.	*Owing the local community*	***Identity Community***	
3:11	Interview 3	So, then you've got to rely on this sort of philanthropic elements of the landowner or the farmer, and that's, you know, that's quite a big ask if you're tasking them with capturing carbon, producing all the foods, sorting out the environment, you know, and then can you do it all at cost? And you know, that's quite tricky, I think.	There is a lot of pressure on farmers to meet food security and net zero targets as well as them providing a profit for themselves	With these pressures, it will naturally leave some farmers in the dark amidst the competition for the best price, so there is a reliance on farmers to be quite creative in how they diversify their business and allow it to stay resilient in the face of such pressures	*Resilient business models to face the pressures*	***Expectations of the farmer***	
3:12	Interview 3	Yeah. And I almost I think it is possible. I think it's quite complicated to do that, and I think the lack of subsidy, as in taking away BPS because I think it was sort of too easy and it shouldn't be a God given right to someone who just because they happened to own some land, to get some payment from the government.	The past subsidies were 'too easy' to get, and farmers would've been applying to it even if they didn't need it	This would then reduce the value of needing a subsidy, and speaks to how the government should make subsidies fair to apply to	*Subsidy access*	***Expectations of the farmer Incentive***	

3:13	Interview 3	But I do think that all of these juxtaposing issues are placed at the farmers and the landowner's door, not necessarily fairly. When it all goes up in smoke and then they say, well, actually we're gonna import all of our food from the other side of the world and fly it in. And you know, and it can be any season you like and then it's the supermarkets who dictate that kind of stuff. You know, something's gone wrong. Something's majorly wrong. The way we're combating that is by developing our own local market as such. You know, and producing food, processing it ourselves and then selling it and I think the same could be there, for rolled out to electricity and the more self-sufficient you can become or become as a community, probably the more resilient you'll be to all of these changes in the climate in the future and the world in the future and food systems and all the rest of it	There are too many pressures facing farmers, and supermarkets dictate which places they get their food from, be it other countries. This farmer sells their produce at the local market, and likens this idea to rolling out electricity yourself and becoming more resilient for yourself and for your community	There is a focus on being resilient in the face of these problems, especially with how fragile the food system is in the UK	*Resilience*	***Business model Competition Expectations of the farmer Food security Governance Identity***	
3:14	Interview 3	But it's not easy to do especially if you're not necessary set up for it which I don't think that this country is you know. I think definitely the Government at the moment is really pushing climate combating stuff rather than food self-sufficiency. So, you have a very fine line between all the different sort of factions.	The farms that are able to combat pressures are set up to do so, and the government is prioritising the net zero targets over food security in the UK	This speaks to the natural competition of any sector really, but the farmer notes that there is a fine line between food security and the net zero targets, in that they will often overlap to aid in sustainability in the country	*Government prioritising sustainability over food*	***Food security Governance Incentive***	

	Interview 3						
3:15		Exactly that and it's kind of being sidelined at the moment. You know the answer in most politicians' brains is well, it's fine. We just enforce it, but it doesn't take too many crises for you to realize just how fragile the food system is and the problem. You can't import it and then you turn around and go, oh, we're not actually as self-sufficient as we should have been in this country. We should be able to produce pretty much all of our wheat. I mean, fine. If someone wants to have avocados, you are gonna have to import that, but if actually there's viable substitutes for all your major food sources, then you don't need to do that.	The food system is fragile and we as a country are not self-sufficient enough to cope with shocks	We import too much food which is reliant on the state of the place we get it from, and the farmer notes that in politician's minds, they are disregarding this fact and still sidelining UK farming	*Fragile UK food system*	***Food security Governance***	

	Interview 3						
3:16		So, we want everything to be completely sustainable on our own 2 feet economically, so that everything that we do is at least covering its cost and preferably making something to make it worthwhile, but without losing sight of the protect element, which is the environmental stuff, because if you haven't got healthy soil and if you're pumping the place full of pesticides and stuff, then you're not gonna get a healthy habitat. And, umm, biodiversity. You know all that kind of stuff.	The farmer wants to be able to be self-sufficient and cover the costs and keep in sight the environmental focus	This shows the farms focus in face of the pressures outlined previously, and it is mostly about keeping their farm environmentally 'friendly' and producing their own electricity	*Self-sufficiency*	***Business model Environmental impacts***	

	Interview 3						
3:17		And so, and then the final sort of pillar is about learning, which is kind of our social sustainability sort of things. And we have a massive sort of education element to our work that we do because if everyone dies out and the average age of a farmer now is 60, we're always pushing young farmers, you know, school children until all the way up to students, PhDs, whatever, all ages. But, trying to promote farming to a much wider audience than just, oh well, I've had it in my family for 300 years, so I'm a farmer. You know any other industry that wouldn't be the case, you know, if your dad was a lawyer, there wouldn't be any obligation whatsoever for you to go and become a lawyer. So, it just seemed in farming and some family businesses, you know, ohh yes, well, then the children will inherit. Why? And actually, what barriers does that put in place for other people who haven't got a parent who is a farmer? You know? And so on. So, I think that the more we can get this sense of community back to the village and the rural communities, that should be all linked in with the farm and food production as well as environmental work	This farm focuses on educating youths about farming, which is sparked by the fact the average age of a UK farmer is 60 and is saying how 'everyone dies out'. They speak to the traditional aspect of farming being carried through generations and question why that is the case, and what barriers exist for other people to enter the farming sector. It is also important for them to get the sense of community back, which is aided through the farm production and environmental work they they get the children to help with.	There is a concern regarding the barriers into farming and they want to challenge the traditional familial entry aspect, and so they want to educate the younger generations on the importance of farming and the sense of community	*Educating younger generations*	***Identity***	

	Interview 3						
3:18		just think that then people get connected to the environment or to food or to farming generally, and I just think that once you reestablish those things, people care more about nature in their local community, and they will fight for it. And at the moment, most people have been pushed off the land, have no connection to it, and therefore couldn't really give a damn what food they eat, because they're only now learning about it because of the gut Biome and the health project. Realizing that the soil health is to do with gut health, and you know all that kind of stuff. So, those really are the three priorities because if you don't have one, you, you know you're screwed with the others basically.	When people farm, they are generally more connected to the environment and care more about fighting for their local community and its nature.	So, they realise the importance of the education element of their farm, in helping the community build its 'feel' back up	*Connectedness with nature and the community*	***Identity***	

	Interview 3						
3:19		I think yes, there's the costs and the upfront capital cost. But I think those could be mitigated if the benefits are there for everyone to see. And if the government backs it or public/private finance backs it. So again, I think that those are barriers, but they can be overcome. I think probably the biggest issue, which is not impossible to overcome, but I think it's hardest to overcome probably at this stage, would be the sort of social side of it the fact it looks like a robot or the fact that it's machines that is completely unknown. And if you think historically when they first put pylons all across the place, there was outrage for it. And I think that you get someone like Jeremy Clarkson to do it on Clarkson's farm. And then suddenly, it'll all be fine, you know?	There are the clear costs of A.V, but if the benefits are clear then the barriers can be overcome. It is hard to at this stage, as they speak about the social acceptance of pylons and the outrage against that, and states technology can 'look like a robot', and uses the example of Clarkson's farm to engage with the farming community to get them on board	They acknowledge the important social side to accepting such a technology, and that all it takes is someone with a huge impact, like Jeremy Clarkson, to implement it	*Influence*	***Acceptance*** ***Business model*** ***Capital outlay*** ***Early adopters***	

3:20	Interview 3	It's like, I think there is a lot of them, but then I was also farms meeting this morning and it was about integrating livestock onto cover crops and it was a grazing trial that we'd taken part in. And reporting those things and the room was full of people, neighbours and so on, who all know what the right thing is, and they're just scared of having a go. And I was one of two people who had actually integrated livestock into the parable rotation, and there must have been 40 or 50 that hadn't. And I think that that is indicative of an awful lot of farming elements, whether it's no drill, no till or it's putting AV in or being carbon negative or whatever it is, they all know what they should be doing. But they never quite have the guts to try it and to push over that thing. In fact, I was talking to someone, a field scholar, someone else who's done their PhD, but on beetles, and she said exactly what you're talking about of getting people from A to B. You know that middle 60%, there will always be 20% that give everything a go and there'll always be 20% that don't want to, but it's the ones in the middle. How can you influence those the most? Because once you've got that, you're sorted really.	This farmer speaks to farmers not having 'the guts' to push over the judgement of being the first few people to implement a new technology. They speak about there's always 20% of people willing to give new technology a go, and 20% who just don't want to, and its about engaging with the 60% who are on the fence	There are social aspects to how farmers come to adopt certain technologies, and It is about engaging them in the correct way and informing them of the pros and cons that come with new technology	*Engaging with farmers*	***Acceptance Early adopters***	
3:21	Interview 3	Yes. It's not just something that they have to be subjected to, but actually can empower them to make this. Yeah, I think that's really good point, yeah.	They don't have to be told what to do, but just informed	It is about empowering their knowledge and decisions regarding implementing new technologies, rather than straight up telling them that a new technology must be used	*Empowerment and agency*	***Knowledge of A.V***	
3:22	Interview 3	OK. Yeah, because those kind of science, kind of techie questions, that would be quite interesting from a UK perspective even from a local or you know and then national but equally if you've gotta go quite far afield to see those kinds of things.	They need evidence to want to see how it may work for them	They need the UK evidence and pilots to give them the knowledge to inform them about A.V	*Knowledge*	***UK evidence***	

3:23	Interview 3	I mean, if you consider what we do in terms of land mass, but when you think that we're less than 2% of the working population, of course no one takes it seriously because it's a pretty small minority. They're much more interested in bankers because they produce huge amounts of money for the economy. But yeah, if you look at someone like John Deere, they recognize that agricultural technology is far more cutting edge than say, the car industry is. So, we've been doing robotics, and you know, driverless cars and vehicles and so on. Far sooner than the car industry and so there are some elements where it is recognized, but AV doesn't seem to be one of them. Maybe energy is the 1 area that farming needs to have quite a close look at really	They feel disregarded as a sector as they are a minority at 2%. They feel the government focuses on other sectors e.g., banking, that produce a lot of money for the economy. Yet, they feel that farming has been at the forefront of the technology sector.	The government is focusing on other areas than farming, and there needs to be a focus on tech in farming.	*Government prioritising other sectors*	***Competition***	
4:1	Interview 4	But I mean our costs for electric have increased about three times, and in fact they've gone up so much, it's a factor in I'm actually probably losing money and this will be the last year that I grow fruit on the farm because I'm losing money every year. Fact is also that I'm in my mid 60s and I have three children, and no one wants to join to continue with the farm business, so what's point? That's where I am with that, but certainly that's been a very good decision, the first P.V we cited around our reservoir. A second P.V system on the roof of the pack house, so, it didn't really use much. You know, we haven't lost any land relief growing crops. It's a no brainer, really.	The farm is losing money and the children of the farmer do not want to take over, so this farm is going to go out of business.	How can farmers be expected to put in systems like A.V if they are already facing a loss and can't find the money	*Farms out of business due to increasing energy costs*	***Business model***	**This interviewee is a fruit farmer**
4:2	Interview 4	On a larger scale you don't get a feed in tariffs. So, the incentive varies to make your own electric and reduce your electric bill.	Feed in tariffs no longer exist, so there are other incentives for farmers to reduce their own electricity bill	With the lack of incentives, farmers would have to use their own goals for their business to figure out if A.V works for them	*Farmer's being their own incentive*	***Incentive***	

4:3	Interview 4	Basically, you've got to be very good at what you do to make profit farming, and it's been very difficult to make profit and it's not just us going out of business as a number of other fruit farms that I know of that are giving up as well. You know, can't make a profit.	Farmer's having to be very good business-people to currently make profit, as there are numerous fruit farmers going out of business	As with any business, the ones who are the best at maximising their profit and enhancing their business model will stay afloat	*Farming competition*	***Business model***	
4:4	Interview 4	Yeah, incredibly short sighted. I don't know whether you know what's been going on in Wales, but the Welsh Government has decided for farmers that 10% of their farm, will have to be to plant trees. And there's no consideration how that will affect business. I'm very lucky because I have not wanted to go on any of these environment schemes because I think it's up to me to decide what I want to do with the land. Fair enough, the government says, well, you know, we'll give you some money, but it's the amount of money that they give. I mean our farm is quite small anyway, so you know, I think last year from the single upfront payment we received about £3000, that that might seem a lot to you, but, if you compared the fact that our turnover is about 1.1 million, £3000 is not really here nor there, really. It's a contribution but, in the scheme of things, for the amount of benefit to the fall is extremely small and you know the government can go and shove its money as far as I'm concerned	There have been policies put in place in Wales that help target their sustainability goals, like mandating that farmers have to have 10% of their land dedicated to planting trees. The farmer believes that these policymakers don't think about how this will affect the farming business. The grants the government give are not big enough in the grand scheme of things.	Policymakers do not know what is good for the farmer's business model	*Policymakers are not farmers*	***Governance Identity***	

4:5	Interview 4	There is a tendency now for farms to get bigger and bigger and bigger. Yeah. We're just not big enough basically. When I started on the farm, which was in the 1980s there was a fruit growing society, or the Essex fruit growing society, and I used to go to meetings and there used to be 50/60 fruit grows there in the 80s, nineties, maybe 70 or 80. And that's steadily declined. Now there's nobody there, they've all died. Every year, the smaller fruit farms people like myself. Yeah, the farmer gets to their 60s, farmer retires, maybe it's taken over. They dropped out but one or two other farms get bigger and bigger. So, there are two very large fruit plants around. Even they are finding things pretty tough. It's the business, you know. Those who are the best thrive and those who are not as good, maybe, don't have the economies of scale, fall by the wayside. That's business, you know. I think we could rue the day because, in years to come, there will be a lot less family farms. I think that could cause problems with food supply in the years to come.	The farming community is dying out and the business is pretty tough and eventually this could cause problems for the UK food system	In a few years there won't be enough UK farmers, so it might be too late before the government intervenes	*Farming community dying out*	***Business model Competition Governance***	
4:6	Interview 4	I guess it's the capital cost. I guess there's different priorities right now as well. I mean because obviously we're winding up business after the end of this year. You know, I wouldn't want to be spending any more money. I mean, the good thing is that we're still getting the feed in tariffs. So that's on the plus side.	There are different priorities for farmers at the minute, especially those whose business is suffering	There are more pressing issues for farmers than installing A.V or new technologies	*Other farmer priorities*	***Business model Capital outlay***	
5:1	Interview 5	but a lot of our farmers, before you get into their questions, have already kind of flirted with this kind of stuff. So yeah, I'm a bit aware of what's going on	A lot of farmers are interested in A.V	They seem keen in the technology and just need someone to inform them	*Farmer knowledge*	***Early adopters***	**this interviewee is a land developer**

5:2	Interview 5	So, a lot of my work at the moment is based in that arena. I spent a lot of time with farmers, and we're sort of working with them to understand how they can make their farms more sustainable and resilient. And because climate change is happening, stop them being too risky when it comes to shocks. And so, there's quite a lot going on there. Then there's other things like, obviously we have our own solar power initiative at work. We have 188 currently we're looking at doubling that, we have no gas on site, so all our hot water is generated through our own fridges. We have what's called a heat exchange plate and the heat from the fans that are spinning for the fridges and basically heats the water that we need for hand washing and cleaning down and flushing toilets wherever you need it for.	They work towards making farms resilient and sustainable against shocks.	It is important to be resilient in the face of climate and political shocks	*Resilience*	***Land use***	

Interview 5

5:3		And so after the Second World War, about 1950s, 1960s, and the government incentivized farmers to increase numbers of animals because we were starving to death as a nation coming straight out of the Second World War. There was a scheme that came before it, but the main one that came through was called the Headage scheme. So headage, meaning head per head of animals and the logic was to pay farmers per animal and get more food. But the problem was is that the farmers went, oh, this is great. We'll just, you know, keep beefing up the numbers. Essentially what happened was, is we were overstocked. So, the government had to change it again and essentially what came out of that was what was called the BPS or the basic payment scheme and this paid farmers per hectare of land that they were managing whether they owned it all the tenant and they could get the money if they were managing the land. But it didn't pay them for anything other than that, they would just be managing that land. There was no incentive to be good or bad, or indifferent, or look at their business models in an objective way and in most cases for farming in the UK, supermarkets and farmers became increasingly reliant on these grant schemes to the point where if you stripped it out and looked at their business models, they were functioning at a loss and the BPS would give them their profit and they knew that it was coming through the end of the year. There was no really incentive to look at the business model because he knew they get this big chunk of money and they put it into more and more animals	The scheme implemented after WW2 only incentivised farmers to have a lot of animals, rather than think about their business model, and so the farm was overstocked with animals. This is the same as the BPS, in that it only subsidizes their land management, not necessarily how they go about managing the land be it good or bad. These grant schemes were relied on and now farmers don't know how to operate without it	The past incentive schemes didn't motivate farmers to reevaluate their business model, and they became too reliant on these subsidies or grants.	*Farmers are too reliant on schemes*	***Business model Governance Incentive***	

Interview 5

5:4	Interview 5	Obviously, we've had Brexit, we're leaving the EU. It is an EU payment, the basic payment scheme, and the government are trying to replace it with what's called Elms, which is environmental and management schemes. It should have been sorted, everything should be up and running. It's not. It's very much one step forward, 2 steps back. We've got some farmers on it. The government is still very unclear about which way it's going. Still, farmers are finding it increasingly difficult to run the businesses because they've been kind of lured into this false sense of security of that money will always be there. So yeah, so the transition in the farming world in the UK at the moment is to look at ways of maybe changing your farming business to be less reliant on these grant funds	Following brexit, the government have been trying to replace the BPS, but it has gotten nowhere. Farmers feel like they've been lured into a false sense of security with the promise of grant schemes.	The government is failing to follow up on their promises of implementing new schemes, and farmers feel left behind after years of reliance on such schemes.	*Farmer reliance on schemes and a false sense of security*	***Business model Governance Incentive***	
5:5	Interview 5	And because you don't know what they're going to be and look maybe more at diversification on your farm rather than the monoculture of the past. I'm a sheep farmer. I always produce sheep and that's the way we've always done it. That kind of mentality now it's kind of not sustainable basically. And so, farmers are looking at other ways of generating income or resilience or sustainability on Farms, and A.V is one of them.	Farmers have to reevaluate their farming process and diversify to see what is sustainable for their farm	Farmers must diversify to find other ways of generating income and therefore resilience	*Farmers must diversify their income*	***Business model***	
5:6	Interview 5	There's a lot of really good NGOs and not for profit organizations trying to get farmers to think a bit differently about how they're running the Farms, pasture for life is one, and nature friendly farming network is one. Leaf is another. You know, all these things are just giving farmers a bit of knowledge to see how things could be different.	There are sources out there available to farmers that give them the knowledge to evaluate their business model, but its about how they come to access such sources	There should be more knowledge and access to NGOs and not-forprofits which allow farmers to understand different perspectives of their business model	*Farmer's knowledge of diversification*	***Business model***	

5:7		I think a lot of farmers have always loved hard work. They love working a lot and they find a real pleasure in that actually, which is strange. And they seem to be happier when they're busier, which is, which is great. And a lot of them will look at this and think, you know, you could say sort of all harvesting sunlight. So, in a sense, you're still a farmer. It's just you're not having to go out and do anything. It's just there and doing a job and a farmer might look at it and think of it as a lazy option. Which is a shame, really. And it's trying to change that mindset. You don't have to be a busy fool, you can work smarter, not harder. And actually, by stacking your enterprises on your farm, if you're a sheep farmer, maybe look at reducing the amount of sheep you've got. Maybe start looking at cattle as well on the farm. Maybe chickens and an egg lane operation maybe. You know, it's all these things and I think that's where it's gonna be a bit of an issue because I think you know any kind of initiative that you're going to try to implement has to take into account the culture to which it's trying to be adapted to. I mean you could write the best strategy in the world, but if you haven't considered the culture to which it's gonna be administered to, don't bother. Because the culture will eat it for breakfast, it's just a waste of exercise. So, you really do need to get that kind of down 1st and then move on to something else.	This developer has a variety of farmers that he knows and has worked with, and states that they are busy and hard-working people, and they love that. They might think that something like 'A.V' is lazy, as you're not actually going out and doing anything. It is about changing that mindset, but being sensitive to the culture that the technology is being adapted too.	Farmers can 'work smarter, not harder' and choose options like A.V that still work in producing for the farm; 'harvesting sunlight'. But it is also important to understand the culture it is being administered to, otherwise it would just be a waste of time.	*Changing the 'hard-working' farming mindset*	***Acceptance Business model Identity***	

Interview 5

5:8		And he's a farm manager. He's not a tenant farmer, it's a different kind of thing. It's owned by the family, who have owned it like 500 years, and we had a meeting with him and their land agent (essentially like an accountant for a farm), and I said to him, how's it looking? He said when I was talking to him about the BPS being phased out because it won't be there by 2028, that's when it stops. So every year it's coming down incrementally and he said that this January, traditionally because farmers would get their BPS payment scheme at the end of the year and January, places like Wearings that build big farm buildings, big barns and generally their books get filled up and this time and because the Farms have got the payment through, they go like, well, I need a new barn. You know, there's the money off you go this January. The books on most of these places are pretty cold and empty, so it gives you a very clear indication as to which way it's going at the moment, and I think this will be the year where it will start to really bite. I think farmers will start to think I need to get something sorted here. So, what do we do and things like this could be one of those things that they think, Ohh yeah, we'll go down the AV route as well as doing everything else, because heck we need it, you know.	Places that would be fully booked up, like farm building businesses, have empty books, due to the lack of BPS.	Businesses and farmers will start to see this year how much they are suffering, and it may force them to diversify	*Businesses suffering and so forced to diversify*	***Competition Feasibility***	

5:9		When Vattenfall were building the only sandbank wind farm just off the West Coast of Cumbria. Obviously, the landscape, the view changed, he had this beautiful stretch of water, and now all of a sudden you can see all these wind farms. And there was a lot of problems there, but one of the main problems was obviously that all gets funnelled into a hub on the land, and then it's pushed into the grid. And that hub was in a small village on the West Coast, and Vattenfall gifted one of the wind turbines to the village, it is owned by the village. So, everybody in the village has a share in this wind turbine. It sits on the outskirts of the village. It's actually next door to this big pumping station thing and the idea is that because they have ownership over it, it is theirs, it generates power for this small village. The company found it a lot easier to get them on board and say like right, OK, I know things are gonna change, but we're gonna help you out. This is what we're gifting to you. I don't know how much the wind turbine was, but it ain't gonna be £10. It's quite expensive and it's the fact that this local community, they can look at it every day and know it's theirs. They own it. They have a small company that manages it that they created. I think that's a really interesting sort of social experiment. And there could be elements of that, and I think you're right. If you can get farmers to provide for their local community, I think that works a lot easier. Farming is a local enterprise just by virtue of the fact that you're farming the land around you and that facilitates a local community, whether that be a small village or small town or whatever, not just through food production, but also through environmental work and looking at ways of improving it and giving people green spaces to get back to nature. And I think if you can tap into that it will make a lot of sense to them.	The wind turbine provided electricity to the local community, so they feel like they had ownership of it and their negative perception of the turbine changed. It is about tapping into the sense of ownership.	When new technologies like A.V and wind turbines are first in place, they have a negative perception as to their visual impact, and so providing the community electricity will give them a sense of ownership and so heightened acceptance	*Farmer's feel like the electricity source is for their community*	***Acceptance Identity Community***	

Interview 5

5:10	Interview 5	Yeah, it's difficult because I think in Cumbria, as I said, it's obviously it's very hilly and I think you'll do really well in places like on the coastlines and maybe down in the South Lakes where the lands may be a bit flatter. But I think in places like Grasmere and Langdale and Borrowdale and stuff like that, I think it would be difficult to implement it around there unless it was on top of the barns. Because you're gonna come up against people like the friends of the Lake District. So, if you're applying for planning permission to put solar panels on your barn in the middle of Borrowdale, and you'll have to get the OK from the Park Authority, possibly from the National Trust, possibly some larger estate, possibly from friends of the lakes. And these guys often don't agree on the colour of an orange, and it's tough. So, whereas I think in more kind of lowland farming, I think you've probably got more chance of getting something off the ground. It's not saying it can't be done, it's just I'm just showing you the barriers there which would come up	It is easier to implement on flatter lands due to the structure. In some places, the local authorities are rather strict as to what they allow too.	Crop A.V or sheep grazing A.V should only be placed on flatter lands	*Topography selection*	***Feasibility Place-based context***	
5:11	Interview 5	Because the thing is, is that they want farmers to be more diverse. They totally get where they're coming from, but as soon as the farmer wants to do something that's remotely out of the realm of what they've done for the last 50 years, everybody's flipping arms, the riot.	Farmer's want to try new things, but it is down to what the council allows	There are restrictions on what farmers can do with their land	*Local council preventing new land use projects*	***Expectations of the farmer***	
5:12	Interview 5	Yeah, I think it's just a case of maybe focusing on farms have to change. Food has to change, the way we produce our food has to change fundamentally, and the food system is absolutely shot to pieces. And it's too reliant on finite resources. And as we all know, when we're working in sustainability and the more you choose through them, the less resilient your system is yourself to risk	Recent political pressures have highlighted how sensitive the food system in the UK is to shocks	There needs to be a focus on making the UK food system more resilient	*Resilience*	***Business model***	

5:13		I think it is just a case of maybe just getting the word out and start talking to them more and seeing it won't be falling on deaf ears. As you said, they are quite resilient, but that's the trouble with farmers is there's a lot of peer pressure. They're terrified of doing something different for the sake of going to the pub and getting their heads bashed in because all the other farmers are just not doing it, it's difficult. And I totally understand where they're coming from. But yeah, the trouble is, is that we've sort of inherited a situation totally not of our making that we're having to try and change, because they've been given this money for such a long time through no incentivization other than the fact that it's managing the land you know changing that mindset it takes some time	There's a lot of peer pressure in the farming community, and they often follow each other. Changing their mindset takes time but it is about talking to them about new options.	Farmer's need to be provided with sufficient knowledge of how to reimagine their business model, and even then, they fall under social pressures of trying to be accepted by other farmers	*Social pressures*	***Identity***	

5:14	Interview 5	Actually, just thinking about it, so my role, the way that LDF works, it has about 65% of its customer base are kind of standalone restaurants, a lot of them are Michelin starred. Let's take Manchester as a prime example. Onda, the pasta place, yeah. So, these are the kind of places that we work with. And then on the flip side of that, we also work with big catering, corporate catering, hospitality businesses and they'll supply services to people like Google and HSBC, KPMG, massive buildings in London that have a huge workforce and they'll take, you know, meat to provide lunches, dinners, fine dining dinners for border directors, yadda yadda yadda. Now the small standalone restaurants aren't really that concerned about their carbon footprints at this moment in time because the majority of restaurants are quality driven. It's not really important, but if we can provide it, great, wonderful. It's not really part of this strategy to create the best restaurant that they can. However, places like Google, places like HSBC, they do. Now they have huge net 0 aspirations and that trickles down through to me. So, I listen to what the Board of Directors say in these places. Then I have to sort of transfer that to the farmers, so they have a real understanding of their own customers downstream. What they need to understand is if they don't start working towards what these guys want eventually you might run out of business. So future proofing businesses is probably a big thing when we're looking at this, because if you're putting solar panels on your farm and you're not bringing any from the grid, it's a big step forward towards your own carbon footprint at farm level. So that's one place where LDF can be an enabler for them to get their heads around it, because we can tell them that this is what the board of directors were asking for. Google, they're giving you time to put it together, we're talking, you know, 2030. But if you haven't done it by then, it's gonna be a real issue. But, yeah, good, good.	Farmers have customers which range from smaller restaurants to big companies like google which they need to cater events for. Google and similar companies have huge net zero aspirations, and so would only take supplies from farms who can display such net zero models. This then forces the farmer to transition to a net zero model.	Net zero goals from big companies will trickle down to farm suppliers, in that they have to meet their targets to keep the companies as customers. This is part of keeping the business sustainable economically for the future.	*Net zero targets trickling down to farmers*	***Business model***	

6:1	Interview 6	Yeah, I mean, the conversation should be that AV is an option, but it's not the silver bullet.	A.V is feasible in different contexts, but shouldn't be the only solution	It is about seeing which contexts A.V works best in, and how it falls into place with existing business models	*A.V complimenting existing farm configurations*	***Place-based context***	**This interviewee is a land developer and works in natural capital**
6:2	Interview 6	Agrivoltaics is something that is pretty nascent in where it is as a viable solution in industry and business	A.V is a new thing in terms of how it can fit in larger scales in the industry	Again, it is about figuring out how A.V can work within farm businesses	*A.V piloting*	***Business model***	
6:3	Interview 6	I guess the concept of agrivoltaics, not necessarily the term, the coexistence of solar energy and plant cultivation, dates back to 1982 literally. And I guess it hasn't really featured in literature from then until about 2005 or 2006. So, I mean, in terms of its frequency of mentions across literature, it's just absolutely like I guess accelerated in the past, I would say, five years or something and in terms of interest, it just keeps on going up and I mean, even though notwithstanding that 1982 reference, I think it's Australia or something, I can't remember the exact name, but ultimately it's a new thing and I guess with any industry or technology or innovation in that is relatively new, I think there's a lot of people in the market that are obviously trying to pitch for it.	A.V as a concept is not new, but it has accelerated recently and it is ultimately a new thing within the business context	Getting the ball rolling and getting A.V sites out there	*A.V piloting*	***Acceptance Early adopters***	
6:4	Interview 6	And I think the essence of A.V is that it's very specific to the location as to whether or not it can be a viable or successful solution. And there are so many key variables in that equation to determine and dictate whether or not it's successful. And I think with any kind of nature-based solution, it's very location specific. So, I mean, and it goes beyond location, I mean the location in terms of the climatic factors are a key factor for determining whether or not the outcome is the same	There are different contexts as to which A.V can work in	This can be climatic factors or business factors, and both are very important when thinking about naturebased solutions	*Different contexts*	***Place-based context***	

6:5	Interview 6	In the UK, like you cannot say that Agrivoltaics had the same benefits. We don't struggle with water scarcity, so we don't need that increased water retention. We also don't need shading because it the opposite is true. We need more sunlight in order to make our crops successful and also, we need more sunlight to generate solar. So, it's different circumstances and however say in a temperate environment what you might get benefit from storm damage for instance. And you cannot compare storm damage to protection against intense sunlight. So, it's very complex in terms of what the circumstances are with regards to what the outcomes would be and the benefits and therefore the risk / benefits as well. And so, I think in summary, yeah, you know, it could be a solution, but in a very specific criteria.	There are many benefits to A.V which perhaps aren't as needed in the UK context e.g., crop water retention and crop sunlight protection. It is very complex to see what works, but it can with a very specific criterion	It is about adapting it to see how it would work in the UK, e.g., protecting the crops against storm damage, but this is quite a small benefit in comparison to protection against sunlight in other regions	*Different contexts*	***Acceptance*** ***Business model*** ***Place-based context***	
6:6	Interview 6	I guess it's not even about that though. I mean yes, it's about piloting and finding out. There's been a lot of pilots already and we already are in the position that we know where it's successful and where it's slightly more ambiguous and it's not rocket science to know that, you know, ultimately you've got a piece of land if you use that piece of land for 100% agriculture, you're going to have to sacrifice agriculture or proportion of it to then deploy solar to coexist within the same given area. However, if you had 100% piece of land and you dedicate that to solar, you will have 100% generation of solar and then you want to get agriculture to coexist in it.	There have been pilot studies to see where its successful, but it is ultimately about minimising the risk of the trade-off of agricultural land	We can see which contexts it is most feasible, but it is deciding where its best to use the dual-land use approach instead of pure agricultural land	*Land trade-off*	***Feasibility***	

6:7	Interview 6	However, if you had 100% piece of land and you dedicate that to solar, you will have 100% generation of solar and then you want to get agriculture to coexist in it. You will have to drop the 100% generation of solar to compromise to then integrate agriculture, and there's a compromise on either business model. And so, the argument there is how do you make that compromise coexist. The overarching discussion should be OK, well, if we've got land to optimize for one or the other, then great. And does it make a difference if we have to coexist and is does it make economical or environmental sense for us to coexist if one is not optimized? You know, over the other, it's a hard balance to work out what is actually beneficial.	There's a compromise on either business model, but it is about optimizing and seeing what is beneficial	This is probably better on lower grade land where the trade-off isn't as significant	*Land trade-off*	***Business model***	
6:8	Interview 6	So, this then bleeds into a really interesting argument as to what the definition of agrivoltaics is and what is appropriate, right? So loads of people define agrivoltaics in different ways and for different reasons I guess	There are many different definitions to A.V, and different reasons why	We perhaps need to adapt the definition to fit the UK context	*Defining A.V for the UK*	***Place-based context***	

6:9	Interview 6	I guess from my perspective, that's interesting because obviously some people think, OK, agrivoltaics is the raised arrays and arable cropping underneath, right? However, in the UK, we have been practicing ground out fixed tilt utility scale solar like as a standard approach for utility scale solar with no modification to that layout. But we've been integrating grazing right from the start, right? Because the question here, is that agrivoltaics? I would unequivocally say yes, it is, because there's a solar developer and operator, we have to have regard for when we develop solar and so by virtue of this requirement through planning, we will be targeting low grade ALC. So, we will be naturally targeting grade 3 anyway. So, then we go and look and say, OK, well, what the pre-solar baseline for some of this land that we're targeting not withstanding grid availability and restrictions in terms of site selection, but let's say on the AV basis we'll target grade 3B and below. What is the definition of that? Basically, 3B is defined, I can't remember, but it's basically low yield crops, and low yield crops or grazing effectively and that is what the farm was before. And so, if you're talking about appropriateness, like the UK has been deploying agrivoltaics from the start, because what was effectively a grazed field before is effectively a grazed field with solar panels and Co-locating it and that I think is absolutely, wholly appropriate of the UK	UK have had ground mount solar for a while. It only makes sense to target lower, grade 3 land, as that land is only for low-yield crops. Grazing seems most appropriate for the UK context.	Lower grade land being the target for A.V means that there is less of a trade-off for A.V	*Low grade land*	***Place-based context UK evidence***	

6:10	Interview 6	However, the question is, would it be appropriate? Because ultimately the conversation needs to move on from food security and you know, we need to get the most out of land. It's about OK, think about it as the ecosystem service aspect of and dual-use or multifunctionality is that let's say we do have BMV [best most versatile] land and is the best approach to carry on cropping it from a food security standpoint, maybe it would be, because we need to carry on producing food. But is it in the long term? Because what gets discounted out of all of this discussion is like can we then have the same impact if we're preserving the soil for the next 30-40 years of solar to then sequester carbon and replace the biological content of the soil by managing it effectively over that period of time, and plus maybe even increasing pollination services while you're there and therefore increasing food production and contributing to food security in the wider area? And how is that taken into account when it comes to the agrivoltaic discussion?	Moving from the food system aspect of A.V, and the fact that we need to get the most out of the land through the dual-land use aspect. But when it comes to the long term aspects of food security, how doses that look, with preserving the soil and effectively managing the soil for carbon sequestration.	It seems that these aspects of soil preservation are disregarded when it comes to the A.V conversation, as a lot of the talk is about the food system security	*Soil in the future*	***Acceptance Environmental impacts Place-based context***	
6:11	Interview 6	So yeah. It's such a massive topic to unpick and I find it frustrating when people focus on it 1 dimensionally in terms of right, ok, is this the solution in that it should be rolled out because there's so many different angles to the argument that needs to be part of the discussion. Otherwise, we go down a very dangerous route of saying it is the solution, right, when that's not the case, it could be a solution under a very, you know, refined set of circumstances that fall into place.	You cannot look at A.V one dimensionally in terms of something that must be rolled out across the UK, and it is only the solution in a few number of circumstances whereby the factors fall into place.	It is not the silver-bullet nature-based solution and must only be used when it falls into place.	*It is not the silver-bullet*	***Acceptance Business model***	

6:12	Interview 6	Exactly. Well, let's put it this way. If a farmer is successful in terms of their product, they've got enough of an estate to produce a viable business and the high value crop, they are not going to give up their market share. To compromise some of their yield for solar and so yeah, they you can argue. OK. Well, with climate change, maybe we can make your income more resilient. But ultimately, if they're in a position that they are smashing it in agriculture, why give up that reputational aspect of how well they're doing?	If the farmer is successful already, they aren't going to 'give up' that business model and compromise some of their high value cropland for solar.	They don't necessarily need to give up their business model for the sake of installing A.V, if their business model is good already	*Successful farmers don't need to change their working business model*	***Acceptance***	
6:13	Interview 6	And so similarly, if you've got a solar investor and you've got a piece of land and you are promising certain returns on a set capacity, like why would you then sacrifice some of that to then bring on board a third party to farm it and who would also see a sacrifice?	With A.V, there are a lot of parties involved in the investor and landowner, it would complicate things to bring on another party to farm.	Sometimes it's hard to see how investors would sacrifice some of their returns on Solar Farms in order to simply get someone in to farm the land	*Solar investors sacrificing their revenue*	***Acceptance***	

	Interview 6					***Acceptance***	
6:14		Now the best outcome which is the model that is the equilibrium that needs to be also talked about, the point of view is that the farmers that will be considering to diversify are the failing farms where they're not making enough. Where they need that supplementary income to either farm the rest of their estate more effectively because their lower grade fields are just not making the cut and or they want an easy life, and they want just a stable income because the agricultural system is just not working for them. Because maybe their estate is too small, so they just want that stable income, and solar provides that right? So, if they do want that and we're pushing them to go down a route of being able to either get that stable income from the lease from solar operators and or saying, OK, well, we won't give you as much and as part of that lease, but then you can make the rest up with your inconsistent and low value farming that you'll have to sacrifice some yield off of on this given plot. What's the best? You know what's the best solution that's driving that? They'll go for	Failing farms need to diversify their income, where they are not making enough, especially when their lower grade yields are not making the cut. Or, even if they want an 'easy' life and have a stable income through A.V, it is about deriving the best solution for the farmer.	It might work best for failing farmers with low grade yields, as a way to diversify their income	*Diversifying income for failing farms*	***Business model Competition***	

	Interview 6					***Acceptance***	
6:15		But ultimately the business model suggests that if you are farming that you will decrease your yield in solar. But then you would have to have some yield to offset that model from the farming produce, which because solar operators are not farmers, so it's not like we would house the production of food. It would be a third party that would have to come into an agreeable business model that is simply flawed. So, there's lots of things to think about there, like the scaling of agrivoltaics is not a straightforward one. We'll need subsidizing to support it and it would need a different way of regulating it or to mandate it to make it happen, because the natural economics of it doesn't stack up really. I mean, it's great if it does work. It would be great, and I think everyone in the industry is wanting it to work, but making it work, there's a lot of steps and a lot of complexities to navigate through.	The scaling of agrivoltaics is complicated, and there needs to be some subsidy to support it, and a different way of regulating it. Everyone in the industry wants it to work, but there are a lot of complexities to work through.	There needs to be subsidies and regulations to allow for the scaling of A.V	*Scaling of A.V*	***Business model***	

	Interview 6					***Acceptance***	
6:16		And if we're really talking about multifunctionality, then all the other benefits should be in the consideration of what it means to be multifunctional. Because if you're just thinking about food production, then OK. I mean, from a philosophical point of view, agriculture has been, and the industrialization of agriculture or the intensification of agriculture has been the main driver of biodiversity loss across the world. Right. And it has devastated our land and our habitats and our species. And so, if we're trying to reduce the drivers of biodiversity loss through reducing greenhouse gas emissions, through promoting renewable energy, and then what we're trying to do is intensify that use of land even further. You know, there's definitely a contradiction in terms somewhere there. So, like that that there needs to be a more of a holistic consideration of lots of different factors when it comes to agrivoltaics not just right, renewables and agriculture, because it all centres around the intensification of land	Historically, farms have been the main driver of biodiversity loss across the globe, and if were trying to reduce biodiversity loss, farmers are the ones looking to reduce greenhouse gas emissions through the use of renewable energy. But in some ways, this is intensifying the use of the land further, and it is a contradiction. It all centres around the intensification of the land.	A.V is a new kind of intensification of the land	*A new kind of intensification of the land*	***Environmental impacts*** ***Feasibility*** ***Food security***	

	Interview 6					***Acceptance***	
6:17		So, is it really a significant benefit to get as much out of land as possible? You know, what is it that Agrivoltaics is trying to achieve? Which is why I keep going back. It's not a silver bullet. It's great to deploy it where things fall and all things align like business case partnerships, profit shares and grid capacity. You know, tenant farmers, whatever. If all things are aligned, then it's a great solution. It can bring all of these things and people together to come up with a really good solution, but is it the solution to be scaled widespread without thought? Definitely not.	Do we really need to get as much out of the land as possible? Can it be scaled up, definitely not.	Philosophically, it probably is no different to previous intensification of the land	*A new kind of intensification of the land*		

	Interview 6						
6:18		In the UK, because like it's so unintrusive, solar is ultimately, we take approximately 3% of a given land in terms of direct land use. And that's like the pylons, the substations, the inverters, you know? So, like on 100-hectare site or whatever, you know, only 3-hectares literally will be kind of directly taken. All the rest of it, if you think about it in, in fairly general terms, all the rest of it is just as the functionality of it remains, if not increased. And this is where the functionality aspect of it in terms of increasing the value of it becomes important because yes, you've lost 3-hectares, but ultimately, if we can increase the ecosystem service value of the remaining, you know 97 hectares, then you've got ultimately an increase in value, but also we retain the functionality of it being grazed and the agricultural aspect of it as well. And so, it becomes one of these things where it's useful because it counts as the land use alignment of food security that has come about in the UK in particular.	Solar is rather unintrusive, as the amount of land taken up physically is only by the pylons, and so the functionality of the site remains, if not, increases.	Functionality of sites increases	*Actual physical land-use is low*	***Environmental impacts*** ***Food security*** ***Land use***	

	Interview 6						
6:19		I know it's not exclusive to the UK, but in terms of like policy and political uncertainty it's something that is not going away in terms of the land use debate and particularly in, you know the light of and commodity prices exacerbated by Ukraine and Russia in terms of the war like that you know there's a lot of focus on food security and onshoring stuff and making sure that you know our suppliers resilient because we're so reliant on other countries' economics and supply and so vulnerable to those geopolitical aspects, as well. But I guess it's just the times we're living in, but that that won't go away, right? We're always forever trying to be a bit more self-sustaining. Like with Brexit. But is that the answer? Who knows.	The land-use debate will always be prevalent in the UK, particularly due to commodity prices increasing with conflicts like Russia and Ukraine, there is now a focus on onshoring and food security and becoming resilient, rather than relying on other countries	There is a focus on food security and resilience due to offshore price problems	*UK food system resilience*	***Food security Governance***	

	Interview 6						
6:20		I mean, there's a lot of research out there already undertaken, there's a lot of pilot studies and if you look at commercial like truly commercial examples of where it is operating and it's working. I don't think you'll find many. I think you'll find a lot of experiments, a lot of pilots, a lot of things that claim to be commercially viable, but this is where it depends what you're talking about, because the commercially viable ones are like sheep grazing or the ones where everything kind of the lines right in terms of what we've been talking about, where the benefits outweigh the risk, benefits in terms of you know, all the sacrifice in yields or generation. And I think ultimately, everyone is still learning to an extent as to what is commercially viable and forever searching for it.	There are not many commercial examples of A.V working in the UK, everyone is still learning what would look like in the UK	We are still figuring out what the best examples in the UK will look like	*Still learning about A,V in the UK context*	***Business model UK evidence***	

6:21	Interview 6	Now, obviously, for that to align that, I mean it could align, it just depends on circumstance. So it might be that alright, a way to do that would be to make sure that the lease agreement is sufficiently low enough to then make the investment model work to the offset. The drop in yield like maybe, but you know, let's be real about this. Are landowners really going to accept a drop in their market rate in terms of what they can lease land for not withstanding thinking like this is a dynamic that I was talking about earlier on about, you know, well, you've got the lease but then are they really going to say OK, well, we're going to farm it as well through reducing yield, reduced profit but we're going to take a reduced lease but you're going to pay me back with the reducing, like it just doesn't work, like I mean there's too many market forces and I guess it's capitalism, isn't it? Does it work within a set model? But anyway, yeah, thank you for an interesting chat	There are too many market forces in deciding to invest in something like this, as you can't expect the landowner to accept a drop in their market rate to accommodate A.V, but that is the nature of capitalism.	Too many market forces to expect a landowner to take a drop in market rate	*Can't expect landowners to take a drop in rate*	***Acceptance Business model***	
7:1	Interview 7	Well, I think, on Farms where they've got high energy usage, I can see that it's a lot more straightforward. So, like a dairy farm where they're using a lot of electric for, you know, the running and cooling the milk and all that kind of thing and presumably the payback time would be a lot quicker, and they also tend to have big sheds that they could put them on top of. And so plannings like less of an issue. And in the case of a dairy farm, you can just imagine it like fitting in with the infrastructure that's already there and the economics of it.	A.V makes more sense on farms with high electricity use, e.g., dairy farms	Should only probably be used on farms which use a lot of electricity as a way to reduce their own electricity costs	*A.V makes sense on farms which use a lot of electricity*	***Acceptance Place-based context***	**This interviewee is a farmer**
7:2	Interview 7	Well, maybe it would like if we're getting climate change, maybe actually some of the shading above the glass houses would not be a bad thing from solar panels. I don't know, so I don't know about the practicalities of it, but I would have thought the cost would stack if the practicalities could be sorted out.	With climate change, maybe shading wouldn't be such a bad thing	Might work in regions where they are disproportionately affected by climate change and need the shading for the crops, it is hard to say that this is needed in the UK though	*Climate change and the need for shading*	***Environmental impacts***	

7:3	Interview 7	So, I've just found out because we're thinking about having domestic solar panels put in but a ground mounted system and I've just found out that if we put them on our roof we wouldn't need planning permission. But if we put a ground mounted array in, we do need planning permission. So that's quite interesting and we're not in a National Park and I think it would probably be quite straightforward, but it's like a really small array, but part of the reason it's a small array is cause of money things, but also it's cause the grid capacity isn't enough because our neighbours want to put solar panels in and we can both only have 4 kilowatts of it.	Ground solar has more barriers to it in terms of planning permission, and there are also grid restrictions	Ground mount solar is harder compared to roof solar in trying to get planning permission	*Planning permission barriers*	***Governance***	
7:4	Interview 7	Then the other thing, which is really, really significant is the grid connectivity and how much connection, you know, whether there's capacity and if there isn't capacity, how much the grid upgrade costs and all that because that would mess it up for a lot of people, I think	In terms of scaling it, it is heavily reliant on the amount of grid connectivity	If there is no space in the grid, how can they expect to upscale it	*Grid connectivity*	***Electrical connections***	
7:5	Interview 7	And then there's also the whole, like cultural barriers to it. It's just a new thing, isn't it? And people wouldn't be used to it	People aren't used to solar, and so there are some cultural barriers to adopting it	People are less familiar with A.V	*Familiarity with A.V*	***Acceptance***	
7:6	Interview 7	And I think certainly within the National Park, there would be a lot of pushbacks certainly on the hills anyway, and people might accept it more in lowland, but then in the Lake District, like your lowland areas are more your meadows and so on. And you couldn't have solar panels on a Meadow. And because you wouldn't be able to get a grass crop, you know, whether it's silage, hay or whatever. I mean, that's not gonna work with solar panels. And then you're looking at more inaccessible ground and the whole visual amenity thing. I can't see that going down well.	The ground type also plays a massive part in implementing A.V, as you cannot put A.V with hay	It is important to consider the context of the type of crop underneath the panels	*Types of crop*	***Place-based context***	

7:7	Interview 7	And the main thing farmers always want to know is, well, show me where it's happened, you know, let me go and have a look at it for myself. Like farmers are very keen on going to other Farms and having a look and looking at something and talking to someone who's actually done it and then think I might try that I might not.	Farmer's want to have evidence as to where its worked, so that they can have a look at their configurations and see how that could work on their own farm	Farmer's need farms in the UK where they can see it has worked	*Pilot studies*	***UK evidence***	
7:8	Interview 7	So, I would think like if it was gonna be something that was considered to be useful going forward as part of the whole like energy mix in the country, there'd have to be investment. Set it all up for some Farms, like get farmers to apply or something. I don't know, but set it up, reduce cost for people that were keen and like set it up on a poultry farm, one on a dairy farm, one on something else.	There is going to have to be some initial investment either privately or publicly in order to get some farms on board, which can then reduce costs for other farmers to implement it	There needs to be some initial investment to get the ball rolling	*Initial public or private investment*	***Governance Incentive***	
7:9	Interview 7	So, you've got places where the farmers can say, OK, well, that's a farm like mine. I'll go and have a look. I'll see what I think and then maybe have a go.	They can compare farms where it has worked, and see how that could be adopted to their own farm	They can take ideas from where it has worked	*Comparing farms*	***Acceptance Early adopters***	

	Interview 7						
7:10		Yeah. And also, you need to see the figures. You know, this is what we would want. I went to an event on Saturday, and it was about regenerative agriculture and like different, you know, different ways of growing crops and grazing livestock and so on. And they were talking about how to make regen agriculture like more widespread practice amongst farmers and a lot of people were saying, well, the farmers who are not farming it at that moment need to see the bottom line and people need to share their accounts and share their figures to say, well, we've done this and this is the returns what we're getting because at the end of the day, it's not for every farm. But obviously the money side of it is really important and you want to see what the figures are like for other people. Like what have you gained? What have you lost, you know, is it worth doing kind of thing?	With new technologies and pilot farms, it is all well and being talking about how it works, but the farmers need to have access to the bottom-line financially, to see the returns, and how it may not work the same for every farm	Farmers want to see the facts and figures	*Farmers want to see the financial returns from A.V sites*	***UK evidence***	

	Interview 7						
7:11		Hmm. Have you spoken to Arla the dairy company? Because they might be worth speaking to, because they've been ahead of the game like they've been making their suppliers do carbon audits on farm for a long time and they're very keen on sustainability and they do make their farmers go through a lot of hoops and a lot of you know, facts and figures and monitoring and all the rest of it. And I'm pretty sure that some of the farmers, dairy farmers, have got solar panels because they're supplying Arla and Arla's been saying like, what are you doing about sustainability, blady blah, and they're known for like paying a decent price and you know, milk prices go up and down a lot. And Arla is generally thought of as being one of the better players and one of the good companies to be supplying your milk to. So, farmers that might not otherwise be that into sustainability, like if Arla is telling them what to do, then they will do it. And it's a big European corp Arla is	Companies like Arla make their suppliers meet certain sustainability criteria, and they would only take products from those who can display such workings.	Suppliers are needing to meet certain standards, and so A.V may contribute to them meeting sustainability targets	*Company demands trickling down to farms*	***Business model Competition***	

	Interview 7						
7:12		But farmers are just thinking well. That's because they promised after Brexit, they promised to spend the same amount of money on agriculture, and because they've had such crap schemes for the last however many years, no one's applied for them. They've got a load of money swashing about, so they're trying to, like, give it away now, but none of it is about food production. It's all about the environment, which is fine, and a lot of farmers want to support the environment, but a lot of farmers obviously are bothered about food security as well, and the NFU is going on about sustainable food production. I don't know quite what they mean by sustainable food production. I mean, I would like to see a lot more money going towards supporting, like regenerative agriculture and helping with light soil surveys and carbon audits and all that kind of thing, which, there is stuff on that a bit, but in terms of the energy side of things, I don't know	Post-Brexit schemes have been poor, and focused on the environment rather than food production, and farmers don't want to apply for them. Sometimes they also use jargon which is unfamiliar to farmers, and it can show that they don't actually really care about access to subsidies.	The schemes have been poor and not focused on what farmers actually need help with given commodity price increases	*Schemes aren't focused on what the farmers actually want*	***Governance Incentive***	

7:13	Interview 7	The other thing is installers, because there's a lot of skills shortage for things like if you look on the domestic front like things like air source heat pumps, I know people who don't wanna put in an air source heat pump because they're not convinced that their installer is still gonna be in business and willing to service the heat pump over the next 10 years or whatever, or they're worried that someone will just take the money to, like, do the installation. But they're not wanting to do maintenance, and they might end up with some kind of system where your average person doesn't know how to maintain it. It's only specialist people and they're too busy fitting other people's heat pumps and can't be bothered to come and fix one. And there is a big skill shortage I think on these sort of technical type things like, you know electricians and you know, steel fabricators, all these sorts of things that would be needed, like say everyone decided, ohh, AV's a great idea and there wasn't a good connection problem. It's like, would there be the skilled people to be able to not just install these AV but also to maintain them and their whole life? What's the whole life analysis of it as well? Like how long are they gonna be there and what happens? You know, what happens at the other end when they aren't useful anymore and things like that.	There is a skills shortage for maintaining and installing things like A.V, like this farmer speaks about farmers around them not wanting air source heat pumps as they're not convinced the installer will still be around to maintain it in years' time	There needs to be a whole-life analysis of A.V, to ensure a safe, long-term investment	*Whole-life analysis*	***Feasibility***	
7:14	Interview 7	There are all these people out on the ground that farmers like come into contact with. They would all have to be up to speed on it all so that they, you know, if farmers said, oh, what do you think about this, that they would actually say, ohh yeah. Well, I've heard you know this or that. Or, you're right this might work for your farm, or that might work for your farm	Farmers like the in person interactions which allows them to explore new things	They'd like to see the new installations in person and be able to talk to people about it, they're really interested in speaking to people in real life to gather information	*In person interactions*	***Early adopters***	

7:15	Interview 7	I think through a local enterprise partnership or something to install some solar panels, but they're only allowed to use the electricity generated on the farm. But like I said, they are a beef and sheep enterprise. They don't need electricity on the farm, but they have gone for it because the grant was available and they're hoping that they might be able to use it for electric vehicles in the future. But they've basically just gone for it on a speculative basis because they're not having to pay out for it because they've got the capital grant. But in a way, that's a bit of a waste, because you've got to be careful with grant funding that people don't just go for it because it's a grant. And then it's not actually that useful, potentially or I don't know…	With some grants, people are just applying to it because its there, and it can seem a bit of a waste of government's money	Grants aren't being used for the right reasons	*Fix the grant scheme system*	***Incentive***	
7:16	Interview 7	So, there is a grant for installing solar equipment on Farms and reservoirs, it says. Anyway, the grants range from 15,000 to 100,000. But you see, there we are, the £10,000 minimum Funding is equivalent to 25% / 60,000 pound system, so even though you're getting 25%, you are still gonna have to find 50 grand in that case. So yes, it's cheaper. But I mean, there's not that many farms that are gonna have that kind of money to put into. And the other thing actually, it frustrates me with some of these things is that the only farms that do have that amount of money don't actually need the help. Like if they've got 50 grand, they don't need an extra £10,000 from the taxpayer to make the investment. They could do it anyway, and actually I would rather that £10,000 when there's 100% grant to a farm that otherwise wouldn't have a hope in hell of doing it. Do you know what I mean?	For solar systems, the grants only cover so much, and the farmers have to find the rest, despite the grant being helpful somewhat. And the farms that do have the extra money don't need the help	The costs of solar is just too high	*Reducing costs*	***Competition Incentive***	

7:17	Interview 7	Yeah, I mean, the thing is, then you get into the whole thing about resilience and it's those sorts of big farms that tend to have like, again, this is not my area of expertise. But if you take apples, for example, you know there's certain varieties of apples that are gonna be more likely for the big farms to grow because they're like the really commercial ones. This, that and the other, but then smaller, smaller Apple produces would tend to have like the odd quirky variety there. And who knows when you're gonna have some disease that's gonna wipe out the entire, you know, Coxes, Pippins, or royal gala or whatever. These big things are, and it might be some weird apple that's in a small fruit growers thing that is actually the one that's resistant to whatever the new disease is.	Speaks to smaller fruit growers who produce more niche varieties of fruit, and how they are important in the face of being out-competed by larger farms	Need to support smaller farms as they produce more niche crops which can protect against the spread of disease	*Supporting smaller farms*	***Business model Environmental impacts***	
7:18	Interview 7	I don't think, I mean obviously solar panels are not as obtrusive as a wind turbine, but you know, culturally, I think there still could be a backlash, and a farmer might be worried that if they fill the field with solar panels that everyone was gonna hate it, not that that would stop them doing, if they wanted to do it anyway. I think they would. But I think rooftop solar is like everyone's fine about that now, aren't they? But…	Solar isn't as obtrusive as a wind turbine, but there still might be some backlash as to how the panels are perceived	The farmer might be worried as to how others perceive the farm	*Negative perceptions*	***Acceptance***	

7:19	Interview 7	Still in fields, I don't know, but it may be like as the weather changes more with climate change and everything and you know shade might become more important for animals. But then actually this is a key point. So, for me, I've got quite a few fields where I only graze sheep, but most of my fields I do graze sheep and cattle. Or maybe at different times. So, if I wanted to put solar panels in and not pay a fortune, I'd have to put ones that sheep could get underneath and maybe grass could still grow underneath, and you know blah blah blah.	With climate change, sheep might like the shade provided by A.V	A.V is useful in the face of climate change, as sheep might like the shelter provided from the sun or intense weather events	*Sheep protected from the weather*	***Environmental impacts***	

7:20	Interview 7	Yeah. And I think the thing is farmers are used to central government saying things that don't make sense to them. Ohh. You know, kind of coming up with things and you just think, like, really like, when was the last time you were on a farm? You know, and that means that people are a bit skeptical anyway and even things like, at the moment, there's a big national thing about local nature recovery strategies. So, all these different local government bodies everywhere were putting together these local nature recovery strategies. Some of them are engaging with farmers and landowners, but some of them are not really or they kind of saying they are, but not really. But I mean, how are they gonna even implement that if they haven't got farmers in London on board with the local nature recovery strategy? So, I agree with what you say. Like they could say at central government, Ohh AV is the next big thing, you know? I mean, what you're doing is important, isn't it? Cause you're speaking to the people that would then be expected to like, say ohh, that's a great thing, I'm gonna do that, and it's really important to know the practicalities of why that my may or may not kind of be attractive or practical or whatever.	Farmer's are skeptical of new schemes, as they're used to policymakers and central government putting in strategies that don't make sense to them, as these policymakers haven't ever farmed so they don't fully understand the farming business.	Central government don't understand what farmers actually want	*Central government don't know the practicalities of farming*	***Governance***	

7:21	Interview 7	It's at Sheffield University and the thing that they're looking into is oral history testimonies from people about previous heat transitions. So like transition from like coal heating to gas heating, but they're doing it in four different countries like in the UK, and Romania, Finland, and Sweden. And their big thing is that at the moment all the solutions are kind of like focused on technology and economics. So, it's like, if you have a heat pump, the payback is this, and this is how you install it and this is the kind of house you know, blah blah, blah. And it's not taking into account anybody's like emotions about anything, or anyone's feelings, or like a cultural thing, or the fact that people like sitting around a fire or whatever. And like in Finland, they were saying that there's like traditions, especially in rural areas in Finland, where it's like a real communal thing to help everybody get their wood stacked for the winter and make sure that everyone's got some, and it's like everyone all gets together and it's a big like culture thing. They're saying like, well just have electric heating. We'll kind of lose some of our community spirit because we won't have that, you know, and the whole project is about the fact that you can't just have technical and economic aspects considered with a heat transition or an energy transition, whatever you've got to consider, they like social and cultural context of it. Otherwise, it's not gonna work	When implementing new technologies, there seems to be no account as to how the culture affected feels, and what is traditional or communal for them.	The social and cultural contexts need to be understood rather than just energy transitions.	*Social and cultural contexts*	***Identity***	
7:22	Interview 7	You know, whereas in a rural area, like all these things, you've gotta, like sort out with your neighbours or pay for yourself or whatever. And I think that is part of the culture that you're talking about, and that rural people want to be quite resilient. And in a sense sort of selfsufficient and in a way, producing energy should sort of fit in with that. But there's been so many kinds of schemes of this and that and the other, and I think people are just like, what's this coming along now, or is it just someone else trying to come and, you know, scam me or make money out of me or something.	Rural people and farmers do want to be resilient, but there have been so many schemes so they're skeptical about applying for new ones	Farmers aren't so interested in more schemes	*Farmers don't feel supported by existing schemes*	***Identity***	

7:23	Interview 7	I mean, the other thing is that people think that farmers are kind of, you know, trashing the environment and all this sort of thing. And farmers get so fed up with hearing that because no doubt some farmers are doing that and they don't care, like putting pollution into rivers and all that. And I don't defend that at all. And I know that happens, but a lot of farmers are really aware about climate change issues because they're actually out there everyday living it, and they're seeing the effect on like, they know more than a lot of people living in towns about climate change.	Farmers are annoyed with the stereotypes that they harm the environment, when in reality farmers are the ones who are out there everyday living the reality of climate change and seeing the effects of it	Farmer's take a lot of burden on for the impact on the environment, yet the stereotypes of them are harmful and unproductive, and only puts more pressure on them	*Harmful stereotypes*	***Expectations of the farmer***	

8:1	Interview 8	Yeah. And how to make it sustainable, and people will think they can make money farming and you can't, you have to do something else to make it a proper business. You need to do something, and the fact you've got a farm you can do, even glamping. There are so many things you can do. I just think people are missing a trick and then you can farm with more relaxed because you're making more money elsewhere. It's because, I mean, they want to buy big tractors and they want to, put the money in tractors.	You cannot just rely on your income from farming, and you have to do something else alongside it to make it a working business	Farmers are too reliant on just farming, and need to source other areas of income	*Diversifying the farm business*	***Business model***	**This interviewee is a farmer with a diversified business model**

8:2	Interview 8	Yeah, only have 190 kilowatts. So, it's not massive, it's farm scale. We paid for it ourselves and we have actually got an option now for massive solar farm, for 400 acres, because there's a wetland that I'm just a bit sick of farming and especially this winter we haven't drilled anything and what we did drill died and it's just too wet and the government doesn't seem keen on draining land. That's his wet, they're keen on leaving it to flood and it just stays waterlogged all winter, so, that's what we have. We have solar that we use ourselves and export about 70% of what we produce. So, we're exporting our surplus because everything we do on the farm, it's energy efficient and so don't use much. My sister's home uses it first, and then the offices use a bit. But, you know, we've explored the majority of it, we'll be paying rent, so it won't be ours, but we'll be allowed to graze sheep underneath it. I think as to manage it so that we'd have to get some sheep and it looks like it's got grid connection. It just hasn't got planning yet, but there's a good chance it might work.	It makes sense to do it on land that would otherwise not be used due to it being low quality. This farmer thinks they will be able to implement a big solar farm, and use it for their own electricity and also export it to the grid due to it having good grid connection and capacity.	Perhaps it is best to use it on unproductive land, as to not 'waste' it	*Unproductive land*	***Acceptance Business model Land use Electrical connections UK evidence***	
8:3	Interview 8	I think I feel that is the thing. The local press talks about how positive they think it is. It's when people are like, ohh solar, such a bad thing, it shouldn't be taking land out of production. I do think it should be on less good land. I think grade 2 land is wrong. I think shouldn't be on grade 2 land. It should be a ruling on that, but ours is poor grade 3 land. As soon as it's a Grade 3 and poor grade three, I think ours is on the poor Grade 3 and it would always have been grassland historically.	If A.V is to be used, it should be on lower grade land	Makes more sense on lower grade land as it is not compromising productive land	*Low grade land*	***Land use***	
8:4	Interview 8	James who works for me, brings his wife's sheep to graze under the solar panels for free and they always want to put them in this field they've got a few other paddocks around the farm and on this field, when it's sunny, the sheep lay under the panels and it's like, in the past, pasture would have had trees for the sheep to shelter under.	Like old pastureland, when It was covered by trees, the sheep would lay under it, like they would with A.V.	A.V is supporting sheep behaviour that has existed for a while	*Benefits to sheep*	***Acceptance Land use***	

8:5	Interview 8	I think of this struggle and really good land. Most people can't grow vegetable crops. The land isn't good enough to grow vegetable crops, so the price the supermarkets will pay you need to have higher grade land. Maybe we shouldn't be growing vegetables in the UK because there's so little of it. For solar panels, there's so little of it, if it was another place where they have more vegetables it works, I think it fits for me really well for grassland and that's my main living.	The land isn't even really good enough for good quality crop, so A.V shouldn't be introduced to the mix	It should only really be used on grassland	*Already struggle to grow crops*	***Place-based context***	
8:6	Interview 8	I just speak to my friend, and she was saying how she's really struggling with lots of her farmers who have been using the same seed rate their fathers used, but it's amazing how many farms will not just do that basic thing. And so, I think there's two sides of farming. There's a side that really forward thinking and those that just want to be left to do it the same way forever.	There are different sides of farming, those who want to diversify and look towards the future, but also those who are stuck doing what their parents did	It is about informing the farming community all the same, so they can make informed decisions to futureproof their business. This doesn't mean they have to do what the 'scientist' tells them to do, though.	*Disparity in the farming community*	***Identity***	

8:7	Interview 8	They will, and it's difficult to subsidize farmers a lot, when the NHS needs subsidizing, you know, it's difficult to and actually the most cost-effective way of farming is to have big farms. People say they want quality chicken, then they go and buy 2 for five or when it comes down to it. And so, it's really difficult to, I think for the large scale is the way it's going to go because it is more cost effective and that's what the government wants. And there's limit that how big it can be before you start losing efficiency because you can't see any detail, but yeah. It's hard for government subsidized farming when umm, one of so many other things are important as well. But then the NHS and schools are pretty rubbish, you know, just like I am paying for my son to go to school. Because he was struggling at his old school, and I feel really bad about it. But then I just feel that I want him to have an OK time. He's being bullied by someone but and the child he's being bullied by is having real bad problems at home, which we live in quite a mixed area. It's quite divisive around and it needs loads of support, but there isn't support, there isn't the money for a teacher to support this child one to one and stop him attacking other children. And, so yeah, so I think it's difficult, so farmers should just diversify stuff and pay their own way, probably.	Subsidies are hard to get due to many other aspects of the UK economy needing to be subsidised. Big, large-scale farms are really the only way to go as they are cost-effective. Farmers should be able to pay their own way whilst the government prioritises other areas	in the UK, a lot of things need subsidising, so UK farmers shouldn't be reliant on such subsidies and find their own way to make money through diversification	*Farmers not relying on subsidies*	***Governance Incentive***	
8:8	Interview 8	Yes, that's what we do. We do all the SFI based stuff and trying to get credits now. But yeah, it's the same as everything, I was in tailoring before, and that was really hard because we were competing with imported stuff. So, every business has problems, yeah.	The nature of the economic system, is that we constantly compete with cheaper, imported products	It Is about paving your own way in the market, and find a way to stay afloat whilst competing with lower prices	*Competing with imported products*	***Competition***	

8:9	Interview 8	Yeah. Yeah. So, farming generally, and the way I feel morally, we're doing regen farming now. So, nobody is using insecticide and trying to massive reduce our fungicide. And alongside farming, doing football, stuff like the nursery, the offices, dog walking fields, to take the pressure off the farms. I first started the farm, there was a lot of borrowings that I had to work to pay off. We have now paid it off. So yeah, that's my thing, is to make the farm in a way that I feel I can morally accept. What I do think, farming with massive insecticide is wrong. When I was a child, the windscreen was covered in insects. It doesn't happen now, with the use of insecticides. There just isn't any and that's why the birds are doing so badly. You know, the ecosystem of insects has gone and that's because we just blanket insecticide constantly, but then we also need to produce food. I buy organic vegetables from our vegetable people, but I don't think organics necessarily the way forward. But I do think we need to farm much more sustainably and that's my probably my thing is to make enough money elsewhere, so I'm not pushing the farm too much, but also make money. So, we have a decent quality of life, and the farm is sustainable going forward and the handing on of businesses is in better nick than it was when I took it over. Umm yeah, so that's it. Yeah, really.	There needs to be more sustainability in farming and a way to make enough money elsewhere in the business so that they're not pushing the farm too much, in a way that this farmer can morally accept.	Sustainable farming has a lot to do with how they can make money elsewhere in the business, as so to not put a lot of pressure on the farming side	*Sustainable business*	***Business model*** ***Environmental impacts*** ***Identity*** ***Land use***	
8:10	Interview 8	I'm also bringing more people on the farm. We bring a lot of people onto the Farms, so we're having a big open day of at least 1000 people in a couple of weeks, starting to panic about of it. But it's for charity. And we have, we have like generally people on the farmer with things like the dog walking field even though they pay for it. It's just for bringing people on the farm. I would have loads more public right of ways over the farm, but because it's a family business and the family are all a bit more conservative than me; they're terrified about having anybody on the farm. I would just have loads more right aways and let people walk on the farm because I feel slightly uncomfortable with owning land anyway. And so, I feel that's a way	This farmer likes to allow more public access to their farm as a way to soothe their discomfort with being a landowner	This farmer doesn't feel entitled to the land, and so it might inform how they come to diversify the farm through public access, like through dog walking fields etc.	*Public access*	***Identity***	

		to soothe my uncomfortableness with					

		being a landowner. There's a lot of people, a lot of my family just feel totally, totally fine with it. It's interesting how you just have different concepts of it, as they feel entitled to it, I think maybe, I don't know.					
8:11	Interview 8	It probably is financially, you won't put your own solar panels in. It's a struggle, cause ourselves, we can't do it financially and so that's the finances. And if we did it ourselves, we would definitely do it to farm alongside it and the fact that you're actually having to rent the land someone else, you're not in control of it. And if they say they don't want sheep under it, it's not in your control when renting it. They've got massive investors who do not care about saying ability of anything. They're just massive investors to make money and doing their job and so, that'll be the worry for me, is that you can't do yourself. I think it would be a struggle to grow crops under it. Crops don't make a lot of money, and so you'd have to widen them up, then you wouldn't have enough solar panels worth renting off, costs too much to widen them out. So, you could actually grow crops. You could harvest with machinery, and that's for me - having wide enough gaps to harvest things and machinery. And that's it.	Can't afford to put panels in themselves. When renting panels off of investors, they can implement any restrictions on land use, and you can't really do much as the renter	It is heavily reliant on how the investor, the owner of the solar panels, wants their land to be used	*Reliance on the investor*	***Capital outlay Feasibility***	

8:12	Interview 8	I would think it would be mostly and grass under it for the UK, different for other countries, but I think mostly grass and solar for the UK	Grass is the most feasible route for A.V in the UK	This is different to other countries whereby crops make sense	*Adapting to the UK context*	***Place-based context***	
8:13	Interview 8	Interesting to try sheep under solar and see what their weight gain is. You know, must be quite doable to put some sheep under solar panels. Leave them out for two months and then go and weigh them all and have them play. Go in the field. Have a similar field next door, something and then weigh them. After two months, you'd know what their weight gain per day was, and then you could look at the energy, you know, the energy used, and the energy produced in meat. You know, production is still energy production, I think. So, that will be something that I'm interested in, is looking at the actual, I mean, the actual difference between sheep reproduction in solar	There should be a way to measure how much sheeps benefit from A.V through measuring their weight and the energy produced in their meat	These figures can provide a stable backing as to how sheeps benefit from A.V	*Measuring sheep grazing benefits*	***Feasibility***	

8:14	Interview 8	How many sheep fatten? how much they put on under solar versus without solar? They probably would do well because they'll have less stress with the heat and less wet, and so you might find actually that did have a comparison, you have to compare it to a standard bare field and see how they did over summer, yeah?	The sheep will have less stressors due to the shielding of A.V	So, it makes sense that they'd fatten due to the lack of stress	*Measuring sheep grazing benefits*	***Feasibility***	
8:15	Interview 8	Yeah, yeah, yeah. And then you have a financial return on it. Yeah, and it's easy enough to do. I'm sure it is easy enough to.	Healthier, fatter sheep will give a better financial return	So this shows the benefits of A.V	*Benefits of fattening the sheep*	***UK evidence***	
8:16	Interview 8	No, no. But I think it's interesting and I'm very proud, I really believe in renewable energy, and it gets annoying when my dad thinks we should be fracking, he just doesn't get renewable energy and just says its not viable.	This interviewee is very into their renewable energy	So they might have given more biased opinions towards something like A.V	*Renewable energy focus*	***Identity***	
8:17	Interview 8	Hmm. The other thing I was gonna say actually was, in the introduction, it said plants do better under the solar plants cause less heat stress, but with those, we don't really get much heat stress because you know we're wet. We don't get enough days when it's that hot when the north of England. And so, it wouldn't actually. It would benefit wouldn't be there, but in.	in the UK, we don't suffer from heat stress	the benefit of A.V wouldn't really be reaped in the UK	*UK weather*	***Place-based context***	

9:1	Interview 9	It's not really taken up in Cheshire or anywhere else really, that I'm aware of it, I can see where it, especially with vineyards and the largescale sheep enterprises. Sort of hill based. Or up in the North and down South I can see how it fits in. Yeah, I can't quite see it fitting in too much in my region at the moment, and we're seeing a lot more dairy farms have solar panels mounted on the roofs and more very small scale solar. But when you have cattle, they're big. They rub and knock against stuff it. It's not practical at the moment. It would work with sheep or probably more laying hens or. Well, yeah, but we're not seeing it at the moment.	For dairy farms, it makes more sense for them to have panels on the roofs. For ground mount, the cattle are quite big and can knock against the structure	This can damage the structure, so for dairy, it might make more sense for them to do roofmounted solar, until the price of solid steel beams comes down	*Cattle damaging structure*	***Feasibility Place-based context***	**This interviewee is a land developer**

9:2	Interview 9	Probably maybe the biggest opportunity for AV is that agricultural land benefits from 100% inheritance tax relief. Which is very important, especially with the average age of farmers being pretty high. If it's used for solar, it loses that relief. So, the land or the income from it is 100% liable for inheritance tax at 40%. And at the moment, if you can show its use for agriculture or if it works out that agriculture is actually the main income from that land, and then it you could claim a portion or all of your inheritance tax relief on it. Which would then give it a bigger uptake with how it works together.	Land with solar is liable to tax, rather than simply agricultural land. But if you can claim its purpose is for agriculture, you might be able to get around it	Have to figure out the configurations of tax	*Tax relief*	***Business model Feasibility***	
9:3	Interview 9	Yeah, it's why on a lot of solar leases we try and make sure the landowner has a right to be able to graze sheep on it and keeps it tidy, but they can basically say that they are still farming and get to some degree, it's a bit of a grey area, but that's all the principle of why cheaper on there most of the time.	If you say it's for farming, it is cheaper in terms of tax	There are ways around it	*Tax relief*	***Business model Feasibility***	
9:4	Interview 9	Yeah, I suppose the developers spend millions of pounds on this solar farm properties, though really. And when rent for Solar Farm is £1200 an acre. You're gonna have to do very well on your sheep to be able to, yeah. And say, well, actually, agriculture is the main use of that land, you get the various reliefs. But yeah, that's where we are on it at the moment.	To rent solar farms, you'll have to do well on sheep, or other aspects of your business, to make up for the costs	Right now, the costs of the rent and the money from grazing doesn't add up, so it only really makes sense if you are able to get some cost from other parts of your business	*High solar rent costs*	***Business model***	

9:5	Interview 9	Yeah, and very much as you depicted. And in a way, it's the same principle in a way as agro forest. Is that you've got panels there which provide shade. They reduce evaporation, so you sheep are less, and the shade helps keep moisture in the ground and gives you grass growth if it's a drought and both, you know, you get a dual income.	Important for droughts, but we don't really get many in the UK	Maybe better in drought-heavy regions	*Weather in the UK*	***Business model*** ***Environmental impacts*** ***Feasibility***	

9:6	Interview 9	With subsidise it is but the way the government help is through the taxation of it, where the land is used for agriculture, agriculture and solar. Dual purpose gets inheritance tax relief or capital gains tax relief. That is probably the way the government can do it, how it works in practise. The cost of installing all the solar and then being able to connect it to a grid. And unless you're a very intensive energy user, unless they've diversified their farm buildings and have a farm shop or something else, yeah. The cost of installing the solar is probably too prohibitive, so I would expect is currently, you know, a developer will look to lease the land, have the solar, and then just pay rent for it. Yeah, there's not too many sites where landowners put forward all their costs at the moment to get a connection and develop a solar farm.	Dual land use and being able to say the land is used for agriculture can be a way to get around the lack of subsidies, as you're not losing as much to tax. But not many farmers would put forward all their costs just to get a connection to a solar farm.	It is too prohibitive at the moment with the rent	*High solar rent costs*	***Business model*** ***Capital outlay*** ***Governance*** ***Incentive***	

9:7	Interview 9	Yeah, I'm sure you've probably come across one or two places in the UK that doing it or trying to. And if you probably look at the business. They've run it by business rather than your traditional farm route, who does the same as his dad's dad used to do. What we may see is the average age of the farmer is late 50s/60s. Now there's this new generation which just starts to come through. Or, you know, technology is normal to them, and we are operating everything off the phone already. In 10/20 years' time, this may become more important and more normal	The new generation of farmer's are more used to technology, and so when they are the main farmers in say, 20 years, this may become more of a normalcy	There are assumptions made about age groups and their affinity with technology	*Younger farmers more familiar with technology*	***Identity***	

9:8	Interview 9	And limiting factories as well that there is no or very little spare capacity in the grid to be able to take all these solar farm connections. Yeah, so you could build it, but you unless you were using all the electricity yourself, you've got nowhere to send it at the moment, yeah.	The grid has little capacity to take on solar farms, so perhaps you could either use a direct wire or use the electricity for yourself	There isn't much room for solar due to the number of factories taking up the grid capacity	*Direct wires or personal electricity*	***Electrical connections***	

9:9	Interview 9	The farmer's main approach is to be able to achieve a fair price. They don't want it to be dictated to. They want the opportunity to be able to adopt new technology themselves and I think for certain types of farms, like sheep or. Saying, you know, vineyards become a bit more popular. Or yeah, it only really works with sheep and chickens cause your machinery is that big. We will see more interest in it and there's currently a grant of 25% covering new solar farms or new solar panels for farms. So yeah, there's definitely interest from farmers. How it's incorporated into a field scale rather than on a roof, it's probably still a niche area	Farmers don't like being told what to do, and their main goal is to just achieve a fair price.	It is about the knowledge of the technology itself, and being able to empower them to implement it on their own esteem	*Empowerment and agency*	***Feasibility***	
9:10	Interview 9	Yeah, grade 3. And so poor land. Yeah, it is. Yeah. And we'll see good land and we can't afford for good land to be taken out of production, yeah. It yeah, if it is good land, it's probably not being used for sheep and chicken. Well, in relation to the meat industry. I mean, you have your orchards and vineyards and more down the South of the country and.	Good grade land needs to stay in agricultural production, and good land isnt being used for sheep and chicken	Works on cattle or poultry, as they are usually on poorer land	*Farm type*	***Feasibility Land use***	
9:11	Interview 9	Yeah, I think the information is out there and as with all things, there are the early adopters who take a punt or yeah, it will really work for them, and they'll leave a crash in there or they'll be the poster boys for everyone else.	It is about those who take the first steps in adopting it, and being poster boys for other people	People can then see what works/ what doesn't, and go from there	*Pilot studies*	***Early adopters***	
9:12	Interview 9	It's just how would you get them on a scale to allow you to be able to get machinery at large, you know, big cattle, and then not be then raised up 8 foot in the air. What's the solar panels? Maybe when it's tilted on angle? Two to three metres high when you stood alongside it well that how does that then become 6 metres high and not cause a massive visual impact	Concerns about getting large machinery to navigate through the solar farm. Also, if they were raised really high, it will cause a great visual impact	Might be better for farms which are quite far from view, but that might be difficult in the UK compared to the likes of the USA	*Negative visual impact and machinery concerns*	***Feasibility Land use***	

9:13	**Interview 9**	**or the developer or dual wire to a nearby factory to give them green energy. Or there's got to be, you know, a financial incentive to the landowners. Yeah, if they can't make money out of sheep or chickens or whatever as they are. Putting solar panels probably isn't gonna make the business massively more profitable from a farming side. The tax liability or inheritance taxes probably would be an issue to many at the moment.**	**There has to be a financial incentive to the landowners/farmers, as simply getting solar panels isn't going to make the business much more profitable**	**The high rent costs is going to make it hard for farmers to see if it is feasible**	***High solar rent costs***	***Business model Incentive***	