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Supply Chains in Welsh Renewable Energy Projects

UNDERGRADUATE DISSERTATION
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Abstract

The rapid expansion of renewable energy is essential for achieving global climate targets; however, the ethical implications of the supply chains supporting this transition remain underexplored. This study investigates ethical risks within renewable energy supply chains, with a specific focus on projects in Wales. It aims to identify key challenges, evaluate current governance and management responses, and explore potential solutions to improve supply chain transparency and accountability.

A qualitative research approach was adopted, using semi-structured interviews with five professionals from sectors including renewable energy, higher education, and public services. This method enabled in-depth exploration of industry practices, particularly in relation to procurement, barriers to ethical sourcing and regulatory compliance. Interview data was transcribed and analysed thematically using NVivo, generating key themes aligned with the literature, including supply chain complexity, ethical risks, procurement management, and future solutions.

The findings reveal that renewable energy supply chains are highly complex and often lack transparency, making it difficult for organisations to fully assess ethical risks such as modern slavery and exploitative labour practices. Cost pressures and limited visibility beyond first-tier suppliers were identified as significant barriers to ethical procurement. While legislation such as the Modern Slavery Act 2015 provides a framework for due diligence, its effectiveness is perceived as limited in practice. Participants highlighted the need for stronger governance, improved traceability, and greater industry collaboration.

The study concludes that although progress has been made, significant challenges remain in ensuring ethical supply chains within the renewable energy sector. Recommendations include the development of independent certification schemes, enhanced transparency mechanisms, and further research across different regions of the UK to strengthen the evidence base.

1 Introduction

Currently, the world is transitioning from fossil fuel-based energy systems to renewable energy technologies (Guchhait and Sarkar, 2023). This transition is primarily driven by the need to mitigate climate change caused by greenhouse gas emissions from fossil fuel combustion (Vaz et al., 2022; Capua and Rahmstorf, 2023). Meanwhile renewable energy technologies such as solar panels and wind turbines produce little to no greenhouse gas emissions during operation (Algarni *et al.*, 2023).

Despite these environmental benefits, renewable technologies rely on large quantities of critical minerals for their manufacture (Chang et al., 2023). Examples include copper for solar power plants and dysprosium for wind turbines (Calvo and Valero, 2021). Increased demand for these materials has been associated with environmental degradation and worker rights issues in mining regions (Labaran and Masood, 2025).

The pace of renewable energy deployment has accelerated significantly in recent years as governments seek to decarbonise energy systems and improve energy security. Solar and wind power are among the fastest-growing energy sources globally (Ngobeh et al., 2023). However, rapid expansion increases demand for components such as batteries, turbines and panels, placing greater pressure on supply chains for minerals, metals and manufactured goods (International Energy Agency, 2021). As a result, the sustainability of renewable technologies must be considered across their full lifecycle, not only during operation.

Renewable technologies depend on complex global supply chains for their manufacturing. Many minerals are sourced from regions with weaker labour protections or environmental regulations, creating risks such as modern slavery, unsafe working conditions and the displacement of indigenous communities (Amnesty International, 2016). For example, lithium extraction in the Salar de Atacama in Chile has been linked to water shortages affecting local communities (Jerez et al., 2021).

In addition to labour concerns, renewable energy supply chains may create wider social and environmental risks. Mining activities can result in water pollution, biodiversity loss and land degradation, particularly where environmental governance is weak (Hund *et al.*, 2020). Communities located near extraction sites may receive limited economic benefit while bearing the environmental costs of development. Furthermore, long and complex international supply chains can make it difficult for developers to trace the origin of raw materials or verify supplier claims (International Energy Agency, 2022a). This creates challenges for organisations attempting to procure renewable technologies responsibly.

Wales is expanding its renewable energy capacity (Fonseca *et al.*, 2022). It has legally binding carbon reduction targets under the Environment (Wales) Act 2016 (amended 2021), aiming to achieve net-zero emissions by 2050 (Welsh Government, 2021). A key method of achieving this goal is the continued expansion of renewable energy generation. However, ethical sourcing has received limited attention within project-level decision-making in Wales.

Wales provides a useful case study as it combines ambitious climate policy with a growing pipeline of renewable energy developments, including onshore and offshore wind and solar projects. Public sector bodies and private developers are therefore likely to face increasing procurement responsibilities in the coming years. Understanding whether ethical sourcing is embedded within project decision-making is important to ensure that decarbonisation goals are not achieved at the expense of social justice elsewhere in the supply chain.

While existing literature identifies ethical risks within renewable energy supply chains, including weak labour protections (Tomassetti, 2023), limited research has examined how renewable energy projects in Wales screen suppliers and manage these risks in practice. This research aims to address this gap through semi-structured interviews with industry stakeholders. The findings aim to increase transparency around supply chain governance in Welsh renewable energy projects and contribute to broader discussions on ethical sourcing within the energy transition.

1.1 Research Aim

The aim of this research is to explore how renewable energy projects in South Wales assess and manage ethical supply chain risks such as modern slavery.

1.2 Research Objectives

- To examine how Welsh renewable energy developers and related organisations assess and screen suppliers during procurement processes.
- To investigate the extent to which due diligence measures, policies and monitoring systems are implemented to manage ethical supply chain risks.
- To identify the key challenges faced by organisations in Wales when attempting to balance project delivery, cost pressures and ethical supply chain management.
- To evaluate current practices against findings from the literature and identify opportunities for improving ethical procurement within the Welsh renewable energy sector.

1.3 Dissertation Structure

- **Chapter 2 – Literature Review:** Assesses the existing literature relating to renewable energy, supply chain management, and procurement guidance.
- **Chapter 3 – Methodology:** Explains the research design, including the chosen research method, participant selection, and data analysis procedures.
- **Chapter 4 – Results and Discussion:** Presents and discusses the research findings, cross-referencing them with themes identified in the literature review.
- **Chapter 5 – Conclusion:** Summarises the study by evaluating whether the research objectives were achieved, outlining the main findings, and providing recommendations for future research.

2 Literature Review

2.1 Introduction

This chapter critically reviews literature relating to climate change, renewable energy expansion, ethical supply chain risks, governance frameworks and procurement challenges. It establishes the conceptual basis for the study and identifies the gap in literature relating to how Welsh renewable energy organisations manage ethical sourcing in practice.

2.2 Climate Change

Climate change is widely recognised as one of the most significant environmental challenges facing modern society. While natural climatic variation has occurred throughout Earth's history (NASA, 2020), contemporary warming trends are strongly linked to anthropogenic greenhouse gas emissions, particularly from the combustion of fossil fuels such as coal, oil and natural gas (Santer *et al.*, 2023). These emissions intensify the greenhouse effect (Letcher, 2021), increasing global temperatures and contributing to more frequent and severe environmental impacts including heatwaves, drought, flooding and sea level rise (Huber and Gullett, 2011).

The energy sector is a major contributor to global emissions due to long-term dependence on fossil fuel-based electricity generation. Fossil fuels became dominant because of their high energy density, established infrastructure and historically low direct costs (Alagoz and Alghawi, 2023). However, their continued use is increasingly viewed as environmentally unsustainable, particularly as global energy demand continues to rise (Holechek *et al.*, 2022).

As a result, decarbonising energy systems has become a central policy objective internationally. Renewable energy technologies such as wind and solar power are viewed as key solutions because they generate electricity with significantly lower operational emissions than fossil fuels (Maka et al., 2024). However, although renewable energy can reduce emissions during use, the rapid expansion of these technologies has created growing demand for globally sourced materials and components (International Energy Agency, 2021). This means the response to climate change has also generated new supply chain governance challenges, particularly regarding ethical sourcing, labour standards and resource extraction (OECD, 2016).

2.3 Growth of Renewable Energy

Renewable energy is a method of generating power which produces less carbon dioxide (Algarni *et al.*, 2023). It is proposed as a strong alternative to fossil fuel-based electricity generation. According to (Millstein *et al.*, 2024), solar and wind energy reduce CO₂ emissions by 82% and 74% respectively, while also improving air quality. Between 2019 and 2022, wind and solar generation delivered an estimated \$249 billion in climate and air quality benefits (Millstein *et al.*, 2024). Many countries are rapidly expanding renewable energy capacity to reduce greenhouse gas emissions, improve energy security, and meet legally binding or voluntary net zero commitments established under frameworks such as the Paris Agreement (United Nations, 2015).

Although renewable energy reduces operational emissions, scholars increasingly argue that environmental benefits can sometimes mask social and environmental harms embedded within upstream supply chains (Berthet *et al.*, 2024).

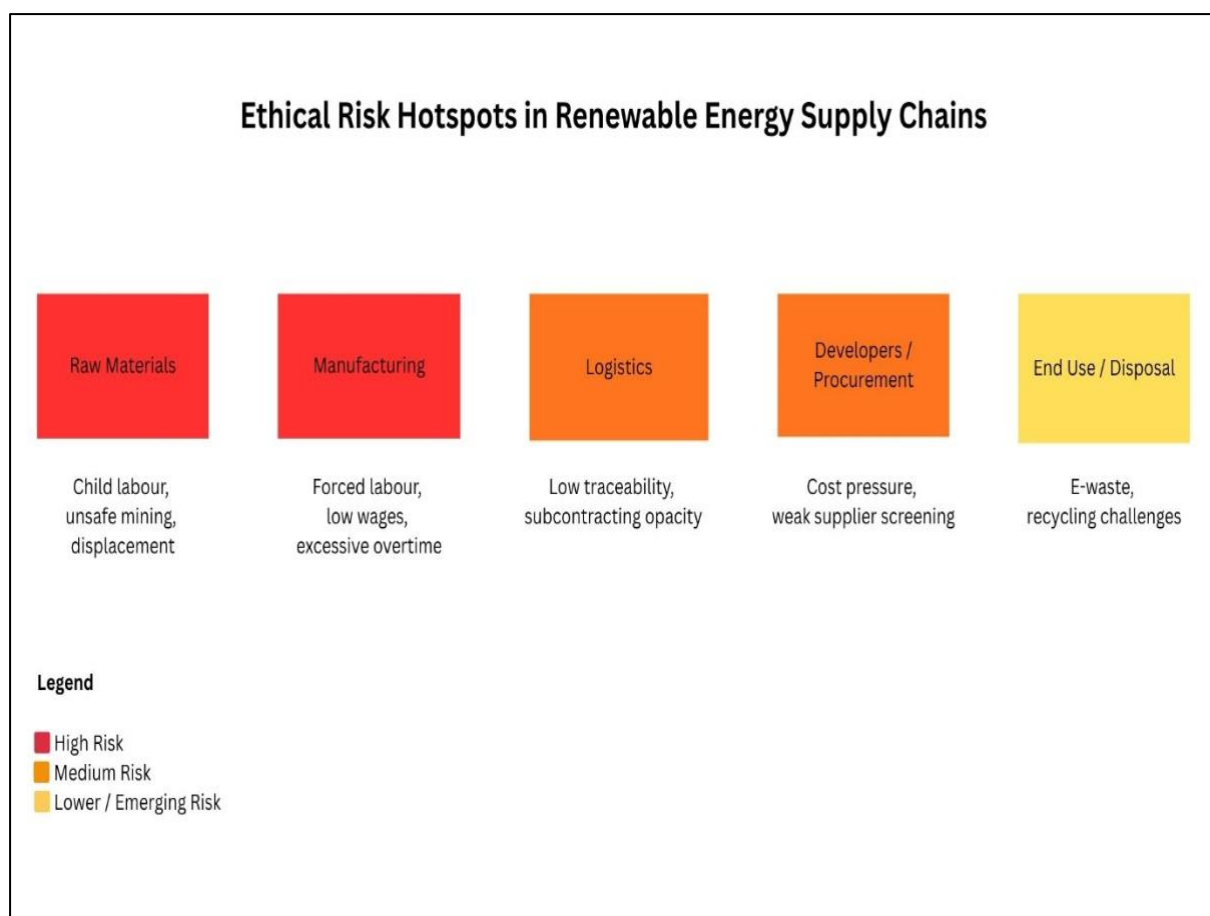


Figure 1: Indicative ethical risk hotspots across renewable energy supply chains based on themes identified in the literature (Author, 2026).

2.4 Just Transition

To address anthropogenic climate change, many scholars argue that energy systems must transition away from fossil fuel dependence towards low-carbon alternatives such as renewable energy technologies (Standal *et al.*, 2023). A Just Transition refers to ensuring that this shift to a low-carbon economy is equitable and inclusive, so that the social and economic costs are not disproportionately carried by vulnerable groups (Rios-Ocampo *et al.*, 2024). This is particularly relevant for workers employed in fossil fuel industries, communities located near renewable energy developments, and workers within global supply chains who may face poor labour conditions or exploitation (Walters *et al.*, 2025). The Just Transition principle has origins in environmental and labour justice movements and is now included in frameworks created by powerful governing bodies such as International Labour Organisation (ILO), United Nations Framework Convention on Climate Change (UNFCCC) and Welsh Government (Wang and Lo, 2021).

Currently the world operates from an extractive economy, where resources are extracted, workers are exploited, and wealth and power are enclosed. A Just Transition is more than just the transition to a lower-carbon economy, it is a transition to a regenerative economy where work is cooperative, resources are regenerated and social well-being is prioritised (Climate Justice Alliance, 2025).

The European Financial Reporting Advisory Group (EFRAG) has developed the Voluntary Sustainability Reporting Standard for non-listed SMEs (VSME) to help smaller firms disclose environmental, social and governance (ESG) information in a more consistent manner. This is relevant to renewable energy supply chains, where many contractors and component suppliers may be SMEs with limited formal reporting systems. By encouraging disclosure on areas such as human rights policies and negative social impacts, the framework may improve supply chain transparency and stakeholder trust (EFRAG, 2024). However, as a voluntary standard, its effectiveness is likely to depend on uptake and enforcement by buyers, investors, and regulators. By improving transparency around human rights and social impacts, the VSME framework may also support broader just transition objectives by encouraging more socially responsible supply chain practices within renewable energy development.

2.5 Supply Chains

Companies are increasingly turning to global sources for supplies which has increased the need for effective supply chain management. Supply chains are geographically dispersed networks of organisations involved in sourcing materials, manufacturing components, distribution, and delivery of final products (MacCarthy et al., 2022). There are three main types of supply chains: “direct”, “extended” and “ultimate” supply chains. Each supply chain is more complex than the previous, with increasing parties being involved in each chain (Mentzer *et al.*, 2001). For renewable energy developers, supply chain management increasingly extends beyond cost and delivery to include environmental, social and governance (ESG) considerations.

2.5.1 Supply Chain Transparency

Supply chain transparency explains the extent that stakeholders in a supply chain have access into the origins of raw materials, production processes and generally the social and environmental impacts of their suppliers (Reynolds, 2024).

Limited transparency is particularly problematic in multi-tier international supply chains, where buyers often possess visibility over direct suppliers but not lower-tier mining, processing or manufacturing stages. Supply chains commonly consist of several tiers. Tier 1 suppliers are the companies that directly supply goods or services to the lead organisation, while tier 2 suppliers provide materials or components to tier 1 suppliers. Tier 3 suppliers are positioned further upstream and are typically responsible for the extraction of raw materials or the supply of basic components used earlier in the production process (Avetta, 2026). As distance from the lead buyer increases, oversight often declines. This can make it difficult for organisations to assess labour practices, environmental standards or sourcing methods beyond their immediate suppliers. Resource constraints may further limit the ability of firms to conduct detailed due diligence across all supply chain tiers (Gold et al., 2009). For example, where critical minerals are extracted in Africa or Asia and later processed elsewhere before reaching European manufacturers (OECD, 2016), renewable energy developers may find it difficult to independently audit extraction sites for risks such as unsafe working conditions, child labour or modern slavery (Amnesty International, 2016).

2.6 Global Renewable Energy Supply Chains

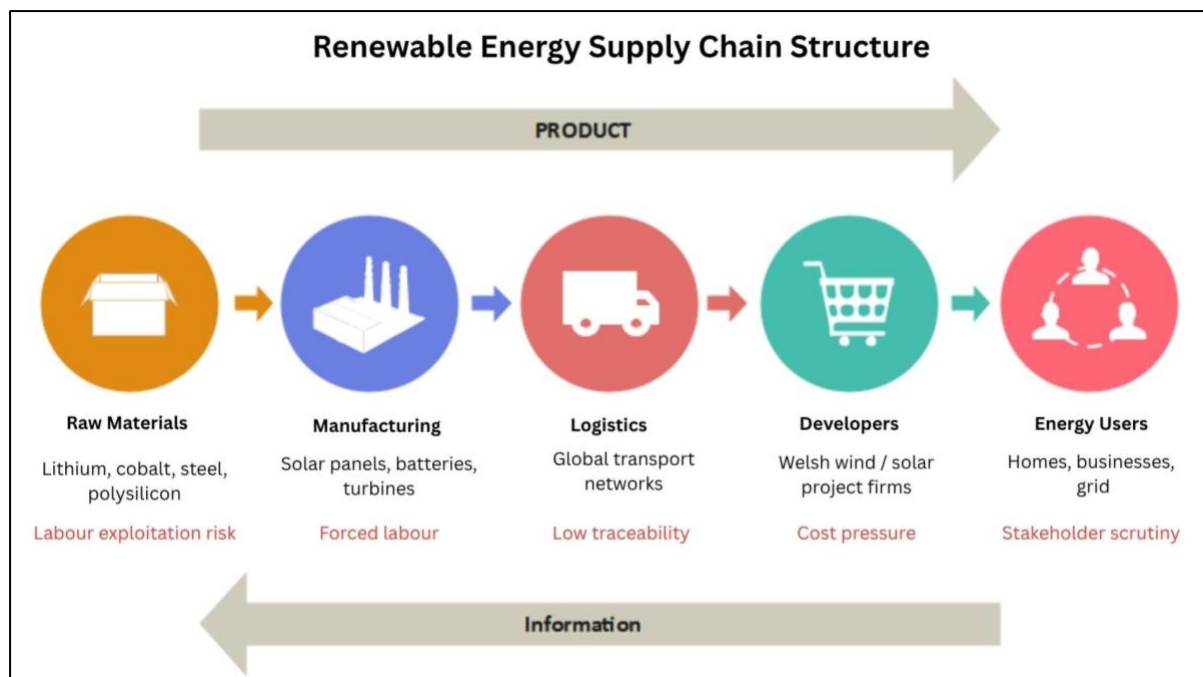


Figure 2: Simplified renewable energy supply chain structure showing key stages and selected ethical risk points (Author, 2026).

2.6.1 Solar Energy

Renewable energy is not without ethical challenges, particularly within globalised mineral and component supply chains. In the solar photovoltaic (PV) sector, China has been identified as the dominant global production hub for polysilicon, a key raw material used in solar panel manufacturing. Estimates suggest that China accounted for around 80% of global polysilicon production in 2021 (International Energy Agency, 2022). More specifically, the Xinjiang Uyghur Autonomous Region accounted for approximately 45% of global polysilicon output, where multiple reports have raised concerns regarding state-imposed forced labour involving Uyghur populations (Murphy and Elimä, 2021).

Similarly, lithium-ion batteries used to store intermittent wind and solar power often rely on cobalt. Around 15–30% of global cobalt production has been linked to artisanal and small-scale mining in the Democratic Republic of Congo, where reports have documented hazardous working conditions, child labour, and exploitative labour practices (Cockayne et al., 2022). These examples illustrate how decarbonisation technologies can remain socially problematic if ethical sourcing and due diligence are not prioritised. These cases also demonstrate that renewable energy technologies may transfer environmental burdens and labour risks to developing nations rather than eliminate them entirely.

To combat the issues surrounding the sourcing of cobalt, supply chain certification schemes have been introduced to promote responsible sourcing. One of these certification schemes is the Responsible Minerals Initiative (RMI). It has more than 500 members and provides companies with the tools and resources to support responsible sourcing from conflict-affected and high-risk areas (Responsible Minerals Initiative, 2025).

2.6.2 Wind Energy

Wind turbine manufacturers have also faced criticism regarding supply chain governance, particularly in relation to the sourcing of balsa wood, a lightweight core material commonly used in wind turbine blades. As global demand for wind energy has increased (International Energy Agency, 2023), demand for balsa wood has risen sharply, creating significant social and environmental pressures within producing regions. In Ecuador, where much of the world's commercial balsa is sourced, reports have documented illegal logging, land encroachment, and conflict affecting Indigenous territories in the Amazon region (Environmental Investigation Agency, 2024). The rapid expansion of balsa wood demand has been linked to weak oversight and informal extraction networks operating in protected areas.

Both the United States and China have been identified as major end-markets driving pressure on Ecuador's balsa wood supply through wind turbine manufacturing and deployment. China, the global leader in installed wind power capacity and new annual additions, was identified as the dominant destination for Ecuadorian balsa exports, reflecting its growing demand for wind turbine inputs (Ireland, 2022). This demonstrates how rapid renewable energy expansion can generate unintended ethical and environmental risks when raw material sourcing is insufficiently monitored. This reinforces concerns that rapid renewable energy expansion can create unintended consequences when sourcing standards fail to keep pace with market growth.

To counter these supply chain risks, the project 'ReRoBalsa' was started in 2017 and is an initiative to try to recover balsa wood from old turbines. The recycling of rotor blades is currently expensive and complicated to do because of the glass fibre-reinforced composite plastic. This results in loss of valuable materials such as balsa wood but also plastic foam (Fraunhofer WKI, 2017). Recovery of balsa wood would mean that less forest would have to be cut down to source the wood for new turbines.

2.7 Governance and Regulation

Governance responses have expanded in recent years, although many more rely on disclosure and voluntary compliance than direct enforcement.

2.7.1 Certification

There are certifying bodies in the renewable energy industry that work similarly to the fairtrade label commonly used on chocolate. An example of this is the Solar Stewardship Initiative, which is a supply chain sustainability assurance scheme dedicated to the needs of the solar PV sector and its customers. It is comprised of a combination of international standards, industry and civil society expertise and political acumen to produce a supply chain sustainability solution (Solar Stewardship Initiative, 2026).

2.7.2 UK Modern Slavery Act 2015

The Modern Slavery Act 2015 was introduced in the United Kingdom to combat slavery and human trafficking while increasing corporate accountability. Under Section 54, commercial organisations above a turnover threshold are required to publish an annual slavery and human trafficking statement outlining actions taken within their operations and supply chains (UK Government, 2015). The legislation forms part of a broader shift towards greater corporate transparency and supply chain due diligence. This wider regulatory and stakeholder pressure is reflected in supplier governance frameworks used by renewable energy firms such as Vattenfall, whose public supplier code requires risk-based due diligence, traceability assessments, and explicit prohibitions on forced labour across suppliers and sub-suppliers (Vattenfall, 2024). However, critics argue the Modern Slavery Act relies heavily on corporate disclosure and weak enforcement mechanisms, which can encourage superficial “box-ticking” compliance rather than substantive action to prevent exploitation (Nolan and Pryde, 2024). This is particularly relevant to renewable energy developers procuring internationally sourced components, where disclosure alone may not guarantee ethical supply chains.

2.7.3 Welsh Procurement Guidance

The Social Partnership and Public Procurement (Wales) Act 2023 provides an important regional governance framework for ethical procurement in Wales. The legislation places duties on specified public bodies to consider socially responsible procurement, fair work outcomes, and greater transparency within contracted supply chains (Welsh Government, 2023). This is particularly relevant where renewable energy projects involve public funding, local authority participation, grid infrastructure, or public land partnerships. Although the Act does not directly regulate most privately led renewable developments, it may still influence wider market expectations by embedding higher labour and procurement standards among contractors seeking public sector work (Gooberman and Hauptmeier, 2025). However, given the global sourcing of many renewable energy components, Welsh procurement legislation alone is unlikely to address upstream international labour risks. Wales also has a broader policy culture emphasising sustainability and long-term wellbeing through legislation such as the Well-being of Future Generations (Wales) Act 2015, which may indirectly reinforce expectations around ethical procurement (Welsh Government, 2015).

2.8 Barriers to Ethical Sourcing

There are several barriers companies and organisations face when attempting to source materials from ethical sources. These barriers often compete with the standards and expectations established by governments, NGOs and industry frameworks relating to ethical procurement. Examples of barriers include cost pressures, limited staff capacity, lack of supply chain transparency and inaccurate self-reporting from suppliers lower down in the supply chain (Gold et al., 2009). Smaller organisations may lack the financial or staffing capacity to conduct extensive supplier audits or carry out detailed due diligence assessments across multiple tiers of suppliers. Ethical procurement can therefore become resource-intensive, particularly when projects face tight budgets or strict delivery deadlines. As a result, in competitive markets, ethical standards may compete with financial and project delivery pressures (Chen and Slotnick, 2014).

A major challenge for renewable energy supply chains is their global and highly fragmented nature. Renewable energy technologies such as solar panels, batteries and wind turbines rely on components and raw materials sourced from multiple countries, often passing through numerous suppliers before reaching the final developer or manufacturer (International Energy Agency, 2022b). This complexity can make it difficult for organisations to trace the origin of materials or verify labour and environmental conditions throughout the entire supply chain (Ahmad et al., 2023). Suppliers may subcontract production stages to additional firms without the knowledge of the buyer, further reducing transparency and accountability (Sovacool *et al.*, 2020). Consequently, organisations may unknowingly source materials linked to exploitative labour practices or environmental damage.

Legislative and regulatory limitations also present barriers to ethical sourcing. Although laws such as the UK Modern Slavery Act 2015 require large companies to publish statements outlining actions taken to address modern slavery risks (UK Government, 2015), critics argue that enforcement mechanisms remain limited and that companies can comply with minimum reporting requirements without demonstrating meaningful action (Stevenson and Cole, 2017). Furthermore, differing regulations between countries can create inconsistencies in ethical expectations and reporting standards across international supply chains. This can make it difficult for organisations operating across multiple jurisdictions to maintain consistent ethical procurement practices.

2.9 End of Life Issues

Renewable energy technologies also present significant end-of-life challenges as increasing numbers of solar panels, wind turbines and batteries approach disposal or replacement stages. Although renewable technologies reduce greenhouse gas emissions during operation, they generate growing volumes of waste electrical and electronic equipment which contain critical raw materials such as lithium, cobalt, nickel and rare earth elements (Zhdaneev and Aleshkevich, 2024). Wind turbine blades are particularly difficult to recycle because they are composed of complex composite materials, while photovoltaic panels can contain hazardous substances that require specialised disposal and treatment processes (Khalid *et al.*, 2023). In addition, many renewable energy technologies have relatively limited operational lifespans, with solar panels typically lasting around 25–30 years, meaning large quantities of waste are expected in coming decades (Xu *et al.*, 2018). (Watkins *et al.*, 2023) argue that current recycling systems are not yet adequately adapted to recover critical raw materials from renewable energy technologies and that recycling rates for many materials remain low. The authors further highlight the importance of circular economy strategies such as reuse, repair and improved product design to enable easier dismantling and material recovery at the end of life (Watkins *et al.*, 2023). Without effective end-of-life management and recycling infrastructure, renewable energy supply chains may continue to rely heavily on environmentally damaging and socially problematic mining practices to meet future material demand.

2.10 Conclusion

This chapter reviewed literature surrounding renewable energy growth, just transition principles, global supply chain risks and governance responses. The review suggests that while ethical risks are well documented internationally, less is known about how such risks are managed at project level within Wales. These themes informed the interview design and provided the analytical framework for the Results and Discussion chapter.

3 Methodology

3.1 Introduction

This chapter first justifies the use of interviews as a research method before outlining the design of the interview questions. It then explains the participant selection process and sampling strategy, followed by the procedures used to conduct the interviews. Finally, the chapter details the approach to data analysis, including the use of NVivo software and thematic coding.

3.2 Interviews

Interviews are a widely used method for collecting qualitative data because they allow participants to discuss their experiences and perspectives in detail (Winwood, 2019). An interview-based approach was selected for this research as it enabled detailed exploration of procurement practices, supplier screening, governance processes and ethical decision-making within renewable energy supply chains. Interviews are particularly suitable for examining complex organisational issues that may not be fully captured through more structured methods such as questionnaires (Braun and Clarke, 2006).

Expert interviews were considered appropriate because the research aimed to obtain detailed professional insight into renewable energy procurement and supply chain management. Unlike large-scale quantitative approaches, expert interviews prioritise depth of understanding over sample size, making them suitable for exploratory research focused on complex organisational practices (Bogner et al., 2009).

An interview-based approach was also considered appropriate due to the limited research focused specifically on ethical supply chain management within renewable energy projects in Wales. Existing literature has widely examined ethical risks within global renewable energy supply chains, including modern slavery, environmental degradation and supply chain transparency. However, limited research has explored how organisations involved in Welsh renewable energy projects interpret these risks and manage ethical procurement in practice. Interviews therefore provided an opportunity to collect original qualitative data within an under-researched area.

3.3 Interview Design

The interview questions were designed to explore key themes identified throughout the literature review, including supply chain due diligence, modern slavery risks, procurement screening, supply chain transparency and regulatory compliance. Particular attention was given to governance limitations, ethical sourcing barriers and the complexity of global renewable energy supply chains, as these issues were consistently identified within existing literature relating to renewable energy procurement and critical mineral sourcing. Questions also aimed to examine how these broader issues are interpreted and managed within the context of renewable energy projects in Wales.

A thematic structure was used to organise the interview guide. Questions were grouped into key areas including ethical risks in supply chains, transparency, governance and due diligence processes, barriers to ethical sourcing and future solutions. These categories reflected recurring themes identified throughout the literature review, particularly in relation to supply chain transparency (Reynolds, 2024), barriers to ethical procurement (Gold et al., 2009) and governance challenges associated with international renewable energy supply chains (Nolan and Pryde, 2024).

For example, participants were asked to identify key ethical risks associated with sourcing renewable energy materials, assess how organisations address modern slavery risks and reflect on the level of transparency within supply chains. This ensured that each question directly contributed to addressing the research objectives while also allowing consistency across interviews.

The interview followed a logical structure, beginning with introductory questions about the participant's role and experience in renewable energy supply chains. This was followed by more focused questions exploring ethical risks, organisational practices and supply chain challenges. The final section encouraged participants to reflect on future developments and potential solutions within the sector. Closing questions were included to allow participants to raise any additional points that may not have been covered.

Semi-structured interviews were chosen as the interview approach for this research. This method does not follow a rigid question order like structured interviews but instead uses a set of guiding questions to ensure that key topics are covered. The flexible format allows the interviewer to monitor the progress of the discussion and redirect the conversation if responses begin to move away from the research focus (Karatsareas, 2022). A key advantage of semi-structured interviews is that they allow the interviewer to ask additional follow-up questions when new or interesting insights emerge during the conversation.

Questions were designed to be open-ended and neutrally worded to encourage participants to provide detailed responses based on their professional experience, while avoiding leading or biased phrasing. Follow-up prompts were used where necessary to explore responses in greater depth.

A pilot interview was conducted with the dissertation supervisor to test the clarity, relevance and structure of the questions. This process enabled minor revisions to be made prior to data collection, ensuring that the interview guide was suitable for addressing the research aims.

3.4 Participant Selection

Five participants were selected using purposive sampling. Purposive sampling involves selecting individuals with relevant knowledge or experience relating to the research topic (Palinkas *et al.*, 2015). This approach was considered appropriate because the research required informed professional perspectives on renewable energy supply chains rather than a large representative sample.

Participants worked within the renewable energy sector in roles including company director, sustainability officer and project manager. Individuals in senior or decision-making positions were prioritised because these roles were more likely to have involve direct engagement in procurement decisions, supplier relationships and governance processes.

All participants were based in South Wales. This region was selected due to the growing concentration of renewable energy developments within Wales, allowing the research to gather context-specific insights into ethical supply chain practices.

Potential participants were identified through professional networks, company websites and sector contacts, then invited via email. Interview dates and times were arranged according to participant availability.

Prior to data collection, ethical approval was obtained from the university. Participants were informed of the purpose of the study, assured that commercially sensitive information would remain confidential, and asked to provide consent before taking part and before interviews were recorded.

3.5 Interview Procedure

Interviews were conducted remotely using Microsoft Teams between January and March 2026. Each interview lasted approximately 30–60 minutes.

At the start of each interview, participants were reminded of the research purpose, confidentiality arrangements and their right to withdraw. Verbal consent to participate and to record the session was then confirmed.

A semi-structured interview guide was used to ensure consistency across interviews while allowing flexibility to ask follow-up questions where relevant. This enabled participants to expand on issues such as procurement practices, supplier screening and ethical challenges.

All interviews were audio-recorded and later transcribed for analysis. Transcripts were then imported into NVivo for thematic coding.

3.6 Data Analysis

Once the interviews had been conducted, the recordings and automatically generated transcripts were downloaded from Microsoft Teams. The transcripts were reviewed for accuracy and then imported into NVivo software to support qualitative data analysis. A thematic coding approach was used to identify recurring patterns, ideas and issues raised by participants.

Initially, open coding was undertaken by reading each transcript line-by-line and assigning labels to relevant statements. Similar codes were then grouped into broader categories. Through this iterative process, five main themes were identified across the dataset: ethical risks in supply chains, supply chain complexity, barriers to ethical supply chains, procurement management, and future solutions. Within each of these broader themes, several sub-themes were also developed to capture more specific issues discussed by participants.

Coding was reviewed throughout the analysis process, with some codes merged, refined or reorganised where overlap occurred between themes. This flexible approach allowed relationships between themes to emerge and ensured that the final structure reflected the most consistent patterns found within the interview data. The coded themes were then used to structure the Results and Discussion chapter.

3.7 Conclusion

This chapter has outlined the methodological approach used to investigate ethical supply chains within renewable energy projects in South Wales. The use of semi-structured interviews provided detailed qualitative insights into procurement practices, supply chain governance and ethical risks within the sector.

Certain limitations must be acknowledged. The relatively small sample size and regional focus may limit the wider generalisability of the findings beyond the Welsh renewable energy sector. In addition, the research relied on participant perspectives and self-reported experiences, creating the potential for response bias or selective disclosure of information. Furthermore, due to organisational firewall restrictions, a full transcript could not be generated for Participant 4's interview. Instead, an AI-generated meeting summary produced by the participant's secretary was used for analysis. While this limited the level of detail available compared to verbatim transcripts, the summary still provided sufficient information to identify key themes relevant to the study.

Despite these limitations, the methodology provided a suitable framework for exploring a complex and under-researched topic and generated data capable of addressing the research objectives. The following chapter presents and discusses the key themes identified through the thematic analysis process.

4 Results and Discussion

4.1 Introduction

This chapter presents and analyses the findings derived from five semi-structured interviews conducted with professionals involved in renewable energy supply chains. The interview data were transcribed and systematically analysed using NVivo software, following a thematic analysis approach. Through this process, key patterns and recurring ideas were identified and organised into five overarching themes, each representing a significant aspect of ethical supply chain management within the renewable energy sector.

The thematic analysis generated several recurring themes from the interview data. The most significant themes identified were ethical risks, supply chain complexity, barriers to ethical sourcing, procurement management and future solutions. While additional sub-themes emerged during coding, these broader themes were selected as they appeared most consistently across interviews and were most relevant to the research objectives. These themes provide the framework through which the findings are presented and interpreted.

In line with qualitative research best practice, the results and discussion are integrated within this chapter. This allows for direct comparison between the primary data and the existing literature presented in Chapter 2, enabling similarities, differences, and emerging insights to be critically examined. Participant quotations are used throughout to support the analysis and provide transparency, ensuring that the findings remain grounded in the perspectives of those working within the industry.

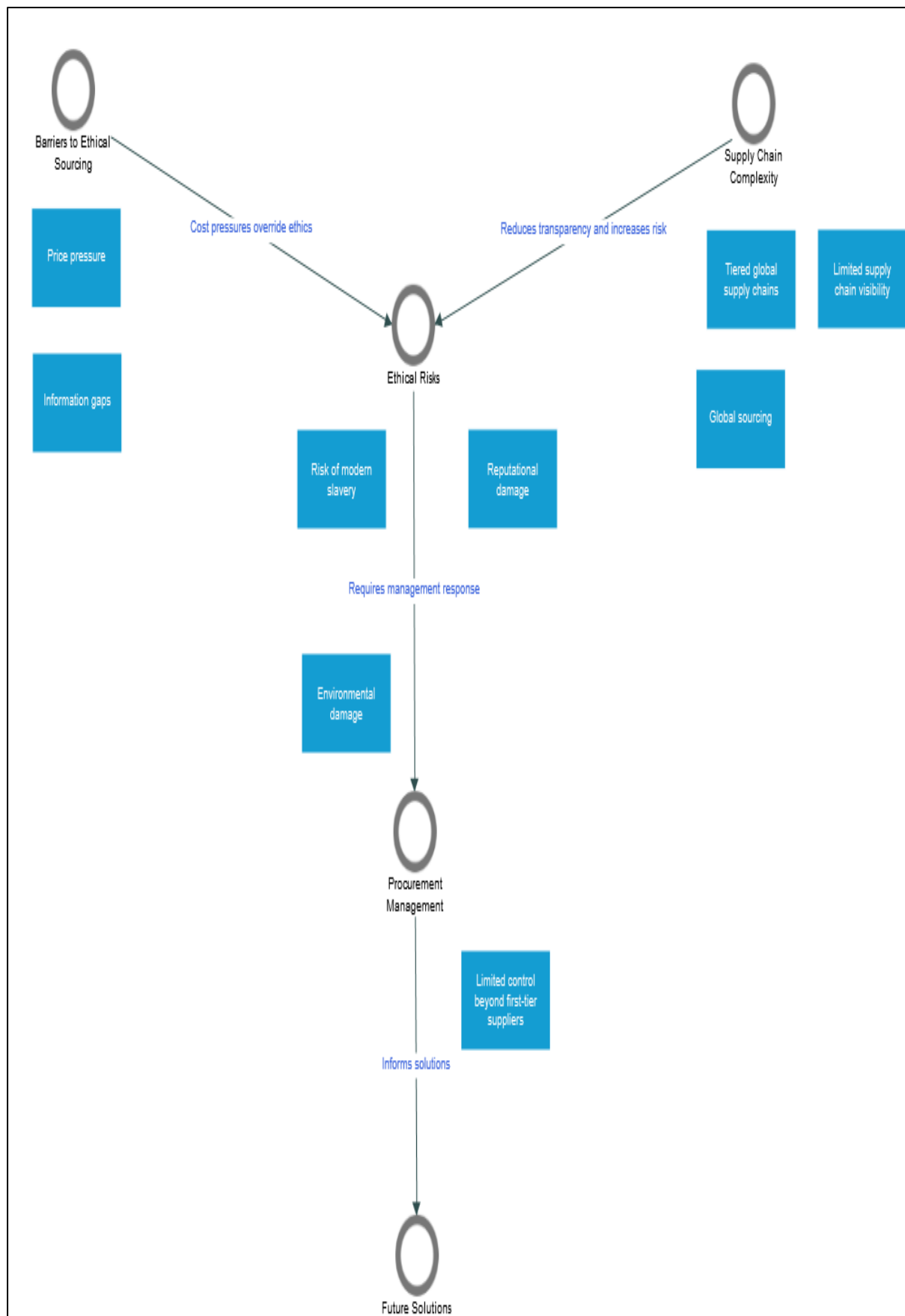


Figure 3: Thematic map of ethical challenges in renewable energy supply chains (Author, 2026)

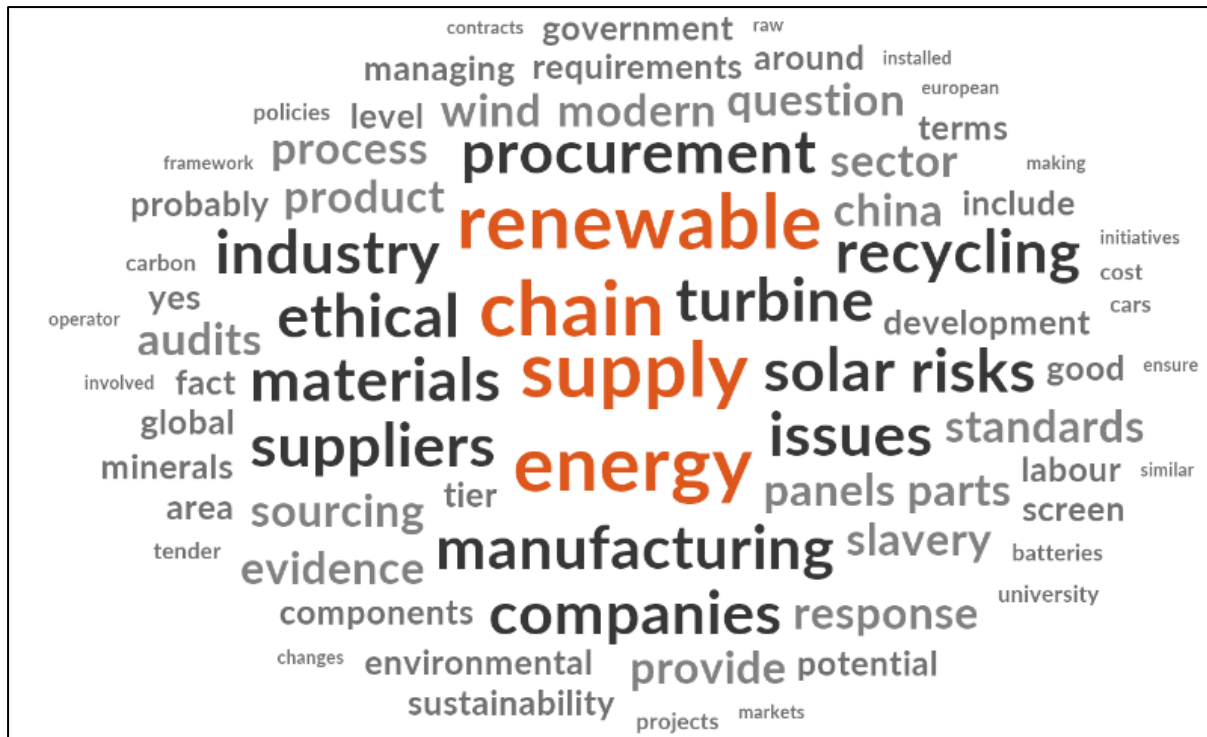


Figure 4: Word cloud generated in NVivo from coded interview transcripts (n=5), displaying the most frequently occurring words after the removal of common stop words and grouping of similar terms (Author, 2026).

Table 1: Participant Profile Summary.

Participant	Role	Organisation Type	Sector
1	Director	Private Company	Renewable Energy
2	Sustainability Director	Higher Education Institution	Education
3	Project Manager	Utility Company	Renewable Energy
4	Assistant Director	Public Health Board	Healthcare
5	Transport Manager	Contractor	Infrastructure

4.2 Ethical Risks

Participants identified a wide range of ethical risks embedded within renewable energy supply chains, highlighting that the transition to low-carbon technologies does not eliminate social and environmental harms but instead redistributes them across global production networks (Cockayne et al., 2022). Key risks discussed included modern slavery, unethical sourcing of raw materials, environmental degradation, illegal resource extraction, and reputational damage. These findings reinforce arguments within the literature review that renewable energy supply chains are highly complex and often extend into regions where governance is weak and oversight is limited (International Energy Agency, 2022b).

A prominent issue raised by participants was the risk of modern slavery within the sourcing of critical materials, particularly in relation to solar photovoltaic (PV) supply chains. This aligns with existing literature highlighting forced labour concerns in polysilicon production in Xinjiang, China (Murphy and Elimä, 2021). Participant 2 provided a direct example of this risk materialising within a Welsh renewable energy project, stating:

“The solar installs we’d done were supplied by Canadian Solar, had links to Xinjiang in China and potential internment camps.”

This example demonstrates that ethical risks identified at a global scale are not abstract concerns but have tangible implications for local renewable energy developments. It highlights the difficulty organisations face in fully tracing supply chains beyond Tier 1 suppliers, supporting literature which argues that multi-tier supply chains limit transparency and accountability (Sovacool et al., 2020). Despite operating within a UK regulatory context, organisations remain exposed to upstream risks that are geographically and institutionally distant.

In addition to modern slavery, participants emphasised reputational risk as a central concern when managing supply chain ethics. Notably, Participant 2 suggested that reputational consequences outweigh legal risks:

“The biggest risk for us as an institution around modern slavery within solar panels is a reputational one rather than a legal one.”

This reflects wider critiques of regulatory frameworks such as the Modern Slavery Act 2015, which have been criticised in the literature for lacking strong enforcement mechanisms and relying heavily on voluntary disclosure (Stevenson and Cole, 2017). As a result, organisations may be more motivated by the potential for public scrutiny, stakeholder pressure, and brand damage than by formal legal penalties. The emphasis on reputational risk also suggests that ethical decision-making is influenced by external perception as much as by internal governance structures.

Participant 3 further highlighted the structural difficulties organisations face when attempting to oversee lower-tier suppliers and raw material extraction processes:

“Otherwise, you’ll be going out to the mines where cobalt or copper are mined and thinking how much direct influence have we got over the activities that go on in these places? The answer is none.” (P3)

This suggests that organisations involved in renewable energy projects often have limited direct oversight over upstream extraction activities, particularly where critical minerals are sourced internationally. As supply chains become increasingly globalised and multi-tiered, maintaining visibility and accountability across all stages becomes significantly more difficult (OECD, 2016).

Overall, the findings suggest that ethical risks in renewable energy supply chains are multifaceted and interconnected, combining human rights concerns with environmental and organisational dimensions. While the literature often emphasises structural issues such as globalisation and supply chain complexity, the primary data reveals how these risks are experienced and interpreted by practitioners. In particular, the prioritisation of reputational risk highlights a gap between regulatory intent and organisational behaviour, suggesting that market and social pressures currently play a more significant role in driving ethical supply chain management than formal legislation.

4.3 Supply Chain Complexity

A key challenge identified by participants was the complexity of renewable energy supply chains, which was consistently linked to limited transparency and reduced organisational control over ethical risks. Interviewees emphasised that globalised production processes, involving multiple actors across different geographical regions, make it difficult to trace the origins of materials and verify ethical standards. This supports findings from the literature review, which highlight that multi-tier supply chains reduce visibility, particularly beyond Tier 1 suppliers where monitoring becomes increasingly resource-intensive and fragmented (Sovacool *et al.*, 2020).

Participant 1 illustrated this complexity by describing the geographically dispersed nature of production processes:

“Materials are sourced all around the world, taken to China, manufactured into something, even if it’s components, and then assembled in different countries.”

This reflects wider industry trends identified in the literature, where China has become a dominant actor in renewable energy supply chains due to its control over critical mineral processing and renewable technology manufacturing. According to (International Energy Agency, 2022b), China accounts for a substantial share of global refining capacity for key minerals used in renewable technologies and dominates several stages of solar photovoltaic manufacturing. As a result, renewable energy supply chains often involve raw materials being extracted in one region, processed and manufactured in China, and later assembled or deployed elsewhere. This geographical fragmentation increases supply chain complexity and makes traceability and ethical oversight more difficult (Gold *et al.*, 2009).

Participant 3 reinforced this point by highlighting the reliance on Tier 1 suppliers and the resulting lack of visibility further down the supply chain:

“We rely on our tier one suppliers, who will then be relying on their tier 2 and tier 3 suppliers ... we don’t get a lot of exposure to specifically where raw materials come from.”

This reflects a common structural limitation identified in the literature, where organisations tend to focus due diligence efforts on direct suppliers while having limited capacity to monitor lower-tier actors (Ahmad et al., 2023). This reliance creates a lack of responsibility for upstream practices as they are effectively outsourced, even though reputational and operational risks remain with the purchasing organisation. It also highlights the lack of transparency within supply chains, where lower-tier suppliers possess critical knowledge about sourcing practices that is not easily accessible to buyers.

The lack of transparency at lower tiers was consistently identified by participants as a significant barrier to addressing ethical risks, particularly in relation to raw material extraction. This is especially relevant for critical minerals used in renewable technologies, which are often sourced from regions associated with environmental degradation and labour rights concerns (Amnesty International, 2016). Without clear visibility over these stages, organisations face challenges in verifying supplier claims, conducting effective audits, and ensuring compliance with ethical standards.

Furthermore, supply chain complexity not only limits transparency but also constrains the effectiveness of governance mechanisms. For example, legislation such as the Modern Slavery Act 2015 relies on organisational disclosure and due diligence processes, yet these mechanisms are often criticised for placing excessive reliance on voluntary corporate reporting (Stevenson and Cole, 2017), particularly where organisations have limited visibility beyond Tier 1 suppliers. This creates a gap between policy expectations and practical implementation, where organisations are expected to manage risks that are structurally difficult to observe or control.

Overall, participants described supply chain complexity as a fundamental challenge that underpins many of the ethical risks identified in this research. While the literature often frames complexity as an inherent feature of globalisation, the findings demonstrate how it is experienced in practice by organisations operating within the Welsh renewable energy sector. In particular, the reliance on multi-tier supplier networks and the resulting lack of transparency highlight the need for improved traceability mechanisms and stronger collaboration across supply chain actors.

4.4 Barriers to Ethical Sourcing

Participants identified a range of barriers that limit organisations' ability to source materials ethically within renewable energy supply chains. These barriers included practical limitations, resource constraints, information gaps, and broader challenges associated with globalised supply networks. Collectively, these findings suggest that while there is an awareness of ethical risks, organisations face structural and operational constraints that hinder the consistent implementation of ethical sourcing practices.

A key barrier highlighted by participants was the practical limitation of monitoring complex supply chains. Due to the scale and multi-tiered nature of procurement networks, organisations are often unable to comprehensively assess the ethical practices of all suppliers. Participant 2 explained that their organisation is:

“Slightly reliant on the companies self-regulating themselves and their modern slavery statements,”

while Participant 1 reinforced this constraint by stating:

“You can’t check everything.”

These responses demonstrate the reliance placed on supplier self-disclosure, particularly through mechanisms such as modern slavery statements. This aligns with critiques in the literature that suggest corporate reporting frameworks may lack depth, consistency, and verification, resulting in a “tick-box” approach to compliance (Nolan and Pryde, 2024). In this context, organisations are required to trust that suppliers are accurately representing their practices, despite limited capacity to independently validate these claims. This creates a significant information gap, where ethical risks may remain hidden within lower tiers of the supply chain.

In addition to practical limitations, cost pressures were identified as a major factor shaping procurement decisions. Participants consistently emphasised that financial considerations can constrain the extent to which ethical standards are prioritised.

Participant 4 acknowledged this tension, stating:

“Price can sometimes override ethical considerations.”

This highlights the reality that organisations often operate within tight budgets and competitive markets, where cost efficiency is a key performance driver. As a result, even when ethical sourcing is recognised as important, it may be deprioritised in favour of more economically viable options (Chen and Slotnick, 2014).

Participant 2 further expanded on this trade-off, noting:

“Balancing what you want to do with the cost of it. So, at what level do you rate various ethical standards against cost.”

This quote illustrates the complexity of decision-making processes, where ethical considerations are not absent but are instead weighed against financial constraints. It suggests that ethical sourcing operates on a spectrum rather than as a fixed standard, with organisations making compromises based on what is achievable with their current resources. This reflects wider literature which argues that market pressures and cost competition can undermine sustainability initiatives, particularly in industries characterised by tight margins and rapid project delivery timelines (Seuring and Müller, 2008).

These findings also highlight limitations in regulatory frameworks such as the Modern Slavery Act 2015, which rely on transparency and disclosure rather than enforcing strict compliance (UK Government, 2015). While such legislation encourages organisations to assess supply chain risks, it does not necessarily address the underlying financial and structural barriers that prevent ethical sourcing from being fully realised (Stevenson and Cole, 2017).

Overall, the results suggest that barriers to ethical sourcing are not solely due to a lack of awareness or willingness but are embedded within the economic and structural realities of global supply chains. Practical constraints limit the ability to verify supplier practices, while cost pressures shape procurement decisions in ways that can undermine ethical priorities. This reinforces the need for systemic changes, including improved traceability mechanisms, stronger regulatory enforcement, and greater alignment between economic incentives and ethical standards.

4.5 Procurement Management

Procurement management emerged as a key theme across all interviews, with participants outlining a range of mechanisms used to manage ethical risks within renewable energy supply chains. These included supplier screening, modern slavery policies, due diligence processes, factory audits, certification schemes, procurement frameworks, tender requirements, and traceability systems. Collectively, these approaches demonstrate that organisations are actively attempting to embed ethical considerations into procurement practices, although their effectiveness is often shaped by the challenges identified in previous themes.

Supplier screening was consistently identified as a fundamental component of procurement processes. Two participants emphasised that suppliers are assessed against specific ethical criteria prior to selection, ensuring alignment with recognised standards and certifications. Participant 1 stated:

“We only choose manufacturers that are registered with the solar stewardship initiative.”

This highlights the use of certification schemes for ethical assurance, enabling organisations to filter suppliers based on existing standards (Solar Stewardship Initiative, 2026). Similarly, Participant 3 described a more contractual approach to screening, where suppliers are required to formally commit to organisational policies:

“To become a supplier, they are screened initially against those policies, and it will be a condition of a contract, like a turbine supply agreement, that they must sign up to that policy. Those policies include environmental protection, human rights and modern-day slavery.”

This demonstrates how ethical expectations are embedded within procurement contracts, shifting responsibility onto suppliers to comply with defined social and environmental requirements.

Modern slavery screening was another prominent aspect of procurement management, although approaches varied between organisations. Participant 2 explained that their process begins with reviewing supplier disclosures:

“It starts with looking at modern slavery statements from suppliers.”

However, as discussed under the “Barriers to Ethical Sourcing” theme, this approach can be limited by time and resource constraints, leading to a reliance on self-reported information:

“We’re reliant slightly on the companies self-regulating themselves and their modern slavery statements.” (P2)

This reflects broader concerns around transparency and verification, where organisations may lack the capacity to independently validate supplier claims. In contrast, Participant 4 described the use of established procurement frameworks to mitigate these risks:

“The Refit framework and Welsh Government energy services provide supply chain assurances, requiring suppliers to meet standards related to sustainability, antislavery, and responsible procurement.”

This suggests that institutional frameworks can play an important role in standardising ethical requirements and reducing the burden on individual organisations contrary to earlier critique of the legislation in the literature review (Nolan and Pryde, 2024).

Due diligence was also identified as a critical, albeit constrained, element of procurement management. Participants acknowledged that while comprehensive due diligence is desirable, it is not always feasible in practice. Participant 2 highlighted the necessity of conducting additional checks beyond supplier disclosures:

“We do a bit of due diligence because obviously no company is going to go big banner on their website going: ‘We use slave labour to mine minerals.’”

This statement reinforces a key issue identified in the “Ethical Risks” theme: companies have strong incentives to conceal unethical practices due to reputational concerns. As a result, procurement processes must go beyond surface-level assessments to critically evaluate supplier credibility.

Overall, the findings indicate that procurement management plays a central role in addressing ethical risks within renewable energy supply chains. While organisations employ a range of tools to screen and monitor suppliers, these mechanisms are often constrained by limited transparency, resource pressures, and supply chain complexity. This highlights a gap between intended ethical standards and their practical implementation, suggesting that procurement strategies alone may be insufficient without broader systemic improvements in traceability and accountability.

4.6 Future Solutions

Participants proposed a range of solutions aimed at improving the ethical integrity of renewable energy supply chains. These included the development of global certification schemes, enhanced transparency and traceability systems, and increased recycling of renewable energy infrastructure. While these solutions vary in scope, they collectively reflect a shift towards more proactive and systemic approaches to addressing the ethical risks and structural challenges identified in earlier themes.

A prominent solution suggested by participants was the introduction of a globally recognised certification scheme for renewable energy supply chains. Participant 3 highlighted the Forestry Commission as an example of best practice (Forestry England, 2026), noting:

“The approach that the Forestry Commission have taken in terms of how that timber has ended up in the marketplace and how it was grown, can be a guide for other products to follow.”

This comparison suggests that a similar model could be applied to renewable energy technologies, where materials and products are certified based on their environmental and social credentials. Importantly, Participant 3 emphasised that for such a system to be effective, it must involve independent auditing:

“What you want to be able to do is go to a supplier that you know has been audited and has been certified as meeting a required global standard.”

This reflects a key limitation identified in the “Barriers to Ethical Sourcing” and “Procurement Management” themes, where organisations often rely on self-reported information from suppliers. Independent certification could therefore reduce information asymmetry, increase trust, and standardise ethical expectations across the industry.

Improving transparency was also identified as a critical solution. Participants noted that without clear visibility over supply chains, it remains difficult to assess whether materials are sourced ethically. Participant 1 described an existing traceability system within their organisation:

“Each of our manufacturers has a traceability scheme. Effectively you can scan a barcode on each panel and identify where all the components come in that panel.”

This demonstrates how digital traceability tools can enhance supply chain visibility and allow organisations to track the origin of components. However, Participant 1 also acknowledged a key limitation of such systems:

“It does not provide evidence that all those materials come from ethical sources.”

This highlights an important distinction between traceability and ethical assurance. While traceability systems can reveal where materials originate, they do not necessarily verify the conditions under which they were produced. As such, transparency must be combined with robust auditing and governance mechanisms to effectively address ethical risks.

Finally, participants identified recycling as an innovative approach to reducing reliance on primary resource extraction, thereby mitigating upstream ethical risks. By decreasing demand for newly mined materials, recycling can reduce exposure to issues such as environmental degradation and labour exploitation (Kotarska and Young, 2023).

Participant 1 noted that:

“It’s now cheaper to recycle which is good,”

and further emphasised:

“The less we dig from the ground the better.” (P1)

These comments suggest that economic barriers to recycling are beginning to diminish, making it a more viable strategy for organisations. Participant 3 provided further evidence of this shift, explaining that their organisation is willing to incur additional costs to use recycled materials:

“We’ve paid a premium so that the steel that’s used in the manufacturing of the turbines... is all from recycled steel.”

This demonstrates a growing commitment to sustainability, even where financial trade-offs exist. As Participant 3 concluded, such initiatives are intended to:

“...raise the bar for our level of sustainability and environmental compliance.” (P3)

Overall, the proposed solutions indicate that addressing ethical risks in renewable energy supply chains will require a combination of improved governance, technological innovation, and shifts in industry practice. While challenges such as cost pressures and supply chain complexity remain, the findings suggest that there is both awareness and momentum towards more ethical and sustainable approaches in the sector.

4.7 Conclusion

Overall, the findings demonstrate that renewable energy supply chains present significant ethical challenges linked to supply chain complexity, limited transparency and difficulties in supplier oversight. While participants identified growing awareness of these issues and examples of improved governance practices, barriers including cost pressures and fragmented international supply chains continue to limit effective ethical sourcing. These findings are explored further in the concluding chapter, which considers the wider implications of the research and recommendations for future practice and research.

Overall, the findings highlight that ethical supply chain management remains a complex challenge. While solutions such as certification, improved transparency, and recycling show promise, their success will depend on addressing underlying structural constraints. The following chapter will draw together these findings in relation to the research aims and objectives.

5 Conclusions and Recommendations for Future Work

5.1 Conclusion

This research set out to explore how Welsh renewable energy projects assess and manage ethical risks within their supply chains, particularly in relation to labour exploitation and transparency. The findings demonstrate that while there is growing awareness of ethical responsibility among organisations, the effectiveness of current approaches remains constrained by structural challenges inherent in global supply chains.

A key insight from this study is that ethical risk management is not solely limited by organisational intent, but by the complexity of multi-tier supply chains. Even where due diligence processes and governance mechanisms are in place, limited visibility beyond first-tier suppliers restricts the ability of organisations to fully assess labour conditions. This suggests that existing frameworks, including regulatory requirements such as the Modern Slavery Act 2015, may encourage disclosure but do not necessarily ensure meaningful supply chain oversight.

At the same time, the research highlights that organisations are not passive actors. Evidence of supplier screening, procurement policies and growing emphasis on transparency indicates that progress is being made. However, these efforts are often shaped by cost pressures and commercial constraints, which can conflict with ethical sourcing objectives. This tension reflects a broader systemic issue within renewable energy supply chains, where rapid expansion and demand for critical materials can exacerbate existing risks.

Overall, this study contributes to the limited body of research focused specifically on renewable energy supply chains in Wales by providing empirical insight into how ethical risks are currently understood and managed in practice. It also demonstrates that improving ethical outcomes will require not only organisational change, but greater industry-wide coordination and more robust mechanisms for transparency and accountability.

5.2 Recommendations for Future Work

To build on the findings of this study, several avenues for future research are recommended.

Firstly, there is a need to extend this research beyond South Wales to other regions of the UK, including North Wales and other devolved nations such as Scotland and England. Conducting comparative studies across different geographical contexts would enable researchers to identify regional variations in supply chain practices and governance, providing a more comprehensive understanding of how ethical risks are managed across the UK renewable energy sector.

Secondly, future studies should increase the number of interview participants to enhance the robustness and reliability of findings. A larger and more diverse sample, including stakeholders from different stages of the supply chain (e.g. procurement managers, project developers, suppliers and regulators), would allow for a wider variety of perspectives and reduce potential bias associated with smaller sample sizes.

In addition, longitudinal research could provide valuable insight into how supply chain practices evolve over time, particularly as regulatory frameworks and industry standards continue to develop. This would help to assess whether current initiatives are leading to meaningful improvements in ethical supply chain management.

Finally, further research could explore the feasibility and effectiveness of industry-wide solutions, such as certification schemes and independent auditing mechanisms, in improving transparency and accountability. Evaluating these approaches in practice would provide important evidence on whether such interventions can address the structural challenges identified in this study.

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7 Appendices

Appendix A - Interview Questions and Consent Screen

Consent Screen

Before we begin, I'd like to confirm your consent to take part in this interview. This research forms part of my undergraduate dissertation and aims to explore ethical supply chain practices in renewable energy projects. Your participation is voluntary, and you may withdraw at any time without giving a reason. The interview will be recorded to assist with transcription and analysis, and all responses will be anonymised. No personally identifiable information will be collected.

Do you confirm that you understand this information and consent to take part in the interview?

Opening Questions

1. To start off, could you tell me a bit about your role and how it connects to renewable energy supply chains?
2. How familiar are you with where renewable energy materials come from and how they're sourced?
3. Do you come across any supply chain ethical issues in your work? If so, what kinds?

Main Questions

4. Thinking about your experience, what do you see as the main ethical or social risks in sourcing materials for renewable energy projects?
5. How do organisations you're familiar with usually assess modern slavery risks in their supply chains?
6. What do you think makes it difficult for organisations to ensure materials like lithium are sourced responsibly?
7. How would you describe the current level of transparency in renewable energy supply chains to your knowledge?

Reflections and Broader Thinking

8. In your opinion, what kinds of changes or interventions would help in this sector?
9. Do you think the wider push for renewable energy affects how organisations approach modern slavery risks?
10. How do you see things developing over the next few years when it comes to preventing labour exploitation in renewable energy supply chains?
11. Will advancements in renewable energy material recycling reduce supply chain risks?

Closing Questions

12. Is there anything important about ethical sourcing or supply chain risks that we haven't touched on yet?
13. Before we wrap up, is there anything you'd like to clarify or add?

Appendix B - Sample Recruitment Email

Hi [Participant],

I hope you're well.

I am currently completing my undergraduate dissertation, which explores ethical supply chains in renewable energy projects in Wales. I was wondering whether you would be willing to take part in a short interview to discuss renewable energy supply chains and related sourcing considerations.

To provide an overview of the topics covered, I have attached a list of the interview questions.

The interview would take place online via Microsoft Teams and would last approximately 45 minutes to one hour. The interview would be recorded for transcription and analysis purposes, and confidentiality would be maintained throughout, with all information used solely for academic purposes.

Please let me know if this would be of interest and whether you may have availability in the coming weeks.

Kind regards,

[Researcher]

Appendix C – Sample Interview Transcript: P1

Participant Information

- Participant Role: Director
- Sector: Renewable Energy
- Interview Method: Microsoft Teams
- Duration: 25 minutes

Transcript

Interviewer

To start off, could you tell me a bit about your role and how it connects to renewable energy supply chains?

P1

Yeah, so I'm a co-director and co-owner of a renewable energy company. Therefore, I'm responsible for redeploying all forms of micro generation. So that's renewable power systems and renewable heating systems and therefore we buy materials from all over the world. Also, we provide services from all over the world and therefore we want to make sure that we have a well audited supply chain and that our expenditure is supporting the work that we want it to and not any unethical practices.

Interviewer

Great, and how familiar are you with where renewable energy materials come from and how they're sourced?

P1

We're fully versed in where all of our materials come from.

Interviewer

For example, polysilicon from the Xinjiang region in China.

P1

The solar panels that we procure have a very clear traceability system that identifies exactly where it's polysilicon comes from and all of the other materials that are used to make up the panels. And we've undertaken factory inspections to audit and evidence that that is the case.

Interviewer

Yeah, that's really good and what is your relationship with University X by any chance?

P1

University X is a customer of ours, so we are part of University X's supply chain.

Interviewer

And so, for example, you supplied the panels that just went up on the roof recently.

P1

Yes, we've installed a range of systems and on Campuses X & Y.

Interviewer

And do you come across any other supply chain issues in your work at all?

P1

Depends on what you class as supply chain issues. If you talk about ethical issues, then obviously there's ethical issues and standards across every supply chain, whether you buy a computer or a car. So, it's about making sure that ethics are matched in the procurement choices you make and the evidence of those. So, when you buy a Big Mac, you want to make sure that it comes from an ethically farmed cow that's been on a farm which doesn't involve slave labour. The same choices are made on everything you buy.

Interviewer

But thinking about your experience, what do you see as the main ethical or social risks in sourcing materials for renewable energy?

P1

So we buy a lot of stuff. Let's say we buy computers, TV screens, office supplies, wind turbines, solar panels and heat pumps that are all effectively made in China. Therefore, you can't really focus on one product any differently than you can another. So, our ethics apply to all of our procurement choices, and we have quite clear standards that we want to apply at each level. I think it's harder for us to evidence where you're buying a TV screen from, then it is when buying a solar panel. So, it's harder to source more typical items than it is for renewable energy items. The renewable energy industry tends to be ethically led, as the people who are involved in the industry are ethically led. That doesn't mean that as it becomes more mainstream, it won't become like a car manufacturer and therefore more normal unethical practices will creep in. What Sheffield Hallam University identified was issues of modern slavery and the production of polysilicon in the manufacture of modules. But that doesn't mean that there are no other issues in other parts of the supply chain or in the normal supply chain, and therefore we should be making sure that we have our eyes open to all elements. Everyone's just zooming in on one subject matter and not actually treating all supply chains in the same way. I say the response by the solar industry has been quite stringent. Sheffield Hallam did their inspections and identified that there was an issue of modern slavery practises at the base supply chain for solar power manufacturing. Then the industry responded by setting up organisations like the Solar Stewardship Initiative, which is like the Forestry Stewardship Council for solar panels.

They go and audit the claims from the manufacturers to give independent scrutiny, because we get lots of corporate social governance information from our manufacturers and they all have ISO standards, which are independent.

Each of our manufacturers has a traceability scheme. Effectively, you can scan a barcode on each panel and identify where all the components come in that panel. However, they don't provide evidence that all those materials come from ethical sources. So, then that is independently audited by the Seller Stewardship Initiative, and they have a range of manufacturers and production sites that are effectively benchmarked as being compliant. They check whether the personnel in the supply chain behind that manufacturer have been exposed to modern slavery and check at the same time whether they meet environmental and quality standards. They're looking at a range of things. But it doesn't give us enough of an evidence base to say that there hasn't been any part of the supply chain that has exposed people to modern slavery.

Interviewer

So, actually, by the sounds of it it's a lot more transparent and scrutinised than many other supply chains in common products we buy.

P1

Yes for example I can't find any information about where the Tesla batteries are manufactured which shocks me. But people still want to put a Tesla battery in the house because of the brand name. At the same time, if you buy Duracell batteries in a shop, do you know where they were manufactured and whether they were manufactured in a clean and ethical way? No, we don't. So, as I said, I think that the solar industry has responded well. There are obviously different performance levels, they have different manufacturers and we only choose manufacturers that are registered with the solar stewardship initiative and comply with that traceability.

Interviewer

It was just interesting that you said you can individually see where each material was sourced. I thought that was really impressive.

P1

That's only recently become available in the last four or five years in response to the original Sheffield Hallam report that shone a light on the issue. I would like other products to respond in a similar way as I think it's good being able to scan a barcode and see where everything's come from. I refer to the Forestry Stewardship Council, because effectively they did a similar thing a few decades ago when they tried to tackle illegal logging and unsustainable timber harvesting. They wanted to provide a system where you could evidence that you were only sourcing your timber from sustainably managed sources which employed ethical practices, rather than illegal logging in Brazil, for example. So, there are other schemes out there of a similar nature.

Interviewer

And so when you said that you've conducted factory inspections, do you think that's quite commonplace in the industry?

P1

No, I think it's a response to these issues. So, some of the suppliers that really have done this work, realised that element of solar panel manufacturing wasn't scrutinised enough. They've obviously responded to that and scrutinised it and adapted their supply chains to suit. That will also come from a commercial pressure. People wouldn't buy their panels unless they can evidence that they're not supporting modern slavery. There's a lot of public sector procurement. You have to provide the evidence before you can justify using a certain product. They invited key clients to come out and have a look around the factory. So, we went to China last autumn to one of our key suppliers.

Interviewer

And what was the result from the inspection?

P1

Yeah, there was an impressive amount of information available, which was satisfying. The fact is that they can't fly all the installers to China just to go and do that. The point is that there's an independent body that's providing that service and that is the Sailor Stewardship Initiative, and we should be able to rely on the fact that they go and do those inspections themselves.

Interviewer

So is the fact that the materials aren't found in the United Kingdom a potential barrier to more domestic manufacturing of panels or sourcing?

P1

I think that's a question that you could ask about everything that's made. For most products, materials are sourced all around the world, taken to China, manufactured into something, even if it's components, and then assembled in different countries. That's just the reality of how things are made nowadays because a lot of our heavy industries have been outsourced to China worldwide.

Interviewer

Probably due to worker costs being lower.

P1

There are so many factors. The fact is that we have been part of that decision making, as have all other parts of Western society. So therefore, that is what has happened. Obviously, to recover that industry to the UK would involve us sourcing those materials, wherever they come from, from the world and then importing them and processing them ourselves. That doesn't stop China. It doesn't stop China that don't have those materials available to them within their own territory. They buy those materials and import them, process them and sell the product. We could do the same thing, but we'd still be sourcing material from other countries, and you'd obviously have to make sure that was done ethically.

Interviewer

And so alongside the Solar Stewardship Initiative, which I think is a great idea and a good step in the right direction, what other kinds of changes or interventions would help in this sector?

P1

I think the renewable energy industry is quite good. I think there was a particular area of weakness, but it's become a way to tarnish the industry. It would be nice to see a similar level of consistency in the car industry or TV manufacturers, smartphones, batteries etc. I think the renewable energy industry is leading the way in terms of supply chain scrutiny. With the traceability system that I explained to you, scanning the barcode and knowing where everything came from, could be applied to every product.

Interviewer

So actually, it's setting a benchmark rather than containing more risk than any other industry really. It's actually pioneering in a way.

P1

I think there's been a positive response. Certainly not saying there wasn't an issue, there was an issue and the response is actually quite impressive.

Interviewer

Which goes contrary to my literature review, interestingly. So maybe literature needs to catch up with the changes that are happening in the sector, because from my review, there seem to be quite a lot of ethical risks present in the industry and not just the solar industry, of course, that's your expertise, but also the solar battery industry and the wind turbine industry. So maybe there needs to be some update in the field.

P1

I think batteries is a different question, though. Ultimately, world politics has changed massively to focus on rare earth minerals, which are associated with making batteries and making renewable energy products. This is because we're moving from oil extraction for energy to rare earth mineral extraction for energy. Therefore, where we have been habitually used to oil territories being very lucrative. Now, obviously, we're looking at rare earth mineral territories being the most lucrative, hence the Greenland debates or debates about the Atacama Desert, Bolivian Salt Flats etc. The fact is that a lot of the materials are held within less developed countries and therefore they are open to exploitation and therefore the ethics of that needs to be heavily controlled, quite rightly. But we'll talk about that, but we won't talk about the ethics of the oil extraction industry. It's been going for a long time and has really, poor ethics. The Battery storage industry does need a lot of scrutiny. But we talk about that just so that the oil industry can carry on doing what they're doing, and nobody asks questions about it. In fact, them using unethical labour doesn't come into the discussion.

Interviewer

Yeah, it's interesting how much literature there is about supply chain risks in the renewable energy industry. And not that I've done a particular amount of research into it, but it doesn't sound like there is that same level of exposure for other energy industries.

P1

That's an interesting topic and you must ask the question why. One reason is that politically, it benefits them to discredit the renewable industry, because almost everyone is so used to the fossil fuel industry, they're not actually asking that question.

Interviewer

Well, a lot of people I interact with say electric cars are great and all, but don't they fund slave labour in countries like the Congo for the rare earth minerals needed to create them? So, it is a very popular argument to try and discredit the renewable energy movement in a way.

P1

Yes, the oil industry is well skilled at that. Look over here so that we can do whatever we want to do over there. I say the renewable energy industry is full of ethical people who choose to be in the industry for ethical reasons. We think about these issues a lot in the renewable energy industry, whereas obviously if you're in the fossil fuel industry, you typically don't have strong ethics, so therefore it's not discussed a lot.

Interviewer

And what procurement guidance do you use? Is it Welsh guidance or UK modern slavery guidance? So, when you source your materials or suppliers, do you have some sort of procurement guidance?

P1

So, there's procurement modern slavery steps, so there'll be checklists behind each procurement activity. For example, when University X procured us, they asked us to evidence our procurement processes and the fact that we do check our exposure level to modern slavery. Everyone's got an exposure level to modern slavery, like the chair you're sitting on the headphones you listen to this on. You can't check everything, but you have to make sure that it's been checked by someone. So obviously this is about making sure that there are systems in place and that you've

got the evidence base behind it. So yes, we provide the evidence base. In terms of where those requirements sit, we were audited in several different methods. So, we provide our evidence behind that for every procurement activity, for every customer. This includes University X. But also, we're a big corporation, so to be a big corporation, we must provide evidence of our scrutiny over our supply chain to be able to do that. We choose to be audited every year to have that qualification. As I said, there are various ISO accreditations that will be also held by us and others that put scrutiny on the supply chains and the supply chain evaluation, be that for carbon management or for corporate social governance, so for social issues like modern slavery.

Interviewer

But looking into the future, how do you see the ethical supply chain procurement developing in the renewable energy industry?

P1

I'd like to see the other supply chains catch up. Just like for solar panels you can see where all the compartments came from, I'd like to see that in all products we buy. So, I see the renewable energy industry maturing and leading the way.

Interviewer

And what's your experience and knowledge with renewable energy material recycling and the potential for it to reduce supply chain risks?

P1

The value of materials is changing, particularly recently. There's a peak in silver and gold pricing now, and that is driving a larger focus on extraction of minerals in the UK and recycling of available materials. It basically means that there's a business case to do it. So, we're seeing that renewable energy products are having a higher potential for recycling. So, there's recycling providers that are set up which are now affordable. Previously, it was unaffordable and that's just because you've got a situation where it's cheaper to dispose of them than it is to recycle. But it's now cheaper to recycle which is good.

Interviewer

And I think that could be a sustainable way to reduce these kinds of supply chain risks, because then you don't need to supply new materials, you can just recycle existing ones.

P1

Yeah, extracting materials from the ground is damaging so the less we dig from the ground, the better.