

Renewable energy technologies and community benefits

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1 Executive summary

1.1 Research background and aims

Community benefits are additional benefits offered by renewable energy developers to support communities. Examples include community benefit funds and in-kind benefits provided by developers such as investment in local infrastructure improvements or funding for education programmes. Community benefits currently operate on a voluntary basis in Scotland. The Scottish Government has published Good Practice Principles for onshore and offshore energy in Scotland, which are currently under review.

Within the context of that overarching review, the primary aims of this research were:

- To understand how different renewable energy technologies affect the provision of community benefits. This included developing and testing a socio-economic analysis framework to understand the factors that influence the nature and level of community benefits associated with different renewable energy technologies.
- To understand how mandating community benefits could work in practice for onshore renewable energy technologies.
- To help identify any necessary adjustments to Scotland's current voluntary community benefits approach for onshore and offshore to better support communities and industry as part of a just transition.

The study methodology incorporated an evidence review, qualitative interviews, and the design and testing of a socio-economic analysis framework. This research focused on the factors influencing how different renewable energy technologies affect developers' provision of community benefits, rather than on the experiences and perspectives of recipient communities. Interviews were therefore conducted with renewable energy developers.

The Scottish Government is gathering other non-industry perspectives on community benefits, including the views of community members, through a public consultation on the Good Practice Principles.

1.2 Understanding the ability of different technologies to offer community benefits

One of the ways this research explored how renewable energy technologies affected developers' ability to offer community benefits was to develop and test a socio-economic analysis framework. This framework set out the parameters assumed to influence the level and nature of community benefits. An initial set of seven draft parameters were developed by the Scottish Government and the research team. Following an assessment of the feasibility of measurement and feedback from renewable energy developers, four parameters were recommended for further consideration (and which are subsequently referred to as "the framework"). These were:

- **Technology maturity** (i.e. more mature technologies, with well-established supply chains and business models, may better allow developers to build community benefit provision into their project plans compared to newer technologies).
- **Market maturity** (i.e. maturity may influence investor confidence, competition between developers, and certainty in supply chains which may in turn determine predictability of financial plans and therefore ability to deliver community benefits).
- **Deployment and operating costs** (i.e. the costs associated with developing and operating different renewable energy technologies may impact the financial capacity to provide community benefits).
- **Revenue and profit** (i.e. a project's revenue and profit will impact on its overall financial viability which may impact on its ability to delivery community benefits).

This study identified significant challenges in developing a single framework to assess how different technologies affect developers' provision of community benefit. For such a framework to work as a practical, decision-making tool, quantitative data on the economics of different renewable energy technology projects would be required. However, existing public data is sparse and of inadequate quality and many developers were unable or unwilling to share commercially sensitive data about their projects. A further limitation was that existing data (e.g. on the value of community benefits from individual renewable energy projects) is based on actual provision rather than an assessment of potential. Additionally, data available is largely historical and therefore challenging to use when anticipating new technologies and emerging economic and regulatory models.

However, it was clear from interviews with developers that the **financial aspects of a renewable energy project (costs, revenue and financial viability) were key factors impacting community benefit levels.** They noted that projects with higher amounts of revenue, and more robust and predictable financial returns are better positioned to offer significant community benefits. Conversely, if the financial viability of a development is low, then it is unlikely it can offer monetary community benefits without the project becoming non-viable. Developers noted that both technology maturity and market maturity can have an impact on a project's financial viability and are therefore, indirectly, also linked to a project's ability to deliver community benefits. However, this was based on qualitative interviews and was not possible to measure using quantitative data.

Developers also reported that **it is easier to offer community benefits for projects involving more established technologies like onshore wind, compared to newer technologies,** due to the latter's comparatively lower profit margins. Less mature technologies (e.g., floating

offshore wind, hydrogen) can have higher risks, higher delivery costs, less predictability in cost and performance, and lower investor confidence which can impact on their ability to offer benefits.

Although not necessarily directly impacting the level of benefit offered, developers identified community engagement as key factor for effective delivery. Developers emphasised the importance of **levels of community engagement and capacity to effectively manage and deliver benefit funds**. Interviewees highlighted the importance of community engagement, consultation and feedback in moulding community benefit initiatives, ensuring more meaningful and tailored contributions. This is difficult to quantify and would therefore be challenging to include in a socio-economic analysis framework.

1.3 How mandating community benefits could work in practice (for onshore renewable technologies)

The available literature does not enable a comparison of the real-world impacts of mandatory, as opposed to voluntary, provision of community benefits. Mandatory community benefits as part of renewable energy infrastructure development exist in Denmark and Ireland, specifically for wind projects. However, the literature reviewed does not allow for a satisfactory comparative analysis of the in-practice impacts of mandatory versus voluntary approaches.

Existing onshore developers felt that the following factors should be considered:

- clear guidance on what the financial expectation attached to mandating is to avoid any potential for confusion;
- allowing for the differences between individual onshore technologies to be taken into account;
- retaining a degree of flexibility, particularly in terms of allowing for community benefits to be designed around the needs of communities;
- avoiding overly burdensome processes. For example, in relation to restrictions on how communities should spend the money.

The power to mandate community benefits is reserved to the UK Government. In May 2025, the UK Government published a working paper seeking views on a mandatory community benefits scheme for low carbon energy and mechanisms for shared ownership of onshore renewables¹. This includes the option to utilise existing powers to mandate offering shared ownership.

1.4 Any necessary adjustments to Scotland's current voluntary community benefits approach for onshore and offshore

This research has not identified any obvious adjustments that need to be made to Scotland's current community benefit approach.

The literature highlights that the Scottish Government is leading the way across the UK in highlighting the role of communities in the development of renewable projects. While there

¹ See [Community benefits and shared ownership for low carbon energy infrastructure: working paper \(accessible webpage\) - GOV.UK](#)

are examples in the literature of other approaches to community benefit provision outside of Scotland (e.g. in Ireland and Denmark), there is limited evidence directly comparing how different approaches have impacted the level of community benefits delivered. Therefore, there are no clear lessons from these international approaches suggesting a need to change the current approach in Scotland.

Guidance from the Scottish Government, in the form of Good Practice Principles and a recommended community benefit contribution of £5,000 per installed MW per year for onshore projects, was highlighted in interviews with developers as being a strength of the current process. They felt it provided a degree of predictability while also allowing for flexibility in application. However, for projects of emerging and/or non-generative technologies, developers noted that **more targeted guidelines would be beneficial, noting that there is no established industry standard approach.**

1.5 Conclusion and recommendations

The intention was that the framework examined in this study could inform policy decisions on the appropriate levels of community benefit for different renewable energy technologies. However, further development and more complete data is needed to be functional for this purpose. Collating the required data would need considerable resources and rely on information that developers perceive to be commercially sensitive. Considering data gaps, collection challenges, the difficulty in sourcing data specifically focused on future ability to offer benefits (rather than actual performance), further research and/or alternative approaches would be required. For these reasons, **the approach explored here does not provide a robust enough evidence base to underpin a framework for use as a decision-making tool.**

The report highlights existing measurement tools and guidance that can be used to understand where a project sits in relation to certain parameters, such as technology and market maturity. Further data collection work would be needed to make the most of these tools for robust socio-economic analysis. This would involve collecting relevant data for a large number of projects across metrics with established measurement tools. This would require a significant time and resource commitment and may not be a practical option.

To better understand how different renewable energy technologies affect developers' provision of community benefits further research, beyond the financial indicators highlighted, would be needed. Considering the challenge of sourcing quantitative data on project economics, further qualitative research may be the most feasible option. Ideally this would be with a larger selection of developers across the full technology spectrum (including those that had not been able to deliver community benefits), direct engagement with communities, and wider stakeholder engagement (e.g. project investors, funders and other partners that have assisted in project development). This type of engagement would add to and build on the insights from developers gathered in this study.

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2 Introduction

This report presents findings from research exploring opportunities for providing community benefits from renewable energy projects using different technologies in way that is fair and consistent. The research was carried out by Ipsos on behalf of ClimateXChange and the Scottish Government.

2.1 Background to the project

The Scottish Government has set ambitious targets for achieving net zero emissions by 2045, emphasising the importance of renewable energy technologies in this transition. The Climate Change Plan update (2020)² sets out Scotland's ambition of a transformed energy system, which supports sustainable economic growth across all regions of Scotland.

Communities are at the heart of the energy transition in Scotland. Community benefits are additional benefits offered by renewable energy developers to support communities, offering them an opportunity to work with renewable energy businesses to secure long-term benefits. They provide an opportunity to share in the benefits of the energy resource and can have lasting social and economic impacts³.

The Scottish Government published Good Practice Principles for the onshore⁴ and offshore⁵ energy sectors to outline how they can achieve a positive legacy for local communities. The approach and nature of community benefits operates on a voluntary basis in Scotland, with the guidelines allowing for flexibility in benefits arrangements offered by industry. Decisions on mandating community benefits are reserved to the UK Government. In May 2025, the UK Government published a Working Paper on community benefits and shared ownership for low carbon energy infrastructure, seeking views on whether mandating is the right approach and if so, to inform the design of future policy proposals.

Good Practice Principles have been widely adopted, but the approach to community benefits has not been wholly consistent across developments. In recognition of this, and of the rapidly changing sectoral and policy landscape, the Scottish Government is undertaking a review of the Good Practice Principles to ensure that guidance continues to help communities and developers get the best from community benefits.

This research sits within that overarching review. It was designed to help the Scottish Government understand more about different approaches to providing community benefits and to explore the opportunities for providing community benefits in future in a way that is fair and consistent for industry and communities. The findings from this research will help to inform a refresh of the Good Practice Principles.

2.2 Aims and objectives

² Scottish Government (2020)

³ Scottish Government (2024)

⁴ Scottish Government (2019)

⁵ Scottish Government (2018)

The primary aims of this research were:

- To understand how different renewable energy technologies affect developers' provision of community benefits. This included developing and testing a socio-economic analysis framework to understand the factors that influence the nature and level of community benefits associated with different renewable energy technologies.
- To understand how mandating community benefits could work in practice for onshore renewable energy technologies.
- To help identify any necessary adjustments to the Scottish Government's current voluntary community benefits approach for onshore and offshore to better support communities and industry as part of a just transition.

The findings aimed to support policy development and further refinement of guidelines and frameworks to help ensure that community benefits are effectively and fairly integrated into Scotland's net zero energy system and strategy.

2.3 Methodology

The research involved a mix of desk research, qualitative interviews with developers and data analysis, as outlined below (detailed methodology is in Appendix A):

- **A desk-based evidence review** that explored examples of community benefits from onshore and offshore renewable energy technologies in the UK and other countries. Literature sources reviewed included 12 peer reviewed academic papers, 20 reports, 2 guidance documents from grey literature (e.g., renewable energy developers, private consultancies) and 1 policy document. These were all published between 2011 and 2024, with 22 documents from the last 5 years.
- **Initial scoping interviews with four industry representative bodies** to understand their views on current community benefit approaches and to explore options for sourcing data that could support socio-economic analysis on community benefits.
- **Design of a socio-economic analysis framework** to help understand the factors which are likely to affect the level and nature of community benefits.
- **In-depth interviews with 21 industry developers** from a range of renewable energy technologies (see Appendix A). As the focus was on how different renewable energy technologies affect provision of community benefits, qualitative research with developers was carried out to help understand the views of those with direct experience of working with projects and benefits. Interviews helped to understand industry perceptions towards community benefits arrangements, collect feedback on the proposed analytical framework, and to understand availability of relevant data for socio-economic analysis.
- **Assessment of the suitability of a framework** to act as a tool for the Scottish Government to understand what type and level of community benefit may be suitable for different renewable energy technologies, based on data availability and feedback from interviews.

2.4 Definitions

Community benefits are defined in this research in line with the Scottish Government's Good Practice Principles:

Community benefits are additional benefits, that are currently voluntary, which developers provide to the community. The Scottish Government does not currently have the power to legislate for community benefits, which lies with the UK Government. A community benefit fund is considered to be a fundamental component of a community benefit package, though other measures may be considered such as in-kind works, direct funding of projects, or any other voluntary site-specific benefits. Community benefits are not compensation for impacts on communities or other interests, including commercial interests, arising from renewable installations and they are not taken into account in a decision over whether a consent for a development is granted.

Community benefit in Scotland is distinct from **shared ownership**. Shared ownership provides community groups or members of a community the opportunity to make an investment in a commercially owned renewable energy project. This includes any structure which involves a community group as a financial partner benefitting over the lifetime of a renewable energy project. As shared ownership is not considered a form of community benefit in Scotland, it has not been included within this research.

In this report **renewable energy technologies** have been interpreted as the range of technologies outlined in the Scottish Government's draft Energy Strategy and Just Transition Plan⁶. This includes onshore wind, offshore wind (both floating and fixed), solar, hydro, pumped hydro storage, battery energy storage system (BESS), hydrogen, and carbon capture, utilisation and storage (CCUS).

2.5 Limitations

This study was limited by data availability. Existing public data (for example on community benefit values, project costs and revenue) is sparse and of inadequate quality to effectively measure the parameters within a socio-economic analysis framework. Many developers were unable or unwilling to share commercially sensitive data about their projects. A further limitation was that existing data (e.g. on the value of community benefits from individual renewable energy projects) is based on actual provision rather than an assessment of project's potential capability. Additionally, existing data are largely historical and therefore challenging to use when anticipating new technologies and emerging economic and regulatory models. Consequently, data gaps mean it was not possible to develop a fully functioning socio-economic analysis framework as part of this study.

A further limitation is that this research draws on the views of a relatively small sample of developers. These represent one group of perspectives on community benefits, albeit from different organisations, working with different technologies. Non-industry perspectives, including those of community members themselves, were not included in the remit of this study and would not be expected to fill the data gaps highlighted above.

⁶ Scottish Government (2023)

3 Current community benefit arrangements

This chapter details the current arrangements for delivering community benefits, based on findings from the literature and from the qualitative interviews with renewable energy technology developers. At various points, examples of community benefit projects identified in the literature are shown to help illustrate the findings.

3.1 Key findings

- The literature highlights that the Scottish Government is leading the way across the UK in highlighting the role of communities in the development of renewable projects and in providing good practice guidelines.
- Community benefits from renewable energy projects in the UK mainly involve community benefit funds⁷, but there are also examples of in-kind benefits such as investment in education and infrastructure programmes. Community benefit funds are not as extensively adopted outside of the UK.
- Onshore wind has more established community benefit practices than other onshore and offshore technologies. However, a key similarity is that all projects, regardless of technology, tended to adopt both community benefits funds and in-kind contributions.
- There is limited evidence directly comparing how different approaches in the UK and in other countries have impacted the level of community benefits delivered.

3.2 Guidelines for community benefits

According to the reviewed literature, the Scottish Government is leading the way across the UK in highlighting the role of communities in the development of renewable projects. The Good Practice Principles for Community Benefits from Onshore Renewable Energy Developments (updated in 2019) and the draft Good Practice Principles for Community Benefits from Offshore Renewable Energy Developments (2018) outline how the energy sector can achieve a positive, lasting legacy for local communities, and a range of successful community benefit projects have been implemented to date.⁸ These guidelines have been widely adopted across the renewables industry, providing best practice for the sector.⁹ The voluntary guidelines suggest practices like conducting impact studies to identify affected communities, engaging in consultations, and tailoring benefits to local context and needs. These principles aim to ensure benefits are well-targeted and meet community expectations, which could be seen as markers of a well-designed scheme.¹⁰

Example 1.

⁷ Community benefit funds typically mean that developers will voluntarily contribute a certain amount of funding to local communities. In some cases, the level of funding is linked to the amount of installed capacity of the project or the amount of energy produced.

⁸ Kerr et al (2017), Anchustegui (2021), Kerr & Weir (2018), O San Martin et al (2022), Scottish Government (2022), Scottish Government (2019), Scottish Government (2018)

⁹ O San Martin et al (2022)

¹⁰ Anchustegui (2021)

Beatrice Offshore Windfarm's Community Benefits Fund used the Scottish Government's Good Practice Principles to guide the development of the fund. The Beatrice Community Benefits Fund also undertook innovative analysis of the potential wider impacts of the community benefits funding, using a Social Return on Investment methodology.¹¹ This illustrates the ability of the Good Practice Principles to be applied alongside other models and approaches.

In Scotland, the Scottish Government also established the Community Benefits Register,¹² managed by Local Energy Scotland. It can be viewed online and offers a form of third-party reporting and public recognition.¹³ Best practice guidance also exists in England, Ireland, the Netherlands and Germany (see Table 2 in Appendix B).

3.3 Approaches used in the UK and elsewhere

The literature provided examples of different approaches to designing and implementing community benefits schemes. However, most examples are from onshore wind farms, with some examples given from offshore wind technologies. There is very little to no reference to other renewable technologies such as hydrogen, hydro, solar, wave, thermal, or BESS.

Community benefit mechanisms referred to in the literature included¹⁴:

- Financial contributions to a community benefit fund, to be used as directed by the community to invest in local initiatives¹⁵;
- In-kind contributions to local infrastructure, facilities, or services¹⁶;
- Grants, scholarships, or donations to support community initiatives¹⁷;
- Electricity discounts or subsidies for local residents¹⁸;
- Provision of environmental or recreational amenities.¹⁹

While these approaches share many similarities, there are some notable differences and ambiguities. These include varying interpretations of what constitutes the "local community" (especially for offshore projects)²⁰ and differing emphasis on the rationale for providing benefits (e.g., impact mitigation).

¹¹ Glasson (2020)

¹² <https://localenergy.scot/community-benefits-register/>

¹³ Kerr et al (2017)

¹⁴ In the reviewed literature, shared ownership was a common practice in countries outside the UK, notably in Germany and Denmark. However, this is not outlined here as shared ownership is not part of the Scottish Government's definition of community benefits.

¹⁵ le Maitre, 2024; Toledano, et al., 2023; O San Martin, et al., 2022;

¹⁶ Anchustegui, 2021

¹⁷ Lansbury Hall, 2020; Regen, 2022; Lane, et al., 2019;

¹⁸ Energy UK, 2024

¹⁹ Centre for Sustainable Energy (CSE), 2005; Walker, 2023; Glasson, 2020; Chen, 2024

²⁰ Regen, 2022

This section describes the different approaches to community benefits in more detail. Differences between the UK and other countries are noted, where available.

Community benefit funds

Community benefits from renewable energy projects in the UK are primarily delivered through community benefit funds. The UK onshore wind industry, in particular, has well established approaches for this.²¹ Through this mechanism, developers voluntarily contribute a certain amount of funding to local communities. In some cases, the level of funding is linked to the amount of installed capacity of the project or the amount of energy produced. For example, in Scotland, it is the industry norm for onshore wind projects to typically deliver £5,000 per megawatt (MW) of installed capacity per year in alignment with the Good Practice Principles for Onshore Renewable Energy Developments.²² However, the per MW model is not the only approach used and the total amount provided is based on the agreement between the developers and the community.

Example 2.

Crossdykes Wind Farm near Lockerbie, Scotland (developed by Muirhall Energy) offered an industry-leading £7,000 per MW per year for a community benefit fund, well above the industry standard of £5,000 per MW per year. The project provided an Initial Investment Fund of £100,000 to support community projects during the wind farm's construction phase, showing a proactive effort to deliver early benefits.

Example 3.

Brechfa Forest West Wind Farm in Wales (owned by RWE Renewables), is an example of a community-administered community benefit fund which is expected to provide £11 million in community benefit funding, administered by the local enterprise agency and a volunteer panel of residents.²³

Regarding offshore wind, the concept of community benefits in the UK is relatively newer and more flexible than for onshore, reflecting the evolving nature of the industry.²⁴ Some, predominantly near-shore English and Welsh wind farms (e.g. North Hoyle and Rhyl Flats off the North Wales coast) have followed the pattern of the onshore wind farms, with benefits pro rata to MW size, although at a much lower rate.²⁵ However, in many cases, and for some of the large North Sea distant offshore wind farms, the benefits packages have been more ad hoc and much smaller (pro rata) than for onshore projects.²⁶ Several challenges have been identified with providing community benefits funds for offshore wind projects, including defining the relevant community to be targeted.²⁷

²¹ van den Berg & Tempels (2022); Glasson (2020)

²² Kerr & Weir (2018), Scottish Government (2022)

²³ le Maitre (2024)

²⁴ Glasson (2020)

²⁵ Rudolph et al. (2014)

²⁶ Rudolph et al. (2014)

²⁷ Glasson (2020)

Example 4.

The Hornsea/Race Bank East Coast Community Fund, off the Norfolk coast, is managed independently by a specialist grant-making charity, GrantScape, on behalf of the developer Orsted. This enables an arms-length, transparent allocation process.²⁸

According to a number of the literature sources, allocation and spending of community benefit funds are usually determined by developers, in collaboration with the local communities, often through local trusts or organisations. Developers often strive to tailor the benefits based on local priorities identified through community engagement.²⁹ Community benefit funds can take different forms, ranging from local funds – investments in communities nearest to developments to enhance services, assets and activities of residents – to regional funds – investment in transformational projects to provide socio-economic growth for wider communities.³⁰

The evidence reviewed suggests that community benefit funds are not as extensively adopted outside of the UK. There are some instances of community benefit funds in Europe. Notably, in Denmark, from 2008-2018, the state-run "Green Scheme" mandated payments per kilowatt per hour of production to host communities. As of 2020, Danish developers must pay fixed amounts per MW installed into green funds for affected municipalities under the "Green Pool" scheme and make annual payments to neighbouring residents under the "VE-Bonus" scheme, with amounts determined by the Danish Energy Agency.³¹ In Ireland, renewable energy auctions require developers to contribute €2 per MW hour to a community benefit fund, with defined spending allocations.³²

Among the developers interviewed for this research, flexible community benefit funds were the most common approach being taken to community benefits in Scotland. The exact sum delivered through these funds varies project-by-project. Onshore wind developers said that they follow, and often exceed, the Good Practice Principles guidelines of £5,000 per MW per year. For other technologies, which developers said often have greater financial uncertainty and/or smaller margins than onshore wind, the levels of community benefit are less predictable. Developers said that the level of benefit is often closely linked to the project's costs and financial returns, which varies.

"We typically work backwards from what we think the returns in the scheme are going to look like. And that's very site specific, dependent on abnormal costs, grid costs, land rights costs...Depending on what that looks like, we'll then generate a number to determine what we can reasonably offer local communities." – *BESS developer*

In a number of cases, these funds are administered by Foundation Scotland, a charitable organisation that helps to support communities to set up, manage and distribute their

²⁸ Glasson (2020)

²⁹ Glasson (2020)

³⁰ SSE Renewables (2024)

³¹ Regen (2022)

³² Le Maitre et al. (2024)

funding. This has particularly been the case where local communities may lack the capacity to manage significant financial resources independently. Some projects also have established their own governance arrangements, involving boards constituted of local community members to determine the allocation of these funds.

Other community benefit mechanisms

Other examples of community benefits mechanisms that appeared in the literature include **tax revenues** or **fiscal contributions** from wind farm developers, which go directly into funding local infrastructure and community services. From the documents reviewed, this is common practice in Germany, Poland, Croatia, France and Italy.³³

Example 5.

The Block Island offshore wind farm development in Rhode Island, USA, is an example of fiscal contributions being made to support local infrastructure. In this case, a formal Community Benefit Agreement was developed in which the wind farm company pays for improvements to town infrastructure where the cable comes ashore. This project was also highlighted in the literature as an example of community engagement resulting in locally appropriate community benefits and high levels of support for the development from the local community. As part of the public consultation on the project proposals, the developer, Deepwater Wind, collaborated with the town council to invite stakeholders and hired consultants from the local community to represent local interests. This helped establish trust and perceptions of fairness in the process.³⁴

The literature also identified Australian examples of **neighbourhood benefit programmes**.³⁵ These programmes aim to address concerns around fairness that can arise when local residents receive no direct benefits from a renewable energy project which affects their experience of their place and community.³⁶ Examples of the types of benefits provided via these neighbourhood benefit programmes include support towards home energy efficiency measures, the installation of residential solar PV, and contributions to electricity bills for neighbours or neighbourhood community facilities (e.g. local hall, local fire-fighting facilities).

The reviewed literature suggests that the **involvement of local authorities** in the delivery of community benefits varies by country. In some European countries (including Denmark, Germany, France, Italy and Spain), the local municipality plays a significant role and often decides funding priorities of community benefits. In the UK and Ireland, local authorities generally decline involvement to avoid conflicts of interest in the planning process. However, Highland Council recently set out plans for a different approach to community benefit decision making and fund distribution and Shetland Council approved a new set of principles around community benefit.

³³ Wind Europe (n.d.); San Martin (2022); Arsenova et al. (2024); Anchustegui (2021)

³⁴ Klain et al. (2017)

³⁵ Lane & Hicks (2019)

³⁶ Lane & Hicks (2019)

Developers interviewed also described the types of **in-kind benefits** they offer communities. Examples included:

- Employment and education programmes. This includes providing funding towards training in green technologies, especially in areas that are reliant on traditional energy industries rather than renewable energy.
- Electricity discount schemes, with money coming off local residents' bills.
- Investment in environmental and net zero initiatives, including activities designed to reduce carbon footprint and support biodiversity in communities, along with awareness-raising around these issues.
- Infrastructure improvements such as broadband access, roads and pathways, and community recreational facilities.

3.4 Impact of different approaches on the level of community benefits delivered

Based on the literature reviewed, there is limited evidence directly comparing how the different approaches in the UK and in other countries have impacted the level of community benefits delivered.

Among the documents reviewed, the only source that explicitly offers comparative analysis between approaches in the UK and European countries was the Department of Trade and Industry report conducted by the Centre for Sustainable Energy, which involved detailed case studies of major wind farms in the UK, Germany, Denmark, Ireland and Spain. The following points are drawn exclusively from this report:

- The overall levels of benefits accruing to communities from wind projects in Denmark, Spain and Germany tend to be higher than in the UK. However, it is important to note that in such countries, community benefits are mostly associated with shared ownership practices, and therefore economic and financial benefits are linked to those practices. Shared ownership is not included in the Scottish Government definition of community benefits and it is also worth noting that developments outside of the UK will have different policy contexts and market conditions to those in the UK, making it difficult to directly compare.
- While the authors do not find robust evidence that higher benefits directly lead to higher levels of support for developments, they suggest that they are likely an important factor in sustaining long-term acceptance of projects.

3.5 Lessons from community benefits projects

Common themes emerged from the literature and interviews around what constitutes good practice in community benefit:

- **Early community engagement.** Establishing trust, building relationships with local residents and identifying concerns and priorities early on can lead to smoother running of the project and help dispel fears of community members early on.³⁷

³⁷ Chen et al. (2024); Klain et al. (2017); Rudolph et al. (2014)

- **Ensuring community representation in the co-design and administration of community benefits**³⁸ as this can help establish trust and lead to higher levels of sustained support for the project.³⁹
- **Providing broad and flexible community benefit.** Literature and interviews highlighted the value of funds being used to support a wide range of community priorities like infrastructure, schools, housing, elderly care, environment, etc. that improve quality of life for residents.⁴⁰
- **Community capacity** was noted by developers as a factor that can impact on their ability to deliver community benefits. Not all communities were seen to have the resources or expertise needed to administer funds efficiently. They noted that the existence of strong community councils or Community Development Officers to help generate ideas have helped contribute to successful community benefit funds.
- **Ensuring transparency of communication and providing full information to communities through trusted messengers** is seen in the literature as a crucial step in securing support from communities.⁴¹
- The reviewed literature also suggests that **formalising benefit commitments and monitoring progress** can promote accountability and sustainability over the long-term. It helps ensure developers deliver on promises made to communities.⁴²
- There is also evidence that **partnering and aligning with local government, NGOs and other companies** allows projects to leverage additional resources and maximise the scale and impact of their community investments.⁴³

4 Understanding how different renewable energy technologies affect the ability to offer community benefits

One of the ways this research explored how renewable energy technologies affect the level of community benefits offered by developers was to develop and test a socio-economic analysis framework. This framework set out the parameters assumed to influence the level and nature of community benefits provided. This chapter outlines the steps taken to develop and test a framework and the extent to which this tool could help to understand how different renewable energy technologies affect the level community benefits provided by developers.

4.1 Key findings

³⁸ Glasson (2020), Manitius (2023), Arsenova & Wlokas (2019), BiGGAR Economics (2024a), BiGGAR Economics (2024b), Toledano et al. (2023)

³⁹ Klain et al. (2017)

⁴⁰ Wind Europe (n.d.)

⁴¹ Chen et al. (2024), Klain et al. (2017)

⁴² Arsenova & Wlokas (2019)

⁴³ Arsenova & Wlokas (2019)

- Within the scope of this study, the available evidence did not support a single framework to robustly determine how different technologies affect the provision of community benefits. For such a framework to work as a practical, decision-making tool, quantitative data on the economics of different renewable energy technology projects would be required. However, existing public data is insufficient to effectively measure the parameters in the framework, and it was not possible within this study to gather the level of quantitative data that would be needed for robust socio-economic analysis.
- However, it was clear from the interviews with developers that the financial aspects of a renewable energy project (costs, revenue and financial viability) were key factors impacting community benefit levels.
- Developers' feedback also highlighted that it is easier to offer community benefits for projects involving more established technologies like onshore wind, compared to other technologies (e.g. offshore wind, solar and battery storage) due to the latter's comparatively low profit margins.

4.2 Original framework parameters

The initial parameters identified at the scoping phase of the project are outlined in Table 1. The following section sets out the feedback received from developers in response to this framework, and the extent to which these parameters are measurable within a framework.

Table 1 Initial list of identified parameters affecting provision of community benefits

Parameter	Justification for inclusion
Technology maturity	More mature technologies like onshore wind and solar PV have well-established supply chains and business models, allowing for community benefit provision to be built in to project plans. The more mature technologies are also more reliable in terms of return on investment (ROI), than less mature technologies. Emerging technologies have less predictability in costs and revenues, affecting community benefit schemes and their provision.
Market maturity	The level of market maturity can determine the provision of community benefits by influencing investor confidence, increased competition between developers, robust supply chains and solidified regulatory frameworks. These all determine predictable project economics and financial plans, increasing the likelihood and scale of community benefits being provided.
Project size/energy yield	The energy yield of a project is a critical factor that can influence the revenue and, consequently, the level of community benefits provided. Smaller projects may have small absolute margins and so may be less able to provide the same level of community benefits as larger projects.
Deployment and operating costs	The costs associated with developing and operating different renewable energy technologies can impact the financial capacity to provide community benefits. If one technology has higher upfront costs or operating expenses, this might reduce the scope of benefits a developer can offer, as well as the timing of delivering these benefits.

Revenue and profit	The amount of revenue generated by a project, or the profits it generates, could also have an impact on a project's ability to deliver community benefit and on the level and nature of community benefits that can be delivered.
Land use, visual, environmental and social impacts	Wind farms, especially onshore ones, can have a significant visual impact and may occupy large areas of land which can influence the local community's perception, and the level of benefits expected. This may differ for offshore wind. It may also influence the type of community benefit provided (environmental, social, economic). In contrast, solar PV installations typically are less sensitive to visual impacts than wind turbines but could be associated with higher land use impacts.
Wider economic impact of the project and its distribution	The economic returns from projects may also influence the level of benefits provided through community benefit schemes. Projects which require a large workforce for ongoing maintenance and operation will provide economic benefits to the local area through jobs and investment which is multiplied through other sectors and amenities required by residents. It can be theorised that a developer's contribution to the wider economy may reduce their overall willingness to community benefit commitments, though it is unlikely that this contribution would affect their ability to provide monetary commitments.

4.3 Community benefit value

There is a lack of data on the level of community benefits offered by renewable energy projects. The Local Energy Scotland Community Benefits Register is currently the most comprehensive data source for capturing the community benefits monetary measures. However, this is not exhaustive and does not cover the full range of renewable energy technologies.

Further steps were therefore taken to identify additional and more up-to-date data for this research. Firstly, data was requested from developers taking part in interviews, but not all were willing or able to share this (either because they could not access the data, or due to commercial sensitivities). Secondly, online searching for publicly available information on monetary values of community benefits was carried out. While data for some projects is available publicly, this requires a significant time commitment to source since it is not held in a central source nor in a consistent format. Therefore, data gaps remained after taking these steps. For the framework to be robust, a more complete set of data on community benefit value is required.

4.4 Technology maturity

Technological maturity is a widely used metric for gauging a technology's development and readiness for deployment.

Developers generally felt that this could have an impact on the viability of a project, and as a result affect the level of community benefits. Some agreed that, compared to mature technologies (e.g., onshore wind), technologies such as floating offshore wind, BESS and hydrogen can have higher risks, higher delivery costs, less predictability in cost and

performance and lower investor confidence. However, some onshore wind developers argued that more mature technologies do not always have more secure financial models because recent cost increases in their supply chains have made viability harder to predict.

Technology maturity is suitable for quantitative measurement using the NASA Technology Readiness Level (TRL) scale (see Appendix E for details). To accurately assess a technology's TRL, it is recommended that individual projects are approached directly for scoring, as they may employ different versions of the technology. If direct assessment is not possible, it would be possible to utilise the International Energy Agency's ETP Clean Energy Technology Guide, which evaluates and provides comprehensive information on each technology's current development stage across the energy system.

This parameter could be included in a socio-economic analysis framework, provided there was sufficient data available or one of the existing guides outlined above could be used.

4.5 Market maturity

Factors influencing market maturity include established supply chains, business models and supporting physical and regulatory infrastructure (ports for deployment of offshore wind, standards for solar farms, etc.).

Developers felt that emerging technologies and immature markets face difficulties determining an appropriate level of community benefits because of uncertainty around securing investment and finances. However, some onshore wind developers also noted that their more mature market can still experience challenges with supply chains, especially in relation to costs of deployment (e.g. turbine costs have increased).

Market maturity could be measured using existing tools. The Adoption Readiness Level (ARL) framework, developed by the U.S. Department of Energy, is a tool for assessing the commercialisation risks of new technologies. It helps identify potential roadblocks to market adoption, such as cost-competitiveness, regulatory landscape, public perception and infrastructure availability. It also helps evaluate market demand by identifying the target market, understanding customer needs, and assessing the competitive landscape.

The ideal approach to understanding this parameter would involve project-level assessments via direct engagement with project owners, using the scoring framework available online⁴⁴. However, given the large number of projects, this endeavour would be challenging. The decision to pursue this should weigh the uncertainties about the parameter's significance in determining community benefits, with the time commitment needed to collect this information.

This parameter would be suitable to include in a socio-economic analysis framework, but the ability to source the level of data required is challenging.

4.6 Project size or energy yield

This measure is quantifiable, based on the level of energy capacity installed for each project expressed in MW. This data is available on the Local Energy Scotland's Community Benefit Register and the Renewable Energy Planning Database (REPD). To enable a comparison

⁴⁴ US Department of Energy (2024)

between different technologies, it is important to convert installed capacity to expected energy yield as each technology has different levels of efficiency.

Capacity and energy yield are both inputs in the estimation of gross revenue. Therefore, inclusion of these metrics as stand-alone parameters in the framework would be duplicative and would correlate very highly with any revenue estimations. For this reason, **these metrics would not need to act as stand-alone parameters in an analysis framework but could be used as inputs to the revenue estimation.**

4.7 Deployment and operating costs

The total costs of developing and operating a renewable energy project captures an important financial aspect assumed to influence the level of community benefit commitment.

Developers noted that the developmental and operating costs impact the financial capacity for a project to provide community benefit. As with revenue, obtaining precise cost figures would involve direct input from project owners. Again, due to commercial sensitivities and challenges in accessing this data, estimating total cost of production might need to rely on publicly available sources. This can be done for a selection of technologies using the Department for Energy Security and Net Zero's Levelised Cost of Electricity (LCOE) estimates.⁴⁵ It is worth noting that not all REPD project technologies are included in this resource, and hence, some projects will require mapping to the closest matching technology category. Despite this challenge, a basic methodology for estimating LCOE from generation technologies is outlined in Appendix D.

When looking at **non-generation projects**, i.e. storage projects, it is important to reflect the differences to generation projects in the calculation of costs. An analogous version of the LCOE is the Levelised Cost of Storage (LCOS), which uses charging cost as fuel cost and uses the discharged electricity instead of generated electricity. Given the lack of access to the necessary data it is not possible to accurately estimate LCOS for storage projects.

Given that project costs provide a direct link to the financial aspects that are assumed to influence community benefits, it is recommended to include this parameter in a socio-economic analysis framework.

4.8 Revenue and profit

Developers agreed that the amount of revenue generated by a project has an impact on their ability to deliver community benefits and the level of community benefits that can be offered.

Ideally, obtaining precise revenue figures would involve direct input from project owners. However, due to commercial sensitivities and challenges in accessing data, estimating revenue might need to rely on publicly available sources. It is important to note that this approach is based on significant assumptions that might not hold true over time. Estimating future revenues is particularly challenging because it depends on projected electricity prices,

⁴⁵ Department for Energy Security and Net Zero (2023)

which are notoriously difficult to predict with accuracy or extend into the future. Despite these challenges, a basic methodology for estimating revenues from generation technologies is outlined in Appendix D.

When it comes to **non-generation projects**, revenue estimation becomes even more complex and uncertain. These types of projects may involve diverse sources of income and variables, requiring a more nuanced approach to estimation. Battery storage projects generate revenue through a variety of mechanisms, often stacked together to maximise returns. Key revenue streams include arbitrage (buying electricity when prices are low and selling it back to the grid when prices are high), grid services (e.g. frequency regulation, voltage support), capacity market participation and ancillary services (e.g. black start capability). The lack of publicly available data for each of these revenue streams make it challenging to estimate revenue for non-generation projects.

Given that revenue estimation provides a direct link to the financial aspects that are assumed to influence community benefits, it is recommended that consideration is given to including this parameter in a socio-economic analysis framework.

4.9 Land use, visual and environmental impacts

There are several challenges associated with quantitatively measuring land use, visual, environmental and social impacts:

- Quantifying land use involves assessing the physical footprint of a project, which can vary significantly based on the type and scale of the renewable technology employed. Further challenges arise in comparing land use impacts across different technologies, such as wind farms versus solar arrays, as each may occupy land differently (e.g., spacing between wind turbines versus solar panel coverage). These differences between technologies were also noted by developers.
- Visual impact assessments are inherently subjective and can vary depending on individual perspectives and local landscape characteristics. Moreover, accurately quantifying visual impacts requires sophisticated modelling tools and surveys that consider factors like visibility range, landscape context, and viewer sensitivity.
- Comprehensive environmental impacts involve a multitude of factors, including potential effects on local wildlife, ecosystems, water resources, and biodiversity. Data collection for environmental impacts may be inconsistent and require long-term monitoring to capture seasonal or cumulative effects accurately.
- Social impacts can include effects on local communities, employment opportunities, and cultural shifts, which are difficult to measure quantitatively and may require qualitative research approaches. In addition, assessing social impacts often involves engaging with communities and stakeholders, which can introduce variability and complexity in data collection and interpretation.
- Each of these aspects often interacts with others, making it challenging to isolate and assess impacts individually without considering cumulative or synergistic effects. Variability in methodologies and data availability can also lead to inconsistent measurements and comparisons.

For these reasons, this parameter is not suitable for a socio-economic analysis framework.

4.10 Wider economic impact of the project and its distribution

Renewable energy projects, especially large-scale ones, often generate significant economic benefits. For example, they may create high-value jobs through operation and maintenance, enhance the local supply chain and attract inward investments. These contributions can lead to substantial regional development and improved economic resilience.

However, there are notable challenges in confining these benefits strictly to the local communities most directly impacted by the projects. Economic effects often extend beyond the immediate vicinity. Moreover, quantifying these impacts presents difficulties, often necessitating self-reported data from projects. Such data can be subject to bias and may not fully capture the comprehensive economic changes occurring in the region. These challenges were reflected in interviews with developers. They noted that projects can add a lot of value to an area through high-value jobs, contribution to the supply chain and driving inward investment. However, they noted that it would be difficult to define this parameter, since the economic impacts may not be contained to the specific community in question. Projects can also incur wider costs, such as seabed option fees and rental fees for offshore wind renewable energy developments and these funds can have a wider economic impact.

Additionally, this metric's applicability varies with different project types. For instance, projects involving CCUS often repurpose existing infrastructure, without necessitating a new workforce. As a result, the direct local economic impacts of such projects might be limited, underscoring the need for careful consideration when using this metric to assess community benefit commitments.

Wider economic impact provides a valuable lens for understanding potential benefits. However, the challenges and variability associated with measuring and applying this parameter across project types should be carefully evaluated to ensure fair, accurate and consistent community benefit determinations. **For these reasons, this parameter is not suitable for a socio-economic analysis framework.**

4.11 Community involvement and capacity

During interviews, developers suggested that **community involvement and capacity** influence the ability to provide community benefits and should be considered as part of a framework. This parameter focuses on the role of communities in both shaping and managing the benefits derived from renewable energy projects. Interviewees highlighted that placing community needs at the core is essential for ensuring that the type and level of benefits align with local priorities. They emphasised the importance of community engagement, consultation, and feedback in moulding these initiatives, arguing that this involvement leads to more meaningful and tailored contributions.

Additionally, while not directly impacting a developer's ability to offer community benefit, the capacity of communities to effectively manage and deliver agreed benefits was seen as important. Interviewees pointed out that variations in the size and organisation of community councils or other community groups can significantly impact their ability to administer benefits. Hence, recognising these differences allows developers to support and

enhance the local capacity, fostering increased participation and benefit realisation from the projects.

However, there are several challenges to quantitatively measuring these aspects. Quantifying community engagement and feedback is subjective, as perceptions of effective engagement vary among stakeholders. Communities often have diverse and evolving needs, making standardisation difficult. Additionally, while the number of consultations can be counted, assessing their quality requires qualitative data, which is harder to quantify. Asking the community to accurately capture and record this data would put significant burden on individuals who quite often are volunteers in the community. Moreover, community needs can change over time, necessitating ongoing updates and flexible metrics.

Due to these challenges, it is **not recommended to include this parameter as a stand-alone element in a socio-economic analysis framework.**

4.12 Conclusion

Following the assessment outlined above, four parameters were deemed suitable to be considered in a socio-economic analysis framework. These were:

- Technology maturity
- Market maturity
- Deployment and operating costs
- Revenue and profit.

To demonstrate how a framework could be used in future, socio-economic analysis has been carried out based on a sample of data on renewable energy projects (see Appendix C). The parameters in scope of this analysis are restricted to those which have been deemed feasible to measure and for which a suitable method to measure them has been identified. This analysis is based on data available from the Community Benefits Register Database, supplemented with additional data sourced through desk research. Due to the data sources available, it only includes onshore wind, offshore wind and hydro technologies.

Key findings from that analysis are:

- **Industry alignment and policy influence:** While many onshore wind and hydro projects in Scotland are clustering around the recommended annual £5,000 per MW capacity for community benefits for onshore technologies, more than half of the onshore wind and hydro projects analysed in the available data set commit less than the recommended amount.
- **Revenue-benefit correlation:** A positive correlation exists between gross project revenue and total community benefit commitments, with larger projects providing bigger packages. However, this relationship weakens for high-revenue projects, suggesting a potential plateau effect.
- **Costs and benefit packages:** There is a positive correlation between total cost of production and total community benefit packages across all project sizes, suggesting that as total costs increase, so does the size of the overall commitment to community benefits. While this may appear contrary to the views of developers shown earlier

(i.e. those who said that high costs can impact on financial viability and therefore their ability to offer community benefits) it should be noted that this data analysis is based only on projects already providing monetary benefits. It excludes those that had not yet provided any community benefits. It can therefore be assumed that the dataset excludes those projects that were deemed not financially viable enough to enable community benefit provision.

In interpreting these findings and considering next steps it is important to acknowledge the distinction between the willingness of projects (measured by actual provision) to provide community benefits and their ability to provide community benefits. The analysis above is based on actual provision of community benefits. It could be assumed that these commitments are indicative of both willingness and some inferred level of ability, but the data does not allow for an assessment of the capability of projects (and different technologies) to offer these benefits. The UK Government's Contracts for Difference (CfD) scheme is the main support mechanism for renewable energy projects. It is important to acknowledge that although community benefit funds are not recognised costs in the CfD framework, they are often treated as part of a project's overall cost base and priced in to CfD bids.

Robust analysis of the capability to provide community benefits would require detailed project-level data. To collate the data needed will require considerable resources and will also require renewable energy technology developers to share data they perceive as commercially sensitive, which may be unrealistic. This work has highlighted considerable data gaps, challenges collecting data in the future and difficulty in sourcing data specifically focused on future ability to offer community benefits rather than actual performance. Therefore, the approach explored here does not provide a robust enough evidence base to underpin a framework for use as a decision-making tool.

To better understand the capacity for projects to provide community benefits, it is suggested that further research and / or alternative approaches may be needed. This could take the form of qualitative research with a larger selection of projects across the full technology spectrum, to understand perceived barriers or enablers of moving from willingness to ability. This should offer insights into the practical challenges faced by projects. Longitudinal case studies may prove beneficial to understand how changes in policy, economic conditions or market incentives could have influenced both the willingness and perceived capacity to make these commitments.

5 Exploring mandatory community benefit arrangements

This chapter looks at current approaches to mandating found in the evidence review and the views of the industry on how mandating community benefits for onshore technologies could work in practice, based on qualitative research with developers.

5.1 Key findings

- Mandatory community benefits approaches exist in Denmark and Ireland, as part of renewable energy infrastructure development for wind projects. However, the

literature reviewed does not allow for a satisfactory comparative analysis of the in-practice impacts of mandatory versus voluntary approaches.

- Existing onshore developers felt that the following factors would need to be considered for mandating to work in practice:
 - clear guidance on the financial expectation attached to mandating
 - accounting for differences between individual onshore technologies
 - retaining a degree of flexibility, particularly in terms of the ability for community benefits to be designed around the needs of communities
 - avoiding overly burdensome processes.

5.2 Current approaches to mandating community benefits

Mandatory community benefits as part of net zero energy infrastructure development exist in Denmark and Ireland, specifically for onshore and offshore wind projects. Other countries have mandated approaches for shared ownership, special taxes, energy subsidies, or monetary compensations, but not community benefits as defined here. This includes Germany, France, Taiwan, and the Philippines⁴⁶.

Denmark has a history of various mandates relating to community benefits. For example, until 2018, the "Green Scheme" required the Danish state to pay hosting communities a fixed amount per kWh of production from new turbines. This applied to offshore wind farms built outside the tender process and within 8km of shore.⁴⁷ More recently, as of June 2020, regulations require offshore wind developers to pay fixed amounts per MW installed into green funds for affected municipalities. The payment is DKK 115,000 per MW (around €15,500).⁴⁸ Additionally, in Ireland, renewable energy auctions mandate that developers contribute €2/MWh to a community benefit fund, with defined criteria for how the funds must be spent.⁴⁹

Other mandated approaches similar to community benefits include special taxes imposed on developers, that are distributed to local authorities, and electricity subsidies for "host communities". The former approach has been implemented in France and Germany. The French Maritime Wind Turbine Tax is imposed on offshore wind farms, and is allocated to local authorities to finance local projects, per a defined formula. Germany requires that tax revenue generated from offshore wind farms in the Exclusive Economic Zone is distributed to coastal states. Energy subsidies for host communities have been implemented in the Philippines and Taiwan. Since 2008, the Philippines has required that 80% of money generated from royalties, or government shares in renewable projects, must be used to subsidise the electricity costs of communities affected by these projects.⁵⁰ In Taiwan, the Electricity Assistance Fund (EAF) is distributed to communities affected by power plant projects (including, but not limited to renewable energy) according to a pre-defined formula. For example, in the case of offshore wind, 30% of EAF funds are provided to "local project

⁴⁶ Anchustegui, 2021; Kerr, 2017; le Maitre, 2024; Rudolph, et al., 2014; Toledano, et al., 2023; Arsenova, et al., 2019

⁴⁷ Herrera (2021)

⁴⁸ Herrera (2021)

⁴⁹ le Maitre (2024)

⁵⁰ Toledano, et al.

fund pools” for the benefit of residents, community groups, and civil society organisations, and 70% is provided for councils and fishery associations.⁵¹

Although shared ownership is seen distinct from community benefits in Scotland, some other countries have mandated shared ownership or compensation payments. For example, in Denmark, the 2008 Renewable Energy Act mandated developers to offer at least 20% of shares in wind projects for sale to local households within 4.5km of a turbine.⁵² Similarly, in Germany, several states have required that between 10% and 25% of wind farm shares be offered to local residents and municipalities. Mandated compensation payments to nearby residents and community funds have been implemented in Denmark and Ireland. Since 2020, Irish legislation obliges wind farm developments to provide an annual contribution to nearby households and communities.

While some of the literature reviewed implies that mandated approaches are more robust,⁵³ no clear evidence is provided of their outcomes and impact compared to voluntary approaches. The literature does not allow for a satisfactory comparative analysis of the in-practice impacts of mandatory versus voluntary approaches.

5.3 Developers’ perspectives on how mandating community benefits could work in practice

Industry stakeholders shared their views on the potential for mandating community benefits for onshore technologies. Mandating was explored in both the scoping interviews with representative bodies and in the main interviews with developers. Developers highlighted some key considerations that they felt should be borne in mind for how mandating could work in practice.

For mandatory community benefits to work in practice, developers felt that there would need to be clear guidelines on what the financial expectation is to avoid any potential for confusion. It was suggested that the community benefit value attached to any mandated approach should be realistic and determined in collaboration with industry to help clarify what the expectations are for developers and for communities.

To work in practice, it was felt that mandatory community benefits would need to take into account the differences between different technologies. For example, by having different levels of benefits that technologies are expected to contribute. Specifically, some interviewees highlighted the different operating contexts and economies (e.g. different capital costs) between some technologies. Further, it was suggested that hydrogen and CCUS should be treated differently because they are designed to complement renewable technologies by operating only when needed. Therefore, it was argued that it is difficult to tie community benefits to specific metrics for these.

“[If] it would be used to set an X amount per megawatt, [then] that would need to be split into different technologies because it's not a clear cut case for all technologies. It has to show this is what it is for BESS, what is for

⁵¹ Arsenova, et al., 2024

⁵² Kerr et al (2017); le Maitre (2024)

⁵³ le Maitre (2024)

wind, what is for solar. Because if you get that number wrong, you can make the scheme unviable or unattractive and therefore it will not come forward.” – *BESS stakeholder*

It was also felt that for mandating to be practical, the approach to community benefits should retain some degree of flexibility and the ability to be designed around the needs of individual communities. For example, one onshore and offshore wind developer said if mandating were to happen it should be around the amount of funding that should be provided and not how communities spend the money. This view echoes findings of a report by BiGGAR Economics (2023) that states that the current voluntary system has allowed communities and developers to be flexible in their arrangements, and has enabled the “formation of mature, collaborative relationships” between parties.⁵⁴

Related to the point above, some developers felt that, in practice, mandates could mean a more bureaucratic process which could slow things down, in turn impacting developers’ ability to deliver benefits. Stakeholders made contrasts with the current system, which was perceived as “fairly simple” and “flexible”. Therefore, it was suggested that approaches to mandates should avoid overly burdensome processes and bureaucracy. For example, it was suggested that it should avoid having too many restrictions around timescales or conditions on how communities should spend the funding.

Another view from developers was mandating might impact on the existing relationships between developers and communities, as it could move away from a collaborative process to one where there is a firmer expectation around what developers are required to give. Therefore, the approach would need to consider the relationships between developers and communities. Developers particularly felt it important to avoid community benefits appearing like compensation. For example, it was felt that creating a mandated system through which a certain amount is paid made directly to homeowners could lead to the system feeling like a form of compensation.

“If it's mandated, it absolutely can't be attributed as compensation to the community. If money had to be paid to compensate people for the effects of a wind farm, then the wind farm shouldn't be being built.” – *Multi-technology stakeholder*

Aside from practicalities, a key concern raised was that mandating community benefit provision could risk investor confidence. Some developers felt that mandatory community benefits would have an impact on financial viability of projects, which could make investors less confident to invest. It was suggested that they may choose to invest in projects in other countries that do not have a community benefit mandate or in which they feel the approach is more straightforward.

“The danger with [mandating] is that it creates investor concerns. There's a lot of competing geographies around the world that want money for renewable energy projects...If one country becomes difficult or the risks

⁵⁴ BiGGAR Economics (2023)

are harder to understand, they'll move that investment to another country where they understand it. And the UK, and especially Scotland, runs a real risk of upsetting investor confidence, which is already very delicate because of the situations with the grid at the moment." – *Solar PV stakeholder*

As the scope of this research was focused on understanding how different renewable technologies influence the level of community benefits offered by developers, interviews were conducted with a sample of renewable energy developers. A wide range of other stakeholders will have views.

6 Adjustments needed to Scotland's current voluntary community benefits approach

This chapter sets out the extent to which any adjustments are required to the current voluntary community benefits approach based on findings from the literature review, interviews with developers and the design and testing of a socio-economic analysis framework.

6.1 Key findings

- This research has not identified any obvious adjustments that need to be made to Scotland's current community benefit approach. Developers felt that the current system could better acknowledge the different realities of different technologies, but they were not specific about what the best future approach should be.
- Developers felt that guidance from the Scottish Government, in the form of Good Practice Principles and a recommended level of community benefit for onshore projects was a strength of the current process. However, for projects of emerging and/or non-generative technologies, developers noted that more targeted guidelines would be beneficial, noting that there is no established industry standard approach.
- The intention was that the framework in this study could be used by Scottish Government to determine an appropriate expectation of the level and types of community benefit required for different renewable energy technologies. This work identified significant data gaps, challenges collecting data in the future, and the difficulty in sourcing data specifically focused on future ability to offer community benefits rather than actual performance. For these reasons, the framework explored here is not robust enough to use as a decision-making tool.

6.2 Lessons from literature and developers' views

Based on the literature reviewed, there is limited evidence directly comparing how the different community benefit approaches in the UK and in other countries have impacted the level of community benefits delivered. Similarly, there is limited evidence to compare the impacts of mandated and voluntary approaches. International examples do not therefore provide any obvious lessons for the current approach in Scotland.

Onshore wind developers interviewed as part of this study were largely satisfied with the current arrangements. They felt that having a recommended standard (of £5,000 per MW

per year for onshore) works well, helping them to predict what the cost associated with each project will be. Since it is a recommended, rather than compulsory standard, they also felt that it also allows for a degree of flexibility, meaning that the community benefit contribution can be responsive to both project and local community needs.

"That financial outlay [£5,000 per MW per year] is much more predictable in our models that we bake in during development...we actually really try to make sure that we can deliver it and protect it." – *Multi-technology developer*

Developers of some less well-established technologies (e.g. hydrogen and pumped hydro storage) expressed a desire for clearer guidance from government on the appropriate levels of community benefit for these technologies. They suggested that new guidelines around levels of community benefit should take into consideration the differences in scale and impact between projects like pumped storage and hydrogen generation, which can be more expensive and less visible than wind projects. Those from non-generative technologies (e.g. BESS) felt that it is more difficult to determine the amount of community benefits (funds) that can be delivered from these projects because they have lower level of return (they do not yield energy) and serve a different function in the energy market than generation projects.

Developers also suggested that further structure and support for communities could help them to manage funds more effectively. They felt that community-led decision-making was vital for ensuring the funds meet local needs, but that this should be balanced with adequate administrative support to prevent the misuse or underutilisation of funds.

"There is also a misconception that communities are underspending this funding. Our analysis shows that if we invest and empower communities, then they are very capable of delivering impactful projects." – *Multi-technology developer*

6.3 Lessons from testing a framework approach

As noted earlier, to effectively measure parameters identified in the proposed framework, project-level data would be required on costs, revenue, technology readiness levels and market maturity. Data on these metrics is not currently available and collecting this data would be a significant task.

Developers felt that certain parameters (see chapter 4) were considered suitable for a socio-economic analysis framework. However, their limited testing means that the framework would need more comprehensive data to fully model these parameters' effects on community benefits. This is especially true for community benefit commitment data (£/MW/yr) which currently is only reported in the Community Benefits Register Database for onshore wind and hydro projects.

When discussing the idea of such a framework, developers noted that community benefits should not have a one-size-fits-all approach and should be reflective of specific circumstances of each technology and each project. Concerns were raised by some

interviewees that a framework might lead to overly prescriptive approaches which could risk stifling development and deterring investment.

“Each [parameter] is relevant and I can see why they have been captured as things that would influence the value and viability of community benefits [...] It all depends on an individual project basis, depends on what else is happening in terms of landscape and development.” –

Multi-technology developer

Interviewees also questioned whether sufficient data would be available to support the framework and there was some concern about using historic data to understand future community benefit levels. A few interviewees also highlighted concerns about data sensitivity and need for any information to be carefully handled.

Considering the data gaps, challenges collecting data in the future, and the difficulty in sourcing data specifically focused on future ability to offer community benefits rather than actual performance, a single framework may not be the most appropriate approach.

7 Conclusions

This research looked at current and future approaches to community benefits to help inform decisions around future provision of community benefits in a way that is fair and consistent. This chapter draws conclusions around the three broad research aims:

- To understand how different renewable energy technologies affect the capacity of developers to provide community benefits, including developing and testing a socio-economic analysis framework.
- To understand how mandating community benefits could work in practice for onshore renewable energy technologies.
- To help identify any necessary adjustments to the Scottish Government’s current voluntary community benefits approach for onshore and offshore to better support communities and industry as part of a just transition.

7.1 Understanding how different renewable energy technologies affect community benefits

Within the scope of this study, the available evidence did not support a single framework to robustly determine how different technologies affect community benefits. For such a framework to work as a practical, decision-making tool, quantitative data on the economics of different renewable energy technology projects would be required. However, existing public data is sparse and of inadequate quality to effectively measure the parameters within a framework and many developers were unable or unwilling to share commercially sensitive data about their projects. A further limitation was that existing data (e.g. on the value of community benefits from individual renewable energy projects) is based on actual provision rather than an assessment of project’s potential ability. Additionally, data available is largely

historical and challenging to use when anticipating new technologies and emerging economic and regulatory models.

However, from data that was available, it was clear that the **financial aspects of a renewable energy project (costs, revenue and financial viability) were key factors impacting the developers' offer of community benefits**. Projects with higher amounts of revenue and more robust and predictable financial returns are better positioned to offer significant community benefits. Conversely, if the financial viability of a development is low, then it is unlikely developers can offer community benefits without the project becoming non-viable. Developers noted that both technology maturity and market maturity can have an impact on a project's financial viability and are therefore, indirectly, also linked to a project's suitability to deliver community benefits. As discussed above, while there are existing tools for measuring technology and market maturity, data gathering is challenging.

Developers' feedback also highlighted that **it is easier to offer community benefits for more established technologies like onshore wind, compared to other technologies** (e.g. solar and battery storage) due to the latter's comparatively low profit margins. Less mature technologies (e.g., floating offshore wind, hydrogen) can have higher risks, higher delivery costs, less predictability in cost and performance, and lower investor confidence which can impact on their ability to offer benefits.

While not directly impacting on the level of community benefits offered, developers noted the **importance of community engagement and capacity to effectively manage and deliver benefit funds**. Interviewees highlighted the importance of community engagement, consultation and feedback in moulding community benefit initiatives, ensuring more meaningful and tailored contributions. However, this is difficult to quantify and would therefore be challenging to include in a socio-economic analysis framework.

7.2 How mandating community benefits could work in practice (for onshore renewable technologies)

The literature reviewed does not allow for a satisfactory comparative analysis of the in-practice impacts of mandatory versus voluntary approaches. Mandatory community benefits approaches exist in Denmark and Ireland, as part of net zero energy infrastructure development for wind projects. While the literature provides examples of where this was happening outside of the UK, it was less clear on the extent to which mandating had an impact on the level and nature of community benefits when compared with voluntary approaches.

Developers felt that for mandating to work in practice, a number of factors would need to be taken into consideration. It was felt that any future mandating approach should allow for the differences between technologies to be accounted for by setting, for example, different recommended levels of community benefit fund value. For mandating to work in practice, it was also felt that flexibility was key, particularly in terms of how communities could make use of the funding provided. Practicalities aside, there was some concern that mandating could potentially pose a risk to projects, by placing a financial burden on some projects

(particularly those with smaller financial returns such as solar and BESS technologies) which could pose a risk to investors.

7.3 Any necessary adjustments to Scotland's current voluntary community benefits framework for onshore and offshore

This research has not identified any obvious adjustments that need to be made to Scotland's current community benefit approach.

Guidance from the Scottish Government, in the form of best practice principles and a recommended level of community benefit for onshore projects was highlighted in interviews with developers as being a strength of the current process. However, developers' feedback suggests the current system needs to better acknowledge the different realities of different technologies. Developers of emerging and non-generative technologies suggested that more targeted guidelines for these newer technologies would be beneficial, noting that there is no established industry standard approach. However, while they suggested some areas for consideration, they were not specific about what the best future approach should be.

The intention was that the framework in this study could be used by the Scottish Government to determine an appropriate expectation of the level and types of community benefit required for different renewable energy technologies. The parameters that were considered suitable for the framework could provide a useful understanding of the factors that influence ability to offer community benefits. However, this would be dependent on data gaps being addressed. Ideally, it would have up-to-date data on community benefit value covering the full range of renewable energy technologies, with at least 50 projects for each technology.

This study has identified data gaps, challenges collecting data in the future and the difficulty in sourcing data specifically focused on future ability to offer community benefits rather than actual performance. The approach explored here does not provide a robust enough evidence base to underpin a framework for use as a decision-making tool.

7.4 Recommendations and next steps

The report highlights existing measurement tools and guidance that can be used to understand where a project sits in relation to certain parameters, such as technology and market maturity. To make the most of these tools, further data collection work would be needed before they could be used for robust socio-economic analysis. This would involve collecting relevant data for a representative sample of projects across the metrics that have already established measurement tools. This would require a significant time and resource commitment and may not, therefore, be a practical option.

To better understand the factors influencing the level of community benefit, beyond the financial indicators highlighted in this study, further research would be needed. Considering the challenge of sourcing quantitative data on project economics, further qualitative research may be the most feasible option. Ideally this would be with a larger selection of developers across the full technology spectrum (including those that had not been able to

deliver community benefits), direct engagement with communities, and wider stakeholder engagement (e.g. project investors, funders and other partners that have assisted in project development). This type of engagement would add to and build on the insights gathered from developers in this study.

8 Glossary / abbreviations table

Acronym/Abbreviation	Definition
ARL	Adoption Readiness Level
BESS	Battery energy storage system
BWE	German Wind Energy Association
CCUS	Carbon capture utilisation and storage
ESAF	Electricity Assistance Fund
ESG	Environmental, Social, and Governance
GW	Gigawatt
IEA ETP guide	International Energy Agency's Energy Technology Perspectives guide
LCLO	Local Community Liaison Officer
LCOE	Levelised Cost of Electricity
LCOS	Levelised Cost of Storage
MW	Megawatt
NASA	National Aeronautics and Space Administration of the United States
REPD	Renewable Energy Project Database
SROI	Social Return on Investment
TRL	Technology Readiness Level

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10 Appendices

Appendix A Methodology

10.1 Evidence review

Aims and objectives

The aims of the evidence review were to:

- Explore best practice on community benefits in the UK and internationally in relation to renewable energy technologies.
- Explore how community benefit schemes operate and examine their funding arrangements in the UK and internationally.
- Provide examples of where community benefits have been mandated and what impact this has had on industry, communities and the delivery of renewable energy technologies.
- Inform the socio-economic analysis in terms of identifying key parameters and contexts that impact the propensity to supply community benefits at varying scales.
- Identify data sources for the socio-economic analysis.

Defining the research questions

To ensure the evidence review is useful in summarising best practises and informing the socio-economic analysis the following research questions were defined:

- **Research Question 1** - What is the best practice on community benefits from onshore and offshore renewable energy technologies internationally?
- **Research Question 2** - How does the UK differ from international counterparts on the processes on the provision of community benefits? How does this impact the level of community benefits?
- **Research Question 3** - Which (if any) countries mandate community benefits as part of net zero energy infrastructure construction? What impact has this had on the provision of community benefits? What impact has this had on communities and the delivery of net zero energy policies?
- **Additional Scoping** – What data is available on the levels of community benefits, and their corresponding technologies/market maturities/technology maturity and other hypothesised parameters which influence the provision of community benefits?

Scope of the literature search

The literature search included the identification of relevant sources from:

- Existing research into/evaluations of community benefit schemes
- Academic literature
- Grey literature
- Policy documents
- Media publications

The search for literature was primarily done through using Google and Google Scholar but also used sources such as JSTOR, Scopus, and organisational websites where necessary. Whilst we did not take a strict view on the geographical scope of our search, we favoured countries which are contextually similar to the UK (European countries, US, Australia) as it is likely these findings will be more relevant to the UK.

We explored literature relevant to onshore and offshore renewable energy technologies. This included, but was not limited to, wind, solar, hydro, wave, thermal, pumped hydro storage, bioenergy, battery storage, hydrogen, Negative Emission Technologies (NETs) and transmission infrastructure. The ability to look at these internationally was dependent on the context and energy mix of the countries in question. It was decided that it would also be useful to assess levels of community benefits for technologies which may be emerging in the UK but are more established elsewhere, bringing in the Three Horizons approach featured in the proposal.

Search Terms

Some initial search terms for covering the aforementioned specifications and research questions were developed and are presented in the table below:

Search Term (Google/Google Scholar)	Relevance/comments
"[insert technology] community benefits best practice [international/UK/insert country]"	All technologies and internationally. This will support answering RQ1 and part of RQ2 by allowing for a comparison between countries.
"[insert technology] community benefits monitoring [international/UK/insert country]"	All technologies and internationally. This will support answering RQ1 and part of RQ2 by allowing for a comparison between countries.
"[insert technology] community benefits evaluation [international/UK/insert country]"	All technologies and internationally. This will support answering RQ1 and part of RQ2 by allowing for a comparison between countries.
"[insert technology] community benefits lessons [international/UK/insert country]"	All technologies and internationally. This will support answering RQ1 and part of RQ2 by allowing for a comparison between countries.
"[insert technology] community benefits impacts [international/UK/insert country]"	All technologies and internationally. This will support answering RQ1 and part of RQ2 by allowing for a comparison between countries.
"[insert technology] community benefits funding arrangements [international/UK/insert country]"	All technologies and internationally. This will allow us to understand the structure of community benefit funds, supporting RQ1 and RQ2

“[insert technology] community benefits management arrangements [international/UK/insert country]”	All technologies and internationally. This will allow us to understand the structure of community benefit funds, supporting RQ1 and RQ2
“[insert technology] mandate/mandated/mandating community benefits [international/UK/insert country]”	All technologies and internationally. This will provide an answer to RQ3, where we can begin to assess the impact of mandating community benefits and what this looks like in practise
“[insert technology] community benefits press release”	This search supports the scoping of what is feasible for the socio-economic analysis. At this stage, a high-level search will be conducted, with more in depth web scraping for data (if possible) to be completed as part of the socio-economic analysis.

Prioritisation approach

A long list of 86 sources were initially identified which were then prioritised using the prioritisation criteria set out below:

1. **Based on existing evidence:** Does the document focus on existing practice/examples of renewable projects/developments?
2. **Focus on community benefits:** Is the main focus of the document around the provision of community benefits (as opposed to for e.g. broader discussions of social acceptability of renewable energy developments OR community engagement)?
3. **Policy guidance:** Does the document include policy recommendations/best practice guidance/reflections on lessons learned?
4. **Geographical scope:** Does the geographical scope of the document include Europe, the UK or US?
5. **Peer reviewed / grey literature:** Peer reviewed sources were prioritised over grey literature sources.

Additional considerations:

- Ensuring the inclusion of evidence on a wide spread of renewable technologies.
- Ensuring the inclusion of evidence from both voluntary and mandatory community benefits schemes.
- Ensuring the inclusion of evidence from a wide spread of types of community benefits.

Additional sources were added to the short-list of literature as suggested by Scottish Government and stakeholders in the scoping interviews. A total of 35 sources were reviewed in-depth. The final list of literature sources reviewed included 12 peer reviewed academic papers, 20 reports, 2 guidance documents from grey literature (e.g., renewable energy developers, private consultancies) and 1 policy document. The publication years of the reviewed documents ranges from 2011 to 2024, with 22 documents from the last 5 years.

Evidence extraction

The prioritised literature sources were then reviewed and findings relevant to the research questions were extracted into an excel sheet. Ipsos Facto, a Large Language Model, was used to assist with identifying and summarising relevant data.

10.2 Scoping interviews

In parallel to the evidence, we conducted four in-depth scoping interviews with industry bodies, trade associations, and members of developer groups to enhance the findings from the evidence review.

The aim of these interviews was twofold:

- to understand their views on different types of community benefits and their perceptions of current / best practice arrangements related to community benefits;
- to explore options for sourcing data from the industry, including the types of information they think businesses will / will not be prepared to share with us.

Learnings from the scoping interviews were used specifically to inform the design of the subsequent stakeholder engagement and framework development.

10.3 Developer interviews

In-depth interviews were conducted with 21 industry developers. Interviewees covered a range of technologies including onshore wind (7), offshore wind (7), solar PV (5), battery storage (6), grid stability (1), hydro (3), pumped hydro storage (3), hydrogen (6 including 2 green hydrogen) and carbon capture, utilisation and storage (2). Among interviewees, 11 were mostly multi-technologies developers and 10 were single-technology developers.

The objectives of the interviews were threefold:

1. To gather qualitative data on the types of community benefits they have delivered/plan to deliver, views on current arrangement for community benefits and potential different approaches (including mandating for onshore), and what factors have contributed to the provision/ success of their community benefits (i.e. to help inform what parameters are most important in informing potential future community benefits). This will help contextualise the socio-economic analysis and the findings in the report.
2. To gather quantitative data that we will then use in our analysis, using the parameters set out in the framework (these will be developed further based on CXC/SG feedback). This will include information such as the cost of developing the project(s), value of community benefits, proportion of those values in comparison with turnover/profit, employment impacts etc.
3. To help reframe/revise the socio-economic analysis framework as required, based on their views on what parameters/variables are important

Ahead of the interview, stakeholders were also requested to complete a 'Data request sheet' that aimed to gather data for the socio-economic analysis (see below).

10.4 Framework development

The development of the framework to assess the influence of various parameters on community benefits involved a systematic approach following stakeholder interviews. Each initial parameter underwent a comprehensive evaluation to determine the feasibility of its measurement and potential impact on community benefit commitments.

- **Assessment of measurement challenges.** Initially, each parameter was scrutinised to identify any inherent challenges or limitations in its measurement. This involved examining the complexity, availability of data, and any factors that could hinder accurate quantification.
- **Identification of pre-existing measures.** For parameters where it was determined that measurement challenges were minimal or non-existent, existing methodologies and measures were sought. This step involved a thorough review of established metrics and tools already in use.
- **Development of proxy measures.** In cases where no established measures were applicable, proxy measures were devised. This involved identifying the closest available data that could serve as a stand-in to approximate the parameter's influence on community benefits. These proxies were selected based on their relevance and potential to offer meaningful insights.

Throughout this process, each parameter's potential to influence community benefits was evaluated. This iterative methodology ensured a robust and nuanced framework, capable of effectively guiding future assessments and decisions concerning community benefit commitments.

10.5 Socio-economic analysis

To illustrate the application of the framework, a socio-economic analysis was conducted using a sample dataset of renewable energy projects. This analysis examined the relationship between the parameters detailed in Section 5 and the levels of community benefits, employing the methodologies outlined in the framework.

The analysis focuses on parameters deemed feasible to measure with available methods, specifically revenue and costs, along with technology type. Technology type was used as a proxy for technology maturity, given the current uniformity of maturity levels within each technology. The analysis relied on data from the Community Benefits Register Database, supplemented by additional information obtained through desk research.

For this analysis, the scope included onshore wind, offshore wind, and hydro technologies. These were chosen based on their data availability and relevance to the parameters evaluated.

Appendix B Examples of community benefit-sharing initiatives

Table 2 Examples of community benefit-sharing initiatives and related guidance for renewable technologies in selected European countries (from O San Martin et al. (2022))

Country	Guidance document	Scope of initiative
Scotland	Scottish Government: Onshore Wind Policy Statement (2017); Scottish Government: Good Practice Principles for Community Benefits from Onshore Renewable Energy Developments (2019 Update); and Good Practice Principles for Community Benefits from Offshore Renewable Energy Developments (2018)	Wind farm operators currently utilise both community funding options and shared ownership, both are seen as good practices and responsive to the local community's specific wishes.
England	Community Benefits from Onshore Wind Developments: Best Practice Guidance for England (2021)	Both a community benefit fund and community shared ownership are recommended. Noted that many developers are providing funds significantly below the recommended amount.
Ireland	Code of Practice for Wind Energy Development in Ireland Guidelines for Community Engagement; and Best Practice Guidelines for the Irish Wind Energy Industry (2012) ORESS 1 Community Benefit Fund - Rulebook for Generators and Fund Administrators (2023)	Irish wind farm operators currently offer both community funding options and shared ownership; both are seen as good practices.
Netherlands	Dutch Wind Energy Association (NWEA): Code of Conduct for Acceptance & Participation of Onshore Wind Energy (2016)	Both a community benefit fund and community shared ownership are acceptable, but shared ownership is generally preferred and expected by local communities.
Germany	German Wind Energy Association (BWE): "Collectively Winning – Local Wind Energy": Framework Paper for the topics added value, public participation, and acceptance (2018); "Citizen-owned Wind Energy" – Energy from the region for the region (2013)	Best practice in Germany heavily tends towards community stakes/shared ownership in wind farms as the main model of how communities benefit. In contrast, the community funding model is less well-received in Germany.

Appendix C Socio-economic analysis results

To demonstrate how the framework could be used in future, socio-economic analysis was carried out based on a sample of data from net zero energy projects. This analysis explores the relationship between the parameters outlined in chapter 4 and the levels of community benefits, using the methods outlined in the framework.

The parameters in scope of this analysis are restricted to those which have been deemed feasible to measure and for which a suitable method to measure them has been identified. These include revenue and costs, as well as technology type (which serves as a proxy for technology maturity, as maturity levels do not vary within technologies currently). It should be noted that this analysis is based on data available from the Community Benefits Register Database, supplemented with additional data sourced through desk research. Due to the data sources available, it only includes onshore wind, offshore wind and hydro technologies.

The subsequent analysis in this chapter presents the relationships between the measurable parameters for which data is available and the level of community benefits.

10.6 Key findings

- **Industry alignment and policy influence.** Many onshore wind and hydro projects in Scotland are clustering around the recommended annual £5,000 per MW capacity for community benefits for onshore technologies. However, a significant number of onshore wind and hydro projects (more than half of those analysed in the available dataset) commit less than the recommended amount.
- **Revenue-benefit correlation.** A positive correlation exists between gross project revenue and total community benefit commitments, with larger projects providing bigger packages. However, this relationship weakens for high-revenue projects, suggesting a potential plateau effect.
- **Costs and benefit packages.** There is a positive correlation between total costs and total community benefit packages. For projects costing less than £25 million, when comparing onshore wind and hydropower projects of the same energy capacity and with equivalent community benefit budgets (£5,000 per MW annually), onshore wind offers greater community benefits per pound spent on energy production.

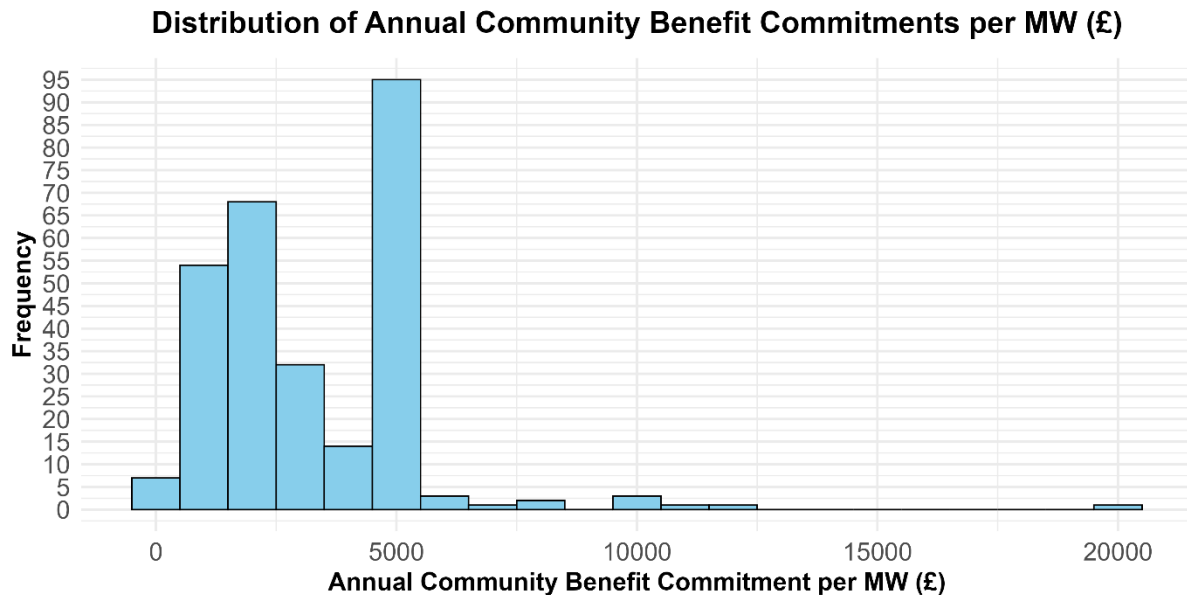
10.7 Analysis of community benefit commitments

Many onshore wind and hydro projects in Scotland are aligning with the recommended community benefits package of £5,000 per MW capacity. The clustering of commitments around the recommended amount suggests that policy guidelines are influencing industry behaviour, but full compliance among onshore projects has not yet been achieved. This is observed in Figure 1 by the number of projects committing less than the recommended amount. Of the 282 onshore wind and hydro projects analysed, 177 were committing less than the recommended amount.

There exists a small but notable group of projects that have committed to providing community benefits from onshore renewable energy developments above the recommended £5,000 per MW capacity. These projects may be setting new benchmarks for

corporate social responsibility. The strong concentration around the £5,000 figure could indicate an opportunity for standardising community benefit packages across the industry, potentially simplifying expectations for both developers and communities.

Figure 1 Distribution of Annual Community Benefit Commitments per MW – Onshore Projects

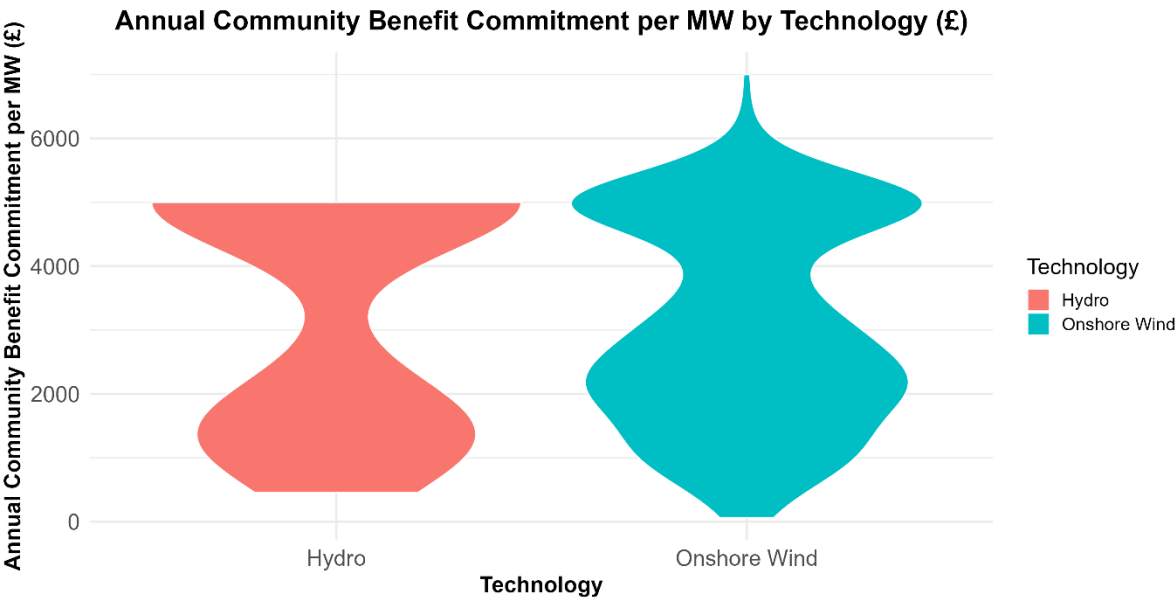


SOURCE: COMMUNITY BENEFITS REGISTER DATABASE

Figure 2 below illustrates where most of the data points are concentrated and the variation in the data. There are distinct patterns in community benefit commitments across the two different onshore renewable technologies shown. Figure 2 shows that hydro projects commitments range between £456 and £5,000 per MW per year, while onshore wind commitments range between £60-£20,000 (the upper end of this range is not visible in Figure 2 below as this distorted the shape and scales of the figure).

There is a concentration of commitments around the £5,000 figure for both hydro and onshore wind which aligns with the recommended amount (as demonstrated by the width of the violin plot), indicating a level of industry-wide acceptance of this guideline for land-based projects.

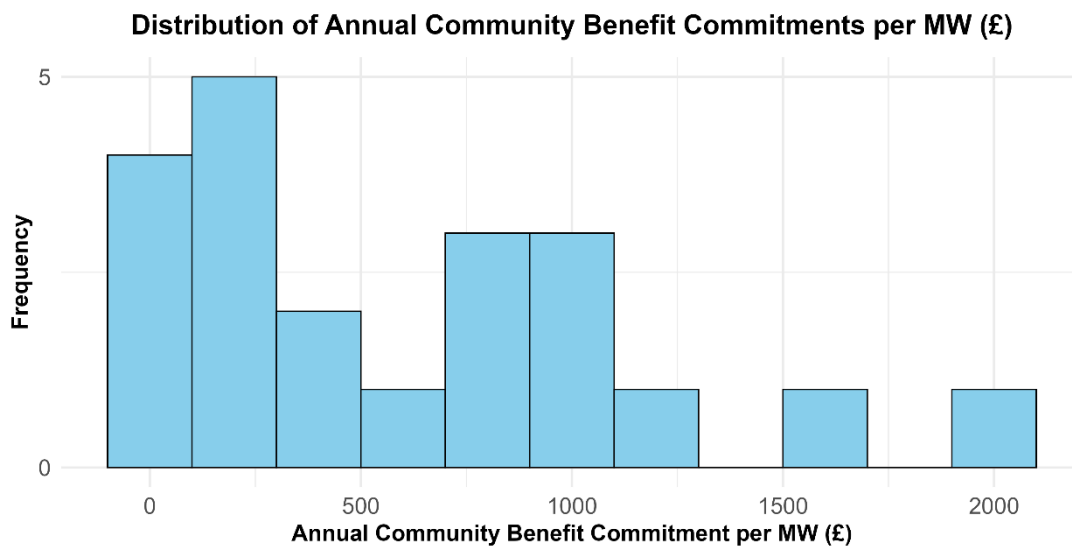
Figure 2 Distribution of Annual Community Benefit Commitments per MW by Onshore Technology



SOURCE: COMMUNITY BENEFITS REGISTER DATABASE

Figure 4Figure 3 below shows the distribution of community benefit commitments among offshore projects. It should be noted that there was very low coverage of offshore wind projects captured in the register, and hence efforts were made to manually collect benefits data through desk-based research. This may have resulted in some discrepancies in actual provision versus what projects would have reported through the register. Figure 3 shows offshore wind projects notably committing lower amounts compared to onshore wind and hydro projects, with a range between c.£20-£2,000 per MW per year. It is acknowledged here that this analysis is based on 21 projects out of a possible 47 operational offshore wind projects in the UK⁵⁵ and therefore figures should be treated with caution.

Figure 3 Distribution of Annual Community Benefit Commitments per MW – Offshore Projects



SOURCE: DESK RESEARCH

There are several reasons why offshore wind projects might be committing lower amounts than their onshore counterparts. Most importantly, onshore renewable energy projects in Scotland are encouraged to offer community benefits, typically around £5,000 per megawatt of installed capacity annually. This is a voluntary guideline, not a requirement, specifically for onshore projects, and does not apply to offshore projects. Beyond this, offshore wind farms, being located further from communities, might be perceived as having less direct impact on local populations, potentially justifying lower community benefit packages. The offshore wind sector in Scotland is also at an earlier stage of development compared to onshore technologies, with community benefit standards still being defined. This technological and market immaturity means standards for community benefits are still evolving within this sector. In contrast, onshore wind technologies are more established and benefit from years of development and market experience. The advanced state of onshore wind technology may allow for greater efficiency and cost reduction, enabling more substantial community support relative to their offshore counterparts. Moreover, the scale of offshore wind projects may mean that while there are lower per-MW commitments, the overall total community benefits package may still be substantial.

⁵⁵ Four operational offshore wind projects were in Scotland, two in Wales and fifteen in England.

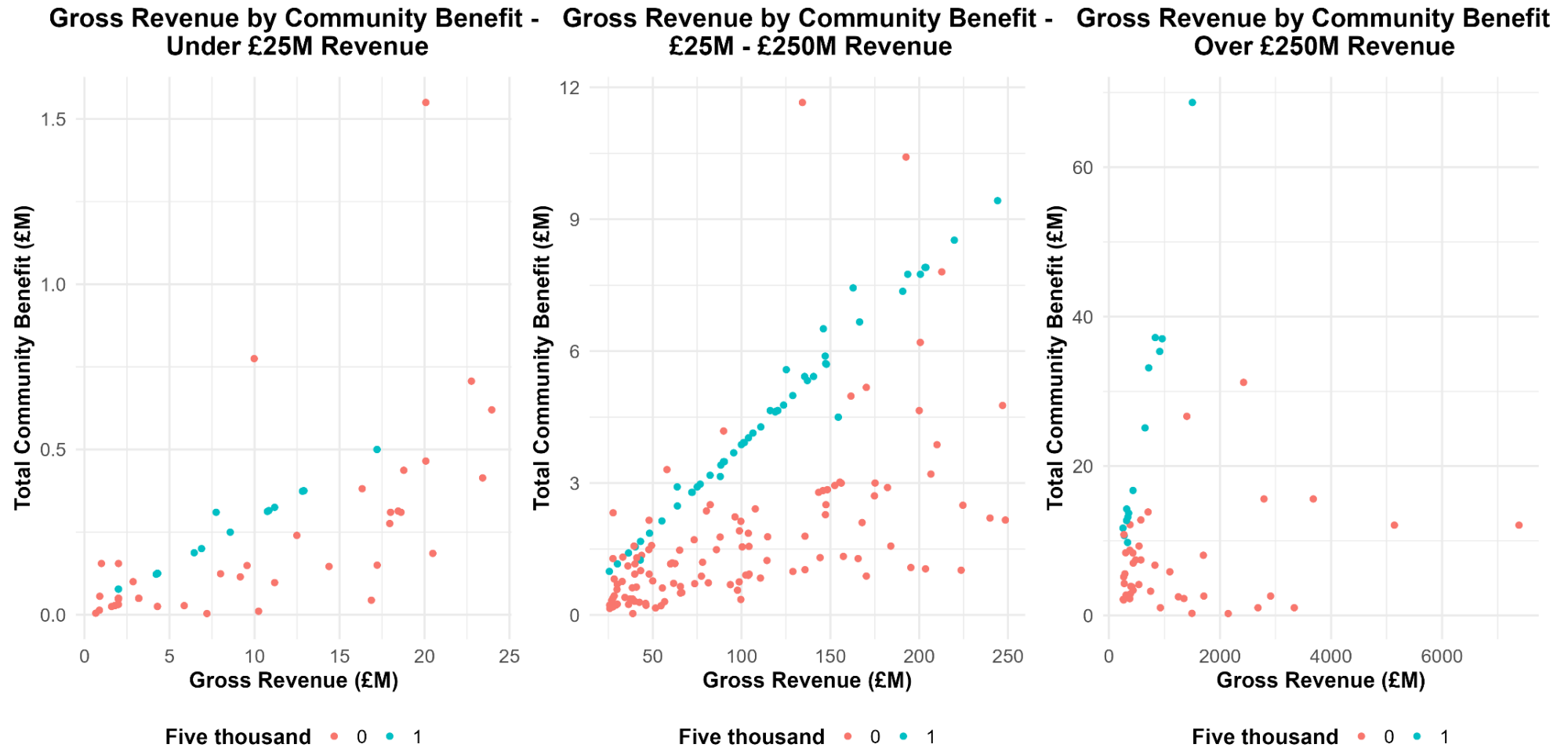
10.8 Analysis of community benefit parameters and their impact

Revenue and profit

Figure 4 below illustrates the relationship between estimated gross revenue and total community benefit commitments over the project lifetime. The relationship is split and visualised by revenue levels due to the variation in the strength of the relationship as revenue changes. Blue dots represent projects that have committed £5,000 per MW per year, while red dots represent any figure other than the recommended £5,000 per MW. There is a clear positive correlation between gross project revenue and total community benefit commitments across all renewable energy projects in Scotland. This suggests that as projects become more financially substantial, they tend to provide larger community benefit packages. As project size increases in revenue terms, there is a widening range of community benefit amounts. This indicates that larger projects have more diverse approaches to community support. The relationship between gross revenue and community benefits appears to weaken for larger revenue projects. This suggests a potential plateau effect where community benefit increases do not keep pace proportionally with revenue growth beyond a certain point.

Small (under £35m gross revenue) and medium-sized (£25-250m gross revenue) projects frequently demonstrate commitment to the recommended £5,000 per MW amount, suggesting strong guideline adherence among projects of these scales. Across these sized projects, there are few instances of commitments exceeding the recommended amount relative to their revenue, suggesting a general reluctance to exceed standard guidelines.

Figure 4 Community Benefits Package by Gross Revenue Bucket (Under £25M, £25M-£250M and £250M+ Gross Revenue)



Source: See Appendix F (Recommended Data Sources)

Deployment and Operating Costs

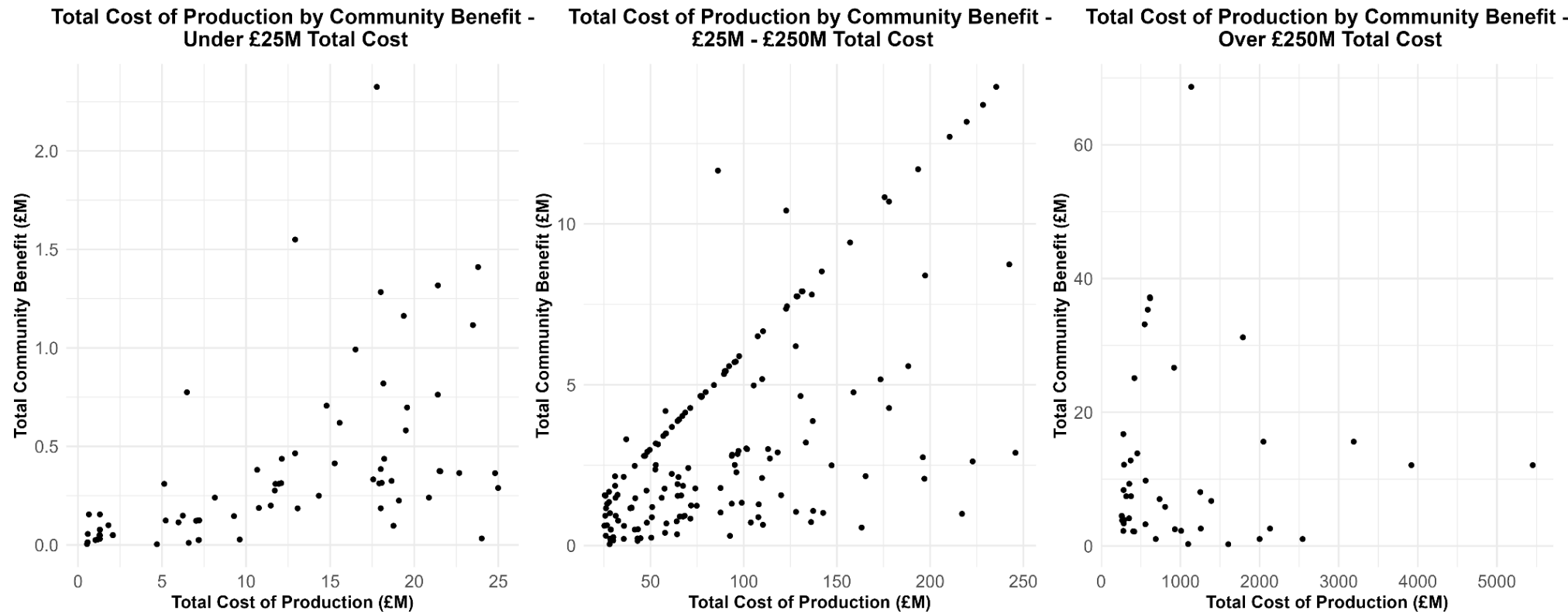
Figure 5 below shows the relationship between estimated total cost of production, expressed as the average cost of producing one unit of energy (LCOE - £/MWh) multiplied by total expected production over the project lifetime, and total community benefit commitments over the project lifetime. As above, the relationship is split and visualised by total cost of production levels due to the variation in the strength of the relationship as total cost changes. There is a positive correlation between total cost of production and total community benefit packages across all project sizes, suggesting that as total costs increase, as does the size of the overall commitment to community benefits. The correlation between total cost and total community benefit are relatively strong (Pearson correlation coefficient⁵⁶ = 0.56) at lower total cost levels (under £25M total cost). This increases to 0.62 for mid-sized projects (£25-250M total cost). However above £250M total costs, there is no correlation (Pearson correlation coefficient=-0.002), indicating that total cost plays less of a role in determining community benefits at large cost levels.

While this may appear contrary to the views of developers shown earlier (i.e. those who said that high costs can impact on financial viability and therefore their ability to offer community benefits) it should be noted that this data analysis is based only on projects that were already providing monetary community benefits. It excludes those that had not provided any benefits. It can therefore be assumed that the dataset excludes those projects that were deemed not financially viable enough to enable community benefit provision.

This analysis goes further to explore whether there are any differences by technology class within onshore projects only (offshore projects have been removed at this stage as the recommended £5,000/MW applies only to onshore technologies). In order to do so, it is important to control for project size (as measured by MW capacity), so as not to produce spurious results. Figure 6 illustrates how many pounds (£) are allocated to community benefits for every pound (£) spent producing energy, categorised by the project's size in capacity (MW). Blue dots represent projects that have committed less than the recommended £5,000 per MW per year, while green dots represent projects that have committed more than the recommended amount and red dots represent project that have committed the recommended £5,000 per MW. For projects with total production costs under £25 million, when comparing hydro and onshore wind projects of the same capacity that both allocate £5,000 per MW annually to community benefits, onshore wind projects are actually providing more community benefits per pound (£) spent on energy production than hydro projects.

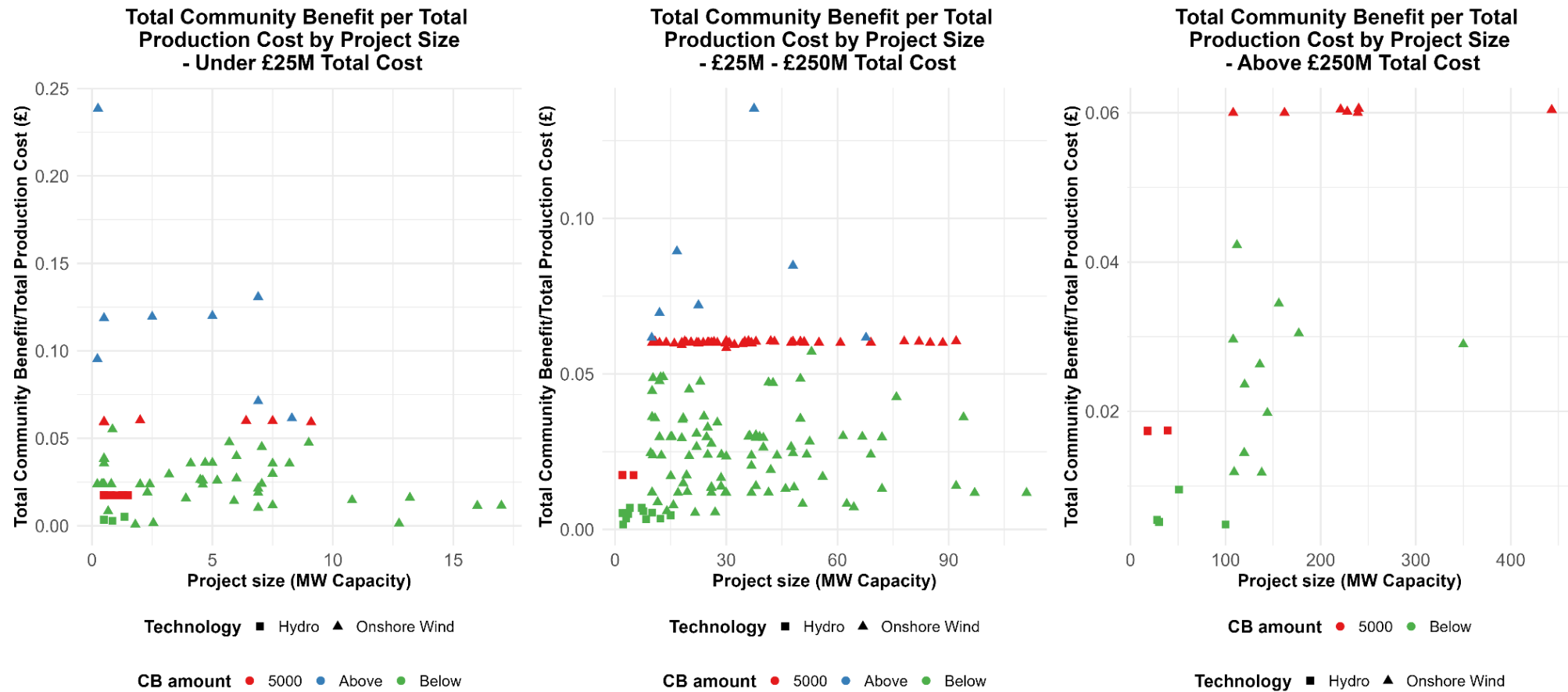
⁵⁶ The Pearson correlation coefficient measures how strongly two variables are linearly related, ranging from -1 (perfect negative correlation) to 1 (perfect positive correlation), with 0 indicating no linear relationship.

Figure 5 Community Benefits Package by Total Cost of Production Bucket (Under £25M, £25M-£250M and £250M+ Total Cost)



SOURCE: SEE APPENDIX F (RECOMMENDED DATA SOURCES)

Figure 6 Community Benefits Package by Total Cost of Production Bucket (Under £25M, £25M-£250M and £250M+ Total Cost)



SOURCE: SEE APPENDIX F (RECOMMENDED DATA SOURCES)

Appendix D Methodologies for estimating revenue and costs

10.9 Project Revenue

Simplified Annual Revenue Estimation – Generation Projects

The fundamental formula for estimating annual revenue is as follows:

Estimated Revenue = Expected Generation (MWh) * Electricity Price (£/MWh),
where

Expected Generation (MWh) = Capacity (MW) * Capacity Factor* Hours in a year

Breaking down these components:

- **Installed Capacity (MW):** This represents the maximum power output of the project under ideal conditions. This data is readily available from the Renewable Energy Planning Database (REPD).
- **Capacity Factor:** This represents the actual output of a project as a percentage of its maximum potential output over a specific period. Historical capacity factors for certain technologies (onshore wind, offshore wind, hydro, landfill gas, and sewage sludge digestion) in Scotland can be found in the Energy Trends: UK Renewables publications⁵⁷.
 - **Addressing Missing Capacity Factors:** For technologies where Scotland-specific capacity factors are unavailable (e.g., solar PV, tidal, wave, biomass), several approaches can be used:
 - UK-wide Proxies: Use UK average capacity factors as a starting point, acknowledging this as a limitation and potential source of error.
 - Technology-Specific Adjustments: Adjust UK proxies based on technology and location characteristics. For example, solar PV capacity factors are influenced by latitude and solar irradiance. Tools like PVGIS can provide location-specific solar irradiance data to refine estimates (this approach is out of scope for the analysis in this study).
- **Average Annual Electricity Price (£/MWh):** This represents the average price received for each MWh of electricity generated over a year. Given the difficulty of obtaining project-specific PPA data, the wholesale market price serves as a practical proxy.
 - **Wholesale Price Data Sources:** While real-time wholesale price data requires plugging into Elexon's BMRS API, a simplified approach for this framework should entail using Ofgem's published weekly wholesale day-ahead price

⁵⁷ <https://www.gov.uk/government/statistics/energy-trends-section-6-renewables>

data⁵⁸ to calculate annual averages. These are GB-wide averages, and hence regional variations should be recognised as a limitation.

- **Simplified CfD Approach (for CfD-supported projects):** For projects under a Contract for Difference (CfD) the strike price is a guaranteed price. This figure is a conservative estimate of returns, as actual revenue could be higher if market prices exceed the strike price. CfD data is available from the Low Carbon Contracts Company (LCCC).

Estimating Future Revenue (also applicable for projects not yet operational) – Generation Projects

For revenue in future years, or for projects under development or construction, estimating future revenue requires additional considerations:

- **Project Lifetime Assumption:** Specify a reasonable assumed operational lifetime for the technology (e.g., 25 years for offshore wind, 20-25 years for solar PV). This assumption directly impacts total revenue calculations.
- **Future Capacity Factor Estimation:** Project future capacity factors based on recent trends and technological advancements. If historical capacity factor data for the specific technology in Scotland (or a similar region) is available, this trend should be analysed over the past years.⁵⁹ This trend should be extrapolated outward to estimate future capacity factors. For less established technologies with limited historical data, the technology's maturity should be considered. Rapidly evolving technologies may see more significant performance improvements expected while more mature technologies might expect to see more stable future performance anticipated. For example, floating offshore wind might be expected to see larger capacity factor gains in the coming years compared to a more established technology like onshore wind.
- **Future Electricity Price Estimation:** Given the volatility of electricity markets, projecting future prices is challenging. For projects supported by a Contract for Difference (CfD), the strike price offers a guaranteed future revenue stream and can be used as a conservative estimate. For non-CfD projects, where future revenue is directly exposed to market price fluctuations, a simplified approach involves using the average annual CfD strike price for the corresponding technology in each future year. However, it's essential to acknowledge that:
 - CfD strike prices are influenced by auction dynamics and may not perfectly represent the market value of electricity from non-CfD projects.
 - Not all technologies are represented in CfD auctions.

⁵⁸ HYPERLINK

"<https://www.ofgem.gov.uk/energy-data-and-research/data-portal/wholesale-market-indicators>" [Wholesale market indicators | Ofgem](#)

⁵⁹ It is recommended to aim for a minimum of 5 years of historical data. This provides a reasonable basis for identifying trends and patterns, while also smoothing out short-term fluctuations or anomalies.

- Using CfD strike prices as proxies across all non-CfD projects might result in a somewhat conservative revenue estimate, as market prices could exceed the strike price in some years.

Prices beyond the latest future year reported in the CfD auction reports are set at the price in the latest year for the respective technology. For example, if CfD auction strike prices are set for the year 2027, the strike price in all future years will be set at the prices in 2027 for that technology. It is acknowledged these prices are unrealistic, however, they serve as the most appropriate benchmark against which to extrapolate.

- **Discounting Future Cash Flows:** To compare projects and scenarios, discount future revenue streams to their present value using an appropriate discount rate that reflects project risk. We propose using the technology-specific discount rate of 10% used by DESNZ in their Levelised Cost of Electricity (LCOE) methodology documents.

10.10 Total Cost of Production Calculation

Total Cost of Production Calculation – Generation Projects

Estimating the total lifetime cost of production across the range of projects in scope requires a consistent and transparent method to apply cost assumptions across different generation technologies. To support this, we use benchmark Levelised Cost of Electricity (LCOE) estimates published by DESNZ.

DESNZ's LCOE values represent the average lifetime cost (£/MWh) of generating electricity for each technology type. These figures include all relevant capital, operational, fuel, and decommissioning costs, spread over the expected lifetime electricity output of a project. As such, LCOE is a useful and well-recognised benchmark for comparing the cost-effectiveness of electricity generation technologies in the UK.

Importantly, we are not re-estimating or recalculating LCOE. Instead, we are using DESNZ's published LCOE values as input parameters in our framework to estimate total cost of production across different project configurations. Specifically, we apply the LCOE estimates to the expected energy output of each project to calculate a total cost figure. This calculation can be expressed as:

$$\text{Total Cost of Production (£)} = \text{LCOE (£/MWh)} \times (\text{Installed Capacity (MW)} \times \text{Load Factor} \times \text{Annual Operating Hours} \times \text{Project Lifetime (years)})$$

This approach allows us to derive a consistent estimate of total production cost, using technology-specific LCOE values as cost rates, scaled by the expected energy output of each project over its lifetime.

The process for estimating total cost of production is as follows:

- **Technology categorisation:** Categorise REPD projects to align with the technology categories used in the UK Government's LCOE estimates file. This may involve mapping project types to the closest matching category in the government data.
- **Energy Output Calculation:** Estimate the annual energy output (MWh) for each project based on its capacity and typical capacity factors for the relevant technology.

- **Total calculation:** Using the scaled cost components and estimated energy output, we will calculate the total cost for each project using the formula. It's important to note that the UK Government's LCOE estimates are provided for projects with commissioning dates in 2025, 2030, 2035, and 2040. Therefore, our total cost calculations will need to be based on the estimate that most closely matches each project's expected commissioning date. We will assign each project to the nearest available estimate year based on its planned commissioning date.
- **Inflation-adjustment:** Furthermore, all costs in the UK Government's estimates are reported in 2021 prices. To ensure consistency and accurate comparisons across projects with varying commissioning dates, we adjust these figures to a common base year using HM Treasury GDP deflators. These temporal adjustments will help ensure that our total cost calculations accurately reflect the economic conditions and technological advancements expected at the time of each project's commissioning, within the constraints of the available data.

Appendix E **Socio-economic scoring mechanisms**

Table 3 NASA Technology Readiness Levels

TRL	TRL Summary
1	Basic principles have been observed and/or formulated: Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.
2	Developing hypothesis and experimental designs: Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3	Specifying and developing an experimental Proof of Concept (PoC): Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4	PoC demonstrated in test site/initial evaluation of costs and efficiency produced: Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.

5	Technology/process validated in relevant environment: Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include “high-fidelity” laboratory integration of components.
6	Technology/process validated in operational environment: Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7	System complete and qualified: Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
8	Product/technology in manufacture/process being implemented: Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation (DT&E) of the system in its intended weapon system to determine if it meets design specifications.
9	Product/service on commercial release/process deployed: Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation (OT&E). Examples include using the system under operational mission conditions.
10	Dead end and reached.

Table 4 IEA Technology Guide Technology Maturity Scale

Technology Readiness Level	Description
11	Proof of stability reached
10	Integration needed at scale
9	Commercial operation in relevant environment
8	First of a kind commercial
7	Pre-commercial demonstration
6	Full prototype at scale
5	Large prototype
4	Early prototype
3	Concept needs validation
2	Application formulated
1	Initial idea

Table 5 Market Maturity Scale

Score	Reasoning
5	Fully Mature Market: A fully mature market is characterized by high levels of competition, well-established regulatory and policy frameworks, and a global supply chain. The technology is fully integrated into the energy system, and investment is based on market forces rather than policy incentives. The market operates efficiently with clear pricing signals. Hydropower , especially conventional dam-based installations, has a fully mature market with a global presence and long history of integration into energy systems.
4	Established Market: Established markets have a stable and supportive regulatory environment, a robust and competitive supply chain, and a broad base of stakeholders. Investment is seen as lower risk, and financing models are well understood. There is strong competition, and the technology is a significant part of the energy mix. Onshore wind and solar PV have both reached this level of market maturity, with widespread adoption and a solid market presence.
3	Growing Market: At this stage, markets are experiencing noticeable growth in demand and investment. The regulatory environment is becoming more supportive, with clearer policies and standards. The supply chain is expanding, and costs start to decrease as economies of scale are realized. There is a healthy level of competition with several established players. Fixed-bottom offshore wind is at this stage, with a growing number of projects and increasing investor confidence.
2	Emerging Market: Markets at this stage have begun to establish some regulatory frameworks and attract early adopters. The supply chain is forming but may not be fully reliable or cost-effective. There is a growing interest from investors, but financing often depends on policy incentives. Competition is limited, but there are signs of market growth. Floating offshore wind , which is beginning to see commercial interest and investment, but lacks the extensive market presence of fixed-bottom offshore wind, would fall into this category.
1	Nascent Market: The market at this stage is in its infancy. There are few, if any, regulatory standards or guidelines, and the supply chain is undeveloped. Investment is highly speculative, and there are very few players in the market. The technology may still be reliant on grants or government support with no established commercial financing models.

Appendix F Recommended data sources

The following below provides a summary of the key data sources currently available to measure framework parameters. However, these are not complete and additional work is required to fill gaps.

Parameter	Measurement item	Recommended data source
Community Benefit	Community benefits monetary value (£)	Community Benefit Register Database. Since the database does not cover all technologies, this would need to be supplement with data from individual developers, either through requesting this directly or sourcing it from company reports (where available).
Technical maturity	Technology maturity scoring	NASA TRL Scale IEA ETP Clean Energy Technology Guide. While the database is comprehensive in its technology classification, there is likely to be some mis-classification of REPD projects to specific IEA ETP technologies. Ideally, project TRLs should be sourced directly from project owners.
Project revenue	Installed capacity	Community Benefit Register Database and REPD
	Capacity factor	Energy Trends: UK Renewables publications. Historical capacity factors are only available for certain technologies. Newer technologies are therefore not captured and will need to be sourced directly from projects.
	Electricity price	Elxon Ofgem wholesale day-ahead price
	CfD strike price	Low Carbon Contracts Company
Capital and operating costs	Technology categorisation	UK Government's LCOE estimates. This data source captures LCOE for a selection of common technologies. More niche/newer technologies are not captured within this data source and therefore should be collected directly through projects.
	Energy output	REPD Energy Trends: UK Renewables publications

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