Business Modelling

Report

Highlands and Islands Enterprise Project: Optimising carbon sequestration opportunities for community wealth building in Argyll and Bute

AZETS

Contents

Glossary

Corporate parties

Azets or “we”	Azets Corporate Finance
HIE or the “Client”	Highlands and Islands Enterprise
Imani	Imani Development – Project Management

Information

All information sources	referenced throughout both excel models. Some key sources highlighted below:
Carbon Price	https://www.reuters.com/business/energy/eu-carbon-price-tops-50-euros-first-time-2021-05-04/
Social Value of Carbon	https://thedocs.worldbank.org/en/doc/911381516303509498-0020022018/original/2017ShadowPriceofCarbonGuidanceNoteFINALCLEARED.pdf
Tree Thinning	Jim McAdam - Queens University Belfast - "How can Agroforestry make sheep farming more sustainable?"
Forestry Grants	https://forestry.gov.scot/publications/108-the-forestry-grant-scheme-a-guide-to-grant-options-for-woodland-creation
Peatland Grants	https://www.gov.scot/news/peatland-restoration-fund-tackles-global-climate-crisis/

Financial & Other terms

A&B	Argyll and Bute
Capex	Capital expenditure
CC	Carbon credit
CO2e	Carbon dioxide equivalent
FY	Financial year
Ha or ha	Hectares
M2	Metres squared
NI	National insurance
NPV	Net present value
NBV	Net book value
Opex	Operating expenditure
PAYE	Pay as you earn (Income Tax)
P&L	Profit and loss
tCO2e	Tonnes of carbon dioxide equivalent
YoY	Year on year

Azets Team

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1. Overview

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Overview

Summary and Scope

As per the Mini Tender Proposal document dated 8 April 2022, we have developed a proof-of-concept business model that allows 3 core Carbon Sequestration scenarios to be modelled in detail.

Our work has focused on three specific methods of Carbon Sequestration:

- Woodland - Planting new woodland;
- Peatland - Peatland restoration; and
- Silvopasture - Planting trees amongst livestock.

The supporting data and assumptions used in the business models have been derived from Work Packages 1 to 4, which we have used to present the following three business models:

1. **Individual Farm model ("Scenario 1")**

   Scenario 1 reviews the potential income and expenditure associated with carbon sequestration under an individual farm model of up to 50 Hectares.

2. **Farm Enterprise Model ("Scenario 2")**

   Scenario 2 reviews the potential income and expenditure associated with carbon sequestration under a farm enterprise model (or cluster of farms) of up to 500 Hectares.

3. **Facilitation Agency Model ("Scenario 3")**

   Scenario 3 reviews the potential income and expenditure associated with a facilitation agency model, whereby the agency is responsible for the verification, validation and other costs in return for a percentage of the farmers carbon credit income.

The above scenarios have been prepared using a combination of information provided by Imani, independently sourced third party information and a variety of assumptions as agreed with Imani.

2. Key Findings

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Key Findings

Below we highlight some of the key findings from the work we have carried out on carbon sequestration. *please note these findings are high level, greater detail on these findings is held within the main body of this report alongside the three business case models that we have prepared.*

Long Payback Periods (Individual Farms):

All three methods of carbon sequestration result in long payback timeframes, between 15-25 years. These long payback timeframes explain the inertia in attracting supply to date. We understand that solutions to this may include:

1) A higher price for carbon - for example at $100 per tCO2e the payback years reduce as follows: Woodland Yr20 (Yr 25), Peatland Yr5 (Yr 15) and Silvopasture Yr10 (Yr15)
2) More public interest to unlock supply;
3) Private interest premium (e.g. give grants for 5 years of sunk costs to move payback to Yr10 from Yr25). Public and private interests, and higher prices, could transform viability significantly and can be modelled using this framework.

Reliance on Grant Funding (Facilitation Agency):

Our work included looking into the feasibility of a facilitation agency to assist individual farmers and farm enterprises with the administration and some of the initial costs of starting up carbon sequestration and in turn help increase the supply. Though we understand, based on our assumptions that farmers would benefit from such an agency (up to as much as 200 hectares – see Section 6 of this report) the agency model itself is significantly loss making and does not break even until Yr27 without any private or public sector support.

We note that more work is generally required to understand in detail the potential operating model of a facilitation agency and how it can promote change in woodland, silvopasture and peatland.

Peatland Feasibility Structure:

Peatland has the lowest initial output costs and achieves payback very early in the model (compared with Woodland and Silvopasture), suggesting that it may be the most attractive method of carbon sequestration (for the land owner). However, there will be value in further research to establish if this is likely to drive action sooner in this area compared to the other methods. e.g. to pull together people such as Islay landowners and distilleries now rather than later to understand the likelihood of uptake in these areas.

3. Individual Farm Model

Scenario 1

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Individual Farm Model: Overview & Woodland

Overview:

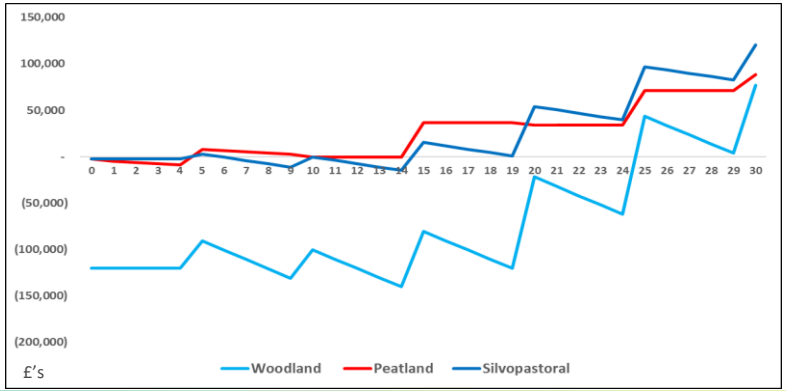
- We have prepared a 30-year forecast model (Scenario 1) with flexible assumptions (please see Appendix 1 for key model assumptions) to present the potential initial outlays and ongoing income and expenditure associated with three different types of carbon sequestration.
- This scenario aims to assist an individual farmer with a small individual land holding (of up to 50 hectares) to understand the potential short and long-term economic benefits of engaging in carbon sequestration.
- The table opposite illustrates the potential cumulative net profit and loss under each of the three carbon sequestration methods, assuming a 50-hectare plot of land each. The output from each method is discussed in greater detail below.

Woodland:

- To plant a new woodland of c.1,100 trees per hectare, being a 3m^2 spacing per tree planted requires significant initial capital investment. This is estimated to cost £280k for a 50-hectare plot of land, though we have estimated that £210k of this would be upfront grant funded by the forestry grant scheme, resulting in an initial outlay for the farmer of £70k.
- Grant income may come in different forms, for example, a public-interest driven grant or a private-interest driven grant-giving or an overt volume-based premium on sequestered carbon, or as part of a looser 'local support' package.
- The ongoing maintenance and monitoring costs are estimated to be between £11k and £13k p.a. We understand that maintenance grant income is available for the first five years by the forestry grant scheme and have assumed this would cover 100% of maintenance costs for the first five years (£10k p.a).
- No carbon credit income is generated until year 10 when the first accumulation of tCO2e is sold on the open market, with recurring sales thereafter every five years. Year 14 is the lowest point in terms of cumulative net losses at £140k. The carbon credit income in years 20 and 25 are most significant at £83k and £91k respectively, alongside assumed tree thinning profits of £31k every 5 years. The model suggests cumulative profitability in year 25 of £44k, rising further to £77k in year 30.
- Though we have not modelled past year 30, the cumulation of tCO2e is reducing each year from year 25 onwards and therefore it is assumed the rate of carbon credit will continue to reduce significantly thereafter, though yearly maintenance costs will remain.

Cumulative Net Profit / (Loss) – Individual Farm (50 Hectares each) (£'s)

	Year	Woodland	Peatland	Silvopasture
Initial Outlays	0	(120,301)	(2,715)	(2,801)
Cumulative Profit / (Loss)	5	(90,892)	7,430	2,874
Cumulative Profit / (Loss)	10	(100,378)	(711)	(400)
Cumulative Profit / (Loss)	15	(80,571)	36,541	15,117
Cumulative Profit / (Loss)	20	(21,905)	33,983	54,023
Cumulative Profit / (Loss)	25	43,574	71,235	96,949
Cumulative Profit / (Loss)	30	76,804	88,127	120,506



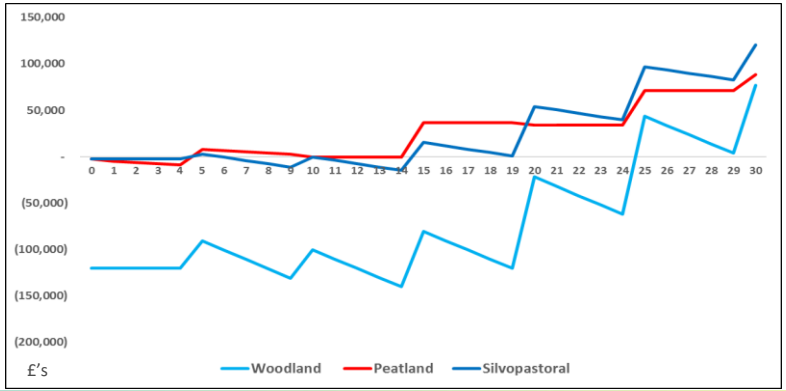
Individual Farm Model: Peatland

Peatland

- Restoring peatland for carbon sequestration is understood to be the cheapest of the three methods to a farmer, estimated at £50k to restore 50 hectares of peatland, plus validation and registry fees (total estimated initial outlays of c.£53k, £50k of which we estimate could be covered by a peatland restoration grant (net £3k outlay for the farmers)).
- The ongoing maintenance and asset monitoring costs are estimated to be between £1 and £3k p.a, though these costs are higher in the early stages and after year ten only verification costs occur, estimated at c.£2k every 5 years. We have not found any publicly available information to identify the availability of maintenance grant income for peatland restoration.
- In line with the peatland code calculator, the model assumes that carbon credit income is claimable in years 5, 15, 25 and 30. Income is generated when the emissions reduction of tCO2e is sold on the open market. Year 4 illustrates the lowest point in terms of cumulative net losses at £9k. Thereafter the process is largely breakeven until year 15 where cumulative profits are £37k, rising to £88k by year 30.
- Though we have not modelled past year 30, the emissions reduction of tCO2e each year is constant per the peatland code calculator and therefore it is assumed that the rate of carbon credit income will continue at this level alongside the costs, thus remaining a profitable operation year on year.
- Please note, as outlined in the previous work packages that there are two eligible methods of peatland restoration under the Peatland Code: “Eligible activities shall be those relating to restoration of either blanket bog or raised bog with an associated baseline condition category of ‘Actively Eroding’ or ‘Drained’ and a minimum peat depth of 50 cm. " there is a significant difference in the tCO2e generated under each method.
- The SAMS report outlines that the following areas of each type of peatland are available for sequestration in the Argyll & Bute area: (i) 3,784 ha of peatland (actively eroding); and (ii) 45,706 ha of peatland (drainage). AS a result, we have assumed a percentage split of hectarage of 7.5% actively eroding and 92.5% drainage per our model under all scenarios.

Cumulative Profit / (Loss) – Individual Farm (50 Hectares each) (£’s)

	Year	Woodland	Peatland	Silvopasture
Initial Outlays	0	(120,301)	(2,715)	(2,801)
Cumulative Profit / (Loss)	5	(90,892)	7,430	2,874
Cumulative Profit / (Loss)	10	(100,378)	(711)	(400)
Cumulative Profit / (Loss)	15	(80,571)	36,541	15,117
Cumulative Profit / (Loss)	20	(21,905)	33,983	54,023
Cumulative Profit / (Loss)	25	43,574	71,235	96,949
Cumulative Profit / (Loss)	30	76,804	88,127	120,506



Individual Farm Model: Silvopasture

Silvopasture

- To plant new woodland of c.400 trees per hectare, being a 5m2 spacing per tree planted requires significantly less initial capital investment than planting a full woodland at 3m2 spacing. Greater spacing of the trees is required to allow livestock (typically sheep) to graze amongst the field as normal and thus the trees can provide the farmer with a secondary source of income. It is estimated to cost £67k for a 50-hectare plot of land, though we have estimated that £63k of this could be grant funded by the forestry grant scheme, resulting in an initial outlay for the farmer of £4k.
- The ongoing maintenance and asset monitoring costs are estimated to be between £4k and £6k p.a. Maintenance grant income could be available for the first 5 years by the forestry grant scheme, which could cover 100% of maintenance costs (£4k p.a).
- No carbon credit income is generated until year 10 when the first accumulation of tCO2e is sold on the open market, with sales then assumed to occur every five years thereafter. Year 14 is the lowest point in terms of cumulative net losses at £15k. The carbon credit income in years 20 and 25 are forecast to be significant at £50k and £54k respectively, and tree thinning profits of £11k every 5 years. The model assumes cumulative net profit of £54k in year 20, increasing to £121k in year 30.
- Though we have not modelled past year 30, the cumulation of tCO2e is reducing each year from year 25 onwards due to ongoing maintenance costs.

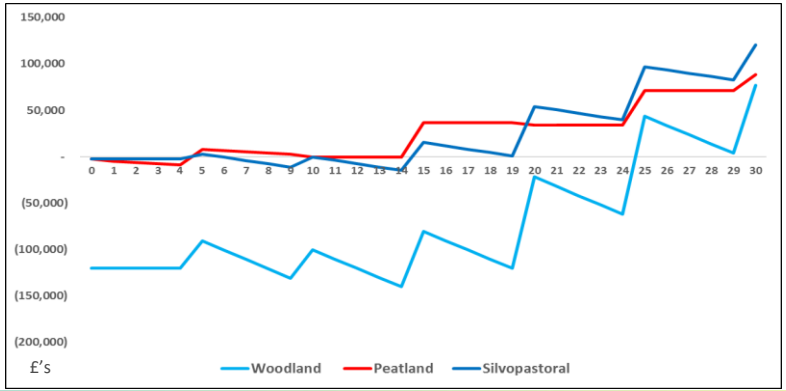
Conclusion

- We would highlight that the 3 carbon sequestration methods identified are not profitable in the short to medium term (15 years) and are reliant on grant income to cover the farmer's initial outlays. However, both peatland restoration and silvopasture are much less onerous than woodland plantation in terms of the initial outlays and peatland can continue to provide steady profits after year 30, as the others lessen.

50 Hectares	Woodland	Peatland	Silvopasture
Max Outlays (net of Grants) **& Year**	£140k (Y14)	£9k (Y4)	£15k (Y14)
Payback Period	**25 years**	**15 years**	**15 years**
Cumulative Profit (Year 30)	**£76k**	**£88k**	**£121k**

Cumulative Profit / (Loss) – Individual Farm (50 Hectares each) (£'s)

	Year	Woodland	Peatland	Silvopasture
Initial Outlays	0	(120,301)	(2,715)	(2,801)
Cumulative Profit / (Loss)	5	(90,892)	7,430	2,874
Cumulative Profit / (Loss)	10	(100,378)	(711)	(400)
Cumulative Profit / (Loss)	15	(80,571)	36,541	15,117
Cumulative Profit / (Loss)	20	(21,905)	33,983	54,023
Cumulative Profit / (Loss)	25	43,574	71,235	96,949
Cumulative Profit / (Loss)	30	76,804	88,127	120,506



4. Farm Enterprise Model

Scenario 2

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Farm Enterprise Model

Overview

- Included within the same model as Scenario 1, we have prepared a further 30-year forecast model (Scenario 2) with flexible assumptions to present the potential initial outlays and ongoing income and expenditure associated with three different types of carbon sequestration.
- This scenario aims to assist farmers with larger land holdings (up to 500 hectares) or a group of farmers with combined land holdings between 50 and 500 hectares, to understand the potential short and long-term economic benefits of engaging in carbon sequestration.
- The table opposite illustrates the cumulative profit and loss under each of the three carbon sequestration methods, for a 500-hectare plot of land each. The assumptions for Scenario 2 are largely aligned with those in Scenario 1 but scaled up for 500 hectares as opposed to 50 hectares.

Assumptions

- The key assumption differences in the farm enterprise model (Scenario 2) compared to the individual farm model (Scenario 1) are noted below:
  - The farm enterprise model assumes a 10% economies of scale saving on all start up costs – it is assumed a saving would be made buying tree seedlings, fencing and other items in a larger quantity. This percentage can be amended in the model to sensitise.
  - Under the three carbon sequestration methods, Scenario 1 and 2 assume that validation, verification, asset monitoring and registry fees are fixed up to a hectarage of 500, in line with with the peatland code additionality calculator for a plot of c.200 hectares.
  - These assumptions assume carbon sequestration being more profitable per hectare as the operation is scaled up.

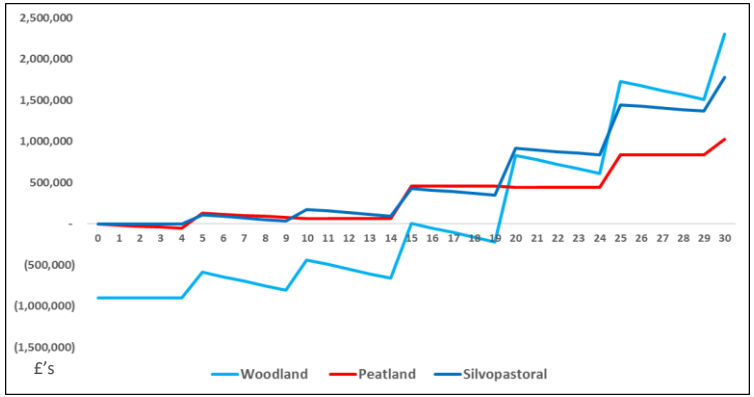
Conclusion

- The results below are aligned to Scenario 1; however, we note that the payback period for Peatland and Silvopasture is reduced further to just 5 years and is much quicker in terms of payback compared to woodland (20 years). Over a period of 30 years, Woodland plantation is estimated to be the most profitable method (£1,032k) – though it requires significantly higher outlays, being £900k (Y0) and a maximum of £900k cumulative net outlays in Y4.

500 Hectares	Woodland	Peatland	Silvopasture
Max Outlays (net of Grants) **& Year**	£900k (Y4)	£54k (Y4)	£3k (Y4)
Payback Period	**20 years**	**5 years**	**5 years**
Cumulative Profit (Year 30)	**£2,305k**	**£1,023k**	**£1,780k**

Cumulative Profit / (Loss)– Farm Enterprise (500 Hectares each) (£'s)

	Year	Woodland	Peatland	Silvopasture
Initial Outlays	0	(900,301)	(2,715)	(3,451)
Cumulative Profit / (Loss)	5	(585,718)	127,661	109,799
Cumulative Profit / (Loss)	10	(438,924)	62,895	174,704
Cumulative Profit / (Loss)	15	2,599	453,870	429,329
Cumulative Profit / (Loss)	20	830,908	444,936	916,031
Cumulative Profit / (Loss)	25	1,729,143	835,900	1,444,739
Cumulative Profit / (Loss)	30	2,304,888	1,023,274	1,779,757



5. Facilitation Agency Model

Scenario 3

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Facilitation Agency Model

Overview

- We have prepared a separate 30-year forecast model (Scenario 3) with flexible assumptions (please see Appendix 1) to present the potential initial outlays and ongoing income and expenditure associated with the set up and growth of a carbon sequestration facilitation agency.
- The purpose of the facilitation agency is to assist farmers with a significant element of the administration and cost required to set up and run a carbon sequestration model under either Woodland, Peatland or Silvopasture scenarios.
- The model assumes that the facilitation agency will meet the initial cost of registry, validation, verification and asset monitoring and in return, will take a percentage (assumed at 30%) of the carbon credit income received from the sale of tCO2e. This scenario aims to assist public sector bodies identify and assess the viability of this concept as a standalone entity, and how much funding it will require before it becomes self sufficient.
- The start up costs associated with this entity in year 0 (£45k) are assumed to include a company car and office fit-out costs (assuming leased premises). Costs are forecast to increase annually with the addition of more staff to facilitate the increasing hectarage of carbon sequestration projects.
- The table opposite illustrates the potential cumulative profit and loss for the facilitation agency, this output assumes oversight of an additional 3000 hectares p.a. (see key cost and staffing assumptions at Appendix 1). The output is explained in greater detail below.

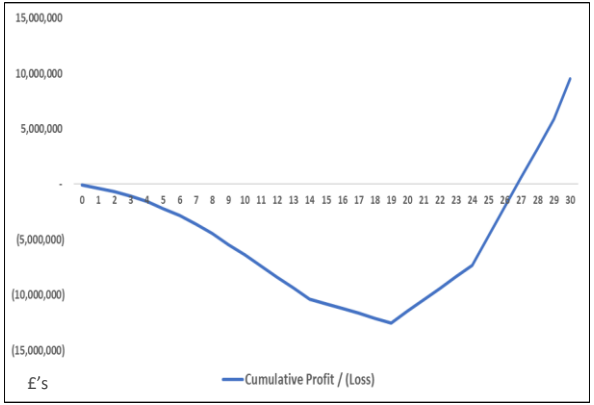
Conclusion

- As summarised in the table below, the facilitation agency model is significantly loss making for years 1 to 19 and is profitable from year 20 onwards. The initial forecast loss is driven from the maximum cumulative outlays of £12.5m in year 19 (largely due to staff costs) and as such, there is an estimated 27 year payback period. However, it should be noted that due to the nature of the income being delayed 5/10 years from onset of each carbon sequestration project, once the entity becomes breakeven (in Y19) there will be significant profit growth thereafter, provided that it can continue to grow and bring on new projects each year at the levels we have assumed. We highlight that the potential cumulative profit for the 30-year period is £9.5m.

Scenario 3	Agency
Max Outlays & Year	**£12.5m (Y19)**
Payback Period	**27 years**
Cumulative Profit (Year 30)	**£9.5m**

Cumulative Profit / (Loss) – Facilitation Agency (£'s)

	Year	Hectares	Profit / (Loss)
Initial Outlays	0	-	(45,000)
Cumulative Profit / (Loss)	1	3,000	(348,429)
Cumulative Profit / (Loss)	5	15,000	(2,207,749)
Cumulative Profit / (Loss)	10	30,000	(6,394,806)
Cumulative Profit / (Loss)	15	45,000	(10,811,736)
Cumulative Profit / (Loss)	20	60,000	(11,499,229)
Cumulative Profit / (Loss)	25	75,000	(4,673,317)
Cumulative Profit / (Loss)	30	90,000	9,521,806



6. Linkages between farm models & facilitation agency model

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Linkages between Farm models & Facilitation Agency Model

Scenario 1 & 2 Costs Compared with Scenario 3 Income

- In Scenario 3 – the facilitation agency model, income is generated through the agency taking a percentage of the individual farmer / farm enterprise's carbon credit income on the sale of tCO2e on the open market.
- Scenarios 1 & 2 assume that the actual costs for monitoring (includes verification, validation, asset monitoring, registry and Brokerage costs) are paid upfront by the farmer / farm enterprise based on a variety of assumptions and in comparison, to industry models.
- Scenario 3 assumes that the costs above would be met upfront by the agency in return for a **30% share of the carbon credit income.** This both lowers the administration and upfront expense for the farmers and / or farm enterprises.
- The table below compares the two models by calculating and assuming the following for each of the three carbon sequestration methods:
  - The below calculates the total monitoring and brokerage costs as a percentage of carbon credit income over the 30-year period.
  - This assumes that $40 is the average sale price for tCO2e throughout the period and the agency share in the risk that the price could drop (we would highlight that the current market price is c.$20).
  - The monitoring costs are assumed to be mostly fixed up to a land holding of 500 hectares – this includes registry, validation and verification costs and asset monitoring costs (for Peatland only).
  - The below only calculates the financial impact over the 30-year period and therefore does not consider other benefits for the farmer of using an agency, including saved administration, saved upfront costs and reduced risk (30% shared with agency). We note that these other benefits could account for as much as a further 15% of their carbon credit income to a farmer – see results below (orange highlight).

Conclusion:

- The result of the table below illustrates that smaller, individual land holdings will benefit financially from using the facilitation agency (scenario 3), and those highlighted in green will be benefit from using the agency by foregoing a 30% share of their carbon credit income against meeting the upfront costs personally. However, as noted in the 4th bullet above, we believe there are other non-financial benefits which **could contribute up to an additional 15% of carbon credit income (**highlighted in orange below for reference). Overall, peatland has the highest monitoring costs to carbon credit income as a %, due to asset monitoring costs each year for the first 10 years of c.£1k p.a, Woodland and Silvopasture do not bear the same cost. As a result, farmers performing peatland restoration would benefit the most from the use of a facilitation agency (up to 35 hectares) or (up to 200 hectares including other benefits).

Monitoring & Brokerage Costs as a % of Carbon Credit Income

Hectares	5	10	15	20	25	30	35	40	45	50	100	150	200	250	300	350	400	450	500
Woodland	57%	31%	22%	18%	15%	14%	12%	11%	11%	10%	8%	7%	6%	6%	6%	6%	6%	6%	6%
Peatland	139%	75%	54%	44%	37%	33%	30%	28%	26%	25%	18%	16%	15%	14%	14%	14%	13%	13%	13%
Silvopasture	92%	48%	34%	27%	22%	19%	17%	16%	15%	14%	10%	8%	7%	7%	7%	6%	6%	6%	6%
Total	**85%**	**46%**	**33%**	**26%**	**22%**	**19%**	**18%**	**16%**	**15%**	**14%**	**10%**	**9%**	**8%**	**8%**	**8%**	**8%**	**7%**	**7%**	**7%**

7. Social Value

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Social Value

Overview

- We understand that there is a 'beyond carbon' value to this exercise which encapsulates the social and environmental benefits of carbon sequestration. Other than the various public and private grant income available , the farmers themselves will not feel 'social value' as a monetary benefit and as such, we have presented all three scenarios in our report without an estimate for additional social value.
- A paper from the World Bank[1] named "Shadow Price of Carbon in Economic Analysis" details that an estimated value of Carbon (CO2e) per tonne including an estimate for social value is between $40 and $80. From this we can assume an average price of $60 per tCO2e. As noted in Appendix 1 (Key Model Assumptions) we have assumed a flat rate of $40 in our models for tCO2e excluding social value. The additional $20 per tonne to account for social value is included separately in each of our models which can be 'toggled' on / off by the user.
- The tables opposite illustrate the original scenario output (in white cells) as a comparison to the scenario output including social value (in light green cells).

Scenario 1 – Individual Farm Model

- As noted above the social value impact would not be included when showing Scenario 1 to an individual farmer as it is not a direct / tangible economic benefit; however, a public body such as the Forestry Commission (grant provider) or Highlands and Islands Enterprise (potential grant funder) will be interested in the wider social value generated. Figure 1 in the table opposite includes the shadow price for social value. We would highlight that the outlays with and without the social value are similar; however, the payback period significantly reduces and the cumulative profit across the three methods is materially higher

Scenario 2 – Farm Enterprise Model

- As aligned with scenario 1, the results are similar for the farm enterprise model as per the individual farm model on a per hectare basis. Per Figure 2 output (right) - including the shadow price for social value the max cumulative outlays are the same, the payback period is reduced or maintained under each method and the cumulative profit across the three methods is materially higher.

Scenario 3 – Facilitation Agency Model

- The facilitation agency focus is to facilitate the success of carbon sequestration which will aid the level of publicly available funds for carbon sequestration and improve the social value for the area through new employment and a cleaner environment. It is therefore important for the public and private sector to understand the social and environmental value benefit to investing in or funding such an entity. Figure 3 (right) shows that with the inclusion of a shadow price for social value, the maximum outlays are significantly reduced from £12.5m to £10m, as is the payback period by 3 years and overall cumulative profit increases by c.£21m.
- We caveat that this is a very high-level approach to calculating social value and is of course subjective.

Fig 1. Scenario 1 - 50 Hectares	Woodland	Peatland	Silvopasture
Max Outlays (net of Grants) & Year	£140k (Y14)	£9k (Y4)	£15k (Y14)
Payback Period	25 years	15 years	15 years
Cumulative Profit (Year 30)	£76k	£88k	£121k
Max Outlays (net of Grants) & Year	£135k (Y14)	£9k (Y4)	£12k (Y14)
Payback Period	20 years	5 years	15 years
Cumulative Profit (Year 30)	£219k	£150k	£205k

Fig 2. Scenario 2 - 500 Hectares	Woodland	Peatland	Silvopasture
Max Outlays (net of Grants) & Year	£900k (Y4)	£54k (Y4)	£3k (Y4)
Payback Period	20 years	5 years	5 years
Cumulative Profit (Year 30)	£2,305k	£1,023k	£1,780k
Max Outlays (net of Grants) & Year	£900k (Y4)	£54k (Y4)	£3k (Y4)
Payback Period	15 years	5 years	5 years
Cumulative Profit (Year 30)	£3,727k	£1,644k	£2,626k

Fig 3. Scenario 3	Agency	Agency Incl SV
Max Outlays & Year	£12.5m (Y19)	£9.640m (Y18)
Payback Period	27 years	24 years
Cumulative Profit (Year 30)	£9.5m	£30.355m

Source [1] :https://thedocs.worldbank.org/en/doc/911381516303509498-0020022018/original/2017ShadowPriceofCarbonGuidanceNoteFINALCLEARED.pdf)

Social Value

Conclusion

- The interest for a private enterprise, local group or similar must be calculated on their terms, i.e. what will make carbon sequestration work for them. But from a public policy or integrated local economy point of view (where there are strong interdependencies between sectors, logistics, employment and social outcomes, as is the case in islands like Islay) it is the role of coordinators to ensure that information barriers are lowered and wider interests are structured in ways that can incentivise individual actors for community good. This will range from support on compliance paperwork, business modelling support (as per these models), setup costs for a facilitation agency, case study examples to help design carbon land use within other value chains, private sector funding including premiums above international competitors to secure supply that may de-risk local economies in future, and so on. Further information on these economic factors can be found in a complementary report [See Ekosgen WP4 report].

- New price expectations are emerging that model far higher values for carbon. At higher prices by 2030, payback periods could be far quicker, for example under 10 years, not further out. This type of price information must be fed through to stakeholders so they can make informed choices.

Fig 1. Scenario 1 - 50 Hectares	Woodland	Peatland	Silvopasture
Max Outlays (net of Grants) & Year	£140k (Y14)	£9k (Y4)	£15k (Y14)
Payback Period	25 years	15 years	15 years
Cumulative Profit (Year 30)	£76k	£88k	£121k
Max Outlays (net of Grants) & Year	£135k (Y14)	£9k (Y4)	£12k (Y14)
Payback Period	20 years	5 years	15 years
Cumulative Profit (Year 30)	£219k	£150k	£205k

Fig 2. Scenario 2 - 500 Hectares	Woodland	Peatland	Silvopasture
Max Outlays (net of Grants) & Year	£900k (Y4)	£54k (Y4)	£3k (Y4)
Payback Period	20 years	5 years	5 years
Cumulative Profit (Year 30)	£2,305k	£1,023k	£1,780k
Max Outlays (net of Grants) & Year	£900k (Y4)	£54k (Y4)	£3k (Y4)
Payback Period	15 years	5 years	5 years
Cumulative Profit (Year 30)	£3,727k	£1,644k	£2,626k

Fig 3. Scenario 3	Agency	Agency Incl SV
Max Outlays & Year	£12.5m (Y19)	£9.640m (Y18)
Payback Period	27 years	24 years
Cumulative Profit (Year 30)	£9.5m	£30.355m

8. Appendices

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Appendix 1 – Key Model Assumptions

Scenarios 1&2

- Key income and expenditure assumptions for scenarios 1 and 2 are outlined in the tables below and the references are outlined in column B of the Income and Expenditure tabs of the model named: “Project Skye – Scenario 1 & 2” (and are therefore not repeated in this report).

Key Income Assumptions	
Spacing of trees: Woodland	**3m2** (1,111 per hectare)
Spacing of trees: Silvopasture	**5m2** (400 per hectare)
Split of Actively Eroding / Drainage per hectare: Peatland	**7.5% / 92.5%**
Scenario 1: Individual Farm total hectarage	**Between 5 – 50 hectares** (Standard model assumes 50 ha)
Scenario 2: Farm Enterprise total hectarage	**Between 51 – 500 hectares** (Standard model assumes 500 ha)
Assumed average no. of farms in a single Farm Enterprise	**10** (assumes average individual farm is 50 ha)
% of carbon sequestered after tree thinning: Woodland and Silvopasture	**70%** (carbon sequestration is reduced after trees are thinned for profit Y20, Y25 & Y30)
Market price per tonne of carbon dioxide equivalent (CO2e)	**$40**
Social value of Carbon Sequestration - Price per tonne of carbon dioxide equivalent (CO2e)	**$20** (over and above market price)
$USD to £GBP exchange rate	**1 / 0.82**
Profit per hectare of trees thinned	**Woodland: £227/ha** **Silvopasture: £629/ha**
Year in which planted trees can be thinned for profit	**Every 5 years – first thinning Y5**
Maximum total grants available (per farm)	**Woodland & Silvopasture: £250,000** **Peatland: £500,000**
Initial grant available per hectare	**Woodland: £3,200 - £4,400** **Peatland: £1,000** **Silvopasture: £3,600**
Annual maintenance payments available	**Woodland & Silvopasture: Up to 5 years** **Peatland: Nil**

Key Expenditure Assumptions	
Median start up cost per hectare – (Planting & establishment costs - Woodland and Silvopasture, Restoration costs - Peatland)	**Woodland: £5,500** **Peatland: £1,000** **Silvopasture: £1,260**
Economies of scale achieved on start up costs in Scenario 2 (Farm enterprise up to 250 hectares)	**10%**
Maintenance costs per hectare per annum	**Woodland: £200** **Peatland: £11** **Silvopasture: £72**
Woodland & Silvopasture maintenance cost reduce with economies of scale (from 100 to 500 hectares)	**5% reduction every 50 hectares – to a max of 45% at 500 hectares.**
Validation costs (assumed static up to 250 hectares)	**Woodland & Silvopasture: £1,250** (Year 0 only) **Peatland: £1,164** (Y0 & Y1 only)
Asset monitoring costs (Peatland only) per hectare per annum	**£14** (years 1-10 and years 20 & 30)
Verification fee	**£1,850** (every 5 years, starting year 5)
Registry fee	**£1,551** (Year 0) **and £200** (Years 5,15,25 & 30)
Brokerage costs (costs of selling tCO2e)	**5%** (of carbon credit income)

Appendix 1 – Key Model Assumptions

Silvopasture

The silvopasture approach used means that we take a smaller effective area compared to Woodland, to model the lower density of trees (as confirmed by Forestry Scotland). Because the model takes the tree spacing of 3m rather than 5m we have reduced the effective area by 60% in our analysis. It should be noted that in the spreadsheet (Woodland code calculator) the maximum separation is 2m for Scots Pine, in the mix used Scots Pine has 15% of the area, so the effective overall area is therefore 57%. We have used 60% as an approximation in our model. See table below for understanding.

Species	Silvopasture Spacing	Spacing Used in Model	% of land per Species	% of land Per Species	% of land as a total
Scots pine	5.0	2.0	15.00%	40%	6%
Birch (downy/silver)	5.0	3.0	20.00%	60%	12%
Rowan	5.0	3.0	20.00%	60%	12%
Hazel	5.0	3.0	5.00%	60%	3%
Alder	5.0	3.0	30.00%	60%	18%
White willow	5.0	3.0	10.00%	60%	6%
				Total	57%

Appendix 1 – Key Model Assumptions

Tree Thinning

We have made a number of assumptions in relation to tree thinning for profit in both the Woodland and Silvopasture methods, below we have outlined the assumptions and the results of whether thinning trees as opposed to not thinning trees is more or less profitable in each case. As you can see from the results in the table below – in each case the profit obtained from thinning trees outweighs the loss of carbon sequestered.

Key Source: Jim McAdam - Queens University Belfast - "How can Agroforestry make sheep farming more sustainable?“

Assumptions:

- Above citation shows £786/ha from thinning of trees after 13 years - taking this on an annualised basis we assume that after 5 years we can earn £302/ha (£786 / 13 years * 5 years), we have multiplied this figure (£302/ha) by 75% to account for assumed costs associated with thinning the trees and prudency. For Woodland we have grossed up this figure of £227/ha by the tree density (1111/400) to give us £629/ha profit in the woodland scenario.

- We have assumed that the trees can be thinned every 5 years for this income, though we note in line with the woodland code this has an impact on the amount of carbon sequestered, see below.

- We note that per the woodland code calculator, after thinning the amount of carbon sequestered is reduced by 30% over a 30 year period, though this only impacts materially in year 20 (affecting years 20,25,30) and we have modelled as such in scenario 1 & 2.

Woodland (50 Hectares)	Thinned	Not Thinned
Carbon Credit Income	£284,478	£383,252
Thinning Profit	£188,750	£Nil
Total	**£473,228**	**£383,252**

Silvopasture (50 Hectares)	Thinned	Not Thinned
Carbon Credit Income	£169,322	£228,583
Thinning Profit	£67,950	£Nil
Total	**£237,272**	**£228,583**

Woodland (500 Hectares)	Thinned	Not Thinned
Carbon Credit Income	£2,844,777	£3,832,516
Thinning Profit	£1,887,500	£Nil
Total	**£4,732,277**	**£3,832,516**

Silvopasture (500 Hectares)	Thinned	Not Thinned
Carbon Credit Income	£1,693,218	£2,285,832
Thinning Profit	£679,500	£Nil
Total	**£2,372,718**	**£2,285,832**

Appendix 1 – Key Model Assumptions

Scenario 3

- Key income and expenditure assumptions for scenario 3 are outlined in the tables below and the references are outlined in column B of the Income and Expenditure tabs of the model named: “Project Skye – Scenario 3” (and are therefore not repeated in this report).

Key Income Assumptions	
Spacing of trees: Woodland	**3m2** (1,111 per hectare)
Spacing of trees: Silvopasture	**5m2** (400 per hectare)
Split of Actively Eroding / Drainage per hectare: Peatland	**7.5% / 92.5%**
Market price per tonne of carbon dioxide equivalent (CO2e)	**$40**
Social value of Carbon Sequestration - Price per tonne of carbon dioxide equivalent (CO2e)	**$20** (over and above market price)
$USD to £GBP exchange rate	**1 / 0.82**
Total number of additional farm hectares per annum	**3,000**
% charge to farmer of carbon credit income	**30%**
% split of hectarage between carbon sequestration methods	**Woodland: 41%** **Peatland: 18%** **Silvopasture: 41%**

Key Expenditure Assumptions	
Cost of office fit out (including computers, desks, chairs)	**£10,000 (Year 0)** **£10,824 (Year 4)** New office for more staff £1,000 per annum upgrade costs from years 9-30
No. of company cars required per team (team of 3 or 5) and cost	**1 per team - £35,000** **Replace each company car after 10 years**
Operating costs per annum	**Insurance: £3,000** **Banking & Accountancy: £3,000** **Marketing: £2,000** **Legal: £2,000** **Office supplies: £1,000** **Lease costs: £3,000** (increases to £5,000 in Year 5)
Subsistence & Travel costs per annum	**£3,000 per employee** (assumes some staff will be fully office based such as administrators)
Recruitment costs	15% of salary of employee recruited
Full Team required on Day 1 (position & salary)	**Administrator: £26,000** **Manager/ Planner: £34,000** **Auditor: £34,000** **Liaison Officer: £45,000** **Team Director: £60,000**
Small Team (position & salary)	**Manager/ Planner: £34,000** **Auditor: £34,000** **Liaison Officer: £45,000**
New Full team hired every 4 years (until year 9 – total staff 21)	**Years 1 , 5 & 9**
New Small team hired every 4 years (until year 11 – total staff 24)	**Years 3, 7 & 11**
Salary and benefits assumptions as % of gross salary	**PAYE/NI: 40%** **Employers NI: 13.8%** **Employers Pension Contribution: 8%**

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