The Site

The Site is located in Melrose off the B6359 to Dingleton.

The site is included in outline Planning Permission for the erection of a dwellinghouse. Reference: 15/00036/PPP. Address: Land South West Of Linthill Cottages, Linthill, Melrose.

Subsequent to the outline permission, the client consulted the planning authorities who agreed the site boundary to be adjusted to allow the footprint to avoid roots of the mature trees.

The site is around 732 sqm and is accessed via a private track. The site will require connection to water supply from existing water main and will have a private waste water treatment tank to soak-away.

There is a Farm to the East, open countryside to the South and Linthill Cottages to the North.

The proposed access to the site is determined by the existing private track running parallel to the site boundary. Access to the field is to be built in accordance with SD08/002.

The Proposal

The proposal is for a low-energy 4-bedroom house for Mr & Mrs Kennedy.

The form of the house is long and thin, with a 45° roofpitch, to be in keeping with the rural location. Strong gables echo the typical vernacular of nearby buildings.

The house has been thoroughly designed. Every aspect of the building, from each stage of construction and build, through to the use and future potential has been carefully considered to make an efficient, warm, dry, light filled and beautifully practical building that will fit in to the environment, whilst minimising impact on the wider environment.

We have taken a fabric first approach, using a fully insulated SIP kit to provide a well insulated, air tight construction. (SIP - Structural Insulated Panel). Design is based on Passivhaus principles. Preliminary energy modelling indicates a heating requirement close to the Passivhaus standard, and certainly improves on the Low Energy standard.

The design makes use of natural resources: Orientation takes best advantage of solar gain. Passivhaus detailing eliminates cold-bridging, whilst also inhibiting condensation and mould growth. A draft lobby forms an air-lock to avoid losing heat when entering, further protected by an entrance canopy. High performance windows complete the insulation envelope. Fresh air is provided through a Mechanical Heat Recovery Ventilation Unit, retaining heat from the extracted stale air.

Open plan spaces and reduced internal partitions make best use of materials and also provide a spacious, light, living environment.

The construction dimensions take full advantage of standard sizes to reduce cutting and avoid waste. Storey-and-a-half construction provides maximum accommodation between minimum slab and roof areas.

Location on the Site

The house has been sited to be parallel with the edge set by the adjacent road. The orientation takes advantage of solar gain and views.

The entrance to the house is located to the rear elevation to provide shelter from the wind.

Finishes

To be in keeping the surrounding rural properties, the gables to this proposal are finished in white render. Larch cladding front and rear complete the facade finishes.

The windows are high performance triple glazed timber to keep out the cold and wind. There are no trickle vents to ensure there are no drafts.

The roof is to be metal standing seam, echoing the traditional metal roofing of nearby buildings.

Summary

We believe this proposal provides an appropriately sited, designed, detailed and finished dwelling that will be of its place and provide excellent, sustainable accommodation for Mr & Mrs Kennedy.

DESIGN STATEMENT

Project: Caber House, Proposed low energy dwelling & hobby farm incorporating Permaculture design linked to One Step Borders programme.
Client: Mr & Mrs Kennedy
Reference number: 1427
Date: 7 September 2018

The Site:

The Site is located off the B6359 to Dingleton from Melrose and is accessed via a private track.

The site is included in outline Planning Permission for the erection of a dwelling house.

Reference: 15/00036/PPP. Address: Land South West Of Linthill Cottages, Linthill, Melrose. Subsequent to the outline permission, the client consulted with the planning authorities who agreed the site boundary to be adjusted to allow the footprint to avoid roots of the mature trees.

The house plot is around 732 sqm with associated land of around 4.6 ha to be developed into a hobby farm. The site will require a connection to a water supply from existing water main and will have a private wastewater treatment tank to soak- away.

There is a Farm to the East, woodland to the west, open countryside to the South and Linthill Cottages to the North.
The proposed access to the site is determined by the existing private track running parallel to the site boundary. Access to the field is to be built in accordance with SD08/002.

The Proposal:

The proposal is for a low-energy 4-bedroom house for Mr & Mrs Kennedy.

The form of the house is long and thin, with a 45° roofpitch, and is in keeping with the rural context. Strong gables echo the typical vernacular of nearby buildings.

The house has been thoroughly designed. Every aspect of the building, from each stage of construction and build, through to the use and future potential has been carefully considered to make an efficient, warm, dry, light filled and beautifully practical building that will fit in to the environment, whilst minimizing the impact on the wider environment.

We have taken a fabric first approach, using a fully insulated SIP kit to provide a well insulated, air tight construction. (SIP - Structural Insulated Panel). The design is based on Passivhaus principles. Preliminary energy modelling indicates a heating requirement close to the Passivhaus standard, and certainly improves on the Low Energy standard.

The design makes use of natural resources: Orientation takes best advantage of solar gain. Passivhaus detailing eliminates cold-bridging, whilst also inhibiting condensation and mould growth. A draft lobby forms an air-lock to avoid losing heat when entering, further protected by an entrance canopy. High performance windows complete the insulation envelope. Fresh air is provided through a Mechanical Heat Recovery Ventilation Unit, retaining heat from the extracted stale air.

Open plan spaces and reduced internal partitions make best use of materials and also provide a spacious, light, living environment.

The construction dimensions take full advantage of standard sizes to reduce cutting and avoid waste. Storey-and-a-half construction provides maximum accommodation between minimum slab and roof areas.

The proposal, besides from the dwelling, extends to the management of a hobby farm, which will be informed by permaculture principles, for sustainable living. This will also be linked to the continued work our clients do with One Step Borders.

It is crucial to recognize the important work that will be made viable on site, linked to the hobby farms resources.

One Step Borders works with young people and families in the Scottish Borders to support young people who are experiencing emotional or mental health pressures and those who are caring for someone with such challenges along with many more issues. This social enterprise has been providing crucial care to those in need.

The hobby farm will link into this support by making an available space for struggling individuals to relax within nature and interact on a health basis with the animals and gardens on site.

Location on the Site:

The house has been sited on the site of the original gatehouse of Linthill estate. This historic reference grounds the proposal in the history of the site.

The siting is also parallel with the edge set by the adjacent road. The orientation takes advantage of solar gain and views.
The entrance to the house is located to the rear elevation to provide shelter from the prevailing wind.

Finishes:

To be in keeping the surrounding rural properties, the gables to this proposal are finished in white render. Natural larch cladding front and rear complete the facade finishes.

The windows are high performance triple glazed timber to keep out the cold and wind. There are no trickle vents to ensure there are no drafts.

The roof is to be metal standing seam, echoing the traditional metal roofing of nearby buildings.

Summary:

This proposal for a house and hobby farm has great potential to create a special area of well-managed land serving as an exemplar for how sustainable living can be implemented and well engrained into its location and community. Every aspect of this plot feeds and supports another, all linking back to how the inhabitants work with the land. The work our client's do with social outreach will provide allow a space for this to develop within the plot aiding the further community.

We believe this proposal provides an appropriately sited, designed, detailed and finished dwelling that will be of its place and provide excellent, sustainable accommodation for Mr & Mrs Kennedy.

Briefing Document

Project: Hobby Farm incorporating Permaculture design linked to One Step Borders programme.
Client: Mr & Mrs Kennedy
Reference number: 1427
Date: 7 September 2018

Note: Permaculture is an on-going learning and adaptation to the natural world. Certain strategies implemented may require observation, review and continued development

1 Table of Contents

2 Project Overview

This proposal is for a new low energy dwelling located near Melrose as part of a sustainable living proposal linked to the upkeep of a hobby Farm. The strategy to achieve this is by the design & construction of a low energy modern dwelling, located within a land management area, using permaculture techniques and principles.
The dwelling has been designed to fit within the rural setting. This hides the extensive energy modeling and site-specific optimization that has been carried out. We also hope to get as close to zero carbon as possible setting this as an example of the high standard homes.

The site is on the site of the original gatehouse of Linthill estate close to the river Ale. Access to the site is via an existing track leading to the estate house and buildings.
The plot is well defined by woodland on the North-East and North-West sides and by the main road on the South-West and access track along the South-East.

The proposal, besides from the dwelling, extends to the proposed management of a hobby farm and improvement following the principles of permaculture, for sustainable living.

House Design:
The house has been designed as a future proof design with all the ground floor accommodation suitable for alteration into a fully accessible living accommodation space.

The building uses sympathetic design and materials and it will be super- insulated, including high performance, triple glazed doors and windows.
An extremely high level of air tightness is aimed for. A heat recovery ventilation system will be installed. The house will have coppicing rights to the adjacent woodland, which will provide heating and potentially, additional energy for the proposal.

Heat Load = 4.5kW:
Preliminary energy modeling indicates that the design could have a heat load of just 4.5kW. This ensures the coppice will be able to meet the requirements for heating demand.

Zero Carbon:
Further to this the house will aim to be as close to zero carbon as possible. All of the heating will be produced on site via resources such as the coppiced woodland and solar panels. Energy production is to be further investigated for on site capabilities.

Working the Land:
The proposed hobby farm will provide for the occupants large amounts of fruit, vegetables and other animal products dependent of availability. Chickens will be part of the management plan, as they will provide eggs, meat and ground maintenance with the use of a chicken tractor. Ponies will also be kept on site and will continue to be used for social enterprise aiding the welfare of children and those struggling with mental health and wellbeing difficulties.

Materials:
In keeping with the sustainable living, a simple palette of materials is proposed. Walls will be finished in render to the gables, with timber cladding to the North & South elevations. The roof proposal is for profile metal sheet to be in keeping with the rural context. This material has a high-recycled content and is fully recyclable at the end of its life. Windows require to be high performance triple glazed for energy efficiency and internal comfort.



(Images are indicative of material palate.)

3 Permaculture Principles

"Permaculture is about creating sustainable human habitats by following natural patterns." It derives its name from "PERMAnent agriCULTURE"

In this case we are designing a full plot, which can continuously, all year round provide for the inhabitants, reducing the reliance on external factors. The majority of the inhabitant's requirements for food shall be provided for. The surplus product can be used to support other avenues within the plot such as rare breed animals, chickens and sale of produce to local outlets. There are potential local outlets such as:

Melrose(6.8m) - The Fruit Shop, Country Kitchen Deli, various supermarkents and café's.

Selkirk (6.4m) - Down to Earth Foods LTD, various supermarkents and café's.

Lilliesleaf (0.8m) and Midlem (1.7m) - hold potential for the creation of local outlets / markets.

One way of seeing permaculture is as a DESIGN SYSTEM, of looking at how elements are placed in relation to each other in order to maximize their efficiency in creating a self-sustaining, low input/high output, non exploiting whole.

This is not only beneficial for inhabitants but ensures a balanced ecosystem where every animal, insect and plant can benefit from each other within a loop cycle.
This will also involve fully understanding the disadvantages and benefits of each aspect of the garden and finding systems to work in place of energy intensive continual maintenance.

4 Local Trade and Support

Supporting the local community and industry wherever possible is important for the integration of the design.

The decision to use Structural Insulated Panels (SIPs) construction was thoroughly thought through. Using local knowledge and skill is an important consideration within permaculture principles and linking this to all aspects of this project is desirable.

Looking at the construction industry and local trades within the area, JML Contracts based in Auchterarder, Perthshire offer the perfect mix of locality, energy efficient construction and sustainable materials. SIPs are manufactured and processed under factory controlled conditions and can be fabricated to minimize waste for even complex designs.

The polyurethane (PUR) core of insulation in Structural Insulated Panels is CFC/HCFC-free with zero Ozone Depletion Potential and has a low Global Warming Potential (GWP). The outer skins of SIPs panels are manufactured from Orientated Strand Board (OSB). This is made from young fast growing trees, which are deliberately grown in plantations accredited by the Forest Stewardship Council (FSC). Young trees produce oxygen and remove more carbon dioxide from our atmosphere than mature trees and are renewable, recyclable, biodegradable and non-toxic. Unparalleled thermal efficiency combined with high build-speed and low site wastage makes SIPs a very cost effective, and sustainable way of achieving up to passive house standards.

5 Zone and design Strategy

The plot has been divided into zones for organizing the use and requirements of each. Zones closer to the house will be those which require frequent upkeep and observation while those further will be less intensive and frequented less.

Zone 0: The house itself and immediate exterior. The principles that can be observed here have more to do with conservation of heating, energy and water. As we have proposed a highly insulated and airtight design with an estimated heat load of just 4.5kW, it can be seen that a lot can be designed into the fabric itself. The decision to look into the use of a wood gasifier to supply energy and hot water for the property means that the coppiced woodland can support the house and its inhabitant's energy needs. However if this is not opted for the dwelling will still be supported with solar panels on the south roof elevation, reducing the reliance of power from the grid connection, along with all of the space heating supplied by the coppiced woodland via a wood burning stove, further creating a fully sustaining plot, linked to the surrounding land.

Grey water harvesting will feed into a filtration system along with, rain water collection from the roof will be used for plant watering, there will be little input needed from the mains connection for garden maintenance.

Zone1: This zone surrounds the house and will predominantly be planted with herbs and other short growing plants and flowers. Crops such as strawberry or raspberry's can be grown within this area. If a greenhouse is desired it is best suited to being close to the house for maintenance, attention to the surrounding context is important for the placement of a greenhouse as it will require good sunlight.

Zone2: Perennial plants will typically be planted here and if interested would be an ideal spot for placing bee hives, a Polly-tunnel and large compost bins as it is within a central spot with good access to both zone 1, 2 and 3. Current bushes and orchard trees are ideal to be planted here. These will be planted with companion plants, which will help the soil to be maintained yearly and reduce the potential of soil degradation. It is a good idea to include the seven layers of planting:

Canopy: large fruit & nut trees

Low tree layer: dwarf fruit trees

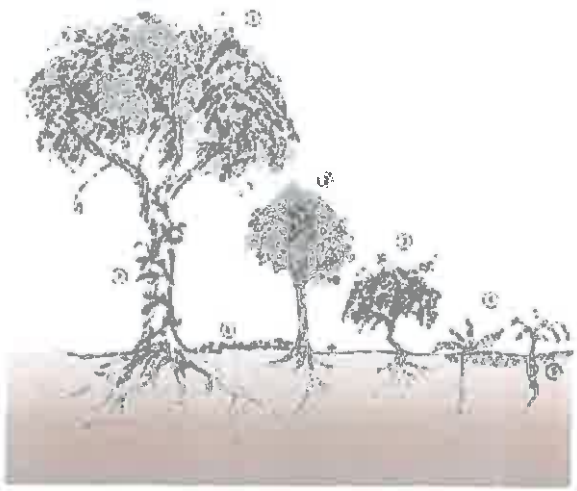
Shrub layer: currents & berry bushes

Herbaceous: comfrey, beets, herbs

Rhizosphere: root vegetables

Ground cover: strawberry's etc

Vertical layer: climbers & vines



(Modified from: Quercusrobur at the English language Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=5965343)

Crop beds will also be placed here for longer growing fruit and vegetables. A 3-year crop cycle will be implemented for this area, which will be based on a three-plot rotation. It is suggested to split the site into 8 plots keeping two asides for specialist planting and have two groups of three. The first year Plot 1- Brassicas, Plot 2- Legumes and salad crops and Plot 3- Root vegetables. Mulching will be the main care and maintenance proposed.

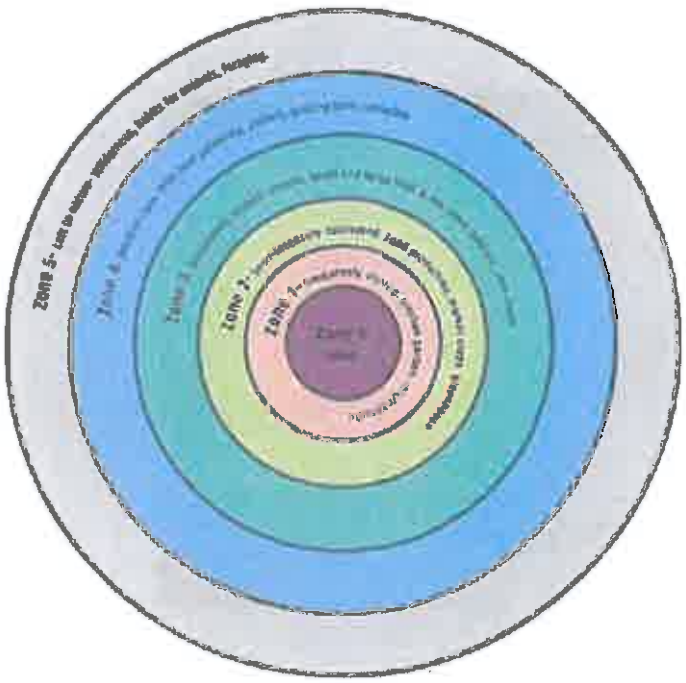
Zone3: Main crops will be planted here. As the area provided will be more than enough to produce crops for the inhabitants. The surplus can be used for trade purposes. This area will be diverse with a variety of grains, fruit or vegetables again planted with companion plants to aid the maintenance of soil year on year.

Zone4: This area is to be very low maintenance. It includes a large grazing area for ponies, which are to be used in conjunction with a social enterprise for the care and welfare of those struggling with wellbeing and mental health difficulties. These animals have already worked with One Step Borders within this capacity, and this proposal will allow the continued and potential expansion of this resource for the wider community.

The Kennedy's are currently involved with One Step Borders. One Step Borders seek to work with young people and families in the Scottish Borders to support young people who are experiencing emotional or mental health pressures and those who are caring for someone with such challenges along with many more issues. This social enterprise has been providing crucial care to those in need.

A section of the woodland will be used for sustainable coppicing to provide the house with all of the energy and heat requirement's, further ingraining the connection with house and place, along with offering management of the woodland.
It is worth noting that this woodland is close to reaching maturity and is ready for coppicing from this area will provide ample resources.

Zone5: This area is not to have any human intervention. It is to be left to nature and enjoyed and appreciated for such. Natural ecosystems will be set up and it will encourage animals to inhabit the area and nurture connections between nature the garden and house. Mushrooms may be able to grow within this area, which can be foraged for.
This area has been set up to surround the site ensuring that the well-defined edge is maintained even after coppicing and more importantly that existing wildlife have a safe area to flourish.



(Architeco, 2017)

Sectors: Considering the energy's (wind, water, sun, shade, etc.) that flow through the site can drastically affect the way we use the land. Wind barriers are naturally sited around the site and no hard walls have been used to separate areas as these could lead to frost pockets forming. The house benefits from the southeast orientation for solar heat gain. The access track provides ease of access and movement of supplies for the animals. This is also directly next to the

grazing area and unmanaged area. Monitoring the site over the first year will give a good basis for how to carry forward any design revisions, which have been noted due to specific monthly energy factors.

6 Drainage Design

The standard drainage test is to dig a square hole one spade deep, fill it with water and note the time to drain away. In a dry period this should not be longer than 1 hour. There is a problem if it takes any longer. Fill the hole a second time to get a more accurate account of soil drainage. On a site basis, a drainage system of pipes below the growing strata can be inserted on an oblique grid or herringbone grid draining to the lowest point. For clay soils the herringbone grid should have a maximum spacing of 4m with up to 8m spacing for other soils. Be careful that any water problems are not transferred to the neighbouring land. It may be advisable to consult SEPA* about the final run-off/outflow. (Minister's Forward 2013)

A soil investigation should still be carried out to fully assess soil condition and inform the best drainage practice.

7 Access

The site paths are 1m wide with a material that will allow the use of wheelbarrows and such allowing access to all areas of the site. The paths should be arranged to for minimum interference with the site. These paths will have auxiliary routes to allow access into specific growing areas throughout the site, these paths will be less defined and more on a desire line basis.

It may be desirable to have some paths covered with arched trellis, which vine plants can grow. This allows an otherwise unplanted area to support growth, while also adding a shaded and dry area within the garden.

There is a vehicle road right up to the house and one that follows the site's long edge. This route allows for easy harvest and transport of produce from the main growing area.

8 Planting Strategy

Within each zone different planting techniques can be implemented. Intermittent planting can save whole areas of crop from being hit all at once by any specific disease or invasive bugs or insects.
Issues that do arise can be dealt with implementing a new system to maintain balance rather than more invasive pesticides and chemicals.

Herb spirals- allows for a variety of micro conditions suitable for a variety of species.

Raised beds with mulching and subsequent no-dig planting- can aid the growth and health of the plants and soil.

Keyhole beds- maximizes the edge condition to the planting area providing easy access to all plants while minimizing the compaction of the usable soil, creates a good habitat.

Agroforestry- where fruit trees are planted, companion agricultural and horticultural crops to create a divers mixture of planting that aid and maintain each other.

Swales- shallow ditches that collect water, usually dug out along a contour to sink water. Hydrates the soil and prevents water running downhill and eroding the landscape.

Berms- raised plots that prevent runoff. Designed along with swales the two can direct water to plant beds. This conserves water and prevents soil erosion.

Terraces- layered steps into the sloping hillside to prevent water running downhill, gives a flat area for easy access and planting.

Composting- Hot composting can be used. Typically this is done with three boxes one for new material, one with material composting and the last with usable compost. While the materials are composting it radiates heat this can be utilized for other uses such as heating spaces or aiding the growth of seedlings.

9 Year Round Food

As being completely self-sustaining is a desire, it is important to ensure the garden is providing crops all year round with surpluses that can be used as an income stream to pay for maintenance. Within the UK we have four seasons and as such requires careful consideration of when we plant what and how we can benefit from that yield for the short and long term.

Example plots:

"A single person could just about manage with half an acre of rich land"(A & G Bridgewater p11)

"Two people in this day and age would need more like two acres"(A & G Bridgewater p11)

"We could quite comfortably provide for ourselves and our family on 15 acres of reasonable ground. Some people manage very well with a lot less." Dot & Tim North wales, (Tott, 2015)

"Five acres of medium to good land in a temperate climate, and the knowledge, you could grow all the food necessary for a large family." (Seymour, 2009)

"Five acres of good well-drained land, you could support a family of, say six people and have occasional surpluses to sell" (Seymour, 2009)

From these examples is can be seen that the land available here will be far more than what is required to feed a family of three. This means that there should be a surplus that can be sold or putting back into the garden via livestock or composting.

This table is not exhaustive and only provides examples of potential plants and seeds that can be used each month, dependent on location, soil and climatic conditions.

Month	Sow	Plant	Available
Jan	Broad Beans	Bare rooted fruit trees, bushes, garlic.	Cabbage, savoy, broccoli, brussels sprouts, kale, leeks, salsify, spinach, lettuce, celeriac, (beets, carrots, onions, parsnips, potatoes, shallots, swedes, tomatoes, garlic, apples, pears)
Feb	Peppers, Cabbage, leeks, broad beans.	Bare rooted fruit trees, bushes, garlic.	Cabbage, savoy, broccoli, brussels sprouts, kale, leeks, salsify, spinach, lettuce, celeriac, rhubarb, (beets, carrots, onions, parsnips, potatoes, shallots, swedes, tomatoes, garlic, apples, quinoa)
Mar	Cabbage, tomatoes, leeks, carrots, lettuce, peppers, pears, onions, turnips, broad beans, spinach, celeriac, salads	Bare rooted fruit trees, bushes, onions & potatoes.	Broccoli, cabbage, kale, salsify, chickweed, (Beets, parsnips, garlic, potatoes, tomatoes, turnips, apples)

Apr	Carrots, brassicas, leeks, radishes, peas, beans, spinach beets lettuce, parsnips, swedes, squash, corvettes, salads.	Onions, potatoes, perennial herbs & vegetables.	Broccoli, cabbage, leeks, spring onions, spinach, rubarb, salsify, herbs, nettles, (beets, onions, tomatoes, garlic, quinoa, potatoes)
May	Beets, brassicas, lettuce, runner beans, salads, sweetcorn, spinach, squash, turnips, quinoa.	Squashes, sweetcorn, perennial herbs & vegetables.	Broccoli, cabbage, lettuce, spinach, nettles, spring onions, (onions, garlic, potatoes, tomatoes)
Jun	Beets, brassicas, salads, spinach, peas turnips	Leeks, tomatoes, sweetcorn, runner beans, squash, peppers, perennial herbs & vegetables.	Broad beans, carrots, cauliflower, cabbage lettuce, onions, potatoes, peas, radish, spinach, turnips, gooseberries, rhubarb, strawberries, nettles, herbs, edible flowers, (quinoa, tomatoes)
Jul	Beets, brassicas, carrots, Swedes, spinach, lettuce	Runner beans, sweetcorn, squashes, leeks, perennial herbs & vegetables.	Beans, beets, carrots, lettuce, cabbages, lettuce, peas, onions, potatoes, spinach, garlic, radishes, gooseberries, cherries, plums, blackcurrants, herbs, (tomatoes)
Aug	Brassicas, spring onions, spinach.	Cabbages, perennial herbs & vegetables.	Beans, beets, carrots, lettuce, cabbages, lettuce, peas, onions, potatoes, spinach, garlic, radishes, squashes marrows, gooseberries, raspberries, blackcurrants, vegetables & herbs, (quinoa, tomatoes)
Sep	Brassicas, beets, lettuce, salads.	Cabbages, perennial herbs & vegetables.	Beans, cabbage, beets, carrots, cauliflower, lettuce, squashes, marrows, onions, potatoes, peppers, peas, spinach, tomatoes, plums, apples, blackberries, peaches, vegetables and herbs, quinoa, (garlic)
Oct	Broad beans, salads.	Bare rooted fruit trees, bushes, garlic, onions.	Runner beans, cabbage, leeks, beets, lettuce, squashes, onions, potatoes, spinach, tomatoes, pears, apples,

			blackberries, (quinoa)
Nov	Broad beans.	Bare rooted fruit trees, bushes, garlic.	Beets, broccoli, cabbage, carrots, leeks, onions, potatoes, parsnips, spinach, apples, pears, (quinoa, garlic, tomatoes)
Dec	Broad beans	Bare rooted fruit trees, bushes	Broccoli, cabbage, carrots, celeriac, leeks, kale, onions, potatoes, parsnips, salsify, swede, turnip, parsnip, (beets, garlic tomatoes)

(Burnett, 2016)

Companion Planting Chart

The following is a guideline for companion planting vegetables. Keep in mind that companion planting is not the same for everyone, everywhere; it will require experimentation to find what works best in your area.

Vegetable	Companion	Antagonist	Insight
Asparagus	Basil, Coriander, Dill, Parsley, Carrots, Tomatoes, Marigolds	Garlic, Potatoes, Onions	Marigolds, Parsley, Tomato protect from asparagus beetles
Beans	Beets, Brassicas, Carrot, Cabbage, Cauliflower, Cucumber, Celery, Chards, Corn, Eggplant, Peas, Potatoes	Alliums (chives, garlic, leeks, onions), Peppers, Tomatoes For Broad Beans: Fennel	Corn is a natural trellis, and provides shelter for beans Beans provide nitrogen to soil.
Beets	Brassicas (ie. broccoli, Brussels sprouts, cabbage cauliflower, collard greens, kohlrabi,turnip), Kholrabi. Garlic Lettuce, Onion, Sage	Pole and Runner Beans	The beans and beets compete for growth. Composted beet leaves add magnesium to soil when mixed.
Broccoli	Basil, Bush Beans, Chamomile, Cucumber, Dill, Garlic, Lettuce, Marigold, Mint, Onion, Potato, Radish, Rosemary, Sage, Thyme, Tomato	Grapes, Mustard, Oregano, Strawberry, Tomato	Rosemary repels cabbage fly. Dill attracts wasps for pest control.
Brussels Sprouts	Dill, Potato, Thyme	Strawberry, Tomato	...
Cabbage	Beets, Bush Beans, Celery, Chamomile, Dill, Mint, Onion, Potato, Oregano, Rosemary, Sage	Beans (Pole and Runner), Mustards, Peppers, Strawberry, Tomato	Celery, onion and herbs keep pests away Rosemary repels cabbage fly.
Carrots	Beans (Bush and Pole), Garlic, Lettuce, Onion, Parsley, Peas, Rosemary, Tomato	Dill, Parsnip	Beans provide nitrogen in soil, which carrots need. Onion, parsley and rosemary repel the carrot fly
Cauliflower	Beans, Celery, Oregano Peas, Tomato	Strawberries	Beans provide the soil with nitrogen, which cauliflower needs

Celery	Bush Beans, Cabbage, Dill, Leeks, Marjoram, Tomatoes	Parsnip, Potato	--
Chives	Basil, Carrots, Marigold, Parsley, Parsnip, Strawberries, Tomato	Beans	--
Corn	Beans, Cucumbers, Marjoram, Parsnip, Peas, Potatoes, Pumpkin, Squash, Zucchini	Tomato	Tomato worm and corn earworm like both plants. Beans and peas supply nitrogen.
Cucumber	Beans, Celery, Corn, Dill, Lettuce, Peas, Radish	Potato, Sage, strong aromative herbs, Tomato	Cucumbers grow poorly around potatoes and sage.
Dill	Cabbage, Corn, Cucumbers, Dill, Fennel, Lettuce, Onions	Cilantro, Tomato	Cross-pollinates with cilantro, ruining both. One only a few plants that grows well with Fennel.
Eggplant	Beans, Marjoram, Pepper, Potato	--	--
Kohlrabi	Beets, Lettuce, Onions	Strawberries, Pole Beans, Tomato	Lettuce repels earth flies.
Leek	Carrots, Celery, Lettuce, Onions	Beans, Peas	Companion attributes are the same as garlic, onion, chives(alliums).
Lettuce	Beans, Beets, Carrots, Corn, Marigold, Onions, Peas, Radish, Strawberries	Parsley	Mints repel slugs (which feed on lettuce).
Marigold	Brassicas (broccoli, etc), Cucurbits (cucumber, etc), Peppers, Tomato, and most other plants	--	It is said that you can plant Marigolds throughout the garden, as they repel insects and root-attacking nematodes (worm-like organisms).
Onions	Beets, Cabbage, Carrots, Lettuce, Marjoram, Rosemary, Savory, Strawberry, Tomato	Beans, Peas	Repels aphids, the carrot fly, and other pests.
Parsley	Asparagus, Beans, Radish, Rosemary, Tomato	Lettuce	Draws insects away from tomatoes
Peas	Beans, Cabbage, Carrots, Celery, Corn, Cucumber, Lettuce, Marjoram, Parsnip, Potato, Sage	Alliums (Chives, Garlic, Onion, Shallots)	--
Potato	Beans, Cabbage, Corn, Eggplant, Horseradish, Marjoram, Parsnip	Celery, Cucumber, Pumpkin, Rosemary, Strawberries, Tomato	Cucumber, tomato and raspberry attract harmful pests to potatoes. Horseradish increases disease resistance.
Pumpkin	Beans, Corn, Radish	Potato	--
Radish	Cabbage, Corn, Cucumber, Eggplant, Lettuce, Marjoram, Parsnip	--	Radish is often used as a trap crop against some beetles (flea & cucumber).
Sage	Beans, Cabbage, Carrots, Peas, Rosemary, Strawberries		Repels cabbage fly, some bean parasites.
Spinach	Beans, Lettuce, Peas, Strawberries	--	Natural shade is provided by beans and peas, for

			spinach
Squash	Fruit trees, strawberries	--	Similar companion traits to pumpkin
Strawberries	Borage, Bush Beans, Caraway	Broccoli, Cabbages	The herb, Borage, is likely the strongest companion
Tomatoes	Alliums, Asparagus, Basil, Borage, Broccoli, Carrots, Cauliflower, Celery, Marigold, Peppers	Brassicas, Beets, Corn, Dill, Fennel, Peas, Potatoes, Rosemary	Growing basil about 10 inches from tomatoes increases the yield of the tomato plants.
Turnip	Peas		

(VegetableGardeningLife, 2015)

10 Crop Requirements

Human Energy Requirements and growing capacity from the garden.
The number of calories a person needs per day is specific to the individual. Height, weight, gender, age and activity level all affect your requirement. Three main factors are required to calculate how may calories your body needs per day.

1. Basal metabolic rate (BMR) this is the amount of energy your body requires to function at rest.

2. Physical activity that takes into account your daily activates, and inputs such as weight, height etc.

3. The thermic effect of food is also considered which is the energy required to breakdown the food you eat.

For the purpose of this exercise we will average the amount of calories required by the family of three to the basic NHS recommendation of 2500kcal for men and 2000kcal for women. (Choices, 2016)

Taking these figures for the year a single person would require:
Kcal total per year per person
Male (250 x 365 = 912,500 kcal)
Female (2000 x 365 = 730,000 Kcal)

On average 146kg of fruit and veg of food is required per year per person. (Hugo, 2017) Taking 2 kg of produce per square meter (How many m2 you need to cultivate in order to be self-sustainable? 2017) for one person would require an estimate of around 73m2 of garden space. This is based on a supplemented diet with nuts and meat, which should be considered.
This is all dependent on crop, yield and individual species etc.

The list below demonstrates one account of how many plants a family may require for a years worth of food. This is subjective as to what you may prefer to eat but can be used as a starting point for planting quantities.

Asparagus: about 10-15 plants per person
Beans (Bush): about 15 plants per person
Beans (Pole): 2-4 poles of beans per person
Beets: about 36 plants per person.
Broccoli: 3-5 plants per person
Cabbage: 2-3 plants per person
Carrots: about 100 seeds per person (1/4 oz would be plenty for a family of six)
Cauliflower: 2-3 plants per person
Collards: about 5 plants per person
Corn: start out with 1/2 lb. seeds for the family and adjust as needed

Cucumbers: 3-6 plants per family
Eggplant: 3-6 plants per family
Lettuce: 4-5 plants per person
Okra: 3-4 plants per person
Onions: 12-15 plants per person
Parsnips: 12-15 plants per person
Peas: about 120 plants per person
Peppers: 3-5 plants per person
Spinach: about 15 plants per person
Squash (including Zucchini): about 10 per family
Sweet Potatoes: about 75 plants per family
Tomatoes: about 20 plants per family
Turnips: about 1/4 lb seeds per family

The Table below gives an average of how many kg of produce can be obtained from a hectare of land. This is one account and in practice a variety of factors may affect the outputs however it can be used as a broad estimate of what to expect.

Wheat	8,000 kg/ha
Barley	7,000 kg/ha
Potatoes	45,000 kg/ha
Beet	70,000 kg/ha accounting for approximately 11,000kf of sugar
Onion	46,000 kg/ha
Winter Rape	5,000 kg/ha
Peas	4,000 kg/ha
Beans	3,000 kg/ha
Carrots	40,000 kg/ha
Tomatoes	5,000 kg/ha
Chicory	350,000 kg/ha
Leek	30,000 kg/ha
Brussels Sprouts	20,000 kg/ha
Broccoli	8,000 kg/ha
Courgette	3,000 kg/ha
Cabbage	30,000 kg/ha
Flax	6,600 kg/ha of straw and 900 kg grain/ha
Apples	40,000 kg/ha (13yrs, from 5th yr)
Pears	25,000 kg/ha (35yrs, from the 7th yr)

11 Livestock

Rare bread animals will be a beneficial addition to the plot. Looking at the input and outputs of keeping such animals helps to evaluate their success within a plot.

Inputs: Time/care, food, water, medicine/vaccines, space, other variants dependent on animal.

Outputs: Manure, plot maintenance/grassing, pest control, food, offspring, income, enjoyment, and other variants dependent on animal.

With livestock the possibility of hot composting is very viable. This can aid many other activities within the garden as the compost radiates heat. Seed maturing, heating other areas such as a shed or greenhouse is achievable.

Different animals will require different amounts of space. Within the plan we have set aside ---m2 roughly for grazing and housing of animals. It would be advantageous to defiantly keep some chickens (six hens is recommended to get started) and one cock if you would like to bead chicks.

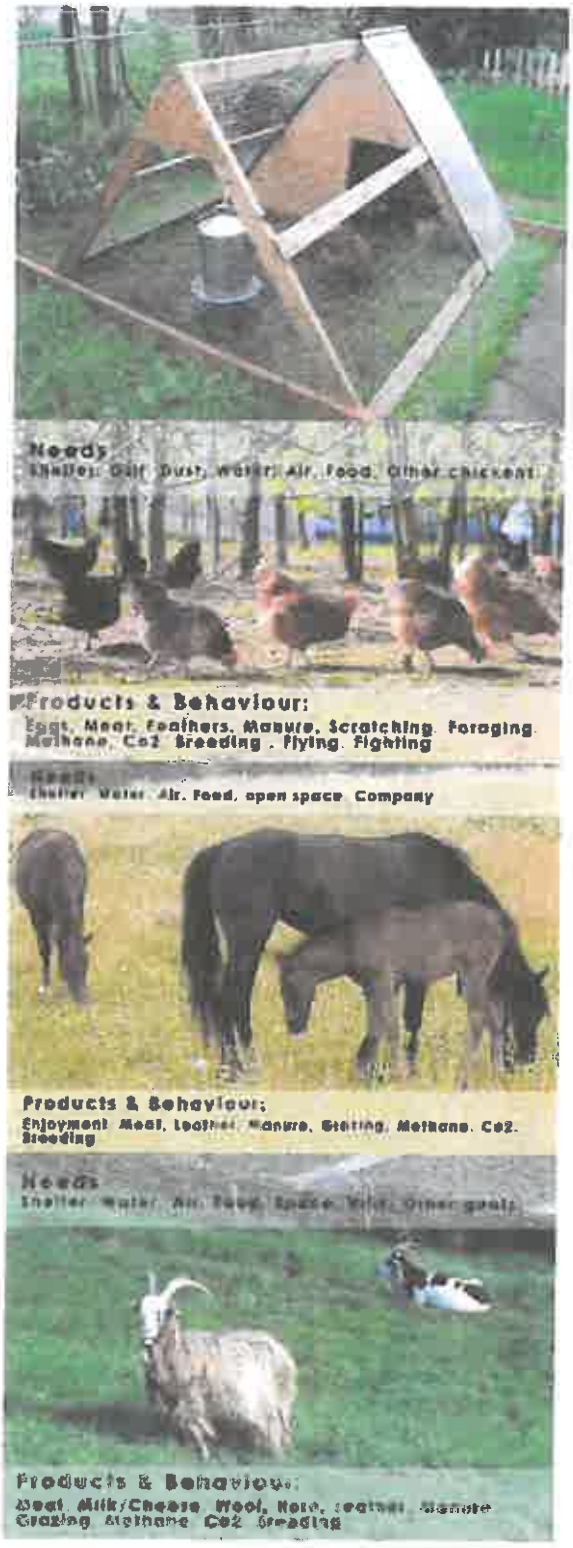
Chicken Space- 6m2 roughly

Ducks- 20m2 per bird: Will require a lake or pond.

Geese- 20m2 per bird

Birds will generally be let out over areas of the garden and moved frequently within a bounded area or in a chicken tractor.
Chicken tractors are popularly used as they keep the chickens caged and safe in a designated area while allowing them freedom to move from house to exterior space. Top right is an example of a simple small chicken tractor.

Costs associated with animals such as Horses and Ponies.
Feed cost (£260 - £520).
Hay/Straw £1040 - £1560
Other supplements can vary in price.
Vets fees £70
Insurance £240 - £480
Dentist £50 - £70
Worming £40 - £105
Extras £1000
Annual price basis (Ltd. A.t..)



Our Clients have three Ponies currently, which will be required to relocate to the site. The breeds of ponies are Welsh, Connemara and Palomino. These animals have extensive experience working with social care patients and have a proven record for aiding the wellbeing of patients who are given the benefit of their company. This is an essential part of our client's business and will seamlessly integrate into the hobby farm.

Cows, pigs or goats are other viable animals for supporting the plot: for future development. Products from these animals will support the family and farm. There are possibilities of selling the products from the animals for added income.
Products like goats cheese could be sold to local product manufacturers setting up a micro business and promoting local produce etc.

12 Linked social care - One step Borders

It is crucial to recognize the important work that will be made viable on site, linked to the hobby farms resources.

One Step Borders works with young people and families in the Scottish Borders to support young people who are experiencing emotional or mental health pressures and those who are caring for someone with such challenges along with many more issues. This social enterprise has been providing crucial care to those in need.

The hobby farm will link into this support by making an available space for struggling individuals to relax within nature and interact on a health basis with the animals and gardens on site.

It has been specifically beneficial for children with additional support needs (ASN) who have been able to feel the benefit of compassion and care from and to these such animals. Teaching them core skills with coping and dealing with the stresses and difficulties of everyday life. Unfortunately this is a rare opportunity for children within Scotland to be able to interact with animals who encourage a caring nature such as ponies. We believe this service should be commended for the work being done and should set a precedent for further study and potential development.

13 Energy Usage and production

Energy Calculations Draft.

Energy Performance Evaluation

1271 Laver, Auchterarder

Preliminary

Key Values

General Project Data		
Project Name:	Laver Auchterarder	
City Location:	Auterarder	
Latitude:	56.29° N	
Longitude:	3.67° W	
Altitude:	131.00	m
Climate Data Source:	Strusoft server	
Evaluation Date:	9 Feb 2017 17:42.51	

Building Geometry Data		
Gross Floor Area:	261.8	m²
Treated Floor Area:	215.3	m²
External Envelope Area:	390.4	m²
Ventilated Volume:	538.79	m³
Glazing Ratio:	9	%

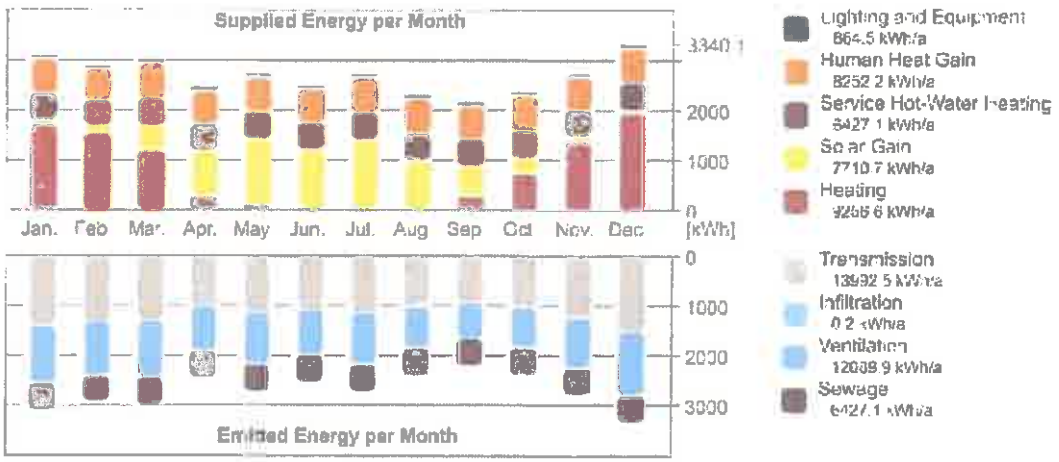
Building Shell Performance Data		
Infiltration at 50Pa	0.09	ACH

Heat Transfer Coefficients	U value	[W/m²K]
Building Shell Average	0.32	
Floors:	0.15 - 0.15	
External	0.13 - 1.71	
Underground	--	
Openings	0.70 - 1.33	

Specific Annual Values		
Net Heating Energy:	42.99	kWh/m²a
Net Cooling Energy	0.00	kWh/m²a
Total Net Energy:	42.99	kWh/m²a
Energy Consumption:	49.99	kWh/m²a
Fuel Consumption	49.56	kWh/m²a
Primary Energy:	66.36	kWh/m²a
Fuel Cost:	--	GBP/m²a
CO_2 Emission:	1.20	kg/m²a

Degree Days	
Heating (HDD)	4020.46
Cooling (CDD):	395.67

Project Energy Balance



Thermal Blocks

Thermal Block	Zones Assigned	Operation Profile	Gross Floor Area m²	Volume m³
001 GF Thermal Block	7	Residential	137.4	317.51
002 FF Thermal Block	5	Residential	109.7	186.87
003 GF Cold Thermal Block	3	Residential	12.4	33.48
004 FF Cold Thermal Block	1	Residential	2	1.12
Total:	16		261.8	538.79

Energy Performance Evaluation

1271 Laver, Auchterarder

Preliminary

001 GF Thermal Block - Key Values

Geometry Data		
Gross Floor Area	137.4	m²
Treated Floor Area:	115.5	m²
Building Shell Area	181.6	m²
Ventilated Volume:	317.51	m³
Glazing Ratio	14	%
Internal Temperature		
Min. (22:00 Feb. 26):	20.00	°C
Annual Mean	21.57	°C
Max. (18:00 Jul. 10).	32.33	°C
Unmet Load Hours		
Heating:	0	hrs/a
Cooling.	138	hrs/a

Heat Transfer Coefficients	U value	[W/m²K]
Floors:	0.15 - 0.15	
External	0.13 - 0.23	
Underground:	-	
Openings	0.88 - 1.33	
Annual Supplies		
Heating:	9256.56	kWh
Cooling	0.00	kWh
Peak Loads		
Heating (23:00 Dec. 21):	4.19	kW
Cooling (01:00 Jan. 01)	0.00	kW

002 FF Thermal Block - Key Values

Geometry Data		
Gross Floor Area	109.7	m²
Treated Floor Area.	88.7	m²
Building Shell Area:	181.0	m²
Ventilated Volume	186.67	m³
Glazing Ratio:	6	%
Internal Temperature		
Min. (24:00 Dec. 21):	11.82	°C
Annual Mean:	22.87	°C
Max. (19:00 Jul. 15):	46.59	°C
Unmet Load Hours		
Heating:	3503	hrs/a
Cooling:	1917	hrs/a

Heat Transfer Coefficients	U value	[W/m²K]
Floors:	-	
External:	0.13 - 1.71	
Underground:	-	
Openings:	1.10 - 1.33	
Annual Supplies		
Heating:	0.00	kWh
Cooling:	0.00	kWh
Peak Loads		
Heating (01:00 Jan. 01)	0.00	kW
Cooling (01:00 Jan. 01):	0.00	kW

004 FF Cold Thermal Block - Key Values

Geometry Data		
Gross Floor Area.	1.2	m²
Treated Floor Area	0.8	m²
Building Shell Area:	1.9	m²
Ventilated Volume	1.12	m³
Glazing Ratio:	0	%
Internal Temperature		
Min. (11:00 Dec. 22):	12.46	C
Annual Mean:	23.36	C
Max. (23:00 Jul. 09):	41.22	°C
Unmet Load Hours		
Heating	3438	hrs/a
Cooling	2218	hrs/a

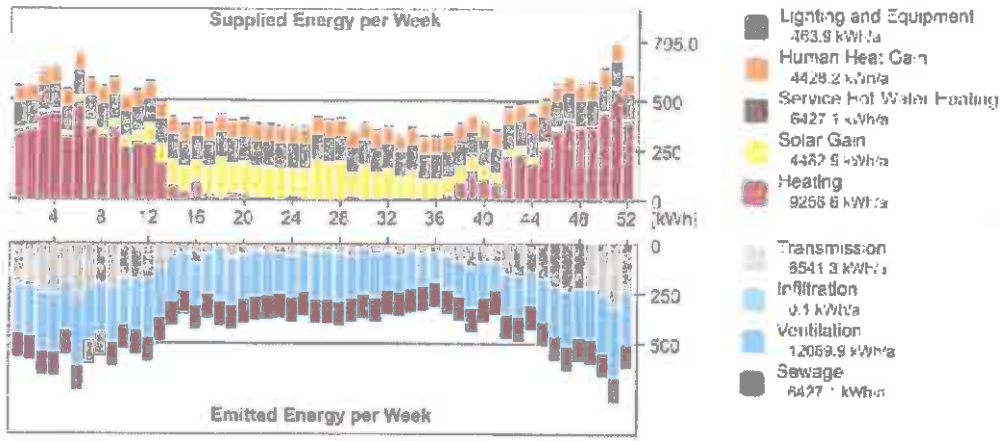
Heat Transfer Coefficients	U value	[W/m²K]
Floors:	-	
External:	0.13 - 0.14	
Underground:	-	
Openings:	-	
Annual Supplies		
Heating	0.00	kWh
Cooling.	0.00	kWh
Peak Loads		
Heating (01:00 Jan. 01):	0.00	kW
Cooling (01:00 Jan. 01)	0.00	kW

Energy Performance Evaluation

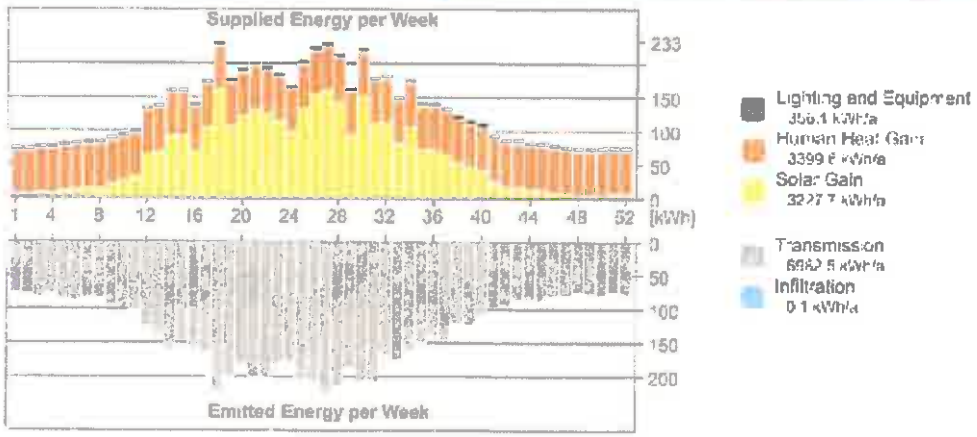
1271 Laver, Auchterarder

Preliminary

001 GF Thermal Block Energy Balance



002 FF Thermal Block Energy Balance



Energy Performance Evaluation

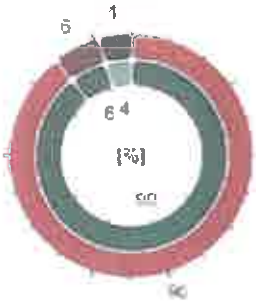
1271 Laver, Auchterarder

Preliminary

Energy Cost

Not Applicable

CO_2 Emission

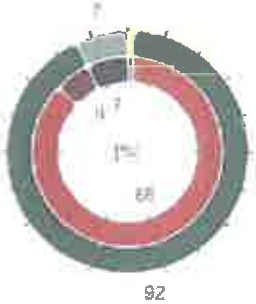


Energy Sources
Renewable
Solar (Thermal & PV)
Wood
Secondary
Electricity

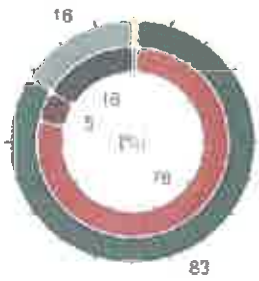
Energy Consumption by Sources

Source Type	Source Name	Energy Quantity kWh/a	Primary kWh/a	Cost GBP/a	CO_2 Emission kg/a
Renewable	Solar (Thermal & PV)	92	92	NA	0
	Wood	9899	11879	0	247
Secondary	Electricity	772	2317	–	11
	Total	10763	14288	Not Applicable	259

Energy Quantity



Primary Energy



Energy Performance Evaluation

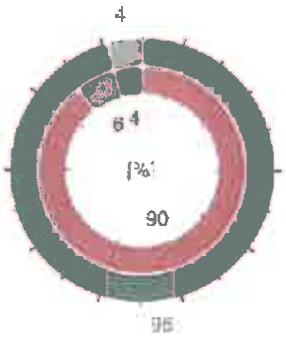
1271 Laver, Auchterarder

Preliminary

Energy Cost

Not Applicable

CO_2 Emission



Energy Targets

- Heating
- Service Hot-Water Heating
- Cooling
- Ventilation Fans
- Lighting
- Equipment

Environmental Impact

Source Type	Source Name	Primary Energy kWh/a	CO_2 emission kg/a
Renewable	Solar (Thermal & PV)	92	0
	Wood	11879	247
Secondary	Electricity	2317	11
	Total:	**14288**	**259**

Co2 emissions from Coppice- reabsorbed allowing zero carbon to be achieved.

Energy Performance Evaluation

1271 Laver. Auchterarder

Preliminary

Renewable Building System Summary

Building System	Annual Energy Generated kWh	Renewable Energy Cost GBP
Photovoltaic System	92	0.0
Biofuel-based Heating	9899	0.0
Total LEED Renewable Energy	9991	0
Total	**9991**	**0**

Thermal bridging:

The design has ensured that thermal bridging is kept to a minimum to ensure no energy is wasted from heat escaping and cold entering the house. Our calculations highlight risk areas, so that the design can resolve any possibility of unnecessary thermal bridges ensuring the building is as efficient as possible.

This also allows us to evaluate whether the wall build chosen is best suited to the chosen site and design. Doing this at an early stage helps us to make more informed decisions to ensure a building that is as sustainable and energy efficient as possible.

A wood gassifier is a gasification unit which converts timber or charcoal into wood gas, a syngas consisting of atmospheric nitrogen, carbon monoxide, hydrogen, traces of methane, and other gases, which - after cooling and filtering - can then be used to power an internal combustion engine or for other purposes.

Wood gasification is a very clean way to make biogas. The wood acts as a solar store as wood gas is a form of solar chemistry. It is the perfect complement to solar photovoltaic as you can tap into energy day or night and even during winter, leveling out the issues with peak time energy from solar.
The Gassifier can be used intermittently with the provision of solar panels to ease usage and materials for the gassifier.

Recommended batches run for 2-6 hours dependent on feedstock capacity for the wood. Use in the morning, solar during the day and a fill at night is easy and cost efficient.

Power output: 3-20 kilowatts / hr is a realistic output. Each kilowatt-hour requires about 2.5 pounds of dry wood (dependent on machine used).
A 10-kilowatt generator is usually preferred as it is a good blend of power and efficiency.

Below are some examples of gasification units available (others are available, as many gasification units are home made kits, this means they vary on specific technical details)

L.E.A.F GENERATOR

Here is a simple unit that is cost effective. It can be used to run a 7kW generator.

7kW
Down Draft Gasifier
Battery charging, household uses,
ances
wood blocks/chips
s, 2014)

ALL POWER LABS

Size: 20 kW
Type: Down Draft Gasifier
Uses: Heat and power, can be used to charge batteries, run a house or shop and heat your spaces
Fuel: wood blocks/chips
(Ewings, 2014)

VICTORY GASIFIER

This is the complete plug and play unit. It comes with the gasifier, engine and generator. It can create both heat and power.

Size: 5kW
Type: Down Draft Gasifier
Uses: Heat and power, can be used to charge batteries, run a house or shop and heat your spaces
Fuel: wood blocks/chips

(Ewings, 2014)

14 Silvaculture/Coppicing

The site benefits from a plantation on one edge which is now maturing to coppice age.

Coppicing is a traditional method of woodland management, which produces a highly efficient fast growing, sustainable timber source, without the need to replant. Implementing this can increase biodiversity as well as keeping a traditional craft alive.
Coppicing takes advantage of the fact that many trees make new growth from the stump or roots, if cut down. In a coppiced wood, young tree stems are repeatedly cut down to near ground level. In subsequent growth years, many new shoots will emerge, and, after a number of years the coppiced tree, or *stool*, is ready to be harvested, and the cycle begins again.
Typically coppiced woodland is harvested in sections on a rotation. This ensures there is a crop available each year somewhere in the woodland. Coppicing has the effect of providing a rich variety of habitats, as the woodland always has a range of different-aged coppice growing within it, beneficial for biodiversity. The cycle length depends upon the species cut, the local custom, and the use to which the product is put. (Lawton, 2012)
Alder, Birch coppices poorly, beech coppices better in wetter west.
Most frequently coppiced species are oak, hazel, ash, willow, field maple and sweet chestnut. (Giraffe, 2011)

Cutting rotations take place every 5-25 years, primarily dependent on species of tree and intent.

Some animals can eat the newly growing tree stems before they have matured. This can either be protected or cut higher than the animal can reach to protect the growth.

Alder: Opinion varies, works best well seasoned.

Apple: Splendid/ It burns slowly and steadily when dry, with little flame, but good heat. Good scent. Must season well

Ash: Best burning wood; has both flame and heat, and will burn when green, as it has low moisture content. Will burn even better dry.

Beech: Best when well seasoned

Birch: The heat is good but it burns quickly with a bright flame. Nice smell, works well when mixed with other woods that burn more slowly.

Cedar: Good when dry. It gives little flame but much heat, and the scent is beautiful.

Cherry: Burns slowly, with good heat. Wood with the advantage of scent and does not spit.

Chestnut: Mediocre. Apt to shoot embers. Small flame and heating power.??

Cypress: Burns well but fast when seasoned, and may spit

Douglas Fir: Poor. Little flame or heat.

Elder: Mediocre. Very smoky. Quick burner, with not much heat.

Elm: To burn well it needs to be kept for two years. Even then it will smoke. Very high water content – more water than wood.

Hawthorne: burns well

Hazel: Good, burns fast without spitting. but has other uses, so you might not want to burn it

Holly: Good, will burn when green, but best when kept a season.

Hornbeam: Good, burns well

Horse Chestnut: Good flame and heating power but spits a lot.

Laburnum: Totally poisonous tree, acrid smoke, taints food and best never used.

Larch: Crackles and spits, scented, and fairly good for heat. Oily soot in chimneys

Laurel: Has brilliant flame.

Lime: Poor. Burns with dull flame.

Maple: Good.

Oak: Dry oak is excellent for heat, burning slowly and steadily with a good heat. Seasoned for 2 - 3 years is best.

Pear: Slow and steady, good heat and a good scent.
Pine: Burns with a splendid flame, but apt to spit. Needs to be well seasoned. Gives off a large number of resins.
Plane: Burns pleasantly, but is apt to throw sparks if very dry.
Plum: Good heat and scent.
Poplar: Burns slowly with little heat – better for making matchsticks
Rhododendron: The thick old stems, being very tough, burn well.
Robinia (Acacia): Burns slowly, with good heat, but with acrid smoke.
Rowan: Burns well
Spruce: Burns too quickly and with too many sparks.
Sweet chestnut: burns well when seasoned but sends out sparks. Only for use in a stove with door closed!
Sycamore: Burns with a good flame, with moderate heat. Useless green.
Walnut: Good, and so is the scent. Aromatic wood.
Willow: Poor. It must be dry to use, and then it burns slowly, with little flame. Apt to spark.
Yew: Last but among the best. Burns slowly, with fierce heat, and the scent is pleasant.
(Davis, 2012)

Density (kg/m3)	Softwood Species	Hardwood Species
>800		Hawthorn,
710-800		Ash, Beach, Apple, Pear
610-700	Yew,	Birch, Cherry, Oak, Walnut, Sycamore,
510-600	Cedar, Douglas fir, Larch, Pine,	Chestnut, Elm,
410-500	Hemlock, Spruce,	
<400	Willow, Alder	

Woods Calorific Value (CV)

There are three factors which affect woods CV or the amount of available heat per unit of fuel:

1. Species Choice
2. Wood Density
3. Moisture Content

General differences in species are that hard woods are denser and soft woods tend to contain more resin. When compared at the same moisture content CV species shows little variation. The main differences between species are moisture content when the timber is green, at the time of felling, and the rate at which this moisture is lost during seasoning.

For the above table it can be seen that the wood density of Hawthorn is twice as much as willow.

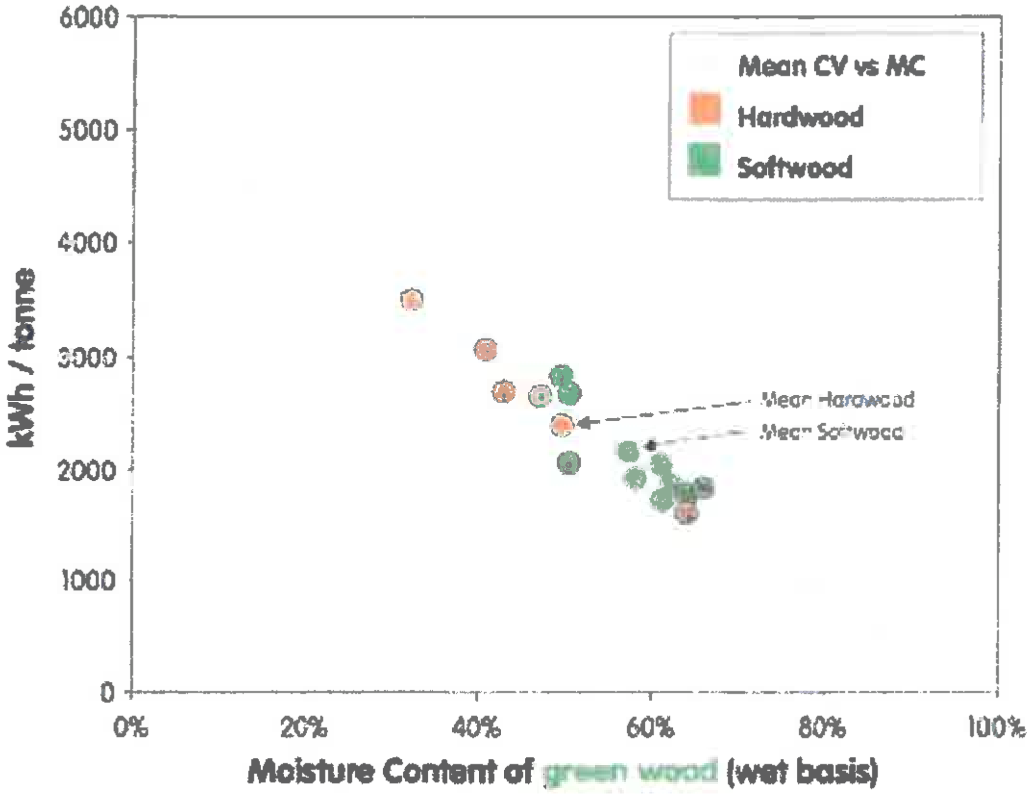
"As hardwood species are generally denser than softwood species, a tonne of hardwood logs will occupy a smaller space than a tonne of softwood logs. Dense woods will burn for longer than a less dense woods, this means you will need fewer top ups to keep a log stove burning. If you measure wood by volume you will generally receive more kilowatt hours (kWh) of heat from a cubic metre (m3) of hardwood than softwood. However, softwoods are often cheaper and easier to source." (HM Government, 2010)

Wood Moisture Content is the weight of water in a piece of wood, expressed as a percentage oven the dry weight of wood. Fresh cut trees can have wood moisture contents over 200%, while completely dried wood will have wood moisture contents of 0%.

$$\frac{\text{Weight of water in a given sample}}{\text{Total weight of the sample}} \times 100 = \text{MC\%(wet basis)}$$

For example if a freshly sawn timber weighted 50lbs and once dried weighted 20lbs you would divide 30lbs (weight of water) by 20lbs (dry wood weight) X100 = 150% MC

As Calorific value relates to specific batches and drying conditions among others, it can be difficult to compare x to x however the table bellow gives a general concept of how each species can perform.



Graph Reference No	Species	Green MC (wet basis)	kWh per Green tonne
1	Ash	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	Birch	[illegible]	[illegible]
4	Oak	[illegible]	2635
5	[illegible]	50%	2722
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	Elm	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	Poplar	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]

(HM Government, 2010)
In general there are some species that have been proven through experience to work better for burning within wood gasification than others.
Most frequently coppiced species are: oak, hazel, ash, willow, field maple and sweet chestnut. (Giraffe, 2011)

"Yields of 20 tonnes of firewood per hectare per year are feasible." (andrews, graham)

The area of woodland coppicing is 3,236m2. By using a woodland coppicing rotation it can be expected to achieve around 6.5 tonnes per year from the designated woodland area. This includes time for cut specimen to grow and mature ensuring the woodland is maintained appropriately.

15 Water management and harvesting

Water management will be an important factor for the permaculture garden. Attention to the details of this setup will be vital as maintaining the right balance for crop diversity is important. A drip system with a manual close will be perfect as it offers a slow steady exposure of water which is easily turned on and off.

Grey water reclamation from the home will be implemented to feed into any water strategy. Reducing the waste of water from the home while also adding to the irrigation system to be set up for the crops within the garden.

16 Conclusion & Summary

This proposal for a hobby farm and house has great potential to create a special area of well-managed land. An example of how sustainable living can be implemented and well engrained into its location and community. Every aspect of this plot feeds and supports another, all linking back to how the inhabitants work with the land.

- **Design Aesthetic** – A mainstream zero carbon house. Although it may look normal extensive energy modeling and site-specific optimization has gone into ensuring the design achieves zero carbon.

- **Design Detail** – The building uses sympathetic design and materials and will be super- insulated, including high performance, triple glazed doors and windows. Thermal bridging is kept to a minimum dramatically reducing the waste in heat escaping and cold entering the house. An extremely high level of air tightness is aimed for and a heat recovery ventilation system will be installed. Every aspect of the house is designed to be as sustainable and energy efficient as possible.

- **Local Trades** – the project is designed to benefit from the knowledge of local trades and support the businesses within the area. Exemplifying the possibilities of good design and local trades within the area of the Scottish Boarders.

- **On site produce** – All the required food for the family can be cultivated from the designated land with ample produce to spare for resale to outlets such as farmers markets. This also provides an additional income for the family.

- **Energy generation** – The coppiced woodland supplemented with solar panels will provide all of the required energy and heating for the house year round. This allows zero carbon to be achieved.

- **Waste Management** – Gray water will be collected and fed into a filtration system and linked to ponds and irrigation for the planting area. Food, animal and garden waste will be composted creating a waste cycle to minimizing the output from the household.

- **Permaculture principles** - will allow the land to be nourished, maintained and build a natural ecosystem for the area.

- Social Outreach work – further benefiting those in greatest need in the local community.

17 Bibliography

Book resources:

Bell, G., Clarke, J., Bellamy, D. and Mollison, B. (1992) The Permaculture way: Practical ways to create a self-sustaining world. London: Thorsons Pub.

Bridgewater, A. and Bridgewater, G. (2007) The self-sufficiency handbook. United Kingdom: New Holland Publishers.

Burnett, G. and Strawbridge, B. (2016) Permaculture: A beginner's guide. 2nd edn. London, United Kingdom: Spiralseed.

Candlin, A. (2011) The self sufficiency manual: A complete, practical guide to living off the land. London: A & C Black Publishers.

Cooke, I. and Ian, C. (2011) Self-sufficiency: Grow your own fruit and vegetables. United Kingdom: New Holland Publishers.

Seymour, J. (2009) The new complete book of self-sufficiency. London: Dorling Kindersley.

Web resources:

andrews, graham (no date) Growing trees for firewood. Available at: http://www.grahamandrews.com/growing_trees_for_firewood.html (Accessed: 22 February 2017).

Davis, S. (2012) *Heating qualities*. Available at: http://www.firewood.co.uk/heating-qualities/ (Accessed: 30 January 2017).

By the numbers • the urban homestead (no date) Available at: http://urbanhomestead.org/about/by-the-numbers/ (Accessed: 27 January 2017).

Choices, N. (2016) *what should my daily intake of calories be?* Available at: http://www.nhs.uk/chq/pages/1126.aspx?categoryid=51(Accessed: 27 January 2017).

Ewings, S. (2014) *Build A Gasifier - build a gasifier - power for homes and business*. Available at: http://www.build-a-gasifier.com (Accessed: 27 January 2017).

Experts confirm that fruit and vegetable consumption reduces risk of mortality (no date) Available at: https://www.sciencedaily.com/releases/2013/09/130926102433.htm (Accessed: 27 January 2017).

GiffordSmFootprintFam, D. (2012) How much land is needed to be self sufficient. Available at: http://www.smallfootprintfamily.com/how-much-land-is-needed-to-be-self-sufficient (Accessed: 27 January 2017).

Giraffe (2011) *What is coppicing?* Available at: http://www.coppice.co.uk (Accessed: 30 January 2017).

HM Government (2010) Calorific value by species hardwood species softwood species. Available at: http://www.forestry.gov.uk/pdf/FR_BEC_Wood_as_Fuel_Technical_Supplement_2010.pdf/$FILE/FR_BEC_Wood_as_Fuel_Technical_Supplement_2010.pdf (Accessed: 30 January 2017).

Kendra (2013) how much should I plant to feed my family for a year? Available at: http://newlifeonahomestead.com/how-much-should-i-plant/ (Accessed: 27 January 2017).

Krajnc, N. and FAO (2015) *Cover photo: Nike Krajnc*. Available at: http://www.fao.org/3/a-i4441e.pdf (Accessed: 30 January 2017).

Lawton, G. (2012) *Verge Permaculture – Permaculture for professionals, innovators and entrepreneurs*. Available at: https://vergepermaculture.ca (Accessed: 30 January 2017).

Ltd, A.I. (no date) *Cost of owning A horse*. Available at: http://www.equineworld.co.uk/buying-loaning-selling-horses/buying-a-horse/cost-of-owning a horse (Accessed: 3 February 2017).

Minister's foreword (2013) Available at: http://www.sags.org.uk/docs/ScotlandAllotmentDesignGuide.pdf (Accessed: 10 February 2017).

Hugo (2017) how many m2 you need to cultivate in order to be self-sustainable? Available at: http://survlivel.cultu.be/how-many-m2-4-self-sustainable (Accessed: 27 January 2017).

Roser, M. (no date) *Food per person*. Available at: https://ourworldindata.org/food-per-person/ (Accessed: 8 February 2017).

Tott, R. (2015) How much land for self-sufficient living? Available at: https://homefarmer.co.uk/how-much-land-for-self-sufficient-living/ (Accessed: 27 January 2017).

VegetableGardeningLife (2015) Companion planting charts. Available at: http://www.vegetablegardeninglife.com/companion-planting-charts.html (Accessed: 27 January 2017).