

## PDC Final Design Project

### Kristi Liiv, Kivistiku farmstead in Estonia, 2024

#### Final Design Overview

##### Goal

Kivistiku is an old farmstead in Southern Estonia. The farmstead is located on the eastern bank of Kavilda primeval valley. Down in the valley flows a small river. The site consists of 10 ha/25 acres) forest (of which 4 ha/10 acres is nature reserve), 13 ha/32 acres of farmland and 3 ha/7 acres of residential land. Most of the farmland is rented out to a local organic agricultural company. Since 2018 we have been rebuilding the place from scratch. At the moment there are two residential buildings on the site, a greenhouse, outdoor shower and a compost toilet/outdoor kitchen. The site is 100% off-grid. We use sunpanels for electricity, harvest as much rainwater as possible and use a water ram to pump spring water up from the valley. **Since 2020 we have been establishing a garden area on 0,7ha/ 2 acres.** The soil on the site is rather dry and sandy and somewhat drained by intensive agricultural production over the years. **By 2030 I hope to see the site with a fully functioning permaculture garden that would produce enough food for permanent residents and also our guests who come to learn about sustainable living or visit us for restorative vacation.** Many other profitable activities can be developed over time (selling the surplus produce and locally produced products like honey, jam, soft drinks etc).

##### Technical Data

###### Location:

The Estonian climate is **temperate and mild**, characterized by warm summers (up to +30 degrees Celsius) and fairly severe winters (up to -30 degrees Celsius). The weather is often breezy and humid due to the proximity of the Baltic Sea. Seasons in Estonia vary widely. The approximate coordinates for the site are 58° 23' 00" N and 26° 43' 00" E.

The site has an excellent location in terms of mobility. The Estonian second biggest city Tartu is about 25km away and we have a good bus connection. Two smaller villages with shops etc can also be easily reached by bicycle, riding a horse or even by foot (7km from the site).

###### Site size:

The Kivistiku farmstead is 30ha/ 74 acres of which relevant to this final design is **7ha/ 17 acres:** 3ha/7 acres of residential land and 1ha/2,5 acres of farmland that has been isolated from the rest of the farmland. Small part of the forest (2 ha/5 acres) is also to be considered part of the present design project.

## **Buildings on site:**

- **Main residential building:** Old Estonian style farmhouse (6\*17m/ 20\*56ft) where under the same roof are residential rooms for people (100m<sup>2</sup>/ 1076ft<sup>2</sup>), storage area (35m<sup>2</sup>/ 376ft<sup>2</sup>) and barn for chicken or other livestock (15m<sup>2</sup>/ 161ft<sup>2</sup>).

- **Second residential building:**  
Small house built with clay and wood (40m<sup>2</sup>/ 430ft<sup>2</sup>).

- **Greenhouse:**  
1,5\*4m/ 5\*13ft located in the garden area near the outdoor shower and pond.  
Second bigger greenhouse is planned to be implemented by 2026.

- **Cellar:**  
Beautiful granite stone cellar is the only historical building on the site. It's probably built at the beginning of the 20th century. It's well preserved and used by us daily to preserve vegetables, apples, jams, juices etc. During the winter months bats use it for hibernation.

- **Sauna:**  
We are planning to build a new log sauna or preferably bring an old sauna from somewhere nearby to use it for hygiene procedures and social events. When not in use, it can also be used as a storage room.

- **Animal shelter:**  
4\*10m/ 13\*32ft to be built by 2030.

## **Elevations:**

Landscape is diverse with many smaller elevations and declines. Forest grows on the slope of the valley (35m/ 115ft decline from the main site). Garden area is open from the south and closed with forest from other directions with small decline from outwards to inwards.

## **Wind:**

On the site predominantly from south or south-west. Average speed of the wind is 2,5m/sec.

## **Solar:**

Area relevant to the current design project is open to the sun from the south. The main building is positioned east-west, the residential area is on the west end of the building. Sunpanels (currently 1kw) are positioned vertically and face south behind the main building. In 2025 we are planning to implement 10kw of sun panels to have it easier in winter months. Garden area is fully open to the sun from the south and surrounded with forest/trees from other sides.

## ELEMENTS

### 1- Main building

The main building is built by an example of old Estonian farmhouses, where everything was placed under one roof (except the sauna which was always separate because of the fire hazard). Historically in Kivistiku farmstead there was a similar building but twice as long as the one we have built currently (out of timber from our own forest). The location of the main building was chosen because of its openness to the south, which allows it to harvest sun energy. Currently a small self-built **solar system (1kw)** is in use, but it's planned for **2025 to build a bigger solar system (10kw)** to have enough electricity for winter months. Panels are placed on the ground vertically to catch most of the sunlight during winter months when the sun moves lower. Vertical positioning also spares time and energy from cleaning the snow and dust from the panels. Since there have been severe hail incidents, vertical positioning also minimizes damages from such extreme weather conditions.

Water in the main building will be heated using a boiler which uses stove heat in winter and electricity in summer (planned to be installed in 2027).

The main building has a **roof area of 170m<sup>2</sup>/1829ft<sup>2</sup>** which is very good **for rain water harvesting**. In all four corners of the building are placed 200l/ 53 gallon barrels. Water is not filtered and is mainly used for washing dishes and ourselves and watering plants. **Drinking and cooking water is pumped up from the springs by a water ram. In 2026 we are planning to build a borehole** to have local water available also in winter months when there is no rainwater and the water ram is not working due to freezing (it's also possible to bring water from the river or springs in the valley, but it's a bit too much manual labor in the long run; though it is a good backup for emergencies).

On the east end of the main building **barn** is located which consists of two rooms: one to keep livestock in emergencies (extreme weather) and the second for poultry (8m<sup>2</sup>/ 86ft<sup>2</sup>). Barn is currently under construction. **The chickens** are planned to be brought into their new home in the spring of 2024. Connected to the building is an outside fenced area for poultry. It's built very strong to avoid foxes and covered with a net on top to avoid attacks from above. It's also possible to let the chicken roam freely on the site while under surveillance. Chicken eat food waste, produce eggs, meat, feathers, manure and are helpful in pest control.

Most of the water needed for livestock/poultry can be harvested from the roof of the main building (only for winter months some special arrangements are needed such as heated water vessels).

The storage area and the second floor living room in the main building can be used for workshops, events and accommodation. The second floor living room has a big roof window facing south to be used during early spring for pre-cultivation of annual plants.

The main building should last at least 100 years. Water being its biggest enemy we have built a high foundation and wide roof. Strong winds can also cause damage to buildings in Estonia and it has been taken into account during the process of construction.

Construction video: <https://www.youtube.com/watch?v=03QiDEc72pA>

## **2- Second residential building**

Second residential building is located 200m/ 656ft north from the main building. It's built out of old clay walls and timber harvested from the local forest (fir trees were mostly already dead due to European spruce bark beetle damage). The roof of the building is built of timber (chipped wood). Total living area of the building is 40m<sup>2</sup>/ 430ft<sup>2</sup>. Both buildings are heated by wood burning stoves since firewood is plentiful from local forest. For heating mostly storm brake is used. Both residential buildings use the electricity from the same solar system located on the south side of the main building. In the construction of this building mostly local, organic and recycled materials (doors, windows etc) are used.

Construction video: <https://www.youtube.com/watch?v=3arcVSbBt8E>

## **3- Composting toilet/ outdoor kitchen**

Near the main building 3\*3m/ 10\*10ft composting toilet/ outdoor kitchen is located. It's the first building we built on the site in 2019/20. It's made of straw bales and plastered with clay which is available on site almost everywhere (the place where we dug clay is now a pond in the garden area). Contents of the toilet are regularly brought out to compost. On the outside of the building is a small outdoor kitchen that we use in summer (there's a gas stove and a sink and a working surface and shelves). Near the outdoor kitchen is a small sitting area under the birch trees (location is perfect for very hot summer days and nights, but a bit windy and cold for most of the year). On the other side, under the roof, we keep tools that are not too sensitive to the weather (spades, rakes etc). There are also water harvesting systems on this small building. Human urine is mostly collected separately and often used in fermented state as a fertilizer. In the longer run we are planning to have a regular bathroom (water toilet and a bath) in the main building, but a composting toilet would be the first preference during summer months.

Construction videos: <https://www.youtube.com/watch?v=nFGT7PNmLx0>  
<https://www.youtube.com/watch?v=yYIV7ULyU3A>

## **4- Greenhouse**

Small 6m<sup>2</sup>/ 64ft<sup>2</sup> greenhouse is located in the garden area near the pond and outdoor shower. The location was chosen hoping that it would be warm with very little wind. There's also a pond nearby for irrigation (in case other irrigation systems don't work). There's a sauna stove at the end of the greenhouse which can be used during spring colds to protect the plants or during winter as a sauna. The greenhouse is built out of local timber, old windows and plexiglass (real glass broke near the sauna stove). The location of the greenhouse is not optimal. Its nearness to the forest and wide wooden frame cast too many shadows and the plants on the forest/north side don't get enough sunlight. I have tried to solve the problem by cutting down some trees behind the greenhouse and planting shorter plants on the south side.

Construction video: <https://www.youtube.com/watch?v=y2OJcvT486k>

## **5- Outdoor shower**

Outdoor shower was built in the summer of 2023. Spring water is pumped up into the black tank with the power of a water ram (pumps up about 700 liters/ 184 gallons of water daily). An electric hydrophore and a gas water heating stove are used for getting warm water any time of the year (shower works from April to October until frost). Used water is currently not harvested since a water ram can pump up enough water for all the needs of the household and garden (irrigation is used only when needed during long dry periods). It's very enchanting to walk to the shower with an oil lamp in hand and shower there in the moonlight during warm but dark summer nights in August. Location was chosen since the garden area is somewhat more private than the area near the main building. It's also important that it's very sunny and warm there, which helps to heat up the water in the tank. Area under the tank can be used to store gardening tools and a trash bin (for non-organic waste).

## **6- Cellar**

Cellar is a special place on our site since it's the only old structure probably built at the beginning of the 20th century. It's beautifully handmade from big rocks. Its area is 15m<sup>2</sup>/ 161ft<sup>2</sup>. The temperature in the cellar is all year round 4-10 degrees Celsius which is optimal for storing vegetables, fruit and other food products. During winter it's home for many insects and bats. There's also a small stove which can heat up the cellar to be used as a shelter during times of catastrophe.

## **7- Sauna**

Currently there's no sauna on the site. Sauna has a special place in Estonian culture since it was historically used for many purposes. Traditionally children were born in the sauna, the sick were treated in warm rooms of the sauna and also the dead were washed in the sauna before the burial. The room is also used weekly for hygiene procedures. Sauna can be used for all tasks that need cleanliness or much water (e.g. cleaning poultry after slaughter or washing and drying wool). Nowadays the sauna has become a place of socializing - we invite friends over just to talk and go to sauna together. Sauna is also a "must be" any time you invite friends over to help with some work. Ideally we would like to transport an old log sauna from somewhere in the neighborhood. Gray water from the sauna should be used for irrigation.

## **8- Water tank**

A 900 liter/ 237 gallon old milk tank is placed on the highest point on the site near the cellar. From there water flows through a pipe to the outdoor kitchen. In 2025 it's planned to connect the garden irrigation system to the tank to decrease manual labor during dry periods. The tank is filled with spring water and pumped up there by the power of a water ram (the pump is located 35 meters lower in the valley and uses purely hydraulic energy to pump the water up through

300 meters of pipes). Since the water ram works 24/7 from April to October I hope to use as much water as possible productively (for drinking, cooking, irrigation, shower, sauna). When all other needs are met, water is pumped into the pond (which can be used when the water ram is out of order or springs run out of water). There are two springs used to feed the water ram and although during the dry periods water level falls, the springs have never run empty.

## **9- Compost shed**

Compost shed is planned to be built in the summer of 2024. It will be a shed with a roof and tree boxes for different stages of compost and an area for keeping gardening tools. Compost shed's location is chosen to be near the garden, but not in direct sunlight so as not to dry up the compost. It's also not far from the main building and outdoor kitchen to bring organic waste into the composter. Currently a small compost pile is located between the outdoor kitchen and main building. Since the soil in the site is rather poor in nutrients (consisting mostly of fine sand and clay), it's very important to use compost in the garden.

## **10- Pond**

Pond is located in the heart of the garden. It's about 10\*10m/ 32\*32ft and 3m/10ft deep. It's shaped like a raindrop with deeper and shallower areas. The pond is actually a hole in the ground where we dug clay plaster for the outdoor kitchen and the same clay plaster is also used in the interior of the main building. Although the pond is located in the lowest part of the garden, the ground is not able to keep water, so a rubber liner (EPDM membrane) was implemented in the summer of 2023. Growing fish in the pond is somewhat complicated, since the pond freezes in winters and fish can't get enough oxygen. To keep an ice hole for fish would be a big task in our climate. Currently there are fish in the pond that can survive in very harsh conditions (Crucian carp). The pond is also a home for not so common green frogs (*Rana esculenta* või *Pelophylax kl. esculentus*). Last autumn probably a mink came to visit and killed some fish and frogs. I have also seen many birds drinking at the pond and also bees get their water from there. The pond is also very much loved by dragonflies and other insects. Its location between forest and garden/fields makes it a very important place for many other species (all sorts of wild animals and birds). I'm planning to plant some water lilies and other plants at the banks of the pond (the banks have already proven to grow the biggest flowers and all sorts of plants). In very warm summers water can heat up too much and make algae blooms. To avoid that it's possible to implement a solar powered fountain. The pond will provide water during extreme droughts for the garden (probably an electric pump will be used). It's also an option for people to cool down and refresh themselves during hot summer days. Hopefully the pond could also raise air humidity in otherways hot and dry areas of the garden.

## **11- Vegetable, herbs and fruit garden**

The garden area is about 0,7ha/1,7acres. The land has been out of intensive agricultural usage since 2019. The first clover was sowed to bring more nutrients into the soil. Surrounding fields are managed organically. Since 2020 we have planted fruit trees (apples, plums, cherries,

peaches), berry bushes (blackcurrant, gooseberry, grapes, strawberries) and growing vegetables (potatoes, carrots, pumpkins, zucchini, onions, garlic etc). We also grow a number of herbs like sage, peppermint, and chamomile. There are two types of beds: raised beds and low beds. All beds are mulched with straw and cut grass every year, the principles of companion planting are used. The garden is established to have vegetables and berry bushes nearer to the main building, fruit trees and wild herbs further on back. In 2025 a second greenhouse will be installed to have more space for heat loving vegetables (chillies, paprikas etc). We are also planning to plant a few more fruit trees and raspberries. There are also some birches, linden and maple trees planned to be grown in the garden area for offering shade, linden flowers for tea and honey and birch/ maple for juice in spring time and fresh branches for sauna whisk. Over the years also wild mushrooms will probably start to grow under the trees. I change the placement of annuals regularly.

The garden needs attention from May to October. Assuming the beds are prepared beforehand 1-2 days are needed in spring for planting and sowing. Then it's important to cover the plants during cold nights and later in spring also irrigate in case of very little rainfall. Mulching needs to take place in June when plants are big enough, harvesting starts mostly in July when also irrigation might be necessary to increase produce later in summer. Some weeding might be done where necessary in July and August. In September-October harvesting is done and simultaneously the garden is prepared for winter.

There have already appeared many problems in the garden area:

- Raised beds built of branches, soil and mulch tend to have too thin a layer of soil and dry up too fast. Since they are somewhat sparse inside mice and other animals live inside them, which makes them even more sparse. But it is nice to see all the life happening inside raised beds (snails, weasels, mice)! Some raised beds have started to grow wild champignons and other mushrooms. In conclusion, my experience with raised beds is that they tend to be somewhat uncontrollable and "do their own thing". So it needs some more experimenting to see what plants will grow well in there and which will not. I also try to add more mulch and compost/soil whenever I have it available.
- Standing cold air and humidity in the location of the garden. The garden was established in the chosen area because it's open to the south and gets much sunlight and warmth from early spring to late autumn (which is beneficial in our climate). It's also very windless in that area, since it's surrounded with forest from west and north and has a slope on east. Since the landscape is somewhat lower in the middle of the garden, cold and sometimes also humid air tends to flow down there and stay there for extended periods of time (due to lack of wind). It has caused mold problems on vegetables (peas) and fruit trees. Since now I have managed to save most of the young trees, but it's a constant battle in early spring and autumn. I still have to learn how to protect my garden from mold diseases using natural means.
- Forest pests love fruit trees, berry bushes and vegetables! Nearness of forest brings great numbers of pests (e.g. *Agelastica alni*) on fruit trees mostly during spring months. It's a daily task to check all trees and bushes and differentiate harmful and harmless insects. The problem will probably solve itself over the years when trees and bushes are bigger and not so susceptible to pest attacks. Since now I have simply picked off harmful

pests and also sprayed natural repellents (nettle soaked in water with some chilly peppers). I have also thought about installing bird nest boxes in the garden or on the bigger trees around the garden to support pest control by birds.

- Poor soil (sandy clay loam). The soil in my garden is very sandy with very little humus. I have been adding much straw mulch over the years and the soil has improved in beds. It's still a constant work to create more fertile soil for new beds and the whole garden. I have noticed that the population of earthworms has already increased over the past 3 years (probably due to ending intensive agriculture). There are plenty of other insects (like ladybugs) wintering in the mulch of the beds which is lovely to see. To solve the problem of poor soil it's crucial to build a good compost shed and learn to make great compost!
- Wild animals. I have built fences around all my young fruit trees to protect them from deer and hare. The garden area is too big to build a fence around it and personally I don't like the idea of a totally closed area. There have still been occasions that a hare ate my cucumber plants in raised beds in early summer. I have also avoided growing cabbage, since there's now chance of success until the otherwise lovely hares roam around freely. To solve the problem I have decided to try to grow cabbage under young fruit trees inside the fences. In a longer perspective it's also possible to use electric fences around the beds if it turns out to be necessary.

## **12- Bees**

Currently we have four beehives, there are bees in two of them. We have been keeping bees since the spring 2023, so we are totally new to this. Last summer we got 40kg//88lb of honey out of two beehives. Bees are important for the pollination of the garden, producing honey and beeswax (which we use to make candles). It's also relaxing just to watch bees working.

## **13- Natural herbs area**

There's an area in the back of the garden near the forest where many wild herbs grow naturally (*Hypericum*, *Achillea millefolium* etc). Every two years or so I must cut off all the wild trees (mostly birches) to keep the area suitable for wild herbs. We use the herbs for making teas and medicinal drinks with alcohol. The herbs are also nice decorations when dried for residential rooms and the sauna. It's also possible to use herbs for making creams and other cosmetics and all sorts of soft drinks. It's also possible to use some of the herbs in plant protection.

## **14- Old orchard**

There's an old orchard on the north side of the main building. It's probably planted at the beginning of the 20th century, but the apple trees still bear fruit from time to time. We have managed to identify most of the apple varieties. All varieties are very tasty and there are also some winter varieties that stay perfectly edible in the cellar for 6 months. Since the soil in the old orchard has not been used for many decades, the grass growing there is always thick, tall and green. We are planning to use the orchard as the grazing area for sheep or horses which we are



planning to introduce in the coming five years or so. A good fencing must be built before bringing in livestock.

### **15- Livestock pasture/ wooded meadow**

Livestock grazing area can be extended to north and west, since there are green areas with few trees and bushes. Wooded meadows are proven to be very rich in life and I would love to have old style meadows on my site which would fulfill many functions - food for livestock, habitat for all sorts of wildlife, recreational areas for people. It's crucial to bring in the livestock as soon as possible since forest extends its borders very fast in any direction it can. It will probably be sheep first since they are not so expensive to buy and maintain. From sheep we can get wool and meat.

### **16- Forest**

Mostly on the west end of the site grows natural forest (10ha/ 24acres). Currently it's a mixed forest with both coniferous trees and deciduous trees. We have used lots of dead fir trees in the construction of buildings and its branches to build fences (<https://www.youtube.com/watch?v=4oBajsQNQzkl>); deciduous trees like birch and ash are mostly used as firewood. Generally we don't need to cut down healthy trees since there are enough broken or dead trees for all purposes. Willows can be used in the future to build more green fences in the garden or to make baskets and furniture. Since it's a very fast growing tree it can also be sold for wood chips. We have also made some simple furniture and bird nest boxes out of our own timber. Apple timber is perfect for making kitchen ware. Lower part of the forest grows in the bottom of the valley and is under natural protection for being habitat for a number of endangered plant species. It's a special habitat because the whole ground is full of smaller and bigger springs, which make the environment cooler in summer and warmer in winter. At the very bottom of the valley flows a small river. The water in the river is cool even in summer (because of many springs flowing into the river) and offers an opportunity for people to cool themselves during hot summer days. Usually the river doesn't freeze in winter due to relatively strong current, which is a good backup in case there's now water available from other sources (e.g. as drinking water for animals or sauna water for people). We also use the forest for recreational purposes - we have a small hiking path there where we have organized a number of events (<https://draakonjadelfiin.ee/matkarajad-ja-matkad/>). The website is currently available only in Estonian.

There is a rich wildlife in the forest, since the valley is 30km long and it's the only forest covered area that long in the neighborhood, being a habitat and traveling route for bear, lynx, wolf, moose and many other animals that need bigger territories.

### **17 - Well**

There is an old well on the site, but it has been dry for decades. In spring 2023 we got it cleaned for a few meters, but there's still no water. The well is 20m/ 65ft deep. The most certain way to

have groundwater available all year round is by having a drilled well. Average drill wells in this area are 80m/262ft deep. We are planning to have it drilled in 2026 or 2027. Since the old well is in a rather good condition, we could imagine some usage for it too (e.g. as a storage room for something). But since the existing well is so deep, it's very important to have all the safety measures in place so that no one falls into it by accident (it's covered with a strong lid).