LowarchiTech

Development of a website for low-tech architecture concepts

Master's Thesis

Lowarchitech

Development of a website for low-tech architecture concepts

Achieved for the purpose of the acquisition of a master's degree in architecture
under the guidance of **Ass.Prof. Dipl.-Ing. Dr.techn. Karin Stieldorf**
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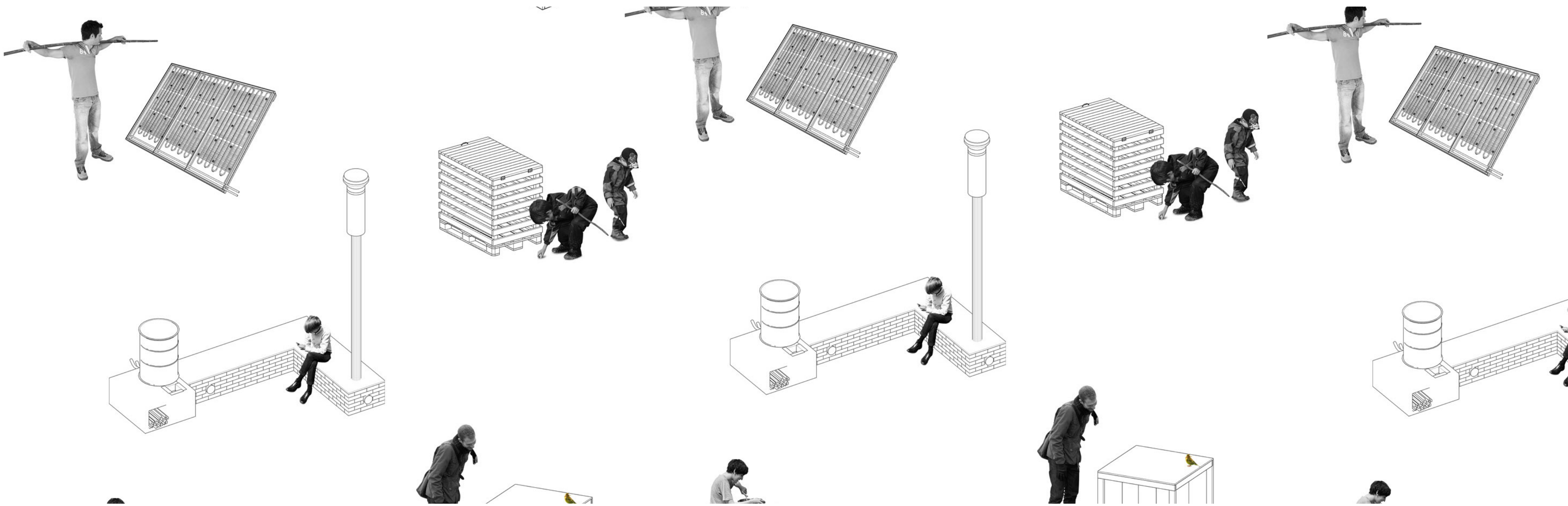
Abstract

Entwicklung eines architektonischen Projekts berücksichtigt wird. In diesem Kontext sollte auf die Tatsache hingewiesen werden, dass Gebäude für 43 % der verbrauchten Energie verantwortlich sind und zu 22 % zum Ausstoß von Treibhausgasen beitragen*. Es findet eine individuelle Bewusstseinssteigerung in Bezug auf die damit verbundenen Herausforderungen statt, was bei einer radikalen Umsetzung eines ökologischen Ansatzes zu einer bedeutenden Kostensteigerung führen kann. Auf eine ökologische Art zu bauen bedeutet aber auch, dass man durch die Reduzierung von oder einem Verzicht auf externe Arbeitskosten sehr große Einsparungen vornehmen kann. Selbst Hand anzulegen steht heute im Einzelbau hoch im Kurs. In Europa wohnen 41,7 % der Menschen gemeinschaftlich und 58,3 % in Einzelhäusern, die auf die Wohnfläche umgerechnet 10 bis 50 % mehr Heizenergie verbrauchen als Mehrfamilienhäusern. Der Selbstbau von Einzelhäusern bietet viele Möglichkeiten zur besseren Umsetzung der Energiewende. Wenn ein vernünftiger und auf fachlichem Rat basierender Ansatz verfolgt wird, kann ein geringerer finanzieller und verbrauchstechnischer Aufwand während des Baus und während der Nutzung eine Kostenreduzierung praktisch auf null erreicht werden. Low-Tech-Architektur bietet praktische Lösungen für jeden Lebensabschnitt eines Gebäudes; in Hinblick auf Design, Bau, Nutzung und Abriss. Heute werden Projekte gemäß den Prinzipien des Low-Tech-Designs erstellt, was für einen Einblick in die Möglichkeiten einer neuen Wirtschaft bietet, die auf Informationsaustausch, das Internet der Dinge sowie die Entstehung von zusammenarbeitenden Communitys sorgt. Lowarchitech beschreibt und erklärt Schritt für Schritt alle Low-Tech-Lösungen in Hinblick auf Ihr Zuhause. Die Erläuterungen verdeutlichen, wie man mit Hilfe natürlicher Materialien bauen und dank Energieeinsparungen ein Haus errichten kann, das Lebenskomfort und

Environmentalism is not an end in itself. It must become an integral part of the development of any architectural project, given that buildings represent 43% of energy consumption and contribute 22% to greenhouse gas emissions. An individual awareness of housing issues is growing and, as it's radically applied, budgetary problems arise. Green construction involves costs that can be dramatically reduced through self-building by reducing or eliminating labor costs. Self-building is applied today at the scale of individual construction. In Europe 41.7% of Europeans live in multi-family housing, 58.3% in single-family houses. Single-family homes consume 10 to 50% more energy for heating than multi-family units per unit of living space, due in part to greater heating needs. Self-built individual housing offers considerable benefits to the energy transition. Well-reasoned and informed self-building can ensure housing construction that involves modest financial and energy impacts during construction and virtually none throughout its use. Low-tech architecture offers practical solutions at every stage of building life - design, construction, use, and demolition. Today projects are undertaken according to low-tech design principles and provide a glimpse of the possibilities of a new economy based on the exchange of information, the Internet of Things in the emergence of collaborative communities. Lowarchitech references and describes step-by-step low-tech housing solutions. The explanations reveal how to build a robust building with natural and recycled materials that offers comfort, convenience, and independence so that everyone can live in "abundance".

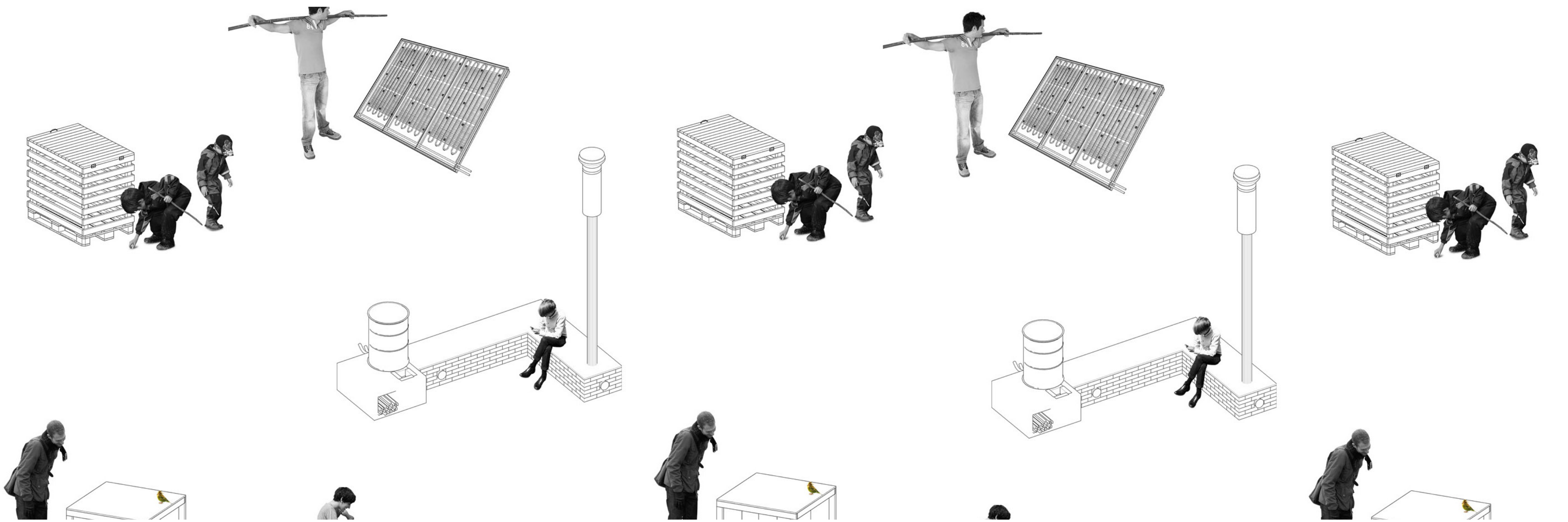
Synopsis

*You sit down at a table
where there is food and wine in abun-
dance;
masked from a shabby fact,
you go away hungry from a Potemkin
village.*



Preface

Unlike birds, ants or wasps, people don't build houses purely by instinct. We have to think, plan, find money and organize. For the modern human without access to an indigenous culturally specific building system, the building process must be even more intimately intertwined. Housing is a natural and innate basic need designed to sustain human life. It supports physiological needs such as hunger, thirst, maintenance of a stable temperature, breath and sleep. Walls and furniture are tools helping our survival. Housing also answers to psychological needs of protection, anchoring and stability. Private space enables an appropriation of that space with an arrangement, furniture and behavior that are necessary to be able to thrive. Walls define private space and public space. Housing can perform a social function, when a couple or friends decide to live in the same accommodation. It is a place for interaction



between individuals. To live in a place is also to remain in existence and take up a place in society. Pierre Sansot, an anthropologist and sociologist, develops the link between appropriation and the capacity of having stable social relationships. An individual maintains a particular relationship with their housing that may be either a source of fulfillment or a source of enslavement.

The theory described in this master's Thesis asserts a point of view on the evolution of the dependence between inhabitants and their housing. This dependence call into question the notion of freedom which is a subjective issue. Freedom could be defining as a release of the needs maintenance; humans can survive with idleness and work only to satisfy desire. This freedom is generally enabled by wealth, and leads to an enslavement of a part of the population in charge of the basic needs of the many. In contrast, freedom could be defining as free and direct access to the basic needs of production; human work for their needs. Some favor money, while others opt for time and knowledge assets. This three factors are the components of wealth.

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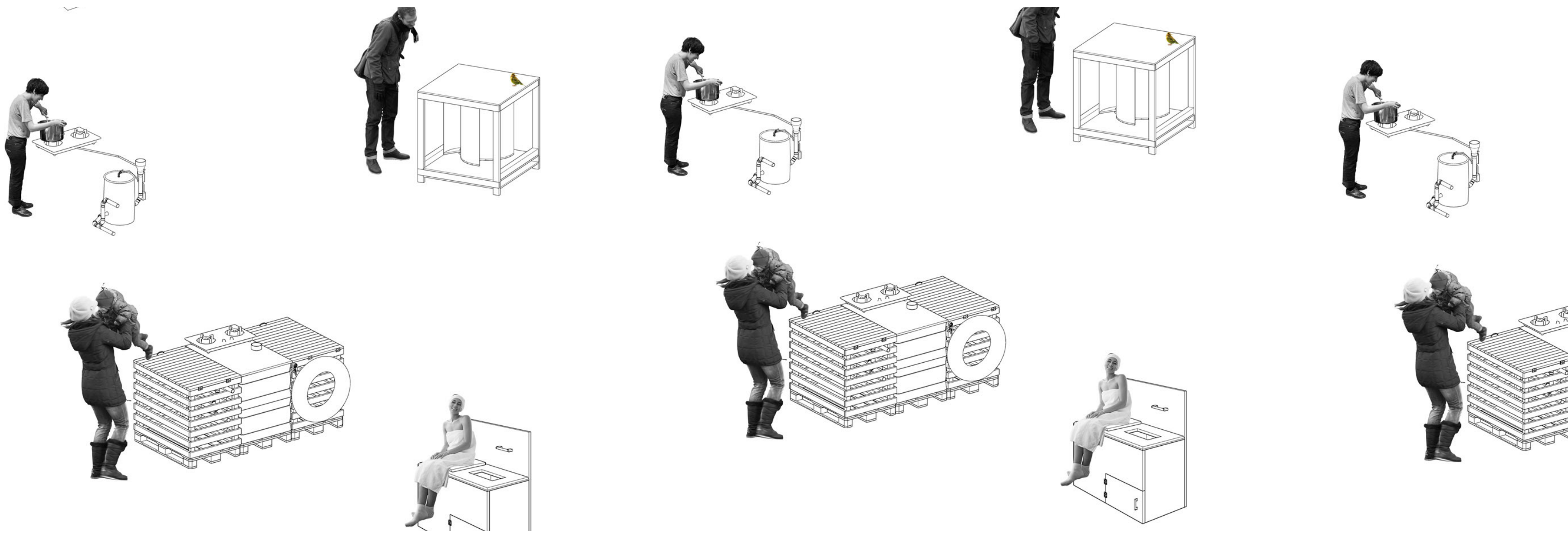
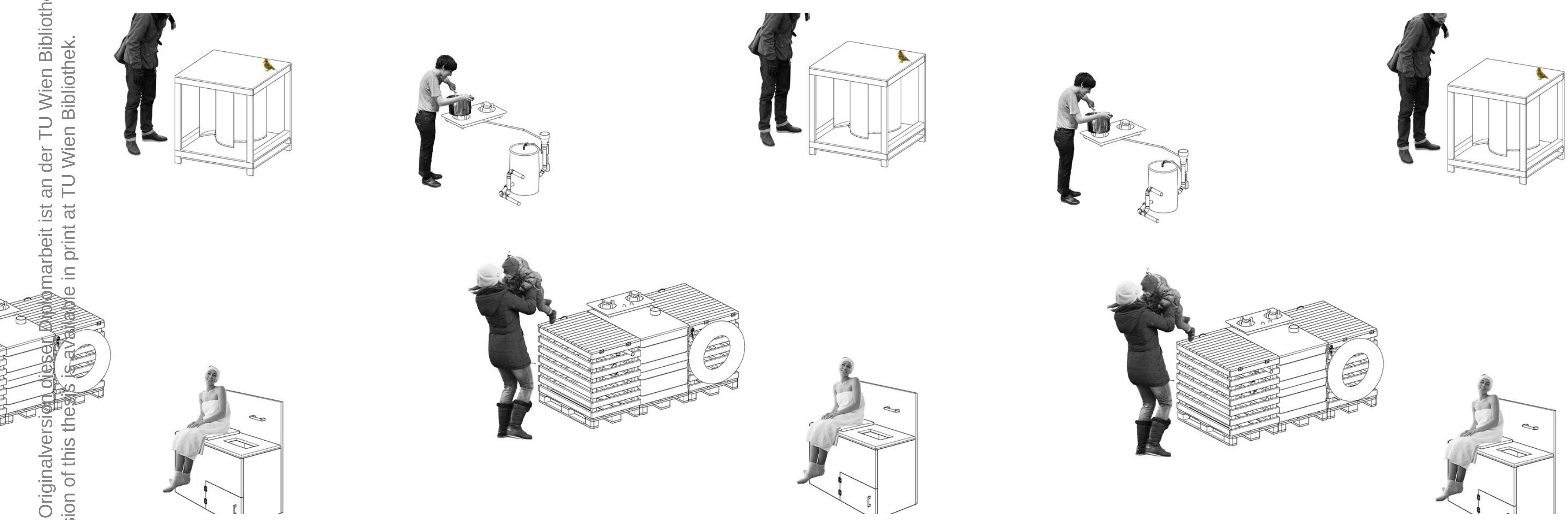


Through this research, I do not want that you trust in an utopia that may save humanity by making a complicated issue easier. For every complex problem there are many answers. This investigation describes one among so many other answers, this one can inspire the more enterprising with a thirst for knowledge.
The idea is to come back to the origin of the housing components to initiate an awareness and an understanding of what housing entails. This solution inspired myself by its creative expression and its global practical application. People that act in this field seem passionate, full of life and drunk with happiness. This subject is an answer to my actual desire and a fascinating topic for my relatives and friends on which I wanted to put words and images. This study has no reason to remain in the framework of theory and academia . For me it is the starting point of a big undertaking that will be progressively enhanced. It's the theory that will inspire practical action. Finally, it is a project that will take on its full meaning by being shared.

The energy solutions describe in the last chapter are borrowed open sources that has been already built, tested and approved. These one



are reinterpreted to constitute complementarity that enables the efficient global autonomous of the building. I invite you to go back to the bibliography to develop your own propositions, adapt it to your context and have a better understanding of the issues.

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Introduction

At first glance, abundance seems to be material wealth that provides safety. But abundance is not what later generates a shortage. Material wealth must be split in order to be share, it is therefore not a fearless abundance. One can provide oneself with the means to generate knowledge and social abundance, that which one produces with creativity, one does not object to sharing.

The material abundance race on a physically finite planet, that aims to produce cost-effectiveness rather than usefulness, is today doomed to fail. This mindset legitimizes the will to build up, for instance, the third runway in Vienna airport on agricultural land to promote pollutant airplane, or to cut trees down to extend brown coal in Hambach or a highway in Strasbourg. It is called a boondoggle, an unnecessary and expensive piece of work that is paid for by the public and continued due to extraneous policy or political motivations. You can find this approach in small and large scale project. At the cost of quality, the goal is often a rapid result and a low price. This phenomenon results partly of a distance between the consumer and the contractor. One wants to save money and doesn't know the value and the quality of the product, the other need to sell its product. In architecture, it makes fast-construction a frightening reality where the building is energies vacuum, a material has to be changed after a few years and owner are in debt. This counter-productivity leads to overconsumption. Faced with this situation, the ecological transition approaches two aspects: the conscientization and the normalization. The architect can find a place as an advisor in making people aware by giving the example and advising the customers, the normalization of alternative methods of environmentally friendly architecture may follow. The most drastic approach of the conscientization is to provide the possibility to each to be a “prosumer”, a person who both consumes and produces a product. It involves and questions the individual in each step of production, the time dedicated offers a personal value to the object and the production uses mostly human energy. Thus, low-tech methods offer the possibility for anybody to build systems that are simple, sustainable and accessible in terms of costs and know-how and that answer to vital problems. The principles may be diffuse in architecture to radically change the relation of the inhabitant with their housing.

Starting with the socioeconomic context, research highlights the necessity of tools dedicated to the new environmental paradigm. Architecture formalizes the mindset of a society. Productions, made of contradiction, emerge and undertake this transition with the same goal but with an opposite approach. Low-tech architecture is a tool that offers many practical solutions and calls into question each component of architecture: the way to design, plan the construction, live and demolish. Today, projects are undertaken according to these principles and offer an overview of the opportunity provided. The wealth of these productions is based upon a knowledge duplication apart from the economic system as "collaborative common" matter.

lowarchitech.com is a website that indexes low-tech solutions dedicated to housing. From diverse energy sources to structure propositions, the whole documentation is available in Creative commons. Autonomous buildings are clearly diffused with step by step explanations and 3D Sketchup files allowing anybody the capacity to build with principles of abundance.

"Anyone who believes in indefinite growth in anything physical, on a physically finite planet, is either mad or an economist." Kenneth Boulding

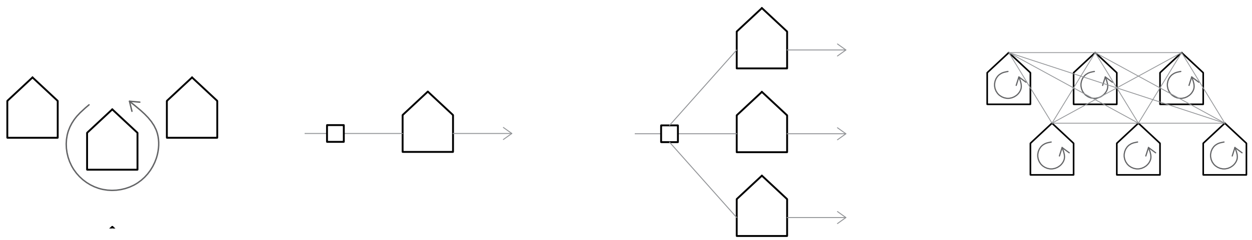
I

Once upon a time the low-tech architecture

Housing is a way to choose the contribution that we want to make in the world. Furthermore, the physical realization of our convictions might be inspirational for other people. This could take the form of environmentally-friendly ideas that offer a positive impact and an integration into nature, or a technological improvement that reflects progress and quality of life.

As a major tool in daily life, the housing is always built as a mirror of our society. The fast development and socio-economical changes operated during the last century left a deep trace on architecture. The current conception of buildings has reached a stalemate and is looking for new model.

1. History of the energy management in residential housing



self-sufficient community housing

connected individual housing

The **first industrial revolution** gave rise to building of individual housing, dependent on the manufacturing industry both economically and for its energy

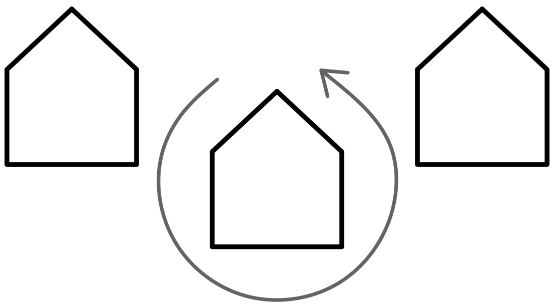
connected State housing

The **second industrial revolution** worked to put an end to the problem of insalubrity through an overall policy framework. Social housing organised according to a model was connected to urban infrastructures.

network housing

Housing design appears to apply **third industrial revolution** principles by automizing its energy production and through its reliance on electronic data interchange in the context of resources headed toward depletion.

Self-sufficient community housing



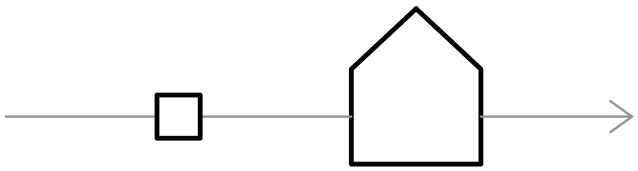
Like many other disciplines, architecture developed into a high-tech area of expertise. By improving the way it addresses needs with ever more complex products, it has resulted in construction not being within everyone's reach. This gap particularly took off during the industrial revolution with the emergence of the comfortable home that we currently know.

The term "industrial revolution" was coined in 1830 in France to define the current state in England, upgraded by Watt's steam engine. Today, we talk about a "take-off" to define this worldwide phenomenon which began in the XVIII century in England and is still ongoing. These revolutions highlight the interdependence of technical processes such as energy, materials and communications and their effects on the whole of society. Almost every aspect of daily life was influenced in some way. Average income increased and brought the standard of living up. The population grew rapidly due to the reduction of infant mortality and rising life expectancy.
This historical process has had an influence on housing and domestic supplies.

Prior to the Industrial Revolution, the population was mainly rural and agricultural. Most of the workforce was employed in agriculture, either as self-employed farmers as landowners or tenants or as landless agricultural laborers. All types of goods were made by hand including housing, furniture, and energy sources. Historians called it the Domestic system wherein the manufacturing of products was carried out at home or in small workshops. The workers involved could work at their own speed.

According to the research of Françoise Choay, the village works as a community between each household. Their properties and their relatives enable them to be self-sufficient and everybody knows each other. In the city, the inter-knowledge integrated by the neighborhood delivers a similar relation between the inhabitants. Personal identity is confused with the group undertakings; collective identity takes priority over the individual. Still, there are confrontations with different mindsets and ways of doing things in a village. This system enables a certain degree of security. This stability prevents the need for economic growth. Hierarchy is broadly accepted and there is no class mingling. Local wood, oil and wax candles were used to heat and light living spaces.

First industrial revolution



The invention of steam engines in 1769, as well as new inventions, led to better communication were a catalyst for the First Industrial Revolution. James Watt's improvements to the steam engine and his collaboration with Matthew Boulton on the creation of the rotating engine were crucial for industrial production: machinery could now function much faster, with rotary movements and without human power. Improvements in mining technology built up coal extraction to power the factories and run railway trains and steamships. The First Industrial Revolution saw steam-powered machines replace human labor in the industry.

With a growing population requiring food, clothing, and housing a new means of production was needed to meet the demand. The factory system is a method of manufacturing using machinery, powered by water or steam, and division of labor in order to produce more in less time. With a long line of people willing to work, employers could set wages as low as they wanted because people were willing to do work as long as they got paid. Meanwhile, the Enclosure Acts and the mechanization of agriculture increased productivity and freed up labor. Many farmers left their fields to join the cities; causing rural depopulation, an opportunity to leave behind the misery of the agricultural lifestyle and to improve living conditions. New towns were established around the industry and connected by a well-organized system of transport. The new railway connections improved both coastal towns and isolated provincial towns. With the combination of printing and transport connections, knowledge was more easily publicized across the world.

People faced global anomie, a condition of instability resulting from a breakdown of values and due to the socioeconomic lack of understanding. It led to alienation, a sense of disenfranchisement, and feelings of powerlessness. People couldn't slip through the system. The priority of the "I" took precedence over the "we". The depersonalization of social relations, as well as inhumane working conditions, highlighted the conflict of interests. Confrontation with other cultures, other modes of organization and thought led to an increased consciousness. Social hierarchy, hitherto accepted as natural, was questioned. The existence of socio-economic differences no longer appeared as obvious. The opposition between employers, property owners, and workers' organizations led to negotiation or a struggle for political power, for the management of neighborhoods.

Housing

The massive influx of new workers led to a social and housing crisis.

People from different localities and different cultures came together and reestablished themselves in the same place. People moved in so rapidly that there was not enough capital to build adequate housing for everyone, so low-income newcomers squeezed into increasingly overcrowded slums. Accommodations were designed in new locations, without an interface between the Community, in order to have a private space.

Domestic supplies

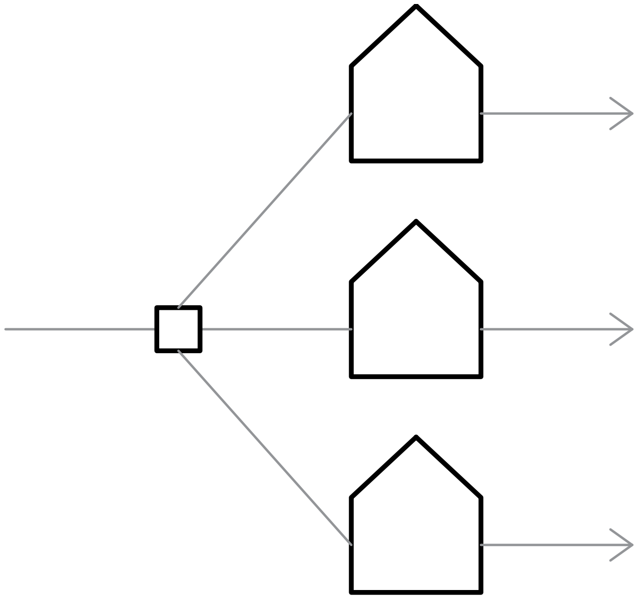
Coal from coal mines was progressively used instead of wood and oil for domestic and industrial heating. Originally created as a by-product of the cooking process, coal gas took over the wax candle and oil for lighting. In 1812, coal gas replaced oil to light the cities of London and Paris.

Due to coal burning, urban air pollution often reached very high levels and urban smog, chemicals compounds that combine smoke and fog, were formed during foggy conditions. The effects of this pollution on buildings and vegetation became obvious and caused death rates to rise dramatically. London, the center of the industrial revolution, became famous for its high level of air pollution in that period. In 1873, nearly 700 Londoners died in a single day due to smog. The 1875 Public Health Act contained a smoke abatement section to try to reduce smoke pollution in urban areas.

The population grew rapidly due to the reduction of infant mortality and rising life expectancy.

This historical process has had an influence on housing and domestic supplies.

SECOND INDUSTRIAL REVOLUTION



Introduced in 1880, Taylorism follows "The Principles of Scientific Management". The philosophy behind Taylorism focused on the belief that making people work as hard as they were not as efficient as optimizing the way the work was done. Taylor proposed a new method of factory management which would increase productivity by optimizing and simplifying jobs. He introduced time and motion study for optimum job performance and broke each job down into its individual motions. With unnecessary motion eliminated, each basic, mindless and repetitive task is carried out by one worker. The efficiency of a worker is evaluated by the number of similar tasks accomplished and motivated with a piece-rate pay method of wage determination. In other words, if a worker didn't achieve enough in a day, he didn't deserve to be paid as much as another worker who was highly productive. The purpose is to maximize profits by reducing the marginal cost until the production of one more unit of a good is almost equivalent to material cost.
Henry Ford was influenced by the high efficiency

of Taylorism; he was the first to use scientific management techniques at his factory. In 1913 Ford introduced the assembly lines in his factory; instead of workers moving around, the product moves past the workers who progressively assemble it. These lines became the key to mass production, leading to a price decrease which resulted in automobiles that were affordable for almost anybody. The success of Fordism enabled a rise in wages. It was a simple rule: high pay for hard work. Henry Ford introduced a new pay system by enhancing Taylorism.

While Taylorism increased the gap between social and working life, a debate arose concerning the morality of the factory system. Workers did not feel that they were benefiting from the economic growth they were hearing about. One of the problems concerned women's and children's labor; in many cases, women were paid almost a quarter of what men made and children were hired for little or no pay. By the 1810s, in industrial countries, this period saw the growth of labor unions or organizations of workers who unite to make decisions about conditions affecting their work. The main claims opposed the long hours with little pay, unfair treatment, and child labor. Labour unions organized strikes and protests. In each European country, they succeeded in acquiring rights. Unions have been responsible for most of what people now consider normal working conditions now and still continue to influence these areas. Labour unions reveal the necessity to satisfy the many by empowering the working class rather than the few who have wealth and institutional power.

That is what the two philosophers Engels and Marx present in an analysis of current conditions based on the critics of a polarized society between the bourgeoisie - people who own land, resources, factories, and other means of production, and the proletariat -people who work for wages. The proletariat constitutes a majority of the population and their dehumanization may lead to social revolution. Many of their political actions, considered communist, have been implemented throughout the world during the past century-and-a-half.

Some industrialists themselves tried to improve factory conditions for their workers. The government became involved to provide a basis for agreements and a framework between employees and employers.

Housing

Policy and industry experts have also started to take part in living conditions. They try to respond to the problem of housing that restricts the self-fulfillment of the population.

Françoise Choay discusses two architectonics models:

- The progressive model was defined by writers such as Owen, Fourier, Richardson, Cabet, and Proudhon. All these writers shared the rejection of worker alienation in the industrial city. They assigned mathematically standard requirements that allowed for a worker's fulfillment as a person. Science and technology can enable people to solve problems. This positive thinking oriented toward the future proposes bright, green and, wide open spaces. These spaces bring together housing, workspace, and culture and leisure activities. In France, Jean-Baptiste André Godin was an industrialist and a highly involved reformer. Influenced by the utopian Charles Fourier's Phalanstère, he developed an industrial and residential community called the Familistère de Guise. This social palace, built within Guise in 1861, enhances not only the physical comfort of the housing but also its "production, trade, supply, education, and recreation". All of the accommodation is spacious, clean and provides many supplies. The architecture of the commune reflects in detail these ideals of self-contained community life; each worker would have an apartment for his family to live privately, but with access to shared services. The working class keep working hard but earn a decent home.

Despite the Godin's commitment to overcome alienation, Michel Foucault accuses the familistère of being a panoptic architecture that tries to keep control of the workers by monitoring social and cultural life. This comfort zone allows for an increase in the ability to work and helps to curb the proletarian revolution.

- The cultural model theorized by Ruskin and William Morris focuses on 'human grouping' rather than on individuals as in the progressive model. Each member of the community contributes to the community and is unique. In 1898, Ebenezer Howard initiated the garden movement in the United Kingdom, a method of urban planning with self-contained communities surrounded by "greenbelts", containing proportionate areas of residences, industry, and agriculture. His concept was implemented by Raymond Unwin in Letchworth and Welwyn Garden City in north London and spread all around the world..

After the World Wars, the need for housing reached an unprecedented high. In 1928, the International Congresses of Modern Architecture (CIAM), was organized by the most prominent European architects of the time, with the objective of spreading the principles of the Modern Movement. CIAM proposed that the social problems faced by cities could be resolved by functional organization. A new model emerged that sought a new and better world for the people. Le Corbusier would further develop the ideas of Godin and Howard. The "Unite d'Habitation" in Marseille focused on communal living for all the inhabitants to shop, play, live, and come together in a "vertical garden city."

These models shared the ambition of a collective framework constructed upstream. The structure describes scientifically the individual's needs and expresses them into a geometrical incremental model.

Domestic supplies

Public policy multiplied the standards related to construction, security, comfort, accessibility, urbanism, the environment, standard conditions concerning the right to erect buildings, property rights for building use and the openness of buildings to the public. For example, the Public Health Act 1875 of the Parliament of the United Kingdom was the first step on the road to improved public health by regulating things such as sewage, hygiene, and home construction. Edwin Chadwick, a social reformer and architect, played an important role in its creation. He believed in using science as a means for social improvement and published 'The Sanitary Condition of the Labouring Population of Great Britain', a study of the issue of sanitation amongst the poor. He investigated the economic argument by giving a value to each life and showed that there was a direct link between poor living conditions and disease and life expectancy. Most of the poverty relief was given to the families of men who had died from infectious diseases due to a lack of hygiene. Money spent on improving public health was, therefore, cost-effective when viewed from a long-term perspective. For Edwin Chadwick, the main priorities were to improve drainage and provide sewers and clean drinking water, to remove all refuse from houses and to maintain unimpeded access to medical staff in each town. After the cholera outbreaks that occurred in 1832, 1849 and 1855 in London, killing tens of thousands of people, followed in 1837 and 1838 by epidemics of influenza and typhoid, combined with the Great Stink of 1858, the government asked Chadwick to carry out a new inquiry into sanitation and this investigation came to fruition in the Public Health Act of 1848.

Waste management

Throughout history, waste generated by humans was biodegradable and negligible due to a low population. Demographic growth with high population areas and new materials led to the necessity of waste management. The build-up of waste due to the onset of industrialization and sustained urban growth caused a rapid deterioration in sanitation levels and the general quality of urban life. Municipal systems of waste disposal sprung up at the turn of the 20th century in large cities of Europe.

Waste management was established in 1846 in London with The Nuisance Removal and Disease Prevention Act. Then the Public Health Act 1875 made it mandatory for every household to deposit their weekly waste in a trash can. Later, it became compulsory to collect household garbage in and around Paris in 1883. For Berlin, waste management started in 1895.

Drinking water and sewage

In the mid-nineteenth century in Europe, modern sewage with clean water and sanitation were built as a reaction to the exacerbation of sanitary conditions brought on by heavy industrialization and urbanization. The cities' needs for a steady water supply became the responsibility of the state whereas it had until then been left to a private and religious incentive. Water turned into a matter of public good. New York became the first city in 1842 equipped to manage water. In London, in 1865, Joseph Bazalgette designed a vast underground sewage system for the safe removal of waste. Contrary to Chadwick's recommendations, Bazalgette's system and others later built in continental Europe did not pump the sewage onto farmland for use as fertilizer; it was simply piped to a natural waterway away from population centers, and pumped back into the environment. In many European countries, housing and public buildings are now obliged to connect their sanitation to the national sewerage where possible.

In 1880, manufactured gas was replaced by electricity for urban lighting, and by natural gas for household and industries activities, including heating and cooking.

Electricity

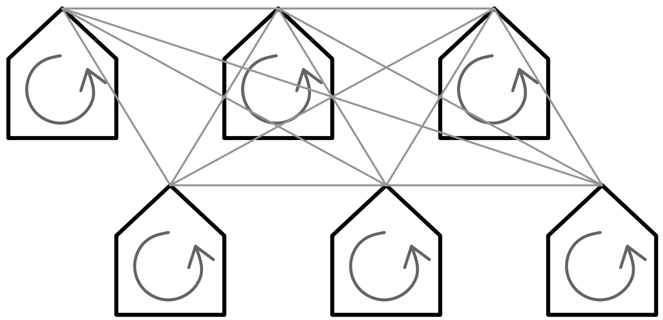
Electricity was used in many areas, including for urban lighting, electric railways, telephone, telegraph, TV, and radio. In 1879, Thomas Edison introduced a new way to produce light with the electric light bulb. The same year, in Switzerland, the first hydroelectric plant was built. In 1882 energy supply was for the first time installed over a large distance with 57 km between Miesbach and Munich. The strong electricity expansion enabled network coverage across the industrial country.

Gas

The Gas Council in Great Britain proved in 1959 that liquid natural gas could be transported safely, efficiency and cost-effective results over a long distance by sea. London was connected to Leeds by a 510 km long high-pressure trunk pipeline. Town gas started to be supplied to households via municipally owned piped distribution systems.

Housing management became a nation-wide community organization operated by the state. Collective housing was designed and built by experts according to standardized models. The management of domestic supplies was organized and shared by the state in partnership with companies. Resources are extracted, processed and distributed; refuse was removed from houses. Water is withdrawn, shared and discharged after treatment. Networks were developed to diffuse the production of electricity and natural gas extraction.

Third industrial revolution



By the middle of the 20th century, new information and communications technology made it possible to automate production. The arrival of electronics, computers and then robots, allowing the automation of manufacturing works, brought about a rise in the service industry at the expense of the secondary sector of the economy.

The efficiency of capitalism reached its peak. The maximization of profits by reducing the marginal cost exceeded expectations by reaching almost zero. The Internet is one of the most significant examples; the Internet revolutionized communication by creating a worldwide open network leading to more democratic access to knowledge. Information could be duplicated almost for free in a numerical shape. New ways to produce material goods or services emerged, based on the open source philosophy to build common ownership in a collaborative way. We witness the emergence of new working organizations that build upon the collective intelligence and collaborative works.

The phenomenon of dematerialization subverted our entire economy. For example, it was seriously disruptive for the musical industry. "We don't sell the music we shared it": this quote from Leonard Bernstein has never been more pertinent than in case of the music streaming, where companies tried to address the issue of free access to music by the providing a free online music library. The publicity generated by the visibility of the website generates the artist's pay. The music industry is not the only one affected in that way; this transition extends to the whole cultural industry, including movies and books. Today, one-third of the population produces their own content with their Smartphone and computer and shares it on the Internet network with a marginal cost close to zero.

In parallel, this knowledge sharing comes up against new capitalist economic regulation; By appraising the value of knowledge from a commercial standpoint, and an increasingly granting intellectual and information property rights for what used to be common property, post-industrial companies have opened up new trading areas but have also instituted new monopolistic rents for ownership rights. New companies have emerged, symbols of the third revolution. Their power is no longer bound by their material property but rather their ability to connect people. Uberisation refers to a property of a tele-networked business which is highly economical and efficient by providing a technological platform to match users and providers on a massive scale. Uber, the most powerful taxi company, does not have any taxis but rather a platform accessed via its websites and mobile apps. Through these apps, anybody can be a taxi driver and prices for the customer are lower. Following this process, many companies were born such as AirBnB to replace hostels, Amazon for retail stores, Blablacar for regional transport, and so on. There is a growing complexity of trades, and production is no longer a chain reaction but a worldwide network.

Housing

In Europe, cities are increasingly polluted. Since the 1970s, urban exodus surpassed over the

rural exodus. The consequence is significant commuting in both, the morning and the evening for all who work in the city and live in the surrounding area.
The number of motor vehicles in urban areas steadily increased and air quality problems associated with motor vehicles became more prevalent. The urbanization contributed to significant social change; give a rise to the first urban development policies by the implementation of public transit such as the subway or comprehensive urban policies. The city became a wide network of public transport.

New technologies of automation also have also taken place in the construction process.
For the professional: Building Information Modelling (BIM) is an emerging process involving the generation and management of an intelligent 3D model that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, analyze and inspect buildings and infrastructure. Each professional is interconnected in order to boost the efficiency of the production process by reducing rework, improving productivity, reducing conflicts and changes during construction, and so reducing the cost.
For the layman: The reproduction of knowledge as an open source also comes out also in the housing field. Websites provide information and describe the process of construction. On Youtube, there are abundant tutorials on this topic. Self-construction belongs to people who have time to accumulate and study the different experiences spread through the Internet...

Domestic supplies

Waste management

In the 1990s, separating waste became no longer just of environmental importance, but also of economic concern. Center for waste sorting in Landfills are an increasingly pressing problem; the volume of waste is growing, whereas less and less land is available to deposit refuse. Waste sorting, the process by which waste is separated into different elements, began to appear in development policies. The idea is to promote awareness of the environmental impact of waste. In 2014, each European inhabitant produced an average of 475 kg of waste. Europe is committed to reach 70% of recycled waste by 2030.

As an answer to this waste management issue, the zero waste movement gained publicity in 1998–2002. Zero waste is a philosophy that encourages the redesign of resource life cycles so that all products are reused. This philosophy is currently promoted by zero waste shops, markets, CSA model or even city composts.

Heater

The task soon became not only how to keep heat out but also how to keep heat in. The 20th century saw a gradual rise in public awareness of the value of thermal insulation. The gradual introduction of air-conditioning systems into home design also contributed to a greater need for thermal insulation. In the 1970s, the production of domestic oil had peaked, which subsequently created a greater dependence on foreign exports, a dramatic shift in public awareness and sensibility toward energy conservation.

The Kyoto treaty was signed in 1997 that commits state parties to reduce greenhouse gas emissions. The scientific consensus is that global warming is occurring and it is extremely likely that human-made CO2 emissions have predominantly caused it. States committed to establish regulations aimed at improving the energy performance of buildings as well as the dependence on fossil fuels. Walls became high tech products. Instead of being dependent on energy supplies such as gas or electricity for heating, people favor good performance. Building design took into account thermal capacity, air proofing, air-conditioning, and heating.

ELECTRICITY

Electricity represents an important part of the energy consumed in the world. Its production has been, by the 1990s and after research on greenhouse gases, a question of vital importance to our society. The energy self-sufficiency of countries contains a geopolitical aspect. The production of electricity is usually carried out by a generator that converts fossil fuels, renewable or nuclear power energy, to electrical energy. The necessity of generating electricity while reducing CO_2 emissions and promoting renewable energy sources is now at the heart of our concerns.

Wind power, hydropower, solar energy, geothermal energy, and bioenergy represents the mainstream technologies in these fields. Renewable energies are collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, geothermal heat, rain, and waves. They can be adapted to each location and on a habitat scale.

Procurement of solar panels is first an investment, then electricity production doesn't require anything extra; the marginal cost is zero. Housing acquired relative autonomy within the framework of the service life of the PV.

2. Environmental issues

Nowadays, The environment appears as a distant time horizon, poorly defined by our society, and as a utopia facing economical and sociological limitations. It's worth highlighting the minor share of the environment in public politics largely outweighed by the technical and social concerns. This irrational blindness to the relationship between our lives and the environment call for a global reassessment of our system. The ecological transition undermines the idealized framework that we want to keep. This transition is an increasingly urgent task exposed by scientists in the IPCC report, the Intergovernmental Panel on Climate Change. Do we really have the choice to separate the ecological transition from the third industrial revolution while the earth's sixth mass extinction is occurring?

«The day is not far off when the economic problem will take the back seat where it belongs, and the arena of the heart and the head will be occupied or reoccupied, by our real problems - the problems of life and of human relations, of creation and behavior and religion.» John Maynard Keynes

Collaborative commons

Jeremy Rifkin spread the expression of the third industrial revolution as a starting point for the ecological transition. The expansion of a worldwide network, and the destabilization of capitalism through a new socially-oriented economy are the components of a new paradigm. We are already witnessing the emergence of a hybrid economy, part capitalist market, and part collaborative commons. The Internet technological revolution brought marginal costs near zero, making goods and services low cost, nearly free, and abundant, and no longer subject to market forces. Production and distribution of those goods and services, therefore, became meaningless. It created a cornucopia from which capitalists cannot feed. The marginal cost of zero production connects a strong network. The Internet of things enables humans to communicate, finding a synergy between each thing in order to optimize the energy efficiency of the society while ensuring the overall well-being of humanity and the planet. Rifkin mentions the evolution of the notion of affiliation to a social group; beyond blood ties, human has created religion affiliation, national identity and now associative community. According to him, it is possible to create a biosphere affiliation which considers all living creatures as being a part of our social group. This affiliation is empowered by a common goal to save the planet.

" The result is that "exchange value" in the marketplace is increasingly being replaced by "shareable value" on the Collaborative Commons." Jeremy Rifkin

Currently, social commons is growing faster than the market economy in many countries around the world. However, it is often ousted by economists, in light of the fact that it does not have a monetary value. The John Hopkins University Center for Civil Society Studies conducted a survey of 40 nations about the actual economic impact of the social commons. This survey reports a non-profit commons value averaging 1.9 trillion in operating expenditures. For instance, in France, Canada, Japan, and the United States, the non-profit sector already makes up 5 percent of the GDP and this number is steadily increasing. The individuals implicated in this social common are called the "prosumers", they are producing and sharing their own information and goods at a near zero marginal cost. Green energy, 3D printed objects, cars, homes, clothes, tools, toys and a myriad of other items are shared via social media sites, rentals, redistribution clubs, cooperatives and so on. Crowdfunded innovative social enterprises built by young entrepreneurs helps frame this blossoming economy.

Green architecture

The 20th century has seen the standardization of housing by taking into account the global perspective of hygiene and comfort, in particular in functionalist modern architecture which limited the architecture to a calculated and normalized framework. The 21st century will reveal the uncertain integration of natural fluctuations, and green architecture integrates this value in buildings that are environmentally friendly and that maintain the modern living conditions of the last century. Francis Gendron, a mentor in green building design, talks about six green architecture movements in which we can find different approaches and their certification:

- Healthy and natural housing
- Energy-performing housing
- Low Grey energy housing
- Resilient Housing
- Simple survivor
- Living Building Challenge

Compressed earth block housing by Ginette Dupuy, in Quebec © Ginette Dupuy

HEALTHY AND NATURAL HOUSING

Forget about the usual building materials such as concrete, vinyl siding or pink foam insulation when it comes to natural and healthy housing. The walls are made of biotic and inorganic materials such as straw, hemp, COB, wood, clay, etc... Housing is built from the earth, quite literally. The construction doesn't require plastic vapor, air or rain barrier, the natural wall simply perspire; the vapor is regulated whereas the air is retained within the building. At the end of its usage, the organic matter naturally breaks down; the building is biodegradable. The cost is mostly the main challenge due to it being highly labor-intensive, the necessity for a well-trained workforce, and in some cases, the price of materials.

Building based on the passive house concept in Darmstadt, Germany. © Passivhaus Institut

ENERGY-PERFORMING HOUSING

The core focus of energy-performance is to dramatically reduce the requirement for space heating and cooling, whilst also creating excellent indoor comfort levels. Passivhaus is the standard certification for those kinds of building, which originated in Germany. While it is possible to achieve the new Passivhaus building standard with artificial materials, it is often difficult to achieve with natural materials making it quite expensive and labor intensive. But the additional energy required for their construction is rather insignificant compared with the energy they save later on. From 31 December 2020, all new buildings in Germany have to be nearly zero-energy buildings. Germany's largest source of domestic fossil fuel is coal. The country is the world's biggest producer of lignite (brown coal) which emits particularly high levels of CO2 and still has extensive deposits. Germany is also the world's biggest natural gas importer, having to bring in 92% from the gas it consumes in from outside the country. This economic and political context pushed this standard in building code requirement for financial and energy independence.

The CFLD Feng Tai Science Park in Beijing, achieved LEED Gold for Core and Shell. © Haozhen Pan

LOW GREY ENERGY HOUSING

The certification LEED, aims to achieve high performance in human and environmental health: location and transportation, sustainable site development, water efficiency, energy efficiency, the selection of materials, indoor environmental quality, and stewardship of resources and sensitivity to their impacts. It helps to encourage owners and operators to be environmentally responsible and to use resources efficiently.

and still has extensive deposits. Germany is also the world's biggest natural gas importer, having to bring in 92% from the gas it consumes in from outside the country. This economic and political context pushed this standard in building code requirement for financial and energy independence.

Earthship in Taos by Michael Reynolds © Biodiesel33

RESILIENT HOUSING

The house takes care of the owner. Water, electricity, heat, and food are mostly provided by the house which is perpetually in interaction with the natural cycle. From a survivalist point of view, if our entire system collapses and with it, all the infrastructure that supplies our house, our ability to survive isn't compromised. This house can be produced with resources such as waste, natural materials or tools found locally, or tools found in nearby hardware stores.

SIMPLE SURVIVOR

A simple survivor building aims to lower the budget by reducing our needs. The challenge is to optimize the space in order to have a small space that seems bigger. This purified space provides freedom by diminishing material dependence.

Keret house by Jakub Szczesny © Marie Chatard

R.W. Kern Center © courtesy of Robert Benson

LIVING BUILDING CHALLENGE

This certification is the world's most rigorous proven performance standard for buildings. It visualizes the ideal for the built environment to create spaces that, like a flower, give more than they take and create a positive impact on human and natural systems. The living building takes into account the place for an Eco-friendly lifestyle, water management and efficiency, solar energy, health and happiness, the materials, equity, and beauty. This certification combines all the environmental interaction without raising the financial issue.

Whatever the constraints, each of these principles aims to build a more sustainable world. This sustainability starts with the need for processed products, that could include artificial material,heating, and gray energy, the sum of all the energy required to produce good and services... A certain self-efficiency come out of this way of thinking. A green building uses these different approaches by accentuating or accumulating them.

3. HIGH TECHNOLOGY & LOW TECHNOLOGY

This paradigm pits humans in a struggle against nature. To solve social issue and needs, it makes the economy grow and enslaves the planet. But this economic growth confronts the limits of the planet. While the physical limit is reached, new social issues emerge which are no longer about the fulfillment of comfort, but about the fulfillment of basic needs. Two main visions for development emerge from this statement: the high-tech and the low-tech.

We are already engaged in a fourth industrial revolution based on cyber-physical systems. Klaus Schwab, a German engineer and economist, highlights the effects of robots, digitalization and artificial intelligence on the global economy and the arrival of a new society on the basis of full usage of these technologies. The main fields usually identified as a part of high technologies are aerospace, information technology, nanotechnology, robotics, and biotechnology.

Among others, climate engineering is an array of technologies for large-scale intervention in the Earth's climate system with the main aim of mitigating the adverse effects of global warming. High tech promotes technology research as a solution to face environmental issues. In the 1830's, the American meteorologist, James Espy wanted to burn a large part of the Appalachian forest, theorizing that the heat from the fire pits would cause it to rain. 140 years later, the United States launched a military operation, called Popeye, during the Vietnam War, in which American aircraft induced rain by dispersing tiny particles such as silver iodide. The roads became impassable for the army troops. "Make mud, not war." Climate engineering was born, giving humans the power to control the weather. The

Gaïa, the 3d printed house © Wasp

IPCC mentioned climate engineering in 2013 for the first time as an emergency solution against climate change.

In geoengineering there is two main options :

- Solar Radiation Management (SRM); these techniques attempt to reflect sunlight back into space to reduce some of the impacts of climate change. In 1991, nature naturally tested this theory. The eruption of Mount Pinatubo in 1991 caused global cooling in the northern hemisphere for three years, owing to the ash spewed out into the atmosphere, which confirmed the SRM theory. One year later, there was 50% less rainfall than during the driest year observed up until then. Food resources were particularly threatened.
- Carbone Dioxide Removable (CDR); is a large-scale removal of carbon dioxide from the atmosphere. This has led some people to suggest seeding the oceans with iron in a bid to increase photosynthesis, thereby reducing atmospheric CO2 and tackling climate change. However, mine production would have to be multiplied by one hundred in order to collect this iron and this one will have to be transported and spread into the oceans. This hypothesis is an environmental failure; produce Co2 to capture Co2

With all these failures in environmental applications, climate engineering lost its credibility. The only success of this form of bioengineering seems to be providing hope with a fast answer without individual effort in front of complex and deep issues.

In architecture fields, the fourth industrial revolution brought the giant 3D printer into the world. These high technologies use 3D printing as a core method to fabricate buildings or construction components. The 3D printer implements a new way to produce things.
The Italian company WASP has developed one of the largest and most environmentally friendly 3D printers which is capable of building homes from locally sourced materials. By using solar, wind, or hydropower, this 3D printer doesn't need access to electricity. Housing structures can be built everywhere, this proposition offers promising avenues.

House 3D printing offers many benefits, including a reduction in costs, faster construction, increased complexity and accuracy, reduction of accidents, and less waste produced. Although there are certain limitations due to volume limits and th initial expensive investment, home 3D printers can sometimes cost up to one million dollars and require a combination of business and technical expertise for the conception of the printer, the numerical model design and for operating the machine.

High tech radically responds to most of the challenges presented but may go too far in emphasizing relational skills over content. Possibilities are unlimited and many technology investments are sometimes simply don't lead to positive advances in the standard of living. Energy and technical requirements may discredit a high-tech solution, sometimes calling into question the legitimacy of its realization. By contrast, low technology requires barely any energy and technology but has limits.

Low technology

Are we able to satisfy our daily needs with tools that are readily manageable, with long service life, without losing comfort, instead of sophisticated and disposable items that make us completely dependent? Low-tech is booming. Everywhere in the world, ingenious inventors innovate with what they have at hand. Low tech can be built by all, used by all and repaired by all. The systems are simple, resilient, sustainable and accessible in terms of costs and know-how. The processes of building low technologies are mostly shared on the Internet as an open source. The production cycle is radically controlled by each, thereby each keep awareness of the steps and its stakes.

Financial constraint has developed into a source of creativity. Therefore, worldwide economic hardship combines with growing recognition of the need to move towards green construction and to foster this creativity in architecture. Sobriety becomes pretty attractive, with some architects planning new forms of housing that are less opulent but smarter and functional.

Low tech and high tech yet tend to reach this world in transition and the limits of their own principles. In its complexity, high tech uses limited resources, generates a high up-front cost and requires elaborate know-how that carries on the tradition primed by the industrial revolution of using technical jargon to respond to basics needs. In its candor, low tech is capable of offering a different answer to vital, economic or environmental problems. Low tech is an extensive emancipating factor that we will investigate in the next chapter.

II

The three principles of the low-tech Architecture

Physical safety, guaranteed by autonomous building and the mental capacity to answer to their needs, contrasts with the financial safety which is by nature unstable, the fictional value. Either a source of fulfillment or a source of enslavement, housing may respond to most or even basic needs and provide to most part or even all basic needs and create this physical safety. We can build walls without being locked in.

Apart from that system based on skills organization, we may be able to respond to our needs. The low-tech principles used for architecture offer self-sufficiency accessible to all. A low technology can be built by everyone, use easily-sourced materials and works without energy intake. It's a self-sufficient tool than enters into the life cycle.

1. To build on your own

Do It Yourself

A number of initiatives are being set up that aim to help consumers better control their lives and support their optimistic views of the future. Low tech is a technology that is "Do It Yourself". Anyone is capable of producing a variety of low tech items rather than relying on paid specialists. Self-production is a crisis remedy through self-empowerment. DIY was born out of the anti-consumerism socio-political ideology which seeks to repair rather than throw away and build rather than buy. With that in mind, the actions are not longer in link with the market economy and represent an act of rebellion. DIY is also an environmental initiative by requiring less materials and energy resources.

Low-cost

Although justified by skilled labor, prices are not always affordable for anyone. We usually pay for time, material, expertise and quality assurance. The budget is usually insufficient for our expectation, so we don't want to compromise on the material quality, DIY is often ideal. Most of the time, first-time DIYers welcome the opportunity as a solution to cost constraints, as the need has forced them to get involved for the first time in unfamiliar physical labor and learn new DIY techniques from scratch f. Later, DIYers continue to exercise their new found talents and enthusiasm even when no longer forced by financial constraints to do so. Acquiring skills is a resource that lasts a lifetime and brings invaluable and non-pecuniary wealth.

Illuminating self-discovery

DIY is also appropriate for those seeking an opportunity to gain a sense of achievement and personal fulfillment through the realization of a full project. There is nothing better than the feeling of empowerment and achievement inspired by the act of making an object from start to finish. This experience impacts the drive to tackle more ambitious projects. The DIYer is a curious person who appreciates stimulating is the brain in many fields. He responds to his question in material form. A DIYer is also highly valued in our society; the creation being useful and material, the DIYer may show it off.

Therapy

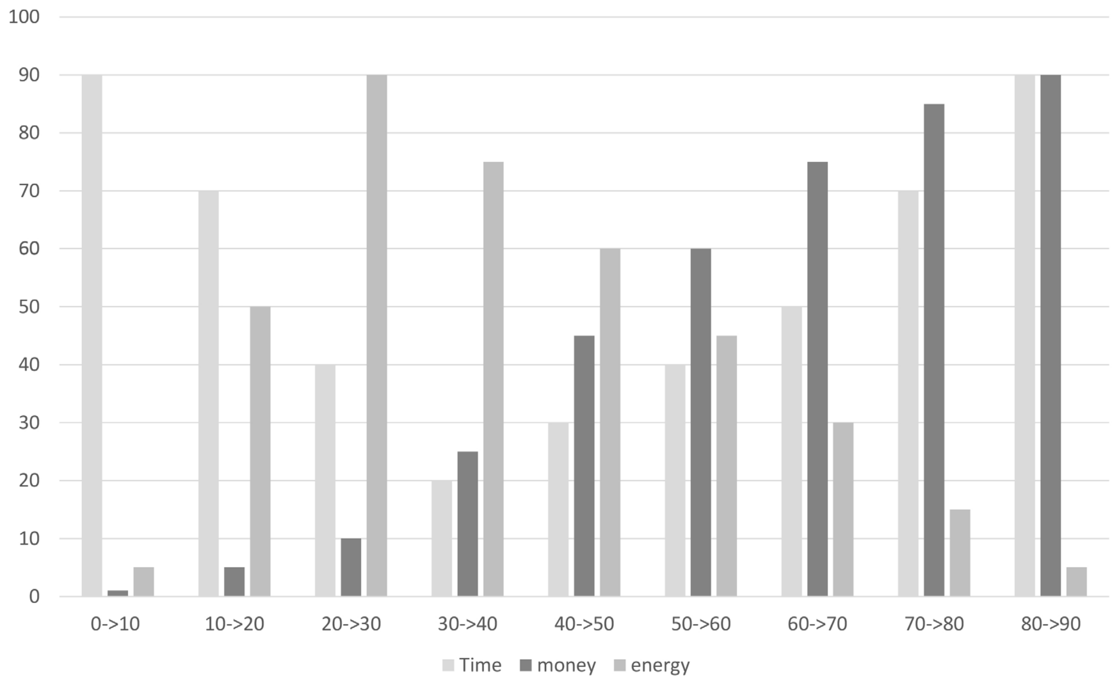
Through value-enhancing and attention captivation, DIY provides effective therapy. It can be a positive way of relieving stress after a long day at work through occupational therapy. DIY is sometimes an end in itself, rather than just a means of achieving something. It's appropriate leisure to unwind tension.

Self-construction

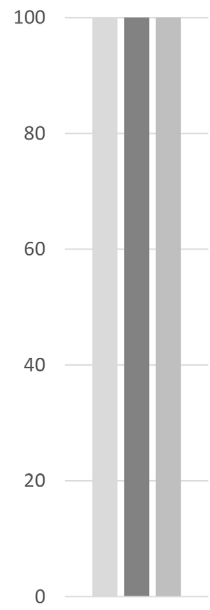
People are generating enthusiasm and energy through projects, and they are equip ping themselves with the means to build. It could be the dream of one person, a family or many families, and in every situation, an exhaustive investment is required. A building is the result of time organization, economic management, construction knowledge, and law enforcement. In order to find information about that topic, people read books, do research on the Internet and ask other people questions. We can find massive open Online courses (MOOCs) with unlimited participation and open access via the web, that offer e-learning about self-construction, and also a lot of videos on YouTube describing the processes.

The research conducted by the IAS, the Institute for Advanced Studies, showed that, for the population surveyed for the study, the main motivations to self-build were the low cost, the social aspect of the participative construction and recognition for achieving this difficult task. Young families and people with low incomes form a major part of the interested population. Time can also present a barrier to this population;

a weekend construction schedule can help them to take the first step. They are usually attracted by green exterior surfaces and good equipment. In some cases, they plan to have children, hence, it is important to propose a model which could be extended. With the right balance in place, the



Capacity to self-build according to age



Ideal state for self-builders


HANDELN
HJCU 403175 9

Usage :
Living space

Year of construction :
2012-2015

Location :
Various location

Architecte :
31 students under the direction of Peter Fattinger

DAS MOBILE STADTLABOR

Architects follow this school of thought by involving themselves in self-construction projects. Since the year 2000, the Vienna University of Technology has become a place to experiment self-construction. Students implement 1:1 scale projects under the direction of a supervisor who orients the results and provides advice. Under the direction of Peter Fattinger at the Department of Housing and Design, the Mobile Stadtlabor in Vienna is a relevant example of this approach. A design class of 30 students planned, communicated and built an accessible and usable installation in public urban space, first at Karlsplatz than at OpenMAX. The students had to work and progress together in order to complete a project on time with all the traditional issues of a construction process: the cost, the organization and the management of unforeseen concerns. This organization goes against traditional architecture competition that promotes individualism which is mostly counterproductive.

The experimental site of Openmarx is going forward with the idea of self-construction. In the project "displaced" coordinated by Karin Harather, architecture students and immigrants share their cultures, dreams, and languages around DIY projects and the organization of events and dinners, events organization and dinners, with the common ambition of transforming a fallow ground into a valuable public space as well as socializing. The experimental space shows its concerns spatially, on the left several recycled materials with tools, across the way a fancy DIY building called the mobile Stadtlabor and on the right a broad table with the kitchen. The personal experience of learning by doing is a really immediate way to foster learning. The experience doesn't stop at the simple achievement of the project; a real community is set up between the participants with spare time leisure activities after official hours such as dinners, parties, concerts, and games.

Das mobile Stadtlabor © Roman simply4friends

Ecological Habitat Network

The Ecological Habitat Network organizes itself according to the same prospect: being one with nature through self-empowerment and helping one another. Volunteers work on sustainable construction projects around the world and help lay the foundations that will set up basic infrastructure in developing communities for years to come. The experience of the participatory site for building or renovation works promote cultural and educational experiences based on trust and non-monetary exchange. Thereby a sustainable global community based on collaborative commons is emerging and reinventing the principles and organization of construction. This community grows thanks to the Internet which facilitates connections between initiators of ecological transition in the building field and gradually builds this ecosystem that gives access to the implementation of solutions that respect humans and the environment.

Here are different construction volunteering websites that contribute to this exchange:

- *https://www.workaway.info/*
- *http://thepoosh.org/*
- *https://fr.twiza.org/*
- *https://www.horyou.com/*
- *http://www.botmobil.org/ (FR)*
- *https://wwoofinternational.org/how-it-works/*
- *https://www.helpx.net/*
- *https://reclaimthefields.org/*
-....

2. To use abundants materials

Until relatively recently, our production paradigm was focused on manufacturing materials for their performance, their physical appearance, and their price. Only the first purpose of its usage was considered; the material was later discarded into landfills or in the best case burned up for energy. We were processing materials which would later be rendered useless because they were being buried or destroyed: "from cradle to grave". With this linear consumption arises the problem of a great impact on the environment in terms of pollution, the environmental and human energy waste, and an expensive production cost in terms of production as new materials have to be manufactured from scratch every time. To produce easily and at a low cost, the low tech uses abundant material from, so-called, technical nutrients and biological nutrients that can be used in a continuous cycle.

Biological nutrients

Nature provides organic materials that can decompose without affecting our environment. As biological nutrients, they are absorbed and further processed by organisms and ecosystems to support their growth, reused and then returned via biological processes over and over again.

Technical nutrients

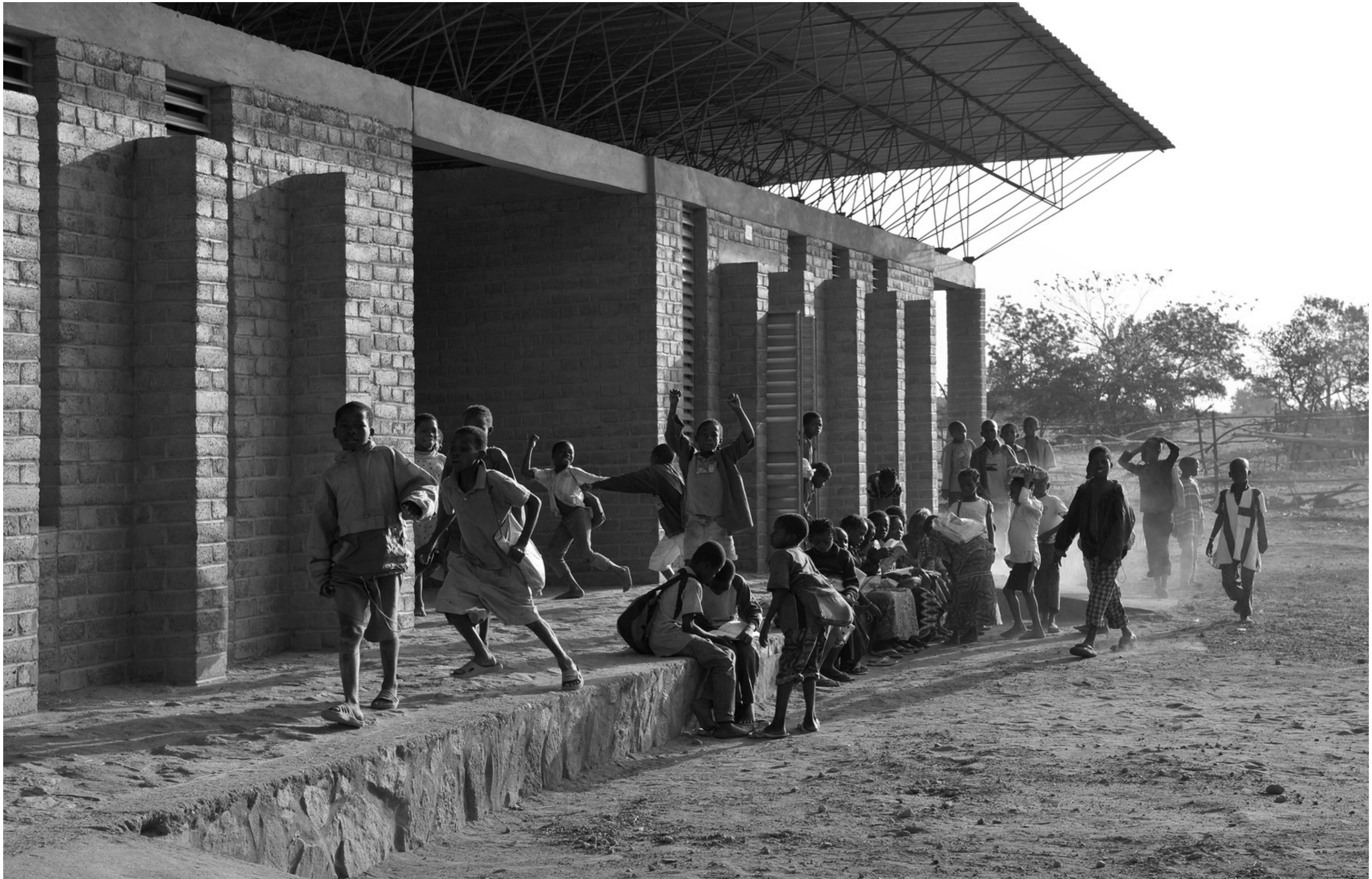
Some inorganic or synthetic materials manufactured by humans can be used many times over without any loss in quality. Technical nutrients include things like metals, minerals and plastics. The nutrients require energy for their first production and can retain their quality; after their first usage, they can be revalued for another task. In this principle, waste gains value and production processes do not have to start again and again from the beginning. Technical nutrients are materials that remain within closed- loop industrial cycles. These technical nutrients are currently abundant on earth but their management and revaluation is neglected. All inorganic and synthetic materials should now be designed for infinite and easy recycling indefinitely.

Cradle to Cradle

The problem arises when biological and technical nutrients are mixed and cannot be separated. When you mix a technical material that is recyclable with a biological material that is compostable you get a material that is neither recyclable nor compostable. The materials are called "monstrous hybrids" by William McDonough and Michael Braungart in their book "Cradle to Cradle: Remaking The Way we Make Things".

Cradle to Cradle is a design certification of products, with biomimetic approach, in which the discarded material from one entity becomes the nutrients for other entities. Biological nutrients form the biosphere and technical nutrients from the technosphere can go through potentially infinite life cycles within the system. The low tech is a tool of this Cradle to cradle approach; a simple assembly enables a long service life with necessary easy reparations, and subsequently an upcycling. The knowledge of each step of the fabrication makes Cradle to Cradle easy.

Cradle to Cradle goes a step even further since the idea is to create a society on the premise that policies, business models, working conditions and energy production could follow this living cycle approach. This philosophy could change our damaging our damage ecological footprint into an enhancement of our environment. In accordance with this vision, Cradle to Cradle in architecture has the goal of utilizing the environment instead of only reducing damaging effects.



Usage :
School

Year of construction :
2001-2008

Location :
Gando

Architecte :
Francis Kéré

PRIMARY SCHOOL OF GANDO

From Burkina Faso, the architect Francis Kéré grew up with many challenges and few resources. After his studies in Europe, Francis Kéré began the construction of the Primary School with the support of his community and funds raised through his foundation. In keeping with this cultural practice of building and repairing all together, everyone could participate in construction process and the success of the project is attributed to the involvement of the local population.
Kéré wanted to use locally available resources. In Burkina Faso, schools are usually built out of concrete. A visible sign of wealth, the concrete is nonetheless poorly suited to the climate, as the interior becomes intolerably hot. Furthermore, concrete production is expensive and requires a lot of electricity. The clay, traditionally used for the construction of housing, is regarded as a building material for poor people but is the main resource locally available and is suited to hot climate. These traditional clay-building techniques were modified and modernized in order to create a more structurally robust construction in the form of mud bricks. The community was initially skeptical, in view of the violent rain season. However, he protected the wall from damaging rains with a large overhanging tin roof.
There is a space between the roof and the interior to avoid overheating that may result from the tin sheet. An ample ventilation is naturally introduced and reduces the ecological footprint of the school by alleviating the need for air-conditioning. Eucalyptus wood, normally used for firewood in the city, is used for the roof structure and for the rhythmical facade that creates calm atmosphere to study.
Two years after completing the Gando Primary School, demand was so high that Kéré had to begin work on a major extension. Also built using local materials and labors, it created space for an additional 120 students.

Primary school of Gando © Erik-Jan Ouverkerk

Usage :
Library

Year of construction :
2011

Location :
Gando

Architecte :
Francis Kéré

Library of Gando © Enrico Cano

PRIMARY SCHOOL LIBRARY OF GANDO

After the great success of the Primary School, the construction of the School Library began. The library maintains the materials used in the other works but changes from an orthogonal to an elliptical geometry reminiscent of the traditional vernacular housing in the region. The ceiling is perforated with clay pots allowing light to pass through and air to circulate.

3. TO LIVE WITH SELF-SUFFICIENT SUPPLIES

In a world that is constantly evolving, independent living can be an invaluable discipline. With smart solutions, it's possible to become independent of anyone but yourself. A building is entirely self-sufficient by providing the electricity, heating and cooling, water and food, the four primary needs that need to be met. The approach is either Eco-friendly or geographically required. Building a self-sufficient home is a great way to stay green, secluded and prepared.

Usage :
House

Year of construction :
1972

Location :
Chateaubriand

Architecte :
Patrick Baronnet

Baronnet house © heol2

BARONNET HOUSE

The Baronnet family, Patrick and Brigitte, left Paris in 1972 to set up in a rural area in Chateaubriand in an old house on a little plot with a well. They undertook many arrangements with the stated goal of being completely self-sufficient. Having proven this gamble successful for 20 years already, they suggest a way of life that anyone can follow by anybody through a commitment to the earth and humanity. Gaining more independence begins with choosing resources based on four abundant elements: water, air, soil, and sun. This autonomous building no longer needs to be connected to an electrical grid, water supply network and sewage system. This prototype implements many simple, economical and reproducible techniques to meet our basics needs and the concrete realization of a life philosophy.

Water

A few years after their move, the water well was polluted by surrounding intensive farming. They had to find another solution for water supply. They began to collect rainwater to use for all their water needs. The water is collected by a roof of slate or clay, strain, and stored in a tank. Rainwater doesn't require a significant filtration, but rather, remineralization. The PH is adjusted to 6,9 by staying in a tank of concrete or masonry during a few days; Bioelectric exchange between H2O and mineral salt naturally adjusts the PH.
A natural sewage system utilizes the functionality of the vegetation, sediments filter media and micro-organisms to purify the wastewater streams. The first solution to save resources such as water is to reduce the consumption and avoid polluting the water a composting toilet. If these rules are respected, it's possible to treat the water only with a grease remover tank with straw and a sewage trench only composed of iris and reeds. The straw with grease is used as compost and the water goes back to nature.
Joseph Országh, a researcher at the "Université de

Mons-Hainaut" in Belgium, tried to put forward a similar natural sewage system at the European level on his website Eautarcie. The idea is to change our chemical sewage system into wetland areas. This change requires to addressing the source of these problems with different propositions: water conservation, pollution reduction by the use of environmentally friendly products, rainwater reuse for irrigation and cleaning, and the use of dry toilets.

Energy

With 6 square meters of photovoltaic solar panels for sunny days and a wind turbine for the windy days, the Baronnets succeed in having electricity all year long with tools that complement one another. In the main room, mudbricks constitute the thermal mass that stores heat for a delayed release and works as air conditioning during summer. They heat the water with a thermal solar panel; this panel is a flat glasshouse with 40 m of copper pipe, the water flows inside it and is warmed up. It's enough for 8 months of the year otherwise the water is warmed up by a wood-burning stove. They have a washing machine without a heating resistor; the water is warmed by the thermal solar panel or by the wood. That way, the washing machine consumes only 400W.

Food

The Baronnet house provides food for the whole year. The south facing glasshouse contains a garden heated by the sun during cold days. A thermal mass enables the regulation of the temperature: a bench made up of earth, a bottle of water and a slab of schist. The bench regulates the temperature in the glasshouse. Thanks to this glasshouse and the bench, they can have vegetables outside of the growing season. This glasshouse includes a solar dryer that helps the food preservation; the production is not continuous throughout the year and it's necessary to plan the food preservation for the non-productive periods. They don't have a fridge and organize themselves without it; canning, dehydration or lacto-fermentation enables them to preserve food. Patrick and Brigitte Baronnet describe this glasshouse as a pleasant place to

stay. Outside, there is also a garden with a pond for biodiversity.
This food self-sufficiency represents know-how that we have progressively lost. A century and a half ago, 80 to 90% of people were living from the land. Today, farmers that provide food from the earth make up only 2%. This issue is even more alarming given that our intensive farming is based on limited resources.

The Baronnets lived with their 4 children during 17 years with only a part-time income, and now with an income of 1400 €. They live a comfortable life. Instead of having a wage to consume, they produce on their own what they need. They eat for free from their garden, they don't pay any rent, water or electricity bills.
The notion of work isn't separable from the notions of time and money. Work became a requirement to provide for basic needs. In their way of life, the notion of work poses a challenge. Are they working when they produce and directly supply their needs by building a self-sufficient system and garden? The work is an added-value, an improvement. Work can be for a personal enrichment or wealth enrichment. They are not architects or engineers, they didn't have prior knowledge about it before, but they proved that it's possible even without a lot of money.

Our economy is now based on oil, iron and rare-earth metals that are limited resources. However, nature supplies an unbelievable abundance for those who consume sensibly. The project of the Baronnet family shows that with renewable energy, it's possible to free ourselves from coal, oil, gas, and nuclear power without losing our quality of life (or for them, even making it more beautiful). By being self-sufficient, you rediscover back the meaning of simple things and you change your relation to the others.

Solidarity is essential to this self-sufficiency. Indeed, the variety of talents of a community enables it to live in collective self-sufficiency in which each member blossoms according to their capacities. The Idea is not only to build an autonomous housing but a space of solidarity. Being self-sufficient doesn't mean for living alone on the fringes of society. Communal based activities which promote collective living can be implemented to inculcate community spirit. It's the transition from a social dependence to social self-sufficiency that creates more valuable relationships.

III

WWW.LOWARCHITECH.COM

The communication of a Low-tech project generally makes sens through a website:

www.lowarchitech.com

A self-production is possible, at home, thanks to an Internet service provider that gives services for participating in the Internet. Different shape of service exists such as commercial, community-owned, non-profit, or otherwise privately owned Internet service provider that simplify more or less the processes of website production.
Informations may be produce, publish and duplicate endlessly with a close to zero marginal cost by anybody with Internet access. According to the International Telecommunication Union in 2018, 55.1% of the world's population has Internet access. It's in our current society an essential tool to communicate.
The web is a malleable and self-empowered medium that can evolute by the contribution of anybody.

In this reflexion appears an antinomic issue: promote low tech thanks to high technologies. Internet requires high investment from the Internet service provider and so can be control. Net neutrality is a question that should not be disregarded; Internet service providers should treat all Internet communications equally. Without net neutrality regulations, ISPs may prioritize certain types of traffic, meter others, or potentially block traffic from specific services, while charging consumers for various tiers of service. The Environmental impact of Internet is also not insignificant. The information on the Internet is, in fact, not just kept in the "virtual world". Data are processed through servers that requires electricity and generates emissions.

However, the social commons, mention in the chapter I.2., blossoms thanks to the capacity of self-production, the abundance of information and the self-empowerment offer by Internet. The network build by Internet is a strong communication support to move towards Eco-friendly solution. Again, It's the question of the self-efficiency that lose its meaning by being reclusive.

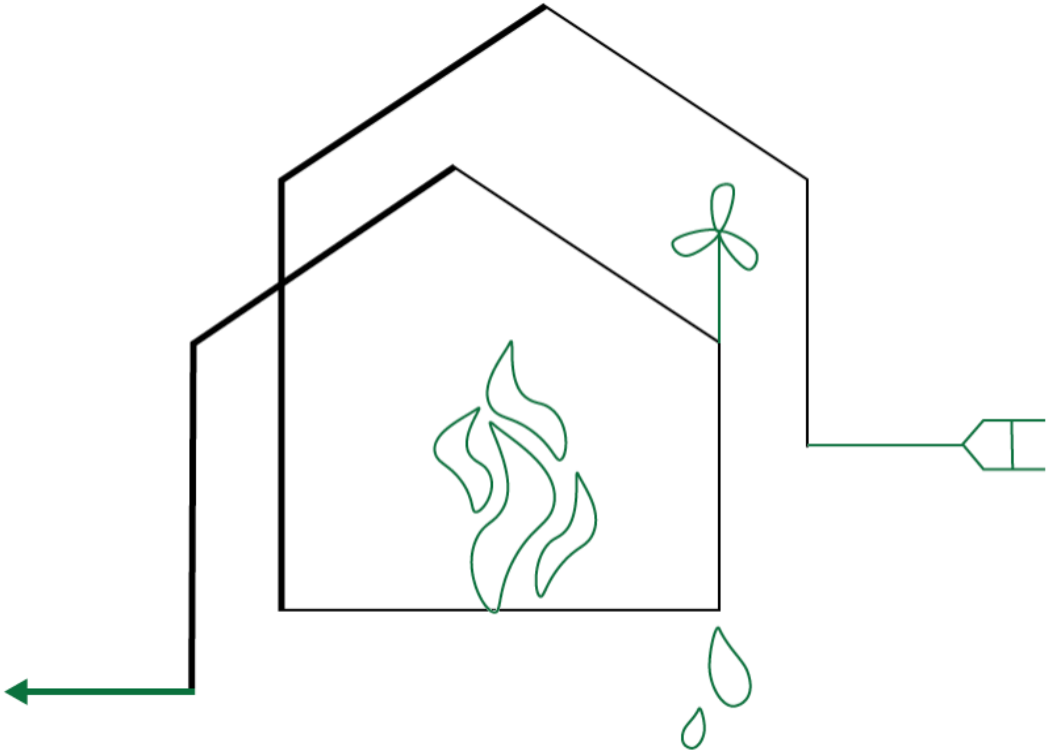
LOWARCHITECH

Current housings are children that demands to grow by gaining greater independence. The tutorials on the website provide yourself the means to build your autonomous housing through the description of the low-tech architecture tools; in other words, an architecture that is self-built, autonomous and made of abundant materials.

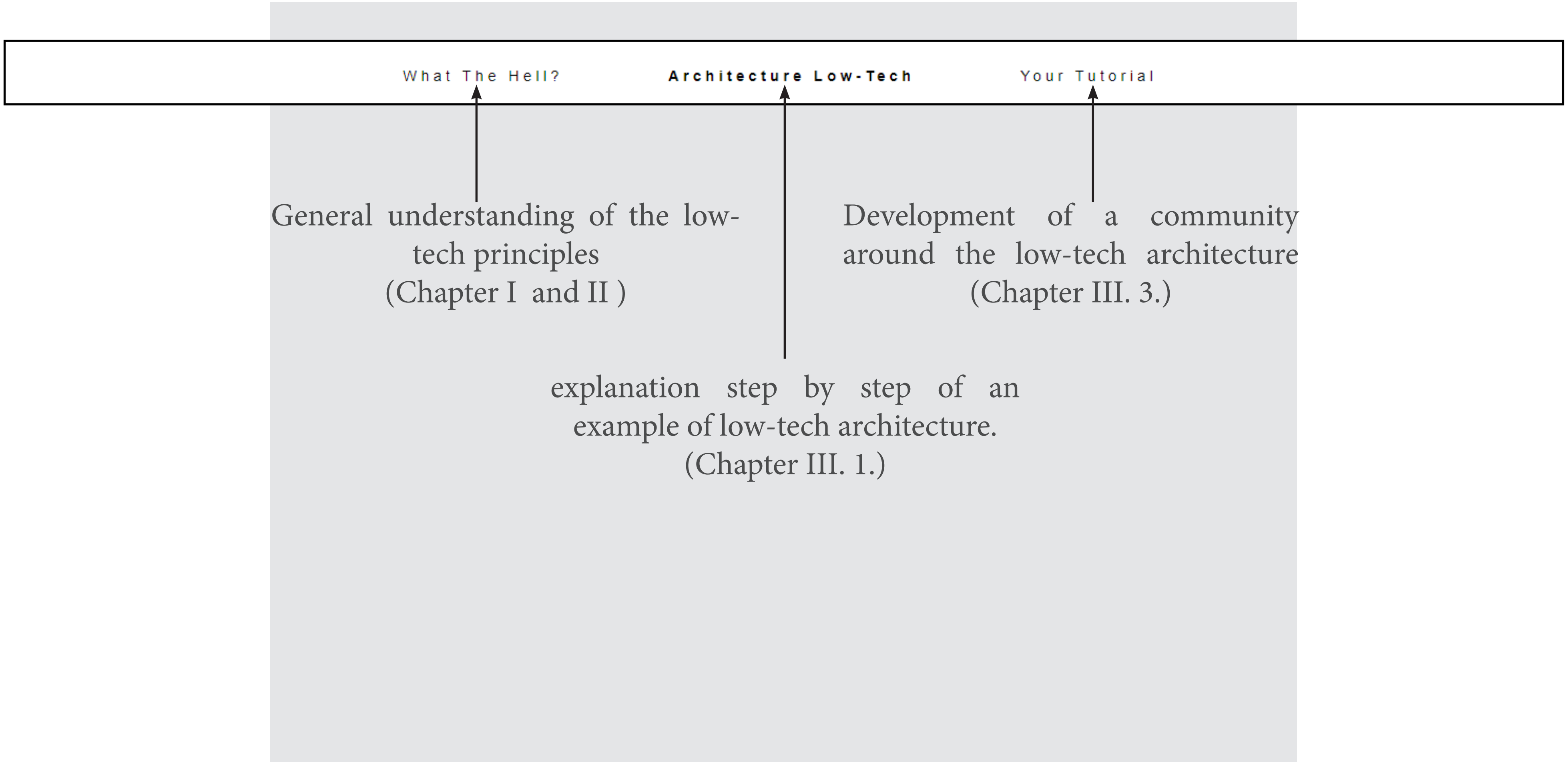
LOWARCHITECH

What The Hell? **Architecture Low-Tech** Your Tutorial

Lowarchitech provides yourself the means to build your autonomous housing through the description of the low-tech architecture tools; an architecture that is self-built, autonomous and made of abundant materials.

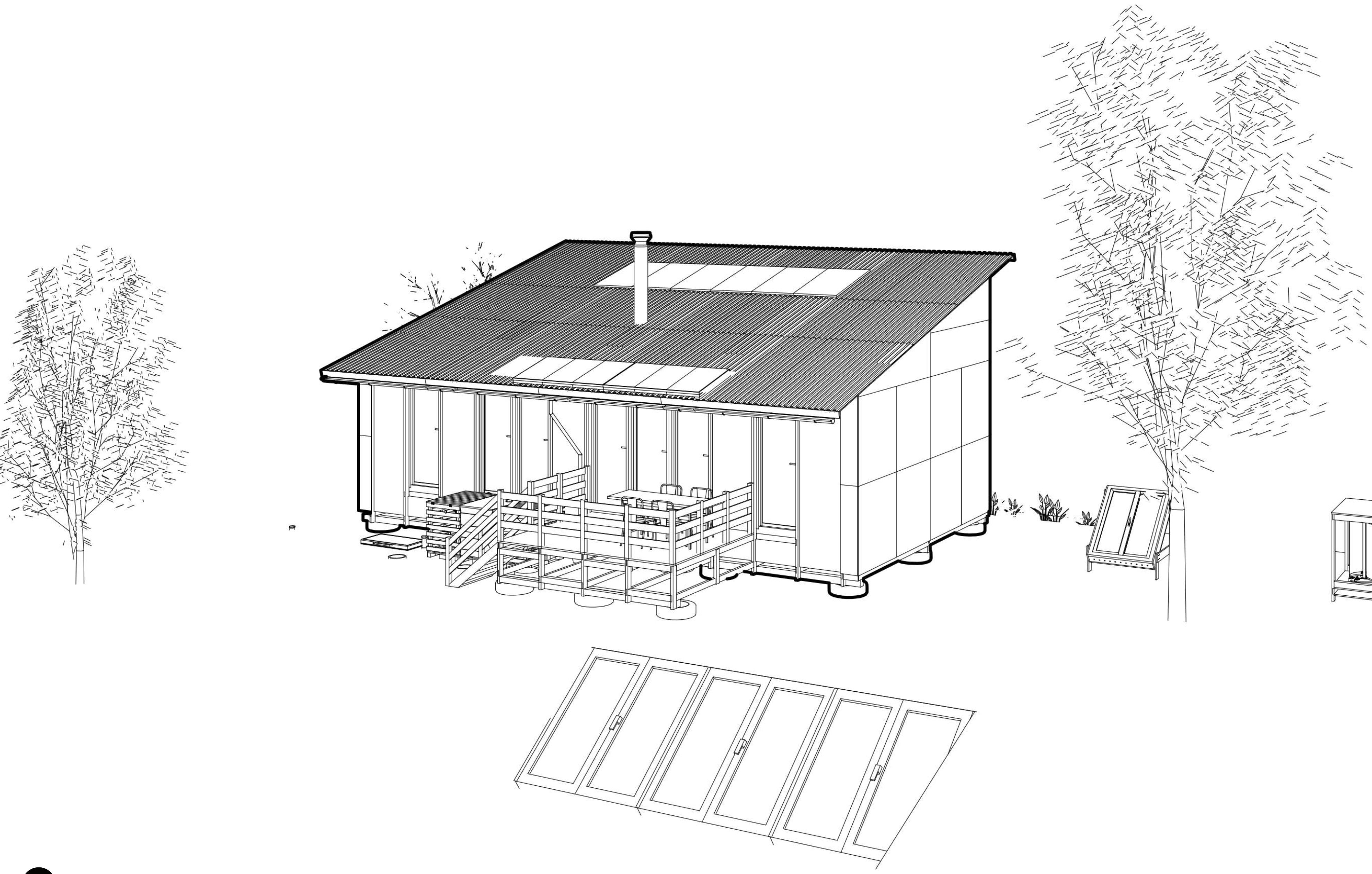


Homepage outline



1. Tutorial content of the website

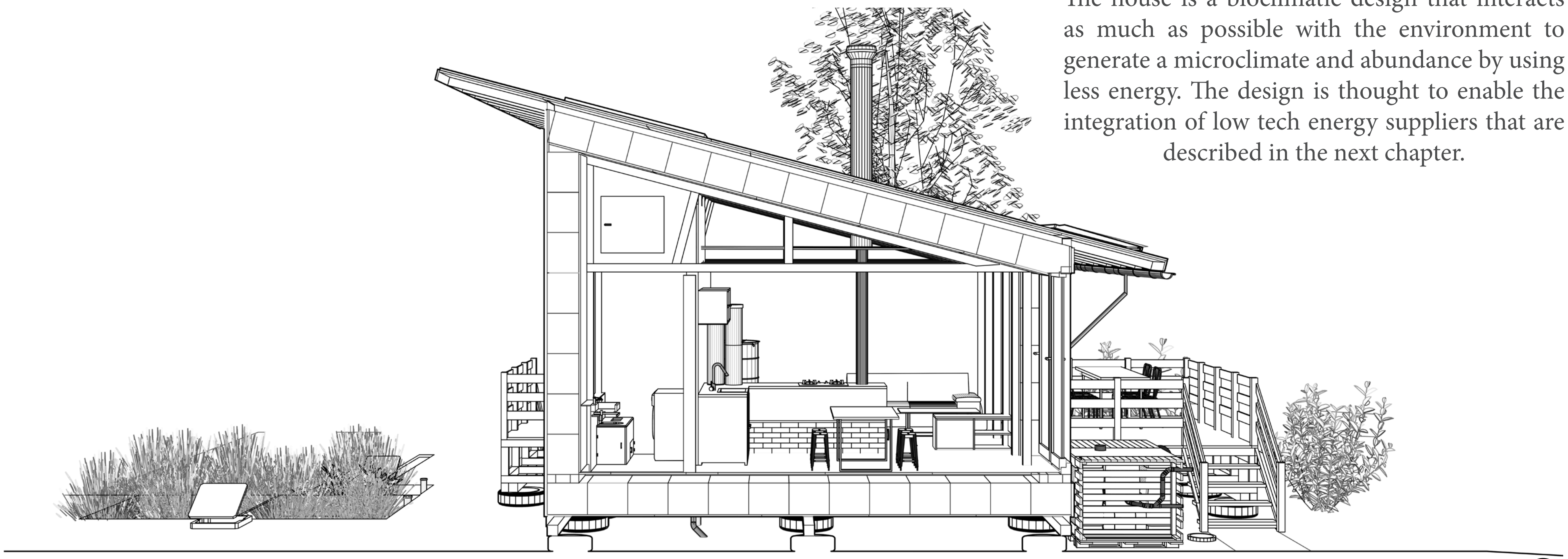
The website proposes an example of a low-tech construction and its energy management.



CONSTRUCTION EXAMPLE

To produce a "committed, innovative, environmentally friendly" architecture is the greatest challenge for our generation of architects. In search of the architecture of the lesser impact and complexity, this example is largely limited to the strict minimum. The aim is to initiate or to rediscover a relationship marked by sobriety which are some of the characteristics of rural vernacular architecture. The reference to rural heritage far from generating an archaic habitat is the support for technical innovations in terms of comfort, ambiance, and energetic efficiency.

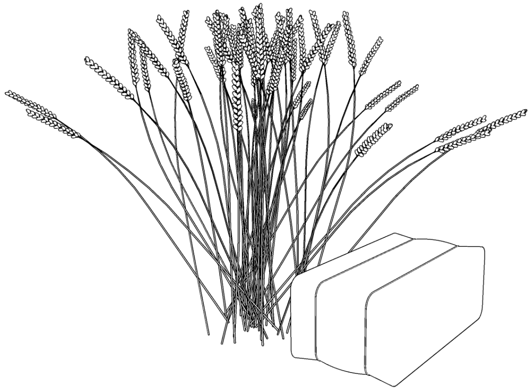
The house is a bioclimatic design that interacts as much as possible with the environment to generate a microclimate and abundance by using less energy. The design is thought to enable the integration of low tech energy suppliers that are described in the next chapter.

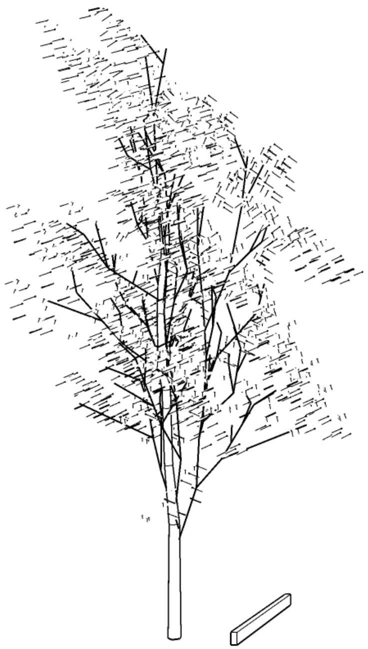


The choice of local materials, such as clay, straw, and wood, and recovery inorganic materials, that can be used many times over without any loss in quality, were main concerns for the environmental impact reduction.

Straw

Straw is a spin-off product of the wheat that is widely locally available and can be supplied directly from the farmer. The local economy is support and transport is reduced. The straw building is long-lasting buildings that may keep their efficiency several hundred years. Surprisingly, straw is so compressed that it doesn't enable oxygenation of combustion; straw is therefor fire resistant. Furthermore, Straw is too hard for the mouses and European insects. Straw can be easily recycled on a place by composting.



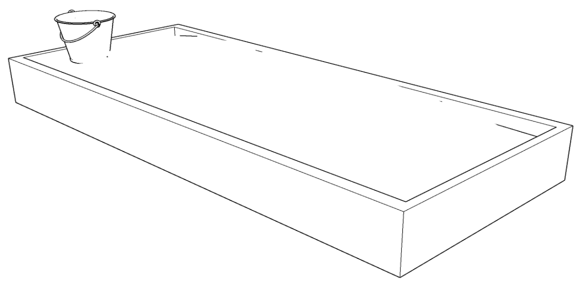


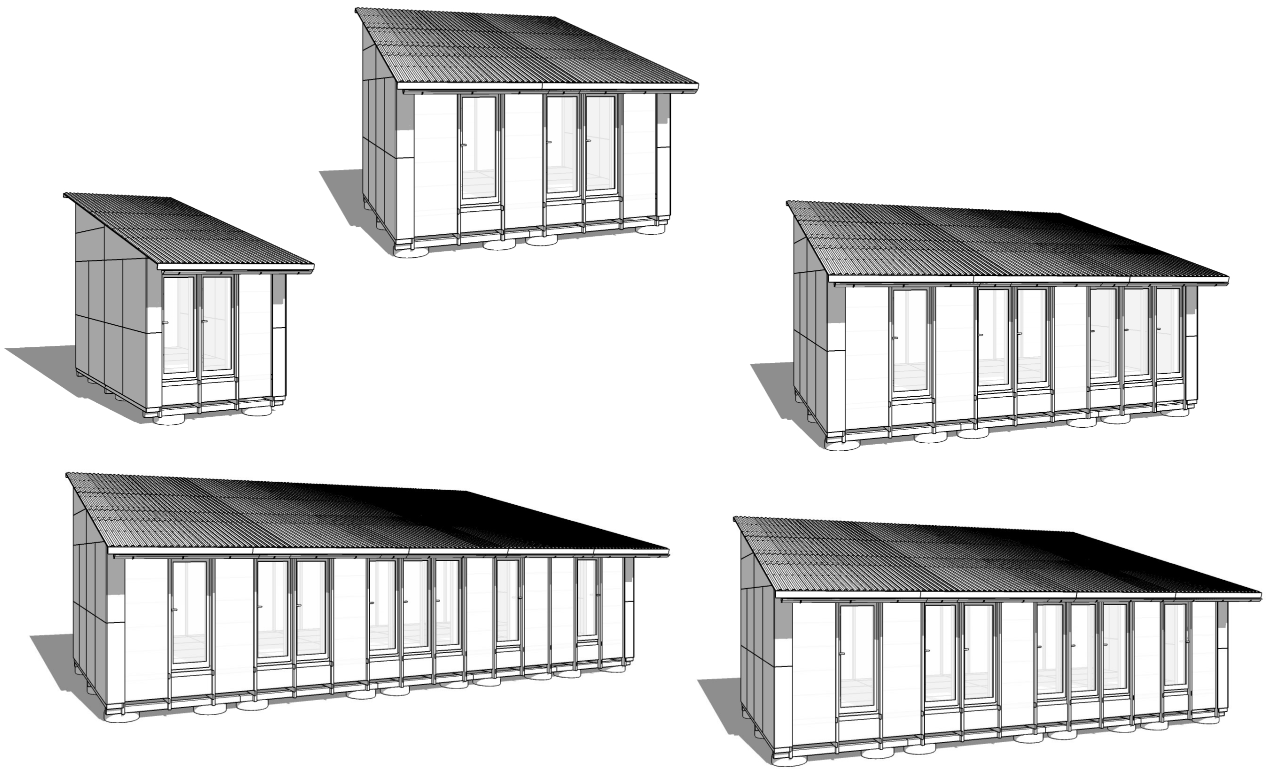
Wood

Wood is local and from sustainable forest management. Such as straw, the wood is long-lasting material that may keep their efficiency several hundred years. The wood structure can be disassembled and reused.

Clay

Clay is mainly extracted underneath your foot. Such as straw and wood, clay building is long-lasting buildings that may keep their efficiency several hundred years. In Facade, clay cracks are easy to repair with a little bit of water. Clay simply return to earth at the time of the demolition.





With modules and removable walls, the house is adapted for each step of life; the inhabitants benefit from distribution in time of investment cost and effort. Each module constitutes 14,5m2 (5,35x2,70m) that can stand next to each other. A removable wall made of wood wool boxes enables incrementally this extension.

Choice of the plot

Localisation

Weather: The constructions suggested in this website are adapted for warm temperate climates, fully humidity with warm and warm to hot summer (identified under the acronym Cfb and Cfa in the World map of Köppen-geiger Climate Classification). What climate conditions will affect the plot in consideration?

- Verify your position using the map provided here:

http://koeppen-geiger.vu-wien.ac.at/present.htm

Altitude: Anything built above a certain height will most likely experience cold weather. The key factor is that the average temperatures drop as altitude increases (by around 0.55°C per 100m). Then Due to limited interaction with the sun and because cold air travels downwards, valley floors should be avoided. What is the altitude of this land?

Exposure to sun: It is best not to build anywhere that has limited sunlight.

What is the sun path on my plot? Find the south and make sure that there is no obstruction such as buildings, vegetation...
Find the south And make sure that there are no obstruction :

- Buildings
- Vegetations: e.g., deciduous trees have leaves from the spring until the autumn.

Exposure to wind: Avoid building on an exposed hill or coastal cliff. The stunning view will unfortunately provide whipping gales and eroding salt air.
What direction does the wind usually come from?

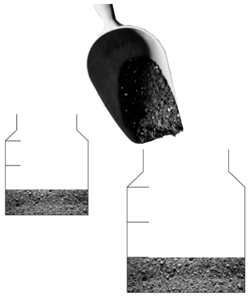
Soil

Good drainage: Avoid building on marshy land or flood plains.
Is my land well drained?

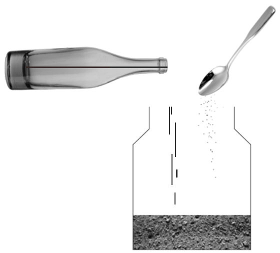
Sub-surface Geology: The subsoil of the land should be solid and of one homogeneous material. The soil has an influence on the choice of the foundation and can be used as a construction material.
What are the components of my subsoil?
Run the shake test and determine the ratios of each component. A foundation cannot be built on very clayey subsoil, the clay layer has to be removed and the foundation started on the solid bedrock. A subsoil consisting of roughly 15-25% clay and 75-85% aggregate is optimal for the foundation and cob wall.

SHAKE TEST

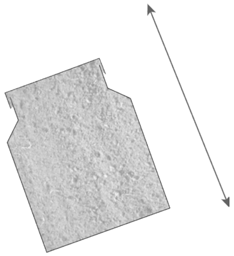
1 Dig until reaching the subsoil, differentiable from the topsoil because the subsoil is harder to dig and more colourful.



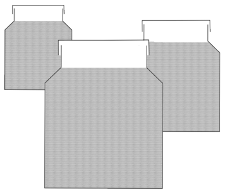
2 Remove large stones and break up any lumps. Fill one third of the jar with a sample of subsoil.



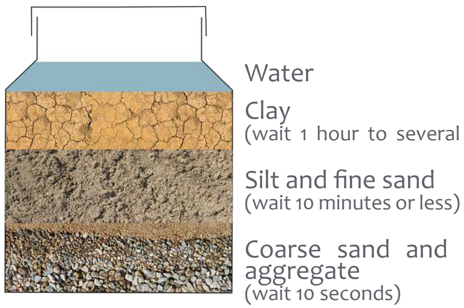
3 Add clean water to the jar containing the subsoil until the jar is two-thirds full.



4 Close the lid of the jar and shake for more than 30 seconds.



5 Do the same with several jars from the same plot. Don’t move the jar for 48 hours.



6 Once everything has settled and the water has become clear, mark the different layers with a pen and determine the ratio.

Water

Ground water : Proximity with groundwater should be avoided. Foundations built in groundwater require laborious treatment.
What is the depth of the water ground ?

Flood area : The durability of your construction might be compromised by flooding.
What are the flood risks ?

- Avoid land along rivers, lakes or the sea without a good height difference.

History of the land

The quality of the soil and the atmosphere of your future living area may depend on the previous use of the land.
What still remains on this plot from the past?

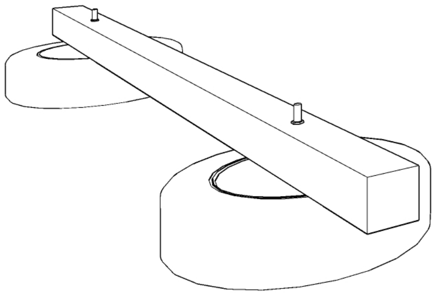
Future of the land

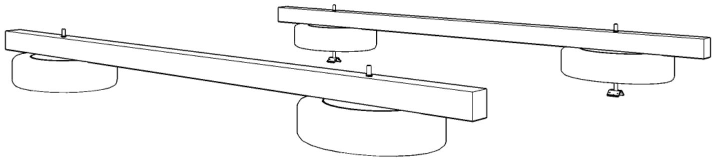
In the same way, ensure that the land on which you wish to build is free of future developments that may alter the quality of your plot.
What projects are being planned in the direct vicinity of your plot?

Legal restriction

- Read the municipal laws.
- Zoning determines the land use permissions and restrictions.
- Openness of the municipality: The creation of alternative eco-building may cause fear and mistrust.

- Speak with the municipal officers
- Inform them as much as possible
- Maintain good relationships





Car tire foundation is a simple way to build strong sturdy pillars, reusing a waste material and without concrete.

Foundation

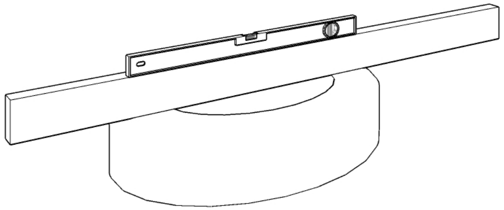
Materials:
- Tires
- Planks of wood (same width as the tire)
- Beam 125 x125 mm
- 10-20mm pea gravel
- Thread and bolts
- Corner Bracket

Tools:
- Lump hammer
- Crowbar
- Level

Step 1: collect the tires

You can find tires at a garage and thus help the garage owner get rid of them instead of having to send them to a landfill. You should get a variety of sizes, you will need to select, mix and match to reach the desired height.

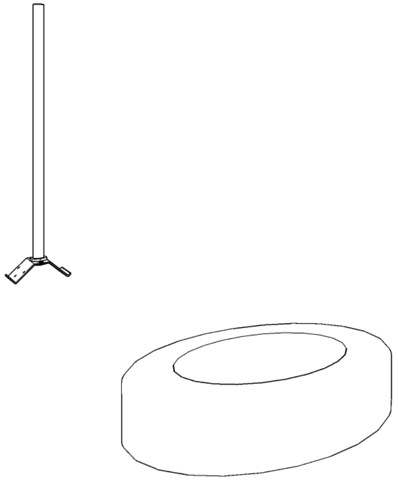
Keep only the tires where the "wide of tread" is between 185 and 245 unit and where the "tyre wall" is superior to 55.



Step 2: Level

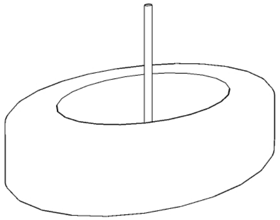
- Remove the topsoil, differentiable from the subsoil because the topsoil is softer to dig and less colourful.
- build a flat platform by redistributing the ground thanks to a straight beam and a level

Once your ground is level;
- Define your starting point
- Place the first tyre and correct its position with the level and the beam
- Move the tyre up and down until level



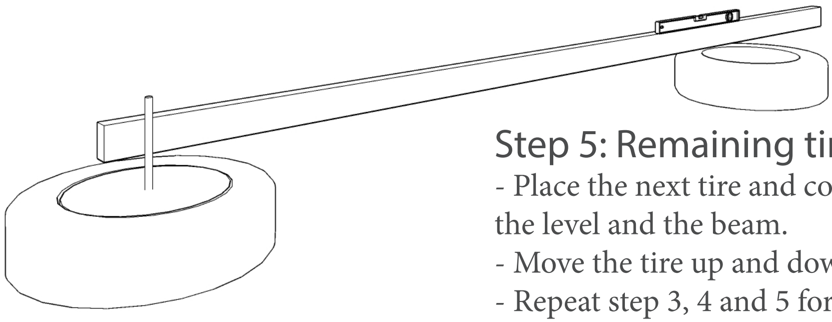
Step 3: The anchor

- Assemble the corner bracket with the thread between two bolts to produce a kind of anchor
- Sink it in the ground in the middle of the tire.



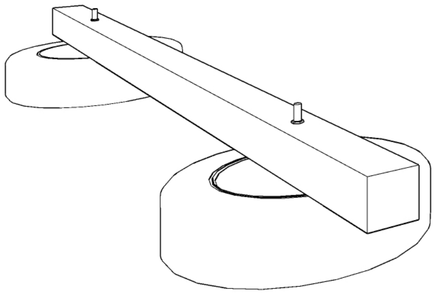
Step 4: fill the tires

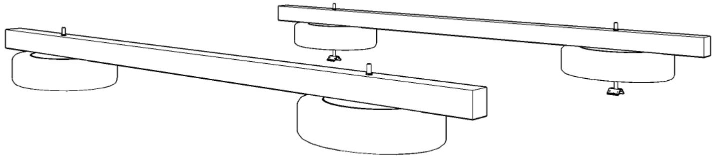
- Pour in 10-20mm of pea gravel in the tires and keep the anchor vertical and in the middle of the gravel.
- Push it gently right underneath the rim.
- Spread.
- Stamp on the gravel to get it well down.
- When the tire looks full, level up the rim with a crowbar supported by a plank of wood that laid across the tire and push more gravel underneath.
- Use the crowbar to "stir the pot" so that the gravel goes down deeper.
- Pack the shingle until the tire is very hard.
- Check the surface level of the tire.



Step 5: Remaining tires

- Place the next tire and correct its position with the level and the beam.
- Move the tire up and down until level.
- Repeat step 3, 4 and 5 for each tire.

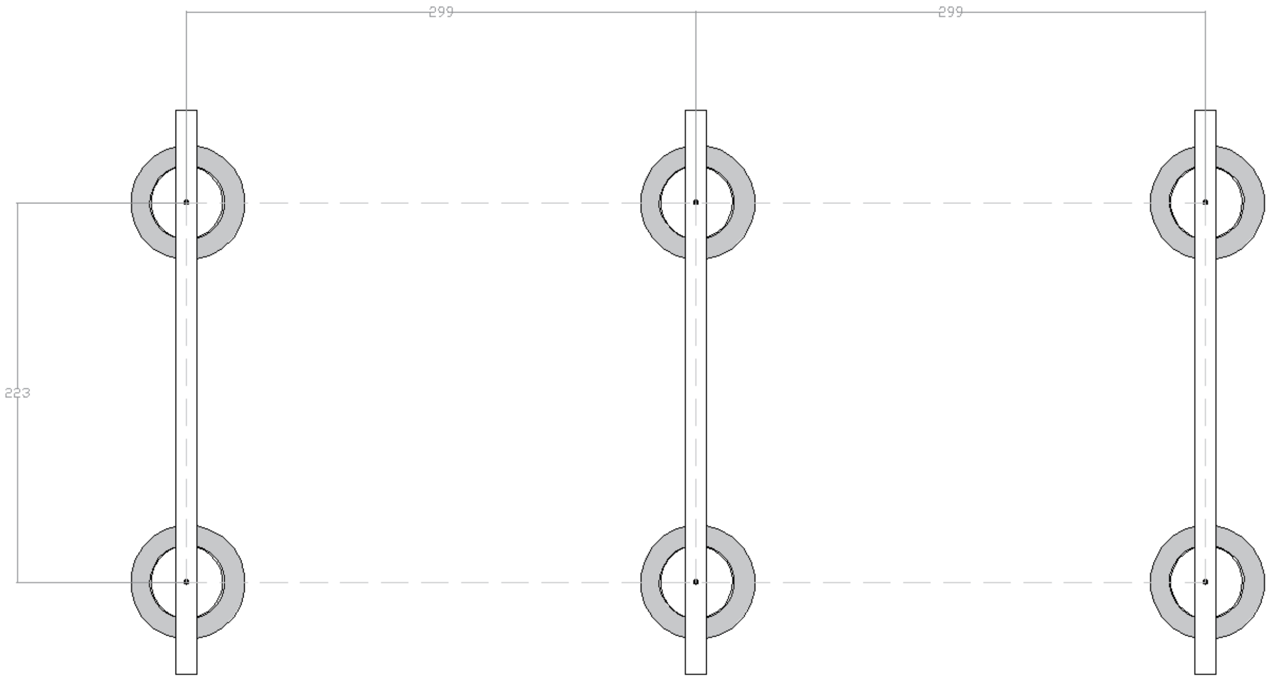


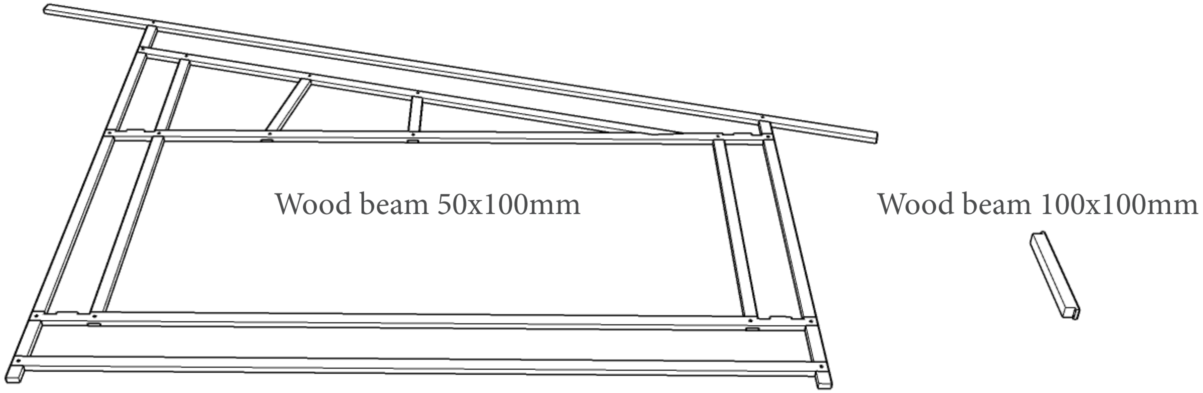


Step 6: Close the anchor

- Drill two holes in the beam 125mmx125mm with the diameter of the thread (the dimensions are on the plan).
- Put the beam in place on the anchor.
- Secure it with a bolt.
- Cut the rest of the thread.

FOUNDATION PLAN in centimeter



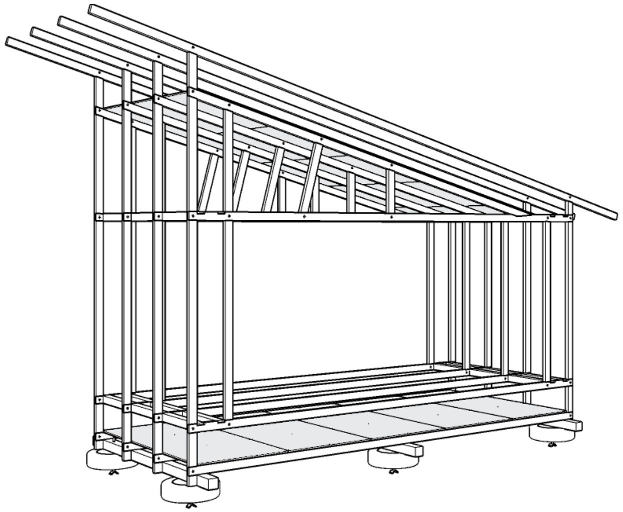


A unique wood framework is repeated along the structure. A module is composed of four frameworks that are linked by beams and CLT board.

Structure

Materials:
- 50x100mm Wood beam
- 100x100mm Wood beam
- 22mm OSB
- Long beams that have to carry the first framework
- A load such as earthbags

Tools:
- Drill
- Router
- Circular saw

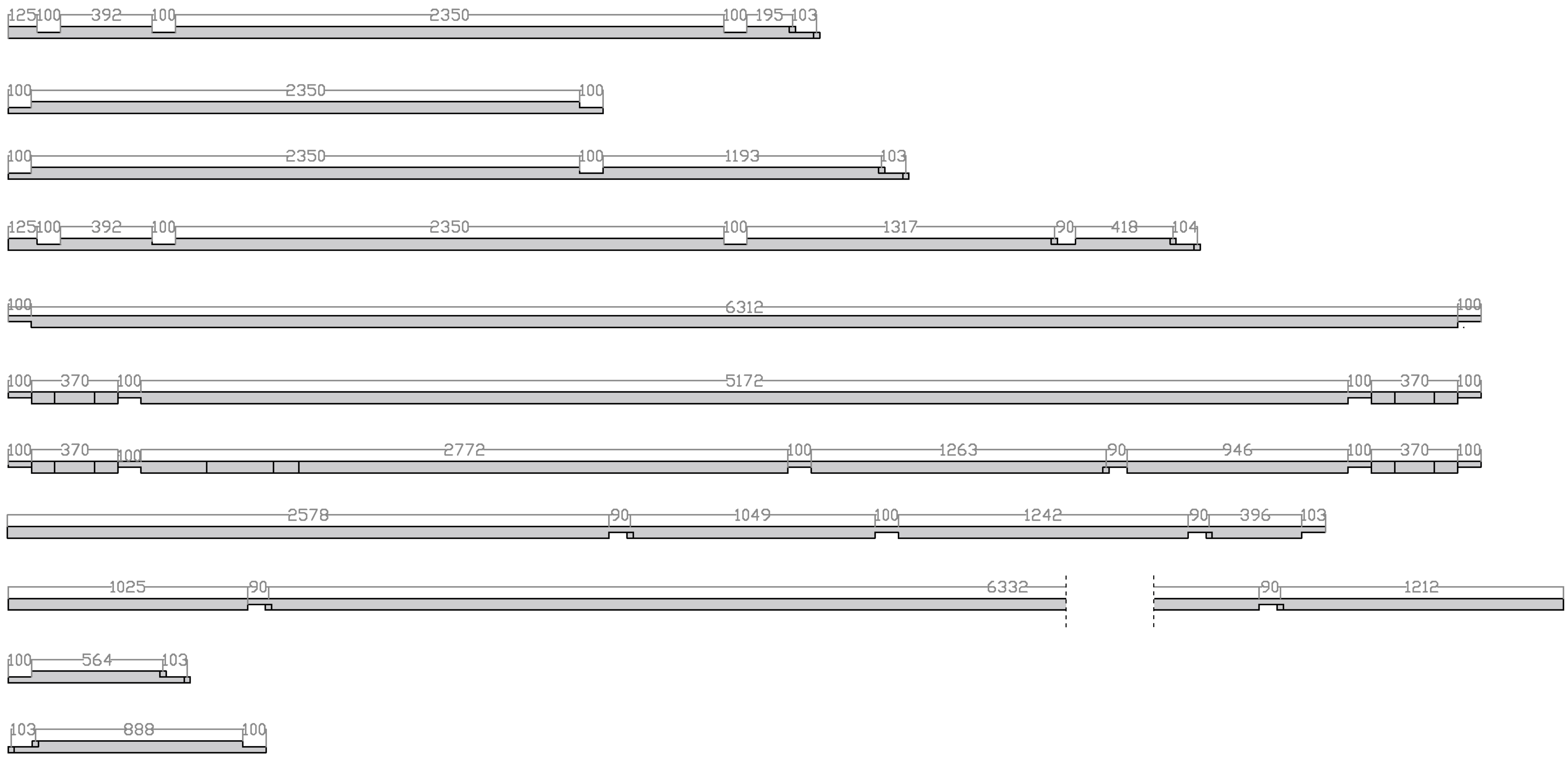


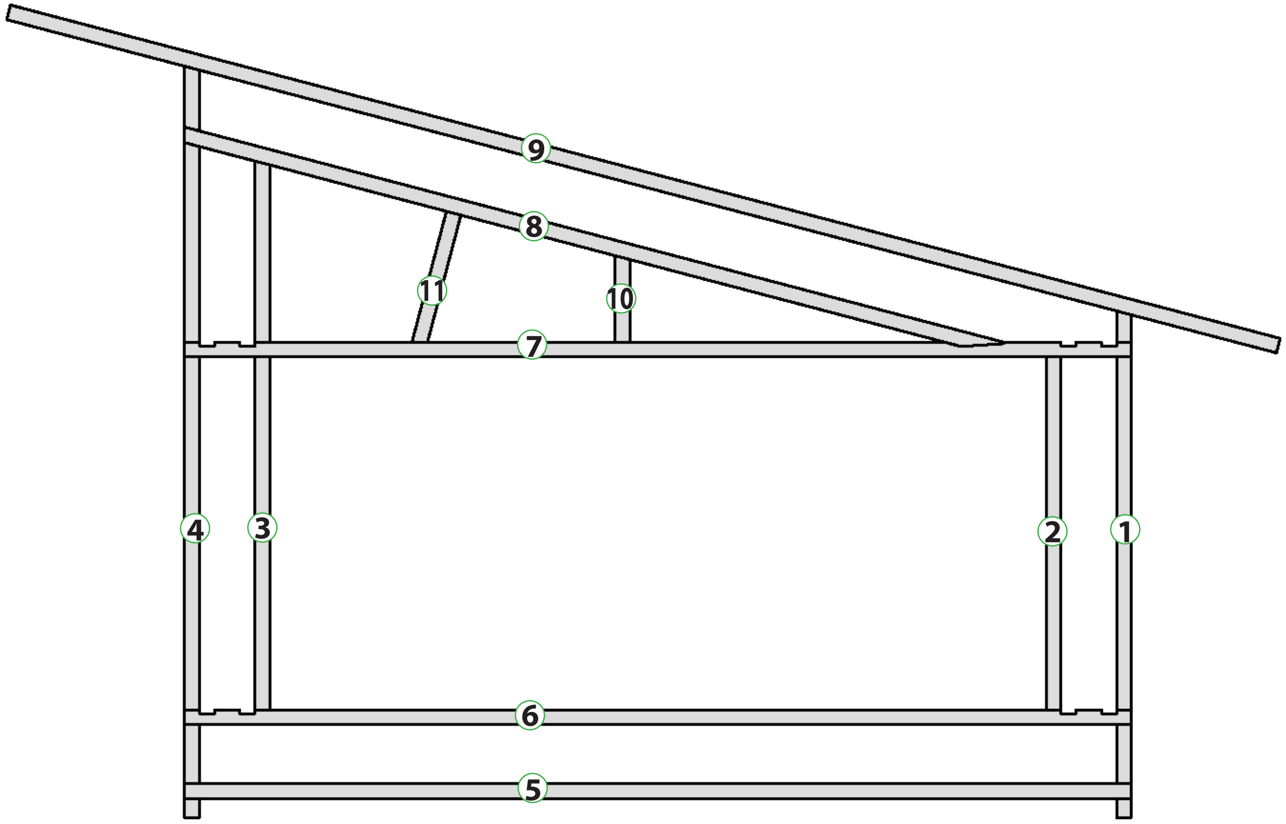
Step 1: the framework

According to the plan in the following pages, prepare the different sections that constitute the wood framework:

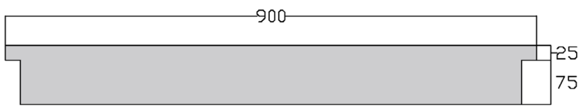
- With the circular saw, cut the length of the different 50x100mm wood beams.
- Prepare the halved joint with a 25mm deep router.

PLAN 50x100 wood beams in millimeters

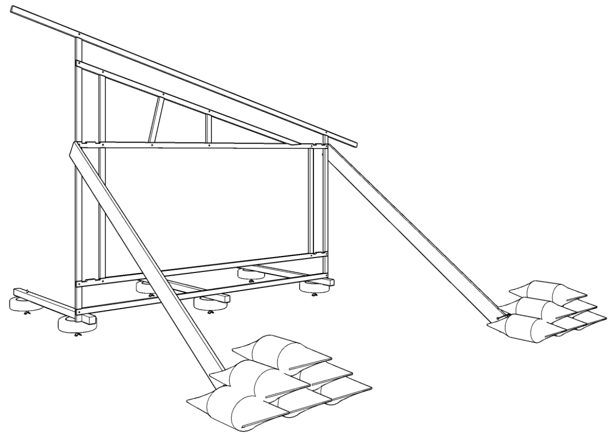



9
8
11
10
7
4
3
2
1
6
5

ELEVATION Wood beam 100x100 in millimeter



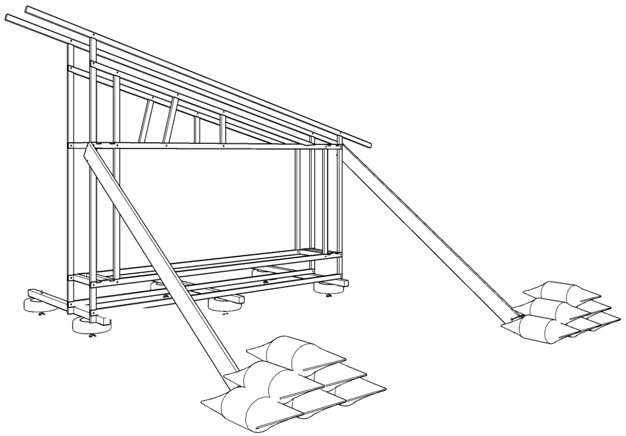
- Assemble the different sections with a bolt.
- Repeat it four times to obtain the material necessary to produce a module.
- Cut and rout twenty-four beams 100x100mm according to the plan in millimeter.



Step 2: module

- Lift the first framework on the foundation 280mm away from the border of 125x125mm foundation beam.
- Screw two beams on the framework and anchor it with earthbags or whatever you have to stabilize the first frame.

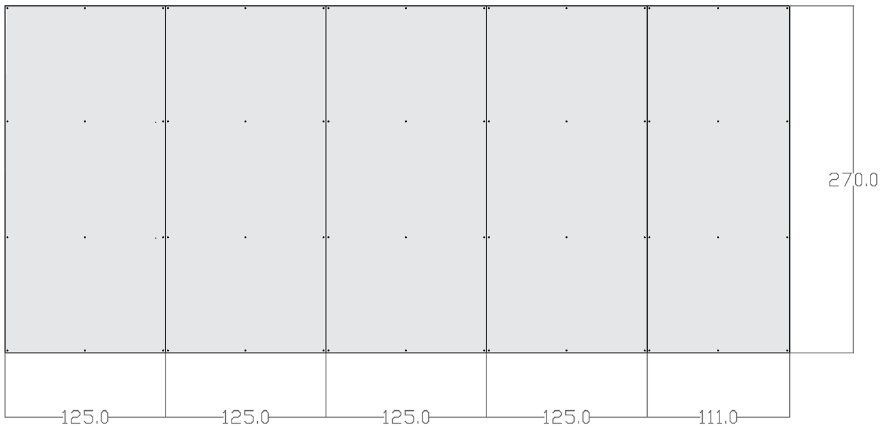
- Lift the second frame
-Link the two frameworks with 100x100mm beams
- Screw the beams
- Keep going with the next frames



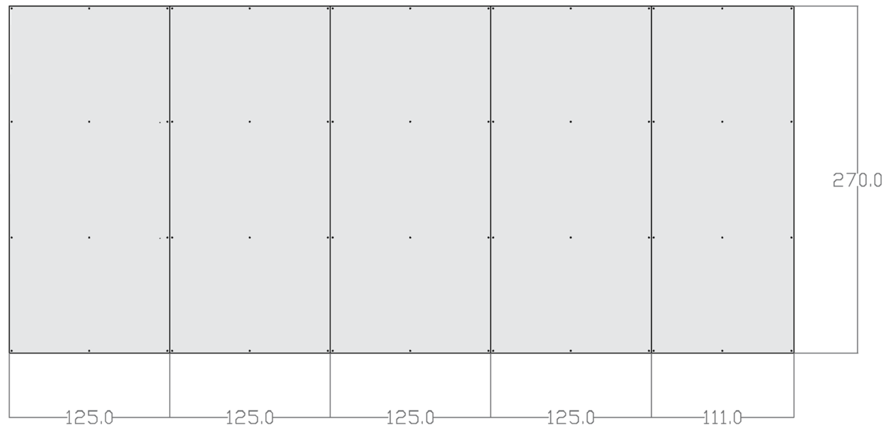
Step 3: Bracing

- cut the OSB board for the roof and the floor.
- screw them on the structure.

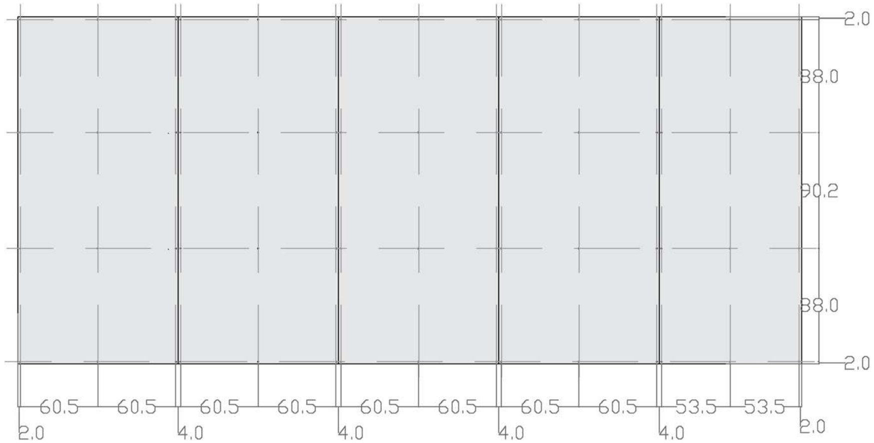
FLOOR OSB plan in centimeters



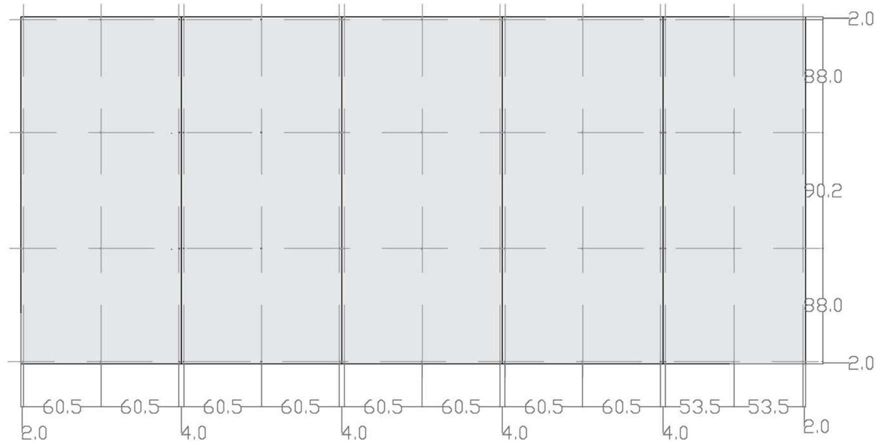
ROOF OSB plan in centimeters

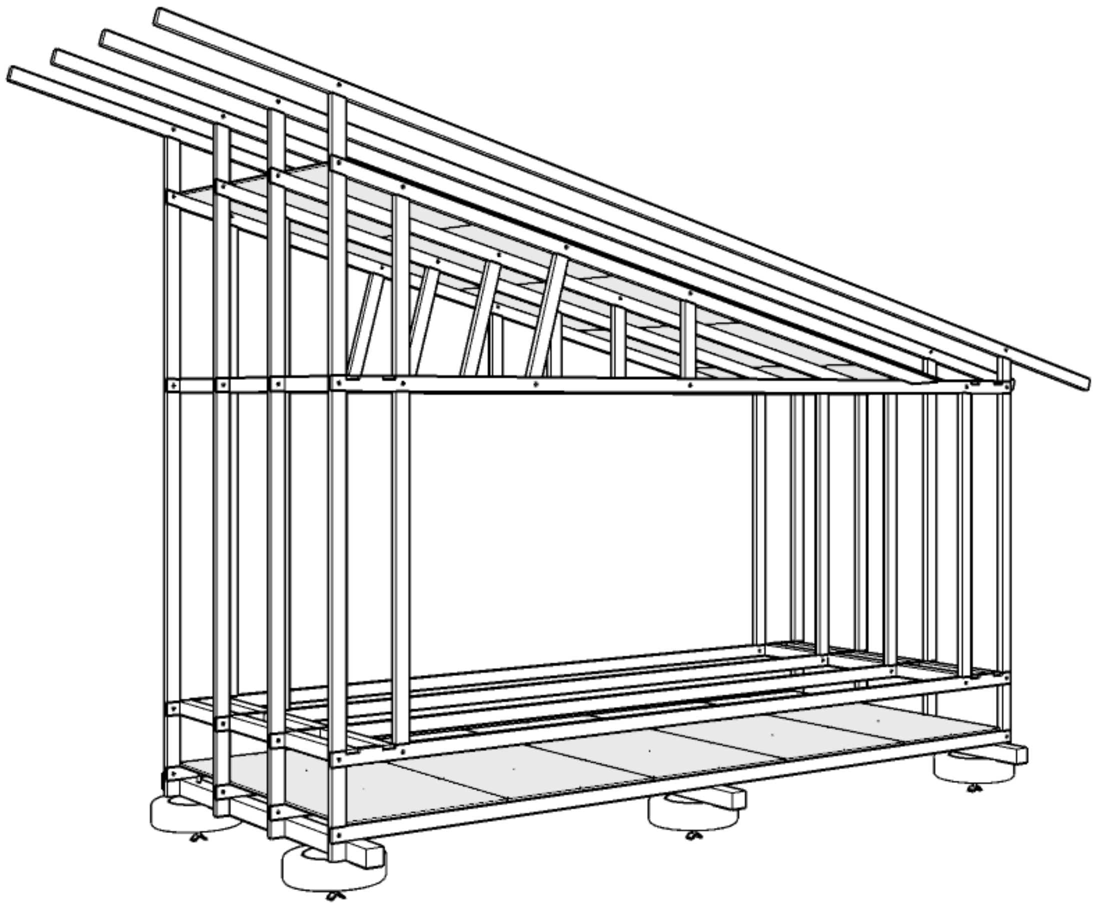


FLOOR screws plan in centimeters



ROOF screws plan in centimeters





Straw bale insulation has turned out to be an excellent green building element, that is ultra sturdy, surprisingly fire resistant, and excellent at controlling the temperature in your home. Straw bale is a renewable, natural source of insulation that may be found almost everywhere in Europe. Straw walls are load-bearing walls, which can cut by half the amount of timber needed in a modern home, reducing demand on forest resources.
They offer good insulation from the heat and cold with a thermal conductivity of a material (λ) of 0,06 W /(m²K). It also is a sector presenting a really competitive cost and is an easy implementation. Compacted straw reduces the chance of combustion. Its implementation necessitates a plastering on both sides or cladding. Unlike a common preconceived idea, straw bales do not particularly attract insects and rodents.

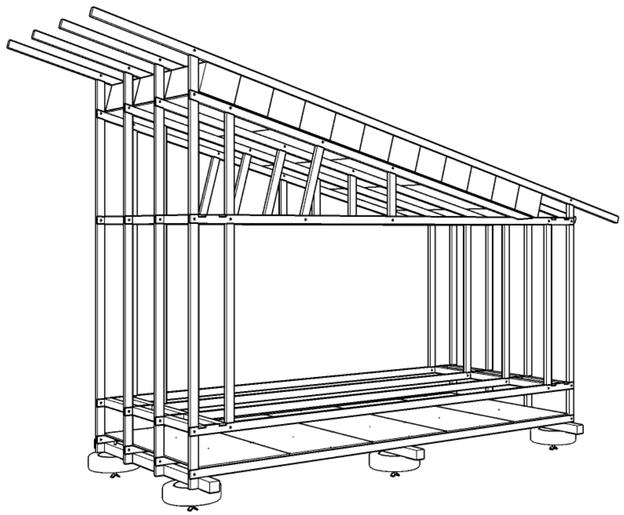
Insulation

Materials:

- 104 straw bales 470x370mm (λ of 0,06 W / (m²K))
- Pannels of cork 10mm (λ=0,036W /(m²K))
- Loose straw
- OSB
- Corrugated sheet
- Stainless steel galvanized screws with washer
- 2 Wood boards 22x150x3550mm
- Screws
- Bolts

Tools:

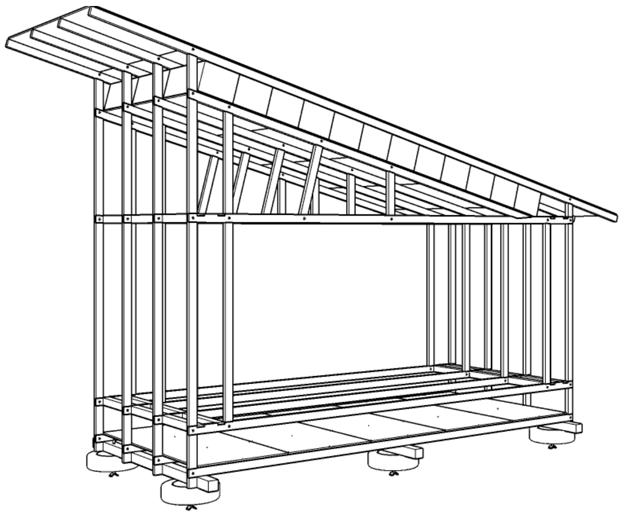
- Pursuading (may be build on your own)
- Circular saw
- Screw-gun



Step 1: Roof

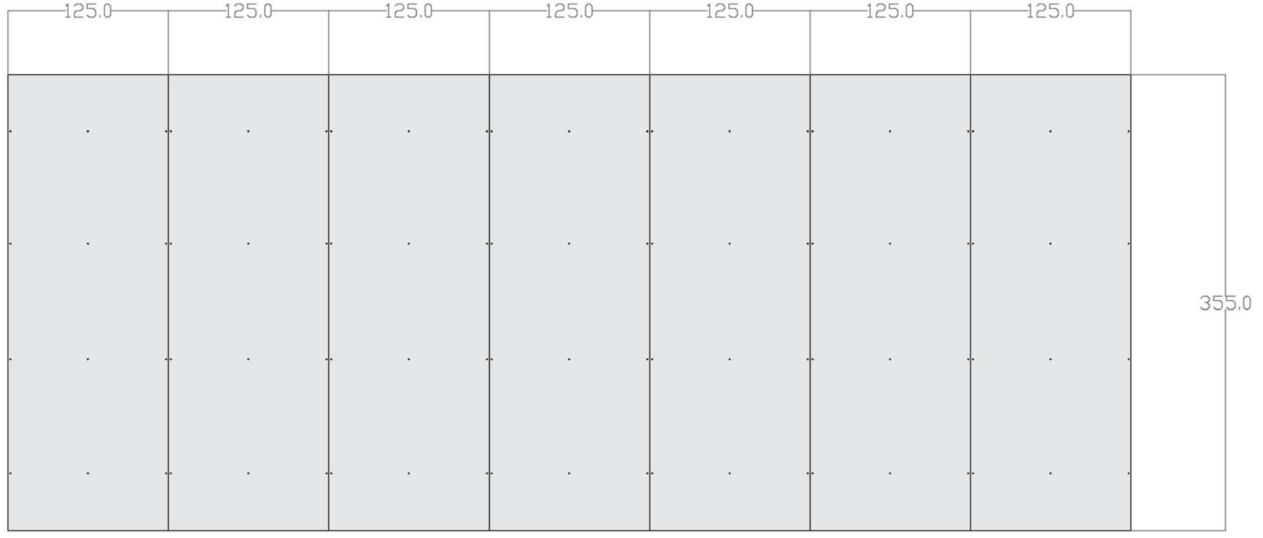
To protect the follow-up of the construction, the roof has to be put in as soon as possible. The roof is built as a cap that protects the straw walls from the rain and the inside from the sun during the summer days.

- Insert the straw ball in the framework

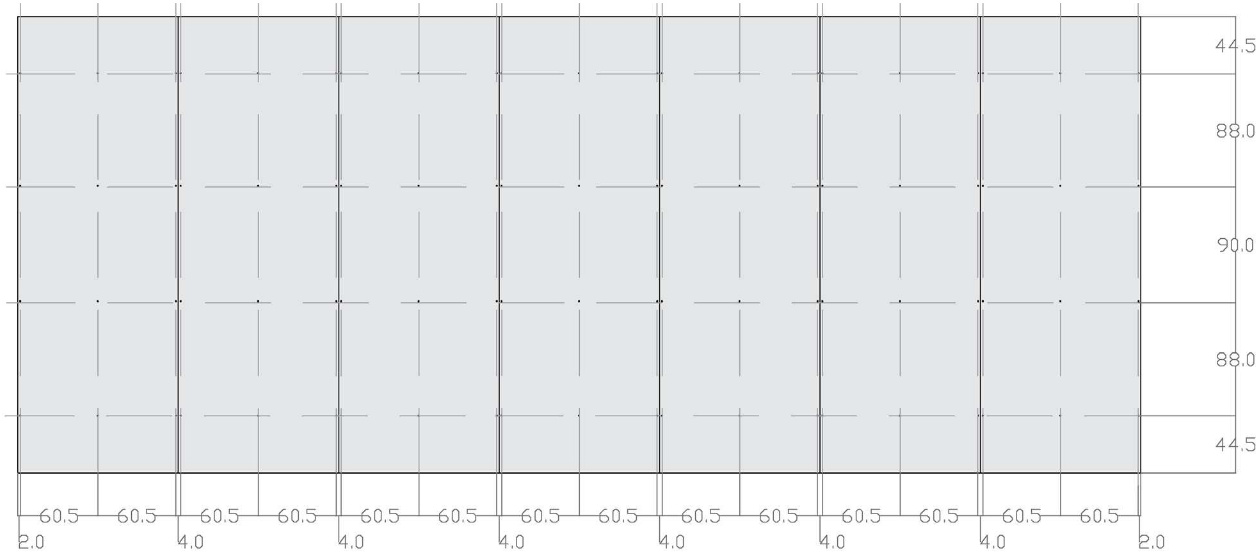


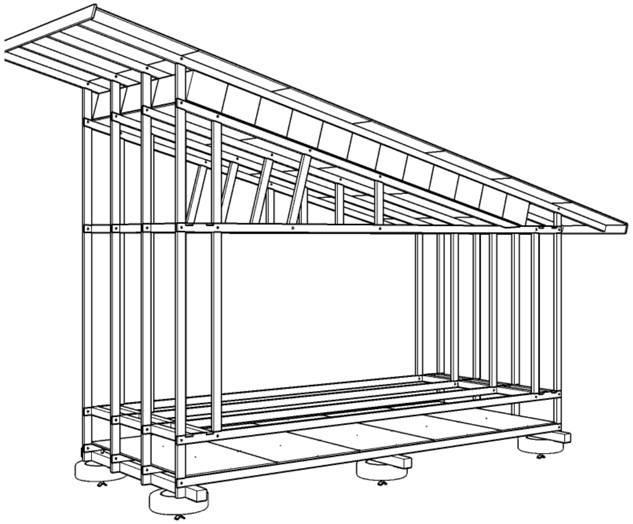
- Cover the upper part of the framework with OSB 125x270mm

ROOF OSB plan in centimeters



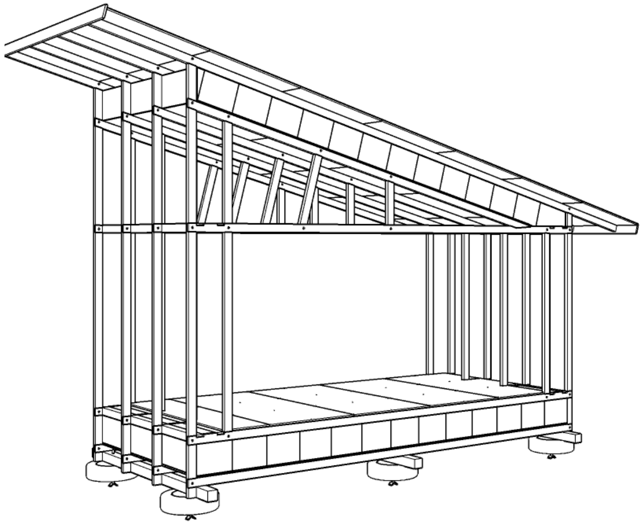
ROOF screws plan in centimeters





- Screw the corrugated sheet with stainless steel galvanized screws with washers.

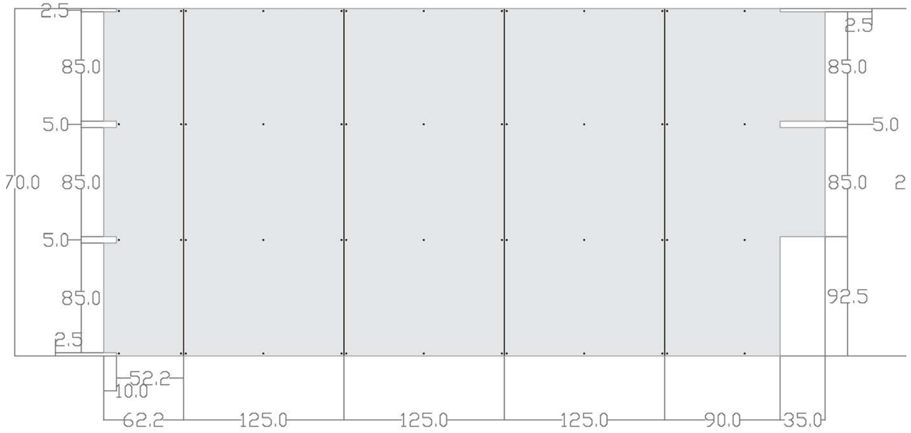
Screw 22x150x3550 wood board along the edge of the roof



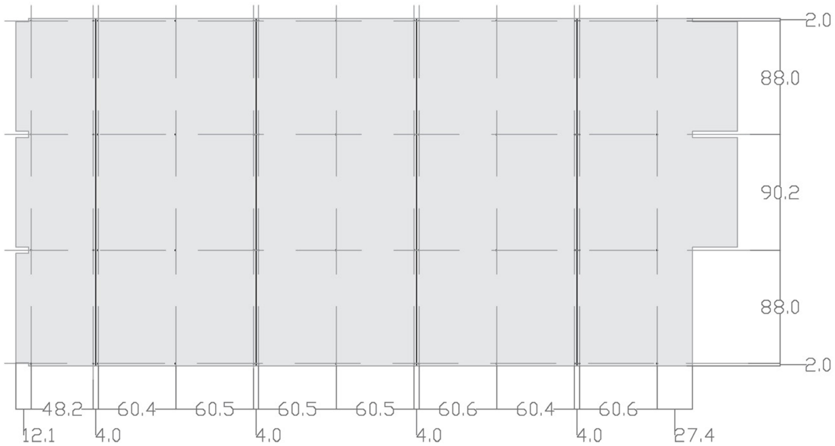
Step 2: Floor

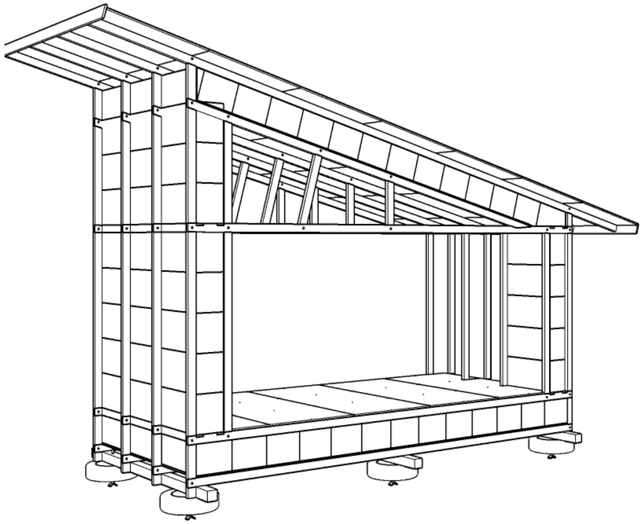
- Insert the straw ball into the framework
- Cover the upper part of the floor with OSB panels

FLOOR OSB plan in centimeters



FLOOR screws plan in centimeters





- Insert the straw ball and the panels of cork between the beams that link the frames (λ=0,036W /(m²K))
- Close the border of the roof with OSB panels and compress loose straw in order to close the gap.

How to cut bales to custom length?

Step 1: needle

- Prepare a needle by drilling a hole in a chain link fence tensioning bar or a stiff piece of metal.
- Cutting the end to a point on the end helps the needle move through the bale.

Step 2: sewing workshop

- Thread the needle with two wires and fold them over the needle so they won't come off in the bale.
- Measure of the amount of straw needed in the new bale.
- Push the needle into the bale next to the existing string and through the other side.
- Wrap around the new small bale.
- Pull up the slack and made a single twist by hand and with a pair of pliers.
- Cut off any excess.

Step 3: separate

- Use a chain saw to remove the rest

or

- Use another wire to tie up the other half of the bale.
- Repeat the process by pushing two more wires through next to the bale's other original string.
- Cut the old strings and pull old bale apart to create two new bales.

Materials:

- Tensioning bar
- Wire or polypropylene twine
- Bolts

Tools:

- Drill
- Metal saw
- Pair of pliers
- Chain saw

Finishing work

- Windows and doors:

Materials:
-Windows/doors 2350x900mm
- OSB
- Silicone

Tools:
- Screws
- Screw-gun
- Level

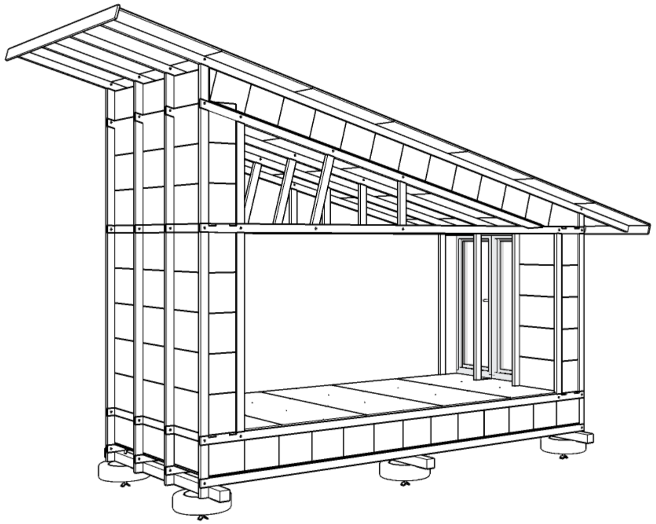
According to the bioclimatic principle most part of the doors and windows have to face the south. The module lets a space of 2350x900mm between each framework.

Step 1: build a frame for the windows

- Verify the dimension of your windows/doors.
- If there is a gap between the straw and the framework, fill it with wood wool or compacted loose straw and OSB.

Step 2: positioning

- Place the windows/doors against the framework.
- Silicone the contact area between the windows/ doors and the framework.
- Verify that they are level.



- Floor:

The earthen floor is a technique that leaves a light footprint on the environment and doesn't bring toxic junk indoors, provides a good thermal mass and, best of all, is accessible to novice builders. It is a carefully mixed and processed recipe with three main ingredients: sand, clay soil, and fiber.

Materials:

- Sand
- Clay soil
- Straw
- Linseed oils blends (tung oil, pin rosin, beeswax..) that don't contain chemicals or heavy metals
- (Pigment)
- (Wax)
- Vapor retarder

Tools:

Tool for gathering and preparing materials

- Leaf blower/shredder - straw chopper
- Steel trowel
- Shovels
- Pick-ax
- Wheelbarrow
- Plywood for the tests
- 3mm mesh screen
- Bucket, shovel, wheelbarrows
- Measuring spoons
- Cups
- Buckets

Tool for the subfloor

- Vapor retarder 2800x5700mm
- tape

Tool for mixing

- Wheelbarrow with a hoe, mortar mixer, tarp...

Tool for pouring

- Bucket, shovel, wheelbarrows
- Level
- Trowels and floats

Tool for burnishing

- Trowel

Step 1: test the floor mix

- Try three batches in the following ratios:

sand : clay
2 : 1
3 : 1
4 : 1

- Add water until mix reaches a consistency"cake batter".
- Spread each batches on a plywood and smooth it over with a steel trowel.
- Label the test with its sand-to-clay ratio.
- Let the test patches dry .
- Once you determined the sand-to-clay ratio, make a new test using fiber: measure as a percentage of the total volume of dry mix, (take 15% of the sand/clay volume) .
- Run a final testing with the final recipe.

Step 2: determining quantities

In order to calculate the quantities of raw materials, you will need to make enough mix for the floor.

- Multiply the surface area of the floor by the thickness of the pour
- For a module we obtain 14.8m^2 and the floor is 0,02m thick.

In cubic meter, 14.8x0.02= 0.296m^3

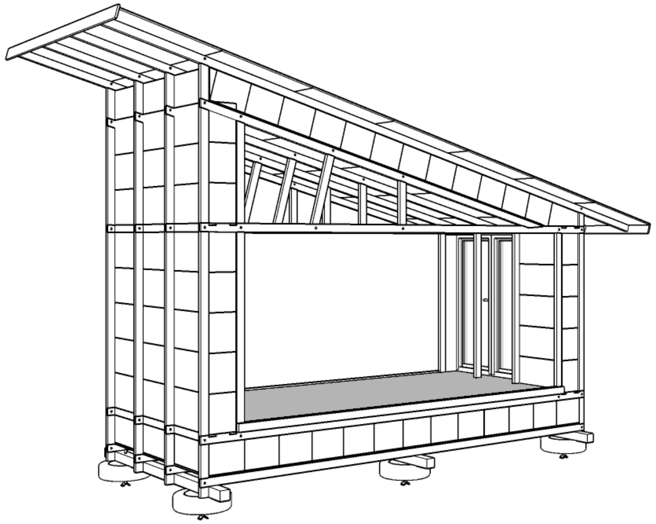
- Add an additional 20 percent to account for spillage and shrinkage.

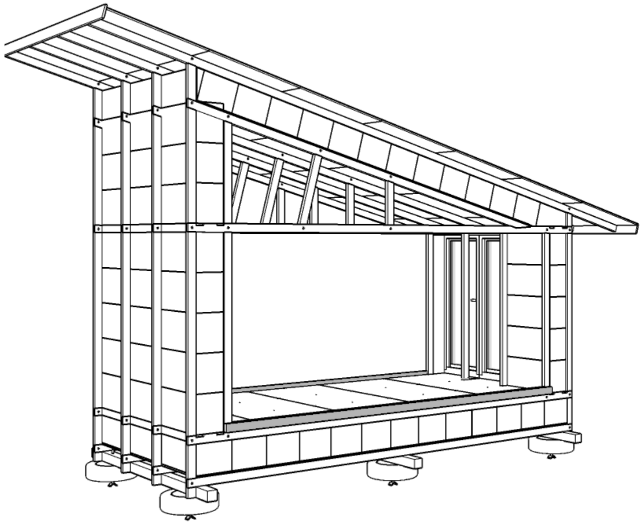
1.2x0.296= 0.355m^3

- Multiply the total volume by the percentage of each ingredient to get the total volume for each ingredient.

In our case with a sand-to-clay ratio 3 : 1

- Sand: 0.355/3 = 0.12 m^2
- Clay: 0.355/1 = 0.355m^2
- Straw, take 15% of the sand/clay volume, (0.12+0.355)x0.015 = 0.007m^2





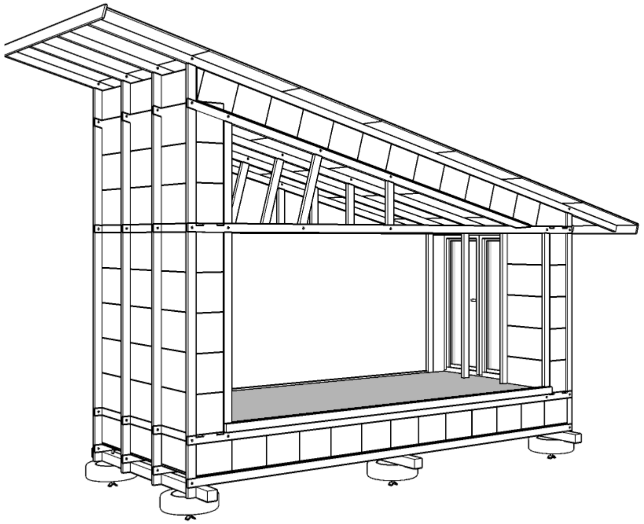
Step 4: preparing the work area

- Prepare form work adapted to the edge of the removable wall more than 5cm high.
- Mark around the finished floor height at several point around the perimeter .
- Wrap 2c of foam around the post base to help reduce the likelihood of cracks developing. In our case, around the beam that goes through the floor surface.

Step 3: Subfloor

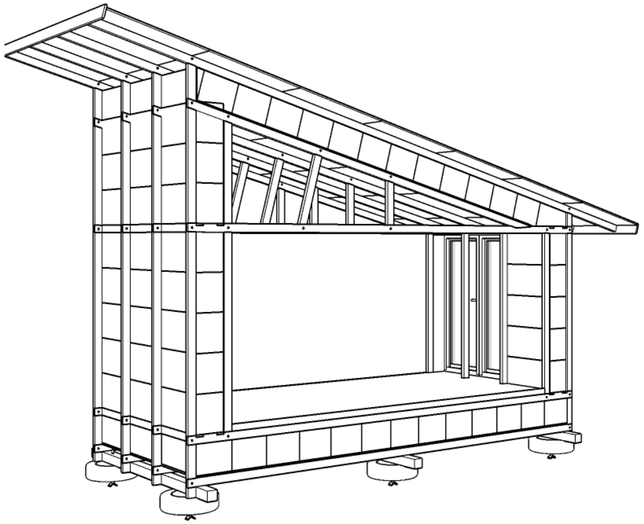
The ground contains moisture which evaporates. This vapor can migrate from the ground below up into the house and cause mod growth and, in extreme cases, rot. The vapor retardater is a waterproof membrane that blocks the movement of water vapor. There should be a vapor retardater on the top of the subfloor (OSB) to protect the wood framing from rot.

- Bring the vapor retardater right to the edge of the module and fold it up along the wall
- Tape around the wall and the frame.



Step 5: making the floor mix

- Sweep and vacuum the subfloor.
- Mix the batch, either in a mortar mixer, a wheelbarrow or on a tarp on the ground
- Depose one or two bucket onto the subfloor.- Work the wet mix with a wood float to get it to the proper thickness and level.
- Lightly smooth over surface the floor with a trowel.
- Repeat the process until completing the whole module. Try to complete the module in one day or cold joint cracks could result...



Step 6: drying the floor

Ideally the floor will dry uniformly and slowly in order to reduce the possibility of mold growth or cracking. Cover the structure with a tarp to protect the earth floor from the sun.

Step 7: finishing the floor

The floor is still very fragile and unsealed. The finishing steps transform the unstabilized earth into a durable and waterproof surface by oiling the floor to create a modern version of the earth-en floor.

- Prepare the floor; remove any large bits of de-bris but don't sweep it .
- Prepare the oil approx.1L= 1m3, The floor of the module requires 14,8L.
- Apply the oil with a brush, roller or rags.
- Let it dry.
- Remove the form work.

- Prepping for plaster

Trimming bales

Wild undulations or patches of loose straw can make plastering difficult which is why it's recommended to trim the bales. There are different ways to trim the wall:

- Chainsaw all work is very accurate but very dangerous.
- Weed-eater with a nylon string has a lot farther and doesn't get clogged up with straw.
- Grinder with wire brush or cutting wheel is suitable for small areas.

Stuff loose straw into all voids between bales.

Covering wood

The plaster has tendency to crack, all the more if something that the plaster is covering moves. The wood can expand and shrink and the movement could cause cracks. The OSB board and beam that are integrate in the wall will be cover up with strips of metal.

- Cut strips of metal lath or diamond stucco mesh using a metal cutting blade on a circular saw (and ear and eye protection). The mesh should be a few centimeters larger than the dimension of the beam and constitute at the same time the insect screen and the covering for the OSB board .
- Screw or nail the mesh to the wood.
- Attach the mesh to the straw bales with rigid wire staples.

- plaster

Plaster is applied in multiple coats to avoid cracks.

- The first coat, the "scratch coat", is designed to completely cover the surface and create a good foundation for the second coat.
- The second coat, the "brown coat", avoid cracking in the first coat and smooths the surface.
- The final, the "finish coat", is the thinnest and least likely to crack coat that creates the final desired look.

Materials:
- clay soil
- sand
- straw
- lime
- water

Tools:
- Your hand
- Gloves
- Stiff brush
- Hawk or trowel
- Wheelbarrow
- Shovels
- (Paddle mixer)
- Leaf blower/shredder - straw chopper
- (Hoe)
- 3mm mesh screen

Step 1: scratch coat of earth plaster

Mixing earth plaster

- Run the shake test described in the chapter "choice of the plot" and define how you have to adjust your earth with sand or clay to obtain the proportion 1:1 (sand:clay) for the outside wall and 1:11/2 (sand:clay) for the inside wall.
- Mix the soil, soaked clay and plain unsifted sand with a paddle mixer, your foot or whatever you have at hand...
- Chop the straw (for instance, with a mulching leaf blower) until you have straw of 2 or 4 centimeters.
- Mix with a hoe or your hand and add progressively as much chipped straw until obtaining a nice paste of straw surrounded by plaster.

Applying earth plaster to the straw bale

- Smear some earth plaster on with your hand and work it in with your fingers to really tie the earth plaster into the straw bales.
- Push plaster tightly into the joints around windows and behind the framework.
- Let the mix dry completely before applying the next coat (about a week).
- Cut away any excess earth plaster.
- Run over the wall lightly with a stiff brush to knock off any loose pieces of plaster.

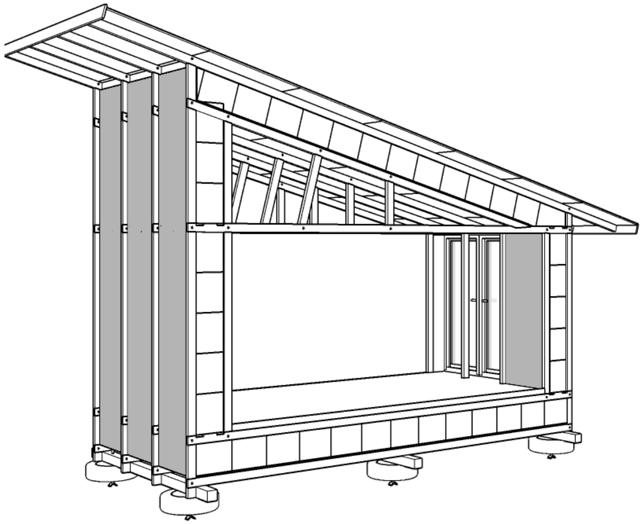
Step 2: brown coat of lime plaster

Mixing lime plaster

- Mix a 3:1:1/2 (sand:lime:straw) plaster batch for the outside wall and a 4:1:1/2 (sand:lime:straw)for the inside wall with sand that had been sifted through a 3mm mesh.
- Soak the straw in lime water before adding it to the mix to help slow the drying time and diminish cracking.
- Obtain a wet enough paste wet enough to easily spread it with a towel, but firm enough to stick the wall.

Applying lime plaster over earth plaster

- Paint on some lime water to wet the wall and create a bond between the two coats.
- Apply the plaster in a thin coat of 6mm
- Let the mix dry completely before applying the next coat.



Step 3: finish coat plaster

- Mix a 3:1: 1/2 (sand:clay:straw) for the outside wall and a 3:1 (sand:clay) for the inside wall. You can add vegetal oil to make it more water resistant.
- Apply the plaster in a thin coat.

TRIMS can be installed between the wall and the floor and may contain the electric wires.

HOMEMADE PAINT made of kaolin clay, silica sand, mica flour paste, milk powder, and vegetable oil may be used to cover the wall.

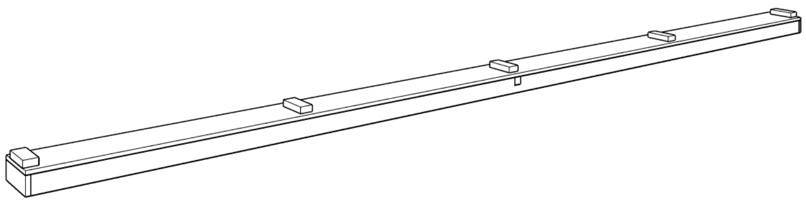
With modules and removable walls, the house is adapted for each step of life; the inhabitants benefit from distribution in time of investment cost and effort. Each module constitutes 14,5m2 (5,35x2,70m) that can stand next to each other. A removable wall made of wood wool boxes enables incrementally this extension.

Incremental and adaptable

REMOVABLE WALL

Each removable wall comprises eleven puzzle pieces that can be easily assembled and disassemble by two peoples. Those pieces are composed of CLT board, wood beam, and wood wool.

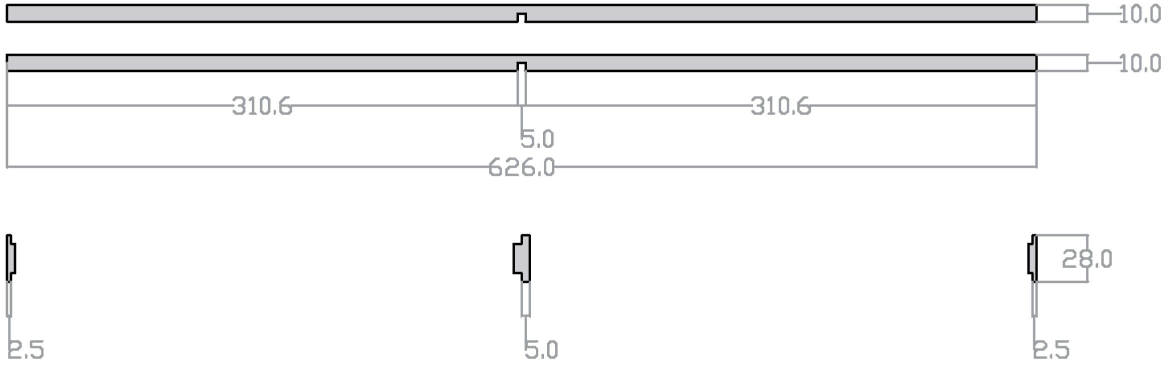
- Support of the removable wall :



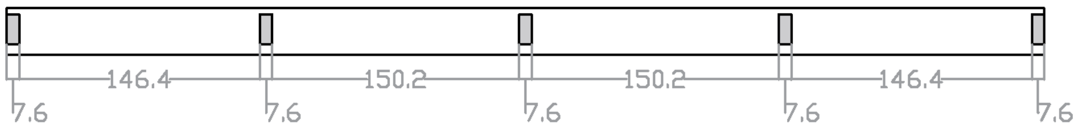
Materials:
- 7150mm Beam 100x50mm
- OSB 630x280mm
- 10 Pieces of wood 38x76x182mm
- screws

Tools:
- circular saw
- router

- cut and routs the beam 100x50mm according to the plan.



- Assemble the beam 100x50mm to shape a frame.
- Close the frame with the OSB.
- Screw the pieces of wood on their precise positions.

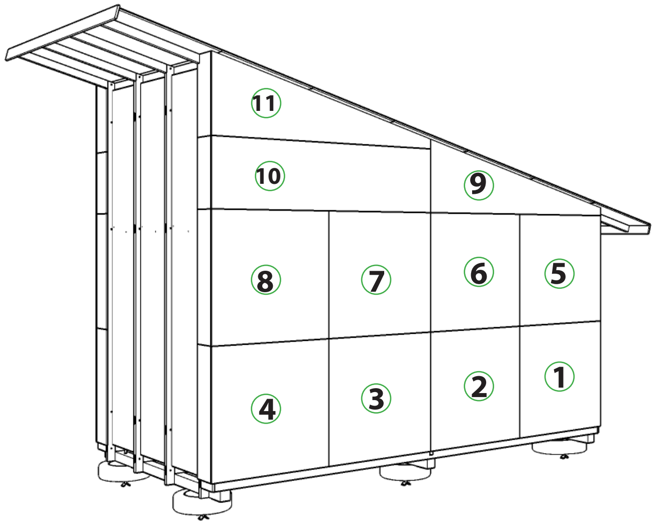


- Puzzle pieces

Two walls are require to close the building; each of these steps will be perform two time in mirror.

Tools:

- Router
- Drill
- Circular saw
- Screw-gun

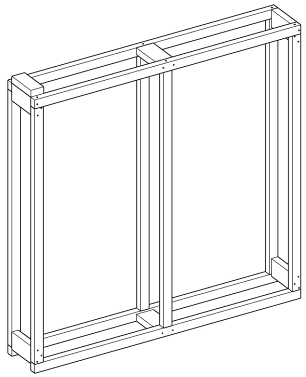


Step 1: piece 1#

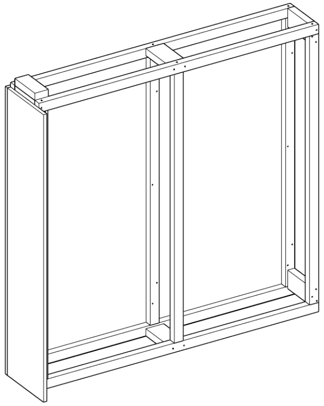
Materials:

- wood beams 38x50mm (6x)1452mm - (4x)1578mm
- wood 350x1820mm (6x)100mm - (1x)76mm
- woodwool panel 220mm (1x)1579x1553mm
- CLT board 22mm (1x)1600x1527mm (inside)
- CLT board 19mm (1x)1622x1552mm(1x)1552x330mm (outside)
- screws

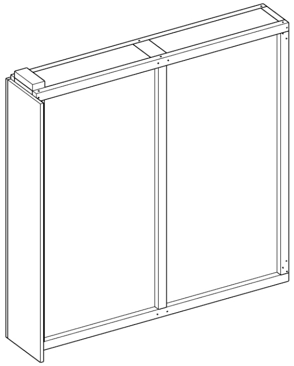
- Assemble the different pieces of wood to shape a frame.



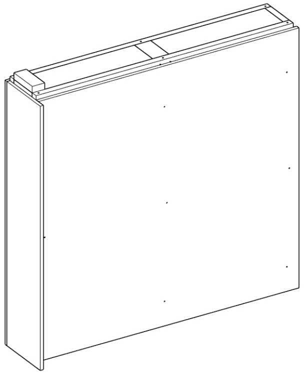
- sand the external border of the CLT 19mm boards
- Screw the CLT 19mm, that will be the outside part of the puzzle piece, on the frame.



- Adapt the woodwool to the frame by removing some part with a circular saw. Underestimate the dimensions that has to be remove in order to obtain a continuity of the insulation; it's better to compress the panel rather to have a hole. Notice that a space is kept maintained between the outside panel and the woodwool.



- screw the inside panel of 22mm on the frame.



Step 2: piece 2#

Materials:

- wood beams 38x50mm (6x)1452mm - (4x)1578mm
- wood 350x1820mm (6x)100mm - (1x)76mm
- woodwool panel 220mm (1x)1580x1555mm
- CLT board 22mm (1x)1578x1527mm (inside)
- CLT board 19mm (1x)1578x1552mm (outside)
- screws

- Repeat the process explained in the step 1.

Step 3: piece 3#

- The piece 3 is exactly the same than the piece 2.

Step 4: piece 4#

Materials:

- wood beams 38x50mm (6x)1452mm - (4x)1578mm
- wood 350x1820mm (6x)100mm - (2x)76mm
- woodwool panel 220mm (1x)1580x1555mm
- CLT board 22mm (1x)1553x1527mm (inside)
- CLT board 19mm (1x)1572x1552mm(1x)1552x330mm (outside)
- screws

- Repeat the process explained in the step 1.

Step 5: piece 5#

Materials:

- wood beams 38x50mm (6x)1452mm - (4x)1578mm
- wood 350x1820mm (6x)100mm - (1x)76mm
- woodwool panel 220mm (1x)1580x1555mm
- CLT board 22mm (1x)1600x1552mm (inside)
- CLT board 19mm (1x)1622x1552mm(1x)1552x330mm (outside)
- screws

- Repeat the process explained in the step 1.

Step 6: piece 6#

Materials:

- wood beams 38x50mm (6x)1452mm - (4x)1578mm
- wood 350x1820mm (6x)100mm - (1x)76mm
- woodwool panel 220mm (1x)1580x1555mm

- CLT board 22mm (1x)1578x1552mm (inside)
- CLT board 19mm (1x)1578x1552mm (outside)
- screws

- Repeat the process explained in the step 1.

Step 7: piece 7#

- The piece 7 is exactly the same than the piece 6.

Step 8: piece 8#

Materials:

- wood beams 38x50mm (6x)1452mm - (4x)1578mm
- wood 350x1820mm (6x)100mm - (2x)76mm
- woodwool panel 220mm (1x)1580x1555mm
- CLT board 22mm (1x)1553x1552mm (inside)
- CLT board 19mm (1x)1572x1552mm(1x)1552x330mm (outside)
- screws

- Repeat the process explained in the step 1.

Step 9: piece 10#

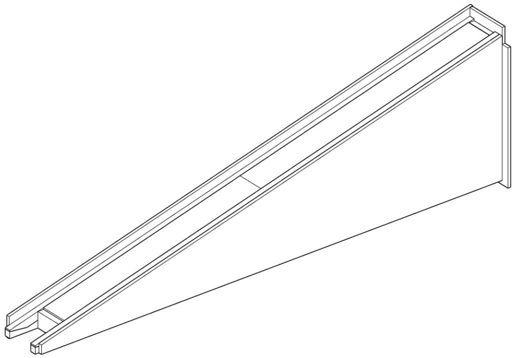
Materials:

- wood beams 38x50mm (6x)728mm - (4x)3156mm
- wood 350x1820mm (6x)100mm - (2x)76mm
- woodwool panel 220mm (1x)3157x829mm
- CLT board 22mm (1x)3131x853mm (inside)
- CLT board 19mm (1x)3150x828mm(1x)828x330mm (outside)
- screws

- Repeat the process explained in the step 1.

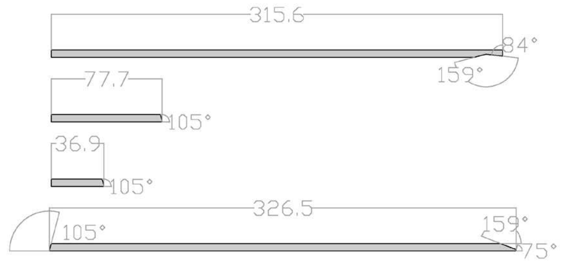
Step 10: piece 9# & piece 11#

Those pieces shape the slop of the roof and are triangulates.

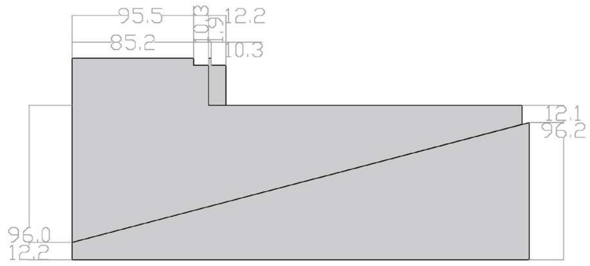


Materials:

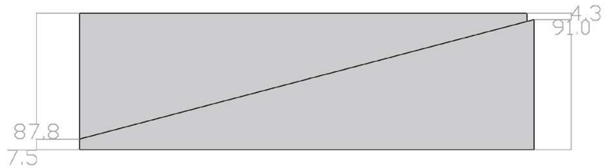
- Wood beams 38x50mm (4x)3156mm - (4x)777mm - (4x)369mm - (4x)3265mm



- Wood 350x1820mm (10x)100mm
- Wood wool panel 220mm (1x)3157x829mm
- CLT board 22mm (1x)3181x954mm (inside)



- CLT board 19mm 1.(1x)3200x1083mm - 2.(1x)1078x330mm (outside)



- screws

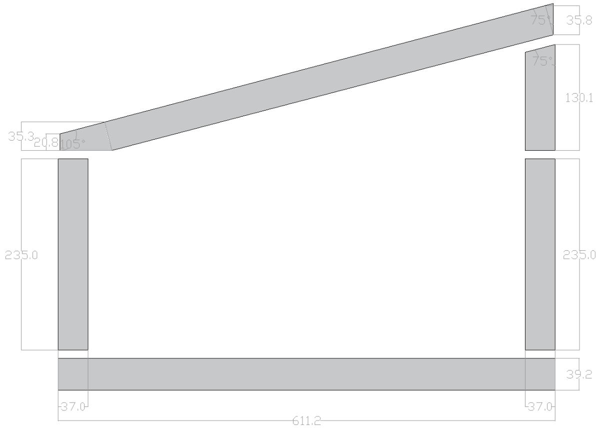
- Assemble the different pieces of wood to shape a frame.
- Sand the external border of the CLT 19mm boards
- Screw the CLT 22mm, that will be the inside part of the puzzle piece, on the frame.
- Adapt the wood wool to the frame by removing some part with a circular saw. Underestimate the dimensions that has to be remove in order to obtain a continuity of the insulation; it's better to compress the panel rather to have a hole. Notice that a space is kept maintained between the outside panel and the woodwool.
- Screw the outside panel of 19mm on the frame, only when the wall is assembled.

- Assembly

The different piece of the puzzle is put together. The connection and the air-proofing between the module and the removable wool are insured by compressed wood wool.

Step 1: wood wool connection

Cut the pieces of wood wool adapted to the frame gap.

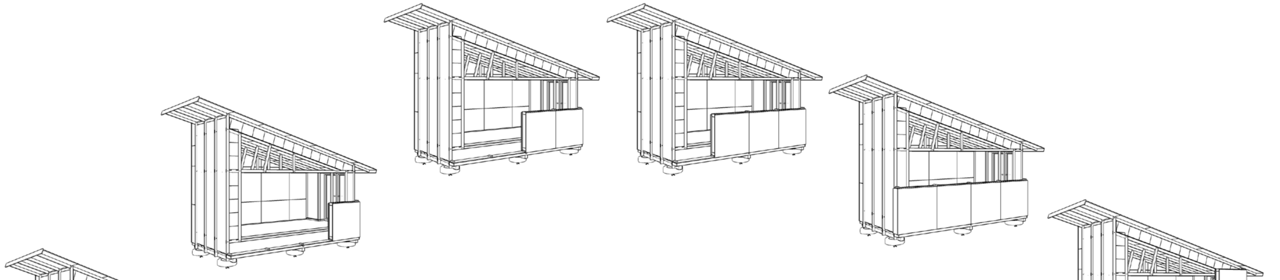


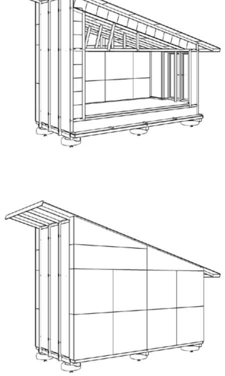
Materials:

- Wood wool panel 30mm
- Support
- Wood wool puzzle pieces
- Screws Ø5mm

Tools:

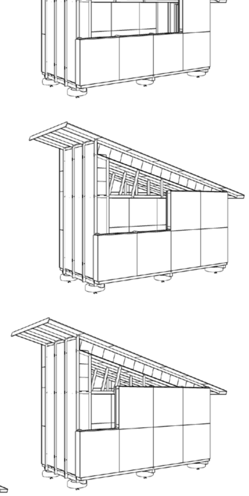
- Circular saw
- Screw-gun

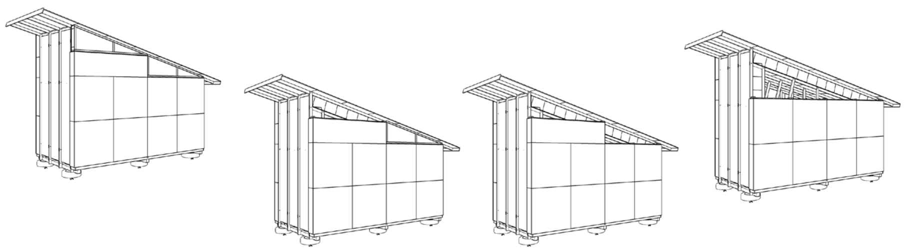


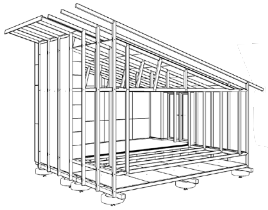


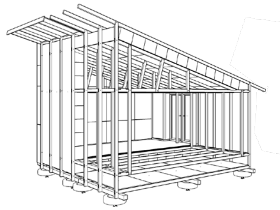
Step 2: Puzzle

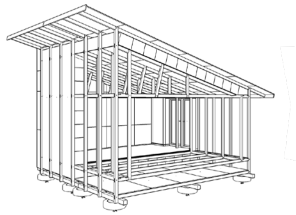
- Screw the support on the wood framework
- Assemble the progressively the piece of puzzle. Screw them along the woodframe. Insert progressively the wood wool between the module and the piece of puzzle.
- For the last two pieces #9 and #11 of puzzle add the CLT coating at the end by screwing them outside.

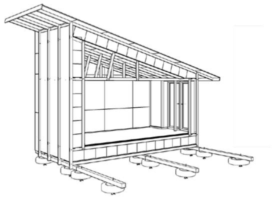






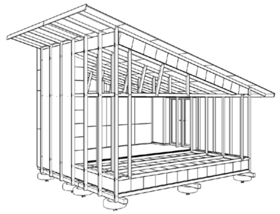


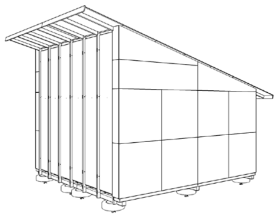


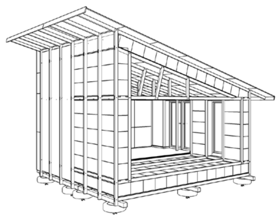


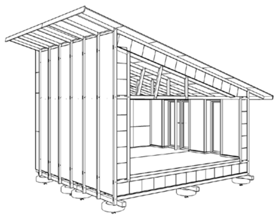
- Incremental module

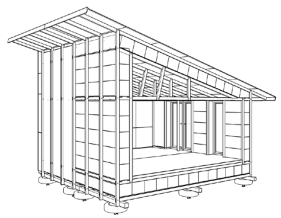
After disassembling one removable wall, an other adapted module may be easily add. Only the length of the foundation beam 125x125mm, of the OSB board of the roof and the roof border have to be reduce of 610mm.







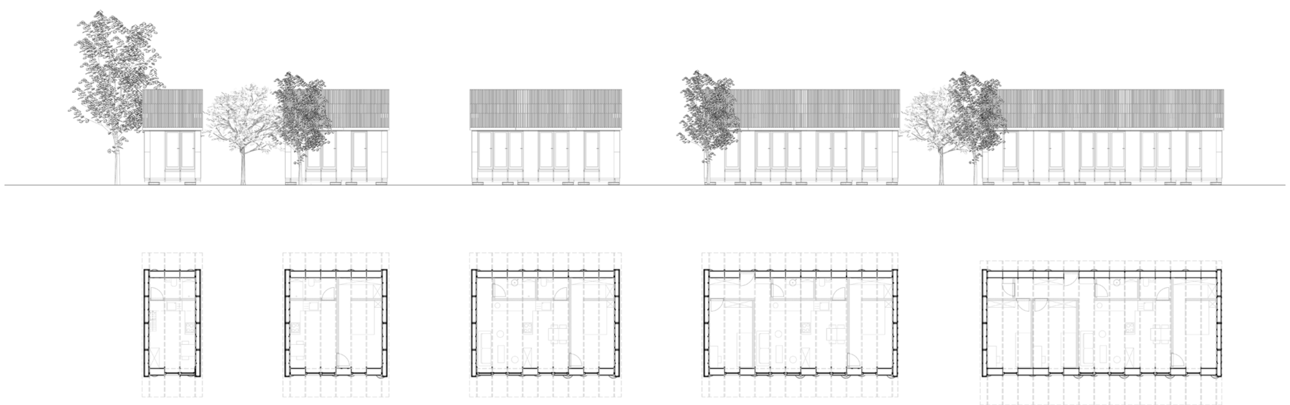


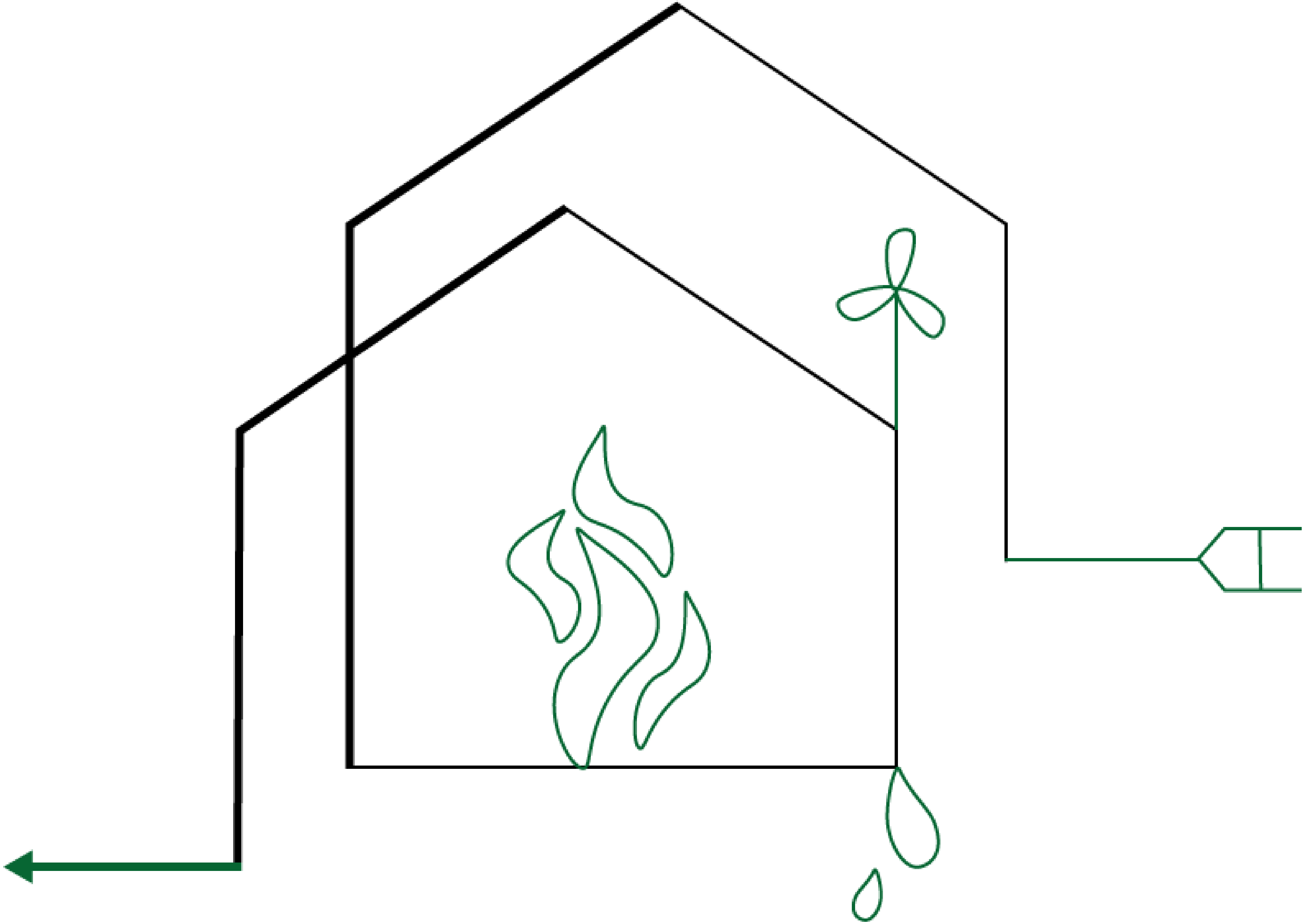


- Adaptable facade

The North and the south facade of the modules may be adapted according to your arrangement and climate. In north hemisphere, bioclimatic construction try to avoid opening the north face, this facade is the coldest and is never in direct contact with the sun. The opening has to be as small as possible and only for the door or for the ventilation.

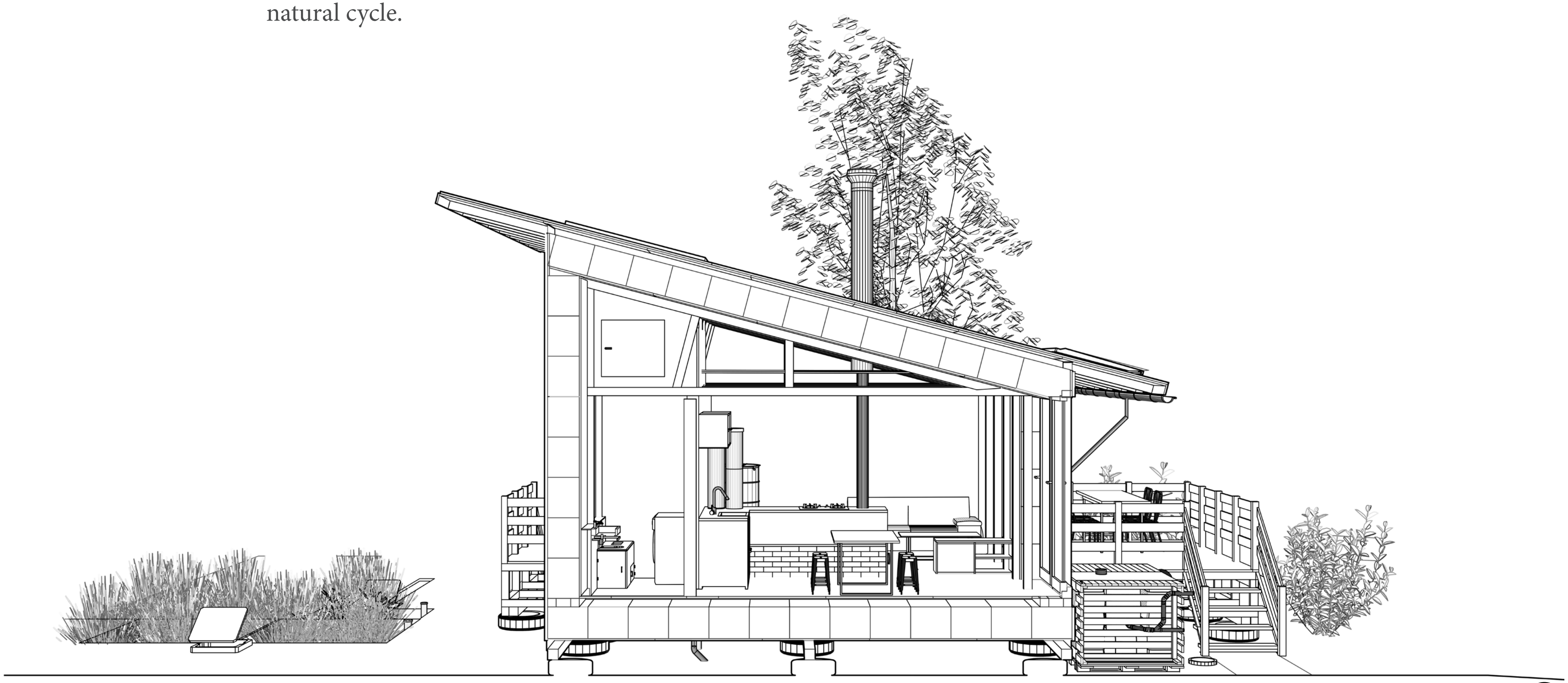
On the contrary the south facade face directly the sun and so is privileged for the opening. To avoid overheating during the summer and thermal loss during the winter, glasses cannot get over 8-12% of the surface floor. A good thermal mass and sun shade enable to increase this value. South-facing glasses are in our project shaded in summer by the roof. More information will be given in the bioclimatic heater chapter (p.152).





ENERGY MANAGEMENT EXAMPLE

Tradition energy suppliers can be supplemented with or replaced by off-grid equipment or arrangements that allows needs to be supplied autonomously and in a way that is environmentally friendly. The Technicals detailed in this chapter, enable the transformation of housing into healthy housings integrated into a natural cycle.

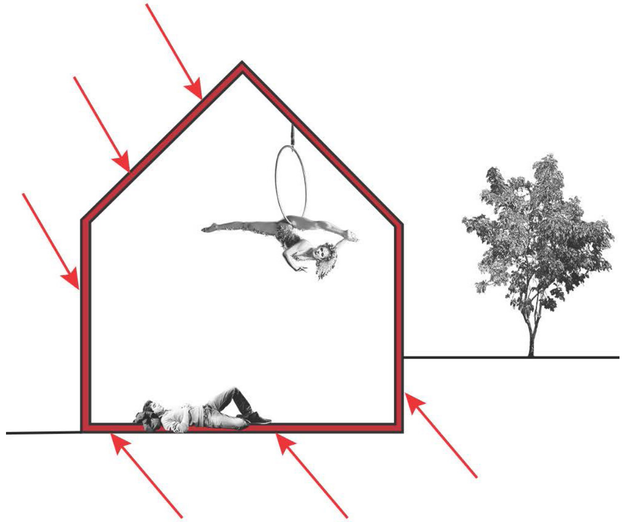


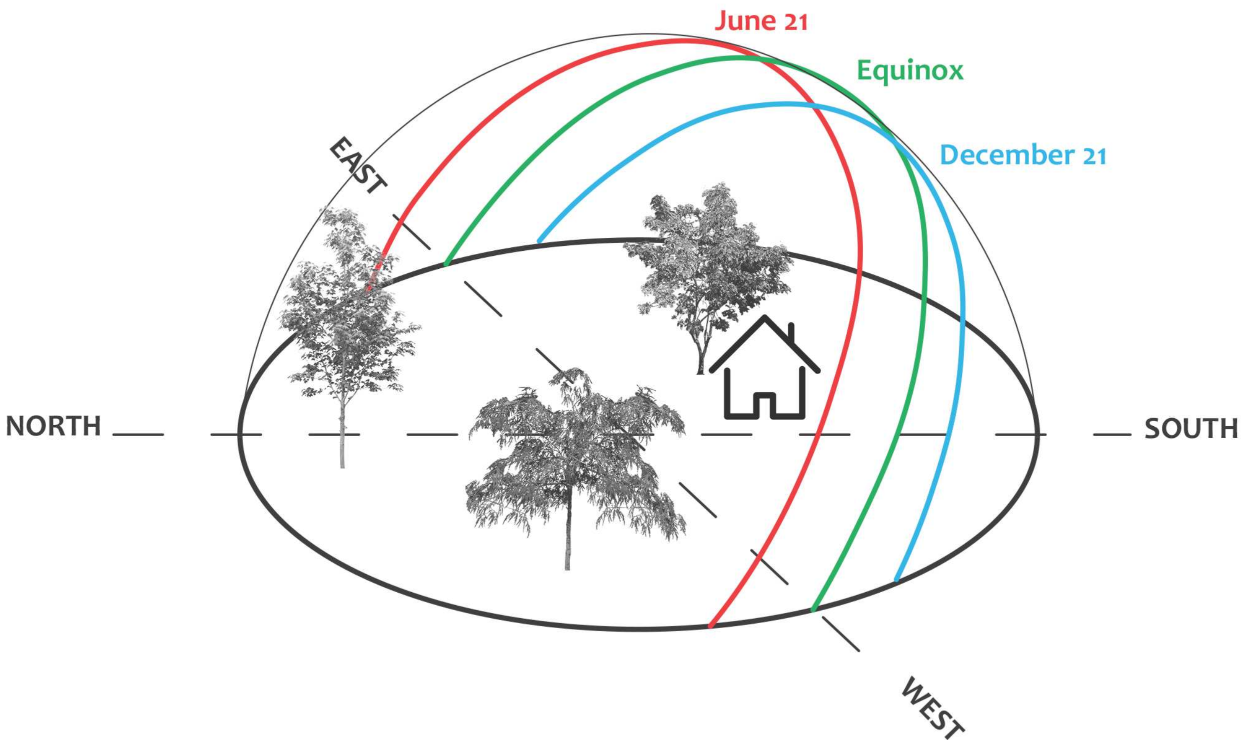
BIOCLIMATIC HEATER

Good design can radically reduce heating demand.
The principle of this design takes advantage of a building's site, climate, and materials to minimize energy use. It draws on their strength of them thanks to efficient orientation, buffer spaces, and interactions. The design is providing sufficient passive heating.

This warmth may be maintained thanks to good insulation. The efficiency of the air heating is thereby provided in entirety by the sun and even your body heat. This heat gain is not negligible because the heat loss from the home is dramatically less than the heat loss in a traditionally built home.
Otherwise, active heating could be added up to react to extreme situations.

Heater




June 21
Equinox
December 21
EAST
NORTH
SOUTH
WEST

Passive Solar

The building can get most of its space heating from the passive solar design.

Site selection:

If you're planning a new passive solar home, a portion of the south side of your building must have an unobstructed "view" of the sun.

Orientation:

The sun rises in the east and sets in the west, the side of the house that is utilized for solar gain needs to be facing the south to take maximum advantage of the sun's potential energy.
Tip: If you want sun rays to warm chilly morning, the house can face the south-east.

Dimension:

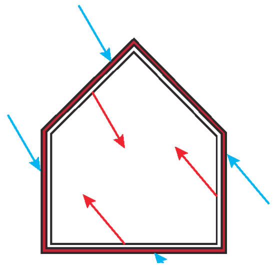
it's generally more convenient to have a building twice as long as it is wide.

Windows:

to avoid overheating during the summer and thermal loss during the winter, glass cannot get over 8-12% of the surface floor.
A good thermal mass and sunshade enable to increase this value. South-facing glasses are usually shaded to prevent overheating and increased cooling loads.

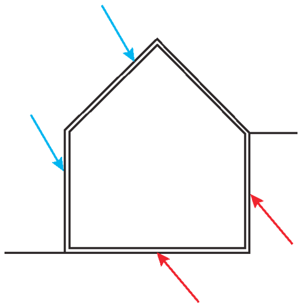
Thermal mass

Objects with high thermal mass absorb and retain heat, slowing the rate at which the sun heats a space and the rate at which space loses heat when the sun is gone. Without thermal mass, heat that has entered a space will simply re-radiate back out quickly, making the space overly hot with sunlight and overly cold without.



Insulation position:

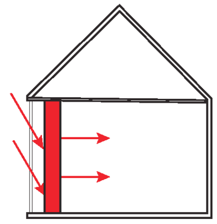
Thermal mass has to be on the interior of the wall components and protected by insulation.

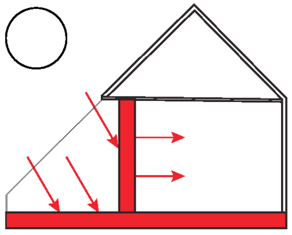


Geothermics:

The building can extend underground to benefit from energy generated and stored in the Earth. This quality depends on the climate and water table distance from the construction site.

Trombe Wall:
it consists of a thick masonry wall on the south side of a house with glass mounted in front. The dark-colored wall absorbs solar heat, which is stored in the wall's mass. The heat migrates through the wall and radiates into the living space.
This quality depends on the climate and water table distance from the construction site.



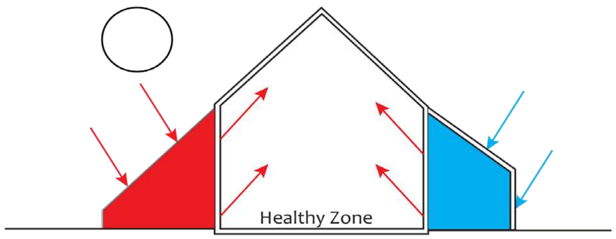


Bioclimatic design

To maintain a healthy zone, we have to take care of the temperature and the humidity. The healthy zone may be supported a surrounding warm zone and cold zone.

A south-facing greenhouse could be a buffer space and contribute heat to health space. It increases the quality of life through an eventual additional all-purpose space or for a garden. Excess heat can be transferred elsewhere thanks to a heat pump.

Northern part may be protected by another buffer space which could include a garage, fridge and freezer, water collector, wine cellar...



ACTIVE HEATER

As a last resort when the bioclimatic heater isn't efficient enough, turning on an active heater should be a possibility. Wood is the most ecological and affordable source of energy.

Rocket mass heater

Rocket mass heaters are super-efficient masonry heaters and built inexpensively. Reclaimed and site-sourced materials are used by many owner-builders to produce this kind of heater. Furthermore, It functions more efficiently with small pieces and scraps of wood. In winter, it warms areas. In Summer the heater is in use, it stores in the bench the evening cool and buffers against daytime heat. The top of the barrel, the radiant bell, provides a tertiary function of cooking and heating a pot of water. In our case, we will link the rocket mass heater with the warm water pipe in order to use the rocket mass heater as a boiler as well. A copper pipe is inserted in the radiant bell.

Rocket mass heaters are most effective heating areas in its line of sight when located near the core of the house. The rocket mass heater is composed of two parts: the combustion units and the heat-exchange mass. Change in combustion units often cause performance problems, it's possible, however, to adapt the heat-exchange mass.
The J-style firebox that we use as an example is the most popular and reliable example of a rocket mass heater.

I seriously suggest you read the book of Erica &Ernie Wisner, The rocket mass heater builder's guide, complete step-by-step construction, maintenance and troubleshooting, which provides valuable advice. It's not recommended to take the design of a rocket stove lightly.over 8-12% of the surface floor.
A good thermal mass and sunshade enable to increase this value. South-facing glasses are usually shaded to prevent overheating and increased cooling loads.

Materials:

Earthen Masonry

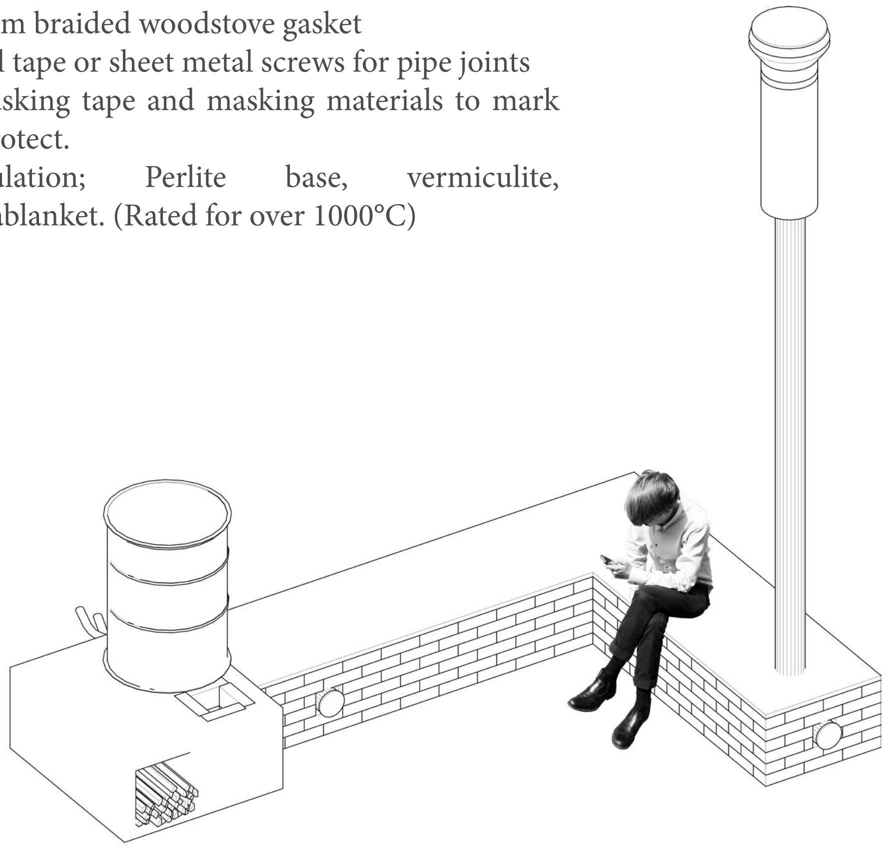
- Clay slip
- COB earthen masonry
- Aggregates: sand, bricks or small gravel
- Straw and fiber

Metal

- 1 or 2 steel drums 200L Ø60mm (clean and coated with high heat cooking oil or high heat enamel)
- Oil drum
- Stovepipe Ø20mm: elbow, capped T, straight pieces according to the shape of your bench
- A matching cap for stovepipe
- Chimney measured to fit the structure: stove pipe from rocket stove to the ceiling, insulated class A chimney sections from the ceiling through the roof, matching through-roof fittings, screened chimney cap.

Bits and pieces

- Firebricks 215x112,5 x 65mm
- Half-fire-bricks 215 x112,5 x 30mm
- Rubble (broken concrete, local field-stone, bricks...)
- 35cm braided woodstove gasket
- Foil tape or sheet metal screws for pipe joints
- Masking tape and masking materials to mark or protect.
-Insulation; Perlite base, vermiculite, Durablanket. (Rated for over 1000°C)



Tools:

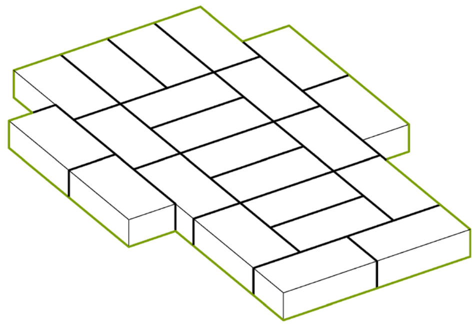
Measuring and marking
- Tape measures
- Masking tape
- Level
- Angle bevel

Masonry and mortars
- Buckets
- Shovel(s)
- Tarp
- Mason's trowel
- Hammer
- Wheelbarrow

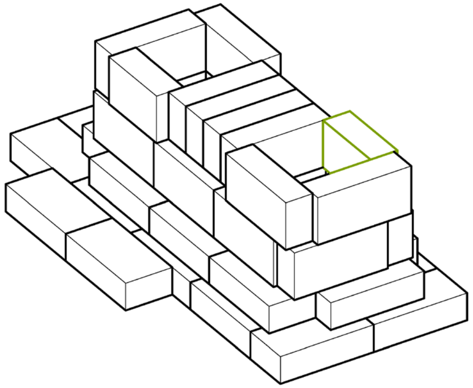
Metal
- Heavy cutters
- Stovepipe
- Hacksaw or grinder
- Screwdriver and bits
- Wrench,pliers,gloves

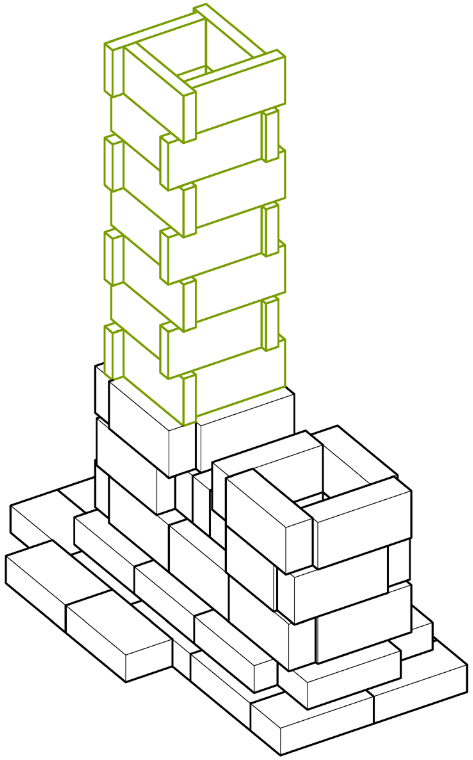
Woodwork
- Saw (circular/flush-cut)
- Hammer
- Drill

Step 1: firebox.
- Make sure that the foundation of the rocket stove can support a heavy additional weight. Otherwise, reinforce the structure.
- Settle the brick base pad and draw a line around it.



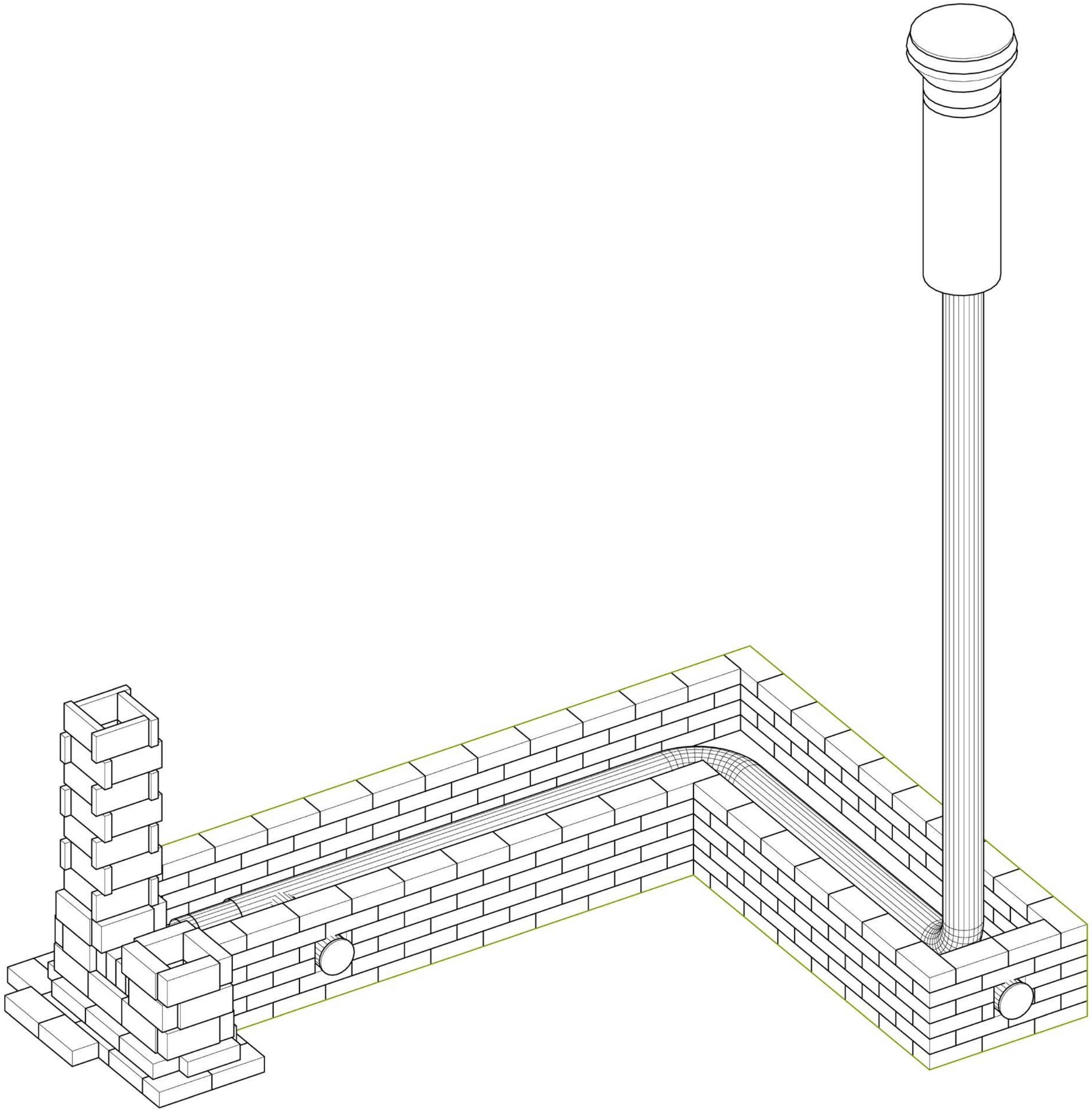
- Prepare the clay slip: clay from the land mixed with water. A good slip should coat fingers thick enough that you can't see fingerprints» Erica & Ernie Wisner.
- Wet each brick in a bucket of water.
- Use the slip as a glue to assemble it.
- 2 bricks (in green) have to be cut with a tile-saw, a diamond-blade masonry saw or a grinder. (Approx. 180 mm length: set all the bricks up and leave a mark to know the perfect length)
- The heats riser is composed of half-firebrick





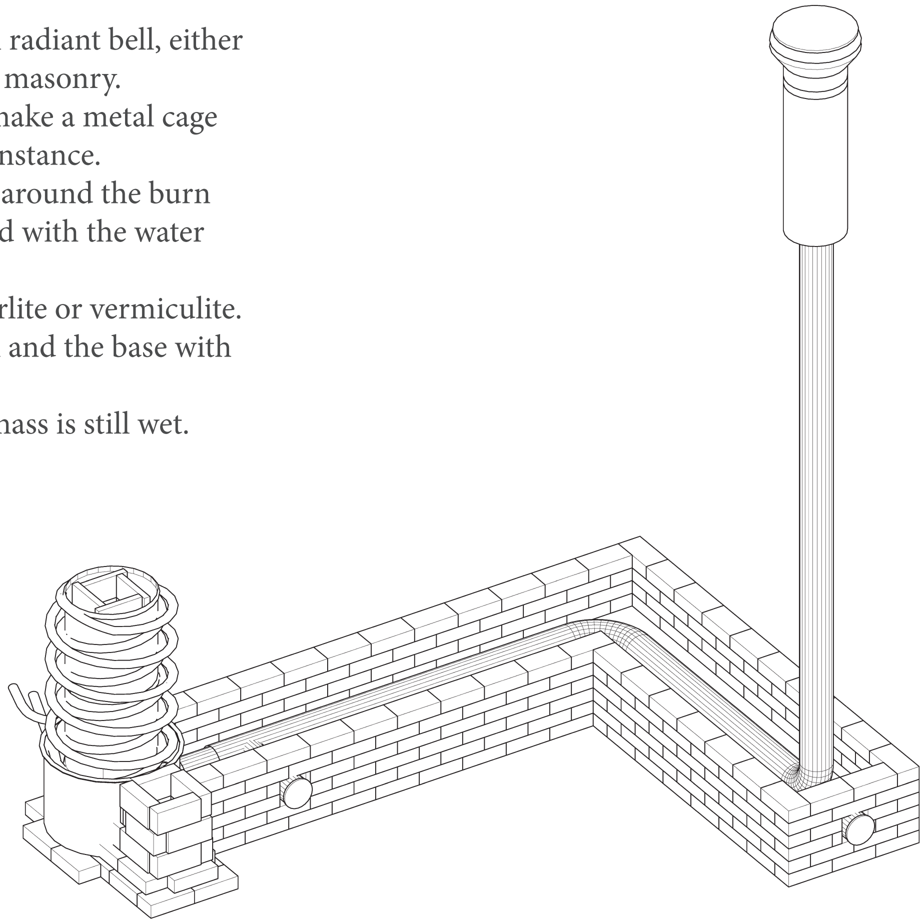
Step 2: Bench

Let it dry.
Meanwhile, start the bench.
- Build a frame of bricks or stones that shape your bench.
- Build the smoke pipe with a clean-out for annual maintenance.
- Close the join up with foil tape or metal screw.
- Set up the base of the bench with aggregates and mud.



Step 3: radiant bell

- Build the base of the metal radiant bell, either with a cut-off barrel or with masonry.
- Around the burn tunnel, make a metal cage with an open oil drum, for instance.
- Add copper pipe wrapped around the burn tunnel that will be connected with the water facility.
- Fill the metal cage with perlite or vermiculite.
- Link the metal radiant bell and the base with braided wood stove gasket.
- Test-fire while the heater mass is still wet.



An electrical grid usually provides delivering electricity from producers to consumers thanks to an interconnected network. The electricity cannot totally be considered as a low technology, due to the fact that the installation will always engage high tech elements and it is used to feed high technologies.
We can just light the building with gas and get high technology over with. But our century is built upon communication with smartphone, computers and many other electronic instruments that require electricity. To avoid digression with a high tech DIY and give the key to satisfy this need, global principles will be described.

It is, however, possible to produce our own electricity from hydropower, wind power or directly from the sun.

Electricity

The first step is the calculation of our needs for electricity:

- Define the electric devices which you use every day and the number of hours of use. Every device has an indicated precise consumption either on the charger or on the device directly. Most of the time, the indication of the consumption in electricity is in Watt (W). But it happens that you have only the indication in Volt (V) and in milliampere (mA). In this case, you will have to do the following calculation to convert in Watt: V x A = W (The voltage multiplied by the amperage = Watt). For the record: 1 ampere = 1000 milliamperes.
- Which solar charge controller: PWM or MPPT?
- How long do you want to let this electric devices plug?
- What is the minimal sunshine duration in your region?

- Then add these data on a solar sizing calculator: https://www.renogy.com/calculators [accessed on 18 January 2019]

You will obtain information about the system and battery size.

According to your region and plot, you can pick the most obvious source of energy. For the sunny regions, a photovoltaic solar power plant is the most efficient system. The electricity is mostly provided by a wind turbine on a plot facing the wind. With a bit of luck, the plot is cross by a river, hydropower can be an efficient power plant.

Charge controllers

The PWM controller, (Pulse Wide Management), is, in essence, a switch that connects a solar array to a battery. We use it for sun device that has a low tension (between 11 and 15 Volts). Even if a solar panel delivers 17 Volts, the solar charge controller will only use 11 to 15 Volts, the voltage of the array is pulled down to near that of the battery.

The MPPT controller, (Maximum Power Point Tracking), more sophisticated and more expensive, is adapted for higher tension. It will adjust its input voltage to harvest the maximum power from the solar array and then transform this power to supply the varying voltage requirement. The MPPT is more efficient than PWM.

Type of Batteries

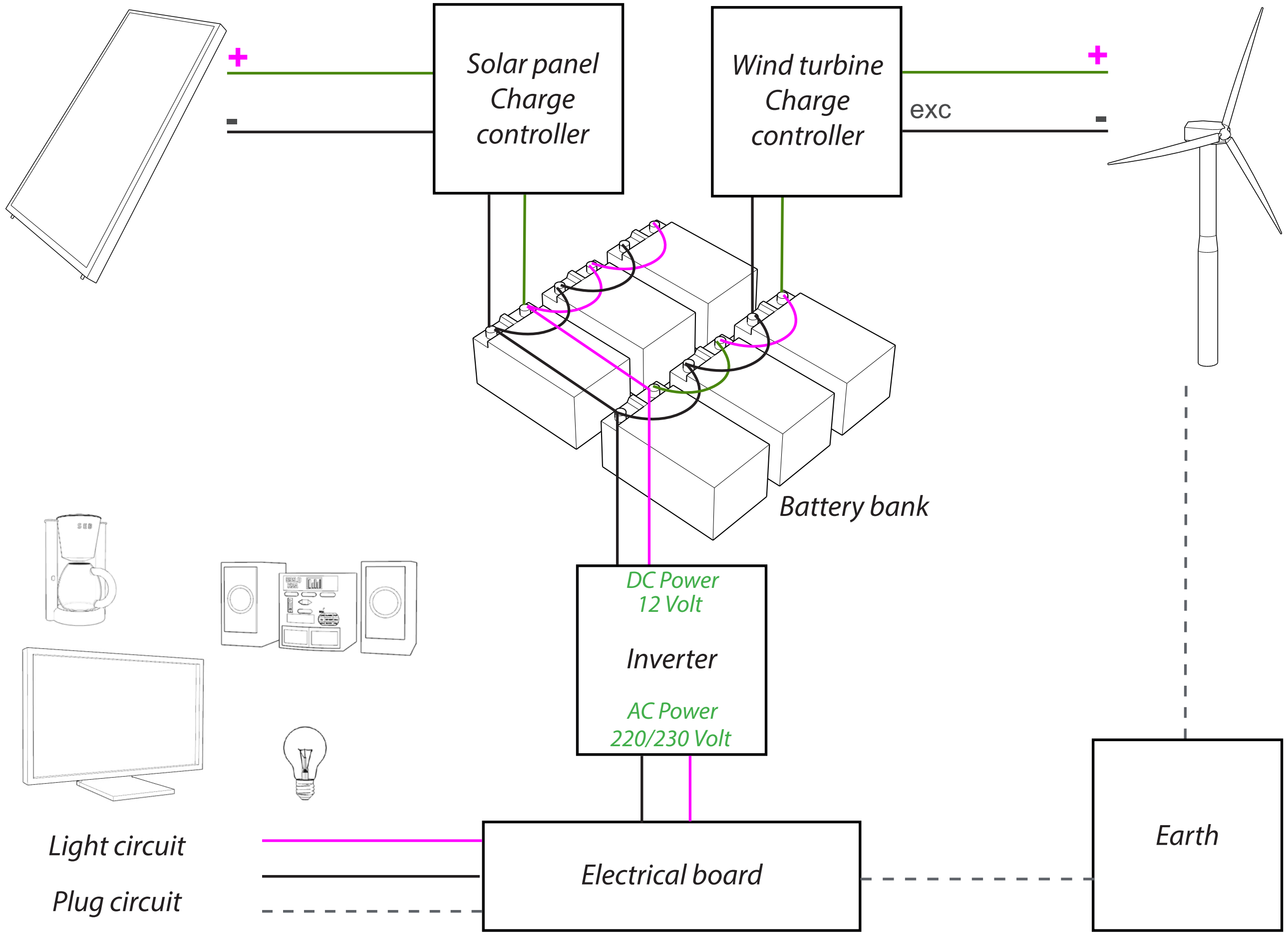
There are two main types of batteries, Lead Acid batteries, and Lithium-Ion batteries. Lithium-ion has six to ten times a longer lifetime than lead-acid batteries, are 1/3 the weight of lead-acid batteries and smaller too, have a low self-discharge which means they don't lose energy over time by just sitting there. The energy you put in is the amount of energy you can get out of it. Both batteries age slower in cooler temps but the lithium-ion can last longer in high temperatures. Lithium is much efficient an well suited. Lithium-ion batteries are more expensive, around twice the cost of lead acid batteries. But in a full lifetime, it can work out cheaper.

Batteries might be found in an old car for free at the mechanic.

wiring batteries in series or parallel
The same holds true for battery connections, batteries wired together in parallel will maintain the voltage and increase amperage and batteries wired together in series will maintain amperage and increase voltage.

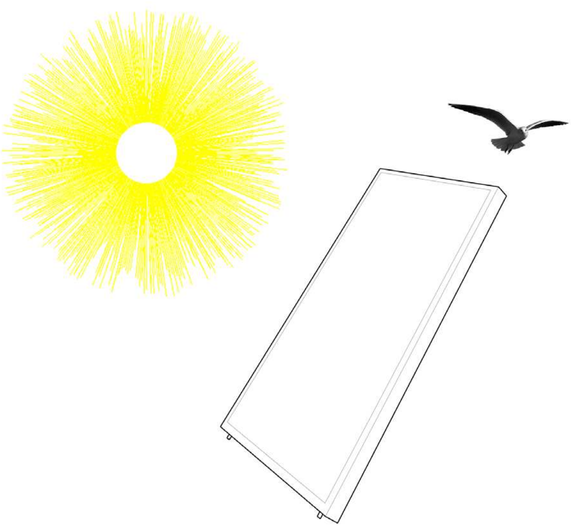
Inverter
Inverters convert direct current (DC) to alternating current (AC). Houses traditionally run off of AC for the TVs, smartphones, coffee machines...

For the autonomy of a building, two complementary electricity suppliers are recommended. For instance, with photovoltaic solar panel and wind turbine we obtain this basic solar set up :


+
-
Solar panel Charge controller
Wind turbine Charge controller
+
exc
-
Battery bank
DC Power 12 Volt
Inverter
AC Power 220/230 Volt
Light circuit
Plug circuit
Electrical board
Earth

Photovoltaic solar panel (PV)

Photovoltaic energy converts the sunlight into electricity. You can build your own solar panel. However, experience shows that it's neither cost-effective nor more ecological as we have to buy the main element: solar cells. However, a homemade from scratch solar panel is a self-empowering project that offers enjoyment and broadens your mind out.



Types of panels

Main solar photovoltaic panels cells are either monocrystalline or polycrystalline. Monocrystalline solar panels have the highest efficiency rates, they are made out of the highest-grade silicon, are space-efficient and last the longest. They also tend to perform better than similarly rated polycrystalline solar panels at low-light conditions. Monocrystalline solar panels are of course the most expensive. With central string inverters, entire circuit can break down if the PV is partially covered with shade, dirt or snows. In contrast, micro-inverters make sure that the entire solar array is not affected by shading issues with only one of the solar panels. Polycrystalline solar panels tend to have slightly lower heat tolerance than monocrystalline solar panels.

Wiring Solar Panels in Series or Parallel

Panels can be hooked up to raise or maintain levels of power or current. The same is true for battery connections. In series, each piece is placed in a line, one after another. Series connections increase voltage but the current stays the same for all of the elements. For example, if you installed 4 solar panels rated at 12 volts and 5 amps in series, you'd still have 5 amps but a full 48 volts. It may be easier to wire your solar panels in series since a disruption to one of the elements will disrupt the entire circuit. While parallel connections increase amps, each solar panel is connected to every other panel in the circuit. For example, if you installed 4 solar panels rated at 12 volts and 5 amps in parallel, you'd end up with 20 amps and 12 volts. Installing solar as a combination of series and parallel circuits maximize the advantages of both types of wiring.

The inverter is chosen according to the connections and the type of panels. MPPT, Maximum Power Point Tracking, can convert higher voltage and so is adapted to series connection. PWM, Pulse-width modulation, is fine for standard 12 Volts solar panels wired in parallel. If the solar panels are the same, wiring them in series or in parallel doesn't make a difference. For mismatched solar panels with different voltage, use an MPPT charge controller and plug it in series. Otherwise, you will not get a most out of your panel and lose power.

Orientation

The power output works best with direct sunlight. Dust, clouds, and other obstructions in the atmosphere also diminish the power output. In Northern Hemisphere, Solar panels have to face south as much as possible. The angle of the solar panel must be adapted to the latitude, the best angle is 90-latitude. For instance in Vienna, the latitude is of 42°; the best direction and angle is south and 48° (90-42).

Wind turbine

A wind turbine is a device that converts the wind's kinetic energy into electrical energy. Before starting or buying your wind turbine, it is recommended to measure the wind with a manometer or to find information in your city. A graph of the wind speed resulting from this research and will determine the essential characteristic of your wind turbine. The turbine requires a certain amount of wind to start, known as the minimal wind speed. The output power is the efficiency of the wind turbine according to the wind speed.

Vertical axis wind turbines have the advantage of operating with wind turbulence rather than only with the laminar wind that needs a horizontal axis wind turbine. Furthermore, the vertical axis wind turbine, that will be introduced, keeps a constant speed and protects itself automatically if there is to much wind. The materials, random wood boards, cheap jewelry, and salvaged material, makes the price low.

Materials:

gear system

- 1 old but functional bicycle drivetrain system
- 1 Car alternator (for free at a garage)
- screws
- 2 single row deep ball bearings
- 1 Joint thread adapter
- Thread adapted to your bicycle drivetrain
- 6 bolts adapted to your bicycle drivetrain
- A piece of wood to wedge the system

Wind turbine

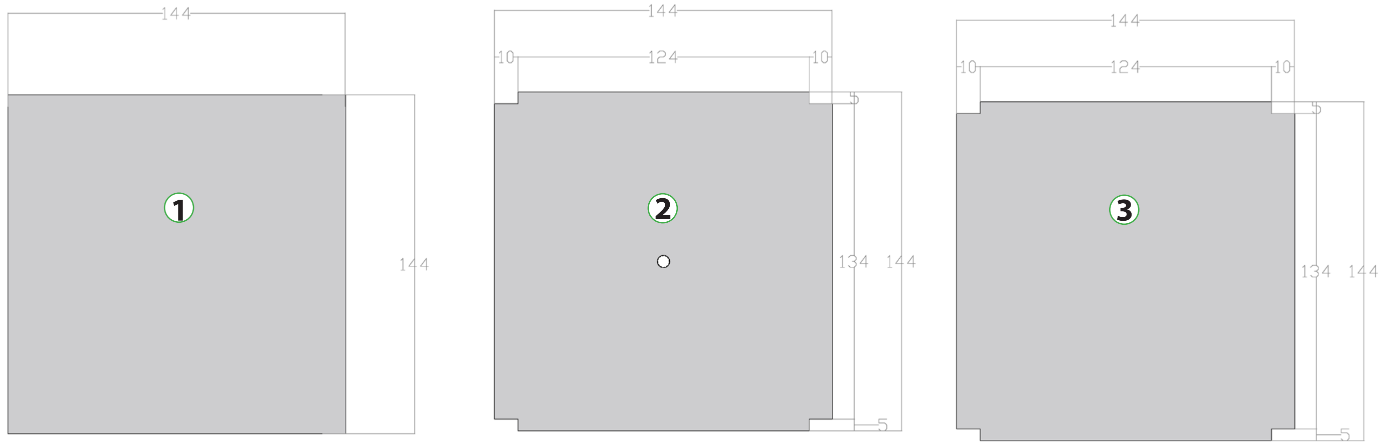
- CLT 10X500x120mm
- CLT 22x870x870
- 4 Ø8mm screws
- Thread Ø8mm
- Bolt Ø8mm
- 4 offset plates (for free at print shops)
- 1280mm iron pipe Ø25mm
- 1 self-aligning ball bearings Ø25mm
- 2 single row deep ball bearings Ø8mm
- 24 single row angular contact ball bearings Ø8mm
- 1 single row angular contact ball bearings Ø25mm
- Rod
- Spring

Stand

- CLT board 22x2900x1450mm
- Beam 50x100x11535mm
- Beam 100X100x5360mm

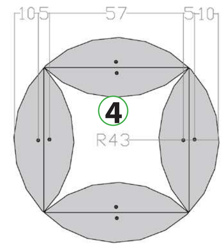
Tools :

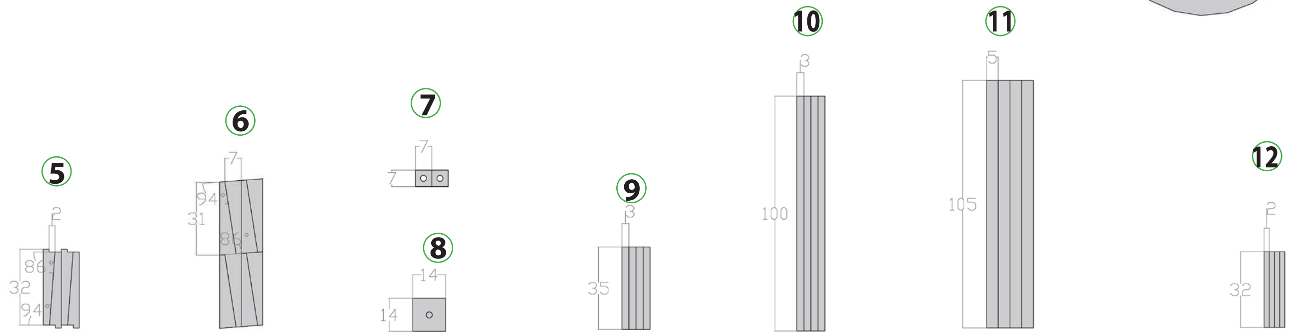
- Screw-gun
- Drill
- Sander
- Hole saw
- Circular saw
- Jigsaw
- Router
- Protective equipment (goggles, gloves, brazing protection glasses)



Step 1: Preparation of the CLT boards

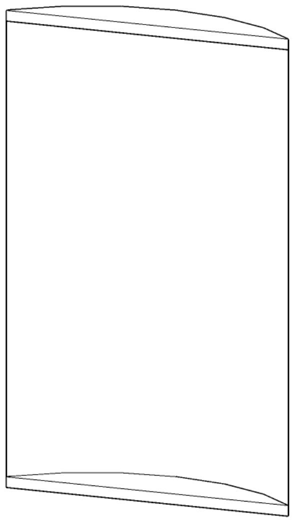
- Saw the CLT boards according to the dimensions below (leave the drilling for later).
- Number the wood board with a pencil.
- Sand the different pieces.





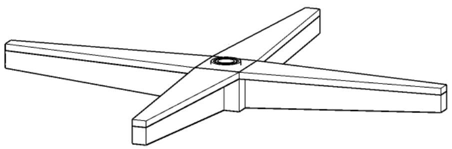
Step 2: blades

- With a trial assembly on the CLT 4 board, find the width of the «offset panel»(approx. 680mm).
- Cut the offset plates approx.680mm x 100mm.
- Screw it progressively on the circular edge of two CLT 4 boards.



Step 3: the Bottom cross

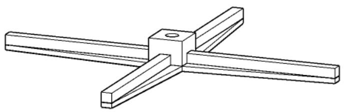
- Cut wood beam (100x50mm) to obtain a block of 70x70x50.
- Make four notches of 12x25mm in the middle of each edge of one face of the block
- Drill Ø25mm into the middle of the wood block.
- Screw the CLT 5 in the four gashes.
- Drill Ø25mm on the middle of the CLT 7.
- With a hole saw, drill a 50 mm deep hollow adapted for the single row angular contact ball bearings of the CLT 7.
- Screw on the last assembly the CLT 6 and 7.



Step 4: the top cross

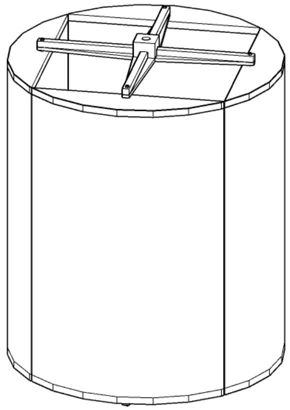
just like step 3:

- Cut wood beam (100x50mm) to obtain a block of 70x70x50.
- Make four gashes of 12x25mm.
- Drill Ø25mm the middle of the wood block.
- Screw the CLT 12 in the four gashes.
- Drill Ø25mm on the middle of another the CLT 7.
- Wit a hole saw, drill a 50 mm deep hollow adapted for the single row angular contact ball bearings of the CLT 7.
- Screw on the last assembly the CLT 6 and 7.



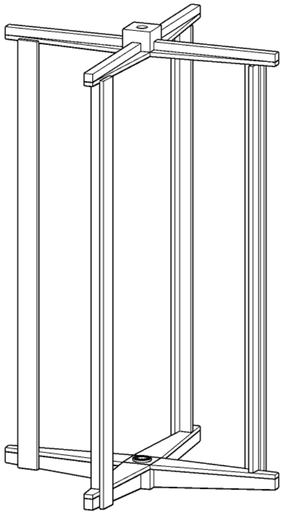
Step 5: Link the blades and the crosses

- Start with a trial assembly; without gluing and screwing.
- Using the trial assembly as a guide, drill Ø8mm on the tip of the crosses.
- Drill also the blades.
- With a hole saw, drill a 50 mm deep hollow adapted for the self-aligning ball bearings on the top and the bottom of each blade.
- Insert the self-aligning ball bearings.
- Connect the crosses and the blades with threads, separate them and enclose them with a bolt.



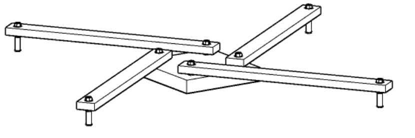
Step 6: Axe stand

- Screw the four CLT 10 and 11 to form support for the crosses.
- Screw them to the crosses as close as possible to the blades.



Step 7: arms

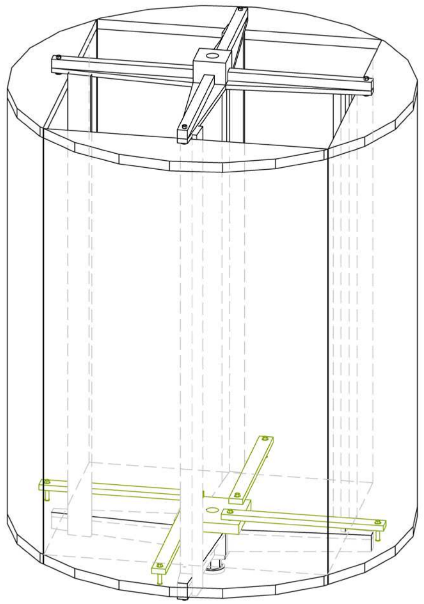
- Drill Ø8mm on each tip of the four CLT 9 «arms».
- With a hole saw, drill a 50 mm deep hollow to fit the single row deep ball bearings on each tip of the four CLT 9.
- Connect the arms on the CLT 8 «the node» with Ø8mm screws and enclose the arm with a bolt.

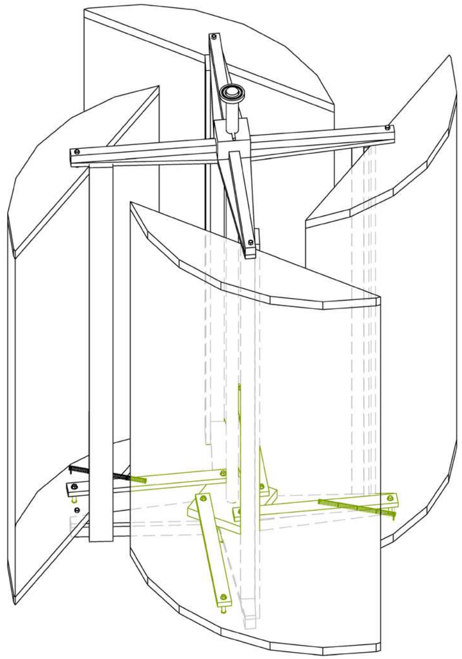


Step 8: Link the blades and the crosses

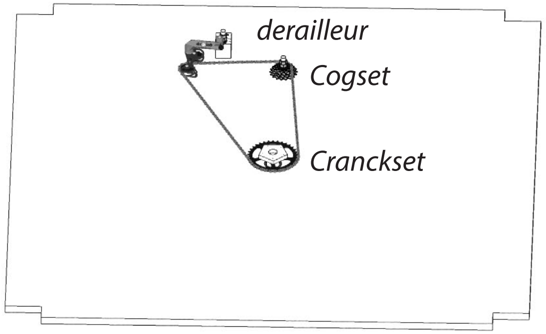
When the wind turbine is close the arms have to be perpendicular to the blades.

- Start with a trial assembly.
- According to the trial assembly, drill Ø8mm on the tip of the crosses
- Drill the blades as well.
- Connect the arms and the blades with threads, separate them and enclose them with a bolt.
- Screw two springs between the crosses and the blade to enable an automatic closing of the blades

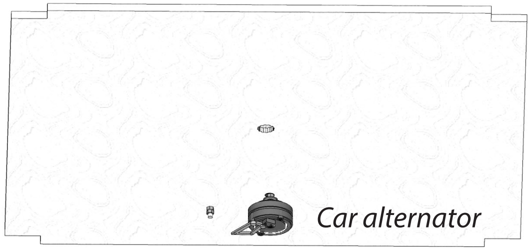




Step 10: Gear system
- Clean the gear system.
Start with a trial assembly;
- Assemble and wedge it on the CLT 2: the Crankset in the middle, then the Cogset, and derailleur gear 470 mm away from the center of the CLT 2.



FRONT of the CLT 2



back of the CLT 2

Step 11: Frame

- Drill a 50 mm deep hollow to fit the self-aligning ball bearings in the middle of the CLT 2 and the CLT 3.
- Cut 8 beams (section 50x100) with a length of 145mm.
- Build 2 frames with these beams.
- Rout a hollow of 100x25mm on each tip of the beams.
- Cut 4 beams (section 100x100mm) with a length of 134mm.
- Assemble a box with the different beams and the CLT 1(the bottom), CLT 2 (the support of the wind turbine), CLT 3 (the roof).

Step 10: Gear system

- Clean the gear system.

Start with a trial assembly;

- Assemble and wedge it on the CLT: the Crankset in the middle, then the Cogset, and derailleur gear 470 mm away from the center of the CLT 2.

Step 12: Axis

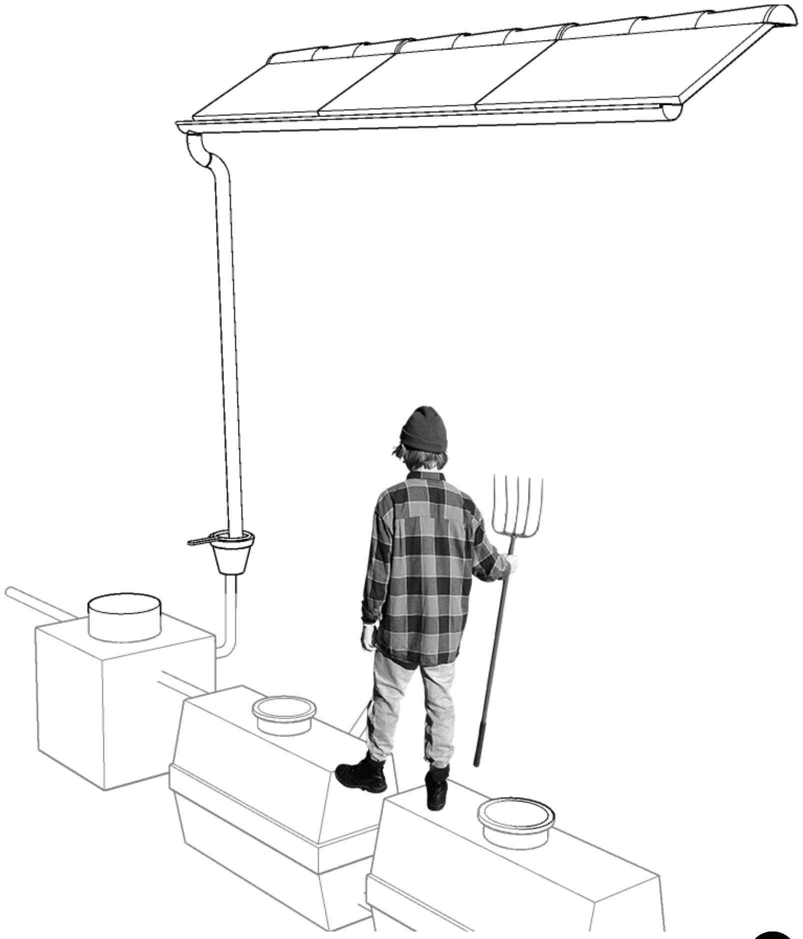
The axis is an iron pipe that has to be supported by a rod on the top of the top cross

- Test a trial assembly with all of the components.
- Drill the axis and insert the rod.

The management and protection of water resources, of fresh and saltwater ecosystems, and of the water we drink and bathe in is one of the cornerstones of environmental protection. Well, spring, lake or river... First, you have to find water on your land. Otherwise, it falls down from the sky.

In Europe, The average person uses around 150 liters per day. It is largely possible to reduce the consumption to 30 liters per day by a rational consumption and the use of organic toilets, to avoid organic waste in drinkable water... The first environmentally friendly act is to reduce our need and adapt it to our environment. You have to know your daily water intake and adapt your system accordingly to this one.

WATER



Water collection & purification

Step 1: Capture the rainwater

The rainwater is a gift from the sky. The «blue gold» falls down on our roof and might be used for our daily water intake. Furthermore, It occurs that the rainwater is 2000 times less polluted than the groundwater.

You have to find the average precipitation in your region and know the period of drought and the period of heavy precipitation to adapt the storage capacity and the roofing area. The water is collected by a roof of slat, clay, zinc, glass, concrete or even galvanized iron sheet. A gutter leads the water to a pre-filter.

Step 2: Pre-filter

The pre-filter is a simple pot with a stainless steel sieve that keeps out insects, dead leaves and debris that might be found on the roof, and gravel. The water is guided through a funnel that sends down the water by gravity and ends up in a decanting tank to get rid of all the suspended matter.

The decanting tank of approximately 80cm x 80 cm contains a decenter partition wall that still let the water goes below; the suspended matter hits the partition and goes down. On the other side of the partition, the water is free of suspended matter.

Step 3: Storage

One or more mineral tanks store water according to your needs. This tank is buried underneath a significant mass of earth, it has to stay at a regulated temperature and in frost-free conditions. The rainwater stays a while in the mineral tanks and is treated by the cement to make it drinkable.
In fact, the rainwater doesn't require a significant filtration but remineralization with a PH adjustment. The PH of the rainwater of 4,6 is corrected to 6,9 by keeping it in a concrete or masonry tank during a few days; bioelectric exchange between H_2O and mineral salt naturally adjusts the PH. The water is mineralized between 30 and 80 ppm.

Step 4: Clean water

This water may be directly used for the shower, the dishes, the laundry...

This filtration might be improved by a cotton filter of 20 microns, an activated charcoal filter of 10 microns and then an activated coal filter of 5 microns, that has to be changed every six months, and also with a UV lamp. These filters are not always necessary, especially with rainwater.

Step 5: Drinkable water

The biosand filter is a household water treatment technology. It was inspired by slow sand filtration, a water treatment process that has been used since the early 1800s. It depends on the same processes that naturally occur in the sand at the banks of rivers. Dr. David Manz invented the biosand filter in the early 1990s at the University of Calgary. He co-founded CAWST in 2001 and made his invention freely available for humanitarian means. The water can come directly from the well, spring, lake or river but caution should be used.

COMPONENTS

The biosand filter is composed of 5 distinct zones

1. Inlet Reservoir: where the water is stored before filtration

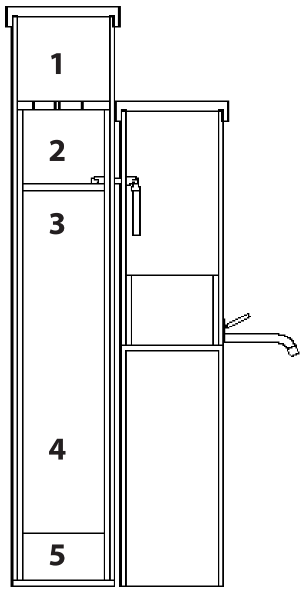
2. Standing Water: keep the sand and the biozone wet

3. Biolayer: Develops at the top 5-10 cm (2-4") of the sand surface.

- The biolayer is adapted to the water that you provide. It's recommended to keep the same source of water, wait a few days if you change the source.
- The biolayer takes 1 month to be effective after the first usage. Don't drink the water in the meanwhile.
- Repeat the filling every day; min. 1h and max. 48h between each filling to maintain the biolayer.

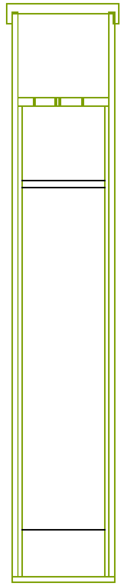
4. Sand Zone: Contains almost no living microorganisms due to lack of nutrients and oxygen.

5.Gravel Zone: Holds the sand in place which protects the outlet pipe from clogging and allows for the smooth flow of water.



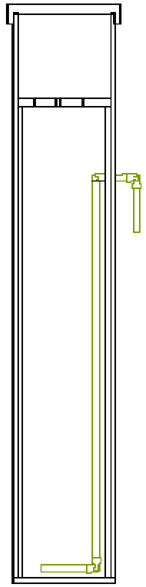
Reservoir

- Join the biggest tube and the plug, sand lightly each and glue with silicone to make it water-tight.
- Drill the lid of the smallest tube with several small holes: the water flow is reduced by the lid so as not to destabilize destabilized the biolayer.
- Fit the smallest tube into the biggest tube.
- Drill a hole of the diameter of the flexible pipe elbows at 75% of the bottom's reservoir.



Flexible Pipe

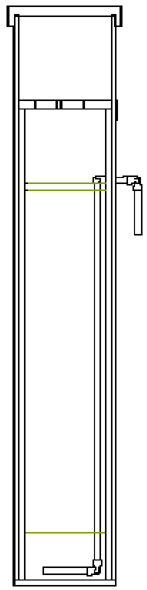
- Cut the flexible pipe: 8cm/ 75% of the height cm/ 5 cm/ 10cm.
- Drill the pipe of 8cm with several small hole Ø5mm.
- Plug the pipe and the elbows with silicone, progressively in this order; the pipe of 8cm- el-bow- the pipe "75%height"- elbow - the pipe of 5 cm - elbow - the pipe of 10cm.
- Clean the Gravel
- Clean the sand



Filter assembly
- Combine the reservoir and the flexible pipe with a watertight silicone.
- Add, first the large gravel, then the gravel, and finally the sand.

Safe water storage container
You must have a clean safe water storage container to collect the water as it flows out of the outlet tube.

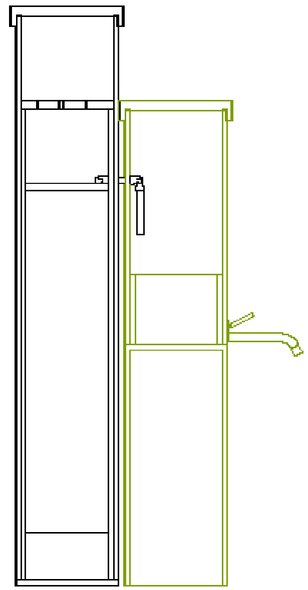
OR : In stores, you might find a ceramic filter with activated charcoal that has to be changed every year.



Step 6: Water Testing
For the first usage, a laboratory test is required (usually less than 100euros)

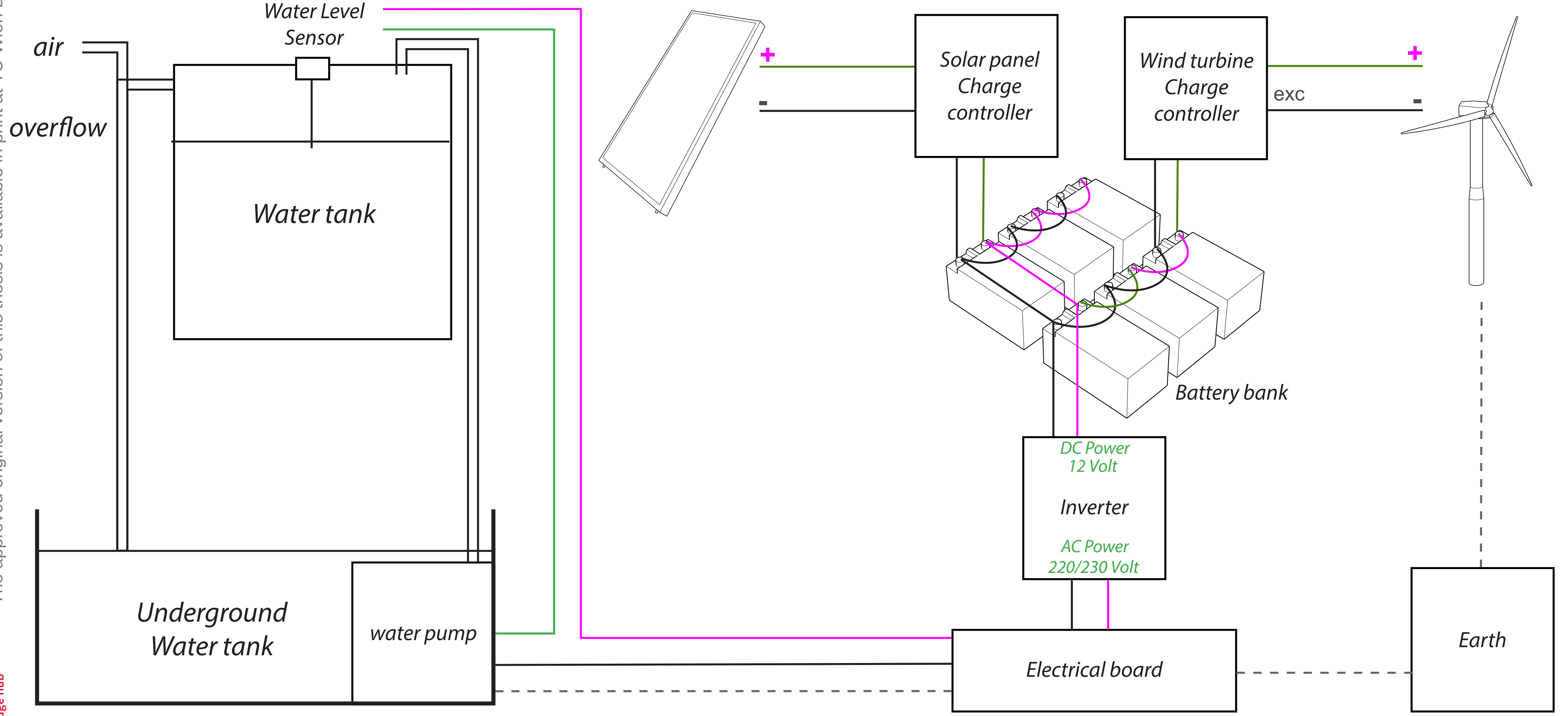
1. Microbiological Testing: Test for e-coli and total coliforms, thermotolerant bacteria can be performed.
2. Physical Testing : Test for turbidity, pH, temperature, conductivity, can be performed
3. Chemical Testing;
4. Test for arsenic, chlorine, fluoride, ammonia, manganese, Iron, nitrites etc can be performed.

Verification systems exists:
- PH measure with Ph test stripes
- Water safe system



Water pump

A water pump is connected to the off-grid electrical system. For moving water from the underground water tank to an upright water tank for drinking, cooking, cleaning and other purposes. A water level sensor stops it when the water tank is full.


Water Level Sensor
air
overflow
Water tank
Underground Water tank
water pump
Solar panel Charge controller
Wind turbine Charge controller
+
-
exc
+
-
Battery bank
DC Power 12 Volt
Inverter
AC Power 220/230 Volt
Electrical board
Earth

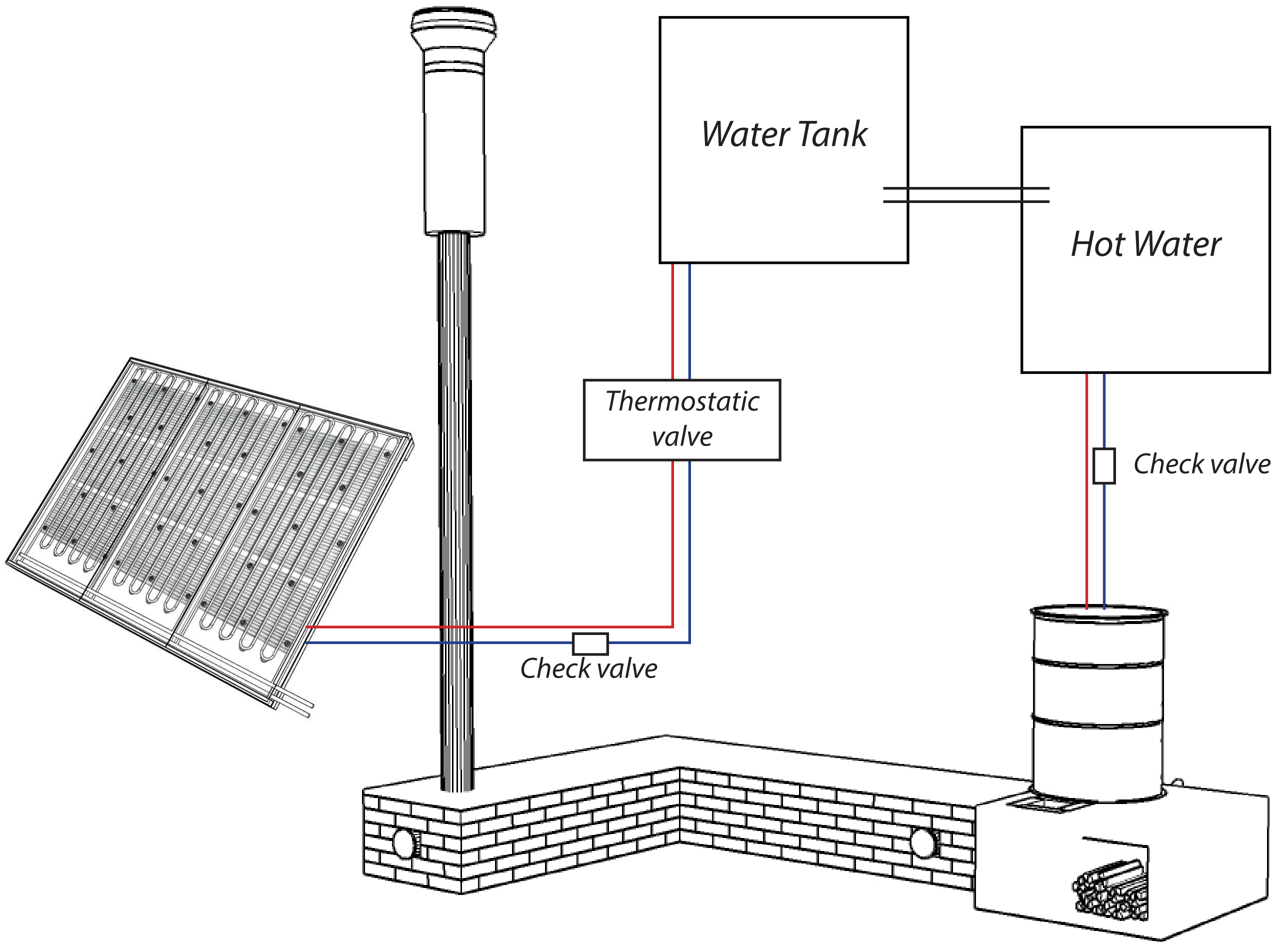
Warm water

In an autonomous building, hot water is what consumes the most energy.

Two complementary systems are implemented to heat the water for any situation:

- The solar panel heater converts the sunlight into energy to heat the fluid.
- The rocket mass heater converts the fire heat into energy to heat the fluid when necessary.

These systems warm a heat transfer fluid that transmits the heat in a heat exchanger to the domestic water in a heat exchanger.


Water Tank
Hot Water
Thermostatic valve
Check valve
Check valve

Thermal solar panel

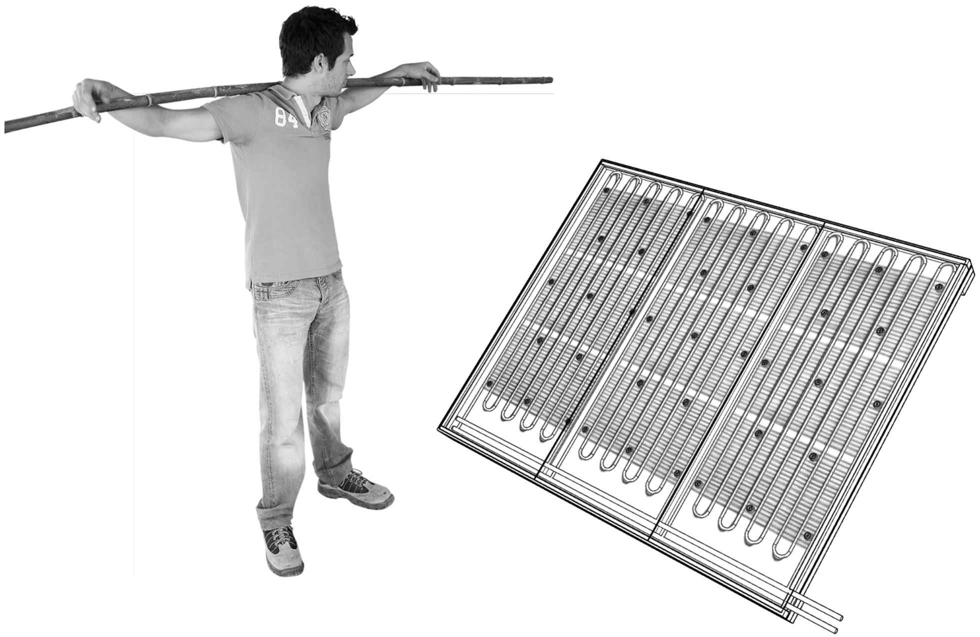
This solar panel, promoted by Camille Duband and Clément Chabot during the Low-tech Tour France, and developed and optimized by Eric Lafond, captures 500W per m2 for a cost of 15 per m2. For instance, in Isère, 3 - 4m² of solar thermal panels will cover 90% of the hot water needs for a two-person household throughout the year. The rocket mass heater will take over during cloudy days.

Reclaimed and site-sourced materials are used. The refrigerator door makes up an insulated back for the solar panel. The grill that you find at the back of a fridge is the solar collector. The glass is from old double-glazed windows. You will find many fridges in landfills or recycling areas, and double-glazed windows at many glaziers.

As with the photovoltaic panels, it works best with direct sunlight. Dust, clouds, and other obstructions in the atmosphere also diminish the power output. The Northern Hemisphere, Solar panels must face the south as much as possible.

The panels are sized and oriented for the most critical period: winter. Just find the zenith of the sun in the middle of winter and orient your panel perpendicularly.

The solar thermal panels must be positioned as close as possible to the hot water tank to minimize heat loss.



Materials:

- Same size refrigerator doors and Grids that must not be in galvanized steel and pipes connected by wire
- Wooden battens (Douglas, larch ...) resistant to heat and to UV radiations
- 2 rafters
- Copper tubes (must have a diameter equal to the sum of the diameters of the pipes they feed)
- Double-glazed window (4mm for a vertical panel and 5 mm for an inclined panel, without anti-UV treatment)
- Wood screw or self-drilling screw
- Washers
- Black Polyurethane sealant. Caution: The use of polyurethane involves risks: it is toxic by inhalation, reactive, irritating and very volatile.
- Brass or silver solder
- Corks
- Black paint resistant to heat and to UV radiations

Tools:

- Cutter and blades
- Pipe cutter
- Screwdriver and bits
- Hacksaw and/or grinder
- Blowtorch
- Handsaw and/or circular saw
- Sandpaper
- Solid iron tube Ø12mm
- Glass Cutter
- Lamella disc
- Protective equipment (goggles, gloves, brazing protection glasses)

Step 1 - Grid recovery

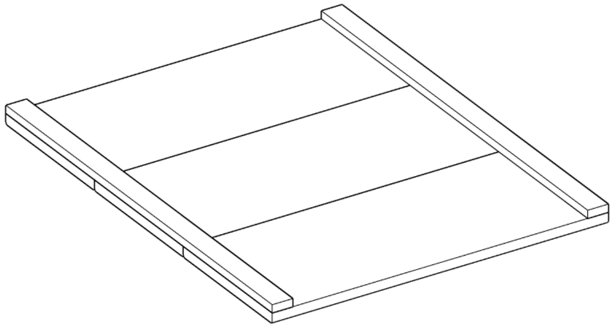
- Collect the largest and most fitting refrigerators in waste collection centers
- Pinching the pipes at the outlet of the compressor will limit the exhaust of refrigerant gases.
- Cut the pipes as close to the compressor as possible to ensure maximum length with the grid.
- Unscrew the grid.
- Wash the grid with soapy water.
- Blow a blower into the pipes to remove impurities.
- Seal the pipes with tape to prevent impurities from getting into them, as they may have a small diameter and become obstructed.

Step 2 - Door recovery

- Disassemble the refrigerator door.
- Remove all the elements except the insulation and the door sheet, make the face as flat as possible.

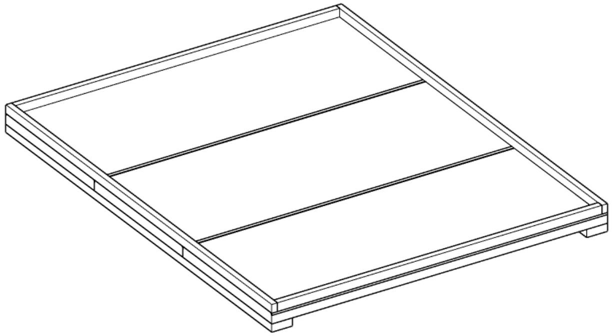
Step 3 - Panel sizing

The panels should be between 1.5 and 2m²:
- If larger: it's heavy and the glass can break if the panel warps.



Step 4 - Making the frame

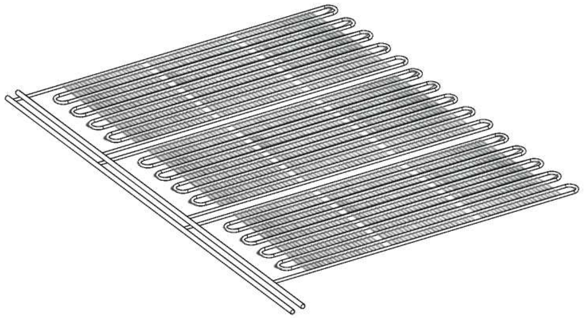
- Cut the doors so that they are all the same length.
- Sand the doors.
- Place the doors on two rafters, lengthwise against length, metal sheet side down.
- Make a joint along the length of the doors then glue them aligned on the front metal face.
- Cut 4 battens to form a frame on the panel.
- Sand the battens.
- Put putty on the width of each batten and glue them, with a good thickness (>1mm), against the sheet metal. Let dry, using clamps.
- Turn the frame over on the rafters and make seal with the putty inside and outside the frame and between the doors.
- Smooth it with a finger soaked in soapy water to avoid getting putty on your fingers. Let dry.



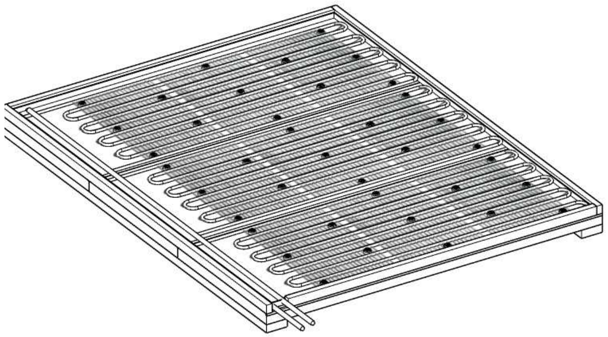
Step 5 - painting
Paint the frame, battens and door edges with matt black acrylic paint.

Step 6 - Assembling the grid and copper tubes
Connect the solar collectors (refrigerator grid) to the heat transfer fluid circuit via two feeder tubes (copper tubes).

- Position the grids on the frame, the blades in front of you. Re-cut the grids to the correct size. Each grid will be connected to two feeders, one with a "cold" water inlet and the other with a "hot" water outlet.
- Cut the inlet and outlet of the pipe of each grid with a pipe cutter, one about 10 cm from the grid and the other about 15 cm from the grid.
- Carefully sand the cuts
- Cut a hole in the frame to get the two feeders out.
- Cut 2 copper pipes that protrude about 15 cm from the panel. One is a feeder for the 10 cm hot water pipe, the other is a feeder for the 15cm



cold water pipe.
- Mark with a pencil the place where the pipes and feeders meet.
- Drill the feeders to the diameter of the pipes and sand.
- Clean by threading a metal rod about 12mm into each of the feeders.
- Crush the ends of the two feeders on the side on which the feeders do not go out.
- Put the metal rods back into the feeders to stop the grid pipes.
- Insert each tube into the corresponding feeder.
- Fasten with iron wire in between the grids and feeders.
- Weld the grid, the pipes and the feeders and the blind ends of the feeders.
- Remove the two metal rods.

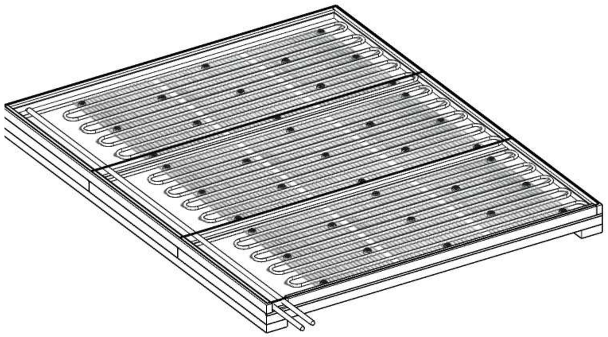


Plug temporarily the inlet, pressurize the system with a compressor and spray soapy water. If there are bubbles, review the solder joints.

Step 7 - Installing the grids in the frame

The grids must not be in direct contact with the metal door. They are spaced by a slice of cork that is rot-proof and resistant to high temperatures.

- Cut corks into 5mm-thick slices with a cutter.
- Every 30 cm, as follows, thread a screw head, a washer, the grid, a cork washer. This forms a pad.
- Screw the grids in the frame.
- Paint everything black that is not already black.



Step 8 - Panel closure

/!\ Protect yourself with long sleeves, gloves, and glasses. Work in vertically, be careful and do not force anything.

- Remove the glazing beads, slide a chisel or screwdriver between the window frame and the glazing bead on the inside of the window, tap with a hammer to separate the two and then remove the glazing bead by hand. Do the same for the other sides. The glazing is wedged on the sides. Remove the shims with pliers. If it is double glazing, separate the two panes. Slide a cutter blade into the seal against the glass. A rag with a little acetone will remove the remainder of the seal. And so on...
- Measure and adapt the glass for the frame. Keep it 1/2 cm smaller on each side to protect the glass on its edge. Dip the glass cutter in oil, Lay out a straight edge on the cut line and pull the cutter along the surface. Position the cutting line on the edge of the table, firmly grasp the edge to be broken and snap it in a downward movement.
- Clean the windows carefully
- Make a bead of Polyurethane putty on the

frame and carefully place the glass panes one by one without pressing them.

- Sand the glass with a lamella along the sharp edge of the glass to round it off.
- Make a Polyurethane seal between the edge of the frame and the glass, and between the glasses.
- Smooth the seal with a finger soaked in soapy water.
- Let it dry and install.

Plumbing

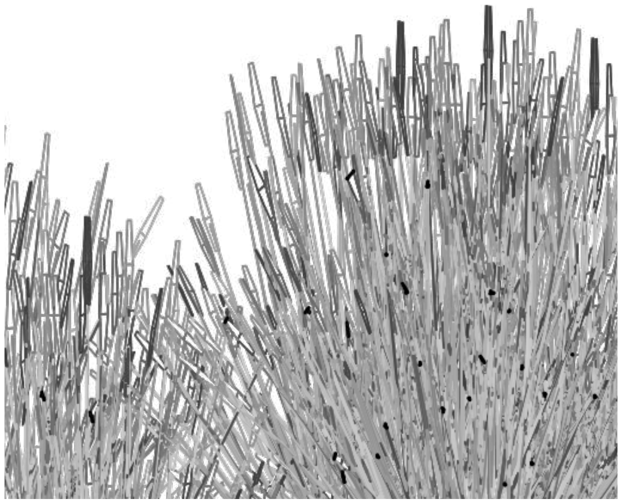
The solar thermal panels and the rocket mass heater must be positioned as close as possible to the hot water tank to minimize heat loss. These two heaters are connected to a Heat exchanger that is at the top of the system. An exchanger passes the heat transfer fluid through the storage tank to transfer heat from the panels to the domestic water supply. It works thanks to the concept of thermal expansion. The warm water fills more space, has a weaker density than the cold water, and goes above the cold water. The cold water of the system goes down by simple gravity. Progressively, at the contact with the hot solar panel or the rocket mass heater that are below, the water gets warmer and goes up the pipe to reach the heat exchanger and warm the water supply. The tank is also equipped with an expansion vessel to absorb the expansion of the heat transfer fluid on sunny days. These elements are generally included with the solar heat exchangers. You can also make them yourself.

It is advisable to use a heat transfer fluid in the system. If it is used in winter it must be antifreeze, otherwise the system must be drained.

Grey water treatment system

First and foremost, it's rational to reduce our water consumption through awareness in each of our individual consumptions, also by using a composting toilet and natural products. If these rules are respected, it's possible to treat the water only with a natural and simple treatment system. Water in nature is cleaned by various ecosystems that can be reproduced. For instance with the natural treatment system, such as the phyto-purification, substrates, bacterias, and aquatic and non-aquatic plants feed on elements that are in the water, yielding oxygen, and thus regenerating healthy and clean water. This technique helps to keep water clean and to purify it naturally. The outlet water isn't drinkable but it is digestible and rich in nutrients for the soil and the plants. However, the water is too rich in nutrients to be directly thrown back in the aquatic field. The input of rich nutriments may perturb the aquatic field leading to asphyxia and eutrophication. The phyto-purification is based on the presence of bacterias, substrates, and plants:

- Bacterias break down the organic particles
- Substrates such as gravel and aggregate hosts bacterias and the roots, and separates the liquid and solid matter.
- Plants simulate the bacteria activities, naturally, ensure the maintenance of the filter and absorb a part of the nutrients.



This system presents the advantage of not consuming any electricity or requiring any labor-intensive maintenance. The diversity of filtering plants is visually pleasant and generates humid areas rich in biodiversity. It is, therefore, the most eco-friendly water treatment system. However, phyto-purification is a system that takes up a lot of space and cannot be implemented individually in a dense area. The equivalent of 2 and 4m2 per inhabitant is required. An inhabitant equivalent reveals the capacity of a building and is equal to the number of the main rooms in a building. For instance, a building with two bedrooms, a kitchen and a living room need 8m2 (4 rooms x 2m2) dedicated to each filter of the phyto-purification system. This system is usually more expensive than a septic tank but quickly makes up for its initial cost. Take a look at your local country regulations, as some of them may require the involvement of an expert or specific measures to be taken.

This phyto-purification system is composed of two filters:

- The vertical filter, oxygen-rich, collects the grease and stimulates the aerobic bacteria activities that help the mineralization of the organic particles. The filter is composed of two beds used alternately each week.
- The Horizontal filter simulates anaerobic bacteria that denitrate the water.

Materials:

- Gravel 12/20 or 20/40mm and 4/8, 4/12 or 6/10 mm
- Siliceous sand 0/4 mm
- PVC pipe
- 2 T PVC pipes
- 2 elbow pipes
- Drainage tube
- PVC glue
- 2 catch basins
- 2 valves

According to your design:

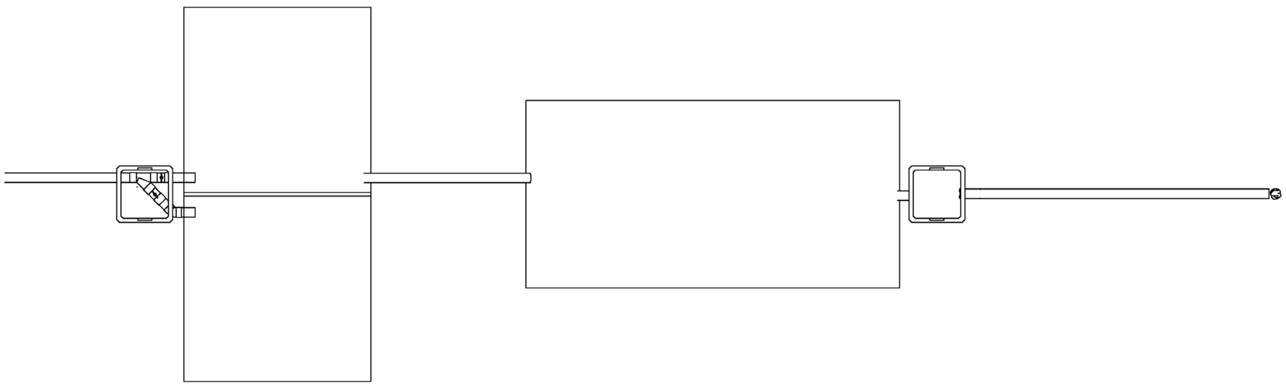
- Geotextile and EPDM rubber+ 2 bulkhead adapters
- Or Concrete and plastic tank
- Or bathtubs

Tools:
- Shovel or mechanical digger
- Pickax
- Rake
- Level
- Saw
- Utility knife

Step 1 - dig

This facility works without electricity thanks to gravity. That's why a slope is required to make it work. The vertical filter is lower than the house, while the horizontal filter is lower than the vertical one. The dimension depends on the building capacity: 2m2 per inhabitant equivalent and a depth of 90cm for a 60cm filter.
- Dig a hole according to the size of your tanks and leave a slight slope (≈1%) headed for the second filter and the final outflow.

Grey water treatment system section



Grey water treatment system plan

Step 2 - plumbing

- Add a catch basin before the first vertical filter
- In this catch basin, install the T PVC pipe and 2 valves to ensure separation between the two beds used alternately each week.
- Add a catch basin that collects the drain water after the horizontal filter.
- In this catch basin, install the outlet pipe a few centimeters lower than the estimated height of the gravel in the horizontal filter (40cm) to keep the water in the basin.

Step 3 - watertightness

- Install the assemblage of geotextile/EPDM/then more geotextile, the tanks or the bathtubs.
- Install a bulkhead or connector in the lowest part of the filter.

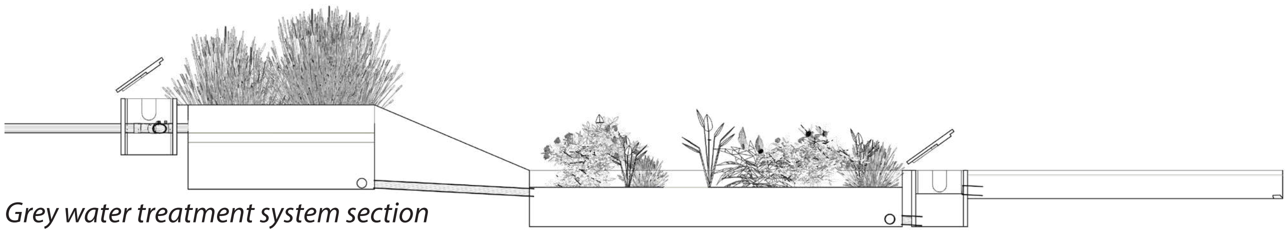
Step 4 - components

In the vertical filter,

- Add a drain.
- Install a PVC tee pipe before the outflow. Add a ventilation chimney.
- Fill with 20cm of gravel 10/20 mm.
- Fill with 30cm of gravel 4/8mm.
- Then 10cm of Siliceous sand 0/4 mm.
- Install the pipe between the valve and the first filter for each bed.
- Place a stone or tile under the inflow to prevent the water from eroding the substrate.

In the horizontal filter,

- Add a drain.
- Install a PVC tee pipe before the outflow.
- Add a ventilation chimney.
- Fill with 40cm of gravel 4/8mm.



Grey water treatment system section

Step 5 - plants

In the vertical filter,

Phragmites communis is usually used for the vertical filter. We can use also : *the Acorus calamus, the Caltha palustris, the Pontederia cordata, the Veronica beccabunga, the Schoenoplectus lacustris, and the Typha latifolia. Pick just one of them, and plant.*

In the horizontal filter,

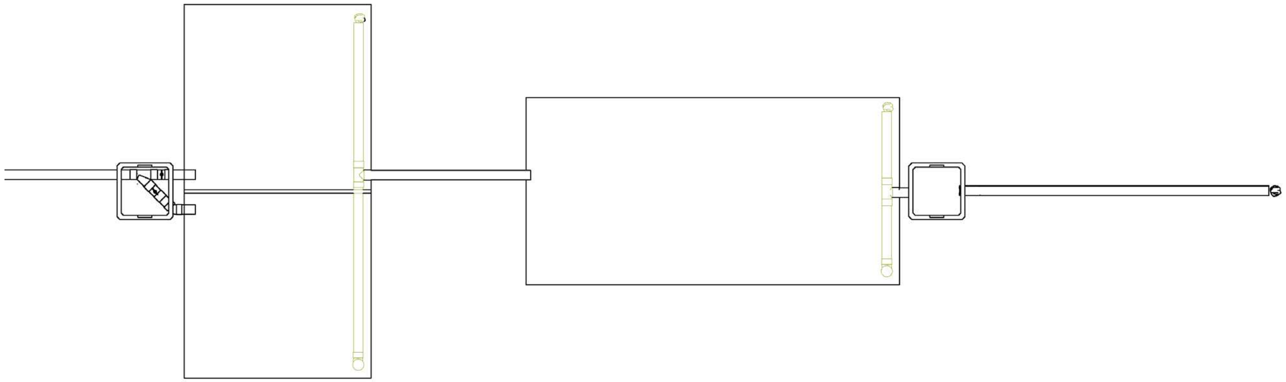
Pick plants that blossom at different period of the year and plant it with a density of 6plants/m2: *the Typha Latifolia, The Sparganium erectum, the Alisma plantago, the Scirpus lacustris, the Mentha aquatica, the Iris pseudocorus, and the Lythrum salicaria.*

Step 6 - outlet

- After the last catch basin, dig a trench 30 cm deep.
- Install a drain at the exit of the horizontal filter.
- Fill it with gravel.

Step 7 - maintenance

- During the winter, keep the ground part of the plants dry; cut them down at the beginning of the spring.
- During the first months of usage add compost on the vertical filter to activate the bacterial activity.
- Every week, orient the water towards another vertical filter bed by turning the valves.

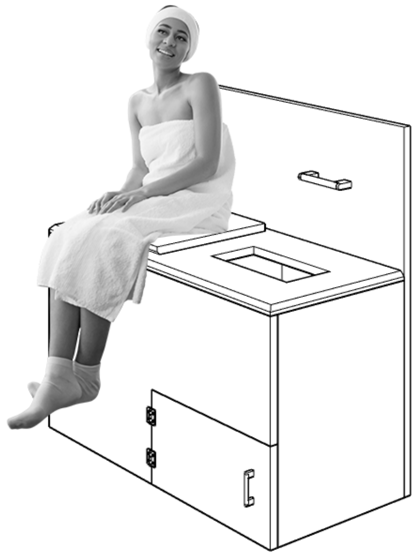


Grey water treatment system plan

Composting toilet

"If we harness all available biomass and return it to the earth to renew the process of soil formation, global water and food shortages would be resolved within two generations, without massive capitalization." Eautarcie

Human excrement is biomass that contains the nutrients that may renew the process of soil formation. With our conventional flush toilet, we consider our excrement as wastes to be eliminated, rather than an integral part of the ecosystem that makes us thrive. Our biomass that is not returned to the earth radically weakens the ecosystem's production capacity. Furthermore, the flush toilet results in vast amounts of purified drinking water being used to flush soil fertility out into the oceans. In the oceans, these excess nutrients cause dead zones from algae overgrowth and decomposition, which depletes the oxygen in the water. These are "eutrophic" areas where fish and other organisms drown.



The composting toilet is one of the possible solutions to renew and perpetuate the humus formation cycle. A composting toilet takes human waste (rich in nitrogen, poor in carbon) and dry material (rich in carbon, poor in nitrogen) such as sawdust, crushed leaves, or wood ash and composts it with straw. The high heat due to the composting reaction kills potential pathogens and progressively change it into rich humus for the soil. Using dry toilets in big cities, especially city apartments, is quite complicated due to the high density without green areas. It is best to reserve the use of dry toilets for those homes that have easy access to a garden, where one can perform composting and gardening activities. However, such changes may be performed in urban areas with a new global policy that collects the hummus and redistributes it in the countryside. Otherwise, it is possible to use rainwater to flush our conventional toilets.

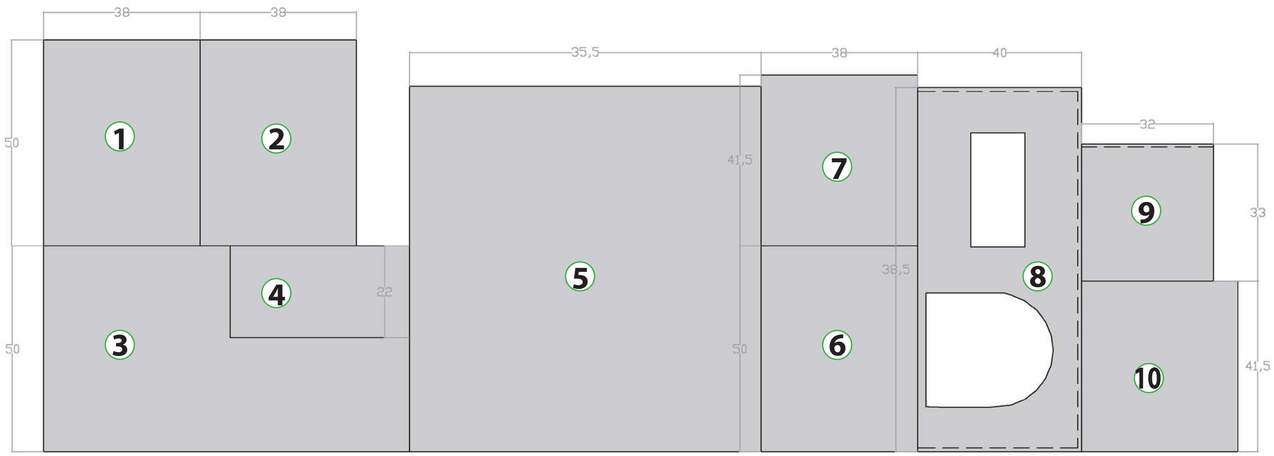
Building a compost toilet is an easy way to take refuse and turn it into a resource. After all, it's just balancing a toilet seat over the top of a bucket and handcrafted wooden work of art. Our food comes from the earth, and our dejecta must return to the earth.

Materials:
- Wood board
- Bucket
- 6 hinges
- 2 handles
- Toilet Roll Holder

Tools :
- saw
- screw-gun
- sander
- screws

Step 1: preparation of the wood board

- Cut the wood boards
- Progressively label the board.
- Sand the edge of the top wood board that is used as a toilet bowl (8) and the lid of the toilet bowl (9).

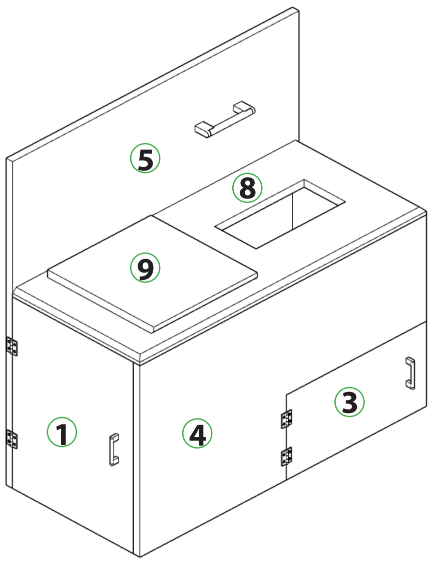


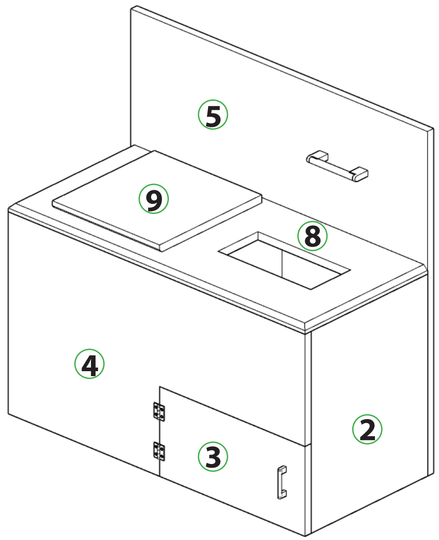
Step 2: assembly

- Screw the different wood boards together.

Step 3: maintenance

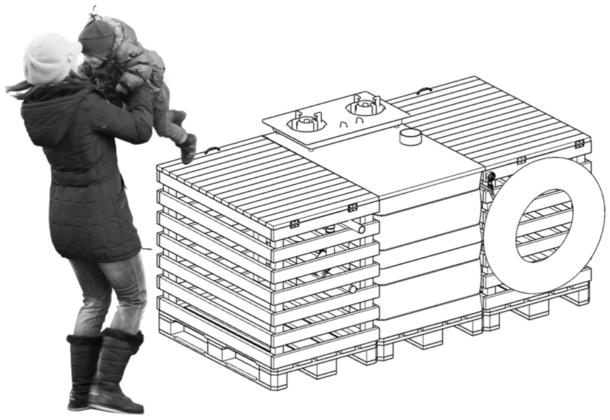
- After every use, add dry materials such as sawdust, crushed leaves or wood ash.
- When the bucket is full, empty it in the compost.
- Regularly toss the compost with a long stick.





WASTE MANAGEMENT

The biogas digester and compost are complementary.
The compost aims to produce humus for the garden, that's why it needs more brown than green components; a high ratio of fibrous carbon. The biogas digester, for its part, aims to produce gas with mostly green components; humid nitrogen. The compost may produce heat for the biogas digester. These two clever organic trash offer directly supply for the household.



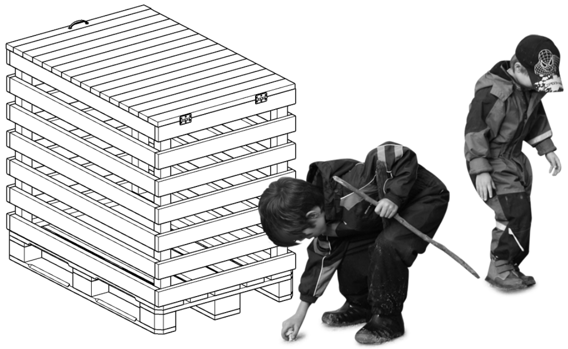
WASTE MANAGEMENT

Compost

Composting is a great way to turn your kitchen refuse into fertilizer for your garden and to reduce the organic trash you send to the landfill. A large mass of organic matter results from yard maintenance and food preparation. These byproducts are rapidly accumulated and might be incorporated back into planters or garden beds as a soil enricher if we consider their management. The result is a large mass of organic matter that is a valuable resource that can be directly recycled as a natural fertilizer. Compost is nature‘s own potting soil, and it increases soil porosity, improves fertility, and stimulates healthy root development. Furthermore, making your own soil enricher through composting is free.

How does garbage turn into plant food? Organisms such as bacteria, worms, and insects and microbes convert compost materials into humus, nutrient-rich soil. The best microbes for decomposing plants are aerobic, the compost needs oxygen. In order to have a compost that smells musty and loamy, like wet leaves, you have to ensure air passageways. Humus is the end goal of composting. Its production can take a couple of years if left undisturbed, or it can be sped up with some help from your pitchfork by turning the pile periodically, and with a little livestock manure. A fast-composting pile produces quite a bit of heat. A constant temperature between 60°C and 65°C is ideal for your pile. The compost process is complete when the pile looks like dirt and is no longer generating extraordinary heat. A fast-burning compost pile requires a healthy balance of brown and green components. Browns are high in carbon, which food energy microorganisms depend on to decompose the pile. Greens are high in nitrogen, which is a protein source for the multiplying microbes. A ratio of three- or four-parts browns to one-part greens is a good target. The humidity of the compost has to be monitored. Take a handful of compost and press it. You should see some drops: some drops in your hand. If it’s too moist, add leaves or straw and if it’s too dry water the compost.

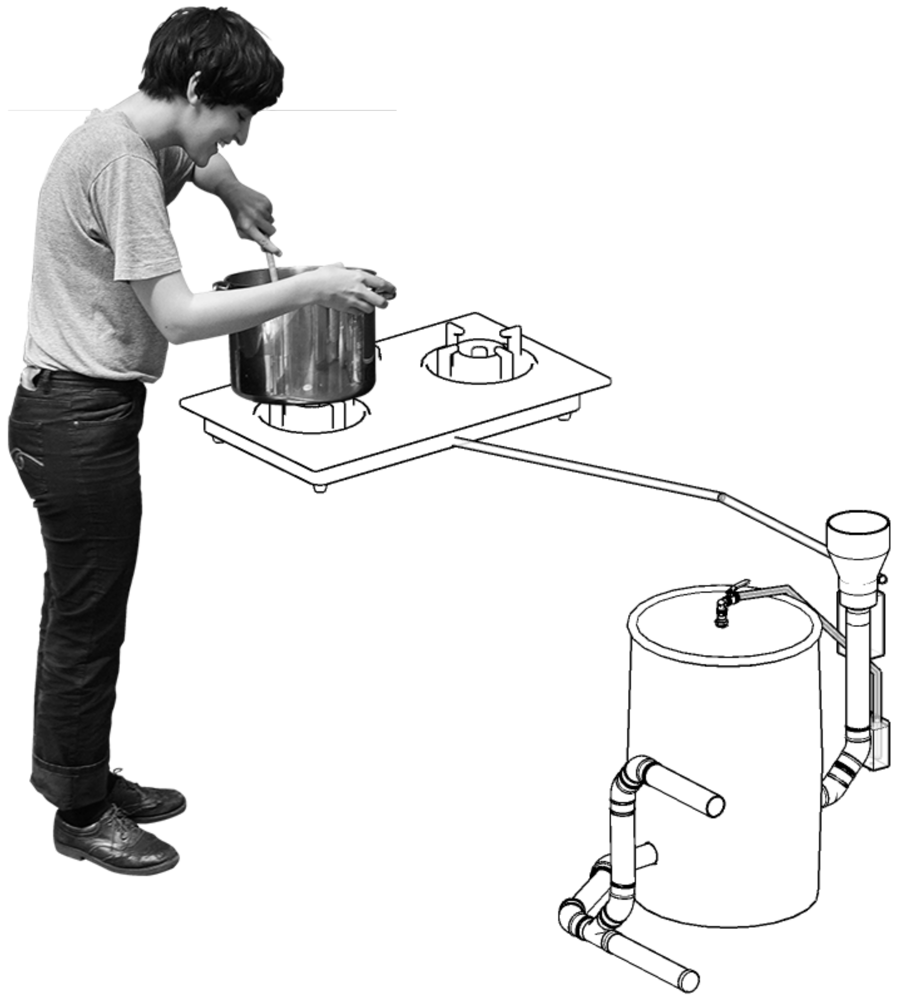
Garden Compost	Not for Compost
"Clean" food scraps-including crushed eggshells, corncobs, vegetable scraps, oatmeal, stale bread, etc.	Fatty or greasy food : meat waste, bones, grease, dairy products, cooking oils, dressings...
Vegetable and fruit peelings and leftovers	Fruit pits and seeds
Coffee grounds and filters, tea leaves and tea bags	cheese
Newspaper, Cardboard and white pages only	Metal. Remove the tea bag staples before composting
Livestock manure	Glossy color ads or wax-coated book covers
Sawdust, wood chips, and woody brush	Cat, dog, or other pet waste, which may contain meat
Wilted floral bouquets	Fruits pits
Shredded leaves and pine needles	Onion, garlic
Old potting soil	



Biodigester

The biogas digester treats organic waste, in a local and sustainable way, to produce biogas and rich fertilizer for your garden. Biogas is a mix of gas that contains mostly methane, it can be used for cooking, heating, lighting or even for fuel for the engine. Just like a digestive system, it cultivates bacteria, requires a warm temperature to be efficient and needs regular nutrition.

Compost takes place in an aerobic environment, the decomposition of organic matter leads to a gas (H_2S, H_2, NH_3) and heat production. In contrast, methane production is produced by bacteria in the anaerobic environment, also generating heat. Methane production requires a temperature between 25° and 45°. It's possible to heat the digester thanks to compost surrounding it, a solar heater or by burning a part of the methane.



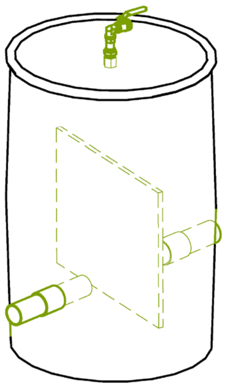
Materials:

1 Plastic water barrels 60 L
2 Bulkhead adapter Ø50mm
Joint compound
4 PVC 45° elbow Ø50mm
1 meter PVC pipe Ø50mm
1 Ducting Tube Reducer Ø160 mm to Ø100 mm with a lid
1 Ducting Tube Reducer Ø100mm to Ø50 mm
1 Y-pipe Ø50mm
1 Detachable Connector Ø50mm with a lid
PVC glue

1 Gas ball valve
1 gas Bulkhead adapter adapted to the gas ball valve
1 Flat washer assortment
1 Truck tire inner tubes
5m of gas pipe
1 Hose Clamp assortment
steel wool
Manometer
3 T gas pipe tees.

Tools:

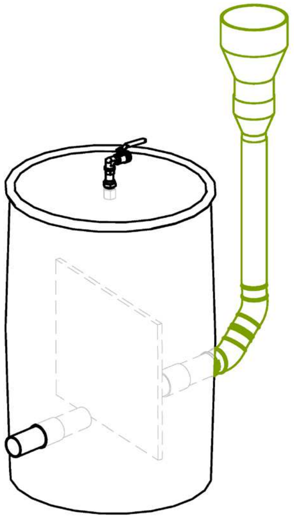
- saw
- Hole saw
- Pipecutter
- Screwdriver
- cutter
- Compressor



Step 1: artificial stomach.

The organic matter is immersed in water to obtain an anaerobic environment.

- Make two 50 mm holes facing each other with a hole saw in the plastic water barrel at one-third height.
- Insert a bulkhead adapter in each hole with joint compound.
- Insert a board between the two holes that let the water go below and above. It will increase the path of the matter path and therefore the digestion.
- Make a hole in the middle of the barrel lid to insert a gas bulkhead adapter with joint compound and flat washer.
- Add joint compound around the barrel lid and close it.
- Install a gas ball valve on the gas bulkhead.



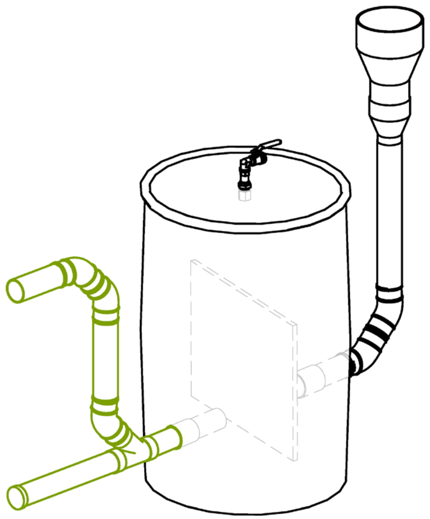
For steps 2 and 3:

- Start by a trial assembly.
- Mark each assembled section with a cross at the junction.
- Clean the area to be glued.
- Glue and let it dry.

Step 2: Mouth

This part will depend on where you want to input the organic matter. This mouth could be conveniently close to the window of the kitchen. The mouth has to be higher than the top of the digester.

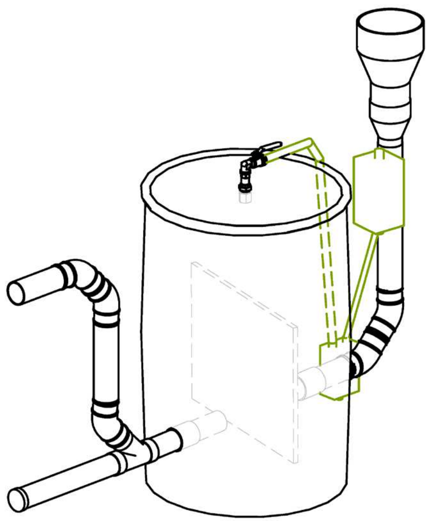
- Link a PVC pipe and 2 PVC 45° elbows to one of the digester holes (a 90° elbow is a too extreme an angle and might be get clogged)
- Link the 2 ducting Tube Reducers with the PVC pipe.



Step 3: Refuse

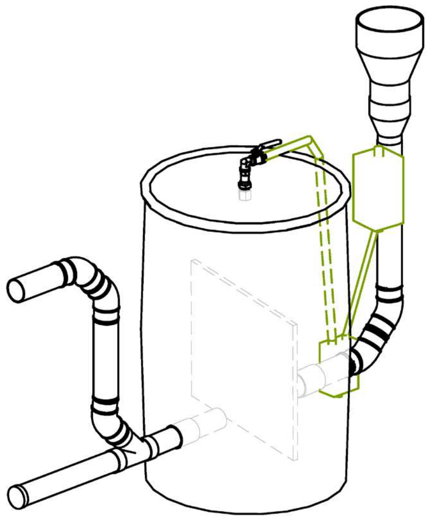
The system releases rich fertilizer with an overflow. To make the maintenance easy, this overflow is combined with a draining part.

- Link a PVC pipe and a Y-pipe to the other digester hole.
- The horizontal pipe is the draining part. Add a detachable connector with a lid.
- The other part of the Y-pipe will provide the fertilizer. It has to be extended by three 45° elbow pipe and a vertical pipe to reach almost the height of the barrel. The overflow will regulate the system.
- Extend it horizontally by a PVC pipe.



Step 4: airtightness

- Temporarily plug the overflow, the mouth, and the draining part.
- Pressurize the system with a compressor and spray soapy water. If there are bubbles, the airtightness is still not effective.



Step 5: biomethane to methane
This digester produces biomethane. The biomethane is purified to obtain only methane.

Remove carbon dioxide (C02) and water vapor
- On the lower part of the system add a water collector that will collect the water and the C02 (unlike the methane, the C02 is very soluble). A lid allows the collection of water enriched in CO2.
- Connect the gas ball valve to the water collector with a gas pipe. The pipe should be submerged in the water.

Remove hydrogen sulfide
Hydrogen sulfide is a highly corrosive gas. To remove it, the gas is filtered through the iron oxide, Steel wool, charcoal or clay balls.

Step 6: Storage
- Connect a safety valve of 100 Mbar and then a nanometer.
- A Truck tire inner tubes or other flexible storage contain the excess gas. It must be positioned just after the safety valve.

- Add pressure using a compressor or 10 cm of water on the storage (cheaper!)

Step 7: airtightness

- Ensure the airtightness with hose Clamp at the junctions between each component.

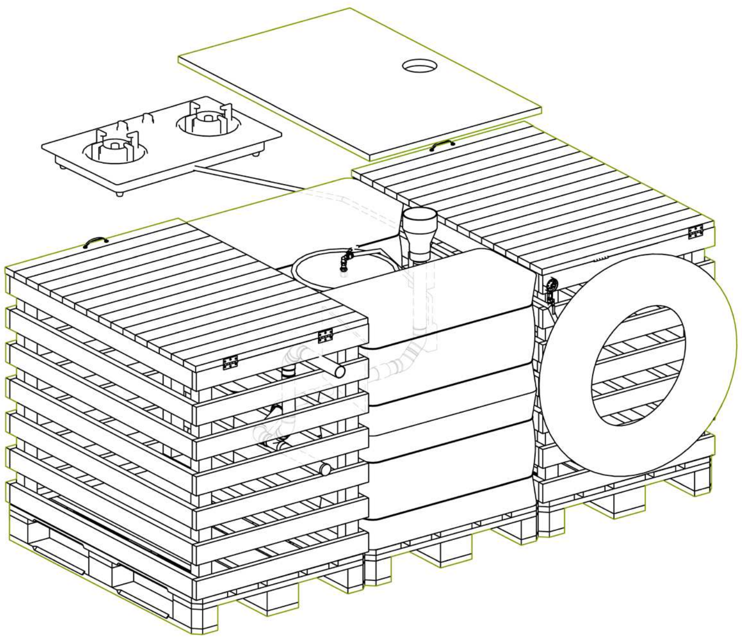
Step 8: gas cooker

- Avoid backfiring with steel wool in the pipe just next to the gas cooker. This will low the temperature in the pipe.

- Reduce the air entrance with aluminum or remove the jet to adapt the cooker to methane that needs less air than other gas.

Step 9: startup

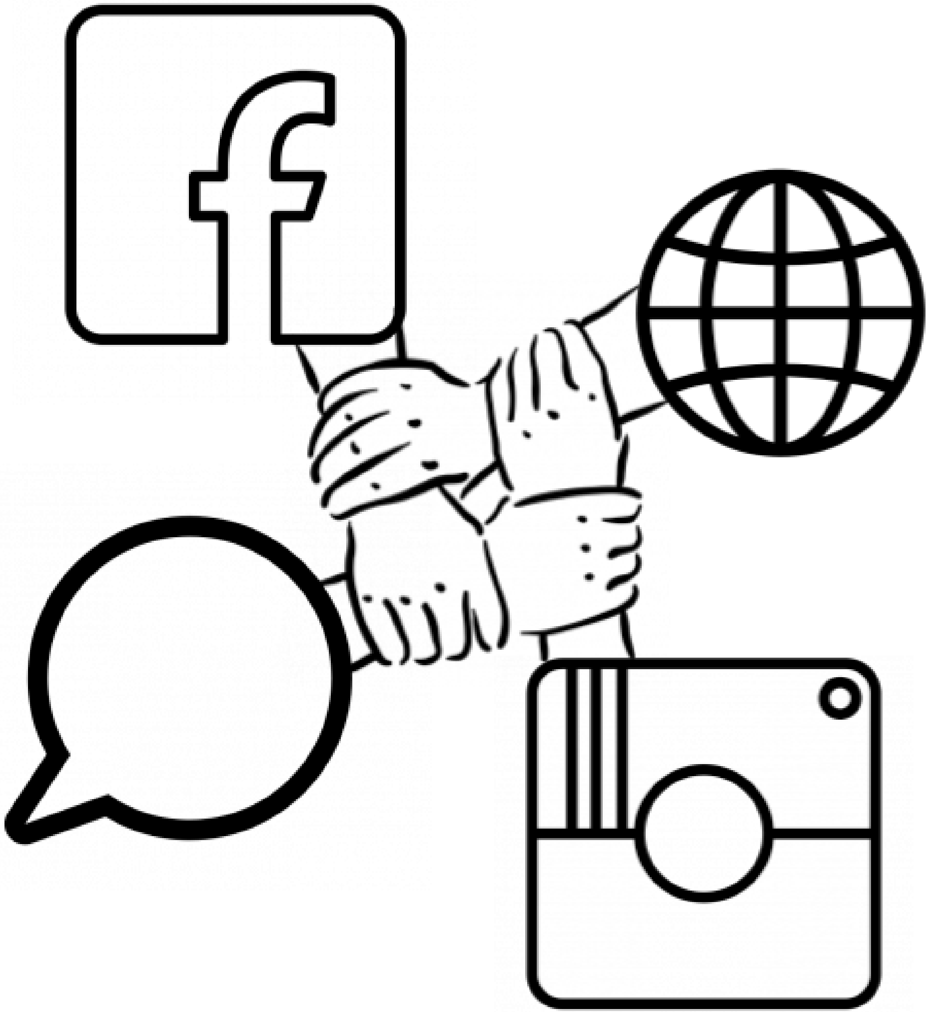
For the first usage, seed with manure mix with the same weight of water the digester. The digester should ideally be feed every day. Beyond one week without food, another seeding will be necessary. The food has to be crushed up and mixed with its weight in water to maximize the digester's efficiency.



The quality of the air primarily depends on the material that you use for construction. If you chose to use synthetic materials and volatile organic compounds, no matter the ventilation system you select, the air will be stale. Natural material doesn't release harmful components and perspire; humidity simply circulates between the indoors and outdoors, whereas air remains inside.

A mechanical ventilation system such as Mechanical Ventilation Heat Recovery System (MVHR) is really efficient and limits energy waste. It is possible to plug the MVHR into the off-grid electricity system, although it is energy-greedy... The most basic ventilation technology is quite simply opening the transversal windows every day for five minutes. For a long time, opening the windows was the only means of ventilation; today global disempowerment, synthetic materials, and increasingly airtight housing often leave mechanical ventilation as the only option.

VENTILATION



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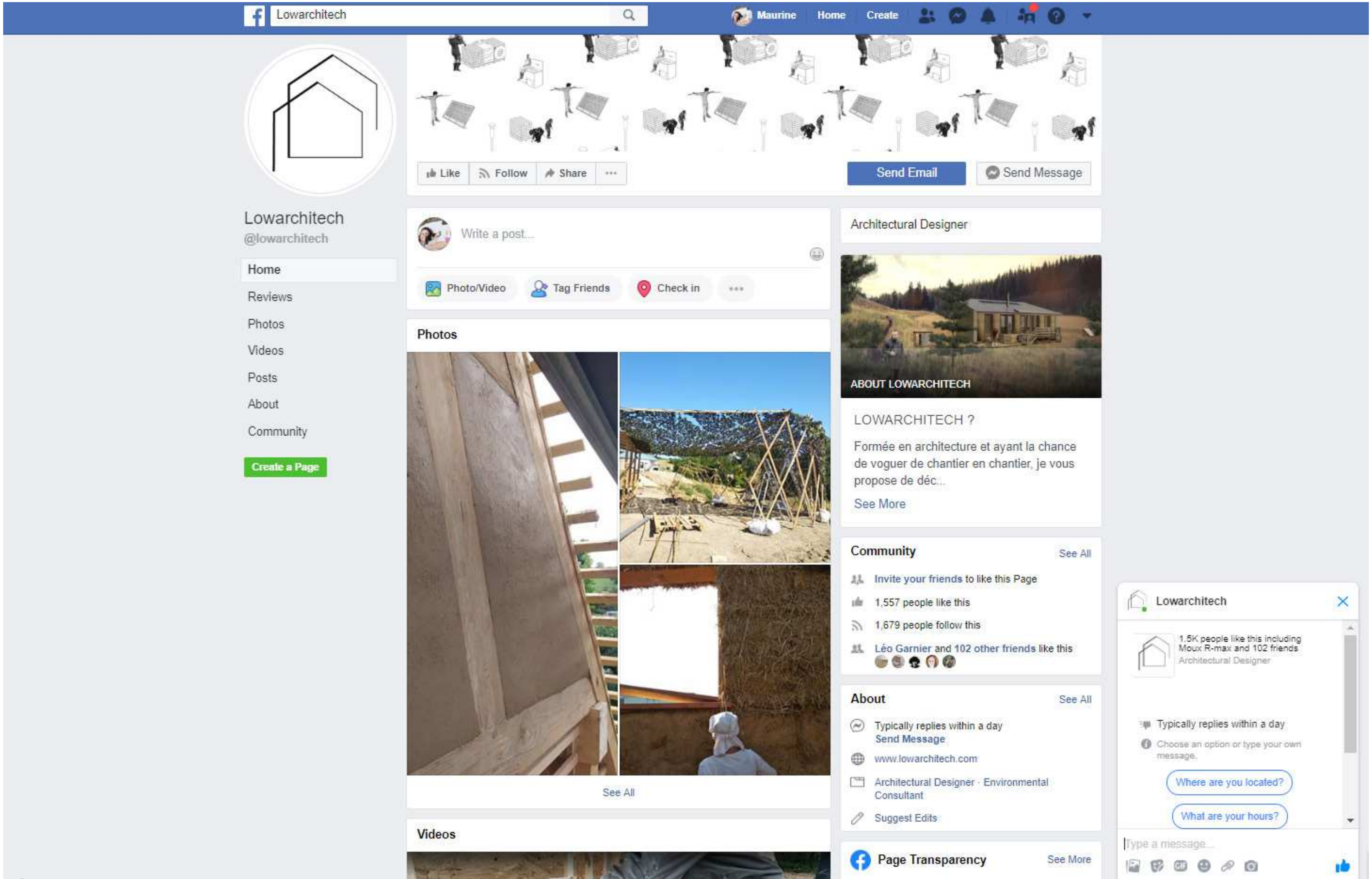
2. A community around low-tech architecture

Social networks around lowarchitech.com help to diffuse the information, to collect them and finally to develop a community around low tech architecture.


Lowarchitech
Maurine
Home
Create
Like
Follow
Share
Send Email
Send Message
Lowarchitech
@lowarchitech
Home
Reviews
Photos
Videos
Posts
About
Community
Create a Page
Write a post...
Photo/Video
Tag Friends
Check in
Photos
See All
Videos
Architectural Designer
ABOUT LOWARCHITECH
LOWARCHITECH ?
Formée en architecture et ayant la chance de voguer de chantier en chantier, je vous propose de déc...
See More
Community
See All
Invite your friends to like this Page
1,557 people like this
1,679 people follow this
Léo Garnier and 102 other friends like this
About
See All
Typically replies within a day
Send Message
www.lowarchitech.com
Architectural Designer · Environmental Consultant
Suggest Edits
Page Transparency
See More
Lowarchitech
1.5K people like this including Moux R-max and 102 friends
Architectural Designer
Typically replies within a day
Choose an option or type your own message.
Where are you located?
What are your hours?
Type a message...

FACEBOOK

https://www.facebook.com/lowarchitech/

Facebook, is an online social media and social networking service company. It can be accessed from devices with Internet connectivity, such as personal computers, tablets and smartphones. Facebook passed 2.3 billion monthly active users in December 2018.

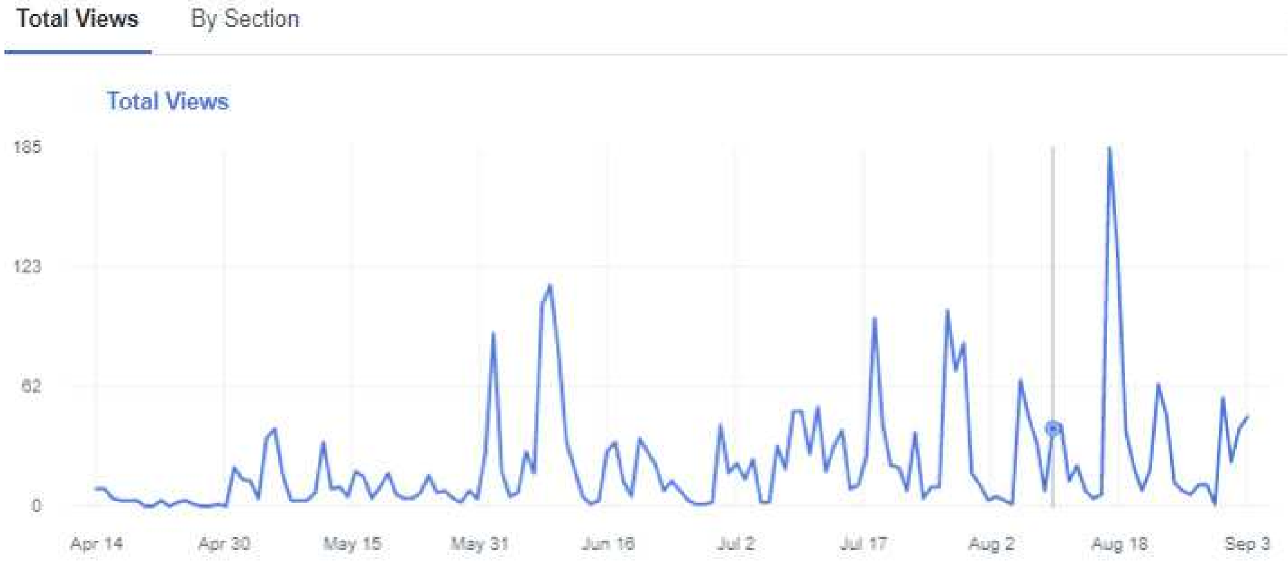
The page "lowarchitech" was born in April fifth 2019. Posts about low-tech architecture are weekly publicate on this page. After four months of use, 1600 people follow the page.

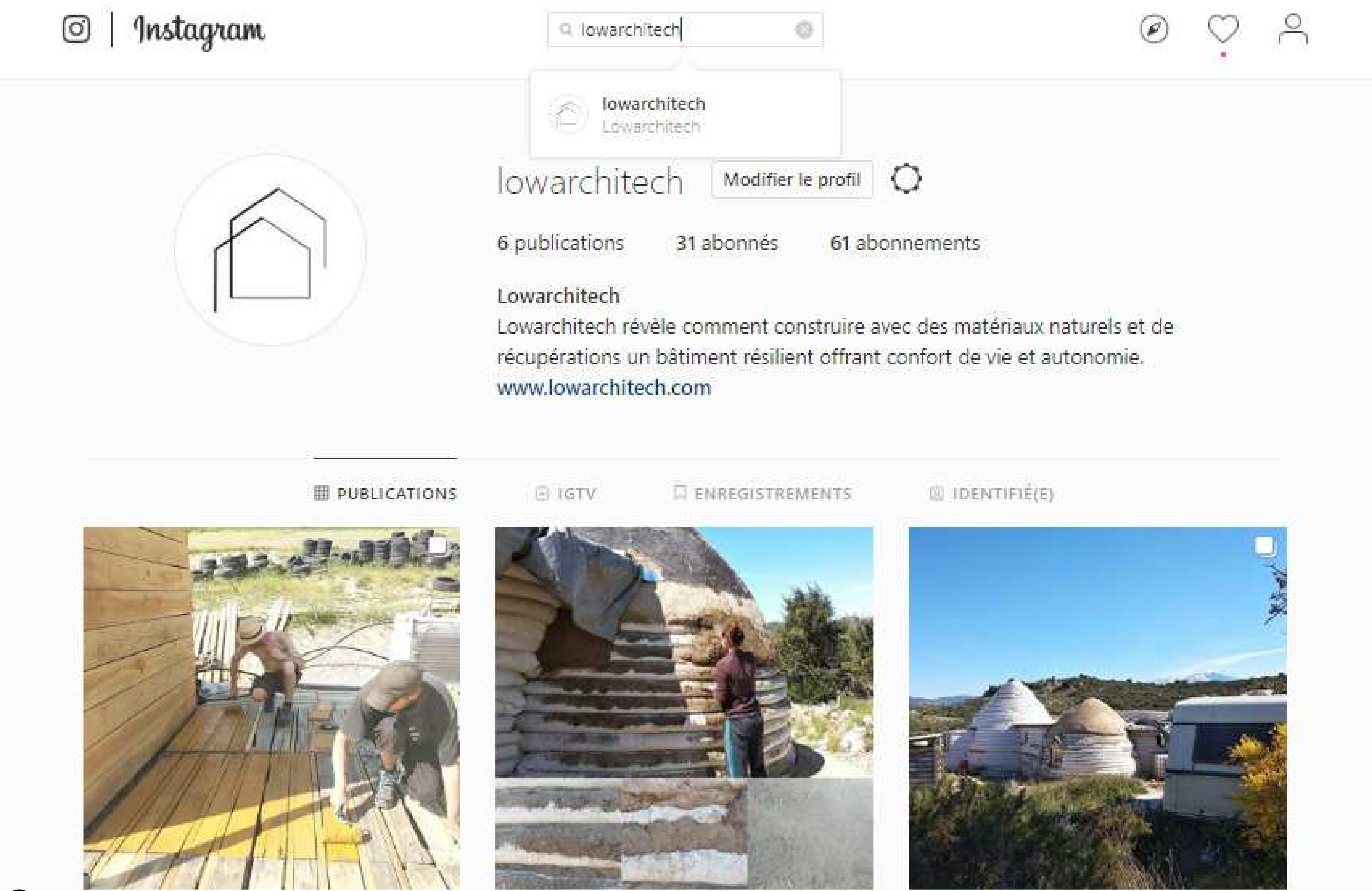
Posts interactions

Published	Post	Type	Targeting	Reach	Engagement
08/31/2019 9:26 AM	- Enduit de corps sur torchis – L'enduit de corps est un mélange			2.8K	2K 345
08/23/2019 12:57 PM				4.6K	635 339
08/17/2019 12:16 PM	- Remplissage en torchis d'une maison Alsacienne - Le torchis, un			6.1K	3.6K 726
08/10/2019 9:52 AM	-Structure paravent avec l'association chouette de vie - Le			2.2K	2K 195
08/06/2019 6:00 PM	- Goudron de pin - /!\ Attention publication en cours de vérification, il			3.4K	2K 300
07/28/2019 2:40 PM	- associer la paille et la terre - Entre la paille et la terre, c'est une belle			2.9K	2.4K 421
07/24/2019 2:00 PM	- mortier de terre - Il n'est pas toujours facile d'obtenir des jonctions			939	1.2K 46
07/19/2019 1:37 PM	- le Flexagone - On vous a dit que construire était difficile ? Le			12.2K	3.5K 342
07/14/2019 8:38 PM	- montage de maison à colombages alsacienne - Une journée et demie			2.2K	2.4K 301
07/12/2019 11:48 AM	- fondations en pneu-piloti en double hauteur avec habitat végétal - Le			3.5K	2K 180
07/09/2019 1:00 PM	- Le niveau à eau - Instrument ancestral se basant sur le principe			7.8K	3.5K 270
06/30/2019 1:18 PM	- préparation du support d'enduit - La barbotine, mélange d'argile et d'eau,			2K	1.8K 159
06/24/2019 3:45 PM	- maison de paille à ossature bois (3) - Les découpes de bottes de paille			2.9K	390 43
06/09/2019 2:57 PM	- peinture suédoise - Une peinture "maison" facile à préparer,			17.3K	4.3K 583
06/08/2019 12:20 PM	- bambou - Le bambou plie, mais ne rompt pas. Il rivalise en résistance			5.8K	2.3K 175
06/06/2019 2:50 PM	-Yourte- La yourte est un habitat nomade typique mongole. Elle est			4.4K	746 82

Statistics

The number of times a Page's profile has been viewed by logged in and logged out people.




Instagram
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Lowarchitech
lowarchitech
Modifier le profil
6 publications
31 abonnés
61 abonnements
Lowarchitech
Lowarchitech révèle comment construire avec des matériaux naturels et de récupérations un bâtiment résilient offrant confort de vie et autonomie.
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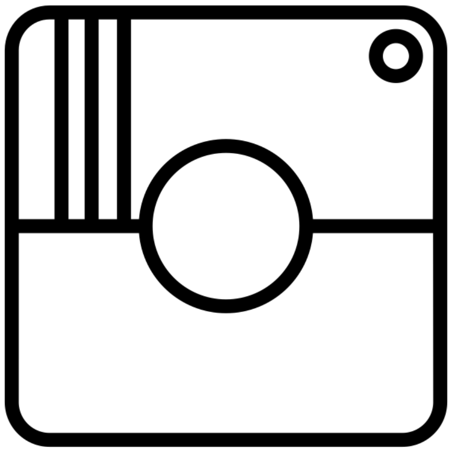
PUBLICATIONS
IGTV
ENREGISTREMENTS
IDENTIFIÉ(E)

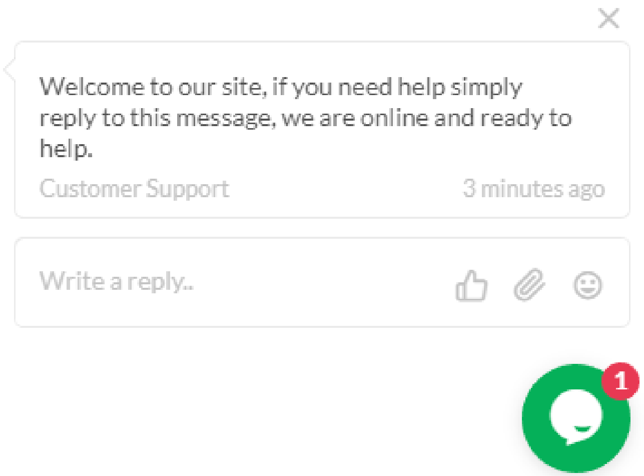
INSTAGRAM

https://www.instagram.com/lowarchitech/

Instagram is a photo and video-sharing social networking service. Such as Facebook, it can be accessed from devices with Internet connectivity, such as personal computers, tablets and smartphones. Instagram is being used by 500 million users daily (january 2019)

The profil "lowarchitech" was born in September firth 2019. Posts about low-tech architecture are weekly publicate on this page.



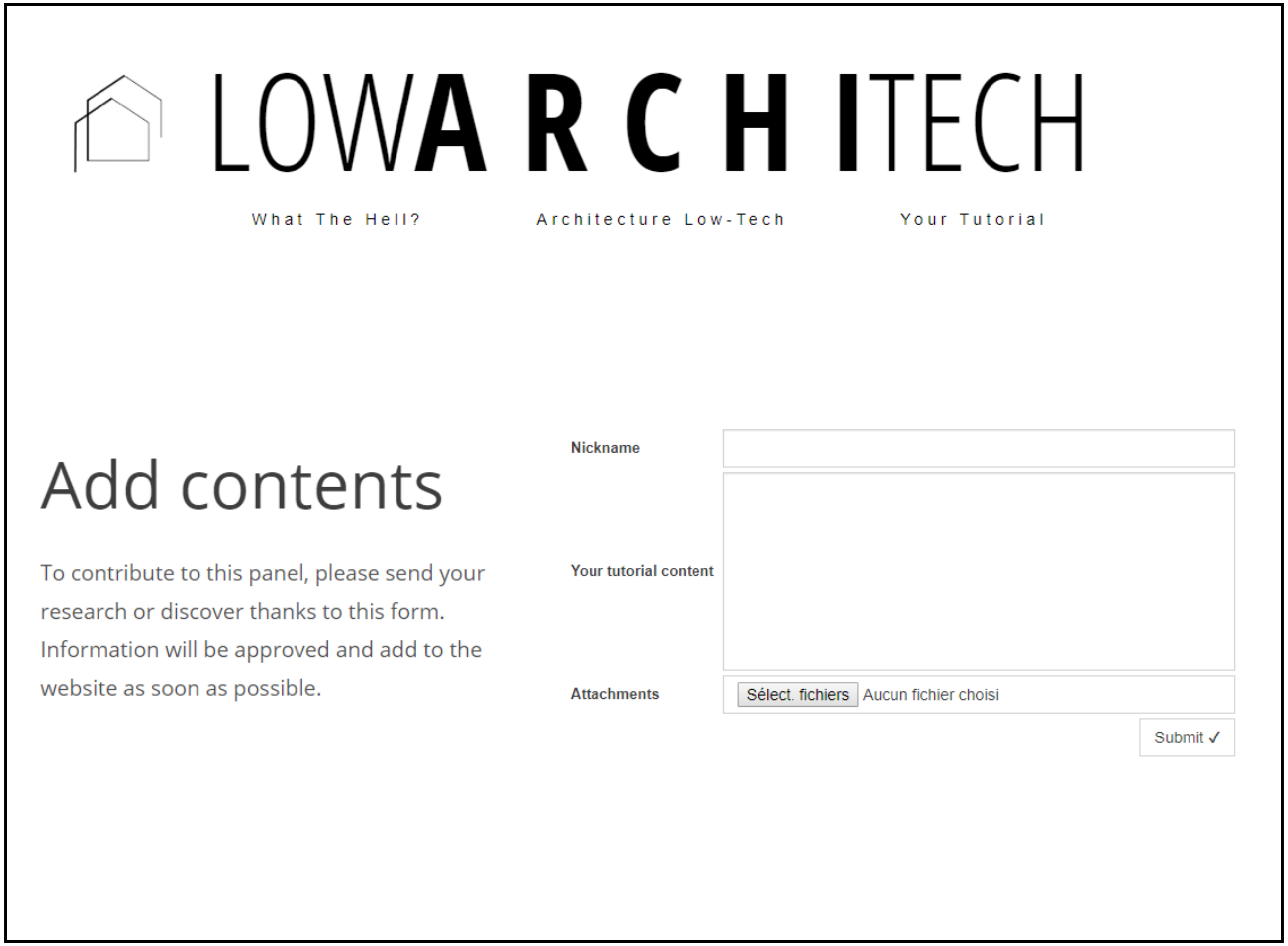

Welcome to our site, if you need help simply reply to this message, we are online and ready to help.
Customer Support
3 minutes ago
Write a reply..
1


We Are Here!

LIVE CHAT

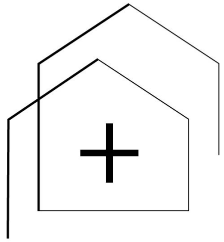
Tawk

Tawk is a free live chat software. that enable to monitor website visitors in real time, answer chats from your Mobile Device, proactively engage visitors with Triggers, customize your Visitor Widget to suit your site, localize greetings and messages in your Language, respond quickly with Predefined Shortcuts...


LOWARCHITECH
What The Hell?
Architecture Low-Tech
Your Tutorial
Add contents
To contribute to this panel, please send your research or discover thanks to this form. Information will be approved and add to the website as soon as possible.
Nickname
Your tutorial content
Attachments
Sélect. fichiers
Aucun fichier choisi
Submit ✓

LIBRARY

“your tutorial” give the possibility to anybody to add his link of a tutorial about low-tech architecture, by clicking on :



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"

Conclusion

The fact of gathering these low technologies enables to have an overview of how they communicate and complement one another. The low tech are individually powerful, but take full power all together. Many combinations are possible and more there are complementary technologies, more the resilience is insure. For instance, the heart of the compost is also a good way to heat the water, and it is possible to pump mechanically the water directly from a wind turbine, a water mill or even a bicycle or produce electricity with the same processes...

To this master's thesis, we should add researches about the food autonomy from the micro-farm with permaculture and agroecology to the food preservation to obtain a global self-sufficient luggage.

What does the future hold for this project? The uncertainties of our generation before the climat change give the feeling of powerlessness in front of the world. This project draw its strength in its capacity as giving back to each the tools to act for his basic needs. Empowered individual gives better means in its consumption and find his place in a more horizontal social order. It's a transition from the social dependence to the social self-sufficiency that create more valuable relationship.

This project is a research that I intend to carry on with the realization and improvement of the different tutorials, and the development of other alternatives. City and Village that initiated the energetic transition are buyer of local solutions. Conference about low-tech may be provide and spread to encourage people to get hold of these solutions and adapts their housings. The idea is to gather people around the activity to build their self-sufficiency by promoting playful tutorials.

"What we need to do is really improve energy efficiency standards, develop in full scale renewable and alternative energy and use the one resource we have in abundance, our creativity."
~ Lois Capps

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