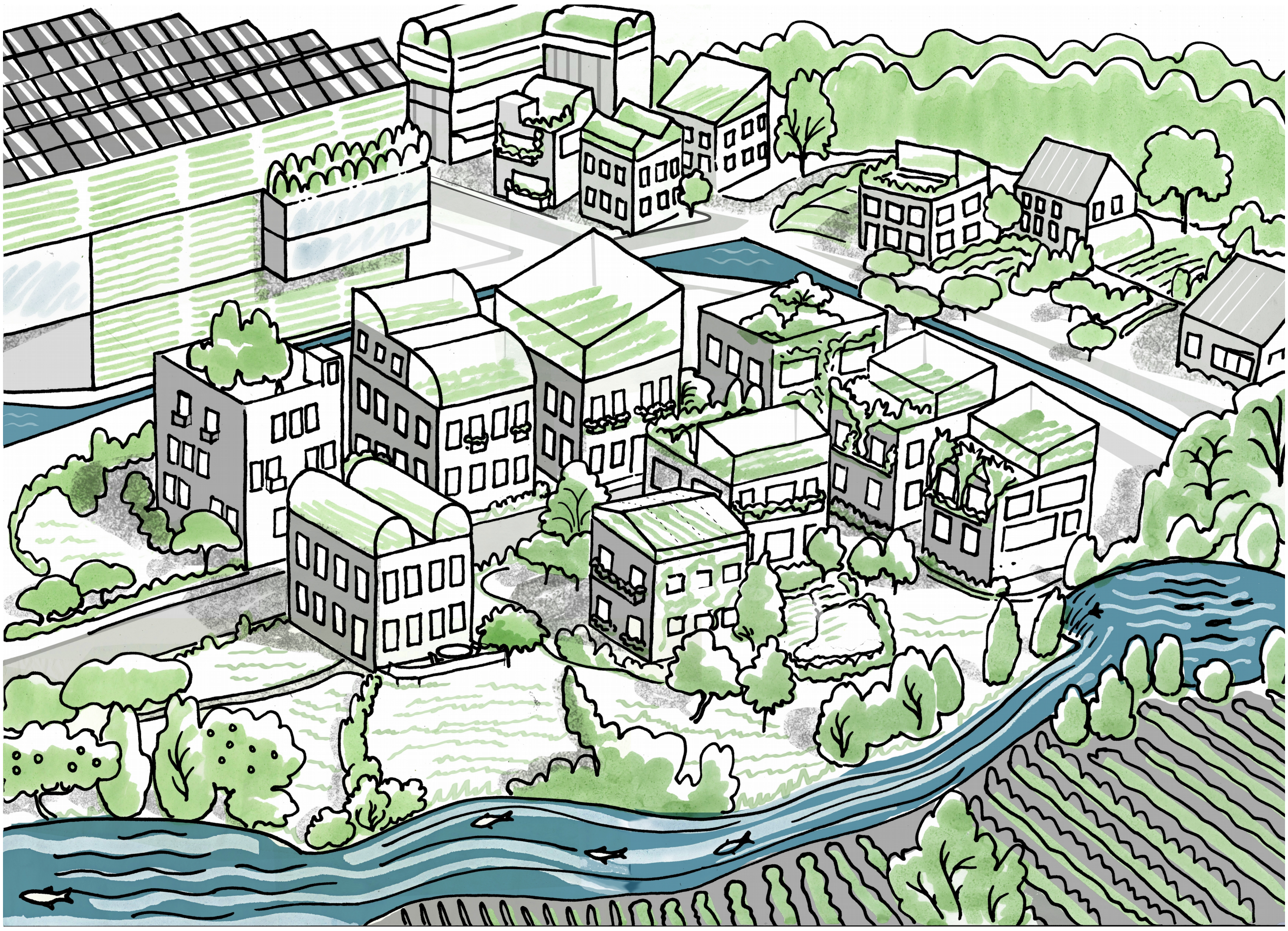
The GCSM Blue responsibility award 2014:

Manufacturing for a Sustainable Terra Preta Sanitation System



contribution of
Gabrielle Mainguy and
Christian Wernitz

submitted the 31th of July 2014

Acknowledgement

The authors thank especialy Lucie B. Mainguy, the creative director of Aliksir-Québec. Moreover we thank Jochen Zeisel for his engagement and contacts. Clémence Sbiss we thank for her support according to the business model. As well all the informations provided from Jochen Zeisel, Dr.-Jürgen Rekin, Marco Heckel, Robert Wagner and the Terra BoGa Team, Berger Biotechnik, Schwärzel Industriedesign and the Project members of “mental work – Geisteswerk" from summer semesters master course studio at TU Berlin.

Table of contents

Abstract

For the implementation of our project we choose the Opel 1 factory site in Bochum and the new city quarter that is currently being developed. We’re conceiving an alternative sanitation system with subsequent terra preta production. The terra preta will be used on site for food production that will in turn be regionally consumed or marketed.

The production project is a web of productive zones that interweaves in the new city quarter (about 2.000 residents and workers) where an aquaculture-agriculture combination based on mine water purification and transformation is being run.

In this project scientists and residents come together, as do producers, consumers, businesses, “garden cooperatives’’ and Ruhr University research projects. Some zones are allocated to melioration research which allows for other uses like market gardening. The aquaculture ponds provide the fields and greenhouses with nutrient-rich water. The productive land of the new city quarter presents a humble surface of about 11 hectares in total and is nevertheless right next to a large green corridor covered with agricultural surfaces for the most of its part.

With our sanitation system and subsequent terra preta production we close a local cycle of matter. We grow all raw materials on site. We cultivate fast-growing trees, miscanthus and bamboo in contour strip forests and constructed wetlands as biomass supply for the vegetable coal production, for example. We’re currently working out an innovative and user-friendly sanitation concept which suits urban conditions and which could be implemented in new habitations and buildings on the site. The sanitation equipment is accompanied by a ready-to-use mulch mix that ensures a hygienic use and induces an effective composting process. Research groups which include scientists, students as well as residents experiment and refine Terra preta production techniques and develop pyrolysis and effective micro-organisms cultivation methods further.

COMMENTS:

For our terra preta sanitation concept we choose the Opel 1 factory site in Bochum, whose closing down and progressive conversion is planned for 2014. As part of the master-studio project ‘’Landscape-Systems-Urbanization’’ with Prof. U. Giseke in winter semester 2013-14, we already formulated an utilisation concept for this site. In this project we conceived a multifunctional city quarter that emerges from the background of mine water purification and utilisation.

Our specific task has been to plan the water purification, the terra preta production system, a sustainable energy supply and the productive areas.

1. Introduction

Every day, humans and animals consume plants or plant materials which have grown in the soil. Still, the natural material cycle is a closed cycle, since every organism which consumes natural material also expels such material again which than in turn is available for other organisms. For this reason, the soil remains a potentially inexhaustible source of life. This natural material cycle functions so well and so simply that it normally should run by itself. Paradoxically, however, it has been greatly impaired by the continual human effort to improve civilization and introduce convenient “problem solutions”.Presently, large amounts of drinking water are wasted by flush toilets which, in the same process, also wash away nutrients, often irrevocably removing them from the material cycle. In consequence, modern agriculture is faced by a substantial threat: In order to nurture plantations it entirely depends on mineral fertilizers which constitute a non-renewable and hence a finite resource.

And still, a sustainable solution for this man made problem is easier than may be imagined: That which has been taken from the soil needs to return to it. This is the only way a human civilization can become sustainable. Modern human civilization can find inspiration for this approach if it looks back in history. The utilization of human excrement is not an innovation of our age. Of course, it is a major challenge to adjust the corresponding methods to the present requirements and, to begin with, to establish a collective sense of responsibility for soil fertility. To achieve this aim, it will take nothing short of a change of culture and a major process of re-education. This contribution introduces the **Terra Preta Sanitation System** (TPS). As an environmentally friendly alternative to customary flush toilets, TPS facilitates the transition to a society that acts more responsible and chooses sustainability over mere convenience. The application of dry separation toilets (urine diversion dry toilets) helps saving both valuable nutrients and considerable amounts of drinking water. The different components of TPS work in a complementary or symbiotic fashion, thus mastering the challenge of reestablishing an intact material cycle without giving up the convenience of conventional solutions. In this respect, locally produced resources and the products of human metabolism as well as the technologies used and the active participation of the local residents are some of the most crucial aspects to be mentioned.

Following, we provide a detailed description of TPS and how it can become a success. First, we discuss a hypothetical yet realistic scenario how TPS can be implemented beneficially (section 2.1). Subsequently, we explain the functioning and manufacturing of TPS toilets (sections 2.2 to 2.4). Finally, we present a business plan (section 3) and deal with some advanced matters (section 4).

2. Technical description of TPS

2.1 Scenario: TPS in the former industrial city Bochum, Germany

We are developing TPS for several contiguous locations in the de-industrialized city Bochum, particularly the location of the former *Opel I site* in Bochum and other developing urban neighborhoods. As a part of this scheme, we are planning to incorporate the designated residential area *Ostpark Bochum* which is projected for the coming years (about 2,000 inhabitants). These plans feature an innovative, decentralized rainwater management which includes the retention and transfer of rainwater over open ditches and gutters, as well as the feed-in of waste water. Further, we plan to co-operate with the projected *Campus Bochum* of Ruhr University (about 50,000 students and associates) and the *Gesundheitscampus* (health campus with some 4,000 patients and associates) as well as adjacent public institutions of the Buildings- *ind Intergovernmental* (BVZ with about 1,500 associates). In accumulation, these locations unite far more than the critical mass of 20,000 potential participants for TPS.

During this time of industrial decline, the business location Bochum is facing major challenges. Not long after the complete retreat of Nokia, General Motors also decided to consecutively shut down their three Opel factories in the city. These are just some prominent examples among many others. While the entire Ruhr area used to be among Germany's strongest economic centers, globally known for its large manufacturing facilities, the region has been experiencing an unprecedented economic recession for some decades now. As the example of Detroit in the US has shown, post-industrial cities often encounter challenges like soaring unemployment and public debts. The final departure of Opel by itself will cost another 3,000 jobs in Chum’s industrial sector. In order to overcome this downward spiral and redevelop a functioning economy, post-industrial cities like Bochum need to identify and establish alternative sectors of growth. One of the limited choices is that of attracting residents and companies from the service sector by converting a former industrial city into a green city. In this respect, a painful economic development may bring a historic chance for the environment to recover. Along the same lines, alternative environmentally friendly technologies like TPS may eventually take the place of the old ones and become part of a more future oriented and sustainable economy.

The idea for using the Opel I site as a pioneer location for the implementation of TPS originates from a study project called “Geisteswerk” (mental work) which was part of a postgraduate course in landscape architecture. It was developed as part of a studio project by Janina Gäckler, Wenye Gong, Andre Schwarz, Thomas Dotzler, Andreas Lüderitz and Gabrielle Mainguy. The project was supervised by professor Giseke of TU Berlin. This prior context knowledge about Bochum and its newly-emerging neighborhoods and clusters helped identify the city as a suitable location for TPS as an integral component of a sustainable local material cycle. For instance, the former mining tunnels create a permanent necessity to pump water out of the ground to prevent the old tunnels from collapsing. Rather than channeling this water which contains much Chloride into the Ruhr river, however, it could as well be desalinated and utilized for the local production of food.

This is our vision for Bochum’s newly developing districts, particularly around the former Opel I site: Residents, businesses and various farming types (plantations, greenhouses, aquaculture as well as innovative aquaponics) are interacting and collaborating with related research. Based on this research, cooperative cultivation and self-sufficiency projects on a household scale can emerge. work together applying research and new technologies for the improvement of the soil. TPS is an integral element of this scheme as it creates symbiotic links between all these elements. The goal is to establish a local material cycle that encompasses all spheres of life. This way, TPS can use existing resources to generate some kind of a terra preta which in turn can be utilized for soil improvement on old, industrial sites and in local agriculture. That which was taken from the soil returns to the soil: With terra preta, food products can grow on open spaces like the former Opel I site as well as on top of flat roofs in the city. Additional needed resources such as bio-char and wood components can be produced locally to offer jobs to local residents.

At this point, we would like to give an overview of the context in which TPS could best be applied at the former Opel I site. The best way to do so is following the water along its alternative route from the mines into the Ruhr (compare Fig. 2 - overview of the Opel I site - appendix). To begin with, heat pumps transport the water at a constant temperature of 20°C into the buildings in order to heat them. As a next step, the water is desalinated via a reverse osmosis system. Some of this purified water can now be used as drinking water, whereas the excess part flows along steep terrain passing through a succession of ponds used for aquaculture, aquaponic greenhouses and crops. After this, the water is purified again by a biological clarification plant before it passes wild rice fields and finally flows into the Ruhr.

As our concept counts on local production cycles, the extraction of resources as raw materials for TPS is an important aspect. Accordingly, fast-growing trees like birch trees and willows are actively grown on plots surrounding the farmlands and on other selected forestry plots. In addition, woody plants such as bamboo and miscanthus are cultivated in the channels and wetlands. In fact, there already are plots with fast-growing trees in Bochum as due to mining tunnels some properties cannot be used for building constructions.

2.2 The functioning of TPS toilets in context

In a nutshell, the basic concept of TPS can be described as follows: The raw materials, litter and a mixture of effective microorganisms (EM) and essential oils, are transported to the respective buildings where they are stored in the basement. Later, they are mixed with human feces and then composted together. The resulting terra preta is used to improve the soil, whereas the urine is used as an additional fertilizer. As indicated above, the needed raw materials predominantly stem from local or regional sources. Both litter and EM can be produced in Bochum, while the essential oils may be purchased regionally (compare table A “starting materials” for a more exact composition of the raw materials). The needed special toilets can be readily purchased (compare section 2.3)

We developed two alternative versions of TPS to meet the specific needs of the different participants. In the case of public or commercial buildings the litter is directly inserted into each urine diverting dry toilet[1] to raise public acceptance, whereas in residential buildings (mostly apartment complexes) it can be given into the fermenter at the basement level. In both cases, however, a caretaker (or janitor) is assigned to regularly restock the raw materials as well as remove the end materials. In the case of residential buildings, the individual residents receive the EM mixture from the caretaker and independently fill them into the designated reservoir of their toilet. Additionally, the caretaker fills up the litter reservoir. In the case of public or commercial buildings, the caretaker hands all raw materials to the responsible cleaning company which in turn fills them into the respective reservoirs of each toilet. After using the toilet, the user presses the button to set the screw conveyor in motion which then starts rotating and transports the feces to the chute. (compare section 2.3). In the meantime, the urine passes via a pipe into a urine reservoir in the basement. In public and commercial buildings, litter from the reservoir behind the rear wall is automatically contributed onto the screw conveyor. When using the toilet, the feces fall on the litter bed. The user then presses the evacuation command so the screw conveyor can carry the mixture to the chute. Afterward, new litter is automatically dispensed for the next use. The litter-feces-mix passes via rotating screw conveyor and chute into the fermenter in the basement. In residential buildings, however, the feces is removed directly by the screw conveyor and the litter is only added in the fermenter.

Semimonthly, the caretaker replaces the filled fermenter with an empty one. The full fermenter remains in the basement for about another two months, however, where it ferments under the absence of oxygen. Afterward, the fermenter is removed from the basement by means of a winch. If any of the residents grow their own vegetables, fruits or flowers, they may insert the fermented material into their soil or they may pile it up and have it compost for about six months while being moved around regularly. In this latter case, however, it is important that earthworms and insects inhabit the compost in large numbers. If the residents have no need for humus, the full fermenter is picked up by our truck every four to six months and brought to a central composting facility which is operated on *Campus Bochum*. Accordingly, the entire area that participates in the scheme is divided into four to six areas which are served by us consecutively. In this way, our truck passes by one of these quarters one day a month to sequentially pick up the fermenters. The urine is pumped out of the basement and also transported to the composting facility.

While the urine can directly be sold as a fertilizer (the customer has to dilute it with water at a ratio of 1:10), the fermented material is composted for 6 months in the fashion described above. The finished terra preta is then sold to farmers and gardeners who either collect it themselves or have it delivered for a set fee. Additionally, the active humus can also be offered to the city as a soil conditioner, e.g. for the Opel I site or other former industrial sites. To have the best effect, terra preta is mixed into the soil at a ratio of 10 liters per square meter and year. This way, the right ratio of charcoal in the ground will be reached within four years. Farmers may also purchase the fermented material at a reduced price before it is composted. In this form it may be directly filled onto the fields in a shallow pit of about 30cm in depth, that can optionally be covered with soil and planted upon. By using metabolic products in this fashion, the matter cycle is almost as closed as nature's model.

[1] Urine diverting dry toilets or separation toilets without any water supply will here simply be referred to as toilets.

2.3 The functioning of TPS toilets in greater detail

At this stage, we would like to narrow down the scope to the technical details of the toilet itself as well as its connected components such as the screw conveyor, the chute and the urine discharge in the basement. Different models of the needed dry separation toilet can be readily purchased from the Swedish manufacturer Wostman. Each of their porcelain toilets has two different sections in the main body where urine and feces are separated. Additionally it has an opening at the back which provides enough space for the installation of the screw conveyor. The section for urine is large enough to collect as much liquid as possible. For closing off the odor, we use a rubber membrane that opens upon passage of a liquid and then closes again. The urine coming from the toilet runs through a hose that is made of PE and fixed to the chute. Upon pressing the button “U” an EM mixture (for composition, see Table A) is sprayed into the urinal in flat broad beams by means of two nozzles quite similar to a high-pressure headlight cleaning system for cars. Through this application unpleasant odors as well as germ formation and unwanted optical changes in the surface of the urinal are reduced to a minimum. The EM mixture creates an acid environment to avoid urine mineral deposits.

Analogically, upon pressing the button “G”, feces are removed into the chute by a screw conveyor via a tube that is inclined slightly downward. A substructure connects the screw conveyor to the porcelain toilet. The square upper end of this substructure is conveniently closed by a flap which is connected to the lid of the toilet as to have it open and close successively. This flap separates the conveyor belt which gets into contact with the feces from the clean part of the toilet. If the button G is pressed the screw conveyor rotates for about one minute, until, finally, a scraper removes the feces from the end of the screw conveyor. On one side the shaft of the screw conveyor is fixed to the substructure of the toilet and on the other side it is fixed to the chute. (compare Fig.1 – cross section of the residential model). In order to run this mechanism, an electric motor is to be installed behind the chute at the end of the screw conveyor.

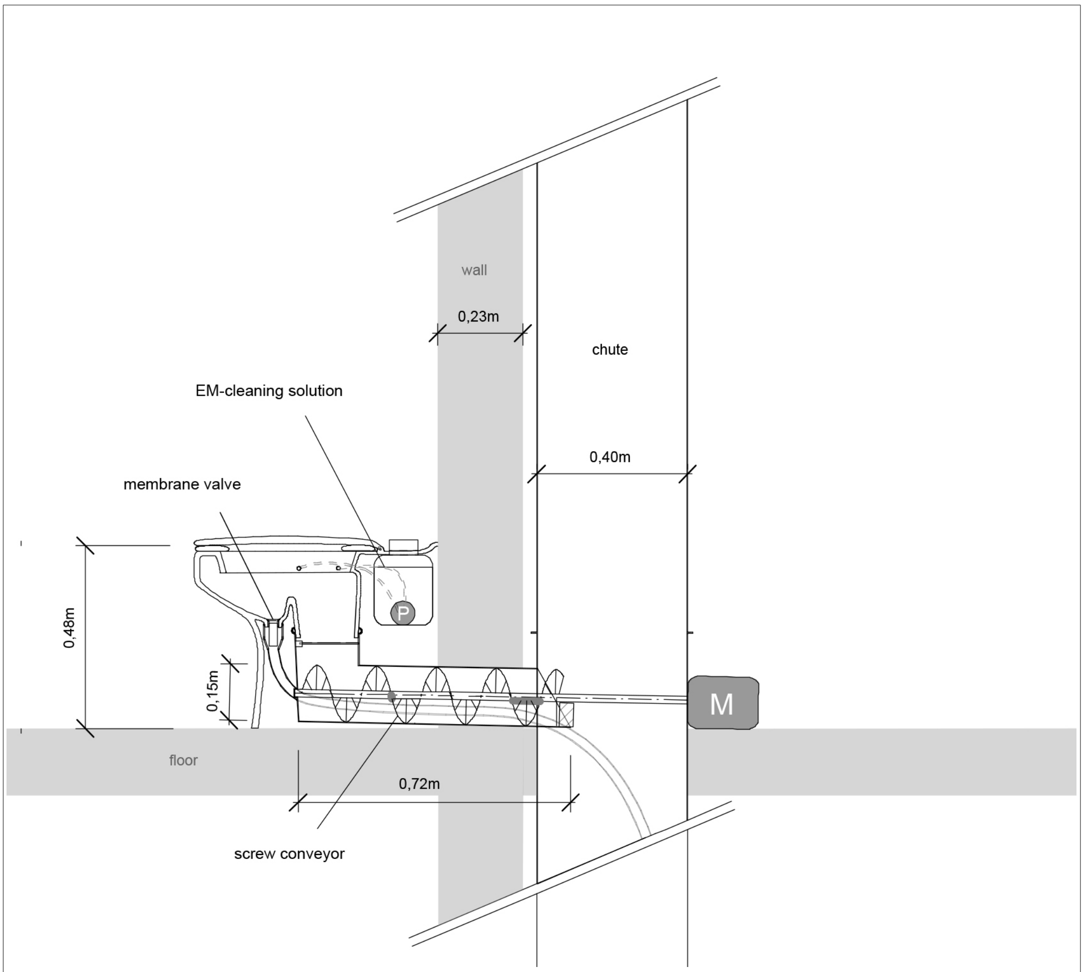


fig 1: cross section of the residential model

In residential buildings, the litter is mixed directly into the fermenter where the signal of a capacitive sensor launches the litter addition. In public and commercial buildings, the litter is located in a reservoir directly behind the toilet wall. This reservoir is connected to the substructure of the toilet through a short tube and dispensing and measuring device. Both flaps are connected to the tube through a screw device that permits their opening and closing by an electric motor. As the inner flap facing the reservoir opens, a defined volume of approximately 0.5 l of litter is discharged into the tube after which the inner flap closes again. The system is designed to guarantee there always is fresh litter on the screw conveyor to receive new feces. Upon pushing the button “G”, the litter-feces-mix is removed by the screw conveyor. After rotating for one minute, the outer flap of the litter reservoir opens automatically and 0.5 l of fresh litter is distributed for the next use. Upon pushing the button “F”, an EM-mixture is sprayed on the toilet's surface via two nozzles each in both the fecal and in the urinal section. If necessary, the surface of the toilet can also be cleaned mechanically with a brush after which the “F” button may be pushed again. The EM reservoir is located in a basin directly behind the toilet. It can be accessed easily in order to be refilled. A barrel at the bottom of the chute functions as fermenter (Fig. E). During the semimonthly exchange of the fermenter, the caretaker switches the electric motors off with a central key. As a result, temporarily no feces can enter the fermenter via the chute. To avoid any malfunction in the process, regular maintenance and upkeep are carried out by us under the supervision of a qualified technician.

2.4 The manufacturing and installation process of TPS toilets

We order the individual components consisting of toilet, substructure, litter reservoir and screw conveyor from selected suppliers and pre-assemble them in our workshop. The final assembly of the toilets as well as the other components, however, takes place at the site of installation. Ideally, TPS should be specifically adapted to each type of building in which it is installed. For TPS to function, however, it is crucially important that bathrooms are located above or offset to each other so they can feed into one central chute. Fortunately, this is the case in most types of buildings.

As indicated above, the toilet made of porcelain is supplied by the Swedish company Wostman. The nozzles are connected to the EM reservoir via a pipe and linked to the reservoir's outlet by a rubber sleeve. The substructure of the toilet is equipped with a flap. In public and business buildings, an opening for the litter is to be included in the substructure beneath the flap. The reservoir for the litter which consists of a short chute for the litter, a litter dispensing and measuring device, a screw mechanism and the motor is pre-assembled in the workshop. The screw conveyor in the tube and its shaft are produced according to our requirements by an industrial technology company such as “Industrial Technology Schwärzel” from Berlin. Companies like the one mentioned also produce several other required components such as chutes, the toilet’s substructure and the additional reservoirs. One end of the tube screw conveyor is inserted into a bearing in the chute at the site of installation. Then, the other end is inserted into the bearing of the substructure of the toilet and screwed unto it. Afterward, the junction between the porcelain toilet and the substructure has to be made leak-proof by a rubber joint. The tube screw conveyor has to be installed with an angle of about 5% so that liquid components of the feces and EM mixture can flow right into the chute. Finally, the electric motor can be installed behind the chute.

3. Business model

3.1 Presentation of the project

	Description
Market	In full growth, because of an increasing potential demand and only few suppliers for mostly private use.
Product or service	Ecological toilets (urine separation dry toilets) for rural and urban areas (offices, housing estates, houses,...).
Economic model	Premium economic model, offering for both the institutional and the residential.
Aims	Developing an innovative and productive highly ecological and decentralised urban sanitation system based on the urine diverting dry toilet principle, which would allow the production of a sustainable, fertile soil that can be used in agriculture or soil conditioning. Our second goal was

	Description
	to develop a toilet that will be as comfortable as possible, in order to suit the average European standard.
Estimation and type of financial needs	First, we need a start capital to create a prototype, as basis of our communication and sales process. According to our financial plan and our sales aim, we also need financial resources to start producing and installing our sanitation system. In order to start our production comfortably, we need enough funding to pay establishment fees, invest in fixed assets and buy transitional goods (toilets) and raw materials. We estimated those investments to 2,000€ in fixed assets, 200,000€ in transitional goods and 1,700€ in raw materials.
Resources	Consequently, we are going to receive financial help from: a stakeholder (50,000€), a European support program (15,000€), the "Zentrales Innovationsprogramm Mittelstand" (20 000€), the "BMU Umweltinnovationsprogramm! (20,000€), the "Förderung der Markteinführung innovativer Produkte und Dienstleistungen" (10,000€) and the "Ich-AG"(600€ per month => 7,200€). We are also going to borrow about 80,000€, with an interest rate of 1,2% over 10 years.

3.2 Analysis of the market

3.2.1 Demand potential

The market of our product will increase remarkably within the next few years. That, simply because individuals, firms and governments are increasingly aware of the environmental concerns and problems caused by human activity and of the growing scarcity of natural resources like water and mineral fertilizer (phosphorus, etc.). Cities, for example, know very well that sewage sludge is increasingly demanding to produce and/or transform and hard to market. Drinkable water is also at stake. It is very important to reduce/eliminate the waste of water for sanitary installations. Drinkable water is a life necessity that lacks in many region of the world. Exactly like the wind-power and the photovoltaic sectors, our market will take off. According to European market studies, 180 apartments in ecological buildings and 300 houses in Germany are already equipped with ecological toilets, but those installations are mostly pilot or private settings. Even though people's interest in environment and ecology has increased, the principle remains widely ignored. Besides, most of the existing ecological sanitation systems focus on an outside use.

Segments	Description
Families	Middle class households wishing to invest in sustainable technologies for long-term savings. They would also be able to save part of the final compost for their own use as fertiliser for their own garden.
Firms	Firms wanting to invest in sustainable technologies and support environmental projects for long-term savings. They can expect benefit from tax credit and a greener image in the public's eye.
Ecologists	Owners with environmental values.
Community gardens	Associations or groups with a limited access to water wishing to benefit from comfortable sanitation and water saving while improving their soil and productivity.
Construction firms	Public or private, willing to offer and install ecological sanitation for ecological buildings.
Farmers	Growers looking for sustainable and efficient soil improvement methods, produced compost being comparable to the Amazonian terra preta, renown for its long lasting fertility.

3.2.2 Analysis of the competitive environment

3.3.2.1Analysis of the macro-environment through a PESTEL analysis (see Appendix)

3.3.2.2 Industry study through the Porter five forces analysis

▪ Concurrence intensity: Because Berger Biotechnik is our major concurrent, we also have to achieve notoriety among the general public. That being said, our unique selling proposition opens us a different market. We need to earn the trust of potential consumers through a strong communication strategy. That strategy will, among other goals, focus on informing potential consumers interested in ecological sanitation systems. Very few information is presently available to the public. The concurrence intensity is not prohibitive: this type of product is very unfamiliar among the general public, therefore the market could theoretically be multiplied.

▪ Substitutive product threat: The only substitutive product is the current sanitary system. Only new environmental products to reduce the use of water for sanitary facilities might be a threat for our project, but they are very marginal as well and less ecological than dry toilets.

▪ Negotiation power (clients and suppliers): The negotiation power of the clients is linked to the importance of the investment, but doesn't challenge our capacity to be profitable. The negotiation power of the suppliers depends on their activities. For technological suppliers, the negotiation power is relatively high, because we would depend on their products. On the opposite, the negotiation power of raw material suppliers is quite low, because we provide real opportunity to increase the value of their by-product.

3.2.3 Analysis of the concurrence

3.2.3.1 Concurrence

The main competitors are Berger Biotechnik, TriaTerra and Viva Verde. Berger Biotechnik is already established in European countries and is our major concurrent. This firm benefits from a 25-years-long experience in selling high-quality products. But it is only well-known among ecologists. Tria Terra sells compost toilets and all consumables necessary to use the toilets. Toilets are cheap but do not meet the comfort standards of most people. They mainly suit a strictly private use in rural areas than a generalised use in urban housing estates. Viva Verde sells humus toilets, urine diverting dry toilets and litter toilets. Even though their website is quite informational, the firm remains largely unknown among the general public. (see Appendix)

3.2.3.2 Success factors

Success factors are strategical parameters conditioning the success of a firm towards its concurrence.

Success factors	Description
Environmental concerns	- No need for water, non-renewable resource, and for polluting cleaning products. - Finding a way to facilitate the closure of the local cycle of matter - CO^2 sequestration for which users, e.g. farmers, receive a CO^2 certificate. - Supports the emergence of independent and sustainable agricultural methods.
Independence	- From traditional systems in sanitation and agriculture.
R & D perspectives	- Development perspectives all around the world, because there is a need to protect natural resources such as water and soil.
Labels	- “Der blaue Engel” in Germany: for energy saving and climate-friendly projects. Synonym of quality for the users.
Costs	- Despite the required initial investment, our product means long-term savings for households. It saves water and promotes recycling.

What would differentiate our product from the concurrence is that:

▪ Our Terra Preta sanitation system is adapted to urban areas because it has a central collection system unlike already implanted pilot or private installations.

▪ The reclamation of various by-products of agriculture or forestry, for example, and promotion of a sustainable and independent agriculture and local food production.

▪ Because our product meets the comfort standard of the average European, it has the potential to reach a broad public.

▪Our product is highly ecological because it eliminates the water consumption for sanitation and facilitates an effective and long lasting carbon sequestration.

▪ We will set up essential and powerful partnerships to implement our product in innovative construction projects and to offer affordable products in order to reach the largest market possible.

3.2.3.3 Competitive advantages

	Description
Strengths	- Savings in natural resources (especially drinking water). - support of local agriculture - Financial and energy savings. - Adaptation to urban areas
Weaknesses	- Need for major and maybe expensive installations, to implant our product in housing estates. - Possible mistrust of consumers, who would wonder about the efficiency and the profitability of the system.

3.3 Executive plan

3.3.1 Resources and aims in terms of quantity, turnover and research and development (see Financial part)

3.3.2 Industrialisation and marketing

3.3.2.1 Industrialisation plan

▪ Subcontracting: We will sub-contract the production of the simple toilets to sanitation firms in order to focus on promoting, selling and installing our systems. We will benefit from the know-how of firms who already produce sanitation goods and be able to obtain wholesale prices.

▪ Necessary investments: To install our system in individual houses, an initial investment of approximately 2,000€ in fixed assets is required. These fixed assets would be amortized linearly over 5 years.

3.3.2.2 Marketing plan

Positioning: Ecological urine diverting dry toilets to invest in eco-friendly self-sufficient sanitation, which will benefit local partners and enable financial savings over the long-term.

	Aims	Means
Product	- Ecological toilets (urine diverting dry toilets) for rural and urban areas (offices, housing estates, houses,...). - Services: recovery of the final litter and urine.	- Through the installation of a new ecological and self-sufficient sanitation process. - Premium economic model: offering for both the institutional and the residential.
Price	- As affordable as possible to limit the financial investment and hence not deter potential consumers.	- Double price system, according to the product (institutional or residential). - Lowered by subsidies or tax credits.
Communication	- Be informative and directly target potential clients. - Make ourselves visible through partnerships.	- Presence in ecological or sanitation trade shows. - Partnerships with recommending firms, such as our suppliers and key partners. - Advertising through a website and showrooms to encourage the contact with clients.
Delivery channels	- Presence on different delivery channels: a showroom in a store or in a trade show is necessary to present our products to potential consumers and to reassure them towards their investment in ecological sanitation.	- Showrooms eventually - Specialized stores and trade shows - Online

4. Additional questions

4.1. Are your proposal or parts of it an already implemented solution, or is it still in conceptual or prototypal phase?

Our proposal is in a phase between the conceptual and prototypal phase.

A prototype of the model will be developed by Aliksir soon. Aliksir is an essential oil company from Québec – Canada. Its director, Lucie B. Mainguy, is very engaged in terra preta sanitation. She wants to utilise *muka*, the by-product that results from producing essential oils. Besides Ms. Mainguy is very engaged in the environmental politics in Québec, so that the terra preta sanitation concept will be accepted for a commercial purpose in the legislation soon.

4.2. On which already existing solutions is your contribution build upon and what is your specific enhancement?

Basically, our contribution builds upon already developed components, e.g. a urine diverting dry toilet. But if we take a look at the existing market, we see that our solution presents a considerable advantage in terms of comfort. Our flap system will make the device discreet and pleasant in smell (with the addition of essential oils to the cleaning solution). Also, we offer central collection of the faeces in the fermenter. Besides, buyers will see advantage in the compactness of our sanitation model, thanks to the central storage of the phases in the basement with transport elements as the screw conveyor under the toilet, and our lightly acid EM-mixture, that reduces the development of urine mineral deposits.

4.3. Please state the type of Creative Commons License under which you hand in your contribution.

For our contribution, we state the following Creative Commons (CC) License:

CC – BY – ND – NC

by – Attribution
NC – Not Commercial
ND – No Derivative Works

Appendix

A

components and costs

table 1 and 2 - raw materials

litter-mixture production costs

component	portion	l	costs
chuff , cuttet	0,7	0,35	70 € je m³
biochar	0,2	0,1	320 € je m³
powdered clay	0,1	0,05	110 € je m³
litter sum	1,0	0,5	0,06 € per person and day
		45	2,79 € per family and month
		270	16,74 € per house and month

EM mixture production costs

component	portion	ml per flush	costs
EM	0,73	14,8	0,73 € per l
citric acid	0,25	5,0	0,1 € per l
essence oil	0,01	0,2	71,76 € per l
EM mixture	1,00	20	1,52 € per l
			0,46 € per family and day
			13,70 € per family and month

table 3 - component costs

toilet component purchasing costs

components per house	€
6 x urine diversion dry toilet by Wostman	3600,00
6 x EM reservoir $3dm^3$	30,00
24 x EM nozzles (10€ per unit)	240,00
50 x pipe for urine (1€ per m)	50,00
6 x screw conveyor DN150 (800€ per unit)	4800,00
6 x electric motor (250€ per unit)	1500,00
9 x chute (30€ per m)	270,00
6 x fermenter barrel $220dm^3$ (50€ per unit)	300,00
1 x pallet truck	200,00
4 x urine reservoir $1m^3$	300,00
1 x litter reservoir with 2 flaps ½ m^3	200,00
2 x electric motor for the flaps (50€ per unit)	100,00

B

Analysis of the macro-environment through a PESTEL analysis :

	Threats	Opportunities
Political and Legal	- Legal exigences towards sanitation, purification and treatment : composting toilets are not yet recognized as a sanitary equipment. - Political changes, which can support and then remove such ecological installations, according to the main party in governments. - Eventual obstacle of lobby for water supply.	- Offer of potential subsidies or tax cuts for the initial investment by European governments, to promote the use of renewable energies and the development of environmental projects, especially for small and medium size businesses (like the "Umweltinnovationsprogramm").
Economic	- Lack of long-term perspectives in the expenses of households, who might not take enough into account the possible savings through an investment in ecological sanitation.	- Economic crisis, which have affected the purchasing power of European households, who are now wanting to consume more economically. - Decentralization of the water supply, independent from transports. - Perspectives of partnerships with influential firms, to develop the required technologies and to help to finance the project. - Absence of already established and developed concurrence for our product on the market.
Social	- Lack of understanding for eventual users towards our product, because they are used to think that the use of water in sanitary processes cleans and protects from diseases → need for information. - Influence of the media towards the perceived advantages and disadvantages of our product.	- Development of environmental concerns among European households → strong appearance of local and biological services or products. - Population growth, which forces the construction of new residences and threatens natural resources.
Technological		- Lower need for electricity than in traditional sanitation.
Environmental		- Constant growth of the sector of renewable energies, underlining the scarcities of natural resources and the water resource mismanagement. - Promotion and protection of the self-sufficient ecosystem, endangered by

	Threats	Opportunities
		human activities.

Analysis of the concurrence :

Concurrent	Strengths	Weaknesses
Berger Biotechnik	- Already implemented in European countries.	- Less information about the system on the website, especially about the whole installation system. - Focus on single family house installation, and not on urban areas with entire buildings. - Not so well-known among the general public, but more among ecologists.
Tria Terra	- Cheap compost toilets and by products.	- Unattractive products - No offer of a whole composting system. - Matching a more private use for rural area than a generalised use in housing estates for urban areas.
Viva Verde	- Offer of 3 different products: humus toilets, separate toilets and litter toilets, matching different purchasing powers and uses. - Lot of disposable information on the website.	- Not a well-known firm among the general public, that we are going to reach.
Pilot programs	- Supported by public regional organisations.	- Only test-prototypes, which are not generalised in buildings.
Isolated users	- Own creation of their ecological toilets, whose initial investment is very cheap.	- Impossibility to set it up for buildings, because it requires more technological and expensive installations. - Not as eco-friendly and complete as our product, which take part in a whole recycling process. - Concentrated on outside use. - No development perspectives.

C

financial model :

2016					
Assets	**Gross**	**Amortization**	**Net**	**Debts**	**Net**
Establishment fees	349	0	349	Share capital	122.200
Fixed assets	2.000	400	1.600	Reserves	0
Inventories	0	0		Profit	31.240
Customers' debts (30 days)	25.000	0	25.000	Bank debt	72.000
Other debts	0	0	0	Suppliers' debts (90 days)	50.425
Investments securities	0	0	0	Other debts	35.298
Cash flow	284.213	0	284.213	Bank overdraft	0
Total	311.562	400	311.162	Total	311.162

2017					
Assets	**Gross**	**Amortization**	**Net**	**Debts**	**Net**
Establishment fees	0	0	0	Share capital	72.200
Fixed assets	2.500	500	2.000	Reserves	68.141
Inventories	0	0	0	Profit	154.762
Customers' debts (30 days)	50.000	0	50.000	Bank debt	64.000
Other debts	0	0	0	Suppliers' debts (90 days)	100.850
Investments securities	0	0	0	Other debts	70.595
Cash flow	478.548	0	478.548	Bank overdraft	0
Total	531.048	500	530.548	Total	530.548

2018					
Assets	**Gross**	**Amortization**	**Net**	**Debts**	**Net**
Establishment fees	0	0	0	Share capital	72.200
Fixed assets	3.000	600	2.400	Reserves	142.958
Inventories	0	0	0	Profit	324.683
Customers' debts (30 days)	100.000	0	100.000	Bank debt	56.000
Other debts	0	0	0	Suppliers' debts (90 days)	201.700
Investments securities	0	0	0	Other debts	141.190
Cash flow	836.331	0	836.331	Bank overdraft	0
Total	939.331	600	938.731	Total	938.731

Sources : http://www.gruenderszene.de/allgemein/ug-gruendung-kosten-neues-notarkostengesetz
http://www.subventionen.de/programme/Umweltschutzfoerderung-der-Deutschen-Bundesstiftung-Umwelt/52
http://www.subventionen.de/programme/Zentrales-Innovationsprogramm-Mittelstand-ZIM/66
http://www.subventionen.de/programme/Foerderung-der-Markteinfuehrung-innovativer-Produkte-und-Dienstleistungen/43
http://www.subventionen.de/programme/BMU-Umweltinnovationsprogramm/89
http://www.subventionen.de/programme/Foerderung-der-Markteinfuehrung-innovativer-Produkte-und-Dienstleistungen/43
http://www.subventionen.de/programme/KfW-Umweltprogramm/39
http://www.subventionen.de/programme/Startkredit-Startkredit-100/80

D

figures

fig 2: overview of the opel1 site

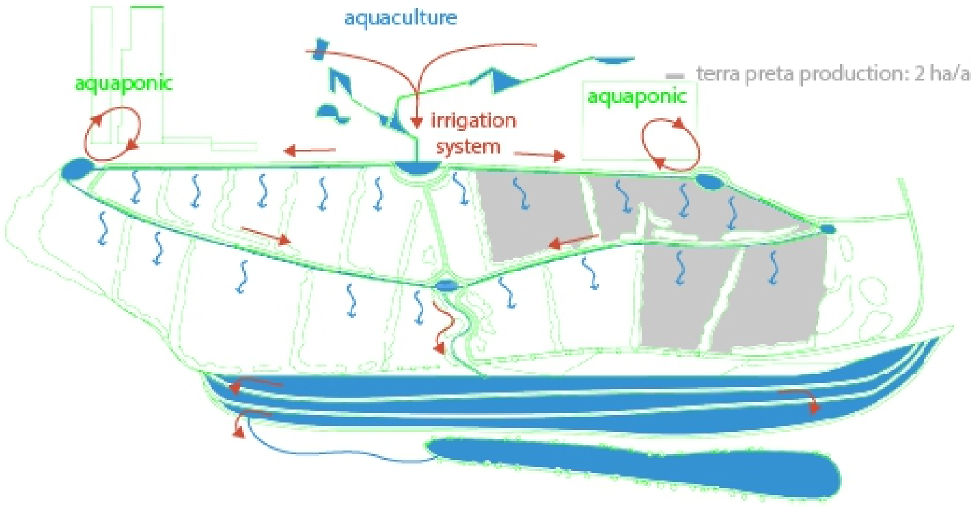


fig 3: aquaculture and irigation system

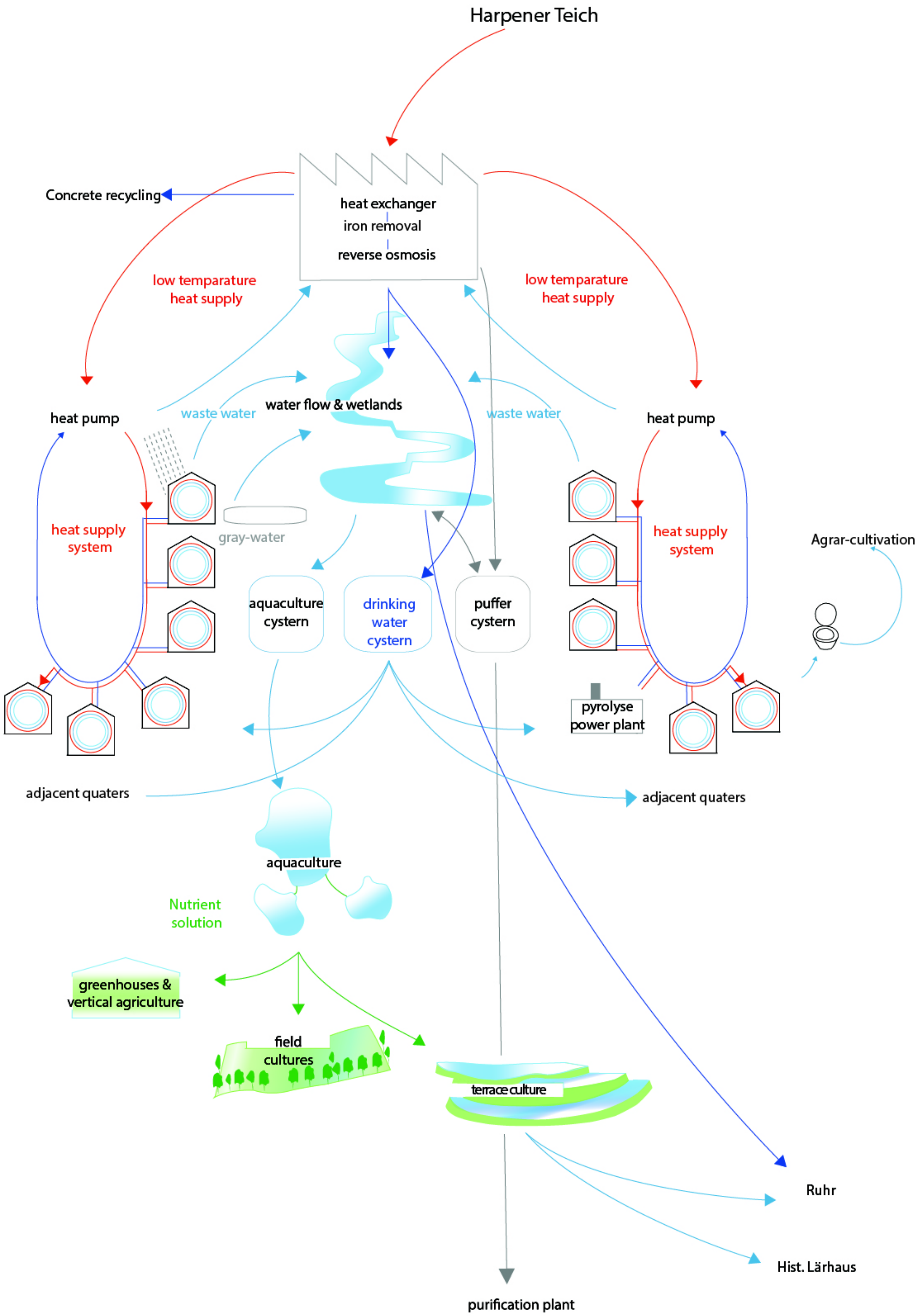


fig 4: water system

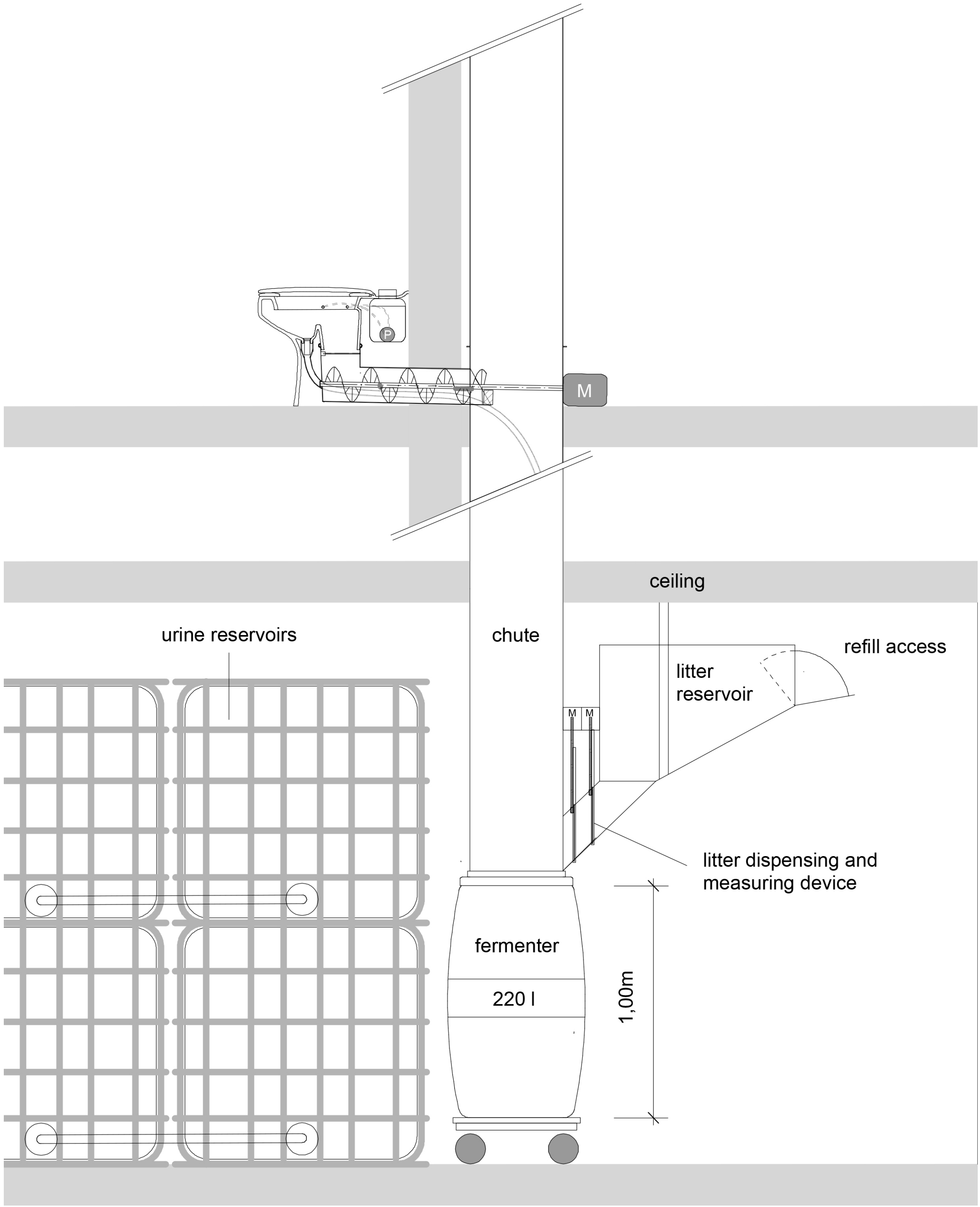


fig 5: overview of the whole residential model