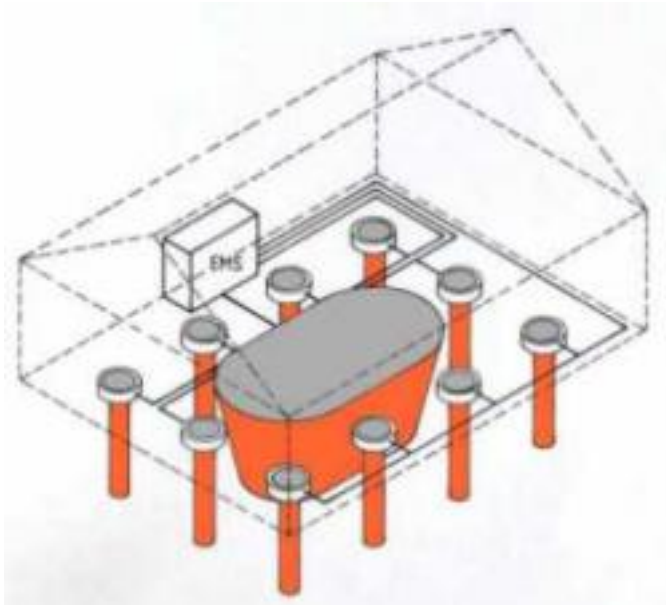


## A new Geo Heat Exchange & Storage System for net-independent construction under green buildings

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A new concept of a underground long-/short-term heat exchange & storage system supported by a water absorbent concrete –strong enough to be over-built, environmentally friendly, maintenance-free, storage efficient and cost effective, long lasting, and corrosion resistant – for decentralised alternative heating & cooling right under residential and commercial houses and buildings.

### Background:

Buildings today account for 40 percent of energy consumption in developed countries according to the Organisation for Economic Cooperation and Development (OECD). In view of the energy shortage and desirability of reducing CO<sub>2</sub>-emissions, there is a need for means of heating and cooling buildings while conserving energy.

The target of the World Council for Sustainable Development (WBSCD) is to be able to design and construct self-sufficient and environmentally sound buildings by 2050. These buildings will use zero net energy from external energy grids and produce carbon dioxide emissions as little as possible, while being economically viable to construct and operate.

Thus, buildings of tomorrow will require a combination of minimised onsite energy generation incorporating maximised renewable heat energy sources; ultra-efficient building and insulation materials and equipment; and waste heat recovery.

Solar energy is one of those most potential renewable energy sources. Today, solar energy heat collectors are working quite efficient. However, in order to make practical use of them, it is necessary to run them in combination with a heat storage system to maintain a sustainable and steady heating and cooling supply of the building. This is especially important during nights and periods of cloudy, sunless days, and in the wintertime (seasonal use).

Other sources like the shallow ground heat, the waste heat from untreated wastewater collection systems and from cooling and air-conditioning systems, and the energy from biomass boilers, from micro-cogeneration to heat pumps are further potential eco heat sources, which can and should be buffered in a heat storage system. So heat storage is an essential part of a very broad range of renewable energy and waste heat recovery applications, and is an enabling technology, without it, alternative heating would not be possible. Although heat storage itself is rather invisible, its impact on the amount of

renewable energy generated in your house, your city, and your country is huge. With advanced heat storage technologies, it becomes possible to store summer solar heat for the winter, raising the solar fraction to 100%.

Further ultra-efficient building and insulation materials are necessary to reduce the general heat energy request and to make smaller heat storage capacities possible. And this opens the opportunity that every new developed real estate or new-built building or house can have its own separate seasonal storage system, - if it is easy and cost effective to install. And this can generally be provided if it is an underground construction, which can be over-built, and no interior space will be used. In narrow city right-of-ways and private land space is limited and very expensive. Also an underground storage structure requires less insulation, because it is covered by the building and embedded in the ground with its own heat potential.

So every alternative or renewable use of heat should be collected in an appropriate seasonal heat storage system together with a modern house building concept to run it efficiently. And very important is the need to make the distance of energy transportation as short as possible. So appropriate heat storage systems become a key technology function in every alternative heating & cooling system.

#### New Building Material:

Following the above basic concept Orange Depot & Exchange Systems has developed a new heat storage building material, which is a modified kind of concrete/mortar cured in one solid block with a very special porous and capillary structure. This structure takes up water completely up to 70 % of its volume and hold it by capillary effect. This material can be over-built while it needs no additional heavy-duty and expensive basin, tank or reservoir construction. And the material consists of conventional building material components like cement, lime, and additives, so it can be simply manufactured and installed by low cost.

#### Construction:

Two basic variants of construction are planned so far:

##### A. Underground heat storage system

The construction is very simple. Before the building will be erected, a necessarily sized and special shaped pit is excavated. Then the heat storage system can be installed in two options.

One option is to deliver the heat storage system as a ready pre-manufactured concrete block with completely integrated technical equipment by a truck to the site and heaved by a mobile crane into the pit. The other option is to fill the ready-mixed concrete directly into the pit, while a heat pipe collector system is integrated.

The heat pipe system can be arranged in horizontal loops on several levels, or as a vertical loop system by a number of spiral (Slinky-) collectors.

Depending on the planned later specific use of the storage system the side and bottom wall of the pit can be lined before/after the concrete installation with a watertight sheeting and/or an appropriate insulation material.

If the storage system is designed to be running as an independent storage system, it needs an additional watertight sealing and insulation. If a horizontal collector system is installed, under the bottom of the storage system insulation is not absolutely necessary, because in the bottom area the cold heat is charged, which gets warmer to the top of the storage block (up to nearly 90 °C). The insulation around is attached on the site by filling a conventional cellular concrete or any other appropriate material into the left empty space of the pit.

If the storage system is designed to correspond with the surrounding soil and its ground heat and other ground heat exchange and recovering systems, as seen in the attached picture of an AFEH plant design, no additional insulation to the side is necessary. In this case vertical spiral (Slinky-) collectors should be preferably used, and the hottest area will be in the vertical middle section of the storage system, and the temperature fall radially to the side (to the circumference of the concrete block). And this kind of onsite construction provides that the liquid bonding agent (cement mortar) penetrates into the peripheral area of the soil and forming there a strong concrete wall after curing, which seals and wraps the cellular concrete body with a kind of a shell against the surrounding ground (self-sealing-effect). This concrete shell can be conditioned as a completely watertight sheeting, or a semi watertight concrete wall, whose controlled leaking is used for emitting additional

water to the soil to optimise its condition for better ground heat storage and transfer. -But the same function can be reached with the pre-manufactured option too.

Then an insulation plate made of conventional watertight cellular concrete, or any other technology, and the base plate of the building can be built on top, while the connecting filling and measurement pipes and sensors will be vertically inserted. Then the storage block can be completely saturated with water.

Now the building can be erected. The porous and capillary structure of the special concrete hold the water by itself, so if there is any leak only a trace amount of water is lost, which can be topped up again via the filling equipment.

#### B. Vertical spiral-(Slinky-) ground heat collector

This variant is basically similar as the variant A with similar options, but its main designed function is less as a heat storage system but more as an underground borehole heat exchanger, which is additionally wrapped in the mentioned special water/heat storage material made of concrete. The depth and cross dimension including the concrete coating can vary depending on the individual request and use. The smaller the cross dimension and longer the depth is the more it is a heat exchanger, the bigger the cross dimension and shorter the depth is, the more the system become a heat storage system.

For that special purpose conventional vertical spirally screwed heat pipe collectors (Slinky-) are recommended. Their depth into the ground do not need to reach more than 3-10 m, and the bore holes can be simply made with a well-drill under low-cost conditions. These collector pipes have a comparable high heat exchange rate per meter installed length, and therefore be only advised to be designed for both, charging and discharging heat or cold into and out of the ground. So they are the perfect equipment for running a heat storage & exchange system right under city infrastructures, resp. houses and buildings. Depending how big the ground heat storage system has to be, a field of a number of those collectors need to be installed.

The main advantage of this new ground heat exchanger construction is, that the heat exchanger pipe(s) are embedded not in a conventional grouting material like normal cement, soil, or bentonite but in a special concrete material saturated completely with water, which provides additional moistening to the surrounding soil, which increases tremendously the heat exchange rate and comfort.

Draft plant design of an Alternative-Fuel-Energy-House (AFEH), see picture attached:

This concept includes a modern building erected with energy efficient building materials and a self-sufficient energy supply system by using a low-energy heating and cooling system and renewable and waste heat energy sources as solar heat & power combined with ground heat recovery technology, and if necessary a heat pump or a biomass boiler. The complete plant is managed by an Energy Management System (EMS).

The picture shows an AFEH building with a hybrid heat storage system, which combines a short-term heat storage system (variant A) integrated into an annual ground heat storage system right under the foundation plate. Both are running with vertical ground heat exchangers (variant B).

These heat exchangers are arranged around the short-term heat storage system, so no additional insulation to the side is necessary. The soil is moistened by controlled leaking of water out of both, the short-term heat storage block and the ground heat exchangers. This creates an optimal soil condition for heat storage even under overbuilt surfaces under most economic aspects. And the heat transportation distances is very short, so heat losses are minimised.

#### Advantages:

The special formulated concrete made of conventional components can be simply produced in large quantities for a reasonable price.

The special formulated concrete is easy to install by minimum use of cement and/or lime.

The special concrete structure can take up a high volume of water, and hold it by capillary effect, making use of the high heat storage capacity of water.

The special concrete has the necessary weight bearing strength, and thus, can be over-built without any supporting building elements.

The special concrete has a self-sealing and reinforcing effect towards the surrounding soil.

The special concrete storage system is environmentally friendly, maintenance-free, storage efficient and cost effective, long-lasting, and corrosion resistant.

The technology is now in the prototype phase, and Orange Depot & Exchange Systems is searching for partners doing the final developing steps for launching and marketing the product in cooperation worldwide.

TEC MANAGEMENT is an engineering and consulting firm in the field of environmental friendly technologies with focus on underground infrastructures, and beside others specialised on alternative energy storage & supply solutions.

Orange Depot & Exchange Systems is the label, under which particular systems, products, and techniques are promoted.

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