

**Tecnologia
Technology**

GT



soilmec



Geothermal Energy

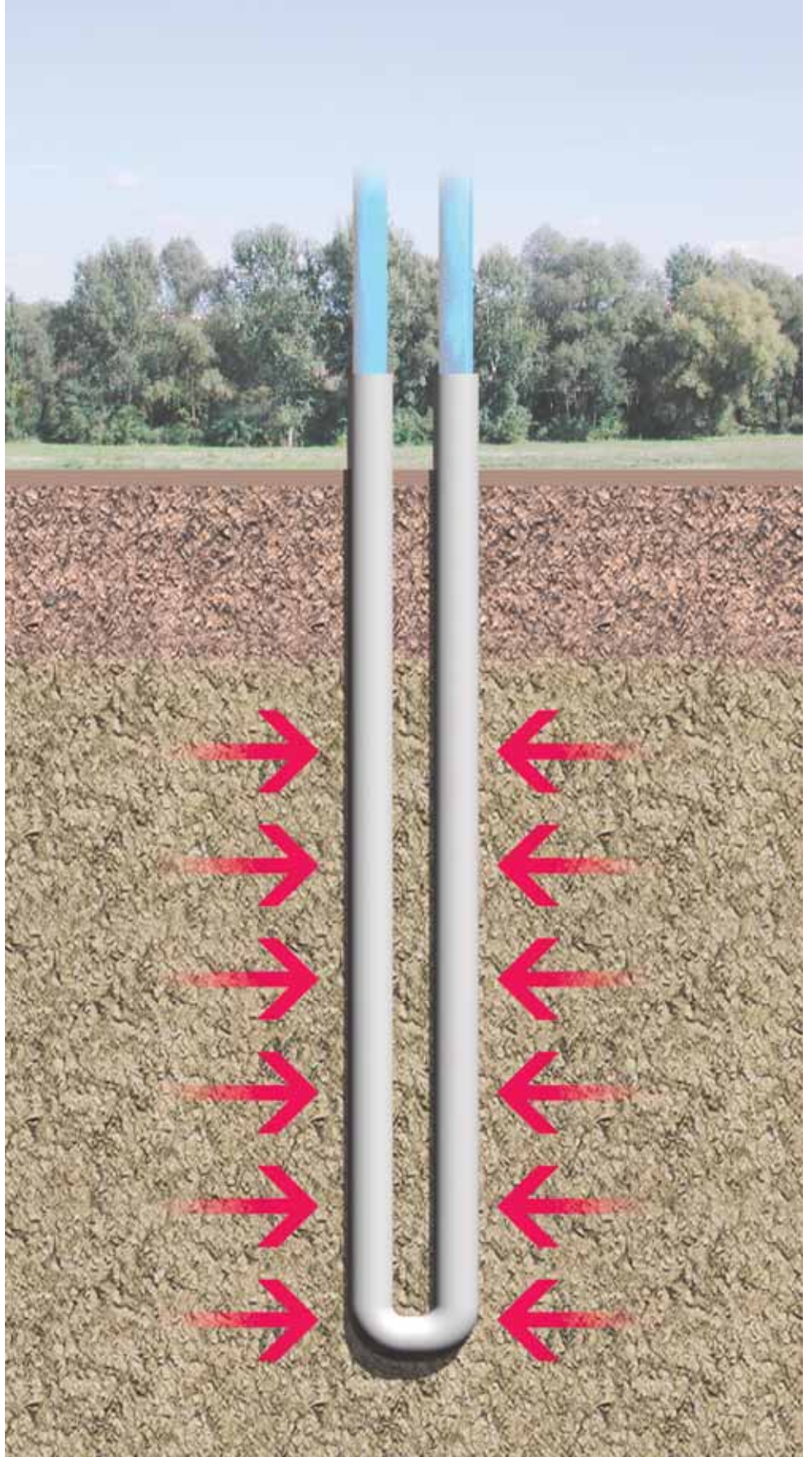
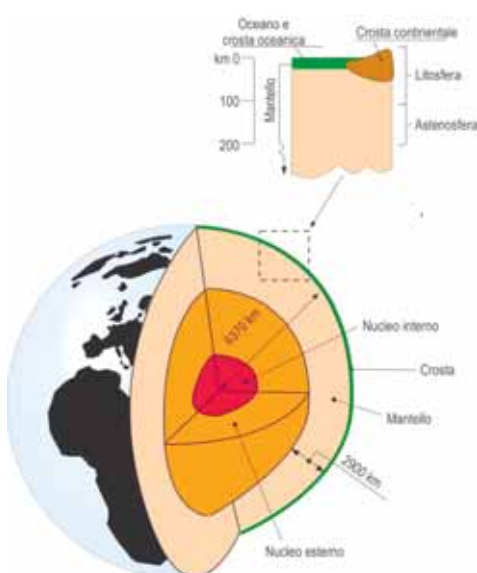
soilmec®
Drilling and Foundation Equipment

Technology

Geothermal energy is the heat naturally contained within the Earth. It is the cause of many geological phenomena on a planetary scale. "**Geothermal energy**" is usually used to indicate the part of the Earth's heat that can be recovered and exploited. This heat originated from the Earth's formation over 4 billion years ago, when dust and gas consolidated. Another powerful source of heat is the radioactive decay of minerals.

The heat flows from the Earth's core to the surrounding rocks (the mantle). When temperatures and pressures become high enough, some of the mantle rocks melt, becoming magma. Then, because of its density - which is lower than that of the rocks - the magma rises up towards the Earth's crust, carrying the heat from below. When it reaches the surface, the magma may flow as lava; however, more often it remains below the Earth's crust, heating the surrounding rocks and water up to 370°C. Some of this hot geothermal water travels back up through faults and cracks, reaching the surface as hot springs or geysers, but most of it stays underground, trapped in cracks and porous rocks. This natural stock of hot water is called a geothermal reservoir.

The Earth's geothermal power is an **immense** and **inexhaustible** source of **cost-effective** and sustainable energy, but just a fraction of it has been used so far. In the past, exploitation of this energy was limited to those areas where geological conditions permitted a carrier (water or vapour) to "transfer" the heat from hot deep rocks to the surface or near to the surface forming the so-called geothermal resources. Nowadays, we can exploit the ground heat also in those areas where geothermal activity is moderate.



GEOTHERMAL ENERGY

Applications

It is evident that extracting heat from the ground, either to heat spaces or release it to cool them off, or even generate electrical energy, requires systems on various scales.

We refer to low enthalpy (near surface geothermal) when we extract energy from a thermal reservoir on the surface. The field of application for this type of geothermal energy is mainly heating and air-conditioning of private houses or commercial and residential spaces (bio-buildings).

Applicable techniques to extract heat are mainly:

- **Vertical geothermal probes**
- **Horizontal closed loops field**
- **Geothermal use of groundwater**
- **Energy piles or diaphragm walls**
(loops for heating or cooling in concrete)
- **Warm tunnel or mine water**
(for heating purposes)

The drilling depth for driving geothermal probes to capture or cede heat varies between 50 and 200 m depth.

Extracting geothermal fluids (deep geothermal), whether they are volcanic or endogenous vapours from greater depths, is an alternative to producing electrical energy. In this case the operation is public and the depth for extracting heat can even reach 3000 m with temperatures of 600° C.

In this case, the most common extracting solutions are:

- Deep geothermal probes
- Geothermal use of hot springs or hot water in single or double borehole systems
- Deep heat mining



Heat exchange is made possible thanks to a set of geothermal loops (polyethylene pipes).

Geothermal Loop Systems can be **Open** or **Closed**.

Generally speaking, the advantage of closed loop systems is the independence from aquifers and water chemistry.

Closed Loop Systems are filled with an environmentally safe thermo-carrier fluid (usually water or water with anti-freeze). They can be vertically or horizontally arranged, additionally to Loop Pond Applications.

Vertical loops:

Restricted underground space for loops

Higher installation costs

High efficiency

Vertical loops are generally more expensive to install, but require less piping than horizontal loops because the Earth's temperature is more stable farther below the surface.

Horizontal loops:

adequate underground space for loops

Reduced installation costs

Lower efficiency

Loop pond applications:

Loops are placed along the bottom of the pond/lake.

Open-loop systems utilize a nearby groundwater source such as an existing well to circulate water. They can use a single water well or multiple water wells.

An advantage of these systems is the higher heat transfer capacity of the wells compared to the boreholes.

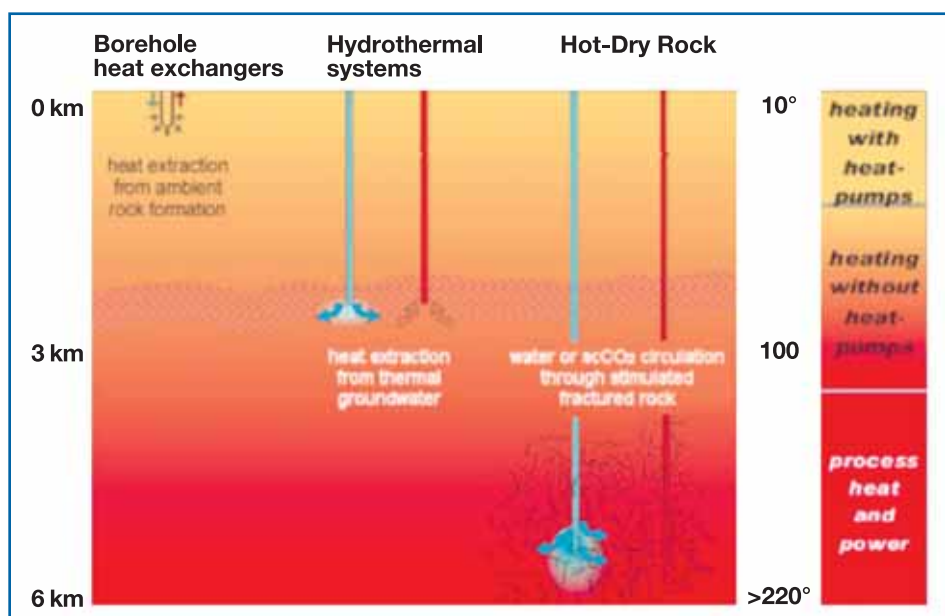
Variable costs

Very high efficiency

Surrounding hydro-geological context to be taken into account

An alternative is the geo-exchange by means of a **building foundation elements**. Such structures are called "energy piles". Concrete thermal conductivity and storage capacity are very useful to accumulate thermal energy. Therefore polyethylene pipes are purposely installed within deep foundation piles and walls in contact with the ground. Such simple technology does not involve great extra costs, but needs a total integration at the very beginning of the structural project in relation to the thermal needs.

Such technology is mostly used in Germany, Austria, Switzerland and the United Kingdom.



GEOTHERMAL ENERGY

Geothermal Heat Exchangers



GEOTHERMAL PROBES

The geothermal probe (or heat exchanger) is installed by drilling a borehole of variable depth, with a diameter of between 152 and 200 mm depending on the required depth and flow. Each probe is made of two modules, each of which consists of a pair of polyethylene pipes are united to form a closed loop, with an outgoing and an incoming pipe, inside which the fluid (water & anti-freeze) circulates.

The geothermal probe is placed underground at the desired depth and is generally next to the perimeter of the building. If there is more than one probe, it is necessary to install a collector, generally laid at the level of the foundation, which directs the delivery pipes to the heat pump.

The number of geothermal probes (each having an output of approx 3000Kcal/h) is according to the room volumes to be air-conditioned or heated.



GEOTHERMAL HEAT PUMPS

Geothermal technology relies on the fact that the Earth (beneath the surface) remains at a relatively constant temperature throughout the year, warmer than the air above it during winter and cooler in summer, very much like a cave.

The geothermal heat pump takes advantage of this by transferring the heat stored in the Earth or groundwater into a building during the winter, and transferring it out of the building and back into the groundwater during the summer.

The ground, in other words, acts as a heat source in winter and a heat sink in summer.

In reality, a heat pump is nothing more than a refrigerator that can be reversed.

Any refrigeration device (window air conditioner, refrigerator, freezer, etc...) moves heat from a space where it is not wanted and discharges that heat somewhere else. The only difference between a geothermal pump and your home refrigerator is that heat pumps are reversible and can provide either heating or cooling to almost any space or location you choose.

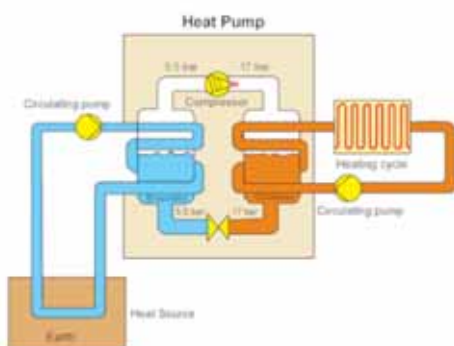
In warm weather the geothermal unit removes unwanted heat from the space being cooled and deposits that unwanted heat in the Earth. In cool/cold weather, the pump acts as a reverse refrigerator because it withdraws heat from the Earth and transfers that Earth heat into the space being heated.

The heat pump produces water/air (low performing) or water/water depending on the type of system studied.

It includes an electrical motor which is fed by electrical /photovoltaic power, a condenser (heat exchanger), an evaporator, a compressor and an expansion valve.

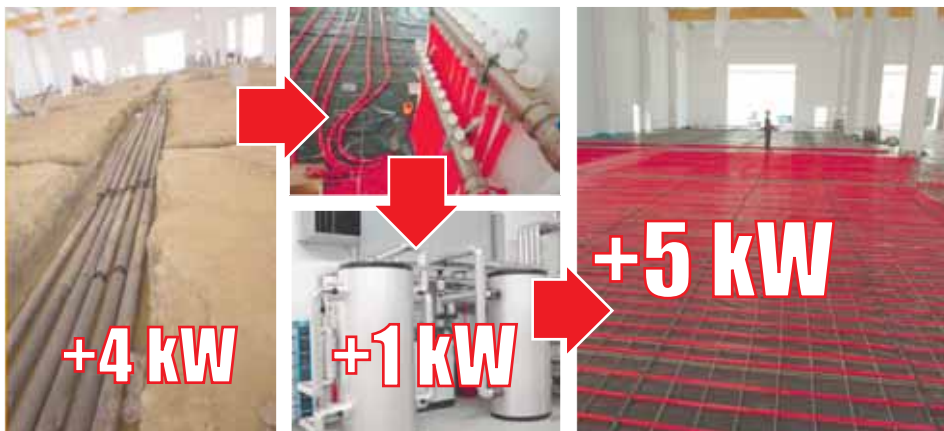
The fluid flowing inside the geothermal probe arrives at the surface at a temperature greater than the original one, causing the evaporation of the coolant which circulates in the heat pump system. At the evaporator outlet, the fluid becomes gas, is aspirated by the compressor which, activated by the electric motor, supplies the mechanical energy necessary to compress the fluid, causing an increase in pressure and consequently in temperature.

The fluid is in the optimal condition to go through the condenser.



GEOTHERMAL ENERGY

Geothermal System



HEAT DISTRIBUTION

Thanks to the technological improvements and the use of a centrifugal compressor instead of screw and reciprocating compressors, heat pumps can generate hot water up to 90°C; so heat pumps are also used to produce Hot Domestic Water.

The best distributing internal system to be coupled with a Ground Source Heat Pump (GSHP) is a low temperature system (radiant panels, chilled beams, fan-coils...). Such systems, in fact, operate at temperatures < 40°C and GSHPs produce water at 35°C with very high COP (Coefficient of Performance).

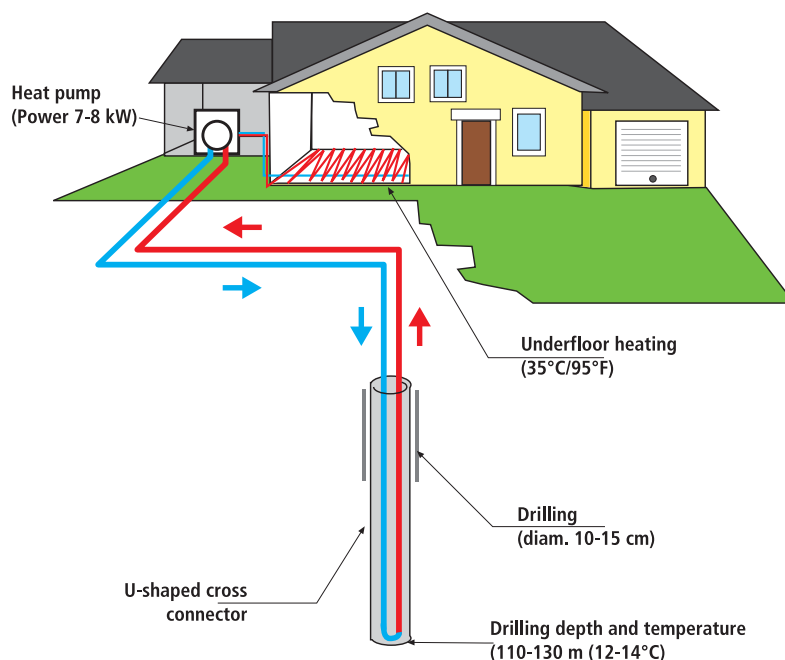
THERMAL CONDUCTORS

In the early days of geothermal development it was not understood how important the grouting of the vertical borehole was to the success of the entire installation. The borehole must be able to efficiently act as a heat sink and heat source. This ability is the borehole's thermal conductivity efficiency and it is impacted significantly by the grouting approach used.

In order to ensure a permanent sealing of the borehole, a thermally enhanced grout should be used to backfill around the U-tube.

Therefore, the thermal grout should have a conductivity coefficient between 1.73 and 2.01 WmK. It is generally pumped with a single piston injector (diam. 40 mm - flow rate between 20 and 55 l/min).

Benefits



Nowadays, heating and cooling systems by means of geoexchange represent the most rational and cost-effective choice in energy management. A geothermal system maximizes the output energy/input resources ratio and allows you to save yearly from 55% to 75% compared to a traditional heating and cooling system. A geothermal system installation is unique to produce heat and cold, reliable (minimum maintenance and no visual impact), safe (no local gas combustion). Moreover, it certainly constitutes a certain and enduring economical investment (minimum lifetime: 50 years).

Geoexchange and photovoltaics

Geoexchange systems can be well integrated with photovoltaic panels. Together, they ensure an even bigger energy saving and can make the user self-sufficient.

GEOTHERMAL ENERGY

Case History - Industrial / Residential

Peschiera Borromeo Office Bldg.



Industrial shed
Directional centre with outbuilt car parking
Closed-loop geoth.system, installed power: 200 kW

Geothermal field
40 vertical probes - Depth 105 m
2 x 40mm turbulence PN12,5 PE100

Heat plant
1 ground/water heat pump installed
Absorbed power/installed power ratio (B0/W35):
53.5/206.5 kW - COP = 4 - Carrier fluid R407C
Three stages modulation - Active Cooling system
Reversibility by means of hydraulic cycle inversion

Office building
Closed-loop geothermal system, installed power
95 kW- Research & Develop. experimental field

Geoexchange field
18 vertical probes 110 m deep- 2 coil probes 15
m deep - Turbulence, Pe-Xa, HDPE types

Heat plant
No. 1 ground/water heat pump installed
Absorbed power/installed power ratio (B0/W35):
24.9/95.3 kW - COP = 3.83 - Carrier fluid R407C
Three stages modulation - Active Cooling system
Reversibility by means of hydraulic cycle inversion

Cesena Directional Centre/Car Parking



Rimini Shopping Centre



Industrial shed
Closed-loop geoth. system, instal. power 500 kW

Geothermal field
Geothermal field - 80 vertical probes
Depth 120 m - 4 x 32mm PN16 PE 100

Heat plant
2 ground/water heat pumps installed
Absorbed power/installed power ratio (cooling):
62.4/344 kW - EER = 5.5
Absorbed power/installed power ratio (heating):
75.8/364 kW - COP = 4.8 - Carrier fluid R410A
Four stages modulation - Reversible internal cycle

Shopping centre
Closed-loop geoth. system, instal. power: 1.25 Mw

Geothermal field
184 vertical probes - Depth 120 m
4 x 32 mm PN16 PE 100

Heat plant
2 ground/water heat pumps installed
Absorbed power/installed power ratio (cooling):
270/1256 kW - EER = 4.65 - ESEER = 8.72
Carrier fluid R134A
Centrifugal compressor with magnetic levitation
Reversibility by means of hydraulic cycle inversion

Cesena Industrial Shed



GEOHERMAL ENERGY Case History

Case History - Residential

Ancona Residential Building



Residential building
Closed-loop geoth. system, inst. power: 15 kW

Geothermal field
3 vertical probes - Depth 150 m - 4 x 32 mm,
PN10, PE 80

Heat plant
1 ground/water heat pump instal. - 3.41/14.5 kW
COP = 4.26 - Carrier fluid R410A
Reversible internal cycle

Residential building

Geothermal field
20 vertical probes - Depth 100 m
2 x 49 mm, turbulence, PN8, PE80

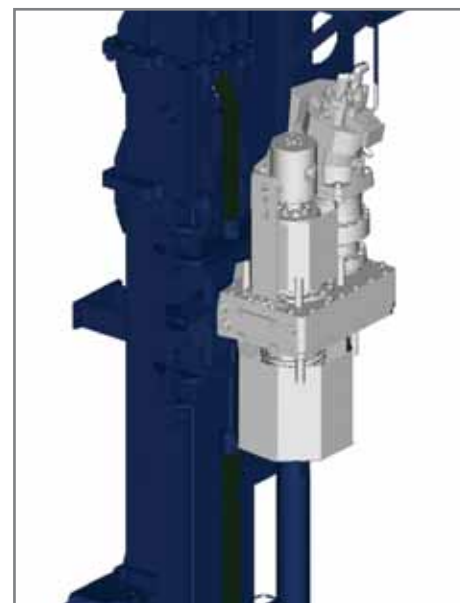
Heat plant
1 ground/water heat pump installed
Absorbed power/installed power ratio (B0/W35):
41.9/162.6 kW - COP = 3.88 - Carrier fluid R407C
Three stages modulation - Active Cooling system
Reversibility by means of hydraulic cycle inversion

Gatteo a Mare Residential Building

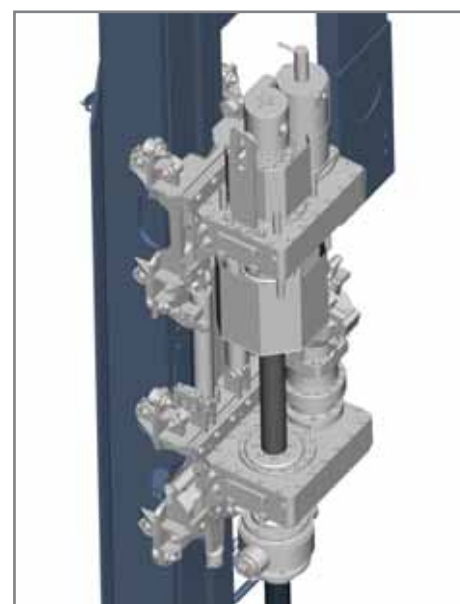


GEOTHERMAL ENERGY

Rotational Drilling



Casing can be driven either by using a single head (rotary or drifter) or a double head system. The double head setup is highly recommended for deeper wells (over 100 m) because a powerful lower rotary better overcomes the friction along the casing walls.



Drilling technologies

For the execution of geothermal works, the drilling method depends on soil conditions, depth and design requirements. Geothermal wells can be either drilled uncased, using muds or polymers to prevent wall collapse, or cased to ensure a flawless positioning of the probe and grout injection.

GEOHERMAL ENERGY

Equipment

We can supply equipment and turnkey solutions for:

- **Geothermal House System**
(House heating and cooling)
- **Geothermal Industrial System**
(heating and cooling of large industrial building complexes, office blocks and shopping centers)
- **Geothermal Research System**
(high enthalpy with extraction of endogenous vapors)

Soilmec dedicated geothermal range includes two crawler mounted rigs, **SM-8GT** and **SM-16GT**.

They have been specifically designed for the "House" and the "Industrial" sectors. They can reach drilling depths between 50 and 200 m, according to the system/technology used and soil type.

The sturdy articulation and compact size are the advantage of our rigs that can be equipped with:

- Diverters (BOPs) with automatic greasing;
- Magnet loading system for rods and casings;
- Third clamp and breaker;
- Double rotary (in alternative, drifter and lower rotary can be fitted);
- Mud pump;
- Rubber crawler tracks.

Drillmec **G-38GT** is better suited to those projects where depths in excess of 200 m are required. In fact, G-38GT can travel with the complete geothermal outfit on board (air compressors and mud pump included).

For greater depths and high enthalpy (beyond 200 m and up to 5000 m), a different class of equipment is required.

Drillmec comprehensive rig range (G, HH or MR series), typically employed for the water, gas and oil exploration, and related integrated technologies better responds to these requirements.

DRILLMEC systems

For applications that do not pertain to low enthalpy, such as the extraction of endogenous vapours or natural gas, at depths of 500 to 5000 m, the DRILLMEC range responds to different needs. The G series truck-loaded machines, MR series mobile rigs, the HH series and lastly the Land Rigs used for oil extraction and related integrated technologies make it possible to satisfy any request.



GEOTHERMAL ENERGY

Equipment *SM-8GT*

The **SM-8GT** is a hydraulic drilling rig designed specifically for geothermal drilling. The fixed kinematic mechanism, wide section mast, and the pull-push system with a 98 kN hydraulic cylinder mean drilling deep, precise bores. The rubber tracked undercarriage and low specific pressure on the ground make this machine ideal for operating in gardens and private courtyards, typical of this kind of application, reducing the impact of the site. Suitable hydraulic clamp and breaker for screwing and unscrewing rods. Additional support for maneuvers during feeding and recovery of the casings. The loading of the drilling string (rods and casings) is fast and safe thanks to a special winch system with magnetic lifting.



	Engine	
	- Model	Deutz TCD2013_04 2v
	- Power	129 kW
	Hydraulic Pumps	
	- Main pump	273 l/min
	- Max pressure	28 MPa
	Lower Rotary	
	- Max torque	1633 daNm
	- Max speed	53 rpm
	Upper Rotary	
	- Max torque	816 daNm
	- Max speed	160 rpm
	Mast	
	- Stroke	3750 mm
	- Max hoist force	9800 daN
	- Max feed force	7400 daN
	Clamp & Breaker	
	- Size	range: 60 - 260 mm
	- Max clamping force	16500 daN
	- Max breking torque	3700 daNm
	Undercarriage	
	- Shoes	400 mm
	- Overall lenght	2420 mm
	- Overall width	2100 mm
	- Max speed	2,5 km/h
	Weight	
	- Operating weight (approx.)	9000 kg
	- Average ground pressure	0,7 MPa

GEOTHERMAL ENERGY

Equipment SM-16GT

The rig, capable of drilling between 100 and 250 m, can meet with the demand of low enthalpy geothermal. This compact size rig has rubber tracks, 2300 mm wide undercarriage and very low ground bearing pressure (0.7 Kg/cm2), thereby minimizing damage to private property (gardens and courtyards) where domestic geothermal energy is used. Equipped with fixed kinematic mechanism (boom) with a wide section mast; it is designed for rapid maneuvering (0.2÷0,6 m/sec), third clamp and magnetic loading system to simultaneously maneuver rods/casings. To keep weight to a minimum, it is not fitted with heavy and bulky casing/rod storing system and is instead complemented by an independent motorized rack system during operations.



	Engine	
	- Model	Deutz TCD2013_L06-2v
	- Power	176 kW
	Hydraulic Pumps	
	- Main pump	280 l/min
	- Max pressure	28 MPa
	Lower Rotary	
	- Max torque	3200 daNm
	- Max speed	56 rpm
	Upper Rotary	
	- Max torque	1100 daNm
	- Max speed	80 rpm
	Mast	
	- Stroke	4000 mm
	- Max hoist force	24000 kN
	- Max feed force	12000 kN
	Clamp & Breaker	
	- Size	range: 60 - 320 mm
	- Max clamping force	23700 daN
	- Max breking torque	11516 daNm
	Undercarriage	
	- Shoes	400 mm
	- Overall lenght	2760 mm
	- Overall width	2300 mm
	- Max speed	2,3 km/h
	Weight	
	- Operating weight (approx.)	16000 kg
	- Average ground pressure	0,7 MPa

Global Presence

SOILMEC distributes machinery and structures all over the world, supported by SOILMEC subsidiary companies and dealers. The complete Soilmec network list is available on the webpage www.soilmec.it

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