

GREEN POWER

MARKET DEVELOPMENT GROUP

Introduction to geothermal energy

Corporate Renewable Energy Workshop

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World Resources Institute & WWF



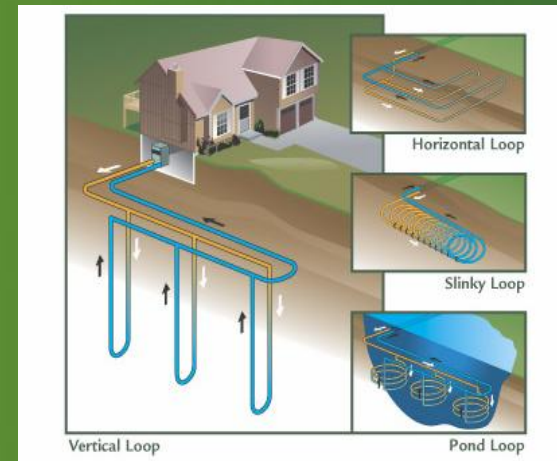
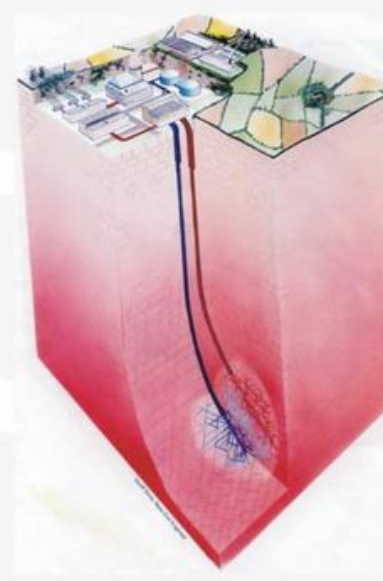
GREEN POWER MARKET DEVELOPMENT GROUP – EUROPE

What is geothermal energy?

	Technologies	Description
Electricity	<ul style="list-style-type: none">• Flash steam plant• Binary cycle steam plant• Combined cycle steam plant• Hot dry rock technology	<ul style="list-style-type: none">• High temp water pumped into low pressure vessels, vaporizes, & drives turbine• Medium temp water mixed with fluid (e.g., isobutene) passed through heat exchanger, vaporizes, & drives turbine• Combines both steam technologies for higher efficiency• Water injected into borehole, circulated through heat exchanger of hot cracked rock
Heat	<ul style="list-style-type: none">• Heat pump<ul style="list-style-type: none">- Ground coupled (closed loop)- Groundwater type (open loop)	<ul style="list-style-type: none">• A water-antifreeze solution circulated through underground pipes• Ground or lakewater circulated through heat exchanger, later discharged



What is geothermal energy?



Appendix



Some European geothermal heat pump market developments

- Market changing
 - 3+ years ago: Environment primary driver
 - Today: High energy prices and natural gas supply issues leading to dramatic sales increases (esp. Sweden, Switzerland, Germany and Austria)
 - EU beginning to promote projects in Southern Europe/ Mediterranean
- Location
 - Based on heating and cooling needs of building, location is secondary
 - GHP works almost anywhere (vertical exchangers / borehole heat exchangers)
 - Restrictions: Deep dry sand/gravel (rare) and placement near drinking water wells
- Incentives
 - Playing decreasing role
 - Brandenburg, Germany still has incentives in place
 - Southern Europe developing incentive programs



Rock temperatures at 5 km depth

