Environmental Issues: an overview of possible environmental impacts related to geothermal power production

Isabella NARDINI

Institute of Geosciences and Earth Resources

CNR - *National Research Council*

Italy

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Public Acceptance

Renewable energies are often associated with **sustainability or environmental friendliness.**

But renewable energies, like geothermal power, **also have environmental impacts** and have the potential to **cause social resistance.**

Environmental issues are normally negative, which leads to a further investigation of negative acceptance issues.

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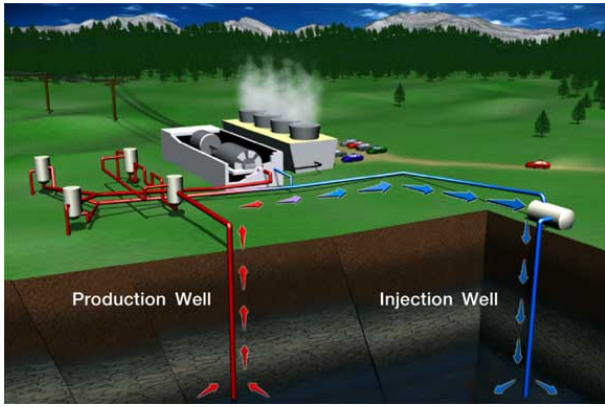
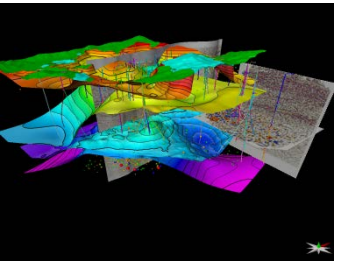
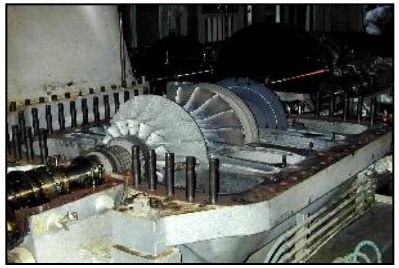
EIA - ENVIRONMENTAL IMPACT ASSESSMENT

EIA is the assessment of the possible impact (positive or negative) that a proposed project may have on the environment, together consisting of the natural, social and economic aspects.



RESOURCE ASSESSMENT → **WELL DRILLING AND TESTING** → **POWER SYSTEM DESISGN AND CONSTRUCTION** → **OPERATION AND MAINTENENCE** → **DECOMMISIONING**




Environmental impact assessment, mitigation and monitoring

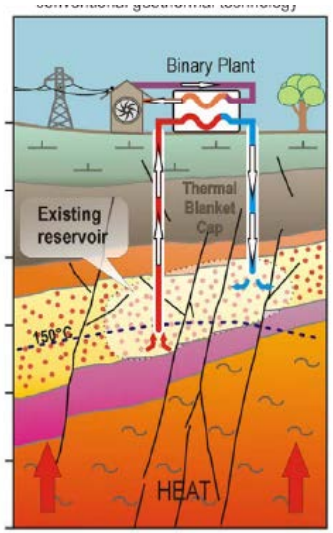
Each stage of geothermal development might generate environmental effects, especially with regard to air and water pollution, noise, land use, and impacts on the aesthetic qualities of the landscape.

In regions with geothermal potential can be also considered social and economic effects

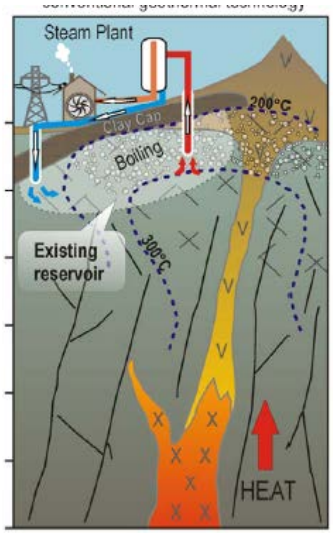
Basic types of geothermal power generation systems

- Geothermal facilities using flash-steam techniques
- Geothermal facilities using binary cycles
- Enhanced Geothermal Systems (EGS)

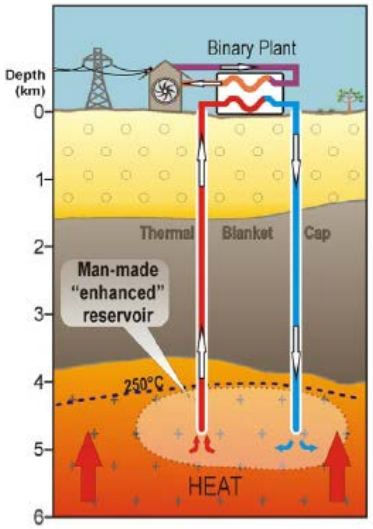
hot sedimentary aquifer



Magmatic play



hot rock play



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Environmental impacts-main categories

1. Surface disturbances
   - Landscape, surface water
2. Physical effects
   - Fluid withdrawal on natural manifestations, land subsidence, induced seismicity, visual effect (buildings, cooling towers, surface pipelines, power transmission lines etc.)
3. Noise
4. Thermal pollution
   - Hot liquid and steam release on the surface
5. Chemical pollution
   - Liquid and solid waste disposal, gas emissions to the atmosphere
6. Ecological protection
   - Flora and fauna

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Activities causing environmental impacts

- Building of access roads and drilling pads
- **Well drilling, repairs, stimulation and testing phase**
- Laying of pipelines, electric power transformation and transmission lines
- Plant construction and equipment installation
- Power plant commissioning and operation
- Decommissioning of facilities

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Access roads, pipe laying

Predominant environmental concerns:

- Surface disturbance

(limited duration)

- **Visual impact**
- Disposal of waste

(limited duration)

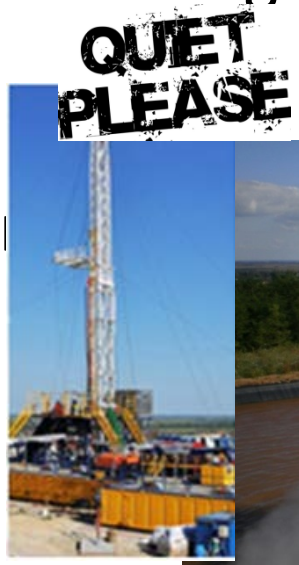
Source: pictures provided by Mannvit

These activities are similar like a normal construction activities, so its environemntal effects and the attached public resictance are the same. These kind of activities are usually accepted by the public. Only the NIMBY-syndrome could araise

Example of landscaping

Source: pictures provided by Mannvit

Well drilling, repair, stimulation and testing phases



Source: pictures provided by Mannvit

Predominant environmental concerns:

- Liquid and liquid carried pollutant release (mainly related to the well drilling and/or well repair activity)
- **Noise and vibration**

(levels around 45 to 120 dB).

- **Induced seismicity and seismic hazards**

(during fracturation - typically deeper than 1 km)

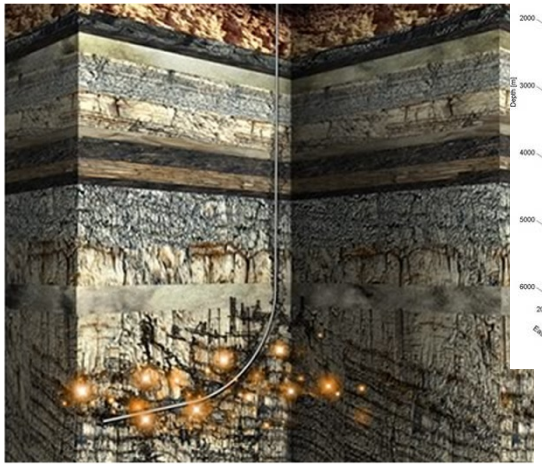
- Surface release of geothermal fluid

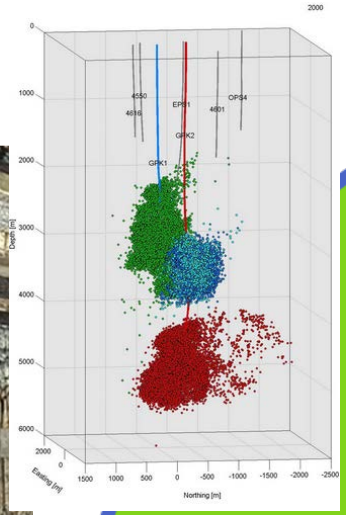
(**s**hort-term and/or emergency liquid releases will have to be accommodated in a special holding tank or a holding pond)

- Surface disturbances

(around 1-1.5 hectare per well)

- Visual impact





Plant construction and equipment installation

Source: pictures provided by Mannvit

Predominant environmental concerns:

- Surface disturbances
- **Noise**

(the noise is temporary and its general level does not exceed 80 dB)

- Visual impact
- Disposal of waste

(The waste that accumulates is normal construction waste, like waste timber, lubricant spill, cleaning fluid waste, metallic waste, packing, cement etc.)

Nesjavellir flash power plant in Iceland

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Power plant commissioning and operation

Predominant environmental concerns are:

- **Emission and injection/reinjection of geothermal fluids** (induced seismicity)
- **Noise** (levels of 55-70 dB)
- **Subsidence** (max event occurred in New Zealand 400mm/year, Tuscany 250 mm/y)

Source: pictures provided by Mannvit

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Gas emissions

GAS EMISSION SOURCES:

- Geyser, Fumarol
- **Well (during well testing operation)**
- **Production Plant**

GEOTHERMAL FLUID

VAPOUR 85-98%

NON CONDENSABLE GASES 2-15%

PM trace

CO_2 95%

H_2S 1%

CH_4 1%

H_2 2%

N_2 1%

O_2, Ar, He, CO, idroc. trace

kg / MWh net	NO_X	SO_2	PM	H_2S	CO_2
Fossil fuels	0.49	0.54	0.024	0	691
Geothermal	0	0	0	3.09 in 2007 1.73 in 2011	372 in 2007 340 in 2011

ENVIRONMENTAL REPORT _ENEL_2011

Decommissioning of facilities

Predominant environmental concerns:

- **Chemical pollution and disposal of hazardous and other waste**

The main risks are fire hazard and poisonous effects in enclosed spaces. Other waste materials can be surplus chemical inhibitors, tracer materials, chemical reagents etc.

- **Surface disruption**

Surface disruptions always accompany decommissioning of facilities.

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Environmental impacts and mitigation measures

Impacts to be considered	Possible mitigation measures
Surface disturbance, disposal of waste and visual impact.	To avoid ecologically sensitive areas, locations of historical value and natural beauty.
Visual impact	It is recommended that each wellhead should be enclosed in a small building of a design that falls well in with the surroundings.
Liquid and liquid carried pollutant release and solid waste	To select only contractor(s) that have good environmental record. State in contract requirements on special waste ponds.
Noise and vibrations	To apply hearing protections and noise barriers. Noise barriers will need to be erected if residential areas are being affected.
Induced sismicity	Prior to EGS activities, the Project Owner will need to implement the Protocol for Induced Seismicity Associated with Geothermal Systems.

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Environmental impacts and mitigation measures

Impacts to be considered	Possible mitigation measures
Emission and injection of geothermal fluids, gases	To minimize the number of hazardous substances in the geothermal fluid return stream **it is recommended to consider thermodynamic scaling control rather than inhibitors where possible**. For mitigation of emission of H_2S from flash geothermal power plants it is important **to monitor the release and apply appropriate measures if emission numbers are above environmental limits. In Tuscany ENEL: AMIS (ABATEMENT SYSTEMS for H_2S and Hg efficiency respectively of >99%, 80-85%)** **Ventilation** should be applied to avoid gases in confined spaces.
Chemical pollution and disposal of hazardous and other waste during the decommissioning phase	In general proper care should be taken when disposing of chemicals, during cleaning up of equipment

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