SWITCH
ENERGY ALLIANCE

The University of Texas at Austin
Hildebrand Department of Petroleum and Geosystems Engineering
Cockrell School of Engineering

NICARAGUA

```
Print ('Energy')
```

Mentor: **Mr. Patrick Welch**

Team members:

- **Imad Smaini**
- **Merouane Sbaihi**
- **Ahmed Guembour**
- **Ibrahim Elkhalil Hadjadj**

Home country: Algeria

SUMMARY:

I. Overview

General information about Nicaragua:

- Nicaragua is a country in Central America situated between the pacific ocean and Caribbean sea.

Nicaragua	
Capital	Managua
Language	Spanish
Currency	córdoba oro (C$)
Total Area	129 494 km^2
Population	6,726,558
GDP per Capita	1,735 $ (2021)
Rural population	43%
Electrification rate	65% (2010)

Fig1: map of nicaragua

Economy:

- In 2011, Nicaragua was reported to have an economic growth of 5.1 percent, which was the highest in Central America.
- Despite all of this good news, a considerable amount of work still needs to be done before it can fully eradicate poverty.
- Nicaragua is one of the poorest countries in Latin America. Most of the poverty in Nicaragua exists rurally (more than 80 percent,).
- In fact,
  - 43% percent of the Nicaraguan population lives in rural areas
  - 68% percent of them are trying to survive off just over $1 per day.
  - 46.2% of the population lives below the poverty line. This percentage is even higher for disadvantaged groups like indigenous and Afro-descendant communities.

- GDP:9,774 billion USD

- Main economic sectors:
  - Agriculture
  - Services
  - Tourism
  - Mining
  - Remittances
  - Forestry and fishing

- Labor force by occupation
  - Agriculture: 31%
  - industry: 18%
  - services: 50%

Energy mix:

- Nicaragua is the least country in producing and consuming electricity in the area of central America with an annual electricity production of just 2,69 TWH and electrification rate of 65% in 2010
- However Nicaragua is considered in the top of central America when it comes to their energy mix with 40% of their electricity generated from renewable resources surpassing the neighboring countries in the renewables energy generation

Nicaragua energy statistics in 2010	
Energy production	69.082 TJ
Total primary energy supply	3.04 Mtoe
Electricity final consumption	2.69 TWh
Net energy imports	55.3 TJ

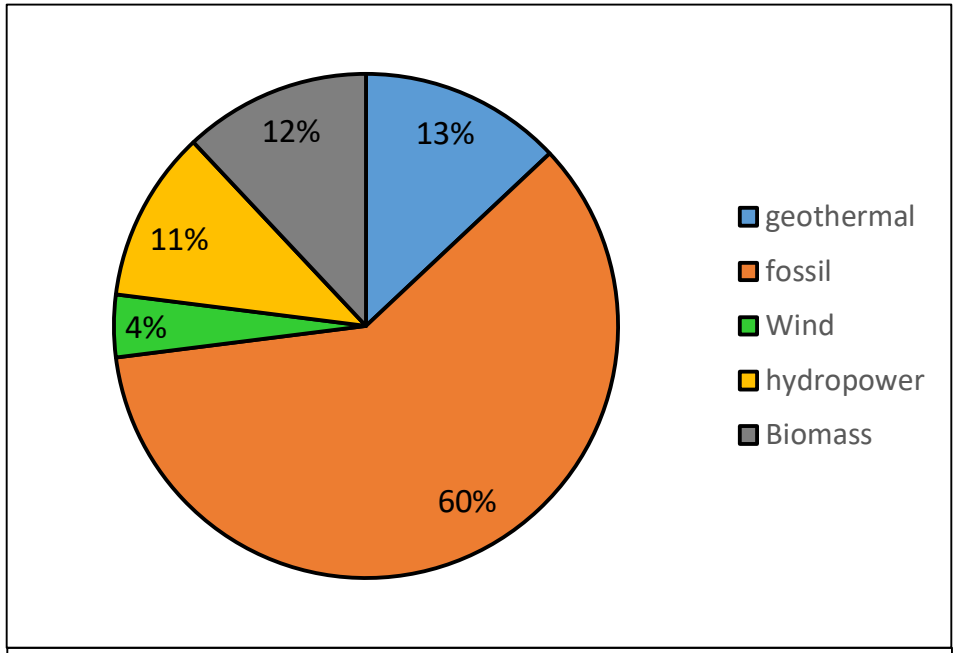


Fig 2: electricity generation sources in Nicaragua

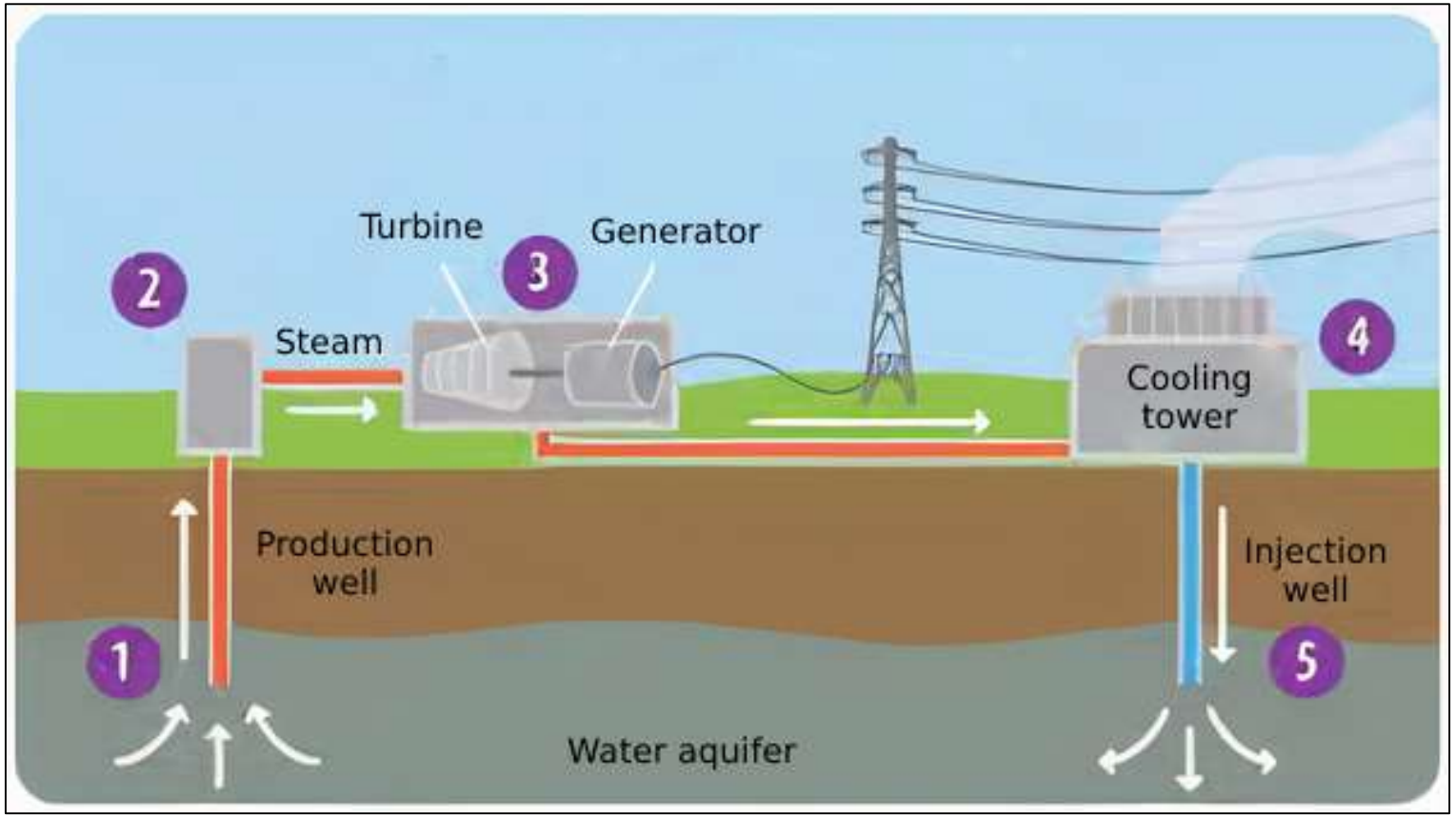
Energy Potential:

- Nicaragua has a wealth of options for renewable energy generation including extensive geothermal resources from its large volcanic chain, and excellent potential for wind and hydropower due to the wind coming from the pacific and the great amount of rivers and big lakes in the country . In terms of energy output, the country has the capacity to generate 5,800 megawatts (MW) annually from clean sources. Currently, however, just over 14% of its renewable potential (wind, solar, hydropower and geothermal) has been developed (World Bank 2015)

Fig3: map of the rivers in Nicaragua

Fig4: map of volcanos in Nicaragua

II. Geothermal Power plant



Why geothermal ?

- Data from Energía Limpia XXI indicate that Nicaragua's geothermal potential is one of the richest in Central America, a resource that could meet national demand and even facilitate energy exports to other countries in the region.

- The energy output of its geothermic resources has an estimated potential of 1,516MW, however, just 154MW have been installed by the country's two existing geothermal power plants.

- Developing geothermal over other renewable generation options is seen as a favorable path for the following reasons:
  - The potential for geothermal energy is double than that of other renewables
  - Stable power generation compared to wind, solar, and hydropower
  - Compared to solar renewable options, geothermal offers significantly reduced land take requirements; for example, a geothermal plant requires (per MW) 5% of the area needed for a solar thermal plant (Sustainable Energy for All, 2017)

Why geothermal instead of other renewables:

- Each of geothermal, wind and hydropower are renewables sustainable and clean energy sources

- However the main reason to choose the geothermal project over wind or hydropower is for economic reasons related to the specific cost of renewable materials in Nicaragua, where:
  - The geothermal cost per installed MW averages between 0,8 and 1,5 million US$ and the operation and maintenance cost of 10 to 30 US$ per MWH
  - The wind cost per installed MW averages between 2 and 4 million US$ in addition to a high operation and maintenance cost of 50,000 US$ per year
  - The hydropower generates a huge amount of electricity but the cost of building a hydroelectric water dam is so high averaging between 700 million to 1 billion US $

- After doing a comparison of the cost of different renewable projects we find that investing in the geothermal energy is the most economic solution for the country,

Casita-San Cristobal Geothermal Project

- The Casita-San Cristobal volcano is located on the south-east slope of the Casita-San Cristobal volcanic complex .
- The Project concession area will cover an area of $20Km^2$.
- The Nature Reserve comprises a chain of five volcanic cones, including the Casita Volcano and the adjacent San Cristobal volcano, which is the country's highest volcano.
- Ultimately, the Project will aim to help lower and stabilize Nicaragua’s electricity costs to enhance its affordability to reduce poverty and stimulate economic growth and competitiveness
- The capacity of the Casita-San Cristobal Geothermal power plant will be 150 MW

Fig 5: Casita-San Cristobal volcano

Goals of the Project:

- The geothermal power plant is estimated to produce between 300 to 350 GWH a year
- Secure a diverse, reliable, high efficiency and low-cost energy supply for Nicaragua
- Meet local demand, interconnect to the national grid to lower electricity costs and make it more affordable to reduce poverty and stimulate economic growth
- Providing employment opportunities to the community residing in the region and nearby (Estimated jobs are 100 for site preparation and 100 for drilling).
- Contribute to the local economy, social and technical infrastructure
- Help to meet the Government of Nicaragua's ambitious goal to increase the country's electricity generation from renewable sources to 73% by 2030
- Geothermal generation significantly lowers greenhouse gas emissions that are generated from the combustion of fossil fuels as a result of increasing population and electricity demand
- Another goal of our project is to raise awareness among the local population about the dangers of fire wood cooking inside the house, and explain to them the dangerous diseases caused from it and advice them to cook in open air areas with keeping the children away as much as possible in addition to transition to cooking with electrical stoves if possible

▪ Casita-San Cristobal geothermal power plant:

- In February 2012: The CCP (a subsidiary of the world bank) undertook integration of surface exploration and slim hole drilling results with preliminary assessment of the geothermal resource, which indicated that the Project has potential for more than 225MWe of generation capacity over 20 years.

- The project will go through three phases:
  - **Phase 1 :**
    - Site establishment (month 1)
  - **Phase 2: (exploration phase)**
    - Geothermal resource confirmation (month 8 to 22)
    - The objectives of the exploratory drilling are to confirm the exploitable geothermal resource and provide key information necessary to prepare a full project feasibility study
  - **Phase 3: (production phase)**
    - Steam field and power plant development (month 30)

- The whole construction will take a duration of 48 months

Cost and funding of the project:

- **Cost of the power plant construction:**
  - The exploration drilling program is estimated to cost between 30 to 40 million US$
  - Production phase of the project is estimated to cost between 101-110 million US$,.
  - The total cost of the Casita-San Cristobal Geothermal with the capacity of 150 MW is estimated to cost between 130 and 140 million US$

- **Cost of setting up the electric grid:**
  - In the area of the power plant there is a lot of nearby cities like: Léon, Chinandega and other near cities and villages away from the power plant with 15 to 40Km with an accumulative population of almost 400 000 people in which half of them lack electricity access
  - 150 MW capacity plant is enough to power 60,000 to 135,000 household which is enough for all of the region
  - Electricity grid after developing an efficient distribution system with good quality poles will cost 5000 dollars per kilometer.
  - Using this data we estimated the cost of electricty grid to be around 350 000 dollars.

Cost and funding of the project

- **Funding and getting a loan :**
  - The program will be funded by the World Bank (IDA funding) and private investors with a loan of 145 million US dollars. The International Development Association (IDA) is the part of the World Bank that helps the world's poorest countries. it provides financial aid for programs that boost economic growth, reduce inequalities, and improve people's living conditions.

- **Repaying the loan:**
  - starting from 2028, the power plant will enter commission and start the power generation and distribution, and the plant will start generating profits
  - With a capacity of 150 MW, an annual electricity generation of 300 to 350 GWH and with an electricity cost of 0,1 US$ per KWH, we can gain about 20 million US$ yearly and we will use the income to pay back the loan, at this pace the loan is fully paid by 2036
  - The profits from the power plant will be used to repay the loan in a duration of 8 years

Implementation of the project

2023:

- Phase 1 : Site establishment (1 month)
- Phase 2: Exploration phase (month 8 to 22)
- Phase 3 : production phase (month 30)
- Connecting the power plant to the electricity grid

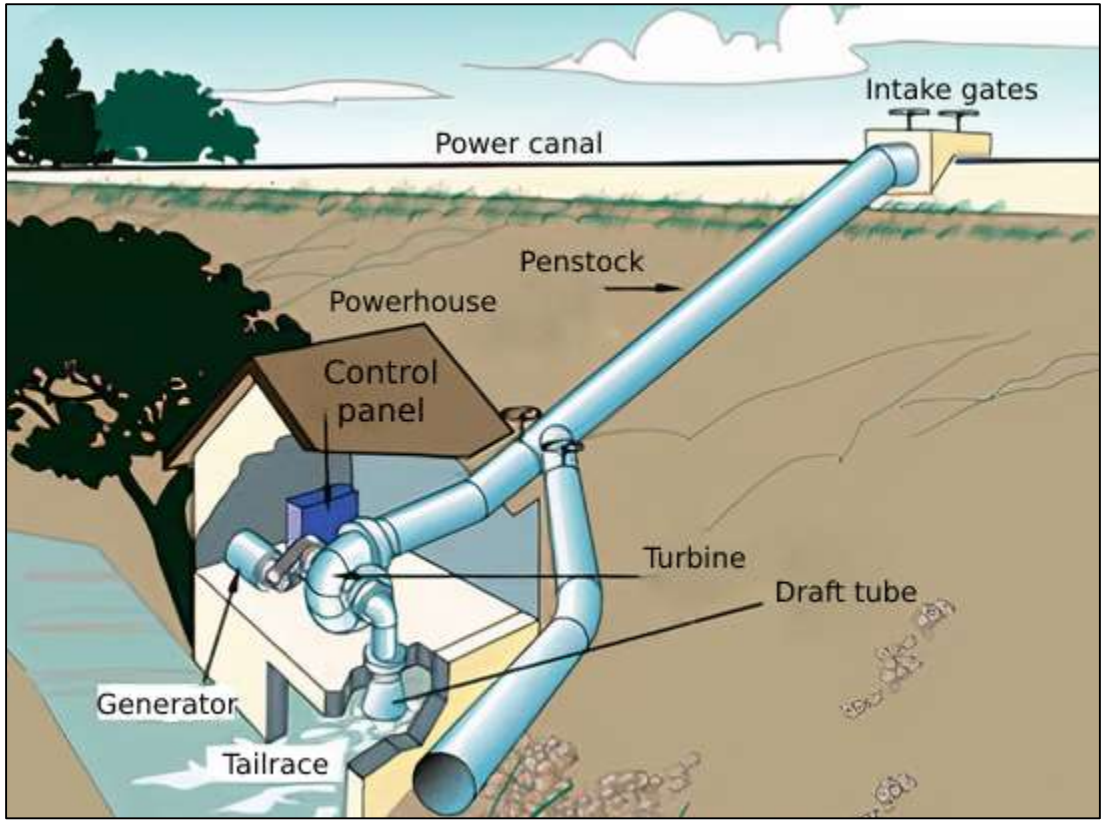
2028:

- The power plant enters commission
- Generation of electricity
- All the income from the power plant goes to repaying the loan

2036:

- The loan is payed back
- The power plant now generates profits
- The profits will be used in upgrading the capacity of the power plant or in other projects

III. Mini hydropower plants



What is a mini hydropower plant:

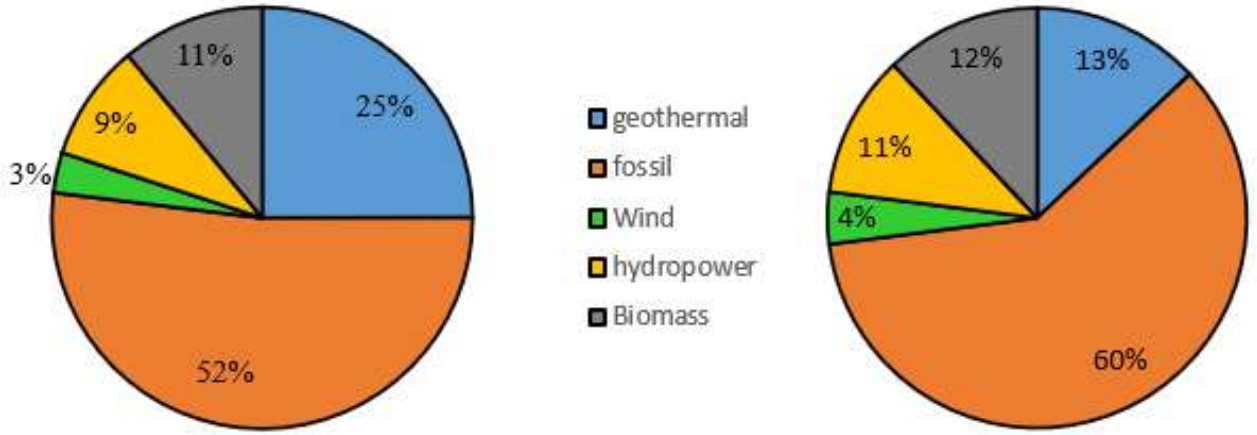
- Micro hydropower plant is a type of hydroelectric power plants that typically produces from 5 kW to 100 kW of electricity using the natural flow of water.
- These installations can provide power to an isolated home or small community in addition the economical and environmental impact from generating electricity without of energy without the need to buy fuel of cut down trees
- The simplicity of the power plant build and the low relative cost of the construction open up new opportunities for some isolated communities in need of electricity.
- With only a small stream needed, remote areas can access lighting and communications for homes, medical clinics, schools, and other facilities.

The «Rio Prinzapolca» mini-power plants:

- The villages of “Walpasicsa”, “Bip Bila”, “Apawounta” and “La Esperanza “are four rural communities living with no electricity source in Nicaragua
- Located near the « Rio Prinzapolca » river the four villages can access, exploit and benefit from the hydroelectric potential of the river
- Each village will benefit from a mini hydropower plant with the capacity of 50 KW placed near the river
- The average cost per installed KW in this type of projects is between 1000 to 5000 US$
- The total cost of the four power plants combined will average between 0,5 and 1 million US$
- The power plants will be constructed with the help of “The association of rural development workers Benjamin Linder ” an association committed to help rural villages and populations by building them mini hydroelectric power plants to honor the memory of ‘Benjamin Linder’ , the association will provide the necessary materials and finances needed
- Each one of the power plants will generate an average annual generation of 60 to 70 Mw providing a clean safe energy source that will improve the health and economical situation of the city and open new doors for opportunities

The new energy mix:

- After the projects enters commission the country electricity system will benefit from an annual 300 to 350 GWH of sustainable clean electricity added to the grid
- This will make Nicaragua annual electricity production jump from 2,7 TWH a year to 3 TWH
- By 2030, Nicaragua will reach a 75% electrification rate
- In addition to increasing the percentage of renewable energy in the country energy mix making it more eco-friendly
- These projects will also generate big economical benefits and profits to the government allowing the country to invest in more , better and bigger projects



New energy mix (2030)

Old energy mix(2010)

The Impact of our projects:

- **The Economic impact :**
  - Decreasing the need of fossil and biomass fuel in generating electricity and as a consequence the country will save a considerable amount of money in oil imports
  - Providing 350GWH of electricity a year to the nearby population of the area and to the population connected to the grid from the power plant
  - The economy will benefit and make considerable of profit after they start charging people for the generated electricity by this power plant
  - The increased power generation provided and the economic profits will help the local tourism, businesses and economy to flourish and open new opportunities for the people and investors
  - Growing the rural economy of the four villages and open new doors of opportunities for the people

- **The Impact on the environment:**
  - Decreasing the CO_2 emissions
  - Decreasing the need of cutting trees in order to produce electricity, which will Strengthen and enhance the local ecosystem

Impact of the project:

The impact on the Population :

- Help stabilize the electricity current and prevent electricity shortage and help rural population connect with the world
- Increasing the population access to electricity and making it more sustainable will help them transition to electricity powered houses,
- Providing opportunities for the children to study in their homes depending on electricity light sources instead of depending just on the light of day
- Make cooking food safer by transitioning from the fire wood cooking that causes lung cancer to women and children to electric stoves and ovens and help empowering women
- Increasing the public health and help the local hospitals get a more sustainable electricity for the medical equipment
- Providing electricity to local schools will improve the learning experience of students and help building a bright future for them

END

Sources:

1. https://fr.m.wikipedia.org/wiki/Nicaragua
2. https://en.m.wikipedia.org/wiki/Micro_hydro
3. World Bank Group - International Development, Poverty, & Sustainability
4. Nicaragua : Development news, research, data | World Bank
5. https://www.iea.org/countries/nicaragua
6. https://images.app.goo.gl/KbWurmAdDAMF86uY7
7. https://images.app.goo.gl/bajXfoeu9bCWhGeDA
8. https://internationalliving.com
9. https://www.ifad.org
10. World Bank, Rural Poverty Portal, Health Poverty Action, The Tico Times
11. https://www.researchgate.net
12. List of countries by electricity production - Wikipedia
13. Nicaragua River Map (mapsofworld.com)
14. https://en.wikipedia.org/wiki/Economy_of_Nicaragua

Sources:

14. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjMs8LW5OPzAhUHkxQKHTsXCO4QFnoECBUQAQ&url=https%3A%2F%2Fdocuments.worldbank.org%2Fcurated%2Fen%2F396091468330258187%2Fpdf%2F728280NWP0Box30k0TR0020120Optimized.pdf&usg=AOvVaw2VVl5Vod2if2Modk0Ss8HG
15. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiwsMuUsO_zAhWszYUKHfo0AMcQFnoECAIQAQ&url=https%3A%2F%2Fgeothermalcommunities.eu%2Fassets%2Felearning%2F9.17.COSTS.pdf&usg=AOvVaw0xJSf81NaYTyEzoTw3NCxw&cshid=1635502148245714
16. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwih9rLLmOPzAhUYDWMBHVXzCrYQFnoECDQQAQ&url=https%3A%2F%2Fwww.geothermal-energy.org%2Fpdf%2FIGAstandard%2FINAGA%2F2001%2F2001-27.pdf&usg=AOvVaw0QMxkGUw6Uo91vLq42s44c