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# Strategies of Saudi Arabia in Utilizing Renewable Geothermal Energy

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## Abstract

**Purpose:** The research explores the energy production in the country and the means that are used for it. Moreover, it highlights the research project defines a research question and some research objectives which relate to the use of geothermal energy as a means of renewable energy production in Saudi Arabia.

**Methodology:** The research project is based on qualitative research that focuses on the use of renewable sources of energy in Saudi Arabia. Already published research findings have been quoted in the project which has been taken from journal articles as well as other authentic sources.

**Findings:** Different findings have thus been revealed in terms of the strategies being used by Saudi Arabia in utilizing renewable geothermal energy sources. Also, the research project has explored the extent this transformation is helping Saudi Arabia's overall productivity.

**Unique Contribution to Theory, Policy and Practice:** The projects adopted by Saudi Arabia to enhance the principle of benefiting from renewable geothermal energy have been highlighted based on the available findings and governmental reports. Finally, it has been established whether the country could fulfill its energy requirements by utilizing renewable geothermal energy.

**Keywords:** *Geothermal Energy, energy production, Carbon dioxide emissions, Sustainable energy, Renewable energy, Energy diversification and geothermal power generation.*

**Introduction**:

Saudi Arabia, known for its abundant reserves of oil and gas, is now focusing on diversifying its energy mix and reducing its dependence on fossil fuels. As part of this transition, the kingdom is exploring the potential of renewable energy sources, including geothermal energy. Geothermal energy harnesses the heat stored within the Earth's crust to generate electricity and provide heating and cooling solutions. With its geothermal potential yet to be fully tapped, Saudi Arabia has an opportunity to develop strategies that effectively utilize renewable geothermal energy. By capitalizing on this clean and sustainable energy source, Saudi Arabia can contribute to its energy security, reduce carbon emissions, and promote a more sustainable future. In this article, we will explore some key strategies that Saudi Arabia can consider in order to maximize the utilization of renewable geothermal energy.

Technologists and researchers have recognized the importance of natural resources that are founded within the earth. The new idea presented by many researchers is to utilize the natural resources present on the Earth to make energy. As the world is moving towards new forms of technology and investment, it is observed that many policymakers are having directions in order to create energy by using natural resources. The main aim of this ideology is to utilize natural resources for the betterment of the population. It is assumed that the energy that can be gained through geothermal energy sources can easily fulfill the need for energy in this world. Geothermal energy is considered to be a renewable energy source that is marked as harmless when it is compared with other energy sources and geothermal energy can be utilized in generating electric power.

The technologists and researchers are having their consideration towards making geothermal energy a source of sustainable and renewable energy. The factors that are convincing the researchers to consider geothermal energy as the best option include the human-friendly nature of geothermal energy, fulfilling the need of this world, providing reliable, safe, and stable energy, and avoiding the contribution in increased pollution in this world. Saudi Arabia is considered to be among the countries that are having consideration towards utilizing geothermal energy to fulfill the need of energy of the state. It is observed that the government of Saudi Arabia is implementing specific strategies in order to use geothermal energy sources. Saudi Arabia is seeking to include the utilization of geothermal energy sources in its policy for the preservation and safety of this world's atmosphere (Salam & Khan, 2017). Because of the multiple advantages of Geothermal, the world is now having a focus on using this energy source to replace other methods of energy sources.

The main advantages that are convincing the governments of the states in order to use geothermal energy sources include a large amount of availability of geothermal energy sources, environment-friendly abilities, pollution-free processing including extraction, transformation, and creating

energy. The government of Saudi Arabia is seemed to be focusing on developing successful strategies in order to construct energy through geothermal energy sources.

As the industrial development and economy of any state are seemed to be deriving from the energy sources, it is observed that the consumption of energy is globally practiced and the stable energy sources are highly contributing to increasing the productivity of any state. In order to create reliable and affordable energy, many states are willing to focus on a method that is a human-friendly and reliable source, that can be implemented in the system of working for a longer run (Mosly & Makki, 2018). [1]

The reports have assumed that the states having large energy consumption will also be having high living standards because, in order to create a stable and reliable energy source, the state's economy needs to be stable enough to cope with the processing cost as well as the cost on consuming energy source for a longer run.

On the other hand, the production and consumption of high energy sources are also seemed to be producing a high amount of carbon dioxide that can lead the world towards negative atmospheric conditions as well as aid in disturbing health concerns and toxic societal conditions. The countries having their consideration towards focusing on the energy source that is environment and human friendly are having their direction towards the utilization of geothermal energy source as this energy source is considered to be creating renewable energy that is human friendly and reliable. Among these countries, Saudi Arabia is one of the countries that is having an abundant supply of fossil fuel resources. Because of the high intensity of fossil fuels and energy sources methods, the government of Saudi Arabia is having their direction towards utilizing geothermal energy sources to replace the contemporary methods of producing and consuming energy for the betterment of citizens. According to the report presented in 2012, Saudi Arabia was marked as the world's largest oil producer and the world's second-largest holder of crude oil reserves. As Saudi Arabia is having high reserves of energy, that is making in overusing and inappropriate allocating of fuel resources. Moreover, it is also observed that the Gross Domestic Product (GDP) of Saudi Arabia is highly dependent on energy exports.

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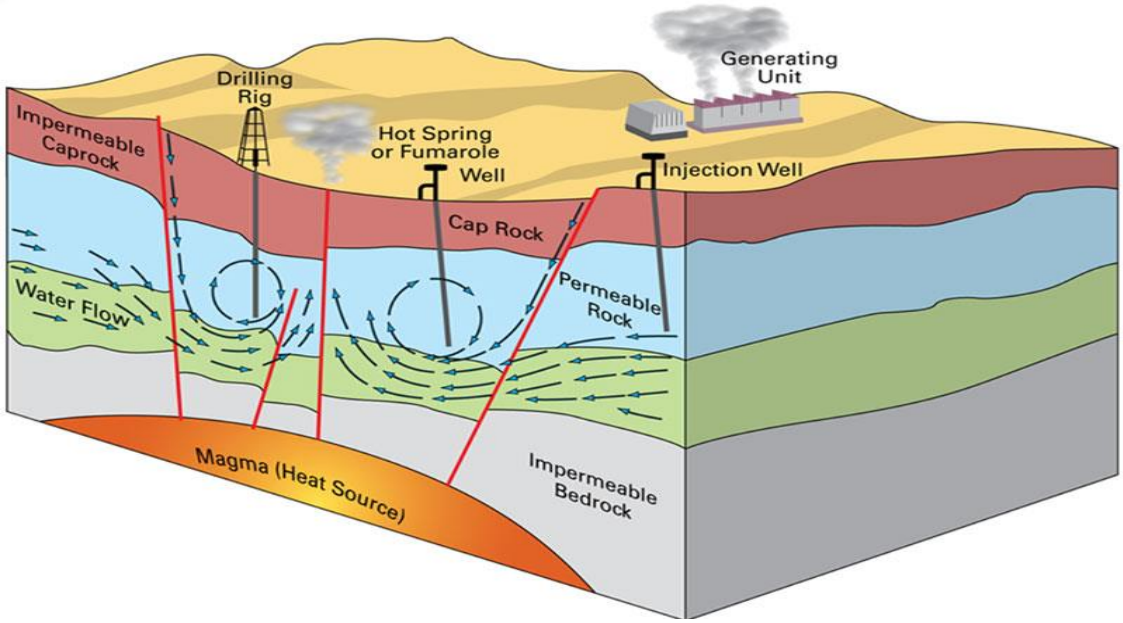


**Geothermal energy** is a form of renewable energy that harnesses the heat from the Earth's core and crust. It is a clean and sustainable energy source that can be used for various purposes, including electricity generation and heating/cooling applications. The Earth's interior heat is continuously replenished through natural processes, making geothermal energy a potentially inexhaustible resource.

Geothermal power plants typically utilize steam or hot water reservoirs deep underground to generate electricity. Wells are drilled to access these reservoirs, and the steam or hot water is brought to the surface to drive turbines connected to generators. Geothermal energy can also be used directly for heating and cooling buildings through geothermal heat pumps, which extract heat from the ground in winter and transfer heat into the ground in summer. One of the advantages of geothermal energy is its reliability and availability. Unlike solar and wind energy, geothermal energy is not dependent on weather conditions and can provide a consistent power supply. It is also a clean energy source, producing minimal greenhouse gas emissions compared to fossil fuels.

While geothermal energy has been utilized in several countries, its potential in Saudi Arabia is still largely untapped. The kingdom's unique geological features offer significant potential for geothermal energy development. By adopting effective strategies and investing in geothermal infrastructure, Saudi Arabia can harness this renewable resource to diversify its energy mix, reduce its carbon footprint, and promote sustainable development.

## Methodology

This research involves a descriptive research design to analyze the strategies used by Saudi Arabia in utilizing renewable geothermal energy. The research will rely on both primary and secondary data sources.

**Primary data** will be gathered through an extensive review of academic literature, research papers, government reports, policy documents, and other relevant publications. These sources will provide valuable insights into Saudi Arabia's approach to geothermal energy and the specific strategies implemented.

**Secondary data** will be collected from reputable sources such as research articles, official government websites, and international energy organizations. These sources will provide additional information and data points to support the analysis.

The collected data will then be subjected to qualitative research methods for analysis. Thematic analysis will be employed to identify and categorize key themes, patterns, and findings related to Saudi Arabia's strategies in utilizing geothermal energy. This analysis will help in understanding the various aspects of the strategies employed, such as policy frameworks, technological advancements, funding mechanisms, and institutional arrangements.

In addition, comparative analysis may be conducted to assess the effectiveness of Saudi Arabia's strategies in relation to other countries' approaches to geothermal energy utilization. This will provide a broader perspective and allow for insights into best practices and potential areas for improvement.

Overall, this methodology will provide a comprehensive understanding of Saudi Arabia's strategies in utilizing renewable geothermal energy, offering insights into the country's achievements, challenges, and opportunities in this field.

**Literature Review**

Renewable Energy Technology (RETs) is considered to be an advancement that is gaining much focus and consideration by technologists and policymakers. As the need of establishing strong strategies in order to gain maximum energy benefits from RETs is increasing, it is observed that the worldwide approach towards this modern technology is recognized and adopted by many states.

As these technologies are highly dependent on producing energy through renewable energy sources, it is observed that the states having an increased rate of natural resources are more likely to adopt the method of producing and consuming energy through renewable sources. Natural resources, being the supply of providing renewable energy, is seemed to be benefiting the states having a higher rate of natural resources and deposits (Alshehry & Belloumi, 2015).

It is observed that the most prominent natural resources that are being used by different states in order to produce energy include solar power, wind power, geothermal energy sources, hydropower, biomass, and wave energy. Each of these natural sources of producing energy is considered to be the renewable source that is benefiting the states to have stable, secure, and human-friendly energy that can be utilized on both, domestic and international levels (Demirbas et al., 2016). Saudi Arabia is a state having huge deposits of natural resources and in order to utilize

natural resources to produce renewable energy, the orientation of this kingdom is seemed to be on utilizing geothermal energy sources to produce environment-friendly and safe energy for domestic and external purposes. The government of Saudi Arabia is focusing on utilizing geothermal energy sources to produce energy because of multiple factors that include avoiding the risk of increasing pollution in the state, producing energy in higher quantity, fulfilling national and international needs of energy, to serve as the world's biggest supplier of fossil fuels and to safe and preserve the environment and nature of the state. In industrial applications, the utilization of energy is considered to be beneficial in generating electricity, heating cooling purposes, and fulfilling the demands of internal and external energy requirements (Taleb, 2009).

Comparing this renewable energy with others, it is observed that this renewable energy technology has the lowest environmental impact because of its marginal resource requirements that are needed for producing and maintaining this energy. Geothermal energy is considered to be a form of sustainable renewable energy that can provide the nation with a carbon-free environment, based on safe and secure energy usage. Saudi Arabia is aiming to utilize geothermal energy in its future plans to make the nations accessible to carbon-free energy as well as reduce the chances of destructive factors like the greenhouse effect, pollution, and climate change. As geothermal technology emits a very low rate of carbon dioxide, technologists in Saudi Arabia are constructing effective strategies in order to produce energy through geothermal sources (Kahouli et al., 2022). The plans and policies constructed by technologists of Saudi Arabia indicate that in the future, the use of energy will be increased and in order to fulfill the demand for energy, Saudi Arabia will be using geothermal energy at a higher rate for both electricity generation and heating purposes. The research conducted by Ibrahim Mosly and Anas Makki shows that in order to have better incorporation of renewable energy technology of geothermal energy source, the technologies in Saudi Arabia will be needing to have strong strategies that can cope with the ongoing production of energy as well as balancing the rate of production of energy in future. This research is highlighting the difference in outcomes gained after the production of energy through geothermal energy sources as compared to other energy sources and it is observed that the plans constructed by policymakers in Saudi Arabia are based on ensuring the citizens live in a carbon-free and pollution-free environment while having accessibility over environment-friendly fuel that can enhance the level of reputation of this kingdom (Hernandez et al., 2014).

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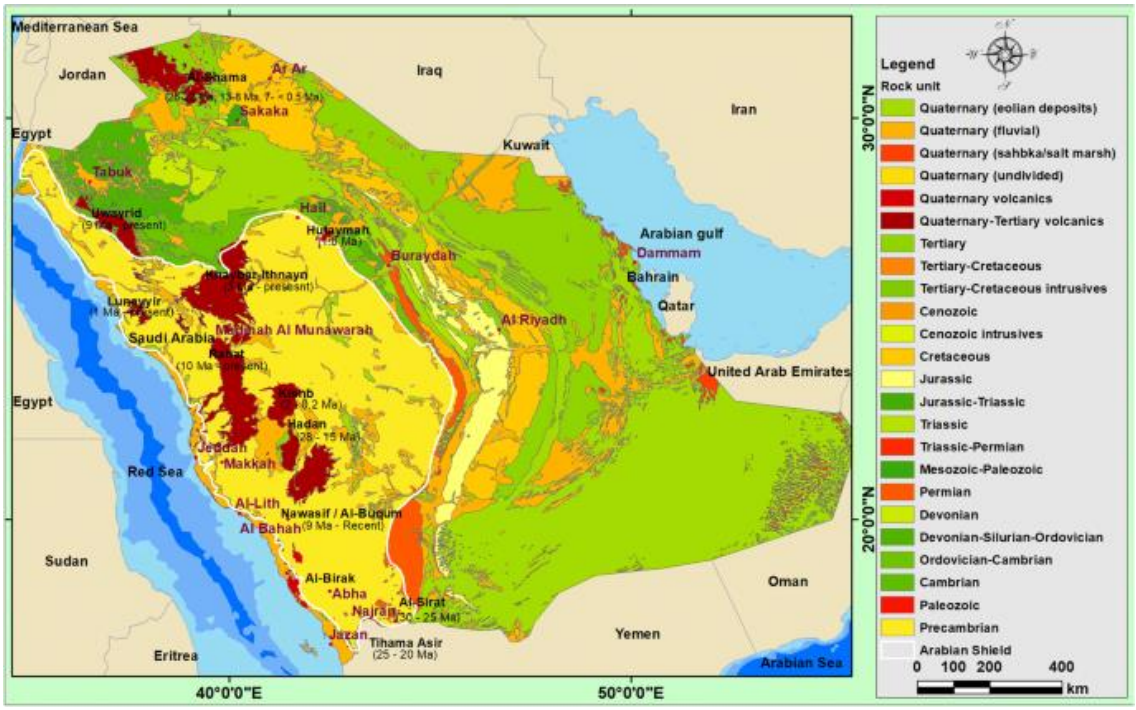
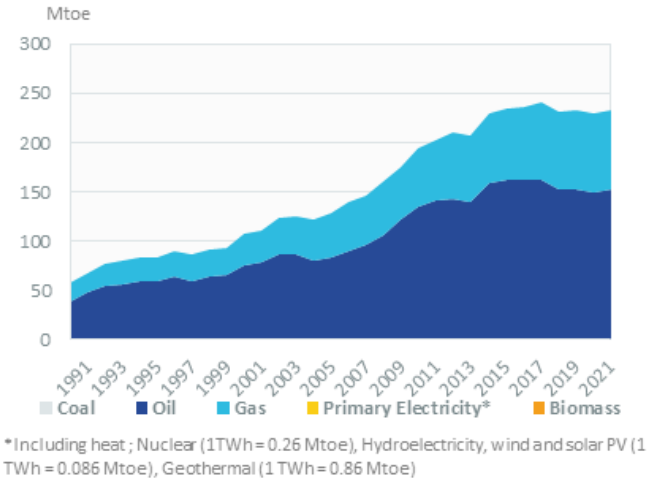



As Saudi Arabia is the largest supplier of oil and gas on the globe, it is observed that replacing the conventional methods of production of fuel is an important concern for the state to have better stability and productivity in the export of fossil fuels. The research conducted by professional researchers and technologists has discussed that the utilization of resources from Earth by the method of transportation of heat from space to Earth is seemed to be much beneficial for the states adopting this method as well as the cooling process during summer session may provide the states to have a higher rate of fuel productivity (Kahouli et al., 2022). The research conducted by Mohammad Asif Salam and Sami A. Khan discusses the matter of adoption of effective strategies in order to utilize geothermal energy in Saudi Arabia and this research is seemed to be providing authentic argumentations regarding this concern. The researchers have argued that the adoptive strategies based on utilization of geothermal energy in Saudi Arabia are just like a nonrenewable country that is having its focus on the adoption of technological advancement. This matter is taken by the researchers as the difference between the country having non-renewable technology versus the country focusing on resources for a generation. This research has evaluated the fact that Saudi Arabia is one of the countries that is having highest energy consumption per capita in the world because of its faster-growing population and rapid advancement and industrialization. By the year 2025, the rate of consumption of fuel and energy in Saudi Arabia is assumed to be doubled because of various factors. Because of multiple factors including increased rate of pollution, higher investment in the field of energy production and consumption, and triggering factors influencing human capital and harmful processing of fuel production, the government of Saudi Arabia is seemed to be having its focus on utilization of natural resources in order to produce a large amount of fuel and energy.




*Including heat ; Nuclear (1TWh = 0.26 Mtoe), Hydroelectricity, wind and solar PV (1 TWh = 0.086 Mtoe), Geothermal (1 TWh = 0.86 Mtoe)

**Energy Consumption Breakdown Percentage be sector in Saudi Arab**

The government of Saudi Arabia has announced an ambitious policy that is based on the installment of 41 Gigawatt of solar capacity and by the year 2032, the investment that is assumed to be made by the government of Saudi Arabia is 108.9 billion dollars (Salam & Khan, 2017).

The process of shifting from non-renewable sources of energy to renewable technology. This research has evaluated that the government of Saudi Arabia is having consideration to replace conventional methods of oil and energy production with modern strategies that can allow this country to have a reduction in oil dependency and improve environmental sustainability for the betterment of citizens. The past three decades have witnessed a rapidly growing economy in this kingdom because of rich and assessable oil and natural gas deposits. Among all the Gulf Corporation Council (GCC) members, Saudi Arabia is having the highest level of GDP but conversely, it is observed that Saudi Arabia is the highest emitter of carbon dioxide among all countries (Salam & Khan, 2017). Experts have suggested that Saudi Arabia can emerge as the highest competitive producing location for renewable energy technology because of its higher rate of economy and stability. The report presented by the British Petroleum Statistical Review of World Energy, Saudi Arabia is considered to be the second-largest holder of oil reserves that are representing 15.9% of total natural gas reserves in the world (Al-Jarboua, 2009) The researchers have discussed that in order to sustain this higher level of oil and energy production, the government of Saudi Arabia is seemed to be focusing on cheaper and human-friendly ways of reducing energy, considering geothermal processing as an appropriate option.

In order to have an implementation of strategies to produce energy from geothermal sources, the government of Saudi Arabia has collaborated with the United States National Renewable Energy Laboratory (NREL) in the year 2013 that is monitoring and mapping Saudi Arabia's initiative steps towards adoption of initiative ideas to utilize geothermal, wind, solar and other methods of energy production through natural ways. This collaboration was aimed to monitor the initiation of Saudi

Arabia towards these strategies and this monitoring was carried out by 70 stations throughout the country (NREL, 2000). It is observed that among the most prominent strategies that are adopted by the government of Saudi Arabia in order to utilize natural ways of producing energy, the most effective policies include investment in the field of Research and Development towards maximum utilization of energy through geothermal sources, creating awareness among the citizens, focusing on environmentally friendly ways of producing fuel and consuming, collaboration with powerful organizations and states to have a better implementation of effective ideologies and investment in the field of technology and science (Jacobson et al., 2013).

The government of Saudi Arabia is seemed to be investing in the department of hiring professional technologists that can develop policies based on creating a space for renewable energy sources as well as providing alternative strategies for replacing conventional methods of energy production with modern ones.

Being a country having many natural resources, the government of Saudi Arabia is seemed to be now recognizing the importance of natural processes and to save the health concerns of citizens, it is observed that this government is highly active in bringing about human-friendly ways of oil and gas production (Demirbas et al., 2016). Saudi Arabia needs to revise its method of producing energy because of risk threats that are being faced by the citizens of this country. In order to overcome the adverse situations in the country, it is observed that the state needs to develop policies that are based on a renewable and sustainable source of the energy system and the government of Saudi Arabia is recognizing these threats and having their focus on sustainable energy processing. For the evolution of a sound energy policy, the driving forces that are considered to be prominent are energy security and energy cost minimization (Arouri et al., 2012).

**Findings and Analysis**

the descriptive-analytical method in order to conduct the research and analyze the given concern. The analysis of dependent and independent variables in this research is carried out by analyzing the extent to which these variables are influencing the overall situation in Saudi Arabia in order to bring about effective strategies for the utilization of geothermal energy sources.

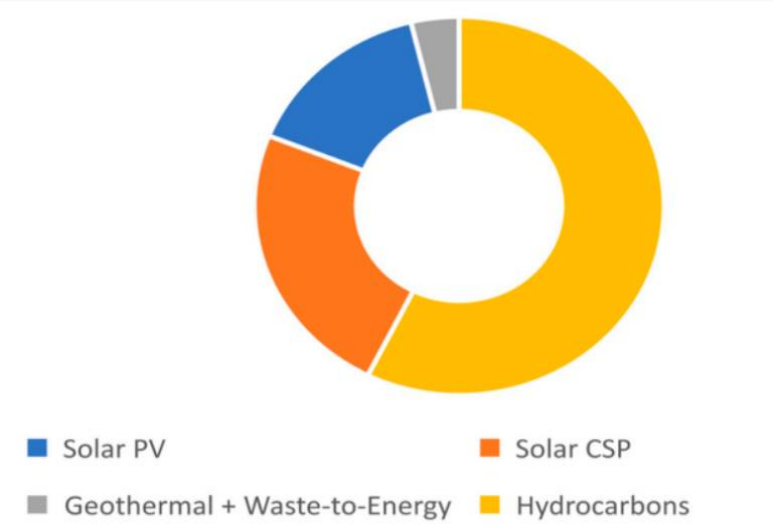
It is observed that by using the inductive approach for the condition of this research, it is evaluated that the current plans and policies designed by Saudi Arabia's government are seemed to be making the orientation of this kingdom towards maximum utilization of geothermal energy sources as well as ensuring preservation of the environment in the state. Saudi Arabia, being one of the countries having a stable economy and trade with other countries, is having a huge consumption and production of energy in industries and domestic use.

The independent variables that are being discussed in this research paper in the descriptive method, that may have an influence on the evaluation of the strategies are Saudi Arabia's foreign trade, the

relationship of Saudi Arabia's government with other governments, and the internal conditions going on in Saudi Arabia.

Whereas, the dependent variables in the utilization of geothermal energy in Saudi Arabia are considered to be economic conditions in Saudi Arabia, the demand for energy in Saudi Arabia on both national and international levels, and the ongoing competitive production of energy on different levels. By using inductive reasoning, this paper aims to begin with specific observations and measures then the detection of specific patterns and regularities is considered during the research while formulating some tentative hypotheses that can be gained after the conduction of this research.

Throughout the research, the inductive approach is seemed to be helping the research to have better reasoning and argumentation because of observation and detection of patterns and regularities that may be founded between different independent and dependent variables as well as the main concern. The use of the descriptive-analytical method of reasoning helped this research to have a better analysis of the ongoing situation is in Saudi Arabia based on the plans and policies constructed by the government of this state in order to utilize geothermal energy and generate electric power through this source. It is observed that Saudi Arabia is having plans to incorporate the utilization of geothermal energy in its working and geothermal power plants are not yet installed in Saudi Arabia but some direct-use low-grade geothermal applications are seemed to be already installed in Saudi Arabia in the last five years (Hussein et al., 2013). This paper has analyzed that different projects and plans are being constructed by the government of this state and these projects include WGC 2005 and 2010, Vision 2030, projects funded by the National Plan of Science and Technology(NSTIP), and the program initiated by KACST. Besides these prominent plans, there are many other initiatives that are developed by this state's government to make possible the utilization of geothermal energy resources for the generation of electric power (Aboud et al., 2021).



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**Summary**

The research paper discusses the strategies implemented by the government of Saudi Arabia in utilizing renewable geothermal energy sources. The paper highlights the importance of natural resources for energy production and the shift towards utilizing renewable energy sources globally. It emphasizes the advantages of geothermal energy, such as its availability, environmental friendliness, and pollution-free processing.

The government of Saudi Arabia recognizes the need to reduce carbon dioxide emissions, lower pollution rates, and diversify its energy sources due to its heavy dependence on fossil fuel reserves and the potential oil shortage by 2030. The government has developed strategic plans, such as Vision 2030 and the National Transformation Program 2020, to increase investment in renewable energy technologies and achieve a significant share of renewable energy in the country's power consumption.

The paper outlines the research problem, which focuses on understanding the strategies employed by Saudi Arabia in benefiting from renewable geothermal energy. It also presents research questions related to the strategies, projects, and the extent to which geothermal energy can fulfill Saudi Arabia's energy requirements. The aims and objectives of the research are to analyze and evaluate the strategies and plans implemented by the Saudi government in utilizing renewable geothermal energy. The paper also includes a literature review, highlighting the importance of renewable energy technologies and the benefits of geothermal energy sources.

In summary, the research paper provides an overview of the strategies and policies adopted by Saudi Arabia to utilize geothermal energy as a renewable energy source. It emphasizes the government's commitment to reducing pollution, diversifying energy sources, and ensuring a stable and sustainable energy supply for the country's future.

**Conclusion**

A well-planned system that comprises different resources of energy shall be adopted by the government of Saudi Arabia so that sustainable growth and development could be achieved without losing the competitive ground and the different implications involved in the adoption or shift towards geothermal power. The government of Saudi Arabia is having their focus on reducing carbon dioxide emissions and lowering in pollution rate because due to high reserves of oil and fuel, Saudi Arabia is marked as one of the most polluted countries in the world.

The researchers have recognized the importance of natural resources that are founded within the earth. As the world is moving towards new forms of technology and investment. The aim it utilize natural resources for the betterment of the population. It is assumed that the energy that can be gained through geothermal energy sources can easily fulfill the need for energy in this world. Geothermal energy is considered to be a renewable energy source that is marked as harmless when

it is compared with other energy sources and geothermal energy can be utilized in generating electric power.

The technologists and researchers are having their consideration towards making geothermal energy a source of sustainable and renewable energy. The factors that are convincing the researchers to consider geothermal energy as the best option include the human-friendly nature of geothermal energy, fulfilling the need of this world, providing reliable, safe, and stable energy, and avoiding the contribution in increased pollution in this world.

**Recommendations**

The recommendations that can be given in order to make such research more effective in the future are as follows:

- In the field of utilization of natural resources in order to generate and produce electric power, it is observed that the need of developing plans and strategies based on encouraging more manual work replacing automation must be processed that can result in better utilization of natural resources for generation of electric power and energy. In order to utilize geothermal energy sources, the plans and policies constructed by researchers and policymakers must be based on modern technological knowledge and advancement because still to date, the concern of generating electric power through natural resources is not much common as many states are not having direction towards this concern. So, there is a need for the researchers to create awareness regarding this concern and use technical knowledge to make the people more aware of this process.
- Another recommendation that can be given to Saudi Arabia's government In order to utilize geothermal energy sources is to create more stable plans that can increase the sustainability and productivity of this state while fulfilling the need for energy and electric power domestically and internationally. It is observed that the state needs to develop more stable and strong policies that must be funded by authorities and organizations in order to benefit the citizens and businesses on a higher level.
- Evaporative cooling systems save over 70% on energy costs and reduce CO2 emissions by 78%. With evaporative cooling, 100 percent fresh air is used to provide the required level of comfort.
- We note that the unit cost of electricity generated from geothermal power plants is very low compared to the energy generated by fossil fuels.

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