ICRRD HIGH INDEX RESEARCH JOURNAL
(An Initiative of International Center for Research and Resources Development)
ISSN Number: 2773-5958, SSM Number: 201901038138(1347468-T), www.icrrd.com

Direct Utilization of Geothermal Energy with Trends and Potential Role in a Sustainable Future Outgrowth

***Md Showkot Hossain[1], Md Israfil Hossain[2], Tasneem Jahangir[3] , Md Akib Hasan[4]**

1, 2, 4 Department of Electrical and Electronic Engineering, Daffodil International University, Dhaka, Bangladesh. E-mail: hossain33-2682@diu.edu.bd, hossain33-2709@diu.edu.bd, akib233@gmail.com

3Department: Mechanical Engineering, University: Infrastructure University of Kuala Lumpur, tas.ja007@gmail.com

**Corresponding author*

KOD JALUR / BARCODE
e ISSN 2773-5958

Date Received: 07 December 2020
Date Accepted: 30 January 2021
Date Published: 20 February 2021
Volume -2, **Issue**-1, February 2021

Abstract: Modern technology civilization, yet rapidly growing dependence on the world, ends with increased demand for energy consumption. An increasing aim of creating a sustainable environment involves careful use of energy sources. The use of renewable energy resources to improve the performance of current technology and thus economically proper use of energy are three important strategies in addressing those concerns. Geothermal energy is a renewable source of energy with the ability to generate a fair amount of the world's natural hot electricity, heating and cooling. In all volcanoes, geysers and the low enthalpy types, it occurs in high enthalpy where the warmth in the crust is contained in rocks. The current research explores the direct use of energy through the ORC method worldwide and the future planning of these prospects for renewable sources of energy. Different nations use heat energy directly in many ways and discuss in particular the generation of electricity over the last twenty years and their future projects. In addition, technology's environmental impact and economic viability are mapped. Recent studies support the advantages and limitations of technology and opportunities for improvement. Briefly, the study discusses the potential role of geothermal technology in an extremely sustainable future. Finally, for further investigation, the likely subjects of future research will be presented.

Keywords: Direct Utilization of Geothermal Energy, Geothermal Resources, Geothermal Power, ORC Method, Working Fluids, Binary Plant.

Introduction

One of the most important facets of any society’s growth is the supply of resources. Today a large part of the energy is generated by burning organic fuels to generate productive work or electricity. These fuels are reduced in supply. For starters, Indonesia has an estimated natural gas reserves for only 33 years and oil for only 75 years [1]. Based on the usage trend, those statistics would likely change with time. The need for electricity is expected to increase overtime. Between 1990 and 2050, energy consumption could grow by up to 275% in 1990[2]. The implementation of green energy technology to replace traditional fossil fuel technologies is one way to mitigate energy concerns. GE is one of the most precious renewable energy sources available. The planet still uses geothermal electricity. In 2014, the gross world energy supplies for geothermal energy were 12.7 GW, mostly from low and medium temperature [3]. Since 2010, this is a rise of about 17 percent. The rise between 2000 and 2020 in geothermal technologies is in figure 11. This research presented an approximately linear trend of approximately 350 MW annually between 2010 and 2014 and claimed that the world could also install 21 GW of power by 2020, and 140 GW by 2050; in that case geothermal would provide 8.3% of the world's energy generation and 17% of the population and 40 countries would produce 100% of geothermal energy [3]. More than 1000 million tonnes of CO_2 can also be removed from the atmosphere annually by geothermal technologies. Another report indicates a conservative figure, with geothermal energy providing 3% of electricity and 5% of heating loads in 2050. [4]. If only 1 % of the total projected geothermal energy available is used by humankind, 2800 years of power could be produced at a constant speed [5]. The biggest challenge to using geothermal technology is to locate the correct location and extraction technology. Potential sites frequently lie at a depth of around 2 km near tectonic site borders [6]. Indonesia has some of the greatest geothermal ability, is situated on the Pacific Rim. Estimated to be eligible for use are about 28,617 MW although actually only 4 percent [1] is in use. By 2020, 3,700 MW of geothermal energy has been installed by the United States with projections of 4,313 MW by 2025[7]. The projected energy required for use in the US state of Idaho is 4,900 MW. Most of it is found in the eastern Snake River plain of Idaho to the south [9].

Global Scenario of Renewable Energy

Renewable contributed 19.2% of world energy consumption, while power production accounted for 23.7% in 2014 and 2015, based on the Renewable Energy Strategy Network for the 21st century. 8.9% of this energy consumption comes from conventional biomass, 4.2% from heat, 3.9% from hydropower and 2.2% from wind, solar, geothermal and biomass electricity [10]. In 2015, worldwide renewable energy expenditure amounted to over USD 286 billion and heavily investments were made in winds, hydropower, solar power and fouls. Overall, the renewable energy sectors have about 7.7 million jobs and the biggest renewable employer in solar photovoltaic.[11] Solar photovoltaic is a crucial technology to capture the advantages of having no waste, no movable components, no pollution, less shipping costs, no water requirements for power generation and no adverse environmental effects. The capacity to produce renewable energy has increased annually since 2016, with the addition of an estimated 161 GW. Every year, the world continued to add more renewable energy than the combined (net) power of all fossil fuels. In 2016, the net contribution of renewables to global power production was estimated at 62% [12].

Geothermal Systems

Geothermal systems are categorized according to temperature, enthalpy, physical condition or fluid nature and the use and geological conditions of the systems. There are potentially still several geothermal systems still to be found, since several systems have no surface activity. Geothermal systems are widely used in the world in the classification of low temperatures and high temperatures based on the geothermal area.

Table 1: Common use and technology commonly used for various reservoir temperature (13).

Reservoir Temperature	**Reservoir Fluid**	**Common Use**	**Technology Commonly Chosen**
High Temperature >220°C(430°F)	Water or Steam	Power Generated Direct Use	➢ Flash Steam ➢ Combined Cycle ➢ Direct Use ➢ Heat Exchangers ➢ Heat Pumps
Intermediate Temperature 100°C-220°C(212°F-390°F)	Water	Power Generated Direct Use	➢ Binary Cycle ➢ Direct Use ➢ Heat Exchangers ➢ Heat Pumps
Low Temperature 50°C-150°C(120°F-300°F)	Water	Direct Use	➢ Direct Fluid Use ➢ Heat Exchangers

Low-Temperature Geothermal Systems

In the continental regions of the Earth's crust, low temperature (< 150 ° C) sedimentary geothermal resources are commonly used. They are very distinct from the geothermal resources of volcanic systems or tectonically active crust areas. Low-temperature geothermal energy is the device used directly in the form of space heating, greenhouse, aquaculture, horticulture, industry and bath, as well as electricity production (10 to 20 MW power plant), geothermal water or surface heat water (temperature varying from 40 to 150 ° C) [14]. Normally this system is formed from a volcanic area and dominates fluid where the hydro static process controls the pressure often with hot or boiling springs. Geothermal activity at low temperatures is dispersed throughout the majority of the planet and is located in different geological conditions. This method depends on the regional geothermal gradient, permeability, porosity and circular depth at various rock types and its temperature varies depending on the rock's permeable depth. Water, which was once conceived of as a geothermal system of lower temperatures, is interstitial water, mostly brine and enhanced and shallow resource forms [15]. In convective fracture control systems, the heat source is the hot depth crust where the heat flow is tectonically active. The geothermal water circulated here at significant depth (> 1 km) to reduce the heat from the rock through mainly vertical fractures.

In many of the world's big sedimentary basins there are sedimentary systems. These systems owe their existence to the presence of high-depth permeable sedimentary layers (> 1 km) and average geothermal gradients (> 30 ° C / km) that, while fractures or failures in some instances, are conductive rather than convective in nature. However, such convective structures may be incorporated into sedimentary rocks. Geo-pressures in a stratigraphic trap in a number of sedimentary basins with pressures near lithostatic values have been established [16]. This enhanced device is often used in manufacture or double-reinjection systems built with Hot Dry Rock (HDR) or generated reservoir permeability. Because of heat pumps from ground sources, low resources are created. The use of these tools has opened up new dimensions with recent advances in the application of ground source heat pumps.

High-Temperature Geothermal Systems

Their origin is volcanic or intricate with respect to the occurrence or the heating source and their temperature is more than 150 ° C at 1 km in depth. These are aligned with the plate limits. This method is suitable for electricity production and is still connected to the volcanic system. Hot intrusions or magma are the heat sources for such systems. The volcanic complexes are often located inside or nearby, such as caldera, most of which are plate borders but some are in hot areas [17]. Permeable fractures and areas of fault primarily regulate volcanic systems' water flow. Aquifers are strata-binding and/or dominated by fracture. In tectonically disturbed areas, several high-temperature geothermal areas are such as calderas, rift valleys and block faulted areas. The intersections of regional defects and defects bordering major structural blocks are especially favorable. Featuring fumaroles, steam winds, mud ponds and a deeply altered soil are dominated by liquid and steam [18]. This type of field is common in the area of Atlantic Ridge (Iceland), Continental Rift (Rivt Valley in East Africa), Pacific (Ring of Fire) as well as various types of volcanic regions (continental margin of arc volcanoes, micro- continental arc volcans and inter arc basins, pressure regime, flank zone volcanos, hot spot volcanos). These types of fields are mostly found in the areas of Mid Atlantic Ridge (Iceland). The United States, Philippines, Iceland, Indonesia, New Zealand, Japan, Italy, Mexico and Costa Rica are the leading nations whose energy generation is used by high-temperatures geothermal [19].

Types of Geothermal Power Plant

Generally there are four (4) types of power plant running all over the world. All the plants have different types of operation system and processes. Different types of power plants have different types of structure and working process. Here discuss all of them below:

Single Flash System

A single-flash plant type often is the best economic option for those geothermic resources with a temperature typically above 190°C. Higher reservoirs create both water and steam under natural pressure. Usually, this two- phase flow is directed to a separator that can be piped to the plant for the steam fraction and piped to the reservoir through injection wells for the water fraction. The vapour that enters the plant sometimes runs through a tumbler to escape the drips of moisture that are conditioned. The steam is directed to a steam jet ejector device and the balance toward the turbine. At the exit of the turbine, the expulsion mechanism produces a very low vacuum, maximizing the mechanical energy of the turbine. Steam leaving the turbine is sent to a lower vacuum condenser. Steam is usually sprayed into the condenser from a cooling tower and the steam is reduced to water. This water is then pumped to the top of the cooling tower for heat rejection to the atmosphere.

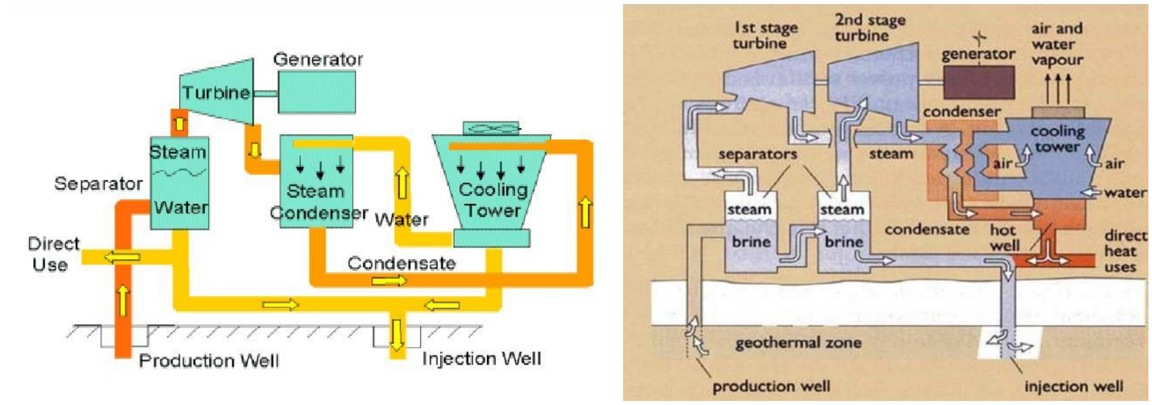


Figure 1: Single & double flash power plant

Double Flash System

A dual flash system employs two flash separating systems, so more steam is generated by the geothermal fluid and cycle performance is improved. The cycle begins with the extraction of high temperature fluids from a geothermal source into a flash-filled HPS. The saturated steam is produced by HPS and the rest of the sauna is directed into a low pressure secondary separator (LPS). Reducing the blinking pressure increases the consistency of the mixture in LPS, which increases the output of steam. Low-pressure saturated steam is combined with the high-pressure turbine drained steam flow and the resulting steam flow goes to the low-pressure turbine generating more electricity. Steam exhausted from the low pressure turbine is then brought down to the ground and pumped. In a flash system, the separator pressure affects the power produced by the system significantly, and the flashing pressures also significantly affect the double flash period. The parameter value versus operating cost should be considered to optimize one design. Double flash systems can generate a higher capacity under the same geo-fluid conditions. That said, since this is a more complicated method, it would not be economically viable for many applications to incorporate such a technology.

Dry Steam Power Plant

Dry steam plants use mostly steam hydrothermal fluids. The steam is directly transported to a turbine driving an electric generator. The steam prevents fossil fuels from operating the turbine (eliminating the need of transporting and storing fuel). These plants emit very little gas and excess steam. The first type of geothermal plant (they were first used in Italy at Lardarello in 1904), was based on dry steam power plant systems. Steam technology is still in operation today at the Geysers, the biggest single source of geothermal energy in the world, in northern California.

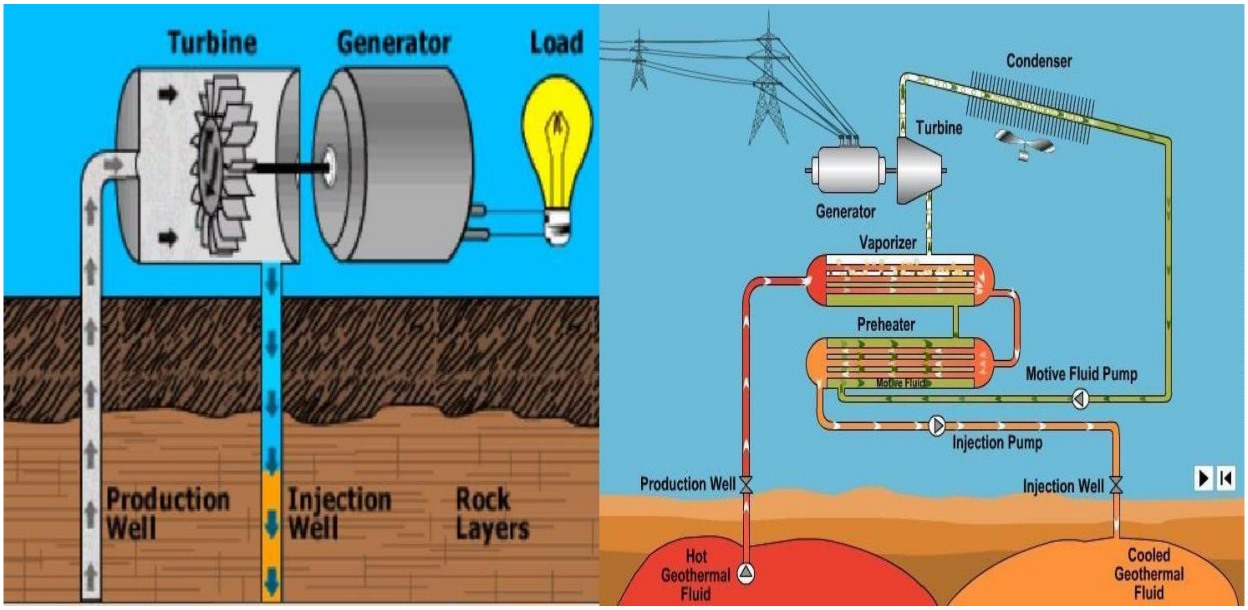


Figure2 : Dry steam & Binary cycle power plant

Binary Cycle Power Plant

Dry Steam and Flash Steam systems vary in that the water or steam from the geothermal reservoir never comes into contact with the turbine / generator units. Geothermal fluid and secondary fluid with a much lower boiling point, which passes through a heat exchange, is medium to moderately (below 400 ° F). Geothermal fluid

heating flashes the secondary fluid to vapour and then powers the turbines and generators. Closed-loop systems are binary cycle plants and practically nothing (other than water vapour) is released into the atmosphere. Since resources below 300 ° F are the most common geothermal resource, a large proportion of geothermal power could come from binary cycle plants in the near future.

Direct Use Geothermal Resources

Geothermal resources are also ordered according to their form of operation. The type of geothermal activity aids to understand a possible asset just as research techniques are characterised to assist in evaluating the potential use of a reservoir [20]. The convection-dominated play and the conductive play are two major forms of geothermics. The perception of the type depends on the proportion of the porosity to penetrability. The geothermal power plant activity aims to discern geothermic potential from temperature and fluid enthalpy in the attributes of the material and to use a geothermal player with increasingly accurate ID tools later [21]. Another way of classifying a geothermal resource is the Basic Exergy Index (SEI). SEI defines the quality of a geothermal resource on the basis of a non-dimensional exergy index rather than classifying a geothermal reservoir on the basis of temperature or enthalpie, which is often different from one source to another [22]. This index displays a resource's power supply or heat capabilities, regardless of different requirements. SEIs rank from 0.0 to 0.04 for lower quality geothermal resources and from 0.05 to 0.5 for medium-quality resources. It is evaluated as a high exergy resource as SEI above 0.5. In Indonesia, Japan and Poland, the quantified SEI approach has been used [23].

The current report is focused on national updates from 62 countries and locations that include information on their direct use of geothermal resources. A further twenty-six nations based on other data sources were included in the rundown [24]. The direct use of geothermal energy is thus an increase in a total of 88 countries, from 82 countries in 2015, 78 countries outlined in 2010, 72 countries declared in 2005, 58 nations reported in 2000 and 28 countries detailed in 1995. In this paper, an estimate of the thermal energy introduced for direct usage by the end of 2020 is implemented and equivalents of 107,727 MWt, a rise of 52.0 percent over 2014 to 8.73 percent per year. The energy used by the thermal sector is 1,020,887 TJ / yr (283,580 GWh / yr) – a growth rate of more than 72.3% in 2015 [25]. For geothermal (ground-source) heat pumps, the distribution of thermal energy is around 58.8 per 100 and for washing and washing 18.0 percent Swims (counting balneology), 16.0% (91.0%), 3.5% (for regional-heating), 1.6% (for mechanical applications), 1.3% (for aquaculture lake and raceway heating), 0,4% (for agricultural drying), 0,2% (for snow liquidation and cooling), and 0,2% (for other use) [26]. Per year, the energy investment funds add up to 596 million barrels of equivalent oil (81.0 million tonnes), with 78.1 million tonnes of CO_2 being discharged to air and 252.6 million tonnes of CO_2. In comparison to the fuel oil used in the production of electricity, this involves investments in geothermal heat pumps in cooling mode. Since the direct use of energy in the era of its accompanying is basically difficult to discern, it is consolidated: in 42 nations, some 2,647 wells bored, 34,500 men were employed in 59 countries for long distances of use and in the US $22,262 billion placed capital into enterprises by 53 nations [27].

This study explores the direct use of geothermal technology beginning with an in-depth review of the ORC binary methods of geothermal energy extraction and potential methods of improvement. An analysis of the geothermic binary system and the ORC approach is provided in a combination with other sources of renewable energy to boost geothermic technology. The presentation of current and previous analyses incorporates new extraction technologies. The growth in geothermal technology and the diverse uses of operating fluids rely not only on public awareness and resource availability, but also on technological performance. Direct use of geothermal energy is classified and addressed using binary device methods for optimising operating parameters and changing them. Two key factors are gathered by research to demonstrate the role of geothermal energy in relation to other energy resources in decision-making, cost and climate. There are also some benefits and drawbacks of the direct use of geothermal energy. The current investigation is concluded by establishing possible fields for future studies for direct use of geothermic power plants. Direct use of geothermal heat pump systems use 25% to 50% less electricity than conventional systems for heating or cooling, and with their flexible design they can be adjusted to different situations, requiring less space for hardware as opposed to conventional systems.

Table 2: Geothermal power and energy generation statistics for 2010 through 2020 and forecast for 2025 [36].

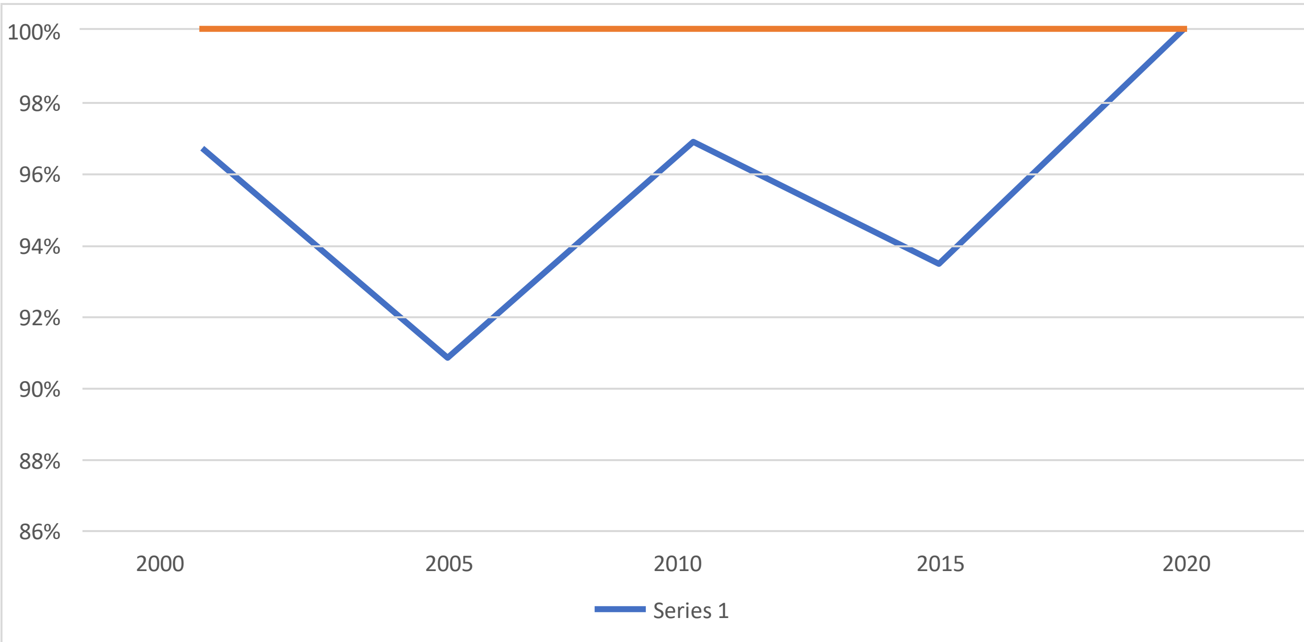
Country	**Installed MWe 2010**	**Energy GWh/year 2010**	**Installed MWe 2015**	**Energy GWh/year 2015**	**Installed MWe 2020**	**Energy GWh/year 2020**	**Forecast for 2025 MWe**	**MWe Increase since 2010-2025**
China	24	150	27	150	34.89	174.6	386	447.89
Costa Rica	166	1131	207	1511	262	1559	262	731
El Salvador	204	1422	204	1442	204	1442	284	692
Iceland	573	4553	665	5245	755	6010	755	2175
Indonesia	1197	9600	1340	9600	2289	15315	4362	7991
Italy	843	5520	916	5660	916	6100	936	2768
Japan	536	3064	519	2687	550	2409	554	1623
Kenya	202	1430	594	2848	1193	9930	600	2387
Mexico	958	7047	1017	6071	1005.8	5375	1061	3083.8
Nicaragua	88	310	159	492	159	492	159	477
New Zealand	762	4055	1005	7000	1064	7728	200	2269
Philippines	1904	10311	1870	9646	1918	9893	2009	5797
Taiwan	0	0	0.1	1	0.3	2.6	162	162.4
Turkey	91	490	397	3127	1549	8168	2600	4546
USA	3098	16603	3098	16600	3700	18366	4313	11111
TOTALS	**10646**	**65686**	**12018.1**	**72080**	**15599.99**	**92964.2**	**18643**	**46261.09**

Year	Capacity MWt	**TJ/year**	**GWh/year**	**Capacity Factor**
2020	107727	1020887	283579	0.3
2015	70885	592638	164621	0.265
2010	48493	423830	117730	0.277
2005	28269	273372	75936	0.307
2000	15145	190699	52972	0.399

1995	8664	112441	31233	0.412

Table 3: Total direct Use Geothermal Energy from 1995 to 2020

Graph from 1995 to 2020 Total direct Use Geothermal Energy



Country	MWe Installed in 2020	Country	MWe Installed in 2020
U.S.A	3,700	Mexico	1,005
Indonesia	2,289	New Zealand	1,064
Philippines	1,918	Italy	916
Turkey	1,549	Japan	550
Kenya	1,193	Iceland	755

Table 4: Ten nations having the most installed geothermal power generation in 2020 [37].

More than 80 countries have electricity production all over the world. Here we describe about top ten country's present status.

USA

With a net capacity of 2542 MWe (running), the current gross installed electrical capacity is of 3700 MWe and generates about 18,366 GWh per year. The most recent facilities in Alaska, Idaho, New-Mexico, Oregon and Wyoming are located in California, Nevada, Utah, and Hawaii. About 602 MWe were added in the last five years. The two key active poles of The Geysers and of the Imperial Valley is California's most significant state. In Chena Hot Springs in Alaska, geothermal fluids run at the world's lowest temperature binary period using 74

‒C. The total temperature is 730 kWe. In Nevada, Stillwater, a 48 MWe geothermal plant has been implemented with 26 MW we of panel and 17 MW of solar thermodynamic at the additional output of 2 MWe, with the first solar photovoltaic and thermal hybrid projects. The production tax credit (of 2.0 cents/kWh) and the renewable portfolio standards are sustaining a growth rate of 3.6% per year. Geothermal energy remains, however, a small contributor to the electric power capacity and generation in the United States, with an estimated contribution of
0.48 % of the total generation. Installed capacity 3700 MWe where the geothermal electricity is 18,366 GWh/y [28].

Indonesia

The volcanoes in Sumatra , Java, Bali and in the eastern part of Indonesia, which provide an expected potential of around 28 GWe comprising 312 geothermal potential locations, are associated with Geo-Resource in that region. Present geothermal fields are run at the following 10 sites: Sibayak (11 MWe), Lahendong (87 MWe), Wayang Windu (227 MWe), Ulu Belu – South Sumatra (110 MWe), Ulumbu – Flores (5 MWe) and Mataloko (2.5 MWe), Diensg (60 MWe), Kamojang (200 MWe), Gunung Salak (377 MWe). The electricity installed is 2289 MWe, while the short-term growth in the year 2025 will be approximately 6000 MWe (replying to 5% of the country's energy requirements). Indonesia installed capacity 2289 MWe Geothermal electricity 15315 GWh/y [29]. Now the Indonesian government and some private power sectors are interested to find more geothermal reservoirs and produced more electricity from there which can give support their total national electricity power supply.

Philippines

A new law provides fiscal and non-fiscal incentives to promote and accelerate the exploration, development and utilization of renewable energy resources which include geothermal energy As a result, 43 GSS / Operational Contracts were awarded, planned to be commissioned by 2014 with an additional 20 MWe at Maibarara and 30 MW We at Nasulo projects. Likewise, pipeline ventures are under way for expansion and optimisation. Geothermal power from Bacoon-Manito / Sorsogon / Albay 131 MWe, Mak-Ban / Laguna 458 MWe, Mindanao
/ Mount Apo 108 MWe, Palinpinon / Negros Ori-ental 192 MWe, Tiwi / Albay 234 MWe, Mayibarara 20 MWe and Tongonan / Leyte 726 MWe contributes with the currently installed capacity of 1918 MWe to the 14 % of total power requirements. The total power consumption amounts to 72%. Development since WGC2010: no major projects, decommis- sioning of Northern Negros (50 MW), commissioning 20 MWe. Philippines installed capacity 1918 MWe Geothermal electricity 9893 GWh/y [30].

Turkey

A significant development was achieved in Turkey in geother mal electricity production and direct uses (district, greenhouse heating and thermal tourism) during last five years, also due to the new Geothermal Law, its regulations and the feed in tariff. In Turkey, some 225 geothermal fields were identified and electricity production today amounted to almost 1549 MWe, with more than 350 MWe of new power stations. The Kizildere geothermal power plant is converted into a liquid carbon dioxide and dry ice processing facility. C, Anakkale-Tuzla 7 MWe, Aydin-Hidirbeyli 92 MWe, Aydin-Salavath 35 MWe, Aydin-Germencik 70 MWe, Aydin-Gümüsköy 7 MWe, Denizli-Kizildère 107 MWe, Aydin-Pamukören 48 MWe, Manisa-Alasheir 24 MWe, Denizli-Gerali 3 MWe are the current plants. The existing plants cover the following areas.Turkey installed capacity 1549 MW and the geothermal electricity 8168 GWh/y [31].

Kenya

The huge total geothermal potential of about 10 GWe of the country is currently under a very aggressive phase of develop- ment, with an impressive construction pipeline of new projects in several areas. All the high temperature prospects are located within the Kenya Rift Valley. In the first two years after the first units were installed, Olkaria Geothermical Field (636 MWe), which was recently extended with some 368 MWe in the last two years, is the main output pole. Kenya Electricity Generation Company (KenGen) and Orpower run it. In addition, the Oserian flour farm has an additional self-production of 4 MWe with a direct consumption of 10 MW for heating greenhouses. Eburru has a small unit (2.4 MWe). The Menen-Gai geothermal industry is currently boiling for the construction of the 100 mWe project (Expected COD in 2016) from the Geothermal Development Company (GDC). Exploration is continuing, with estimates of about 1600MWe in the immediate future (Omenda and Simiyu, 2015) in Eburru, Suswa, Longonot, Baringo, Korosi, Paka, Silali, and Baringo – Silali. The installation in Kenya amounts to approximately 1,193 MW and 9,930 GWh / y of geothermal power.

Mexico

The geothermal installed capacity in the country is 1058 MWe (840 MWe running) distributed into four geothermal fields in oper- ation (Cerro Prieto 720 MWe, Los Humeros 94 MWe, Los Azufres 194 MWe and Las Tres Virgenes 10 MWe), owned and operated by the state utility CFE (Comisión Federal de Electricidad). The plant is currently under development for two additional geothermal projects: Los Azufres III with 50 MWe and Los Humeros III-A with 27 MWe. The total electricity production in the country is approximately 6,000 GWh, representing 2.3 percent. There were approximately 224 operating production wells that contained 57 million metric tonnes of steam and 66 million tonnes of salt that are disposed of by a solar evaporation tank at Cerro Prieto and by 25 injection wells. Three new power plants started operating in the first months of 2015 and four other plants were demolished and taken offline. Los Azufres reached 227 MWe and began to run a new geothermal field in two well-headed plants, named Domo San Pedro in Nayarit. The installed capacity in the country has increased to 1061 MW. Due to a new regulatory system and a national geothermal innovation centre (CEMIE-Geo), geothermal power expectations are high. Two additional geothermal projects are currently under construction: Los Los Humeros III-A with 27 MWe and Domo San Pedro with 25 MWe. One additional 25 MWe plant is planned in Los Azufres [32].

New Zealand

The availability of high temperature and production-related geothermal energy resources associated with lowest electricity production costs, as opposed to other renewable or fossil fuel options, means New Zealand is experiencing remarkable growth in geothermal electricity generation. Around 16 percent of domestic power production (cf. 13 percent in 2010) contributes to a renewable power generation system (75 percent of renewable energy electricity), producing a generating capacity of geothermal electricity. The production areas are all in volcanic Taupo, Wairakei with a production area of 399,000 MWe, Kawerau 140, Reporoa 57, MWe, Rotokawa with a capacity of 167, Ngawha 25, MWe, Mokai 110, Tauhara, and Ngatamariki with its production facilities [32].

Italy

In the two historical areas of Larderello-Travale (795 MWe) and Mount Amiata (121 MWe), geothermal power supplies are located in Tuscany. A new record of electricity generated from geothermal resources in Italy reached 5700 gwh in the gross electricity generation. Several old power plants were decommissioned and replaced by new, with the commissioning of new two-unit electricity plant at Bagnore IV. On the liquid, segregated stream from the primary flash the first binary plant in Italy (Gruppo Binario Bagnore 3-1 MWe) was installed. Finally, at Cornia 2 a first hybrid biomass thermal project began, raising power production from 12 MWe to 17MWe [31].

Japan

The current total capacity of the geothermal energy plant is still around 500 MWe, almost unchanged over a decade, despite the country’s strong geothermal potential of around 20 GW. Following the March 2011 nuclear disaster, the Government has re-started the geothermal production opportunity and mitigation of constraints in national parks, promoting new private sector exploration activities and prompt installation of small binary systems. Around 40 exploration or growth projects are underway. Area of activity is respectively, as follows: Akita (88 MWe), Kagoshima (65 MWe), Miyagi (15 MWe), Oita (155 MWe), Kagoshama (60 MWe),
Tokamachi (2 MWe), Hachijo-Jima (3 MWe), Hokkaido (25 MWe) and Tokamachi (2 MWe) [29].

Iceland

The geological features of the country (its Mid-Atlantic Ridge location) promote the widespread use of Iceland's energy supply of geothermal energy. Geothermal energy’s share in Iceland's primary energy supply is around 69%, exceeding 90% of all the household energy used. The production of geothermal energy began 45 years ago, now hitting 29% of the total energy consumption. The total installed capacity is now 665 MWe and the annual generation is about 5250 GWh, of the following sectors: Námafjall 3 MWe, Hellisheidi 303 MWe, Húsavík 2 MWe [28].

Energy Savings

Other forms of energy use, particularly fossil fuels, can be replaced by geothermal, a domestic source of sustainable and renewable power. Geothermal energy contributes to a decrease in the dependency of several countries on imported fuels which ensures the removal of contaminants such as carbon particles and greenhouse gases in all countries [33]. There is an attempt to measure the fossil fuel economy with an efficiency factor of
0.35 for the generation of electricity using the rivals and 0.70 for the output of heat, for instance in an oven. The savings will be 474 million barrels or 64.4 million tonnes of oil (300 lbs / barrel = 136 kg / barrel = 42 gallons / barrel = 159 L / barrel @ density = 0,855 kg / L) with 1,020,887 TJ / yr energy being consumed in direct geothermal applications by 2020 (see Table 1) and predicting fuel oil content 6,15 x 109 J and fuel being used to produce electricity. The savings would be 237 barrels or 32,2 tonnes if the oil were used directly to generate electricity by heating it. True economies between these two values are most likely. Note that the world consumption of 474 million barrels is about 1.6 days [34].

The data from the Lawrence Livermore Laboratory for the United States was used. The following savings will be made for biomass, CO2, SOx , NOx (also see Table 11) by the Department of Energy (Kasameyer, 1997) and private consultants Goddard and Goddard (1990). Carbon savings will be 20.32 tonnes / TJ of gas compared to energy, 86.81 tonnes / TJ of oil or 100.82 tonnes / TJ of coal, respectively, for a combined CO2 savings of 14.81,

63.38 and 73.62 million tonnes [34]. The CO2 savings of 268,07 million tonnes, respectively, will be 54,27, 229,88, 268,07 million tonnes, with 193 kg / MWh (53.6 tonnes / TJ), 817 kg / MWh (227.0 tonnes / TJ) and 953 kg / MWh (264,7 tonnes / TJ) for carbon diOxide emissions, respectively. The economies of 0,33, 1.39 and 1.51 million tonnes, and 14.06, 42.22 and 45.76 thousand tonnes, of NOx, in the form of SOx and NOx produced by electricity from gas or oil or coal. The biomass, CO2, Sox and NOx emissions would be half those values if the heat were generated by burning those fuels. Again, the real savings between these values would be that a mixture of fossil fuels would be used in the production of heat and electricity [33]. If we accept emission reductions in geothermal heat pumps which are not geothermal, the annual additional reductions in fuel oils are about 122 million barrels (18,1 million tonnes) and 15,5 million tonnes in fuel oil emissions [35]. This means that the annual cooling energy is around half that used in the heating mode. The above figures are summarized in Table 5 below:

Table 5: Direct-use Worldwide Saving in Energy, Carbon and Greenhouse Gases Using Geothermal Energy Including Geothermal Heat Pumps in the Cooling mode (in Millions) in terms of fuel oil (bbl = 42-gallon barrels).

	Fuel oil bbl	Fuel oil TOE	Carbon TOE	CO2 TOE	SOx TOE	NOx TOE
As Electricity	596	81.0	78.1	252.6	1.75	0.054
As Fuel Oil	298	40.5	39.0	126.3	0.89	0.027

Conclusion:

From 1990, the renewable energy sources are growing average 1.9% per year. The growth of wind energy is 24.4%, liquid biomass 8.1%, solid biomass 1.6% [20].According to the World Geothermal Congress 2005 (WGC2005), from 1995 the growth of geothermal energy was "almost two-fold for direct-use (6.6% annually without heat pumps) and 1.3 times for electric power capacity (2.7% annually). The growth for direct-use was almost two-fold (6.6% annually without heat pumps) and 1.5 fold (4.1% annually) for electricity generation [21- 22]. In North America and Europe the annual growth of the geothermal energy production by heat pumps 19.6% but worldwide this rate is 23.6% [20]. In sense of cleaner, environment friendly and sustainable energy system the geothermal energy plays a very important role in the world. It is one of the renewable energy sources that can supply continuous base load power just like fossil fuels. Since 1980, the price of the electricity from geothermal plants is declining. In USA to produce one kilowatt-hour of electricity from geothermal facilities cost about

$0.08 that is also included a production tax credit in USA [23]. It is also possible to use geothermal resources as a heating source for homes and businesses in any location. Geothermal heat founds everywhere under the earth surface but the conditions that make water circulate to the surface are found only in less than 10% of Earth's land area. Many oils and gas fields are under observation to find the possibility to produce electricity by geothermal. Many existing oil and gas reservoirs has significant amount of high-temperature water and high-pressure conditions, which allows to produce electricity from oil or gas, and at the same time these wells can be used for geothermal energy production.

References

1) Bilen, K., Ozyurt, O., Bakırcı, K., Karslı, S., Erdogan, S., Yılmaz, M., & Comaklı, O. (2008). Energy production, consumption, and environmental pollution for sustainable development: A case study in Turkey. Renewable and Sustainable Energy Reviews, 12(6), 1529-1561.
2) Davies, E. G., Kyle, P., & Edmonds, J. A. (2013). An integrated assessment of global and regional water demands for electricity generation to 2095. Advances in Water Resources, 52, 296-313.
3) Kuang, Y., Zhang, Y., Zhou, B., Li, C., Cao, Y., Li, L., & Zeng, L. (2016). A review of renewable energy utilization in islands. Renewable and Sustainable Energy Reviews, 59, 504-513.
4) Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. Applied Energy, 248, 18-34.
5) Barbier, E. (2002). Geothermal energy technology and current status: an overview. Renewable and sustainable energy reviews, 6(1-2), 3-65.
6) Duffield, W. A., & Sass, J. H. (2003). Geothermal energy: Clean power from the earth's heat (Vol. 1249). US Geological Survey.
7) Hakkarainen, T., Tsupari, E., Hakkarainen, E., & Ikäheimo, J. (2015). The role and opportunities for solar energy in Finland and Europe. VTT Technology, 217, 6-16.
8) Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. Applied Energy, 248, 18-34.
9) Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. Applied Energy, 248, 18-34.
10) Sharif, S. I., Anik, M. A. R., Al-Amin, M., & Siddique, M. A. B. (2018). The Prospect of renewable energy resources in Bangladesh: A study to achieve the national power demand. Energy and Power, 8(1), 1-6.
11) Sengupta, P. K. (2017). Industrial Water Resource Management: Challenges and Opportunities for Corporate Water Stewardship. John Wiley & Sons.
12) Kabir, E., Kumar, P., Kumar, S., Adelodun, A. A., & Kim, K. H. (2018). Solar energy: Potential and future prospects. Renewable and Sustainable Energy Reviews, 82, 894-900.
13) Jiachao, H.: Assessment and Management of Sedimentary Geothermal Resources, Thesis, M.S. Degree. Faculty of Earth science, University of Iceland (2012)
14) Saemundsson, K., Axelsson, G., & Steingrímsson, B. (2009). Geothermal systems in global perspective. Short Course on Exploration for Geothermal Resources, UNU GTP, 11.
15) Zeng, Y. C., Wu, N. Y., Su, Z., Wang, X. X., & Hu, J. (2013). Numerical simulation of heat production potential from hot dry rock by water circulating through a novel single vertical fracture at Desert Peak geothermal field. Energy, 63, 268-282.
16) Moeck, I. S. (2014). Catalog of geothermal play types based on geologic controls. Renewable and Sustainable Energy Reviews, 37, 867-882.
17) Condie, K. C. (2013). Plate tectonics & crustal evolution. Elsevier.
18) Masum, M. (2015, April). Low-Temperature Geothermal Systems in Sedimentary Basin and Their Prospect in Bangladesh. In Proceedings World Geothermal Congress.

19) Masum, M. (2015, April). Low-Temperature Geothermal Systems in Sedimentary Basin and Their Prospect in Bangladesh. In Proceedings World Geothermal Congress.
20) Manzella, A., Bonciani, R., Allansdottir, A., Botteghi, S., Donato, A., Giamberini, S., ... & Scrocca, D. (2018). Environmental and social aspects of geothermal energy in Italy. Geothermics, 72, 232-248.
21) Zarrouk, S. J., & Moon, H. (2014). Efficiency of geothermal power plants: A worldwide review. Geothermics, 51, 142-153.
22) Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. Applied Energy, 248, 18-34.
23) Epting, J., Müller, M. H., Genske, D., & Huggenberger, P. (2018). Relating groundwater heat-potential to city-scale heat-demand: a theoretical consideration for urban groundwater resource management. Applied Energy, 228, 1499-1505.
24) Duram, L. A. (2018). Environmental Geography: People and the Environment. ABC-CLIO.
25) Renzaho, A. M., Kamara, J. K., & Toole, M. (2017). Biofuel production and its impact on food security in low and middle income countries: Implications for the post-2015 sustainable development goals. Renewable and Sustainable Energy Reviews, 78, 503-516.
26) Wang, G., Wang, W., Luo, J., & Zhang, Y. (2019). Assessment of three types of shallow geothermal resources and ground-source heat-pump applications in provincial capitals in the Yangtze River Basin, China. Renewable and Sustainable Energy Reviews, 111, 392-421.
27) Moya, D., Aldás, C., & Kaparaju, P. (2018). Geothermal energy: Power plant technology and direct heat applications. Renewable and Sustainable Energy Reviews, 94, 889-901.
28) McCabe, K., Gleason, M., Reber, T., & Young, K. R. (2017). Characterizing US Heat Demand Market for Potential Application of Geothermal Direct Use (No. NREL/CP-6A20-68522). National Renewable Energy Lab.(NREL), Golden, CO (United States).
29) Alhamid, M. I., Daud, Y., Surachman, A., Sugiyono, A., Aditya, H. B., & Mahlia, T. M. I. (2016). Potential of geothermal energy for electricity generation in Indonesia: A review. Renewable and Sustainable Energy Reviews, 53, 733-740.
30) Pan, S. Y., Gao, M., Shah, K. J., Zheng, J., Pei, S. L., & Chiang, P. C. (2019). Establishment of enhanced geothermal energy utilization plans: barriers and strategies. Renewable Energy, 132, 19-32.
31) Melikoglu, M. (2017). Geothermal energy in Turkey and around the World: A review of the literature and an analysis based on Turkey's Vision 2023 energy targets. Renewable and Sustainable Energy Reviews, 76, 485-492.
32) Gutiérrez-Negrín, L. C., Canchola Félix, I., Romo-Jones, J. M., & Quijano-León, J. L. (2020). Geothermal energy in Mexico: update and perspectives. In Proceedings, Proceedings World Geothermal Congress.
33) Noorollahi, Y., Shabbir, M. S., Siddiqi, A. F., Ilyashenko, L. K., & Ahmadi, E. (2019). Review of two decade geothermal energy development in Iran, benefits, challenges, and future policy. Geothermics, 77, 257-266.
34) Lund, J. W., & Boyd, T. L. (2016). Direct utilization of geothermal energy 2015 worldwide review. Geothermics, 60, 66-93.
35) Chandrasekharam, D., Lashin, A., Al Arifi, N., & Al-Bassam, A. M. (2016). Red Sea geothermal provinces. CRC Press.
36) Huttrer, G. W. (2020). Geothermal power generation in the world 2015-2020 update report. In World Geothermal Congress; International Geothermal Association: Reykjavik, Iceland.
37) Huttrer, G. W. (2020). Geothermal power generation in the world 2015-2020 update report. In World Geothermal Congress; International Geothermal Association: Reykjavik, Iceland.