

IGA ACTIVITIES

Message from the Executive Director

Greetings to all members of IGA and those that are reading this newsletter. We hope the third Quarter of 2018 has been a good one for all of you.

The past months have brought some very sad news with first the passing of Mr Ruggero Bertani (Photo 1, next page), a beloved geothermal friend and colleague who is deeply missed by many (*see* IGA News 112, pp. 2-3). On behalf of the IGA and its members we have expressed our sincere condolences to family and friends, and we wish them all strength in this difficult time.

The IGA Board was also confronted with the passing of fellow Board member Mr Noel Salonga from the Philippines. Mr Salonga was loved by many in the

geothermal community and is referred to as a very kind person, passionate about geothermal energy.

On behalf of the IGA and its members we have expressed our sincere condolences to family and friends of Noel Salonga, and we wish them all strength in this

difficult time.

Activities at IGA

For us at the IGA we have been going through a lot of excitement after the successful BoD meeting in Reykjavik where so many decisions have been made by the Board. We have been working hard on our transition to Bonn, and we are happy with the progress so far. As of 1 January 2019 the IGA Team will be seated in Bonn, where we will be close to strong partners such as UNFCCC, IRENA, World Wind Energy Association, the 100%Renewables Platform and the



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International Climate Agency. In addition, we will position ourselves in the direct vicinity of important German Ministries and governmental agencies which are keen supporters of the Global Energy Transition agenda.

WGC2020

Progress is made towards WGC2020 and I invite all of you to visit us online at www.wgc2020.com/, and submit your abstracts before 31 January 2019. As you may know, the Board has also decided to change the frequency of the World Geothermal Congress from five to three years effective from the next one, WGC2020. This means that the first one after WGC2020 will be organised in 2023 and tenders will be opened in Quarter 3 of 2018. We are working full speed to get us ready for tendering, and at Board of Directors Meeting #69 in Reno we will see a decision on how we are going to operate.

Highlights

Highlights of the past few months are the continued focus on being visible and raising the geothermal flag at conferences, panel discussions and workshops. Geothermal is still invisible at the national and multi-lateral level, and it is the mission of the IGA to consistently raise the flag on the enormous potential of geothermal energy as an enabler of the Energy Transition at national and international fora. In addition, the IGA keeps on pushing for stronger collaboration with the Oil and Gas Industry and is working alongside many petroleum associations such as the EAGE, AAPG and IADC to seek synergies and build communities of practice. We are setting up strategic initiatives around major themes, including the UNFC standardizations on geothermal reserves and resources estimations and the Geothermal Sustainability Assessment Protocol (GSAP). I invite all of our members to submit your



Photo 1. The international geothermal community mourns the loss of Ruggero Bertani.

interests and your ideas to iga@lovegeothermal.org.

IGA BoD Meeting – October 2018

IGA Board meeting #69 took place in Reno, U.S., from 12 to 14 October and was hosted by the GRC at the Peppermill Casino. The GRC conducted its annual meeting from 14–17 October in the same venue.

For now I wish you a fantastic remainder of the year and I hope to hear from you at one of our events or visit us online and drop us a note.

Best wishes,

Dr. Marit Brommer, Executive Director, IGA –
marit.brommer@hs-bochum.de

The Colombian Geothermal Association

Ángela Prieto, Secretary of the AGEOCOL

On January 1, 2018 the Colombian Geothermal Association (AGEOCOL, Asociación Geotérmica Colombiana) was formalized under the Bogota Chamber of Commerce and started working officially. Several initiatives to gather people interested in geothermal energy in Colombia started in the last five years. While the efforts of isolated people were not that effective, a group of like-minded people, passionate for geothermal, gave it a kick start in 2017.

AGEOCOL's main purpose is to facilitate the interaction among communities, government, industry and academia, for the promotion of research, development and use of geothermal resources in Colombia with social and environmental responsibility,



IGA team in Bochum in September 2018.

under the values of leadership, unity and solidarity. AGEOCOL is supporting already existing groups and activities related to geothermal energy in Colombia and will look for opportunities for them to thrive and be known in the region and internationally. This includes the annual geothermal gathering RENAG (Reunión Anual de Geotermia), the GRC student chapters, and regional technical meetings.

The Association has a membership base of over a hundred people including professionals, students and people interested in developing and undertaking geothermal projects. It became a member of the IGA in 2017. AGEOCOL BoD is composed of Pablo Aguilera as the President, Valeria García as Vice-President, Ángela Prieto as the Secretary and Carolina Coronado as the Treasurer.

You can contact us in ageocol@ageocol.org and find us [here](#).

In Memoriam: Marcelo J. Lippmann

Luis C.A. Gutiérrez-Negrín, Editor

On September 10th Marcelo Julio Lippmann passed away in Berkeley, California. He was an Argentina-born geologist, retired from the Lawrence Berkeley National Laboratory (LBNL) in 2005 but continued as a rehired retiree up until 2015. He remained as an LBNL affiliate up until the time of his passing.

Marcelo received a BS in Geology from the University of Buenos Aires, Argentina, in 1966, a MS in Engineering from the University of California at Berkeley in 1969, and a PhD in Engineering Sciences (Geological Engineering) from the same UC Berkeley in 1974. His PhD Thesis, Two-Dimensional Stochastic Model of a Heterogeneous Geologic System, reflects well his main scientific interests: geology and geothermal modeling.

Marcelo's first work was in the Instituto Nacional de Geología y Minería of Argentina in 1963-1966 as Assistant Geologist and in 1966-1967 as Sedimentologist, and in parallel he joined the Department of Geology of the University of Buenos Aires in 1965-1966 as Teaching Assistant. Between January and September 1967 he worked as hydrogeologist for the company Hidrosud, SA (representatives of Gilbert Associates Inc.), based in Buenos Aires, Aires.

After that Marcelo moved to California where he joined the Department of Civil Engineering of the UC Berkeley as Research Assistant from 1967-1969 and 1971-1973, and as Assistant Research Engineer in January 1974 through September 1977.

Marcelo joined the Earth Sciences Division of the LBNL in October 1977. He co-led the Mexican-American cooperative program at the Cerro Prieto geothermal field from 1977 to 1982 and helped lead several other international geothermal research projects. Marcelo was the head of LBNL's Geothermal Program from 1985-2000, being responsible of outlining research directions in accordance to the needs of the sponsoring agencies and the Laboratory, and was in charge of managing the group's manpower and funding. He was in charge of assessing geothermal fields with emphasis in determining their energy capacity and commercial longevity and designing exploitation strategies, having studied the fields of Cerro Prieto in Mexico, Heber in the U.S., Miravalles in Costa Rica, and Ahuachapán in El Salvador, among others. He also carried out research in geohydrology and in heat and mass transfer in geologic environments.



Marcelo was an advisor on ground water and geothermal systems evaluation, and lectured many geothermal courses and workshops. He offered technical assistance to the United Nations (UNDP in 1994 and UNDESA/DSD in 1998) and to the Latin American Organization of Energy (OLADE) in 1993-1994, on matters related to the evaluation and development of geothermal resources and training of geothermal personnel. He was also a member of the CEL/GESAL/IDB El Salvador Geothermal Advisory Panel in 1995-2001.

Marcelo served as Editor-in-Chief of the journal *Geothermics* from 2004 to 2008, as Associate Editor in 1992-1995 and 2009-March 2010, and as Emeritus Editor since April 2010. There, he made technical reviews of manuscripts and other editorial activities like solicitation of papers, selection of reviewers, evaluation of comments, communication with authors, acceptance of papers, and so on.

Marcelo was active with the Geothermal Resources Council (GRC), having served as a board member in 1999-2000 and 2004-2009, member of the Education, Honors and Awards, and International committees since 1995, and member of the organizing committees of the 2001, 2003, 2010, 2011 and 2012 annual meetings. The GRC recognized his extensive scientific achievements and contributions to the geothermal community in 2001 with the Special Achievement Award, and in 2010 with the Joseph W. Aidlin award, the highest award bestowed by the Council.

Marcelo also served as a board member for the International Geothermal Association (1993-1998), and member of its Information Committee, among others.

In its 22nd Annual Congress, held in Cuernavaca, Morelos, in March 2015 the Mexican Geothermal Association (AGM) awarded a Special Recognition to Marcelo in order “to highlight his contribution to the geothermal development in Mexico and Latin America”. Being unable to travel to Mexico, Marcelo appointed his long-time friend and countryman Eduardo R. Iglesias to receive the award on his behalf... More than three years later, Eduardo has written in the on-line Marcelo’s Memorial (<https://mjlippmann.wordpress.com/>) the following memories:

“...In 1977 the murderous military government (30,000 disappeared) that took over (the Argentinian Government) in 1976 revoked my fellowship and ordered me and my family back to Argentina. A few months later Marcelo started to encourage me to go back to California to interview for a new job. As a result I landed a job at the then LBL Earth’s Sciences Division, in the Nuclear Waste Containment group. This group shared the building with the Geothermal group, which at the time was engaged in the bilateral DOE-CFE agreement on Cerro Prieto... Thus I was invited to join the Geothermal group and started working under Marcelo’s supervision... Marcelo saved me and my family from the horrors of the military government. This is just one example of Marcelo’s helpful, generous character...”

Marcelo is survived by his wife Martha Alcira-Lippmann, his son Julian, his daughter-in-law Jessica Owley-Lippmann, and two granddaughters.

WGC2020: Call for Abstracts



**WORLD
GEOTHERMAL
CONGRESS
2020 REYKJAVIK**

UPCOMING EVENTS

[Reunión Nacional de Geotermia RENAG 2018](#)

December 11-15, 2018, Bogota, Colombia

[44th Stanford Geothermal Workshop](#)

11-13 February 2019, Stanford, CA, U.S.

[European Geothermal Congress 2019](#)

11-14 June 2019, The Hague, The Netherlands

[World Geothermal Congress 2020](#)

27 April-1 May 2020, Reykjavik, Iceland

[Submit abstracts before 31 January 2019](#)

Note: Please check the [IGA website](#) for more events.

The call for abstracts for the World Geothermal Congress 2020 was launched by the Technical Committee, chaired by Roland N. Horne, and the deadline (January 31, 2019) is now approaching.

The author instructions are on the web at <http://www.wgc2020.com>. The list of themes is grouped into four main subjects, as follows:

General

- Keynote
- Country Updates
- Environmental Aspects
- Policy, Legal and Regulatory Aspects
- Economics and Financing
- Sustainability and Climate Change
- Case Histories
- Societal and Cultural Aspects
- Business Strategies
- Geothermal Education

Geoscience

- Exploration
- Geology
- Geophysics
- Geochemistry
- Hydrogeology
- Resource Assessment
- Geomicrobiology

Engineering

- Drilling and Completion Technology
- Reservoir Engineering
- Injection Technology
- Field Management
- Production Engineering, Steam Gathering Systems
- Power Generation
- Corrosion and Scaling
- Direct Use

Geothermal Heat Pumps

Cross-cutting

EGS - Enhanced Geothermal Systems

Big Data and Data Analytics

Software for Geothermal Applications

Health, Tourism and Balneology

District Heating

Agriculture

Advanced Technology (Magma, Geopressure, etc.)

Integrated Energy Systems, Cascaded Uses

Minerals Extraction and Processing

Other

More info: <http://www.wgc2020.com/>**AFRICA****Ethiopia: Funds for Feasibility Study of Geothermal Project**

The U.S. Trade and Development Agency (USTDA) awarded a grant to TM Geothermal Operations Private Limited Company (TMGO), an Ethiopia-based company, to coordinate a feasibility study supporting development of the first 50 megawatts of a planned 520-megawatt Tulu Moya Geothermal project in the Main Ethiopian Rift. The study will be conducted by U.S. firm, Delphos International, Ltd.

geothermal power generation and over US\$4 billion of private investment in Ethiopia.

“USTDA is pleased to support this important project which will foster energy diversification and improve access to affordable and reliable electricity in Ethiopia,” said Thomas R. Hardy, USTDA’s Director of Congressional and Public Affairs. “This study will also create opportunities for U.S.”

Chief Executive Officer of TMGO, Darrell Boyd, added, “By enabling TMGO to progress technical, environmental, legal, and financial workstreams for the Tulu Moya geothermal project, USTDA’s study is a key component to its success.”

Managing Director of Delphos International, Slav Gatchev, also stated, “Delphos and its leading U.S. subcontractors look forward to delivering a bankable package to the grantee so that this landmark project may move forward expeditiously.”

Chargé d’Affairs for the U.S. Embassy in Addis Ababa Troy Fitrell said, “The United States has a long history of working to support Ethiopia’s economic development... This project brings together a U.S. firm and an Ethiopian company –an example of how private-sector collaboration between our countries can achieve shared goals for mutual benefits.”

Troy Fitrell signed the grant along with TMGO’s Chief Executive Officer, Darrell Boyd. Dr. Frehiwot Woldehanna, State Minister of Water, Irrigation and Electricity, witnessed the signing.



In other related news, it was unveiled that the Tullu Moya Geothermal Operations Private Limited Company has embarked on the development of the 520 MW geothermal project, with an outlay of two billion dollars. The company plans to develop the project in four phases. Reykjavik Geothermal (RG), an Icelandic company, and Meridiam, a US firm, are shareholders of Tullu Moya Geothermal Operations.

The power purchasing agreement (PPA) was signed by the Ethiopian Electric Power (EEP) and the Ministry of

Finance and Economic Cooperation along with Corbetti Geothermal project on December 2017.

Sources: <https://ustda.gov/news/press-releases/2018/us-supports-geothermal-power-ethiopia-creating-opportunities-us-businesses>,

In December 2017, Ethiopian Electric Power (EEP) signed implementation agreements and power purchase agreements allowing the private sector to develop the Corbetti and Tulu Moya geothermal projects. These historic agreements will support 1000 megawatts of

<https://www.thereporterethiopia.com/article/company-embarks-usd-2-bl-geothermal-project>

Kenya: Baringo-Silali, Olkaria I Unit 6, and Akiira Projects

Drilling Started at Baringo-Silali Block - The Geothermal Development Company (GDC) has started drilling wells in Baringo County, in search of steam power. The company's general manager in-charge of drilling and infrastructure, George Kinyanjui, said the first phase of the project at Baringo-Silali Block will be seeking to produce steam that can generate 300MW of electricity to be injected into the national grid.

Kinyanjui added they have identified Paka, Silale and Korossi as prospect areas with each expected to generate more than 100MW. "GDC is currently developing water systems in the project area with more than 20 wells already drilled in Korosi, Paka and Silale. We have also managed to open the road network to the project area with more than 120 kilometers completed," said Kinyanjui.

"We've already put in place drilling wells, three in each of the prospect areas. Drilling works will commence soon once the water system is complete," he stated.

The company has already installed community distribution systems and nine storage tanks, each with a capacity of 4.5 million liters.

GDC expects to generate more than Sh11.5 billion (US\$114.6 million) annually from the project with 15% of the total revenue being channeled to benefit the communities surrounding the resource areas.

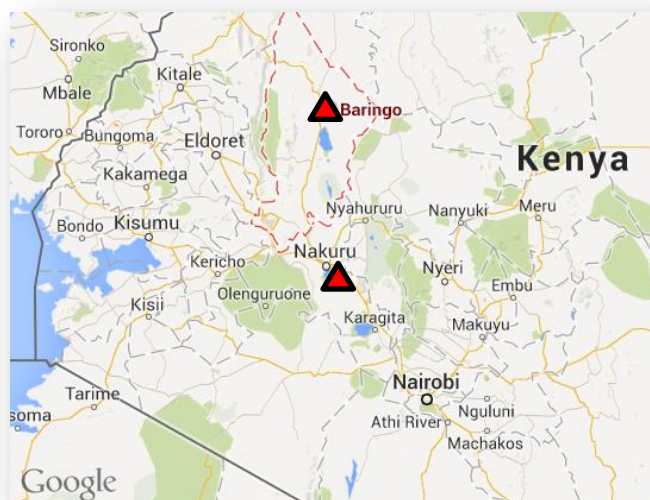
Source: <https://www.esi-africa.com/kenya-geothermal-development-company-to-commence-drilling-wells/>

Sixth Power Unit in Olkaria to Be Completed in 2021 – The Japanese company Marubeni Corporation has been awarded a full turn-key engineering, procurement and construction (EPC) contract from Kenya Electricity Generating Company Limited (KenGen) in relation to the construction of a 70MW geothermal power plant in the Olkaria geothermal field of Nakuru County.

The Olkaria I facility is Kenya's first geothermal power station and one of the largest in Africa. It currently runs five turbines with a combined capacity of 185 MW. Marubeni will build for KenGen a sixth power generation unit, which is expected to be completed in 2021. The main components required for this project, such as steam turbines and generators, will be provided to Marubeni by Fuji Electric Co., Ltd. This is Fuji Electric's first geothermal power plant in Africa.

The project will be financed by an ODA (Official Development Assistance) loan from Japan International

Cooperation Agency (JICA) and also by loans from the European Investment Bank (EIB).



The electrical peak demand in Kenya has been increasing by an average of approximately 5% annually. Under its long-term development program (Kenya Vision 2030), the Kenyan government has set a target to expand its geothermal power capacity to 5000 MW by 2030.

Sources:

<https://www.marubeni.com/en/news/2018/release/20180831E.pdf>, <https://renewablesnow.com/news/fuji-electric-confirms-70-mw-geothermal-order-in-kenya-626611/>

Update on the Akiira Project - Akiira Geothermal Limited (AGL) is the developer of a two-phased 140MW power project with the first phase being the development of 70MW. The project is in the Naivasha area of Nakuru County, Kenya. The project is expected to contribute to the base load power requirements of the national grid as per Government of Kenya's policy. AGL is jointly owned by Centum Investment Company Plc (via Mvuke Power Ltd) (37.5%), DI Frontier Energy Carbon Fund (37.5%), Marine Power Generation (15%) and RAM Energy Inc. (10%).

To date, AGL has invested US\$ 31.6 million, of which US\$2.3 million are grants from Seed Capital Assistance Facility, OPIC and the Geothermal Risk Mitigation Facility (GRMF).

AGL is working towards further drilling in Q4 of 2018 to complete exploratory drilling and achieve target financial close by Q4 2019. AGL is in advanced stages of organizing the project finance from various lenders and the award process for both the Engineering, Procurement and Construction (EPC) and Operations and Management (O&M) contracts is expected to be finalized with financial close of the project.

It is anticipated that AGL will commence production drilling and power plant construction for the first phase 70MW in early 2020 and achieve commercial operation in early 2022. In respect of the second 70MW phase, it is anticipated that in 2020 AGL will simultaneously start the exploratory studies and drilling aiming to deliver the second phase of project by year 2024.

AGL have drilled two initial wells, which did not produce sufficient steam for the planned plant, whose cost was around SH1.2 billion (US\$11.8 million), according to David Njorge, Centum director of developments. "The next well we are sinking we need discharge that is sustainable that we can hook onto our power plants. We want to do the three wells first," said Mr Njorge. He said the firm could ramp up its exploration activities if the planned sinking of additional three well does not lead to productive discharge.

Sources:

http://www.centum.co.ke/images/docs/Statement_by_Centum_Investment_on_Akiira_Geothermal_Ltd.pdf,
<http://www.thinkgeoenergy.com/despite-initial-challenges-akiira-geothermal-to-continue-exploration-in-kenya/>

AMERICAS

Chile: Presentation of Report by the Geothermal Roundtable

The Geothermal Roundtable of Chile was a request from the Geothermal Council of Chile through its Chairman, Gonzalo Torres Macchiavello, to the Ministry of Energy. It was financed by the ESMAP/World Bank and counted with the active participation of the industry, academia and social actors.

The process consisted of 13 workshop sessions held during 2017 and the preparation of the final report took place in the first semester of 2018 which ended covering two successive Government Administrations (from different political wings). An average of 40 people attended every workshop, representing 34 entities.

The Geothermal Roundtable focused on determining CAPEX, OPEX, modelling the insertion of the technology into Chile's energy matrix, identifying barriers to entry and proposing Public Policies to provide incentives for geothermal development.

The final report was released in July 2018, in a ceremony summoned by Susana Jiménez (Minister of Energy of Chile) and attended by Gonzalo Torres Macchiavello. The final report includes the most important points raised by the industry and will play a crucial role in the development of the industry.

Currently Chile has over 25% of the world's active volcanoes. Based on existing exploration work the geothermal potential is between 1300 and 3800 MW and can bring over US\$20 billion in investments. Between 2018 and 2050 the report estimates it's possible to develop 2100 MW, with 700 MW in 2018-2030 and 1500 MW in 2031-2050.

The current unitary cost of an average geothermal project (CAPEX) is estimated by the report in US\$6.16 million per MW, which is predicted to decrease more than 20% by 2050.

Source:

http://geothermalresourcescouncil.blogspot.com/2018/07/chile-geothermal_26.html

Ecuador: Exploration Drilling Reported in Chachimbiro

At the GEOLAC 2018 Conference, held in Mexico City, on July 17 and 18, the state of the geothermal industry in Ecuador was presented. It was informed that in November 2017 the first geothermal exploration well was drilled in the geothermal field of Chachimbiro. The well was financed by the Japanese agency JICA, through a non-reimbursable fund. The results of the well are positive, since a temperature of 235°C was measured.



The second stage of this project includes the drilling of 6-10 additional wells and the installation of a wellhead unit up to 5MW. The government of Ecuador will manage a loan with the government of Japan through JICA and the execution of the second stage will be tendered by the public generation and transmission company CELEC EP under the JICA regulations. According to the results of this stage, the construction

of a plant with an estimated capacity of 50 MW would be continued.

In the other most promising geothermal area, called Chacana, the development of a thermal gradient study is planned, for which gradient wells will be drilled. With these results the objectives of deep drilling will be defined. This project is 40% financed by the GDF (Global Development Fund) and CELEC contributes the remaining 60%. The GDF funds were obtained in the first call made by GDF.

At the GEOLAC conference it was announced that in recent years the Government of Ecuador has promoted a program for the creation of local geothermal capacities, through training programs developed with countries with vast experience such as Iceland, Japan, El Salvador (LaGeo) and Costa Rica (ICE). In addition, it developed infrastructure for the execution of exploration campaigns, for which CELEC acquired geophysical equipment, implemented a rock laboratory and is implementing a laboratory for the analysis of water and gases.

Source: <http://www.thinkgeoenergy.com/ecuador-to-advance-with-geothermal-exploration-at-chachimbiro-and-chacana/>

Guatemala: Flow Tests in Wells of the Mita Geothermal Project

John Robins, Executive Chairman of Bluestone Resources Inc., commented in early September, "In just over 15 months since acquiring the Cerro Blanco Gold and Mita Geothermal projects, Bluestone has advanced from what was effectively a shell company to one that is rapidly advancing these high-quality projects."

Flow testing of select geothermal wells was completed at the Mita Geothermal project. Equipment was installed onsite and four geothermal wells were tested for power generation capabilities. Multiple wells were flow tested for extended durations. The data collected fed into a new reservoir calculation that is expected to demonstrate an economic geothermal resource, as well as an estimated power generation capacity for a potential first phase project. Further drilling and follow up on the deeper reservoir, projected beneath the Mita geothermal concession, could have the potential to increase the projected power generation capabilities in the future.

Further studies are ongoing in this area in conjunction with synergies from the Cerro Blanco Gold project. Bluestone envisions a staged approach, with Phase 1 being a smaller operation that could supplement power requirements to the mine or be sold into the privatized

national grid. A larger development could then be examined in the future as a Phase 2.

Several initiatives establishing business processes in human resources, risk management, and health and safety commenced as part of preparations for advancement beyond completion of the Feasibility Study. In addition to working with expert consultants and non-government organizations to enhance and broaden our stakeholder management and engagement priorities, Bluestone says it's pleased to have commenced work with local and international industry-leading partners to help bolster the Company's capacity.

Source:

<https://www.geologyforinvestors.com/bluestone-corporate-update/>



Mexico: Financing and Risk Transfer Program, First GHP Project in Operation

IDB's Program for Financing and Risk Transfer for Geothermal Development - The Inter-American Development Bank (IDB) has approved a modification of a loan totaling US\$108.6 million that aims to increase private investment in electricity generation projects from geothermal sources, putting at the developers' disposal a number of financial mechanisms tailored to meet the specific needs of each project at every step of their development.

The mechanisms include exploration, drilling, field preparation, construction and operation of private geothermal projects, as well as reducing the value at risk for developers, which is the main barrier to investment. The program's goal is to finance up to 300 MW of geothermal capacity over a 10-year period. It also hopes to leverage other public and private funds to contribute to Mexico's geothermal sector with estimated investment levels to the tune of US\$4.2 billion for proven geothermal reserves.

The Program for Financing and Risk Transfer for Geothermal Energy in Mexico, structured under the global loan modality, will consist of two main components: risk mitigation for geothermal projects and financing adapted to the different phases of project exploration and execution. In addition, it will have a third component of technical assistance to support execution and other implementation costs.

Mexico is the main emitter of greenhouse gases from fuel burning in Latin America and No. 12 in the world. Its ambitious goals include reducing these emissions by 25% by 2030, with the energy sector having the biggest reduction potential. Moreover, 80% of Mexico's energy continues to be derived from fossil fuels, making it even more imperative to transform the country's energy generation system to make it more sustainable and profitable.

"Geothermal power is baseload energy, with a capacity factor of 95%-plus, allowing to have electricity available 24-7 at a competitive price, much like natural gas. Like solar and wind energy, it is renewable, but without their characteristic intermittency. It is fully climate-change resilient and has an enormous energy density, which paves the way for getting large amounts of energy in a relatively small area," says Christiaan Gischler, project leader and IDB's geothermal theme team leader. Its direct use has high-impact applications and social advantages. "Low enthalpy (low temperature) applications are crucial for the fruit drying industry, and the use of steam is critical for small- and mid-sized enterprises," he adds.

The program's total amount is US\$108.6 million: US\$54.3 million financed with resources from the IDB's Ordinary Capital, US\$51.5 million from a contingent recovery grant financed with resources from the Clean Technology Fund (CTF); and US\$2.8 million in technical cooperation.

There are currently two processes under way: first an International

Public Tender to pick the companies that will be in charge of performing the drilling work during the exploration phase; and second, a Call for the Selection of the Eligible Developers who want participate in this program. On September 17, the National Institute of Electricity and Clean Energy (INEEL) –which is charge of this Mexican Geothermal Financing Program (PGM)— unveiled the results of the pre-qualification stage. Five companies applied to the program for five distinct geothermal zones under exploration: Geodesa for the project Domo de San Pedro; Geotérmica Derrumbabas for Las Derrumbadas project; ENAL for two projects: Aeropuerto II and Paredones; and Mexxus-RG for Los Ocotillos project. CFE (Comisión Federal de Electricidad), which also applied initially, stepped down later. The five final applicants were accepted to move the next qualification stage, which will start on middle October. The contract is planned to be signed on November 2018, to start the financing program in early 2019.

Sources: <https://www.iadb.org/en/news/mexico-increase-geothermal-energy-generation-idb-support>, <https://www2.ineel.mx/geotermia/content/minimal/th-e-artwork.html>

First Operational GHP Installed in Mexico - The National Institute of Electricity and Clean Energy (INEEL) installed the first Geothermal Heat Pump System (GHP) for air conditioning of housing spaces. It was developed in collaboration with the Comisión Federal de Electricidad (CFE) and financed by the Energetic Sustainability Fund (FSE), which is managed by Conacyt (the National Science and Technology Center) and the Mexican Energy Ministry through the project 13 of the Mexican Center for Innovation in Geothermal Energy (CeMIE-Geo). This demonstration system was inaugurated on August 31 in the community



INEEL personal involved in the GHP project. Photo taken from the source.

of Los Humeros, located within the geothermal field of the same name operated by CFE. It is deemed as the first GHP project to be commercially operating in Mexico.

The project began in 2014, with the approach to the community to inform of its application, operation and expected benefits for the population. The INEEL researchers had the support of the CFE's staff for this approach, and thus the project was enriched with the participation of the Los Humeros community, whose involvement facilitated the execution of the operational tasks.

The Los Humeros community has approximately 500 inhabitants. The annual average temperature is between 12 and 18°C, but in winter it drops between -3 to 10°C. That's why in winter the population, especially infants and the elderly, is commonly affected by respiratory issues. So, it was decided to install the GHP unit near the kindergarten and the medical clinic of the IMSS (the Mexican Institute for Social Security), with the intention of improving the health conditions of the more vulnerable parts of the population.

At national level, the project aims to make visible the use of GHP as a contribution to the country's energy efficiency. It is expected the project demonstrate practically it is possible to integrate and assimilate in Mexico this technology, which is widely used in China, the U.S. and many countries or northern Europe.

The demonstration system installed in Los Humeros, is part of a set of actions aimed to assimilate and tropicalize the GHP technology, lay the foundations for their introduction to the country and promote their massive use in the regions with extreme or cold weather. The CeMIE-Geo has another couple of projects related to GHP.

The official inauguration of the project was held in the Ejidal House of the municipality of Chignautla, and was attended by representative of the CeMIEGeo, CFE, the Ejidal Commission, county of Chignautla and Puebla, and members of the community and the INEEL staff involved in the project.

Source: <https://www.gob.mx/ineel/prensa/ineel-inaugura-el-primer-sistema-demostrativo-de-bomba-de-calor-geotermica-bcg>

U.S.: Exploration, DOE's Funds, Jeff Tester's Remarks, PGV Wells, Expansion of District Heating

Geothermal Exploration in Washington State - The Department of Natural Resources of Washington State plans to drill this year near Mount Baker north of Baker

Lake. Alex Steely, geothermal project manager for the agency's Washington Geological Survey, said drilling will likely be done at the Mount Baker site in September after drilling is completed at a site near Mount St. Helens –an effort that is expected to begin this month.

Two exploration borehole will be drilled near each volcano. Each 2-inch-wide (~5 cm), 1600-foot-deep (~488 m) well, will take about two weeks to drill. Steely said recreation at Baker Lake and in the Mount Baker-Snoqualmie National Forest is not expected to be impacted by the work near Mount Baker, which will be done on forest land that is not open to the public.

Assessing the state's geothermal resources is one of several ways Natural Resources is working to identify renewable energy sources to replace fossil fuels such as coal and natural gas that are used to run power plants, according to an agency email.

"We are doing this work because we believe strongly in helping to foster renewable energy and de-carbonization of the energy grid," Steely said.

"The eventual hope is that there is a resource large enough to run a power plant," Steely said of the Mount Baker site. "But that's a long way off."



View of Mount Baker (Photo by Scott Terrell, Skagit Valley Herald).

The Mount Baker site is promising because of previous evidence of geothermal heat, the presence of water and the proximity to infrastructure that would be needed to transmit electricity onto the energy grid.

If the holes show geothermal resources with temperatures above 100 degrees, additional drilling, temperature testing, rock analysis and mapping would be needed to determine the size and shape of the geothermal resource before a power plant could potentially be built in the area. Steely said that work would take several years and several million dollars to complete.

Source: https://www.goskagit.com/news/geothermal-testing-to-be-done-near-baker-lake/article_6fb40a5a-e8a5-55db-b31c-45393002e6cf.html

Machine Learning in Geothermal Energy - The U.S. Department of Energy (DOE) announced in July up to US\$3.6 million to address early-stage research and development applications in machine learning that will be key to developing technology improvements in exploration and operational improvements for discovered geothermal resources. Through this Machine Learning for Geothermal Energy Funding Opportunity Announcement (FOA), DOE's Geothermal Technologies Office (GTO) will fund 4-6 projects to develop new analytical tools for finding and developing geothermal resources, to establish the practice of using machine learning in the geothermal industry, and maximize the value of the rich datasets utilized in the geosciences.

GTO is providing funding in two areas:

Topic 1: Machine Learning for Geothermal Exploration – GTO seeks projects that advance geothermal exploration through the application of machine learning techniques to geological, geophysical, geochemical, borehole, and other relevant datasets. Of particular interest to GTO are projects that will identify data acquisition targets (including drilling) and build community datasets for future work.

Topic 2: Advanced Analytics for Efficiency and Automation in Geothermal Operations – GTO seeks projects that would apply advanced analytics to power plant and other operator datasets, with the goal of improving operations and resource management.

The application process will include two phases: a Concept Paper phase and a Full Application phase. Only applicants who submitted an eligible Concept Paper by August 23, 2018 will be eligible to submit a Full Application. The Full Application submission deadline is November 1st, 2018.

Source: <https://eere-exchange.energy.gov/default.aspx#FoaIdbf185673-cdec-49cd-aabe-b152fd31e2d5>

Jeff Tester on Geothermal Direct Uses in the U.S. - Jeff Tester is Professor of Sustainable Energy Systems at Cornell University's College of Engineering and Chief Scientist for Cornell's Earth Source Heat initiative. He became worldwide recognized in 2006, when he, leading another 11 geothermal

experts, published the 358-pages seminal paper *The Future of Geothermal Energy: Impact of Enhanced Geothermal Systems on the United States in the 21st Century*, prepared by the Massachusetts Institute of Technology (MIT), under Idaho National Laboratory Subcontract No. 63 00019 for the U.S. Department of Energy, which made clear the huge potential of Enhanced Geothermal Systems (EGS) in that country. Recently he wrote the following small piece in the *Expert Voices* section of *Axios*, stressing the convenience of developing the geothermal direct uses in the U.S.

Less than a decade after it began its program to deploy geothermal energy on a massive scale, China now has the largest amount of geothermal district heating of any country in the world, providing a cleaner, more environmentally friendly way to heat communities and to mitigate the poor air quality that results from burning coal.

The big picture: First used in Idaho in the 1890s, geothermal works by recovering heat naturally stored in the earth. Unlike wind or solar, it provides a consistent, efficient and nearly emissions-free level of energy production when used for heating. While China and other countries push forward with geothermal technology, the U.S. lags far behind, meeting barely 0.01% of our heating demand with it.

Background: In recent decades, the U.S. has begun using wind and solar resources to substitute for coal- and gas-fired electricity generation, and to use biofuels in place of gasoline and diesel oil. These new technologies are important, but a completely low-carbon energy-system transformation should also include geothermal energy, especially since a fifth of the primary energy the U.S. consumes annually is for heating homes and water, and comes mainly from burning fossil fuels.

Many countries are already successfully taking advantage of geothermal district heating's possibilities.

Iceland has almost completely shifted its energy dependency from fossil fuels to renewables in less than 50 years by using the country's high-grade geothermal resources to meet about 95% of heating needs.

In France, more than 750,000 people now rely on geothermal heat.

There are 240 geothermal district heating systems in 14 countries in Europe.

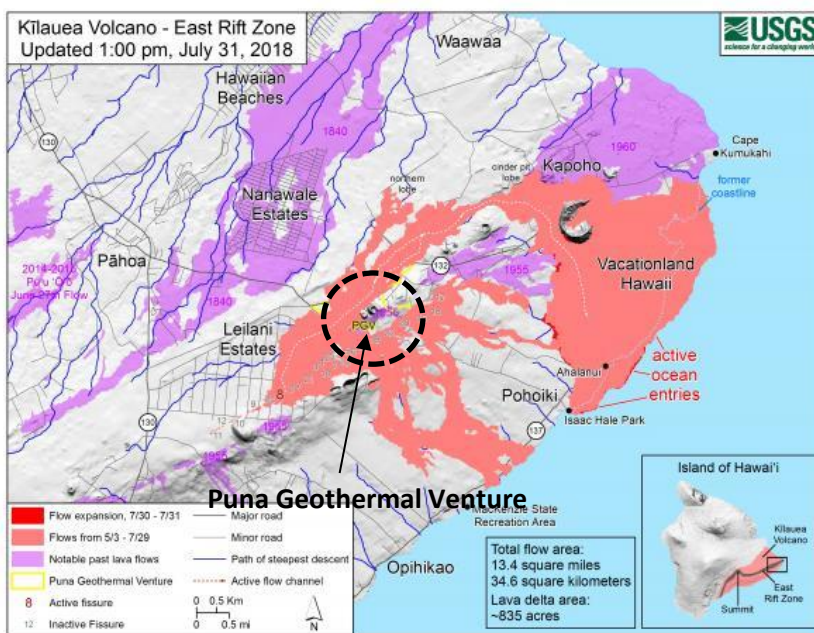
The opportunity: In the U.S., indigenous geothermal resources are well distributed and abundantly available at the right temperatures for heating buildings and water. Developing geothermal resources for district heating now would provide the U.S. with a viable and sustainable long-term replacement for fossil fuels.

Source:



<https://www.axios.com/us-lagging-in-geothermal-energy-as-china-and-others-pull-ahead-ea7ce800-df9b-431c-896c-8b1ab4bb9da2.html>

PGV Wells Were Capped with Barite – During the more critical days of the Kilauea eruption, when lava flows threatened the 38-MW Puna Geothermal Venture (PGV) that used to provide 22-25% of the local power demand in Hawaii, the 11 operating geothermal wells had to be capped in anticipation of the lava eventually reaching them. To do that, the plant workers pumped cold water into all the wells prior to capping them with iron plugs. Then, they removed topside equipment from the wells to present a low-profile to the oncoming lava (see IGA News 112, p. 26).



In late July it was unveiled that, in addition to that procedure, the well-pads were sealed with barite. Barite is an ore composed of barium sulfate that is used as a fire retardant and is capable of harden with high temperature. The only problem was they needed 68 tons of barite to be delivered a.s.a.p. There was when the company Air Charter Service intervened to provide an aircraft capable of flying in the large amount of barite. Richard Thompson, President of ACS Americas, commented: “We were contacted by a specialist freight forwarder to source an aircraft that could fly in a large amount of barite... We found an MD-11 that was capable of carrying the entire shipment in the necessary timescale. The flight went without a hitch and the wells were capped with the barite and deactivated shortly afterwards... Since then, three of the 11 wells at the site have been covered by the lava flow, meaning that it was critical to get the barite delivered as urgently as we managed and in place to protect the wells.”

Source: <https://www.aircharter.co.uk/about-us/news-features/news/acs-helps-to-avert-hawaiian-disaster>

The Oldest District Heating to Be Expanded - Started in 1983, Boise’s geothermal system is the largest of its kind in the United States and sixth largest worldwide, according to city officials, and they want to see it expand. This year, the city received permission from the Idaho Department of Water Resources to increase the amount of water it uses.

According to Public Works Director Steve Burgos, the city plans to grow the system by encouraging buildings that are already near the system to join, as opposed to digging lines farther out of the downtown core.

About a third of downtown Boise is currently heated by geothermal energy, including some of the largest buildings. For all of the 92 buildings and 6 million square feet (55.7 hectares) on the system, it costs the city approximately US\$1000 per month total to heat, resulting in large energy savings for buildings that opt in to the system. Customers on the geothermal system pay for power costs as well as for each gallon of water used by their heat exchanger to warm the building.

The water in the geothermal system flows at 170°F (~77°C), and it is heated by the decay of a large batholith formed from cooled magma beneath the mountains of central Idaho. Snowmelt and rainwater seep into the rocks from the mountains and come in contact with the rock, which is slowly giving off radioactive isotopes as it breaks down, producing a high temperature in the underground rocks. There has been no indications of decreasing water temperature over the last 125 years and the water is not expected to stop being heated to the current temperature for centuries.

Along the Boise foothills, there is an old fault trace that allows water heated by the rock to rise to the surface. There, the city, as well as the other three geothermal districts in Boise, have drilled wells where the water is drawn to the surface and sent to heat offices and homes.

The other districts are operated by the state, powering the state Capitol and a small network run by the Veterans Administration. The third system, which has been in place since 1892, provides hot water to approximately 300 customers along Warm Springs Avenue. According to the Boise Warm Springs Water District website, it is the oldest continuously operating geothermal system in the world.

The water flows into the buildings and then passes through a heat exchanger that transfers the heat through a series of thin metal plates to then be released into the rooms of the structure. Once the water passes through, it is immediately returned to the system and pumped back into the aquifer beneath the city. On an annual

basis, the city pumps between 240 and 290 million gallons (0.9 and 1.1 million of metric tons) of water to heat all 92 buildings on its system.

When the city first started using the geothermal system, the water was dumped into the Boise River. This method worked as a way to heat the buildings, but the water levels in the aquifer began to steadily drop over the next five years. As a solution, the city drilled an injection well in 1999 to return all of the water back into the aquifer. There were fears that pumping the water back into the ground would cause fissures in the ground and increase seismic activity in the area, but that has not occurred.

Once the city began pumping the water back down into the ground, the water level in the aquifer began to slowly rise every year. The water levels hit their pre-1983 levels in 2013, and the levels have continued to incrementally climb since.

Source:

https://www.idahopress.com/news/local/boise-has-the-largest-geothermal-system-in-the-country-here/article_73d9baae-5b08-50fb-8d35-0b7cbd5c339f.html

ASIA/PACIFIC RIM

Armenia: Ratified Plans to Construct a Geothermal Power Plant

SUMEC GeoPower AG has ratified its plans to build a geothermal power plant in Armenia, with a planned capacity between 30 and 50 MW. SUMEC GeoPower AG is an international team of geothermal specialists based in Switzerland and gathered by SUMEC Group Corporation, which in turn is a member of China National Machinery Industry Corporation (SINOMACH).

Since 2001 Armenia has announced a program for develop alternative energy sources in the country, whose goal is to reduce dependence on energy imports. One of the main points of the program is the erection of geothermal power plants, with Armenia's partner being the International Bank for Reconstruction and Development (IBRD, a division of the World Bank), which in 2016 signed an agreement on the geothermal exploration drilling program.

Works on the development of a feasibility study for the construction of a geothermal power plant in Karkar have been carried out since 2017. Its implementation was recently discussed in the framework of a visit paid by Petr Mikyska, the Ambassador of the Czech Republic to the Republic of Armenia, to the Armenia's Minister

of Energy and Natural Resources Artur Grigoryan. Chief Executive Officer of SUMEC Geopower AG, Michal Horacek, also attended the meeting.



Approximate location of Mount Karkar near the border with Azerbaijan

Issues related to Armenian-Czech cooperation in the field of energy were discussed. In that context, the opportunities and perspectives of implementing joint programs in the field of renewable energy were highlighted. It was noted that SUMEC Geopower intends to build a geothermal power plant in Armenia.

Sources: <http://www.thinkgeoenergy.com/czech-company-planning-to-build-30-50-mw-geothermal-plant-in-armenia/>,
<http://www.sumecgeopower.com/en/66/sumec-geopower-ag-intends-to-build-a-geothermal-power-plant-in-armenia/?id=619>

China: The Country Leads in Geothermal Heat, but Power Generation Lags

China is gradually developing geothermal energy, and the country's industrial system has taken initial shape, a new study shows. Installed capacity of China's geothermal heat pumps reached 20,000 megawatts by the end of last year to rank first in the world.

In addition to its primary uses in heating and aquaculture, a lesser portion also goes to generate power, with the nation's power capacity by the end of last year of 27.28 MW ranking it 18th in the world, according to the country's first research report on geothermal energy development issued by the National Energy Administration, Chinese Academy of Sciences, and other agencies on August 25, 2018.

Problems of insufficient and uncoordinated development still exist in China's geothermal energy industry, however, the report also noted.

National geothermal resource statistics are inaccurate, and a clear gap exists here compared with developed countries. Only 1230 measured geothermal data are currently available in China, whereas that figure is 17,000 for the U.S.

Source: <https://www.yicaiglobal.com/news/china-leads-geothermal-heat-capacity-power-generation-lags-study-finds>

Indonesia: Working Areas, Rantau Dedap, Microbiologic Control Trial

Three More WKP Assigned to PLN - Ministry of energy and mineral resources (ESDM) has again assigned state-owned electricity company (PLN) to manage three working areas of geothermal (WKP). They are: WKP Gunung Sirung with an installed capacity of 5 megawatts (MW), Ranau Lake (55 MW), and Oka Ie Ange (10 MW).

Ida Nuryatin Finahari, the director of geothermal at the ministry's Directorate General of New Renewable Energy and Energy Conservation, said her staffers had evaluated the plan on PLN to develop the three areas and officially assigned the task to the company.

Ida said her staffers were currently conducting socialization with the regional government in the three working areas to begin the geothermal development.

Earlier, PLN had had a permit to manage eight geothermal working areas: WKP Mataloko 22.5 MW, Atedei 10 MW, and Ulumbu 50 MW in East Nusa Tenggara; Songa Wayaua 10 MW in North Maluku; Mount Tangkuban Perahu 60 MW in West Java; Tulehu 2x10 MW in Ambon; Ungaran 55 MW in Central Java and Kepahiang 110 MW in Bengkulu.

Source:

<https://en.tempo.co/read/news/2018/07/23/056920178,uk.html/ESDM-Assigns-PLN-to-Manage-3-Geothermal-Working-Areas>

First Exploitation Well in Rantau Dedap Project -

The inauguration of Well RD-I3, the first exploitation well of the Rantau Dedap geothermal power project, was conducted on early August by Director General of New Renewable and Energy Conservation at the Ministry of Energy and Mineral Resources, Rida Mulyana.

RD-I3 is the first production well of the planned 16 exploitation wells to be drilled, 14 of them will be

production wells, with an expected production of 7.8 MW each, and two will be injection wells.

In addition, it was started the construction of the first phase of the geothermal facility, with capacity of 86 MW. The plant is constructed by the consortium of Rekayasa Industri and Fuji Electric Co. The first phase of 86 MW is estimated to obtain commercial on date (COD) in middle 2020, with the second phase of 134 MW targeted COD by 2025. The overall capacity will be 220 MW, with a total cost estimated at around US\$ 700 million.

Rida Mulyana also said that geothermal energy had been set as one of Indonesia's energy priorities, considering the country's geothermal resources that are estimated to be 28,500 MW, out of which less than 10% have been developed so far (1948 MW).



Source:

<http://www.en.netralnews.com/news/business/read/23134/rantau.dedap.geothermal.project.starts.exploitation.well.drilling.phase>

Successful Trial of Microbiologic Control Program

— Effective generation of electricity in a geothermal power plant depends on the control of microbiological slime in the plant condenser cooling system, among other items.

ZI-CHEM is the specialty chemicals business unit of Zuellig Industrial, a multinational organization founded in Philippines with focused activities to the industrial market in Southeast Asia. This company completed in middle August the plant trial for a Microbiological Control Program at the power plant of an international geothermal company in Indonesia whose name not was disclosed. This program comprised of a unique oxidizing biocide and bio-dispersant combination to control microbiological growth in the cooling tower.

The trial has reportedly demonstrated the capability of ZI-CHEM's biocide and bio-dispersant products to

control microbiological growth below the control limit at a reasonable cost. This program also proved effective at reducing consumption of other chemicals needed to maintain pH levels in the cooling water.

According to ZI-CHEM, the operating company of the plant has accepted the future use of the program tested in the plant.

Source: <http://www.zi-chem.com/news-detail.php?newsId=90>

Japan: IoT and AI Technology to Improve Capacity Factor of Geothermal Power Plants

The Japanese firm Toshiba Energy Systems & Solutions Corporation (Toshiba ESS) is conducting research that employs IoT (Internet of Things) and AI (Artificial Intelligence) technology to improve capacity factors of geothermal power plants. The research program, which began in August and is scheduled to continue until 2020, aims to reduce the rate of problem occurrences at power plants by 20% while boosting capacity factors by 10%. This research program has won positive evaluation and a grant from by the New Energy and Industrial Technology Development Organization (NEDO).

Geothermal energy yields steady output, making it capable of serving as baseload power for expanded use of renewable energy which the world demands. With the third largest geothermal resource potential in the world, Japan has high expectations for geothermal energy generation. At the same time, the cost to generate power from other renewable sources such as solar power is dropping, so geothermal power plants need to be managed more efficiently.

Taking these circumstances into consideration, this research program uses actual models within the geothermal power plants to run tests on their predictive diagnostics that utilize big data analytics, and their preventive measures for scaling in turbine scales, which is one of the factors that decrease capacity factor.

For predictive diagnostics that utilize big data analytics, research is conducted by employing analytical tools that break down and evaluate past and real-time plant operating data to predict problems ahead of time which could potentially shut down the power plants.

For preventive measures for turbine scaling, research is conducted with effective sprays including chemical agents which prevent scales to be built inside of the turbine. Control of the scaling is also verified by using

IoT and AI technology to optimize the use of chemicals, as well as the timing.

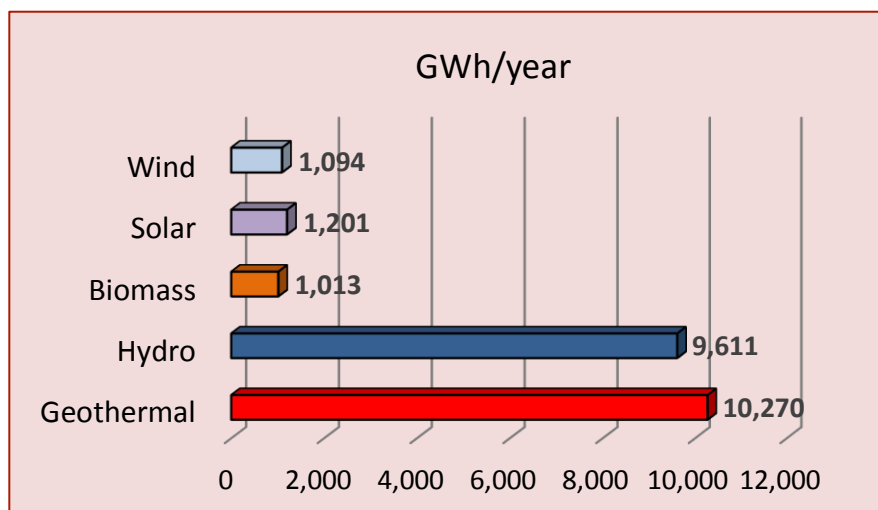
Takao Konishi, Director, Vice President of the Thermal & Hydro Power Systems & Services Division at Toshiba ESS says, “We are confident that these tests will serve for boosting introduction of geothermal power and contribute to a realization of a low-carbon society.”

Source: https://www.toshiba-energy.com/en/info/info2018_0807.htm

Philippines: Geothermal Production in 2017, News from EDC

It was unveiled that in 2017 renewable energy resources, including geothermal, hydropower, biomass, solar and wind, accounted for almost one quarter (24.6%) of the country’s power generation mix that was 94,370 gigawatts-hour (GWh). According to data from the Department of Energy, published by Christine Joyce S. Castañeda from Business World on Line (BWonline), renewable energy-based facilities generated 23,189 GWh in 2017, which represents an increase of 5.5% from the 2016’s generation that was 21,980 GWh.

Geothermal and hydro were the most important energy sources, producing more than 85% of the total of renewables. Geothermal power plants distributed in several fields of the regions of Visayas, Luzon and Mindanao in the Philippines generated 10,270 GWh, which account for 10.9% of the total power generated in the country last year. The graph below presents the outcomes in 2017 by renewable energy source.



Source: <https://www.msn.com/en-ph/finance/topstories/how-reliant-is-the-philippines-on-renewable-energy/ar-BBLiseM>

EDC to Be Delisted from the Philippine Stock Exchange - On early August, the Board of Directors of Energy Development Corp. (EDC) approved the

voluntary delisting of the company's common shares from the main board of the Philippine Stock Exchange (PSE). EDC is the main producer of geothermal power with nearly 1200 MW of installed capacity, accounting for 61% of the country's total installed geothermal capacity. It is also the country's largest renewable energy producer, delivering 1472 megawatts (MW) from hydro, solar, and wind power.

In a disclosure to the PSE, EDC said it would conduct a tender offer for up to 2,040,006,713 common shares at P7.25 (US\$ 0.134) each that are held collectively by the public.

"The intention to eventually delist EDC was shared with the market last year and the tender offer that our board has approved today presents a meaningful opportunity for our minority shareholders to realize their investment prior to the delisting of the company, at a significant premium to the current share price," EDC President and Chief Operating Officer Richard B. Tantoco stated.

EDC, along with its parent firm First Gen Corp., sought a suspension of trading of its shares because of the delisting decision. Its shares were last traded at P4.95 each.

The company said the tender offer price is "subject to certain terms and conditions as now or hereafter set forth" by the company. The tender offer price represents a 46% premium over the closing share price on Aug. 7, and a 40% premium over the three-month volume weighted average price of P5.18.

EDC said independent financial adviser KPMG issued an opinion based on an independent valuation that the tender offer price is fair and reasonable from a financial point of view.

By middle September, the Securities and Exchange Commission extended the tender offer period by another 20 days, under request of EDC. EDC said the SEC allowed the company to extend the tender offer period for an additional 20 business days from Oct. 22, 2018, if an extension would be necessary or desirable in order to complete the tender offer.

The tender offer period is targeted to commence from Sept. 25 to Oct. 22 and is subject to a minimum of 1.162 billion common shares being tendered and eligible for acceptance by EDC through the tender offer.

The tender offer will reduce the percentage of shares held by the public to less than 5 percent from 10.9 percent and in turn, allow a voluntary delisting of the company, subject to PSE approval.

Sources: <http://www.bworldonline.com/edc-delisting-from-phl-stock-exchange/>,

<http://manilastandard.net/business/power-technology/275741/edc-gets-nod-to-extend-tender-offer-period-for-another-20-days.html>

EDC to Upgrade Six Power Units of Palinpinon 1 & 2 - Energy Development Corporation (EDC), through its subsidiary Green Core Geothermal, Inc., will retrofit and upgrade six power geothermal units at two power plants in the Philippines, and has awarded the contract to the firm ABB, currently based in Zurich, which will also deliver a new Control System Integration (CSI) solution for these plants and an area control center facility.

The plants have a total capacity of approximately 200 megawatts (MW), running with Fuji-make turbines and were initially commissioned in 1983 and completed in the mid-1990s. The aim of the project is to deliver a modern control system integrated across all plants that can be easily upgraded over time to take advantage of the latest digital technology as it develops.

The new solution will increase operational and maintenance efficiency and assist management decision-making by providing improved access to better operational information. It will also facilitate central control and remote monitoring of the power plants and steam fields from one location.



View of Palinpinon 1. Photo by First Holdings.

The scope of the contract includes the conversion of a mechanical electro-hydraulic governor to a digital version and the replacement of the existing low-pressure turbine hydraulic equipment with a new a high-pressure solution. ABB will also provide performance calculation and comprehensive cyber security solutions to protect the customer's assets.

The geothermal plants –known as Palinpinon 1 and Palinpinon 2– are located in Valencia, a municipality on Negros, the fourth largest island of the Philippines and home to a number of volcanoes.

Source:

<http://www.abb.com/cawp/seitp202/9abfab2bca4e25c5c1258308005495bc.aspx>

EUROPE

The GEO-COAT Project

GEO-COAT (development of novel and cost effective corrosion resistant coatings for high temperature geothermal applications) is a new three-year research project, funded by the European Union under the Horizon 2020 umbrella, whose aim is to support the development of the next generation renewable electricity and heating/cooling technologies.

Late August, the project published its first newsletter, which informs that it aims at developing corrosion and erosion-resistant coatings to improve the lifetime of components within geothermal plants:

- Liners
- Well casings
- Pipelines
- Heat exchangers
- Pumps
- Turbine components

Specialized coatings will be developed based on:

- High Entropy Alloys (HEA)
- Ceramic/metal mixtures (Cermets)
- Ni-P-PTFE

Applied via thermal powder coating and plating techniques:

- High Velocity Oxygen Fuel (HVOF)
- Laser Metal Deposition (LMD).
- Electroless plating

A decision-based approach will be implemented in the selection of the coatings, based on experimental results, computational modelling of the geothermal fluid and economic considerations.

The newsletter also informed the project held its kick-off meeting on February 2018 at the TWI Ltd. premises in Granta Park, Cambridge, UK, when each work package, together with finances and management details, were discussed in detail and possible project challenges highlighted. The meeting also gave the chance for

everyone to meet and getting to know each other.

The project has the following eleven partners: TWI Ltd. (coordinator), WEIR Group, ON Power, University of Iceland, University Politecnica of Bucharest, Gerosion, Technovative Solutions, Technoid, Flowphys, METAV, and the Innovation Centre Iceland.

Source: <http://www.geo-coat.eu/blog/>

New GECO Project under Horizon 2020 Program

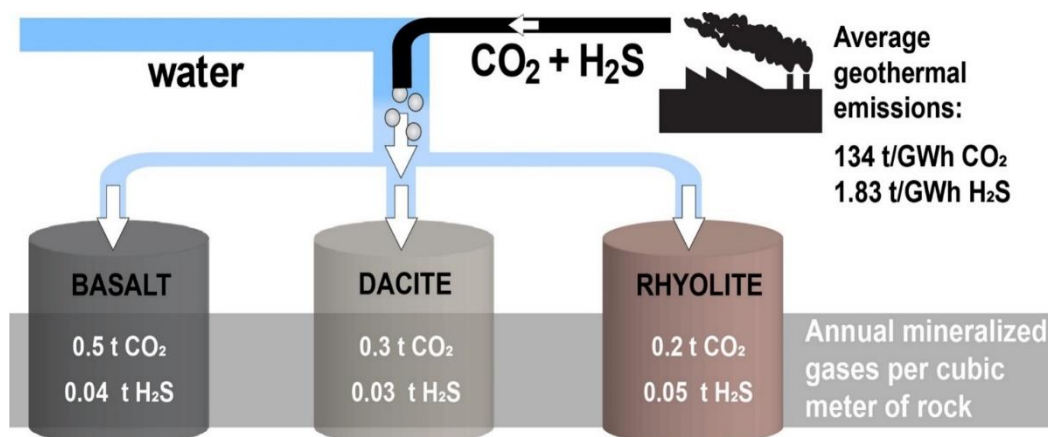
Reykjavík Energy and a group of 17 partners from nine countries across Europe (France, Germany,

Iceland, Italy, Norway, Spain, The Netherlands, Turkey and United Kingdom) have received a EUR 16 million grant from the Horizon 2020 Research and Innovation program. The funding contributes to the GECO (Geothermal Emission Control) project, and aims to advance the provision of cleaner and cost-effective geothermal energy across Europe and the world with reduced emissions of carbon and sulfur.

The core of this project is the application of an innovative technology (CarbFix), recently developed and successfully demonstrated at a pilot-scale in Iceland, which can limit the emissions from geothermal plants by condensing and re-injecting gases in the subsurface or turning them into commercial products (*see figure*).

GECO aims to increase public acceptance and generalize this novel approach. To that end, the reinjection method will be applied in four distinct geothermal systems in four European countries:

- 1) a high-temperature basaltic reservoir in Iceland; 2) a high-temperature gneiss reservoir in Italy; 3) a high-temperature volcanoclastic reservoir in Turkey; and 4) a low-temperature sedimentary reservoir in Germany.



Scheme showing the method of re-injecting CO₂ and H₂S back into the geothermal reservoir, wherein carbon and sulfur are expected to mineralize naturally for a long-term underground storage. Figure taken from paper: Towards 'green' geothermal energy: Co-mineralization of carbon and sulfur in geothermal reservoirs, by Marieni et al., 2018.

Within GECO, gas capture and purification methods will be advanced by lowering consumption of resources (electricity, water and chemicals) to deliver cheaper usable CO₂ streams as commodity to third parties. GECO's unique approach consists of capturing the waste gases, dissolving them in the exhaust geothermal water stream, and reinjecting the aqueous solution. The re-injected acidic gas-charged fluid provokes the dissolution of subsurface rocks, which increases the reservoir permeability, and promotes the fixation of the dissolved gases by mineralization. The waste gases are therefore stored in the long term, in an environmentally friendly manner, while geothermal emissions are cost-effectively cleaned compared to standard industry solutions.

A detailed and consistent monitoring program, geochemical analysis, and comprehensive modelling will characterize the reactivity and consequences of fluid-flow in the geologically diverse field sites of GECO. This will create new and more accurate modelling tools to predict the reactions that occur in the subsurface in response to induced fluid-flow and favor the scalability of gas capture and purification.

Finally, gas capture for reuse will be demonstrated by producing a CO₂ stream with only trace H₂S levels. This prerequisite for most utilization pathways will be demonstrated as part of the GECO project.

The GECO project is largely based on the CarbFix method, and is scheduled to be developed over the next five years. The CarbFix project was founded in 2007 by the University of Iceland, CNRS in Toulouse, the Earth Institute at Columbia University in New York and Reykjavik Energy, but since then several universities and research institutes have in the project.

Source:

https://www.carbfix.com/sites/default/files/atoms/files/geco_pressrelease_en.pdf

Climate Change Made Europe's Heatwave Twice as Likely to Happen

The summer heatwave in northern Europe was made twice as likely by climate change, according to a preliminary analysis.

Temperatures have soared over much of Europe over July, regularly exceeding 30°C and several temperature records have been broken. The conditions have been so extreme that wildfires have broken out in Sweden and the UK.

Heatwaves are one of the most likely consequences of climate change. As the average global temperature rises due to higher levels of greenhouse gases, more extreme bouts of high temperatures follow.

However, heatwaves do happen anyway. To find out if the current heatwave was made more likely by climate change, a team at World Weather Attribution led by Friederike Otto of the University of Oxford, UK has conducted a rapid-response study.

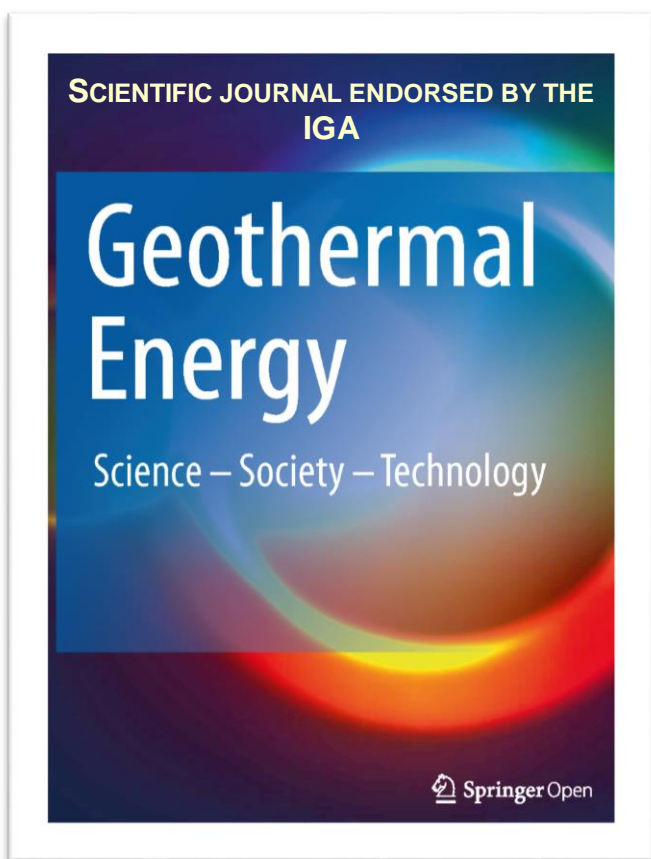
They ran climate models with and without greenhouse gas emissions and tracked how often heatwaves like the current one occurred in both cases.

"We estimate that the probability to have such a heat or higher is generally more than two times higher today than if human activities had not altered climate," the team reports.

The intensity of the climate effect varies somewhat from country to country. "In Ireland and Denmark climate models give a very similar increase in probabilities to the observations –roughly a factor two more likely in Dublin and a factor four in Denmark," the team writes.

The team estimates that similar heatwaves will return soon. In particular, comparable heatwaves will now strike Dublin and the Netherlands every four to seven years in the current climate –"even though they are close to record-high compared to earlier climates".

"In fact, I think that these sorts of analyses are overly conservative," says Michael Mann, of Pennsylvania State University. He says this summer's extreme weather in



[TAKE A LOOK HERE.](https://www.geothermal-energy.org)

the Northern Hemisphere is related to a near-stationary perturbation in the jet stream. Such patterns have been implicated in “many of the most extreme, persistent summer weather events in recent years, including the 2003 European heat wave, 2010 Moscow wildfires, 2011 Texas and Oklahoma drought [and the] 2016 Alberta wildfires.”

In a study published last year, Mann and his colleagues showed that such patterns are becoming more common as a result of human-caused climate change (Scientific Reports, doi.org/f9vwxx). Mann says the “amplified warming in the Arctic” seems to be a major contributor.

“Events like the massive wildfires breaking out around the Arctic Circle really have no precedent in modern history and they are consequently very difficult to anticipate in advance,” says Mann. “It is a reminder that there are many surprises lurking in the greenhouse and they are unlikely to be welcome surprises.”

Source:

<https://www.newscientist.com/article/2175358-climate-change-made-europes-heatwave-twice-as-likely-to-happen/>

Finland: Stimulation Stage of St1 Geothermal Project Successfully Completed

Nordic company St1 Renewable Energy Oy has announced having made significant progress for its geothermal pilot project in Otaniemi, Finland. The company successfully completed the stimulation stage.

The stimulation was used to open closed rock fractures and to investigate the water flow by pumping water into the existing 6.4 km-deep well in highly controlled cycles, so that the micro-earthquakes induced by pumping in the bedrock remained within the limits predefined by the authorities. During the next 5 to 7 months, the results will be analyzed and more cost-efficient drilling technology will be developed. The analysis phase will determine the project's continuation. The planned geothermal heat plant in Otaniemi could fulfil up to 10 percent of district heating demand with emission-free energy in the Espoo area.

“The stimulation test proved that water can be pumped into Finland's tough granite bedrock and be made to flow through the rock. The controlled stimulation technology we opted for, and the pinpointing of the appropriate fracture zones, proved to work and the bedrock behaved as we had expected,” said Tero Saarno, Production Director at St1 Deep Heat.

During the stimulation stage, experts from St1 pumped water into the 6.4-km deep injection borehole, monitoring this process with underground geophones

installed in the Metropolitan area. In addition, the Institute of Seismology at the University of Helsinki used its own geophones to independently monitor the stimulation. The highest micro-earthquake during the water simulation test was a magnitude of 1.9. The limit values for the micro-earthquakes were predefined by the authorities to a much lower level than for example are used in blasting operations. Within these limits, the stimulation was performed in a controlled and safe manner, without posing a danger to people or damage to structures.



“Because the site is located in Helsinki Metropolitan area near housing and infrastructure, the magnitudes were set so low that the disturbing effects would probably remain minor. On site, the effects of stimulation were closely monitored and reacted to quickly when needed,” says seismologist Tommi Vuorinen of the Institute of Seismology.

According to Tero Saarno, the only surprise during the stimulation phase was the noise nuisance caused by the more powerful micro-earthquakes, whose transmission through the rock could not be anticipated. During the stimulation, these micro-earthquakes in the bedrock were audible as distant rumbling or banging noises, while the largest caused structures to vibrate in certain areas.

“I hear for the first time such loud noises coming from so small micro-earthquakes, even though I have lived and worked most of my life in very active earthquake areas, such as California, Hawaii, New Zealand and Turkey. It is very exceptional that these sounds are even audible, as the sediment layers of the Earth normally absorb them. The unique data now recorded opens up a whole new area of research, aimed at identifying their causes, including the potential effect of nearby bays and the uniqueness of Finnish bedrock,” said Peter E. Malin, a member of the project expert team, R&D Director at the seismic monitoring company ASIR, and a Professor

of Seismology at the German Geoscience Research Center in Potsdam.

“The measured vibration levels on the ground were really low: only 1/100 of the level measured in blasting operations and far from the actual level that could cause damage to the buildings. Also, the noise measurements were clearly below the guidelines of the Ministry of Social Affairs and Health throughout the project,” says Vesa Holmström, Technical Manager in Kalliotekniikka.

A team of 25 experts have been working in shifts around the clock during the stimulation phase at St1 Deep Heat's Otaniemi construction site. The project deploys best international geothermal expertise and experience from previous projects.

Source: <https://www.st1.eu/Stimulation-stage-of-St1s-geothermal-project-successfully-completed>

France: Anti-Corrosion Well Concept, New CHP Project

Anti-Corrosion Well Concept Validated in the Paris Basin - On late July the French engineering consultancy GPC Instrumentation Process (GPC IP) announced a new milestone and success in smart-well architecture. The company informed it has successfully completed a new anti-corrosion, fiberglass lined, production well at the Bonneuil-sur-Marne (Paris southern outskirts) geothermal district heating (GDH) site, operated by SETBO, the local heating company managed by the city.



This is a 2020 m deep and 38° slanted well that combines a large (20" x 13 3/8") steel cased propping column and a twin (13 3/8" x 9 5/8") fiberglass production liner assembly, being free the casing-liner

annulus (i.e. not cemented). It is a design started in 1985 on the emblematic Melun l'Almont GDH well GMA4, completed through a simplified architecture: single 13 3/8" casing and 9 5/8" fiberglass liner, and a self-flowing mode production (*see* IGA News 20, pp. 12-13).

The former experience of the well GMA4 validated the fiberglass lining concept to prevent material aging (fiberglass doesn't weep or de-structuring), keep the well integrity (it has not been necessary any heavy duty workover or acidizing in the well so far), reduce maintenance (only one master valve has been changed), maintain the well productive performance (it still presents an artesian, non-sustained, 300 m³/h flowing rate under 2 bar wellhead pressure), in spite of below bubble point self-flowing production and related fluid degassing.

The architecture of the present well in Bonneuil-sur-Marne addresses an artificial lift, pump sustained, production, which implied significant design modifications. The main changes and improvements are the following:

- An upper and wider liner section of 13 3/8" Outer Diameter (11.97" Internal Diameter) acting as a pumping chamber, sized to accommodate a 500 HP rated ESP, placed under compression between the wellhead and the lower section.
- A lower and slimmer production liner of 9 5/8" OD (7.74" ID) freely suspended and connected by the system described below.
- A liner connecting system of 13 3/8" x 9 5/8", placed at the casing interface of 20" x 13 3/8", which allows a free annular fluid (a make-up corrosion inhibitor agent) passage and is a key issue indeed.
- A wellhead expansion pool.

The additional capital investment costs are around 20% compared to a conventional 13 3/8" x 9 5/8" steel cased well architecture, but it is estimated will get payed back in less than eight years thanks to yearly OM costs savings.

This smart well design is a positive measured against thermo-chemically hostile corrosive fluid environments, capable to secure well longevity and low operation/maintenance (OM) costs.

The project, due to its innovative impact, was awarded financial support from ADEME, the French Environmental Agency.

Source:

http://www.geoproduction.fr/sites/default/files/GDC_E18052_press%20release-v2.pdf

ES Starts a New CHP Project in Illkirch-Graffenstaden - Electricité de Strasbourg (ES), the

utility in the city of Strasbourg in Alsace, started on late August the first drilling on the deep geothermal site located in the innovation park in Illkirch-Graffenstaden.

The project plans construction of a geothermal power plant will produce heat and electricity to supply an urban heat network and the surrounding industrial activity. The first well will be drilled to a depth of 3000 meters and the water to be derived is expected with a temperature of 150°C. The second well is planned to be drilled in November.

Source: <http://www.thinkgeoenergy.com/electricite-de-strasbourg-starts-drilling-at-illkirch-geothermal-project-france/>

Germany: First Well of Thalkirchen Project Produces 430 Tons per Hour of Hot Water

The city utility of Munich, Stadtwerke München (SWM) has announced that drilling of its first well for the new planned combined heat and power plant South (HKW Süd) in Munich has been successful. Drilling of this first well, called Th1, took about three months.

Pumping tests at a depth of 2800 meters produced >100°C water at a rate of more than 120 liters per second (432 metric tons per hour). These are better characteristics than expected. In early August the second well started to be drilled, and by the end of 2019 all the six planned wells should be completed.

As informed before (*see* IGA News 112, p. 38), at HKW Süd in Thalkirchen, the most powerful geothermal heating plant in Munich is being built – and the largest geothermal plant in Germany to date. With a thermal output of 50 MW thermal, it is expected to deliver eco-heat for at least 80,000 Munich residents by the year 2020.

SWM currently operates five geothermal plants in Munich and in the region. Its goal is to make Munich the first major German city by 2040, in which district heating is generated 100 percent from renewable energy sources. The main contribution will be provided by geothermal energy.

Source: <http://www.thinkgeoenergy.com/utility-of-munich-successfully-drills-first-well-of-ambitious-geothermal-heating-project/>

Greece: Two Geothermal Projects to Be Started

PPC Renewables plans to start developing two of four geothermal fields to which the company holds exclusive

exploration and utilization rights with ventures on the island Lesvos and Methana, a peninsula in northeast Peloponnese.

These starting choices, where geothermal exploration work is believed to be imminent, have the purpose of demonstrate that geothermal development is environmentally friendly. Locals on Milos and Nisyros, two other spots also being eyed, both object to geothermal development. Back in the 1980s, islanders on Milos strongly reacted against a geothermal development plan, fearing its environmental impact. However, PPC Renewables officials are now hoping this past resistance will ease once islanders are fully informed of technological advancements in the sector.

PPC Renewables plans to establish a strategic partnership with Helector SA, a member of the Ellaktor group, for these ventures. Helector is the winning bidder in a related tender. A wholly-owned subsidiary of the main power utility PPC, PPC Renewables is anticipating the signing of a ministerial decision by the energy ministry before it proceeds with the formation of its partnership with Helector.

PPC Renewables plans to develop an 8-MW geothermal power station on Lesvos and 5-MW geothermal facilities at each of the other locations.



Source: <https://energypress.eu/ppc-renewables-to-start-geothermal-work-at-lesvos-methana/>

Iceland: Production of Hydrogen and Algae, Flúðir Power Plant

Hydrogen to Be Produced with Geothermal Energy - The Icelandic power company ON Power (Orka náttúrunnar) started to produce hydrogen at the end of

August, as part of a European project. An electrolyzer has been installed by Hellisheiði Geothermal Power Plant in Southwest Iceland. Sale of hydrogen for vehicles could begin as early as October. Two other Icelandic companies, Orkan, owned by Skeljungur hf., and Icelandic New Energy, participate in the project. Orkan opened two hydrogen stations earlier this summer. Until ON Power starts its sale, imported hydrogen will be used at those stations.

The electrolyzer to be used has the capacity to produce enough hydrogen for all hydrogen-powered cars in use in the country already, in addition to five hydrogen-powered buses, to be taken into use by the end of next year.

Bjarni Már Júlíusson, CEO of ON Power, states that the idea is to produce the hydrogen by the geothermal power plant and to distribute it in bottles to prevent any loss in transport. The hydrogen will be produced at one location and delivered at two to three stations.

The project's startup cost is funded by European grants, in addition to ISK 100 million (US\$ 949,000) coming from ON Power. Bjarni does not expect the operation to be profitable at first, but notes he hopes that a successful market will be established for clean Icelandic energy in the future.

ON Power has set up charging stations for electric vehicles around the country. Bjarni said that, in his opinion, a dream car for Iceland would be one powered by electricity, but able to switch over to hydrogen during longer trips.

Source:

<https://icelandmonitor.mbl.is/news/news/2018/07/31/hydrogen-to-be-produced-in-iceland/>



Hellisheiði power plant (Photo credit: mbl.is/Golli, taken from the source).

Algae Production to Start in Hellisheiði - Israel-based Algaenovation has signed a 15-year contract

with Icelandic energy utility and operator ON Power for the purchase of energy and other inputs for small-scale algae production, which will be the first of its kind in the world.

Algaenovation is an international technology startup that has been developing new technologies for the production of microorganisms. The first phase of the project will be done this year. It is planned to start production of seafood feed in the middle of next year.

The project is a step towards further utilization of the energy generated by ON Power at Hellisheiði, where Algaenovation buys hot and cold water, electricity and carbon dioxide for production. The Algaenovation small algae production will be located in Geothermal Park ON and the Hellisheiði Power Station will provide electricity, hot and cold water and carbon dioxide. Collaboration with ON enables Algaenovation to have negative footprints and use less than 1% of freshwater and terrestrial areas used by conventional small-scale algae companies in their production.

Small algae are micro-organisms that multiply rapidly and get their energy and nutrition from light and carbon dioxide. In nature, a small algae is a source of a variety of nutrients, such as Omega-3 fatty acids, antioxidants and dyes, all key factors in both human and animal diet.

In autumn 2017, Algaenovation started experimental cultivation of small algae at the Hellisheiði power plant. ON provided facilities, electricity, hot and cold water and carbon dioxide for the experiments. Algaenovation has decided building a small algae production within the Geothermal Park of ON, which will be the first of its kind in the world.

Source: <http://www.thinkgeoenergy.com/algae-production-to-be-set-up-at-hellisheiði-geothermal-plant-in-iceland/>

Flúðir Geothermal Power Plant to Start Producing Electricity

- At Flúðir, small community in southern Iceland, a new low temperature geothermal plant is rising. The first four heat power modules were delivered to the power plant, and a delivery ceremony was held. Approximately 50 guests attended including Ministers from Sweden and Iceland, suppliers, partners and customers. The new power plant is estimated to start producing electricity in the fall of 2018.

The power plant uses a binary cycle system to produce electricity. The geothermal well contains hot water at 116°C and produces 45 liters per second, as it was informed before (*see IGA News 111, p. 25*). The power plant was constructed by the Swedish company Climeon, and is composed of Heat Power modules that can generate electricity by

utilizing resources with temperature from 70 to 120°C and cool the geothermal water. The system operates at low-pressure levels in comparison to traditional heat power solutions using flash power plants.

The four heat power modules of this plant were the first of a series of a total of 197 modules to be delivered to approximately 20 different sites over the next 36 months. The original contract was recently increased from 100 modules to 197 modules.

Sources: <http://www.efla-engineers.com/about-us/news/utilizing-low-geothermal-heat-with-latest-technology>, https://climeon.com/investor-english/?type=single&title=ann-linde-on-site-when-climeon-delivers-the-first-heat-power-modules-in-iceland&encrypted_id=2F223B70DC28438A#cision-table

The Netherlands: Highest Geothermal Heat Production in 2017

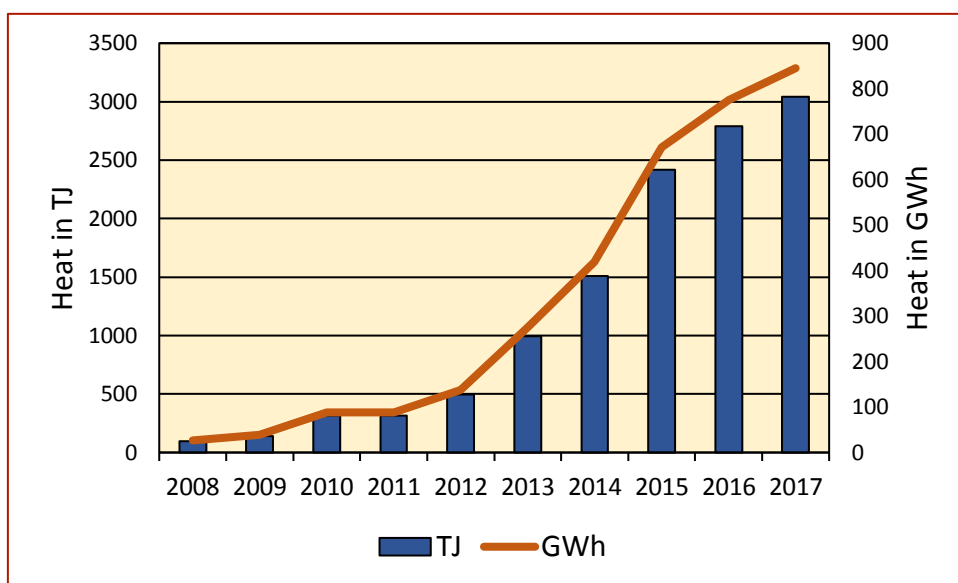
In late July 2018 the Ministry of Economic Affairs and Climate Policy of the Netherlands released its annual report on natural resources and geothermal energy corresponding to 2017. Chapter 13 is devoted to geothermal energy, which is only used in direct applications, and some of the more relevant outcomes are the following:

- As of 1 January 2018 there were a total of 47 geothermal energy exploration licenses in effect, covering a surface of 1751 km², representing an average of ~37 km² per area granted with a minimum of 2 and a maximum of 325 km².
- At the same date, there were only 12 geothermal production licenses, covering 91 km² with an average of 7.6 km², ranging from 2 to 41 km².
- Just for comparative purposes, there were 31 hydrocarbon exploration licenses in the continental shelf and 11 on land, with 8067 km² and 3197 km², respectively. Regarding hydrocarbon producing licenses, they were 112 in the continental shelf covering 18,845 km², and 38 in the territory covering another 14,815 km².
- In 2017, 15 geothermal wells were completed.
- As of 1 January 2018 there were a total of 20 geothermal installations, 14 out of which were operational in 2017.

- The heat is produced from depth intervals between 1600 and 2800 meters and from various geological units like Upper-Jurassic, Lower-Cretaceous, Triassic and Lower Carboniferous.

- The produced heat is mainly used to heat commercial greenhouses. One project also supplies heat to a public utility facility and several buildings. Another project will supply heat to a heating network in an urban area.

- The 14 operational installations produced 3.042 petajoules (PJ) of heat in 2017, equivalent to ~845 gigawat-hour thermal (GWh_{th}). It is the highest production since 2007 (see figure below).



- Small amounts of hydrocarbons are co-produced with the geothermal energy. In most installations the hydrocarbon is gas, but in one installation oil is produced as well.

Source: <https://www.nlog.nl/en/annual-reports>

Poland: Country Update

Following are excerpts of a report prepared by Michal Kruszenski (GZB), and published in the IGA's website on August 23, 2018.

Poland is one of the central European countries with high geothermal potential and strong interests from government as well as local authorities. The country has only low-enthalpy resources, connected in most cases with the Mesozoic sedimentary formations. Six geothermal district heating plants are currently in operation in Poland: Podhale region since 1994, Pырzyce since 1996, Mszczonów since 2000, Uniejów since 2001, Poddębice since 2012 and Stargard since 2012, with total installed capacity of 76 MW_{th} and heat production of 227 GWh.

The most attractive direct applications of geothermal energy in Poland are space heating, balneotherapy,

recreational, aquaculture and other minor uses. Geothermal waters with temperatures ranging from 20 to 100°C and flow rate of up to 150 l/s are being produced from geothermal wells with total depths between 1 and 3 km. Most of deep geothermal installations are based on doublet systems, with exception of Mszczonów and Poddebice district heating plants, where thermal water mineralization is below 500 mg/l.

Ground Source Heat Pump (GSHP) industry, established in Poland several years ago, is in constant development and experienced immense progress since 2013, with 500 MW_{th} installed capacity and 714 GWh of heat production as for 2015.

At the end of September 2017 local authorities of Szaflary, Kolo, Łądek Zdrój, Sochaczew and Sieradz municipalities received large subsidies (in total EUR 46 million) from Polish National Fund for Environmental Protection and Water Management (NFOŚiGW) in order to investigate and explore geothermal resources in various areas in Poland.



Wellhead of geothermal well in southern Poland in Podhale area (source: geotermia.pl)

The deepest planned exploratory well Bańska PGP-4 will be drilled in Szaflary (southern Poland) municipality with target depth of 5.3 km. The well will investigate potential resources of geothermal waters in Podhale region. It will be the fourth production well in the area and the deepest in the field. Well temperatures are expected to reach temperature of 130°C, which is around 40°C higher than temperatures from the typical wells in area drilled to 3 km depth. Such temperature will allow not only for district heating but also create possibility of electricity production, which was not yet investigated in Poland. The new well is planned to start production by the end of November 2020 and will also provide new insights about geology and reservoir conditions below current production intervals. The well will be the deepest geothermal well in Poland and one of the deepest in Europe.

Another geothermal investment is planned in Łądek-Zdrój (south-western Poland) municipality. A 2.5 km deep exploratory well will be used for district heating, balneotherapy, bathing and snow melting purposes in cascade application. It is expected that geothermal energy development in southern Poland will help to mitigate the smog and air pollution problem, which is caused by outdated heating systems, heavy traffic and economy's dependence on coal.

One of the shallowest wells is also planned in the area of Sochaczew (central Poland) with final depth of 1.4 km for district heating purposes. Another exploratory well GT-1 is expected to be drilled in municipality of Kolo, which is regarded as one of the most promising geothermal areas in Poland with plans for geothermal power plant, and Sieradz (both located in central Poland). Production well in municipality of Sieradz is planned to provide heat to around 20 thousand inhabitants in the nearby area. Final well depth would amount to 1.5 km. Such depth will allow for producing thermal water with temperatures of around 65°C and flow rate of approximately 34 l/s. Drilling operations are scheduled to be finished by the end of November 2018.

In September 2017, new directional "S"-type well GT-1 bis was drilled and connected to the Pырzyce geothermal district heating plant, which now owns 5 wells, in north-western Poland with its final depth of 1.8 km, geothermal water temperature of 66°C and flow rate of approximately 56 l/s.

In 1900, Poland was the third biggest oil producer in the world. Currently, many of these oil and natural gas wells are abandoned

(or/and negative) and located nearby residential or industrial areas. This creates perfect opportunity to extract geothermal heat from already drilled petroleum wells. First project of such kind was attempted in Sucha Beskidzka. Due to poor insulation of inner column, project did not achieved satisfactory results. Currently, research works are ongoing in order to improve insulation properties of inner column and increase efficiency of borehole heat exchangers.

Poland has also contributed at many European programs on various geothermal aspects from shallow to deep geothermal, in order to exchange experience and learn from other, more advanced in geothermal heat and electricity production countries such as Iceland. The outcome of such projects shall enable for polish geothermal industry to develop and also draw attention of the public.

Source: <https://www.geothermal-energy.org/country-update-poland/>

Portugal: Governmental Support for Geothermal Projects

The Portuguese government approved on early July three financing lines totaling EUR 2.1 million (US\$ 2.45m) to support geothermal projects. Launched and operated by the Innovation Support Fund (FAI), this initiative has as its main objective the increase of the use of geothermal energy in the country.

The largest of the three funding lines, for total of EUR 1.7 million, is intended for projects such as the development and expansion of the heat distribution network or the connection of new users to the said network, the government said.

The other two lines are intended to finance technical or scientific studies so that Portugal can better understand its geothermal resources. The first of these two is a EUR 300,000 support line to assess the hydrothermal exploration and geothermal resources potential for temperatures above 25 degrees centigrade. The other line, EUR 100,000 total, is for the elaboration of geothermal cartography for the integration and updating of the National Geothermal Atlas, the government

noted.

Source: <https://renewablesnow.com/news/portugal-offers-eur-21m-in-geothermal-financing-618387/>

Russia: Second GEO-HEAT Conference Successfully Held in Kamchatka

Luis C.A. Gutiérrez-Negrín, Editor

From September 4 through 7, it was held in Petropavlosl-Kamchatsky, the city capital of the Kamchatka Peninsula in far eastern Russia Federation, the second annual meeting titled GEO-HEAT International Geothermal Conference. The event was organized by the Research Geotechnological Center of Far Eastern Branch of the Russian Academy of Sciences from the Ministry of Science and Higher Education of the Russian Federation, and particularly by its director, Dr. Roman I. Pashkevich.

The conference gathered around 100 participants distributed in the two first days (September 3 and 4), from Russia (Kamchatka, Moscow and Irkutsk) and other eight countries: Bulgaria, China, Costa Rica, France, Germany, Mexico, Switzerland, and the United States. They attended 30 oral presentations, including one presented remotely via teleconference, as well as 20 poster presentations, among them some of eight



Some of participants in the GeoHet 2018 Conference.

additional countries: Azerbaijan, Bangladesh, Colombia, Democratic Republic of Congo, India, Indonesia, Kyrgyzstan, Tajikistan, Turkey, and Ukraine.

Oral presentations were in English or Russian, but all the slides were presented in the two languages simultaneously in the same slide, which made it easier for all participants to follow the speakers. Since the conference was developed in a cinema room with a wide screen, all the slides were perfectly clear and readable. Questions and answers were translated at the moment. The poster presentations were continuously running in small screens outside the main room.

Dr. Pashkevich gave the opening and closing remarks of the conference, but also there was a brief welcome by Mario César Suárez-Arriaga, from Mexico, on behalf of the Organizing Committee. International organizations, like the International Geothermal Association (IGA) and the IEA-Geothermal, were also represented by Margaret Krieger and Lothar Wissling, respectively.

The final hour of the conference, before the closing remarks and farewell, were devoted to a panel discussion, where some of the participants expressed their ideas about the conference and possible ways and proposals to improve it and make it more visible in the following years.

During the last two days of the conference, September 5 and 6, two field trips were offered to the foreign participants, one to the Mutnovsky geothermal field and power plant, and other to the nearby Malkinskoe hot springs where direct uses like bottling mineral water and geothermal bathing has been developed.

Around 13 participants from Bulgaria, Germany,

France, Mexico, Switzerland, and the U.S. attended the field trip to the geothermal power plant, located at the foothill of the Mutnovsky volcano and around four hours driving from Petropavlosk-Kamchatsky. They were guided by some of the members of the Dr. Pashkevich staff, including the translator.

The power plant started to operate in 2002, according to the explanations from the expert in charge of the operation, a young and well-informed Russian mechanical engineer who leaded the group inside the machine house and the cooling tower. The plant is composed of two flash, condensing turbo-generators, arranged in tandem, of 25 MW each, manufactured by a Russian company. Both operate at 6 bar (absolute) of inlet pressure and 160°C of temperature, and are fed by 11 production wells at different depths of around 2000 meters. Apparently each turbine needs 160 tons per hour (t/h) of steam, which make it very efficient since that means that only requires 6.4 t/h to generate one megawatt-hour. The separators, that seem to have been designed and constructed in New Zealand, are of gravitational type instead of the more common centrifuge type. They deliver almost pure dry steam, with a purity of 99.99% in average. The control and electric part of the plant was not visited but apparently it was provided by the German company Siemens.

After visiting the turbines, the expert of the well-field conducted the visitors to one nearby production well of 1700 meters depth, producing 12 kg/s (or around 40 t/h) of fluids, which contain between 2-4% of non-condensable gases. The separated brine, of sodium-chloride type, is completely returned to the reservoir through 3 injection wells.

Then, the visitors were conducted to an area of superficial manifestations located not far of the power plant, probably aligned to a fracture. It contains hot springs, fumaroles and an extended alteration zone composed mainly of clay minerals. It was a hard hiking, since the weather was a little rainy, cold and foggy, and the manifestations area was very slippery, but the effort was highly compensated.

Dr. Pashkevich and his enthusiastic team of the Research Geotechnological Center are decided to continue with this conference in the following years. As stated in the announcements of the conference, their objectives are "...to distribute scientific and industrial information concerning current state of geothermal science, technology and industry; to share knowledge and results in theory, methodology, technology and applications of geothermal science; to bring together scientists, researchers, engineers, students and managers interested in geothermal science; to promote geothermal innovations; provide a forum to exchange ideas on the exploration, development and use of geothermal resources; (and)



View from the cooling tower to the machine house of 50MW Mutnovsky power plant (photo by Lcagn).

to encourage international communication and collaboration.”

And the place is well suited, since Kamchatka is a part of the Pacific Ring of Fire, and presents hot springs, geysers, fumaroles and volcanoes. The announcement also stated that “There are 30 active volcanoes, about 300 extinct and destroyed volcanoes, more than 2500 volcanic cones, great number of cold mineral water and hot springs and geysers. The Mutnovsko-Gorely Group is located about 80 km south of Petropavlovsk-Kamchatsky on the south side of Avacha Bay. Mutnovsky volcano has one of the world’s largest fumarole fields; and it is one of the most active volcanoes in Kamchatka.” Incidentally, the rivers of the Kamchatka region “...are a spawning place for one of the world largest populations of salmon.”

Serbia: Kursumlija Preliminary Potential, and First Geothermal District Heating

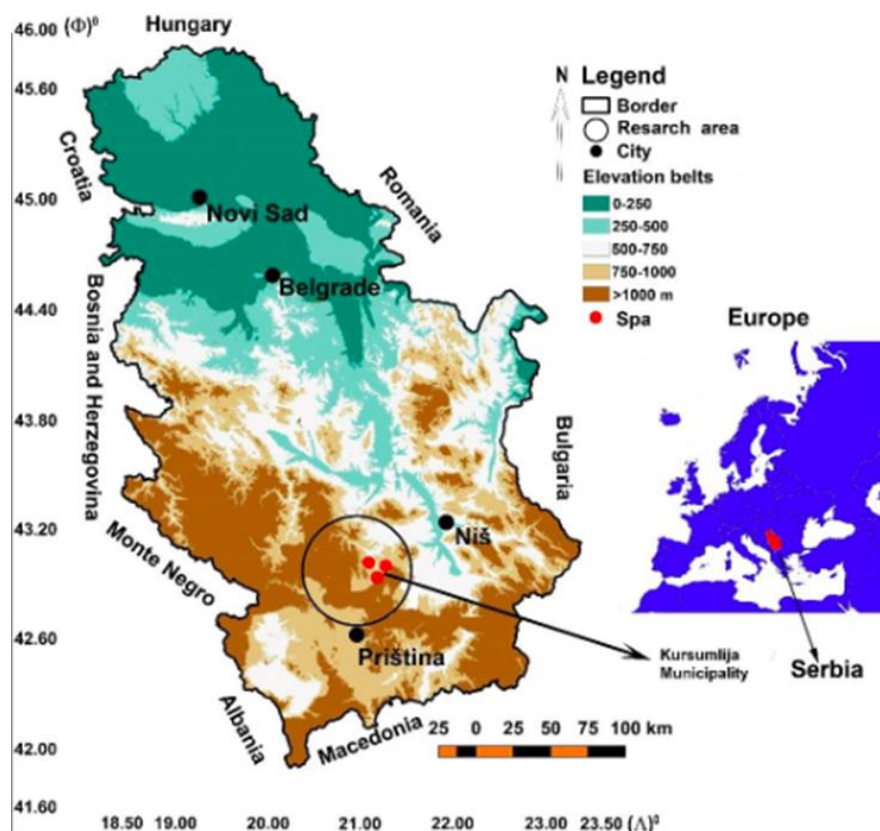
In Serbia, there are more than 240 hot springs. The municipality of Kursumlija, located at the south-eastern corner of the country, covers an area of 952 km², with many hot springs, three official and ten unofficial spas. The indoor temperatures in the spas are between 20°C and 68°C, and they are valuable for space heating, balneology, greenhouse heating, etc.

Currently, the three main spas in the municipality are Lukovska, Prolom, and Kursumlija. The average depth of the wells feeding the spas is between 200 and 300 m. Indoor temperatures vary; in the Kursumlija spa, the indoor temperature is 68°C and the outdoor temperature is 25°C. In the spa of Lukovo the indoor temperature is 67°C with an outdoor temperature of 35°C, while in the Prolom spa the indoor temperature is 31°C and outdoor is 24°C.

Regarding the chemical composition, 90% of the hot waters are of calcium-carbonate type, excluding water in Devil city, which is composed of rare acid water.

Using an advanced GIS, and after more than two years of collecting data, a recently published study has estimated the energy potential for the total area of Kursumlija municipality (see location figure), and concluded that the most important potential is located at the north-east edge of the municipality. The total energy in the whole territory is 620 TJ/year, or 19.6 MW, which could be enough to heat 500 households or more than 100,000 sq. meters.

All of those findings are described in the paper: *A GIS-based method for analysis of a better utilization of thermal-mineral springs in the municipality of Kursumlija (Serbia)*, recently published in the journal *Renewable and Sustainable Energy Reviews*. The paper is authored by Aleksandar Valjarević, Danica Srećković-Batočanin, Dragana Valjarević, and Vesna Matović from the Ton Duc Thang University, Ho Chi Minh City, Vietnam, the University of Belgrade, Faculty of Mining and Geology and the University of Kosovska Mitrovica, Department of Mathematics.



Location of the studied area. Figure 1 of the cited paper.

In other related news, it was unveiled that Serbia is expecting to build its first geothermal district heating system. The system will be in the municipality of Bogatić in western Serbia and will initially be used to heat public facilities, after which it will also be made available to individuals and businesses.

The new geothermal heating system will result in the reduction of air pollution, and annual savings of between 100,000 and 150,000 euros. The contract for construction was signed at the end of 2017, with the total value of the project coming to one million euros, three quarters of which will be financed through a loan and the rest from the budget of Bogatić municipality. The municipality’s mayor, Nenad Beserovac, stated that the project is to be completed “within 120 days.”

Sources: <https://sciencetrends.com/dreams-about-clean-and-renewable-energy-in-one-small-municipality-in-south-eastern-serbia/>, <https://emerging-europe.com/in-brief/serbia-to-increase-focus-on-green-energy/>

Turkey: Baklamici, Buharkent and Manisa Power Plants

19.4 MW Power Plant Started to Operate - Turkish company Akca Enerji said has brought its 19.4 MW Baklamici Geothermal Power Plant on line by July 20, 2018. The plant is located in Alasehir/Manisa, and is composed of a binary cycle power turbine (ORC) constructed by Ormat, under a contract signed on December 2016.

Within the scope of the contract made between Akca Enerji and Alasehir Municipality, Alasehir Baklami determined that there was a high potential for electricity generation in the four geothermal wells that the company drilled as a result of the technical studies carried out with licenses for geothermal energy. EPRK license application was made and production license was obtained.

Domestic turbines and equipment have been used in the geothermal plant and the electricity produced will be evaluated commercially under the local incentive mechanism of YEKDEM.

Source: <http://www.thinkgeoenergy.com/19-4-mw-baklamici-geothermal-plant-in-alasehir-turkey-starts-operation/>

This is a project developed by Limgaz Elektrik Üretim Madencilik Sanayi Ve Ticaret A.S., operating under Limak Holding. The project was successfully completed as a turn-key engineering, procurement and construction (EPC) project in Aydin, Illi, Bharkent District, executed by the Turkish firm EGESIM, that has been involved in up to 28 geothermal power projects in Turkey and cooperated with Atlas Copco for this project.

Source: <http://www.thinkgeoenergy.com/limgaz-starts-operation-of-13-8-mw-buharkent-geothermal-plant-starts-operation-in-turkey/>

More Investment in Manisa's geothermal plants - Türkerler Holding, which operates in Turkey's energy and construction sectors, plans to invest an additional US\$ 664 million in geothermal energy power plants in the Aegean city of Manisa, company Chairman Kazım Türker said in early September.

Türker in a statement said that the company has already invested US\$200 million to complete two geothermal energy power plants, JES 1 and JES 2, in the region. The two plants have an installed capacity of 48 megawatts, and can produce 360 GWh of electricity annually, according to Türker.

The company is currently working on the JES 3 power plant. This US\$136-million plant will produce 220 GWh of electricity annually.

"After completing the third geothermal power plant in Manisa, we will respectively start constructing JES 4, 5, 6, 7 and 8 power plants. We will invest almost US\$ 664 million in these new plants. Thanks to these plants, this



Baklamici geothermal plant, Alasehir/Manisa, Turkey (source: Akca Enerji).

Buharkent Geothermal Power Plant Started Operations in September – Turkish EGESIM reported by September 7th that the 13.8 MW Limgaz Buharkent Geothermal Power Plant, located in Aydin, Turkey, has been completed and received its operational acceptance by the Turkish Ministry of Energy and Natural Resources.

region's installed power capacity will reach 248 MW. Thus, our total geothermal investment in Manisa will reach almost US\$1 billion", Türker announced. He, however, did not elaborate on when these plants will be completed.

In other related news, it was unveiled in late September that company Soyak Enerji, has received the final

acceptance from the authorities for the official start of operations of the Mis 1 geothermal power plant. This plant has an operating capacity of 12.3 MW, and was developed by Mis Enerji Üretim A.S. in Alasehir/Manisa. It is the first of three plants (Mis 1, Mis 2 and Mis 3).

Sources:

<https://www.dailysabah.com/energy/2018/09/07/turkish-conglomerate-to-invest-up-to-1b-in-manisas-geothermal-plants>,
<http://www.thinkgeoenergy.com/soyak-enerji-starts-operation-of-12-3-mis-1-geothermal-power-plant-in-turkey/>

Oceania

New Zealand: New 25MW Plant, Commercial Production of Silica, Geothermal Bacteria, and Old Prediction

Te Ahi O Maui Has Entered the Commissioning Phase – After securing resource consent in July 2014, then getting the green light in September 2015 to begin construction, New Zealand's latest geothermal power plant has now entered the commissioning phase. It's the Te Ahi O Maui power plant that, when fully operational, will generate around 25 MW of baseload renewable energy.



Te Ahi O Maui power plant (credit: Eastland Group).

“This is a momentous stage in the project,” says Matt Todd, chief executive of Eastland Group, the Gisborne-based infrastructure company that owns Te Ahi O Maui operator Eastland Generation.

“All pre-operational resource consent and safety requirements have been met. Operational checks are

now being undertaken to allow commissioning to begin.”

Initial heating up of the plant began the last week of September, with the first synchronization of the plant to the national grid in the first days of October. A reliability run will follow an extensive testing regime, which is being conducted with Ormat Technologies Inc.

Israeli company Ormat, a world leader in the development of binary cycle geothermal power plants, supplied and constructed the Te Ahi O Maui power plant.

Todd said that Eastland Group's original business case had Te Ahi O Maui being commissioned from August 2018. “As with any multi-year project of this scale and complexity, many activities run in parallel. The construction component was delivered ahead of plan, and we're beginning commissioning only a few weeks behind our initial ambitious schedule.”

The Te Ahi O Maui facility consists of three geothermal production wells, two geothermal injection wells, an Ormat binary power station similar to many others already in operation in New Zealand and around the world, and a transmission connection to the national grid.

Consents allow for the extraction of 15,000 tons of geothermal fluid daily from the Kawerau geothermal reservoir, for the next 35 years. Nearly 100% of this fluid will be injected back into the reservoir, ensuring the operation is sustainable.

Initially considered a 22MW plant, the Te Ahi O Maui plant is expected to achieve around 25MW. The increase in output has improved the plant construction cost, including drilling, to US\$5.45 million per installed megawatt.

Te Ahi O Maui is a partnership between Eastland Generation and the Kawerau A8D Ahu Whenua Trust. “Both partners have brought strong commitments to the cultural wellbeing and safety of the whenua and the people working on the project,” says Ben Gibson, Eastland Generation general manager and Te Ahi O Maui project director. “Our kaupapa of development has ensured the project was executed in an environmentally friendly, sustainable and culturally appropriate way.”

“One of our aims was to build a geothermal plant from the ground up, managing multiple contractors and high risk hazards, respecting and working closely with local iwi – with zero harm to workers and visitors,” explained Todd. “We're proud to have achieved this, and it's a testament to all the teams involved.”

Te Ahi O Maui is the first geothermal power station to be built in New Zealand under new health and safety

legislation, and the first of its type to submit a Safety Case. On 16 April 2018, they received notification from WorkSafe that their Safety Case had been accepted.

An official opening ceremony will be held early next year.

Source: <http://www.eastland.nz/2018/09/28/nzs-newest-geothermal-power-plant-is-full-steam-ahead/>

Commercial Extraction of Silica from Geothermal Brines - The NZ based company Geo40, in cooperation with Contact Energy and the Ngati Tahu Tribal Lands Trust, is set to start commercially extracting silica from geothermal fluid as part of a world leading sustainable energy partnership.

The operation will see Geo40 use its technology to extract silica from geothermal fluid used at Contact's Ohaaki power station. Once extracted, the silica will be sold to manufacturers for use in everyday consumer goods, such as paint, providing an environmentally-sound source of silica that would otherwise require amounts of carbon-intensive energy to make. The potential volume of high grade silica that will be sourced from Ohaaki is up to 10,500 tons a year, most of which will be exported overseas.

"Geothermal energy is a proven source of renewable energy and this partnership builds on geothermal's already impressive environmental credentials," said James Kilty, Chief Generation Officer at Contact Energy.

"It's part of our de-carbonization strategy. Our focus is on using innovative ways to support customers to shift off carbon-intensive inputs by maximizing the benefits of the abundant renewable resources in New Zealand."

The partnership offers clear benefits to all parties. For Contact, the operational benefits are significant. Silica builds up in the geothermal pipes over time, and removing the silica significantly reduces equipment maintenance costs and increases the overall life-span of the plant. Removing silica also allows the plant to extract more heat from the geothermal fluid, making it more efficient to run.

The deal provides financial and social benefits to Ngati Tahu Tribal Lands Trust. The partnership will provide an ongoing revenue stream to the Trust, and the processed fluid will restore clarity to the Ohaki Ngawha, a sacred natural hot spring. This will be the Trust's first commercial venture of this nature, with the proceeds going towards restoring the Ohaki Community.

"Our initial aim has been to support the Ohaki Marae Reservation Trust to improve the clarity of fluid supplied to the Ngawha, Marae protection from the Waikato River and re-establish the road from the Marae to the Ohaki Bridge, thereby connecting the Whanau

that live along the Te Toke road," said Aroha Campbell, a spokesperson for the Trust.

"We have strengthened our relationship with Contact Energy as an enabler to form new relationships, and we have already seen the benefit of Whanau being employed by Geo40. We will see positive changes to our landscape over time while being fully in control of that destiny."



View of the Ohaaki's 105 meter-high cooling tower. Using natural convection, the tower cools the water used to condense the steam as it exits the power turbines. Photo credit: © GNS Science / Science & Society Picture Library.

The benefit for Geo40 is the ability to access a source of silica that does not require the same level of heat processing as silica sourced through traditional means.

"Ohaaki's geothermal fluid enables us access to a valuable mineral without harming the environment," said Geo40 Chief Executive John Lea. "The beauty of our technology is that nature –the geothermal reservoir– has already done most of the work for us, by dissolving the naturally occurring silica. Our process extracts the silica and turns it into silica products that will be exported around the world."

There are also positive economic benefits for the Waikato and Bay of Plenty regions, since Geo40's extraction and processing plants will need to be situated close to geothermal fields, creating additional jobs in provincial New Zealand. Plans are already progressing on expanding the partnership, with the parties investigating the possibility of processing up to 10 times as much fluid per day.

Source: <https://contact.co.nz/aboutus/media-centre/2018/07/19/contact-geo40-partner-with-maori-on-world-leading-energy-project>

New Protein from Geothermal Microorganism -

Antimicrobial resistance is one of the biggest threats to global health and the race is on to find new molecules with antibiotic properties. One way scientists try to find these molecules is to study proteins produced by microorganisms themselves, as the bacteria often uses these to fight off other competing bugs.

Scientists analyze the microorganism's genetic make-up –its genome– looking for sequences of code that correspond to types of proteins known to have antibiotic properties. One group of such proteins are called lanthipeptides that have a particular structure known to be effective at fighting off bacteria.

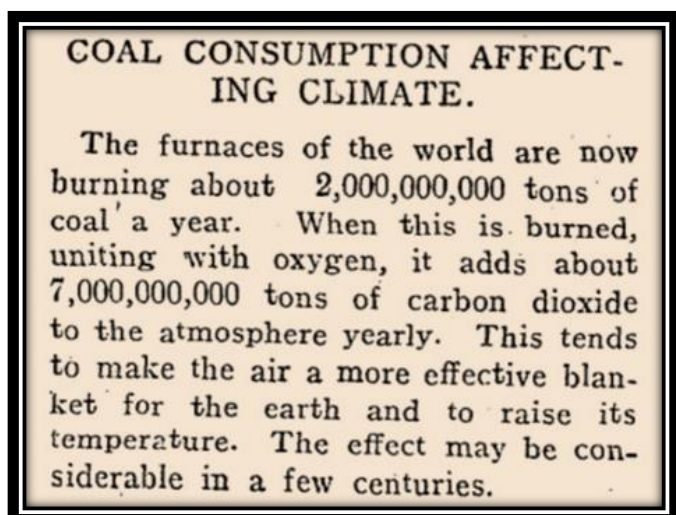
Researchers in New Zealand recently applied this process, known as 'genome mining', to a strain of *Thermogemmatipora* –a type of bacteria that lives in extreme conditions in the heated soil of New Zealand's Taupo geothermal zone. They discovered a new type of lanthipeptide, called tikitericin, which they believe is part of the microorganism's host defense system.

Using a number of different techniques to analyze the protein isolated from the *Thermogemmatipora* strain, the team were able to identify the structure of tikitericin, enabling them to build the peptide in the lab. Now that they can produce larger quantities of the molecule, the team can investigate its antimicrobial properties and hope that it will one day play a role in fighting bacterial infections.

Source: <http://www.rsc.org/news-events/journals-highlights/2018/sep/geothermal-antimicrobial-protein/>

Astounding Prediction on Climate Change -

On August 14, 1912, the New Zealand daily *The Rodney and Otamatea Times* published in its section Scientific News an article, signed by Francis Molena, commenting the effects of burning coal on worldwide climate. In the section titled Coal Consumption Affecting Climate, appeared the following astonishingly correct paragraph:



The original information seems to have been taken from the March 1912 edition of the magazine *Popular Mechanics*, whose only flaw is it resulted too optimistic about the time when this effect would be considerable: it really took less than one century.

Source: <http://www.milenio.com/ciencia-y-salud/106-anos-alguien-predijo-cambio-climatico>

Other

Climate Change: IPCC Special Report on Global Warming of 1.5°C

The Special Report on Global Warming of 1.5°C was approved by the Intergovernmental Panel on Climate Change (IPCC) on October 6 in Incheon, Republic of Korea. It will be a key scientific input into the Katowice Climate Change Conference in Poland in December, when governments review the Paris Agreement to tackle climate change.

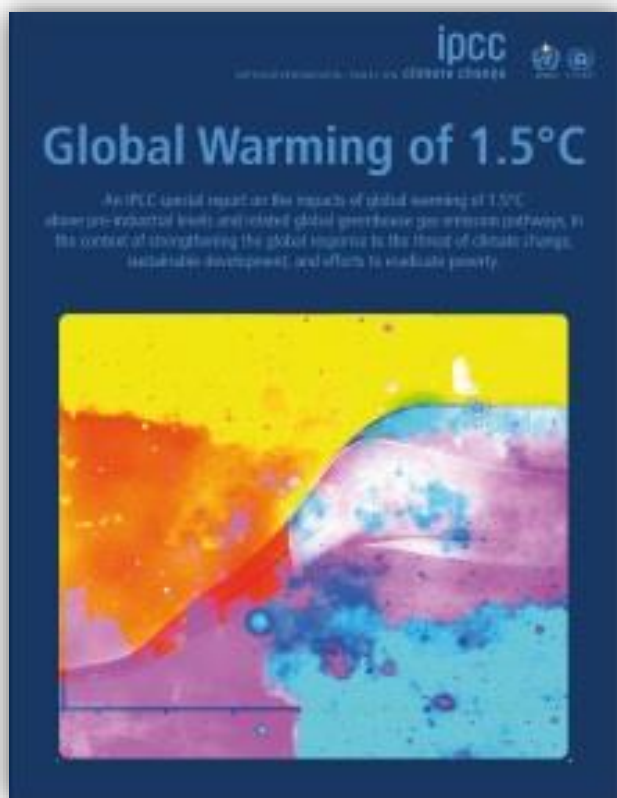
“With more than 6000 scientific references cited and the dedicated contribution of thousands of expert and government reviewers worldwide, this important report testifies to the breadth and policy relevance of the IPCC,” said Hoesung Lee, Chair of the IPCC.

Ninety-one authors and review editors from 40 countries prepared the IPCC report in response to an invitation from the United Nations Framework Convention on Climate Change (UNFCCC) when it adopted the Paris Agreement in 2015.

“One of the key messages that comes out very strongly from this report is that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice, among other changes,” said Panmao Zhai, Co-Chair of IPCC Working Group I.

The report highlights a number of climate change impacts that could be avoided by limiting global warming to 1.5°C compared to 2°C, or more. For instance, by 2100, global sea level rise would be 10 cm lower with global warming of 1.5°C compared with 2°C. The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C, compared with at least once per decade with 2°C. Coral reefs would decline by 70-90 percent with global warming of 1.5°C, whereas virtually all (>99 percent) would be lost with 2°C.

The report also examines pathways available to limit warming to 1.5°C, what it would take to achieve them and what the consequences could be. It finds that limiting global warming to 1.5°C would require “rapid and far-reaching” transitions in land, energy, industry,



buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO₂) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO₂ from the air.

The IPCC is the leading world body for assessing the science related to climate change, its impacts and potential future risks, and possible response options.

The report was prepared under the scientific leadership of all three IPCC working groups. Working Group I assesses the physical science basis of climate change; Working Group II addresses impacts, adaptation and vulnerability; and Working Group III deals with the mitigation of climate change.

The Paris Agreement adopted by 195 nations at the 21st Conference of the Parties to the UNFCCC in December 2015 included the aim of strengthening the global response to the threat of climate change by "holding the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels."

Source: <http://ipcc.ch/report/sr15/>

Climate Change: The U.S. Giants Exxon and Chevron Join the OGCI

ExxonMobil, Chevron and Occidental Petroleum have joined a global group of oil giants aiming to limit their climate impact. According to the Oil and Gas Climate Initiative (OGCI), its three new members recognize and support the Paris Agreement goal of keeping the temperature increase below 2°C. As a first gift, they will be contributing US\$ 100 million to the group's climate fund.

Created in 2014, the OGCI comprises 13 oil and gas companies and aims to minimize the impacts of greenhouse gases through investments and research into green technology. The group funds research into cutting emissions related to the production of fossil fuels. It advocates for carbon capture mechanisms and more efficient transport engines as ways to decrease emissions.

Oil companies are under pressure to report and mitigate the risks climate change poses to their business from shareholders and lawsuits.

Environmentalists have slammed the initiative as superficial and aimed at distracting from the opprobrium the industry has drawn for its inaction on climate change.

Newly released documents revealed oil companies such as Exxon and Shell had already linked their products to climate change as early as the 1980s. Such findings were kept away from the public.

Exxon and Chevron are the first U.S. members of the OGCI. The move comes as an increasing number of cities, states, and private actors are defying U.S. president Donald Trump's decision in June to withdraw from the Paris Agreement by taking independent climate change action.

The OGCI existing members are BP, CNPC, Eni, Equinor, Pemex, Petrobras, Repsol, Saudi Aramco, Shell and Total.

Source:

<http://www.climatechangenews.com/2018/09/20/exxon-chevron-first-us-companies-join-oil-gas-climate-alliance/>

Climate Change: Summer Heat May Soon Be Literally Unbearable in South Asia

Scientists and economists are warning of a quieter, more far-reaching danger: Extreme heat is devastating the health and livelihoods of tens of millions more. If global greenhouse gas emissions continue at their current pace, they say, heat and humidity levels could become unbearable, especially for the poor.

It is already making them poorer and sicker. Like the Kolkata street vendor who squats on his haunches from fatigue and nausea. Like the woman who sells water to tourists in Delhi and passes out from heatstroke at least once each summer. Like the women and men with fever and headaches who fill emergency rooms. Like the outdoor workers who become so weak or so sick that they routinely miss days of work, and their daily wages.

Indeed, a recent analysis of climate trends in several of South Asia's biggest cities found that if current warming trends continued, by the end of the century, wet bulb temperatures—a measure of heat and humidity that can indicate the point when the body can no longer cool itself—would be so high that people directly exposed for six hours or more would not survive.

In many places, heat only magnifies the more thorny urban problems, including a shortage of basic services, like electricity and water.

The science is unequivocally worrying. Across the region, a recent World Bank report concluded, rising temperatures could diminish the living standards of 800 million people in South Asia, a region that is already home to some of the world's poorest and hungriest people, if nothing is done to reduce global greenhouse gas emissions, as shown in the graph. The World Bank defines a decline of more than 8 percent in household living standards as high or 'severe'; four to eight percent as moderate; and zero to four percent as low. Living standards are measured by per capita consumption expenditures.

Worldwide, by 2030, extreme heat could lead to a US\$2 trillion loss in labor productivity, the International Labor Organization estimated. And by 2050, there will be around 100 most populous cities where summer highs are expected to reach at least 95 degrees Fahrenheit, according to estimates by the Urban Climate Change Research Network.

Rajkiran Bilolikar, a professor at the Administrative Staff College of India in Hyderabad, says it's hard to persuade policymakers, even the public, to take heat risk seriously. It's always been hot in many places like Hyderabad. It's getting hotter slowly, almost indistinguishably. Heat, he says, is "a hidden problem."

Sources:

<https://www.nytimes.com/2018/07/17/climate/india-heat-wave-summer.html?ncid=news1tushpnews>

[TheMorningEmail 071918,](https://www.nytimes.com/interactive/2018/06/28/climate/india-pakistan-warming-)

<https://www.nytimes.com/interactive/2018/06/28/climate/india-pakistan-warming->

[hotspots.html?action=click&module=RelatedLinks&pgtype=Article](https://www.nytimes.com/interactive/2018/06/28/climate/india-pakistan-warming-hotspots.html?action=click&module=RelatedLinks&pgtype=Article)

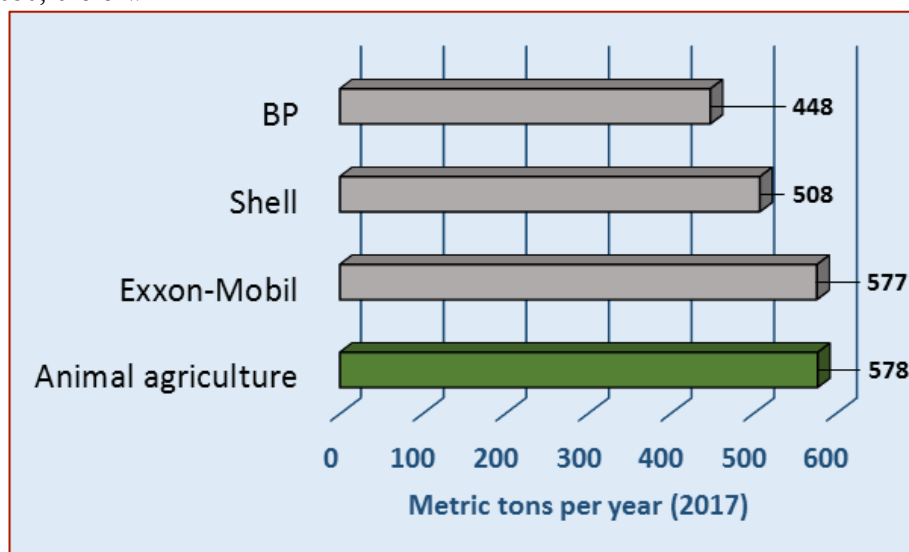
Climate Change: The World's Biggest Farms Pollute More than any Oil Company

The world's biggest meat and dairy operations combined pump more greenhouse gas into Earth's warming atmosphere than any one of the largest fossil-fuel giants.

A report published in late July 2018 by the nonprofit Institute for Agriculture and Trade Policy (IATP) shows the top five animal agriculture companies emit more greenhouse gases than Exxon-Mobil, Shell, or BP.

Researchers drew information from JBS, Tyson Foods, Cargill, Dairy Farmers of America, and Fonterra. The number researchers came up with—578.3 metric tons—was conservative, as much of animal agriculture does not make available data about their environmental footprints, the report states.

The report is a significant at a time when nearly every nation on the planet, with the exception of the United States, has agreed to keep the global temperature increases to "well below 2 degrees Celsius," with the goal of limiting it to 1.5°C. And major animal agriculture companies expect to be doing more business in the near future, which stands to work against efforts to scale back emissions. The demand for meat is on the rise, particularly in developing parts of the world such as China, where a rising middle class is eager to spend more on meat and dairy.



GHG atmospheric emissions per source. Data from IATP.

As the researchers point out, massive meat and dairy companies have for years managed to escape much criticism of their collective environmental impact, unlike

petroleum companies such as Exxon-Mobil and Shell. That's, in part, because most of them don't make public data on their greenhouse gas emissions. In fact, only four companies –one Japanese and three European-- of the 35 largest provided detailed data that the IATP considered credible. Fourteen companies have announced emission-reduction targets. How they plan to do that remains unclear.

The world's biggest farming companies contribute to emissions in three ways. Some are direct emissions from their facilities, machinery, and even methane that literally comes from the digestive systems of grazing cows. Then there are indirect emissions, such as the power it takes to generate enough energy to keep the facilities up and running. Finally there's the larger supply chain –the emissions that come from shipping animals, meats, and milk, as well the energy it takes to grow and transport the food that feeds the animals.

A large portion of the emissions are from a small handful of countries. The report calls out the United States, Canada, the European Union, Brazil, Australia, and New Zealand. Together, they account for 43% of animal agriculture's global greenhouse gas emissions.

Source: <https://qz.com/1332254/the-worlds-biggest-farms-contribute-more-to-climate-change-than-any-oil-company/>

Climate Change: EU and China Joint Statement on Climate Action

The China-EU joint statement, adopted in Beijing on July 16th, 2018, at the 20th EU-China Summit, committed the world's largest and third largest carbon polluters to driving progress in UN climate talks.

They said both would push for agreement on the rulebook of the Paris climate deal, negotiations over which stalled this year, with continuing disagreements between Chinese and European diplomats.

The statement, signed by European Council president Donald Tusk, European Commission president Jean-Claude Juncker and Chinese premier Li Keqiang, also

included:

- An agreement to release long-term strategies for their low carbon development by 2020;
- Agreement to step up their efforts before 2020;
- “Triangular” cooperation with developing countries to increase their capacity to combat climate change and build clean energy;
- A commitment to exchange knowledge on clean energy and explore the development of interconnecting networks.

The statement also called on “all parties” to uphold the Paris deal. That includes Donald Trump's U.S., which remains a signatory until 2020.

In the face of U.S. efforts to undermine international cooperation, leaders said the Paris Agreement was “proof that with shared political will and mutual trust, multilateralism can succeed in building fair and effective solutions to the most critical global problems of our time”.

The climate statement, as the only annex to a memorandum on a wide range of bilateral issues, places global warming at the center of the complex, often fraught EU-China relationship.

The move, which encouraged climate campaigners around the world, could fill a vacuum left by Trump, said Léa Pilsner, a researcher for E3G based in Brussels.

The statement “enshrines climate change at the heart of the EU-China relationship and shows an intention to jointly drive the global climate governance process forward. At a time when climate leadership is very much needed”, said Pilsner.

“Yes! Finally!” tweeted Isaac Valero, an advisor to the EU's climate commissioner, calling it “historic” and a “major boost” to the Paris Agreement.

The EU has signaled it may be ready to increase its emissions reduction pledge to the Paris deal. An influential government think tank in China (the National Centre for Climate Change Strategy and International Cooperation) has recommended the country consider a similar move.

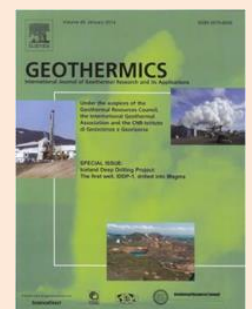
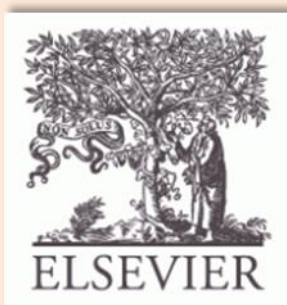
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<http://www.elsevier.com/locate/geothermics>



Source:

<http://www.climatechangenews.com/2018/07/16/eu-china-agree-sweeping-joint-statement-climate-action/>

Science: Yellowstone Super-volcano Has a Different Origin

The long-dormant Yellowstone super-volcano in the American West has a different history than previously thought, according to a new study by a Virginia Tech geoscientist. Ying Zhou published in *Nature Geoscience*, Volume 11, pages 449–453, in May 2018 the paper *Anomalous Mantle Transition Zone beneath the Yellowstone Hotspot Track*. The abstract reads as follow:

The origin of the Yellowstone and Snake River Plain volcanism has been strongly debated. The mantle plume model successfully explains the age-progressive volcanic track, but a deep plume structure has been absent in seismic imaging. Here I apply diffractive tomography to receiver functions recorded at USArray stations to map high-resolution topography of mantle transition-zone discontinuities. The images reveal a trail of anomalies that closely follow the surface hotspot track and correlate well with a seismic wave-speed gap in the subducting Farallon slab. This observation contradicts the plume model, which requires anomalies in the mid mantle to be confined in a narrow region directly beneath the present-day Yellowstone caldera. I propose an alternative interpretation of the Yellowstone volcanism. About 16 million years ago, a section of young slab that had broken off from a subducted spreading center in the mantle first penetrated the 660 km discontinuity beneath Oregon and Idaho, and pulled down older stagnant slab. Slab tearing occurred along pre-existing fracture zones and propagated northeastward. This reversed-polarity subduction generated passive upwellings from the lower

mantle, which ascended through a water-rich mantle transition zone to produce melting and age-progressive volcanism.

The eruptions were very explosive, Zhou added. A theoretical seismologist, Zhou created X-ray-like images of the Earth's deep interior from USArray –part of the Earthscope project funded by the U.S. National Science Foundation– and discovered an anomalous underground structure at a depth of about 250 to 400 miles (402-644 km) right beneath the line of volcanoes.

“This evidence was in direct contradiction to the plume model,” Zhou said.

The use of the X-ray-like images for this study is unique in itself. “This is the first time the new imaging theory has been applied to this type of seismic data, which allowed us to see anomalous structures in the Earth's mantle that would otherwise not be resolvable using traditional methods,” Zhou said.

Zhou will continue her study of Yellowstone. “The next step will be to increase the resolution of the X-ray-like images of the underground rock,” she added.

“More detailed images of the unusual rocks in the deep earth will allow us to use computer simulation to recreate the fragmentation of the gigantic oceanic plate and test different scenarios of how rock melting and magma feeding system work for the Yellowstone volcanoes.”

Sources:

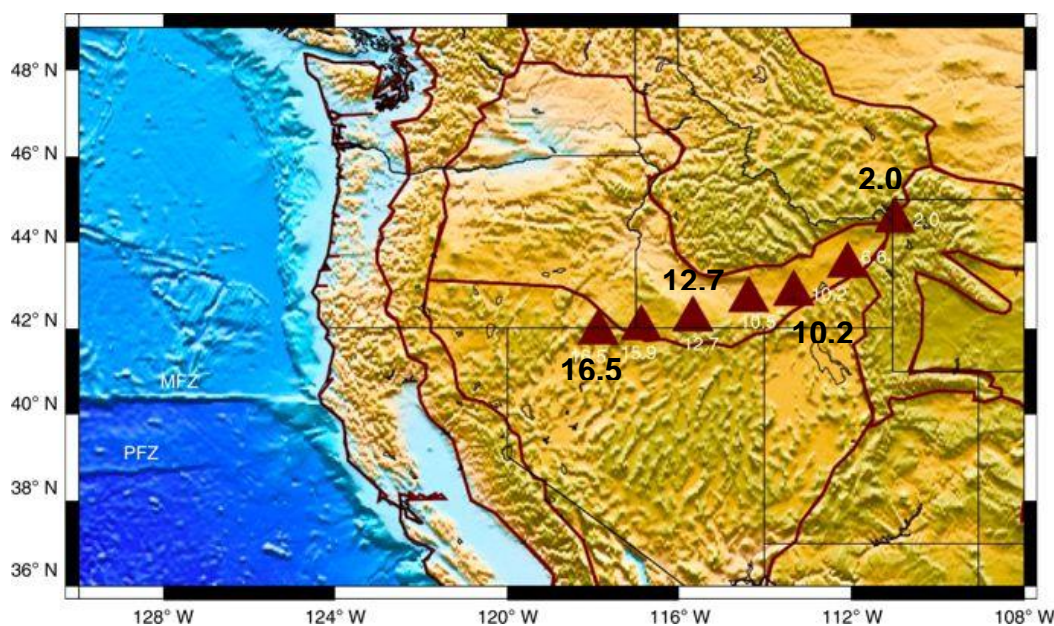
<https://sciencebulletin.org/archives/25994.html>,

<https://www.nature.com/articles/s41561-018-0126-4>

Science: Injection Wells Can Induce Earthquakes Miles Away from the Well

A study of earthquakes induced by injecting fluids deep underground has revealed surprising patterns, suggesting that current recommendations for hydraulic fracturing, wastewater disposal, and geothermal wells may need to be revised.

Researchers at UC Santa Cruz in the U.S. compiled and analyzed data from around the world for earthquakes clearly associated with injection



Location of the Yellowstone hotspot track (Figure 1 of the referred paper, taken from the second source; numbers are ages in million years).

wells. They found that a single injection well can cause earthquakes at distances more than 6 miles (10 kilometers) from the well. They also found that, in general, injecting fluids into sedimentary rock can cause larger, more distant earthquakes than injecting into the underlying basement rock.

“This is problematic, since the current advice is to preferentially inject into the sedimentary sequence as a theoretically safer alternative to the basement rock,” said Emily Brodsky, professor of Earth and planetary sciences at UC Santa Cruz.

Postdoctoral researcher Thomas Goebel said the key issue is the spatial footprint of induced seismicity around the injection well. “It’s not that the basement rock is safe, because there is still the possibility of encountering a fault in the basement rock that can cause a large earthquake, but the probability is reduced because the spatial footprint is smaller,” he said.

In a paper published August 31, 2018, in *Science*, Goebel and Brodsky described two distinct patterns of induced seismicity, which they associated with different physical mechanisms acting in basement rock and sedimentary rock. In the first pattern, associated with injection into basement rock, earthquakes tend to occur in a compact cluster around the well, with a steep decline in earthquakes farther from the well. In the other pattern, associated with sedimentary rock, induced earthquakes decline gradually with distance from the well and occur at much greater distances.

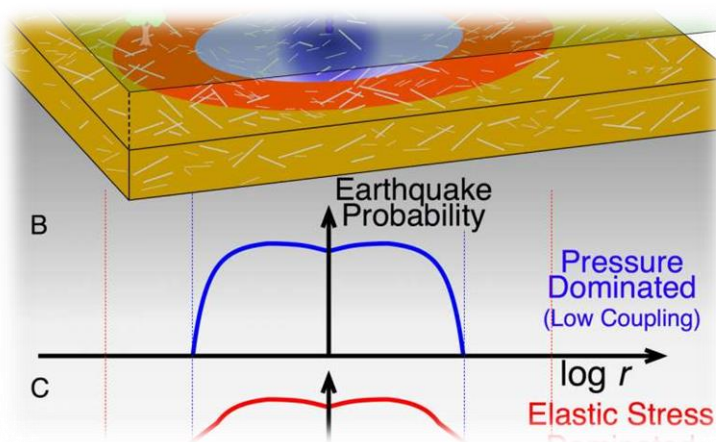
The physical mechanism by which injection wells induce earthquakes was thought to be a direct result of increased fluid pressure in the pores of the rock, causing faults to slip more easily. This mechanism can account for the spatial pattern of seismicity seen with injection into basement rock, Goebel said. But the pattern seen with injection into sedimentary rock suggests a different mechanism resulting from efficient “poro-elastic coupling,” which controls the ability of the rock to transmit fluid stresses into the solid rock matrix.

“When you inject water into the ground, it pushes on the surrounding rock and creates elastic stress in the rock, which can put pressure on faults at a distance without putting water into those faults. So if poro-elasticity is dominant, you end up with a larger footprint because it’s loading neighboring faults beyond the area of increased pore pressure,” Brodsky said.

According to Goebel, the crystalline basement rock is stiffer and has lower porosity than sedimentary rock. “Therefore, the increase in pore pressure is limited to isolated pockets around the well, and the coupling of that with the overall stress field is low,” he said.

Goebel said their findings help explain the extent of induced seismicity in regions such as Oklahoma where there are many injection sites in oil and gas fields. Oklahoma has seen a dramatic surge in earthquakes since 2010, to the extent that there are now more earthquakes each year in Oklahoma than in California. Goebel and Brodsky did not include sites in Oklahoma in their study, however, because there are so many injection wells they couldn’t isolate the effects of individual wells.

“In Oklahoma, they are injecting into the high-porosity sedimentary unit above the basement, but these elastic stresses can be transmitted over a large distance, so you could activate a large basement fault at a distance of 10



In this diagram of an injection operation, the blue and red areas represent the spatial footprint of induced seismicity for injection into basement rock (blue) or the overlying sedimentary layer (red). Gray lines represent the fault network. The graphs below show the corresponding earthquake probabilities as a function of distance from the well. Credit: Goebel and Brodsky, Science, 2018 (taken from the source.)

kilometers,” Goebel said. “That may be what we’re seeing in places like Oklahoma.”

Source:

<https://sciencebulletin.org/archives/26949.html>

Technology: Potential Application of Vacuum Insulated Tubing for DBHE

One of the ways to extract geothermal heat from the Earth’s crust is through Deep Borehole Heat Exchangers (DBHE). These can be either drilled especially for a heat extraction or, more cost-effectively, reconstructed from already-existing, negative, or abandoned oil or natural gas wells.

In many depleted boreholes, exploiting underground geothermal waters is either impossible or technically complex, therefore potential reconstruction for a borehole heat exchanger might be the only potential solution that allows for utilizing geothermal heat.

Borehole heat exchangers allow an exchange of geothermal heat between rock formation and heat carriers, circulating in the closed-loop system between the surface and an underground reservoir. The heat can be supplied directly, for instance from deeper wells with higher geothermal gradient, or indirectly using heat pump systems. During reconstruction operations of an already-existing well, the inner column is the most important feature, which in large part determines the overall success of the DBHE investment. Other properties include already existing well construction and characteristic of an underground rock mass.

The application of an insulated inner pipe with the lowest thermal conductivity coefficient will drastically reduce heat losses of a circulating heat carrier and, as a result, will increase the overall heat uptake. Well reconstruction for the DBHE includes partial abandonment, which constitutes of removing heavy mud from the borehole, sealing off perforated intervals using cement plugs and implementing inner, insulated column in leak tight, closed-loop system.

Vacuum Insulated Tubing (VIT), widely used in offshore industry, might be one of the potential technologies to efficient extract geothermal heat from the DBHE installations. VIT constitutes of two coaxial steel pipes, where air between them is evacuated using a vacuum pump during the manufacturing process.

After achieving the desired level of vacuum, pipes are sealed and welded. This process creates very high thermal insulation and minimizes heat exchange between the vacuum pipe and annulus. VIT technology decreases heat transfer between the inner coaxial column and existing well construction, because its thermal conductivity coefficient varied from 0.006 to 0.0008 W/(m·K), whereas for conventional steel pipes this value amounts to 40 W/(m·K).

Conventional in the petroleum industry, L-80 steel grade is most commonly used for an outer VIT pipe, whereas steel grades with higher chrome content are applied for inner pipe due to potentially hostile and corrosive downhole environment. The main drawback of VIT is the significantly high weight of double steel pipes, which leads to increased costs of transport and operations of running into the borehole with a drilling rig onsite. Other disadvantages include high market price and limited availability.

Source: <https://sciencetrends.com/potential-application-of-vacuum-insulated-tubing-for-deep-borehole-heat-exchangers/>

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