IGA NEWS

Newsletter of the International Geothermal Association

Quarterly No. 111

IGA ACTIVITIES

Message from the Executive Director

Greetings to all members of IGA and those that are reading this newsletter. We hope the first Quarter of 2018 has been a good one for all of you. For us at the IGA it has been an exciting first three months, with loads of activities and events we have been to. Let us start by sharing with you some good news regarding our team in Bochum. Karolina Andersson has taken maternity leave as she is expecting her first mid-May. We want to thank Karolina for three years of outstanding support to the IGA, and wish her all the best for her upcoming journey into parenting and caring for something else than the IGA! Karolina, thank you and you will be missed!

Highlights of the past few months are the IRENA Assembly in Abu Dhabi where Alex Richter gave a plenary speech at the meeting of the Global Geothermal Alliance. We also had the pleasure to organize jointly with the IEA–Geothermal Technical Programme the Asia Symposium prior to the GeoTherm conference in Offenburg, Germany. We had 12 speakers from 10 Asian countries presenting on the opportunities and highlights of geothermal energy. The symposium created a solid networking base and led to some fruitful discussions how both the IEA and IGA can help accelerate geothermal development, especially in countries at the beginning of the geothermal learning curve.

At the ITB Workshop in Bandung, we kicked off our first joint Worldbank / IRENA / IGA workshop on the application of the UNFC Code on Geothermal Resources & Reserves assessment. The workshop was organized by Graeme Beardsmore, Chair of the IGA R&R Committee and led by Prof Gioia Falcone of Cranfield University. IGA experts chairing sessions were Alexander Richter, Harmen Mijnlieff, Varun Chandrasekhar, and Manfred Hochstein. The workshop was well attended by many Indonesian geothermal professionals. Training was received very well, now the challenge is of course to keep the momentum and deploy the code throughout the country. There are two more workshops planned in 2018, although countries are not fully confirmed yet, we are looking into East Africa and the Caribbean Small-Island Development

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States. More to come about this very interesting topic next time.

We are now heading towards our next big events in Iceland, both the Iceland Geothermal Conference (24-26 April) and of course our IGA Board meeting that will take place between 27 and 29 April in Reykjavik. We have 23 Board members registered to join us in Iceland and it will be exciting to obtain sign-off on some of our strategic initiatives we have created over the past year. The IGA needs to transition into an independent sustainable organization that is renowned worldwide for its geothermal leadership and trusted voice. Geothermal is still relatively invisible in the energy transition dialogues taking place on a global scale, however is gaining traction on the regional and national scale. It is up to us as a reputable organization and our renewable partners to facilitate upscaling from national to international, apply best practices and support the growth of geothermal development through active engagement with policy-makers and decision-takers. We cannot stress enough how important it is to hear from our membership about your ideas, your solutions and your contributions. Do not hesitate to connect to us and share your geothermal story with us and the global geothermal community.

For now we wish you happy Easter holidays and enjoy your leisure time with family and friends.

Kind regards,

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

Final Contracts Signed for World Geothermal Congress 2020 in Reykjavik, Iceland

During a ceremony in late January, the International Geothermal Association (IGA) signed a contract with the three leading geothermal energy companies in Iceland: HS Orka, Landsvirkjun and Reykjavik Energy (OR). The agreement secures financial support for the World Geothermal Congress (WGC) in Reykjavik in 2020, which will be held in April that year in Harpa Concert Hall and Conference Centre. The Iceland Geothermal Cluster will host the Congress in 2020.

The WGC is held every five years and will now finally come to Reykjavík. Iceland has been, for the past decades, a strong example of how renewable energy can power a modern economy, and the Icelandic energy companies have played a vital role in the technological development of geothermal concerning power generation, district heating, and other direct usages.

In the picture from left: Hörður Arnarson, CEO of Landsvirkjun; Viðar Helgason, Managing Director of the Icelandic Geothermal Cluster; Alexander Richter, President of IGA; Ásgeir Margeirsson, CEO of HS Orka; and Bjarni Bjarnason, CEO of Reykjavik Energy (OR) (Photo ThinkGeoenergy).

About 3500 delegates are expected to come to Iceland for the Congress and have unique opportunity to see firsthand in some field trips how Iceland has become a leader in geothermal utilization. Hopefully, the visit will help other countries take the next step towards implementing sustainable energy solutions based on their geothermal resources.

The event is a joint effort by the Icelandic geothermal industry led by the Iceland Geothermal Cluster.

Source: http://www.thinkgeoenergy.com/final-contracts-signed-for-world-geothermal-congress-2020-in-reykjavik-iceland/

Project GEMex: Meetings of the Mexican & European Consortia

Luis C.A. Gutiérrez-Negrín, Editor, & Katrin Kieling, GFZ

The Project GEMex (www.gemex-h2020.eu) is a cooperation initiative between Mexico and the

European Union, developed under the umbrella of the Horizon 2020 in Europe and the Fund for Energetic Sustainability (FSE) in Mexico. The project is composed of two consortia, one integrated by 24 European organizations coordinated by the German Research Centre for Geosciences (GFZ), and the other by nine Mexican entities leaded by the Michoacán University (UMSNH).

The project has the goal to bring together the extended Mexican know-how of discovering, developing, and exploiting geothermal energy systems with a variety of European expertise from similar geothermal energy systems in Italy, Iceland, and other places. The focus is the development of the Enhanced Geothermal Systems (EGS) technology, and the search of new approaches to make use of super-hot geothermal systems (SHGS) (*see* IGA News 107, p. 5).

- **Meeting of the Mexican Consortium (Morelia, Mexico, 8-9 February)**

The project's Mexican consortium is composed of three distinct units of the National University (UNAM): the Geophysical Institute headquartered in Mexico City, the Geosciences Center of Juriquilla located in Querétaro, and the National School of High Studies, Morelia campus. Other partners are the scientific research and high education center of Ensenada (CICESE), the National Institute for Electricity and Clean Energy (INEEL), headquartered in Cuernavaca, two private companies (Geominco, based in Querétaro, and JL Energía, based in Morelia), the Comisión Federal de Electricidad (CFE) and the UMSNH.

The second technical meeting and the first administrative meeting of the Mexican consortium was held in Morelia City on 8-9 February 2017, with two main objectives: i) To present the current state of the activities planned for the second stage of the tasks included in the seven technical Work Packages (WP); and ii) To present, discuss and solve the main managerial issues experienced in the first two stages of the project.

The meeting was officially inaugurated by the scientific research coordinator of the UMSNH, Dr. Ireri Suazo, on behalf of the Rector, Dr. Medardo Serna-González, and the Technical Leader of the project, Dr. Aída López-Hernández. Later on, the Rector himself welcomed and greeted the participants in a short ceremony.

Aída López, accompanied by the administrative leader of the UMSNH, Eugenia Macías-Guzmán, welcomed the participants and explained the objectives and expected outcomes of the meeting.

During the first part of the meeting, representatives of the FSE presented their view of the issues they have observed in the development of the first two stages of the project, since February 2017 to February 2018. These problems were mainly related with the flow of the economic resources between the FSE and the UMSNH, by one side, and the UMNSH and the other institutions, by the other side. That situation leaded to the complication and delay in the flow of resources, with the consequent slowing in the technical activities. The FSE urged to improve and ease the interrelations among the administrative responsible of the consortium members, but also among the technical and administrative responsible of all the institutions participant. Also during this first part, the audit company hired by the FSE to review and approve the expenses of the project, presented the criteria used to do that. Since all these resources are of federal provenance, they are subject to complex and sometimes redundant requirements.

Meeting of the Executive Board of the Mexican consortium in Morelia. (Photo: A. López.)

Then, the technical and administrative sessions started in a different, nearby venue, in two separate rooms. The technical sessions were on the following tasks:

- WP 3.1, 3.2. Regional models and characterization of volcanological systems
- WP 3.3. Geohydrological model
- WP 4.1. Definition of petrological,

hydrothermal alteration, micro-thermometric, stable-isotopic, and geo-chronometric properties of basamental outcrops in surrounding areas of Los Humeros and Acoculco

- WP 4.2. Relationships between fracturing and flow of fluids in active systems
- WP 4.3. Origin and paths of fluids
- WP 4.4. Magmatic evolution and heat source of the Acoculco Caldera: comparing the pre- and post-caldera volcanism
- WP 4.5. Characterization of litho-facies in Los Humeros
- WP 4.6. Characterization of superficial discharges of the geothermal system and its relation with the volcanic system
- WP 4.8. Mineralogical characterization of the Acoculco geothermal system
- WP 5.1. Electrical methods
- WP 5.2. Seismic
- WP 5.3a. Heat flow
- WP 5.3b. Gravimetry and magnetometry
- WP 5.4. Inversion methods
- WP 6.1. Rocks, fractures, and properties of reservoir fluids
- WP 6.2a. Petrology of rocks of the Los Humeros reservoir
- WP 6.2b. Characterization of the Acoculco reservoir
- WP 6.3. Approaching EGS models
- WP 6.4. Approaching SHGS models
- WP 7.1. Integrated model of the EGS reservoir
- WP 7.2. Design of operation of the stimulation test
- WP 8.1. Prediction of the SHGH properties in Los Humeros
- WP 8.2. Materials for installation of SHGS
- WP 9. Assessment of environmental, social and economic impacts of EGS and SHGS

In parallel, each administrative responsible of every institution was met with the administrative responsible of the UMSNH and the representatives of the FSE, as well as the technical leader of the corresponding task or WP, to review in detail the specific issues occurred in the first and second stages, with special emphasis in the flow and checking of the economic resources. In every case it was prepared a minute of agreements outlining the best ways to resolve the issues and prevent their occurrence in the following stages.

The event finished with an informal meeting of the GEMex board of the Mexican consortium, with participation of many of the technical participants, not only the formal members.

The general consensus was the meeting was fruitful, particularly in the administrative area where it is expected a better and more efficient operation of the project. So be it.

- **Meeting of the European Consortium (12-13 March, Bari, Italy)**

From 12-13 March 2018 over 80 scientists from ten European countries and Mexico met for the second GEMex interim meeting in Bari, Italy. Scientists reported the first project results, discussed the data collected so far and planned the integration of different datasets.

The meeting was organized by the Bari University (UNIBA), particularly by Domenico Liotta, responsible of the GEMex's Scientific Package 1, and his team. The half of the first day (March 12) was a plenary session composed of a welcome message from the host, news from the coordinators from EU (David Bruhn & Katrin Kieling) and Mexico (Aída López-Hernández), and two updated overview presentations on Los Humeros, by Egbert Jolie, and on Acoculco by Domenico Liotta.

After lunch, there were three simultaneous sessions by groups of the technical Work Packages, which continued during the morning of the next day (March 13). During the final plenary session, the technical leaders of each WP presented the main conclusions and

Technical presentations in Bari (Photo: A. López-Hernández).

next steps.

The Executive Board of the European consortium held a meeting at the evening of the first day, before the welcome dinner in a picturesque place in downtown Bari.

In the breakout sessions, first results were presented by the geologists collaborating in the project: Preliminary 3D-geological models of the two geothermal sites Los Humeros and Acoculco (Puebla), are available to the GEMex consortium. The researchers included the available geological knowledge up to now building on previous efforts within the Mexican CeMIE-Geo project. A regional volcanological model forms the basis for a conceptual model. The next step is to include the new data which is collected during the project.

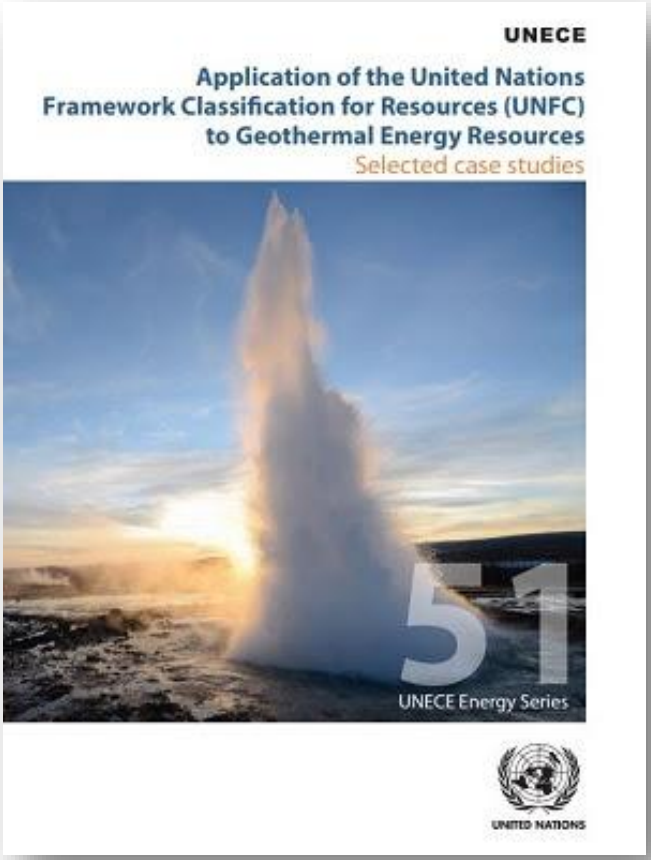
During the last year the database at Los Humeros was increased tremendously in all fields of exploration: 43 seismic stations are deployed in a passive seismic network, 50 magnetotelluric (MT) and 75 transitory electromagnetic (TEM) soundings have been taken, 55 fluid samples for geochemistry, over 70 samples from cores of 15 wells, three large samples (400 kg) for hydraulic fracturing tests, 46 samples for age dating, more than 2500 CO_2-flux measurements, 330 soil gas samples, surveys on UAV thermal imagery, hyperspectral scanning, structural geology fieldwork and many, many more are the prove for a great collaboration between Mexican and European scientists. Fieldwork shall be concluded until the end of this year with greater focus on the site which is investigated for an EGS concept, Acoculco.

The big challenge of the project will be to take advantage of joint interpretation of multiple datasets and to integrate this huge dataset to a joint model. During the meeting in Bari, first steps towards data integration were taken, as well as the transfer from the geological to the reservoir model, which will allow for simulations of the reservoir behavior.

First results of the project were presented to the general public during a GEMex Informative Event on March 27 in Pisa, Italy (please find more information at this link) one day prior to the DESCRAMBLE final conference (info here).

New Publication on the UNFC Applied to Geothermal Case Studies

In the *UNECE Weekly* 739, published on 5-9 February 2018, it was announced the publication of *Application of the United Nations Framework Classification for Resources (UNFC) to Geothermal Energy Resources - Selected case studies*, that was prepared by the UNECE Expert Group on Resource Classification, Energy Series No. 51. This publication includes a set of 14 case studies form several countries, presented to illustrate the application of the geothermal energy specifications for the uniform use of UNFC in different contexts. These examples provide a range of scenarios in the classification of geothermal resources in a manner consistent with the classification of other energy resources.



In the Foreword, Olga Algayerova, Executive Secretary of the United Nations Economic Commission for Europe (UNECE) writes: "The United Nations Framework Classification for Resources (UNFC) was developed under the auspices of the United Nations Economic Commission for Europe by a dedicated community of experts drawn from a range of fields, but with the common goal to develop an internationally applicable scheme for the classification, reporting and management of energy and mineral resources. Though initially developed for the mineral and petroleum sectors, UNFC has recently expanded its scope to include renewable energy. Growing awareness and interest in renewable energy resources, including geothermal resources, has highlighted a need to standardize the way in which renewable energy potential is classified and reported.

"To facilitate improved global communication in the geothermal sector, the ECE Expert Group on Resource

Classification, under the framework of a Memorandum of Understanding between the United Nations Economic Commission for Europe and the International Geothermal Association (IGA), developed specifications for applying UNFC to geothermal energy resources. The specifications were issued in September 2016.

"A set of 14 case studies from Australia, Germany, Hungary, Iceland, Italy, Netherlands, New Zealand, Philippines and Russian Federation are presented here to facilitate a better understanding of the specifications and the uniform application of UNFC to geothermal resources. These application examples illustrate the classification of a range of different geothermal resource scenarios in a manner consistent with other energy resources. The approach also provides valuable indicators to the value of UNFC as a tool to support attainment of the Sustainable Development Goals.

"Experts in geothermal energy resources, as well as those in other energy and mineral sectors, will find this collection of case studies a useful reference document in their efforts to apply a globally applicable integrated resource management system. I commend all those involved in the preparation, review and verification of these case studies and thank, in particular, the International Geothermal Association for its support."

Among the acknowledgements, it is stated that: "The development of these case studies was undertaken by a sub-group (Working Group) of expert volunteers led by Gioia Falcone (Leader) with Miklos Antics, Roy Baria, Larry Bayrante, Paolo Conti, Malcolm Grant, Robert Hogarth, Egill Juliusson, Harmen Mijnlieff, Annamária Nádor, Greg Ussher and Kate Young as members, and Graeme Beardsmore and Horst Rueter as observers… The International Geothermal Association (IGA) has actively supported this work through its IGA Resources and Reserves Committee (Chaired by Graeme Beardsmore). UNECE and IGA have a Memorandum of Understanding to develop specifications and guidelines for the application of UNFC to geothermal energy."

The 14 case studies are: Ngatamariki (New Zealand), Habanero (Australia), Insheim (Germany), Rotliegend-3 and Dutch Rotliegend Play Area (The Netherlands), Hódmezővásárhely District Heating (Hungary), Alto Peak and Baslay-Dauin (Philippines), Canavese GeoDH System (Italy), Vertical Ground-Coupled Heat Pump System (Italy), and Aggregation GSHP-Potential (Germany), Pauzhetsky (Russian Federation), Krafla and Krafla-50 MW Power Expansion (Iceland).

This publication can be freely downloaded from: http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFC_GEOTH/1734615_E_ECE_ENERGY_110_WEB.pdf

Should you be interested in a hard copy, please send an email (iga@lovegeothermal.org) to the IGA Team in Bochum and we send one to you.

AFRICA

Algeria: First Batch of Zucchinis from the Touggourt Geothermal Complex

The first batch of Gloria zucchinis, out of the geothermal complex of Touggourt, destined for export, left the port of Oran on middle March towards Europe. It is a zucchini variety different from those found on the national market. Its color is dark green, and its size varies between 18 and 23 cm. As far as quality is concerned, the complex's managers claim that this product, which stands out due to its 'organic' properties, is very competitive on the international market.

As a matter of fact, according to Taha Derbal, General Director of the National Office of Irrigation and Drainage (ONID), this first shipment of 20 tons will be exported to Spain, and the United Kingdom will be its final destination. The same official says that this is the first vegetable produced by the pilot mega-complex of ONID, using geothermal energy in agricultural production. Located in Touggourt, in the province of Ouargla, this complex was built by ONID, in cooperation with the Spanish company Alcántara.

The complex has four large greenhouses for vegetable crops, a nursery, a seed storage site, as well as a crop treatment and storage station. The complex has 80 employees in service, including nine state engineers in hydraulics and agronomy, all trained in Spain, to take charge of the technical aspect of the project. After all, technology is what allows the vegetables to be harvested 'organically' in a record amount of time, without wasting any energy.

This complex, the first of its kind in Algeria, uses the heat produced by deep drilling for agricultural production; an optimal yield with highly added value.

This technique makes it possible to obtain the ideal conditions for the production of early vegetables. "The complex has four multi-chapel greenhouses of 10 hectares each. Their operation will finance another 40 hectares, which will increase the number of greenhouses to 16" Derbal said. The zucchini, the first vegetable produced by the complex, will be followed up by other products, such as industrial chili peppers, peppers and cherry tomatoes. Studies are also underway for the production of certain fruits, such as watermelon and melon, as to adapt to conditions more perfectly. But priority will be given to the gardening market because, according to Mr. Derbal, these are techniques already mastered by the complex,

Taha Derbal explained that geothermal energy is the energy recovered from the boreholes to heat the greenhouses, thanks to radiators in the form of serpentines, uncoiled inside of them. The supply of hot water (50 to 80°C), with a salinity between 2.5 and 3.5 g/l, comes from the Albien wells in the region. This technique makes it possible to have the same climate conditions throughout the year, especially during the winter period when the nightly temperature drops are noticeable. The complex also has a de-mineralization block which allows for cooling and softening of the salt water. Funded by the National Bank for Rural Development (Badr), this complex is compiled from all sorts of technology, with everything controlled remotely, such as: temperature, watering, and brightness.

The conditioning of the production, from its arrival in the fields, up until its final packaging, is also automated.

Source:
http://www.hortidaily.com/article/41896/Algeria-First-batch-of-zucchinis-from-the-Touggourt-geothermal-complex

Ethiopia: Expansion of Aluto Langano to Be Started

The overdue expansion of the Aluto Langano Geothermal Plant is going to get a fresh start following the recently announced tender by the Ethiopian Electric Power (EEP) to hire a contractor for the project and procure rigs to drill the wells.
EEP is searching for a company that will provide two geothermal drilling rigs and accessories, rig operations and maintenance for drilling geothermal wells along with all the accessories, heavy machinery, trucks and vehicles.

The procurement could likely cost the EEP an estimated US$120 million.

The International Development Association (IDA) of the World Bank has already provided financial assistance of about US$126 million out of the total project cost of US$218 million. IDA extended this support under its Geothermal Sector Development Project (GDSP).

Located on the Aluto volcanic complex of the Ethiopian Rift valley, close to the eastern mountain between Lake Langano and Ziway, some 200 km southeast of Addis Ababa, the plant is expected to generate 75 MW from eight wells.

The initial feasibility study for the project was conducted in 1986. Later, a 7MW plant was constructed in 1998 as a pilot plant to test the geothermal resources in the area. It covers an area of about eight square kilometers, and can generate up to 100 MW of electric energy from the Aluto steam field, known to be one of the high temperature prospected areas in the country.

The plant has been producing just around 1MW from the two small wells it has, but the EEP and the then Ministry of Mines & Energy started an attempt to optimize it in 2013, which had to be cancelled.

The expansion of Aluto Langano is the third largest geothermal project in the country, after the 500MW project in Corbetti Caldera, 250 km south of Addis Abeba, in the Oromia regional state, and the Tulu Moye project, another 500 MW project in Oromia Regional State. Power Purchase Agreements (PPA) and an

UPCOMING EVENTS

25th Annual Congress of the Mexican Geothermal Association
18-20 April 2018, Morelia, Mich., Mexico

Iceland Geothermal Conference 2018
24-26 April 2018, Reykjavik, Iceland

Grand Renewable Energy 2018
17-22 June 2018, Yokoyama, Japan

GEOHEAT International Geothermal Conference
4-7 September 2018, Petropavlovsk-Kamchatsky, Russian Federation

GRC Annual Meeting & Expo
14-17 October 2018, Reno, Nevada, U.S.

Seventh African Rift Geothermal Conference (ARGeo-C7)
29 October – 4 November 2018, Kigali, Rwanda

Note: Please check the IGA website for more events.

Implementation Agreement (IA) were signed for the two projects some months back.

Source: https://addisfortune.net/articles/aluto-langano-geothermal-expansion-comes-to-life/

View of the current Aluto Langano plant (Photo from the source).

Kenya: GDC Pillars, Imminent Drilling in Longonot, Geothermal Power for Railroad & Probable Royalties

Menengai and Baringo-Silali, Are Critical Pillars for GDC - Two geothermal projects of GDC (Geothermal Development Company) have been identified as critical pillars which will catapult the ambitious Big Four Economic Agenda recently launched by the Kanyan President Uhuru Kenyatta.

According to GDC Board of Directors, the Menengai and Baringo-Silali geothermal projects will be key indicators in government's plans for the governmental four pillars: manufacturing, affordable housing, universal healthcare and food security.

Speaking during a tour of Menengai and Baringo- Silali projects on late January, Chairman of the GDC Board of Directors, Gershom Otachi, accompanied by other members of the Board and GDC Managing Director & CEO, Johnson P. Ole Nchoe, said that the Board will fully support the development and ensure both projects succeed.

"Be assured of our support in these projects. We are extremely happy with the good job. These projects are key deliverables in the Government's plan for the Big Four Economic Agenda," said Otachi.

Source:
http://www.gdc.co.ke/gdc_big_four_agenda.php

Drilling to Start in Longonot in June - African Geothermal International Limited (AGIL), a firm linked to National Bank of Kenya chairman Mohamed Hassan, will start drilling its first exploration steam well in Longonot next June, after five years of delays.

The firm said it would cost a minimum of US$5 million to drill one well, the target being to drill up to 40 wells expected to generate enough steam for 140 megawatts of geothermal electricity. A steam well takes about 60 days to drill, reaching depths of up to 3.5 kilometers.

Hassan, the National bank chairman, is a co-director at the AGIL. The company got the license for drilling in 2009, the same year it was incorporated. It was given an area of 132 square kilometres around Mt Longonot for exploration and production for 30 years.

In 2013, the company announced it would start drilling in Longonot searching for steam and build a power plant at a cost of US$600 million. The drilling is yet to start five years later. Also in 2013, the company announced also it had already secured $10 million (Sh1 billion) in equity to start the exploration and another $8.4 million (Sh865 million) was to be signed with the African Union Commission.

Drilling engineers on the ground, said the firm is currently laying the infrastructure such as passable roads to pave the way for the first drills in June. The firm said it has the option of hiring out drilling rigs from either Geothermal Development Company (GDC) or KenGen, both state-owned agencies. In Kenya, the GDC is mandated to drill exploration wells in search of steam on behalf of investors to de-risk the venture before handing the steam wells to power producers who pay for the steam, in return.

Sources: https://www.msn.com/en-za/news/other/agil-to-drill-first-exploration-well-in-longonot/ar-BBIueWK, http://www.africa-geothermal.com/media/news-archive/

Geothermal Power for Electrification of Railroad - Kenya Electricity Transmission Company (Ketraco) has signed a Shillings 24.2bn ($US 239 million) contract with China Electric Power Equipment and Technology Company (CET) for the electrification of the Mombasa-Nairobi section of Kenya's Standard Gauge Railway (SGR).

The electrification project will involve the installation of catenary and 14 substations along the 472 km route, with power being provided by Ketraco's 400kV Mombasa-Nairobi Transmission Line (MNTL), which was energized in August 2017. The line has a transmission capacity of 1500 MW, just short of current national demand of 1700 MW.

Panoramic view of Mt Longonot. Photo by AGIL.

Ketraco said the MNTL was constructed to address the challenges of low voltages, high transmission losses and unreliable supply in Kenya's national electricity grid. The power for the SGR will be provided by geothermal plants, reducing CO2 emissions from train operations to zero.

Electrification is due to be completed within 28 months.

Source:
http://www.railjournal.com/index.php/africa/kenya-sgr-electrification-contract-signed.html

Proposed Royalty for Geothermal-power Producers - Fees will be levied at a rate of 1 percent to 2.5 percent of revenue generated from the energy source within the first decade of a geothermal license being issued, according to the draft Energy Bill presented to lawmakers on middle February. The levy will then climb to between 2 percent and 5 percent, the bill states.

The bill has been revised since October 2016, when President Uhuru Kenyatta asked lawmakers to remove a clause stipulating that Kenya Power Ltd., the monopoly power distributor, compensate customers for losses resulting from electricity blackouts. Outages are an almost daily occurrence in the country, including the capital, Nairobi.

The latest draft defies Kenyatta's order by providing for compensation by Kenya Power if outages, poor quality or irregular supply due to negligence results in damage to property, financial loss, or loss of life. Kenyatta had earlier urged quick passage of the bill.

Other proposals in the bill include:

- The licensing of other electricity distributors and retailers, in what will effectively end Kenya Power's monopoly in the industry

- Establishing a Consolidated Energy Fund to smooth volatility in gasoline and electricity prices

- Assisting counties in developing licensing and regulatory functions

- Giving counties the power to develop energy-conservation building codes to suit local conditions.

- Local communities around power-producing geothermal wells will receive 5 percent of the revenue from royalty payments under the proposed law. County administrations are to get 20 percent on the condition the amount doesn't exceed twice the budget allocations from national government, according to the bill.

"We welcome this proposal," said Lee Kinyanjui, governor of Nakuru county, which hosts the Olkaria geothermal fields that produce all of Kenya's geothermal power. "This will be of great benefit to the community and we'll ensure it percolates to the people."

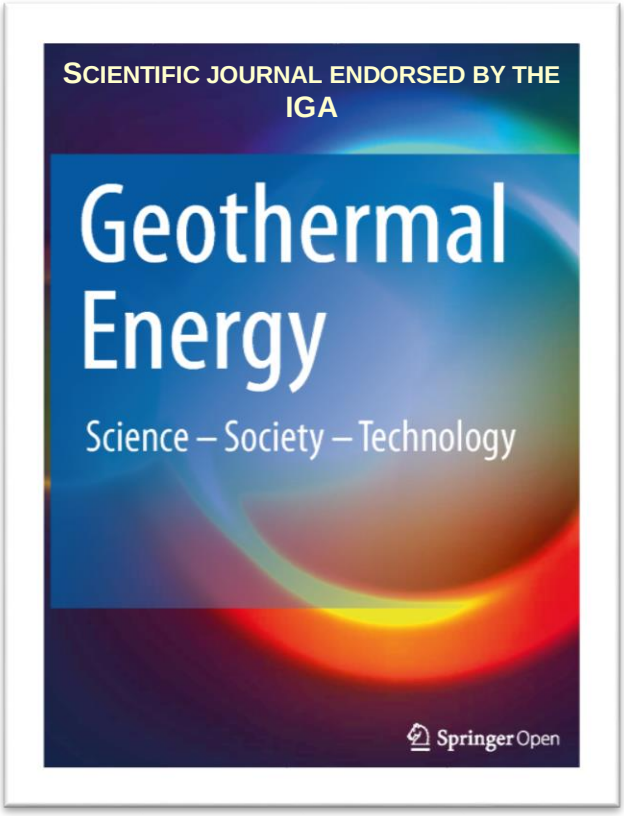
The communities will receive their money through a trust fund managed by a board of trustees set up by the community. However, the bill dampens that benefit for communities in geothermal steam rich regions, by giving immense powers to the Cabinet Secretary to do away with the royalties at will without consultations: "The CS may waive, suspend of reduce the royalty for any licencee in the interest of encouraging the greatest utilization of geothermal resources," reads the bill.

Sources:
http://www.renewableenergyworld.com/articles/2018/02/kenya-plans-royalty-for-geothermal-producers-in-energy-bill.html

AMERICAS

Canada: It Was Founded *Geothermal Canada*

On February 1st, 2018, the Canadian Geothermal Association (CGA) was reborn as the Pan Canadian



TAKE A LOOK HERE.

Society for Geothermal Research, Innovation, & Collaboration, colloquially known as *Geothermal Canada*.

The CGA was founded by Andrew Nevin, Tim Sadlier-Brown and Jack Souther. It was hatched in 1973 at the inaugural Geothermal Resources Council (GRC) meeting in Brawley, CA and was formalized in 1974. The Association met formally once per year in the form of small technical conferences and continued to meet throughout the following three decades. Membership ebbed and flowed with industry ups and downs until the mid-2000s. At that time the Association took a breather and spawned two other organizations from the membership of the original society. These are CanGEA and CanGRC. CanGEA is an industry focused lobby group which is affiliated to the IGA. CanGRC was founded by a group of students; the group no longer exists.

In 2017, a group of like-minded individuals felt the time was ripe to resurrect the original scientifically oriented society with a new name and renewed vigor. As geothermal energy gains prominence in Canada, it was felt that professionals, students, governments and other interested people needed a venue to discuss technical and academic aspects of the industry. Thus on February 1st, 2018, CGA was reborn as the Pan Canadian Society for Geothermal Research, Innovation, & Collaboration, colloquially known as Geothermal Canada. The Society is formulated under the Societies Act of British Columbia #20068829.

Geothermal Canada is a not-for-profit organization committed to advancing science and promoting geothermal research and development in Canada.

Serving Canada's geothermal community by stimulating technology transfer, knowledge exchange, and information transmission, it seeks to promote innovation in Canada in the field of geothermal research. Through fostering collaborative investigations in academia, companies, and organizations, innovation in the field of geothermal research will be supported and disseminated beyond the research community.

The BoD is composed of Catherine Hickson as the Executive President, Steve Grasby as Vice President, Katie Huang as the Secretary, and Jeff Witter as the Treasurer.

Source: https://www.geothermalcanada.org/

Chile: Concession for Tolhuaca Field & Coal Plants to Be Phased-out

Exploration Concession for Tolhuaca Geothermal Field - By official decree published on February 1st, 2018, the Chilean Energy Ministry grants Transmark Chile SpA a Geothermal Exploration Concession in the area known as Peumayén, located in the Quilaco district of the Biobío Region and the Curacautín district of the La Araucania Region, southern Chile.

Within the Peumayén Concession lies the Tolhuaca Geothermal Field, which has been widely studied since early 2000's, with a full-size exploration well drilled and steam production tested to an equivalent in power of 12 MW. Transmark Chile intends to conduct additional exploration studies and expand the current knowledge of the area to define the extent of the reservoir and the potential for base-load renewable power generation.

Geothermal power has great potential to help Chile in meeting its sustainable energy ambitions. Fortunately, there are great opportunities in Chile to increase geothermal power production and Transmark Chile is

taking on the challenge to develop the geothermal resources in Peumayén.

Source: http://www.transmark-renewables.com/news/transmark-chile-published-its-peumayen-concession-tolhuaca-geothermal-field

Phasing-out Coal Power Plants - After France, another country has recently announced plans to start eliminating dirty fossil fuels. President Michelle Bachelet said in early February that Chile will not build any coal plants without carbon capture and will start replacing existing plants with cleaner sources.

Thanks to its geographical and geological context, Chile has excellent potential for renewable energy. With 15% of the world's volcanoes and almost 10% of the world's geysers, the country has vast geothermal potential. Northern Chile also has the highest solar incidence in the world and being a large coastal country, Chile is also quite windy. Yet despite all this, the energy production is dominated by fossil fuels. Coal and oil together generate more than half of the country's energy, with hydro providing just over 30% in 2017. Wind, solar, and geothermal have been relegated to secondary sources, but that might soon change.

The energy ministry has reportedly secured an agreement with its major utilities to not build any coal plants unless they have the technology to store the emissions underground. While this is still less than ideal, it's definite progress. No clear end date has been announced for the end of coal-burning, but environment minister Marcelo Mena has described this stage as "the beginning of the end of coal". Chile has pledged to generate 70% of power from renewable sources by 2050.

Coal phase-outs have been announced in several countries, especially in Europe. France announced it will stop burning coal by 2021, Italy by 2025, and the Netherlands by 2030. The UK is also shutting down its coal plants fast, and even in the US, coal power has dropped from over 50% in 2000 to 30% in 2016.

Source: https://www.zmescience.com/ecology/renewable-energy-ecology/chile-start-phase-coal-02022018/

Costa Rica: Wells for Las Pailas II Are Ready

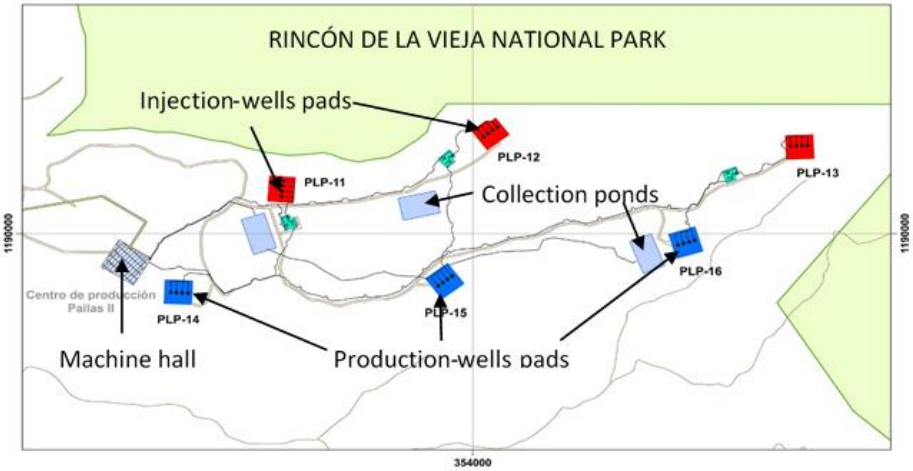
The ICE (Instituto Costarricense de Electricidad) informed in late January it has completed the drilling of 21 geothermal wells for the power plant Las Pailas II, according to the construction program.

Las Pailas II is located in Curubandé de Liberia, Province of Guanacaste, in the northwest of Costa Rica. The installed capacity is 55 MW, and is scheduled to start operations in January 2019. Currently, the ICE is building the machine hall as well as more than 22 kilometers of superficial pipes for conducting the geothermal fluids through the Spanish firm INITEC Energía S.A., which is in charge of the EPC of the project. The 55MW turbo-generator is being constructed by Mitsubishi.

The average depth of the wells is 2200 meters, while the wells in the Miravalles field, recently named Alfredo Mainieri Protti, are 1600 meters deep in average. In Las Pailas, the ICE applied an innovative system of directional drilling, and then built three drilling pads, each one with four production directional wells, and another three drilling pads, each one with three injection directional wells. Thus, the well-field is composed of 12 production wells and 9 injection ones, all grouped in only six drilling pads, so achieving a minimum footprint on the terrain.

Construction of the project started in April 2013. Las Pailas is going to be the seventh geothermal power plant in Costa Rica, with which the geothermal power in the country will be 262 MW. The project is financed mostly by JICA (Japan International Cooperation Agency) through a soft loan at 40 years, and by additional funding by the EIB (European Investment Bank), the IADB (Inter-American Development Bank) and the ICE.

"To have available the necessary steam a year before the commissioning of the plant is a milestone for any project of this kind. It reflects a proper planning and design", said Eddy Sánchez, ICE's director of geothermal resources. He added that the ICE, "…has



Scheme of the Las Pailas II power plant. Injection-well pads (PLP-11, 12 & 13) have only three injection wells each. (Credit: ICE. Taken from the source.)

the knowledge and experience need to continue developing the geothermal resources in the country. We can generate electricity using sustainably and efficiently the resources, at low cost and in tune with the environment."

Source: https://www.grupoice.com/wps/portal/ICE/AcercadelGrupoICE/sala-de-prensa/comunicados-oficiales/325f8ca5-6117-46c2-a005-c3ded0496091

Mexico: The Country Officially Joins the International Energy Agency (IEA)

Mexico's Secretariat of Energy (SENER) announced that it has officially joined the International Energy Agency (IEA), becoming the 30th member country and the first from Latin America.

"We will take our part in setting the world's energy policies, receive experienced advisory in best international practices, and participate in emergency response exercises," said Mexico's Secretary of Energy Joaquin Coldwell.

Mexico's participation comes after the senate ratified the International Energy Program (IEP) agreement and the treaty was subsequently deposited with the government of Belgium.

Back in November 2017, IEA's member countries unanimously approved Mexico's measures to quickly become the next member of the organization, which in turn can provide a major boost for the global energy governance.

With more than 120 million inhabitants, Mexico is currently the 15th economy of the world, the 12th oil producer, the 6th geothermal power producer and has huge solar and wind resources.

With 30 member countries and seven association countries, IEA now accounts for more than 70% of global energy consumption, up from less than 40% in 2015, the government noted.

The International Energy Agency (IEA), based in Paris, France, was created in 1974 in response to the 1973-74 oil crisis. It is an autonomous organization dedicated to ensuring reliable, affordable and clean energy for its member countries and beyond. The IEA's major focus areas are:

- Energy security: promoting diversity, efficiency and flexibility within all energy sectors

- Economic development: ensuring stable supply of energy to IEA Member Countries and promoting free markets to foster economic growth and eliminate energy poverty

- Environmental awareness: enhancing international knowledge of options for tackling climate change

- Engagement worldwide: working closely with non-Member countries to find solutions to shared energy and environmental concerns.

In addition to their many other responsibilities, the IEA encourages international collaboration in energy technology through its broad range of more than 40 multilateral technology initiatives (Implementing Agreements), ten of which are renewable energy technologies, including IEA Geothermal.

IEA Geothermal provides a framework for international cooperation in geothermal research and development. It focuses on both power generation and direct-heat applications. IEA Geothermal currently comprises 16 Members: 13 Country Members: Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Republic of Korea, Switzerland, United Kingdom and the United States; the European Commission; and two Sponsors: Ormat Technologies and the Spanish Geothermal Technology Platform (Geoplat).

Sources: https://renewablesnow.com/news/mexico-officially-joins-the-international-energy-agency-602251/, http://iea-gia.org

Nicaragua: New Projects to Be Developed & Update on the San Jacinto Geothermal Field

Feasibility Studies to Start in Three New Areas - The executive president of the Nicaraguan Electricity Company (ENEL), Ernesto Martínez Tiffer, said on late February that they are planning to start feasibility studies of three power generation projects with geothermal sources located in the Cosigüina volcano, Casita-San Cristóbal and Mombacho volcano. Martinez Tiffer spoke about it after participating in the commemoration of the 84th anniversary of the death of General Augusto Calderón Sandino.

Martínez Tiffer said the expectation is that a power plant of 35 MW be installed in each of those areas, and then a total of 105 MW can be added in six more years to the national interconnected system.

The investment in each of these areas amounts to between US$35 to 40 million, he said. The Inter-American Development Bank (IDB) finances the project in the Cosigüina volcano, and the Japan International Cooperation Agency (JICA) is supporting the development of the program in Mombacho, added Martínez Tiffer. The feasibility study is the formal beginning of the projects, but the Casita-San Cristóbal project has already started, as informed in the next note.

Source: https://www.elnuevodiario.com.ni/nacionales/456510-anuncian-estudios-factibilidad-tres-proyectos-gene/ (in Spanish)

0**EISA Presented for Casita-San Cristóbal Project -** In a meeting hold on late January with community leaders of the Departamento de Chinandega, the Public-Private Partnership (PPP) Cerro Colorado Power reported that progress is being made in the Casita-San Cristóbal Geothermal Project and that they have already completed the Environmental and Social Impact Study (EISA). The geothermal project is planned to have 35 MW of installed capacity.

Eruption of San Cristóbal Volcano in March 2015. (Photo credit: http://noticieroenfoque.com/?p=7047)

The Cerro Colorado PPP is integrated by the Nicaraguan Electricity Company (ENEL: Empresa Nicaragüense de Electricidad) and the Canadian company Polaris Infrastructure Inc. They presented the EISA of the project to the community, highlighting its different stages, the mitigation and environmental protection measures as well as social responsibility programs to guarantee the inclusive development of the inhabitants of the municipalities of Chinandega, Chichigalpa and Posoltega.

The concession area of the Project will be 20 km², spread over those three municipalities. ENEL has informed that the execution of the Project in this region of the country will generate direct and indirect jobs, in addition it will benefit the population, through the shared social responsibility model.

Source: http://www.thinkgeoenergy.com/nicaragua-advancing-geothermal-agenda-with-35-mw-casita-geothermal-project/

Polaris Updates the Drilling Program in San Jacinto – The Polaris Infrastructure's wholly-owned operating subsidiary Polaris Energy Nicaragua, S.A. (PENSA), which owns and operates the San Jacinto geothermal project, informed on late January that it has made substantial progress with drilling efforts. The San Jacinto geothermal field has currently an installed capacity of 72 MW, and the highlights of drilling program execution and preliminary testing activities are as follows:

Production well SJ 12-4. The well was completed in early November 2017 at a total depth of 2624 meters after reaching a total loss of drilling fluids. After a period of thermal recovery, SJ 12-4 was successfully discharged on January 16, 2018, and has been flowing since that date (discharging to the atmosphere). Based on testing completed to date, the estimate initial productive capacity is between 4 and 6 MW.

Production well SJ 12-5. The well SJ 12-5 was completed in early January 2018 at 2416 m depth, after a total loss of drilling fluids. Tests concluded during and after drilling suggest that SJ 12-5 has higher permeability and temperature than SJ 12-4. SJ 12-5 was successfully discharged on January 25, 2018. Based on testing completed to date, the estimate productive capacity is between 8 and 12 MW.

Planned superficial infrastructure investments. Given the substantial expansion of the San Jacinto steamfield over the past 18 months, additional investment has been needed to efficiently accommodate the total mass flows (steam and hot geothermal fluids) being generated. PENSA will install an upgraded separator station on pad 12.

Stimulation of well SJ 4-2. The production well SJ 4-2 was connected to the San Jacinto plant in late August 2017. The well has reliably been a modest producer, with average production in the range of 1.5 to 2 MW. PENSA continues to explore options to improve its production, possibly via acid stimulation. A determination will be made later in the first quarter of 2018.

Source: https://www.newswire.ca/news-releases/polaris-infrastructure-provides-drilling-program-update-671745343.html

U.S.: Company Acquisition, Appointment in NREL, Approval for Site Lease Agreement, McGinness Hill & Wabuska Power Plants

U.S. Geothermal Acquired by Ormat – U.S. Geothermal Inc. announced in late January that it has entered into a definitive merger agreement under which a wholly owned subsidiary of Ormat Technologies, Inc. will acquire the company in an all cash transaction. The agreement has been unanimously approved by both companies' Boards of Directors.

The transaction is not subject to a financing condition and is expected to close during the second quarter of 2018, subject to the approval of U.S. Geothermal shareholders and the satisfaction of customary closing conditions, including applicable regulatory approvals. Certain funds advised by JCP Investment Management, LLC, which own approximately 15.0% of the outstanding shares of U.S. Geothermal, as well as the directors and officers of U.S. Geothermal have entered into an agreement to vote in favor of the transaction.

U.S. Geothermal is a renewable energy company focused on the development, production and sale of electricity from geothermal energy. The Company is currently operating geothermal power projects at Neal Hot Springs, Oregon, San Emidio, Nevada and Raft River, Idaho for a total designed net output of approximately 45 MW. The Company is also developing projects at: the Geysers, California; a second phase project at San Emidio, Nevada; at Crescent Valley, Nevada; and the El Ceibillo project located near Guatemala City, Guatemala.

Source: http://www.usgeothermal.com/releasedetail.cfm?ReleaseID=1055116

New Manager for Geothermal Energy in the NREL - The U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) recently promoted Katherine Young, a senior geothermal analyst and engineer in the lab's Strategic Energy Analysis Center, to laboratory program manager for geothermal energy.

In her new role, Young will work with NREL management to establish the lab's geothermal energy research and development portfolio and lead discussions with DOE's Geothermal Technologies Office to reduce the cost of developing geothermal energy.

Since joining NREL in 2008, Young led the design and development of the Regulatory and Permitting Information Desktop (RAPID) Toolkit, an online resource that helps agencies, industry, and developers to identify the regulatory steps required for renewable power projects. She also led the development of the Geothermal Resource Portfolio Optimization & Reporting Technique (GeoRePORT), which created industry standards for reporting geothermal resources.

"One of my goals is to work with energy leaders to encourage the inclusion of geothermal in the conversation when we're talking about small- or large-scale energy-efficiency and renewable solutions," Young said. "Geothermal can play a significant role in the design and development of energy-efficient buildings and clean cities and is a key contributor to grid reliability and security in areas of deployment."

Source: https://dailyenergyinsider.com/news/10620-young-lead-national-renewable-energy-laboratory-geothermal-energy-program/

250MW Geothermal Project Receives Approval for Site Lease Agreement - The Imperial Irrigation District's board of directors of Imperial County, California, voted on late February to approve a 1900-acre (769 hectares) lease agreement with Controlled Thermal Resources. It is an Australian company that is searching to build a 250MW geothermal power plant along the southern shore of the Salton Sea lake, near the county of Calipatria. The facility would generate five times as much electricity as any of the 11 existing geothermal plants in the area.

The proposal would need to be approved by the California Energy Commission (CEC). It also faces the same obstacle that has plagued all geothermal development in the region: high up-front costs.

Only one geothermal plant has opened by the Salton Sea since 2000, even though the area is home to one of the world's strongest geothermal reservoirs. Researchers at the National Renewable Energy Laboratory recently said there's little hope of new geothermal plants generating billions of dollars for the revitalization of the Salton Sea, frustrating local officials who see energy development as key to funding restoration projects.

But Rod Colwell, Controlled Thermal Resources' chief executive, believes his company will succeed where others have failed.

In the past, developers haven't built Salton Sea geothermal plants larger than 49.9 megawatts, because doing so would require them to get approval from the California Energy Commission, in addition to Imperial County. But Colwell believes his company can bring down costs through economies of scale. By building a plant at 250 megawatts, he said, it can offer electricity at

a price that's attractive to utilities or other potential buyers.

"Our goal is to generate competitive baseload power that's truly competitive with the fossil fuel market," he said.

For now, the company plans to begin drilling test wells and exploring the site. Colwell said he expects the energy commission approval process to last 18 months, and he hopes to finish construction on the power plant by 2020. The facility would be Controlled Thermal Resources' first project.

The company will pay the Imperial Irrigation District US$ 40,000 per year during the exploration phase, plus an additional US$190,000 annually once construction begins. It would later pay royalties on any electricity it generates.

Source: https://www.desertsun.com/story/tech/science/energy/2016/03/15/salton-sea-could-get-new-geothermal-power-plant/81839422/

Starts 48MW Expansion of Geothermal Plant in Nevada – On late March, Ormat Technologies started work on the 48MW expansion of its McGinness Hills geothermal plant in Nevada, after the U.S. Bureau of Land Management (BLM) approved the company's proposal. The project's Phase III is expected to be completed in December 2018. That will make it the largest geothermal power generation facility in the state and the largest located on federal land managed by the BLM.

Commercial production at the McGinness Hills Geothermal facility began in July 2012, and Ormat completed a second phase in 2015. The first two phases gave the complex a generating capacity of 86 megawatts, and power from phases I and II feeds the Nevada Energy grid. Once Phase III is completed, generating capacity is expected to increase to 134 MW. Phase III will contribute power to the Southern California Public Power Authority.

After the completion of Phase III, McGinness Hills will include 15 production wells at about 600-1100 meters deep producing water at temperatures of around 165°C. The site will contain eight Ormat Energy Converters and seven injection wells. All the geothermal fluid is reinjected into the reservoir.

The company's capital investment for all three phases is estimated to total about US$600 million.

Source: http://www.thinkgeoenergy.com/ormats-48-mw-starting-expansion-work-of-mcginness-hills-geothermal-plant/

Wabuska Power Plant Starts Operations - The 4.4MW Wabuska geothermal power plant has started operation. This was reported by middle March by Zhejiang Kaishan Compressor Co., provider of air compressors, that announced the company has successively connected two geothermal power units to the grid recently.

The company said it had received on-site reports on the progress of both projects, namely, the Wabuska geothermal power plant in Nevada, and the Turawell geothermal power plant in Hungary. Both projects have started operations and generate power in good condition, said the Quzhou-based manufacturer.

Wabuska power plant. Photo source: Open Mountain Energy.

In Wabuska, the two units of the plant have been operating steadily for nearly two weeks, generating a total of 4.4MW power. Following a three-month trial period, the power generation capacity can be increased by about 20 percent.

The Wabuska geothermal project was acquired by Open Mountain Energy in April 2017. It is located at the Wabuska community, in Lyon County, Nevada, mainly composed of Washo natives.

Source: http://www.thinkgeoenergy.com/4-4-mw-wabuska-geothermal-power-plant-in-nevada-started-operation/

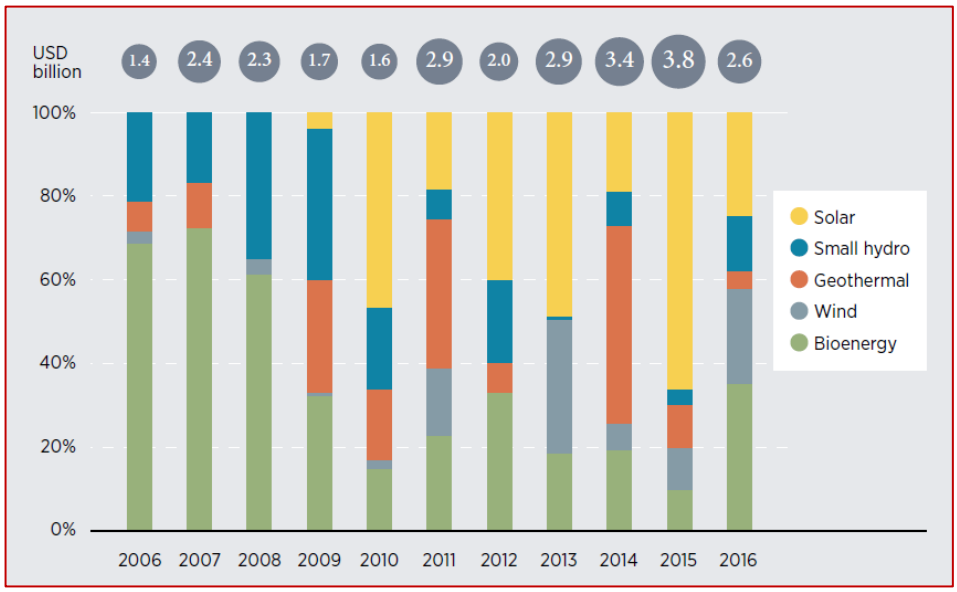
ASIA/PACIFIC RIM

Southeast Asia: RE Market Analysis Report by IRENA

The International Renewable Energy Agency (IRENA) released

in January its report Renewable Energy Market Analysis: Southeast Asia. *It is the third report of this series of analysis, being the first two editions focused on the GCC (Gulf Co-operation Council) region (2015) and Latin America (2016). Some highlights related to geothermal energy in the region are as follows.*

Geothermal capacity has been deployed since the 1970s; over 2.5 GW was installed in 2000, increasing to 3.4 GW in 2016. The Philippines, the world's second-largest producer of geothermal electricity after the United States, leads the region with nearly 2 GW deployed in 2016. Capacity in the Philippines remained largely stable between 2000 and 2016, with much of the regional growth coming from Indonesia, where capacity rose from 525 MW to 1,534 MW in the same time frame. Recently, Malaysia has also forayed into geothermal energy: its first plant is scheduled to be operational by May 2019.



Investment in renewable power by technology in the Southeast Asia region, 2006-16 (Source: Based on BNEF, 2017. Note: Based also on power sector asset finance data for Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam).

Overall, geothermal is the only technology that has seen a slight increase in weighted average investment costs, from US$ 2,937/kW in 2014 to US$ 3,185/kW in 2016. Geothermal costs are highly dependent on the quality and quantity of the resource (and associated economies of scale) and the technological options chosen to develop a site. The observed increase in investment costs of 8% is most likely because of the quality of sites being developed in 2014 and 2016.

The weighted average LCOE of geothermal projects increased slightly from US$ 0.06/kWh in 2014 to US$ 0.064/kWh in 2016, a 7% increase in LCOE mirroring the observed increase in investment costs during the period.

Weighted average geothermal capacity factors declined slightly from 86% in 2014 to 84% in 2016, most likely in line with the development of more challenging projects in the region.

Investments in renewable energy sources in the region have been variable in the last decade, with solar projects leading the investment in the last seven years. However, investments in geothermal energy have two clear peaks in 2011 and 2014, mostly in projects located in Indonesia (see attached graph).

Source: http://irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_Market_Southeast_Asia_2018_summary.pdf?la=en&hash=13DB344A7F8C8EBE30E2EB1A4CAFEC9A63BDED11

China: Funding to Promote Zero-Emissions Heating

The Asian Development Bank (ADB) signed facilities of a total of US$250 million in loans to Arctic Green Energy Corporation (AGE) and Sinopec Green Energy Geothermal Company Limited (SGE) to expand environmentally sustainable district heating services in the People's Republic of China (PRC).

AGE, based in Iceland, is a leading global developer and operator of renewables, including geothermal technology and energy efficiency projects. The company's mission is to export Icelandic expertise in geothermal and renewables to fast growing countries in Asia.

SGE, established in 2006, is the world's largest geothermal district heating company by service area. It is a joint-venture between AGE and Sinopec Star of Sinopec Group, also known as China Petrochemical Corporation.

Coal-based heating is one of the major causes of air pollution in the PRC, including in the Bejing-Tianjin-Hebei region. Geothermal district heating is an alternative sustainable, stable, and cost-competitive to coal and gas, with zero-emissions, and can be integrated into existing networks to replace heat sources.

"This is a landmark project for Asia. Geothermal district heating can provide millions of citizens with safe and stable heat access while dramatically reducing air pollution and greenhouse gas emissions and the reliance

on fossil fuels," said ADB Vice-President for Private Sector and Co-financing Operations Diwakar Gupta.

"How cities are heated or cooled in the 21st century will determine the outcome in the fight against air pollution and greenhouse emissions," said SGE Vice Chairman and AGE Chairman and Founder Haukur Hardarson. "The funding from ADB enables AGE and SGE to significantly expand in the fight against air pollution while providing much needed clean heating to the citizens in the PRC."

AGE Corporation Chairman and Founder Haukur Hardarson (left), ADB Vice-President for Private Sector and Co-financing Operations Diwakar Gupta (center), and SGE Chief Financial Officer Xin Zhao (right) during the signing ceremony (Photo: ADB).

"Joining hands with ADB will help strengthen our long-term partnership on sustainable geothermal development to fight against air pollution and reduce greenhouse emissions. We aim to replicate our successful collaboration across Asia," said SGE Chairman and Sinopec Star Vice President Liu Shiliang.

Source: https://www.adb.org/news/adb-signs-landmark-project-icelandic-chinese-venture-promote-zero-emissions-heating

Indonesia: Pertamina Plans & Sumatra's Geothermal Potential

Pertamina Targets 2,300 MW from Geothermal Power by 2030 - State-owned energy giant Pertamina aims to gradually increase its investment spending for renewable energy to around 15 percent of its total capital expenditure by 2030 from a mere 1 percent at present.

Pertamina set a 2030 target to generate 2,300 megawatts (MW) from geothermal power plants and 600 MW from solar power plants, as well as distribute 17,000 barrels of biofuel per day.

Within the same time frame, the company will be seeking opportunities to produce 300 MW from wind power plants and 200 MW from biomass plants.

"The allocated investment for the renewable energy business might reach around 10 to 15 percent in 2030, compared to only nearly 1 percent as of today," Pertamina investment planning and risk management director Gigih Prakoso told reporters recently.

Pertamina has allocated US$5.59 billion in capital expenditure in 2018, up 55 percent annually. About 59 percent of the allocated figure will be used to support its upstream business activities.

Moreover, Gigih said Pertamina would use organic and inorganic growth strategies to boost its renewable business. "At first, we will develop such a business ourselves. Then, we'll also pursue an acquisition in the next few years," he said.

Pertamina currently operates geothermal power plants with a combined capacity of only 587 MW, a mere 2 percent of the country's total geothermal potential.

Source: http://www.thejakartapost.com/news/2018/02/24/pertamina-renewable-investment-portion-to-reach-15-percent-by-2030.html

High Geothermal Potential in West Sumatra - The provincial Government of West Sumatra in Indonesia sees potential for geothermal development on up to 16 sites around six mountains in the province. West Sumatra Governor Irwan Prayitno said in February that "In total there are 16 geothermal hotspots that can be developed to generate electrical energy… with development potential exceeding 1,600 MW."

So far only a fraction of that has been looked at for development. PT Supreme Energy is developing the Muara Laboh geothermal project in South Solok and PT Hitay Daya Energy a geothermal project near Talang Mountain in Solok District.

But there is more potential, e.g. in Mount Tandikek, Mount Singgalang, and Mount Talamau which so far has not seen any development. "West Sumatra has the potential to develop that energy, because West Sumatra is surrounded by 60% of protected forest, so the energy sector is abundant," said Irwan.

Source: http://www.thinkgeoenergy.com/west-sumatran-geothermal-energy-potential-estimated-at-1600-mw/

Japan: Hot Springs Called on to Share the Steam

Japanese companies like Toshiba, Mitsubishi Heavy Industries and Fuji Electric, dominate the global market for geothermal turbines. Their combined share is 70%. Yet their country lags the world in geothermal power generation.

A number of reasons account for this, one of which is all the years it takes for a geothermal power plant to start generating electricity. The commercialization process, which also includes drilling and environmental studies, averages 14 years.

A solar plant can go up in a year. A biomass project takes five, and a wind farm needs eight years before it can start feeding the grid.

Here is another problem: 80% of those prospective geothermal reservoirs are in national and quasi-national parks, where digging and constructing new buildings is illegal, in principle.

Another main obstacle is the *onsen* resorts, which are becoming increasingly popular among hordes of foreign and Japanese tourists alike.

In the Kagoshima Prefecture city of Ibusuki, one of Japan's most famous hot-spring areas, hoteliers are calling for a geothermal power generation project to be scrapped. They fear being left with little water for their tourist-luring baths.

Hot spring communities elsewhere in Japan are similarly antagonistic toward geothermal power generation projects.

Under a government-mandated feed-in tariff system, electric utilities are required to purchase electricity generated by renewable energy sources at fixed rates for extended periods.

The FIT system has made it easier for geothermal power plant developers, who never have to worry about buying fuel, to see future profits.

But the installed capacity of geothermal power plants rose by only 3%, or 16 MW, after the system debuted in 2012. During the same period, the nation's solar power capacity soared almost sevenfold, by 33.5 million kW.

The government, which intends to triple geothermal power generation to around 1.5 million kW from current levels, intends to do more.

The Ministry of Economy, Trade and Industry will revise its relevant guidelines during fiscal 2018 to allow geothermal power developers to simultaneously move ahead with their written and actual environmental impact assessments.

This geothermal power plant sits in the Oita Prefecture town of Kokonoe (Photo taken from the source).

METI hopes this will result in halving the amount of time these assessments need to two years. The ministry will also double the number of spots where it conducts environmental and resource surveys, then publicize promising geothermal power candidate locations.

As for the development of geothermal resources inside national parks, regulations have been eased, except for "special protection areas", making it possible for around 70% of all resources in these parks to be tapped.

Mitsubishi Materials and its partners plan to put into operation the Wasabisawa geothermal power plant in Akita Prefecture, perhaps during fiscal 2019. It will be Japan's first large-scale geothermal plant, with an output capacity of more than 10 MW, in 23 years.

Source: https://asia.nikkei.com/Politics-Economy/Economy/Japan-s-famed-hot-springs-called-on-to-share-the-steam?page=2

Taiwan: First Mini Geothermal Power Plant Starts to Operate

On early March, Raoul Kubitschek, a renewable energy expert based in Taiwan, posted in his *LinkedIn* page that a 30kW ORC geothermal plant, manufactured by Kaishan, started to operate in Zhiben, Taidong. He indicated that this small plant is a first step, and it "…was installed for power production for the Rainbow Hotel, after three years the developer finally could install the meter and is now also able to sell to Taipower under the FiT (Feed-in Tariff) scheme. It is these pioneers that are laying the foundation for Taiwan's ambitious renewable energy goals." FiT for geothermal energy were increased in December 2017 to accelerate geothermal installations. The Ministry of Economic Affairs increased it to US$ 0.205 per kilowatt-hour from the proposed US$ 0.188 for the first 10 years of the installations' subsidiary period (*see* IGA News 110, p. 20).

Source:
https://www.linkedin.com/feed/update/urn:li:activity:6375330893216747520/

View of the plant. Photo posted by Raoul Kubitschek.

United Arab Emirates: Possible High Geothermal Potential

Considered as the world's seventh largest producer of oil, the United Arab Emirates (UAE) has been focusing on a research on potential uses of geothermal energy as a new source of clean and renewable energy. The project is being undertaken by the UAE University (UAEU) whose researchers are studying the geological sites in Al Ain and Ras Al Khaimah.

They are also examining the hot water spring reservoirs and analyzing their temperatures and sizes.

Researchers found out that the water temperature reaches to as hot as 120°C at about 3 kilometers deep. The project started in January last year with the goal of understanding the possibility of using geothermal energy in the UAE, said Dr Hakim Saibi, associate professor of geophysics at UAEU, and one of the researchers.

According to Dr Saibi, the findings did point to the possibility of tapping geothermal energy in the UAE. "The potential for using geothermal energy is good. Based on our findings and the data gathered at the sites, we can produce around 1,000 megawatts of electricity using the geothermal energies from these areas," he said.

"We can use this energy to power hundreds of homes, and it is done without producing any CO_2 emissions, so it is a very clean and reliable source of energy," he added.

Source:
http://conceptnewscentral.com/index.php/2018/02/25/tapping-geothermal-energy-2/

EUROPE

Deep Geothermal Implementation Plan

The Deep Geothermal Temporary Working Group (TWG) is composed by Member states/Associated countries, stakeholders and the European Commission, representing both the industry and the academia. It is chaired by national representatives from Italy and Iceland and co-chaired by the European Technology & Innovation Platform on Deep Geothermal (ETIP-DG). The group is focused on deep geothermal energy, which can be directly used as heat or converted into electricity or used for cooling purposes. Since its official formation in February 2017, the TWG have met regularly to draft the Implementation Plan, that contains concrete R&I activities and proposes relevant funding opportunities for their realization, which are considered essential for achieving the agreed set of targets. The TWG identified eight research and innovation (R&I) activities as well as two non-technical barriers/enablers:

1. Geothermal heat in urban areas.

2. Materials, methods and equipment to improve operational availability (high temperatures, corrosion, scaling).

3. Enhancement of conventional reservoirs and deployment of unconventional reservoirs.

4. Improvement of performance (conversion to electricity and direct use of heat).

5. Exploration techniques (including resource prediction and exploratory drilling).

6. Advanced drilling/well completion techniques.

7. Integration of geothermal heat and power in the energy system and grid flexibility.

8. Zero emissions power plants.

The two non-technical barriers/enablers are:

- Increasing awareness of local communities and involvement of stakeholders in sustainable geothermal solutions.

- Risk mitigation (financial/project).

The Implementation Plan includes a Declaration of Intents, which establishes the following six targets for geothermal energy in Europe:

1. Increase reservoir performance* resulting in power demand of reservoir pumps to below 10% of gross energy generation and in sustainable yield predicted for at least 30 years by 2030.

2. Improve the overall conversion efficiency, including bottoming cycle, of geothermal installations at different thermodynamic conditions by 10% in 2030 and 20% in 2050.

3. Reduce production costs of geothermal energy (including from unconventional resources, EGS, and/or from hybrid solutions which couple geothermal with other renewable energy sources) below 10 € cents (US$0.125) per kWh for electricity, and 5 € cents (US$0.07) per kWh for heat by 2025**.

4. Reduce the exploration costs by 25% in 2025, and by 50% in 2050 compared to 2015.

5. Reduce the unit cost of drilling (€/MWh) by 15% in 2020, 30% in 2030 and by 50% in 2050 compared to 2015.

6. Demonstrate the technical and economic feasibility of responding to commands from a grid operator, at any time, to increase or decrease output ramp up and down from 60% - 110% of nominal power.

The research and innovation (R&I) actions address relevant issues crucial for the development of the use of geothermal energy resources, both as heat and electricity. The implementation plan pays due attention to low-enthalpy resources, which are widely present in Europe and whose development, together with that of urban district heating networks fed by geothermal, represents a key opportunity to increase renewable heat supply.

With this IP, the work of the Deep Geothermal TWG is completed. The execution of the IP would be coordinated by a new dedicated structure.

**Reservoir performance includes underground heat storage.*

***Costs have to be confirmed establishing at least five plants in different geological situations, of which at least one with large capacity (20 MWe or, if for direct use only, 40 MWth).*

Source: https://www.egec.org/implementation-plan-approved/

New European Cluster: Geo-Energy Europe

Geo-Energy Europe officially started on January 1st, 2018 for a two years duration. It involves eight partners from seven countries: Pole Avenia (coordinator) & Geodeep (France), EGEC (Belgium), GEOPLAT (Spain), Geoenergy Celle (Germany), CAPES (Hungary), Jesder (Turkey), and Geoscience (Ireland).

GEO-ENERGY EUROPE

Geo-Energy Europe is a newborn transnational cluster specifically aimed at increasing the performance and competitiveness of European Small and Medium-sized Enterprises (SMEs) in all industries concerned by the use of subsurface for energy, or geoenergy, on transnational (EU) and world markets.

The two years project will target its actions towards the promotion and industrial take-off of the emerging Deep Geothermal Energy industry for district and industrial heating and power generation, in line with the European and most national energy transition goals.

The overarching purpose of the Geo-Energy Europe project is to create a European Strategic Cluster Partnership (ESCP) with a focus on the sustainable use of the subsurface for energy, as well as to develop and propose an implementation roadmap for a joint internationalization strategy to help this ESCP go international (ESCP-4i), as encouraged by the COSME call for projects "Clusters Go International" (COS-CLUSINT-2016-03-01), and more specifically Strand 1a of the call. Building such a strategic partnership would help create a sort of European label for export opportunities and cooperation in know-how and technology transfer with third countries.

The current targeted third countries are Bolivia, Canada, Chile, Costa Rica, Ecuador, Indonesia, Japan, Kenya, Mexico, Peru, Philippines, and United States.

The detailed specific objectives of the project are the following:

- Foster trans-national partnership building, favoring mutual learning and sharing of resources, cross-pollination between countries & industry sectors, skill & technology transfer towards emerging industries such as deep geothermal, CCS & the geological storage of energy (other than hydrocarbon).

- Map skills, products & services of partners' member SMEs and identify complementarities and cross-sectorial technology and skill transfer opportunities to consolidate value chains & allow complete offers in calls for tenders. Analyze & prioritize research, development & innovation (RD&I) needs across the concerned industrial sectors in Europe & worldwide. Enrich the industrial offer through valorization of past & current RD&I projects' results and creating new partnerships for future projects.

- Create a Partnership Agreement to formalize and sustain the partnership in the mid to long term, with a view to expand in geographic and thematic scope.

- Map, assess and prioritize high potential geo-energy markets in Europe and around the globe, and more specifically the deep geothermal energy markets to start with.

- Develop a joint internationalization strategy to access prioritized third country markets.

- Design an implementation roadmap to facilitate the internationalization of SME members, and get started with the associated action plan.

- Use existing tools (ECC platform) &/or create dedicated communication material and capacity building tools to disseminate knowledge and promote the know-how, products & services of participants' member SMEs.

Source: https://www.clustercollaboration.eu/escp-profiles/geo-energy-europe

Renewable Energy Prospects for the European Union

The International Renewable Energy Agency (IRENA) launched a new report, Renewable Energy Prospects for the European Union (Executive Summary), which finds that doubling the share of renewables in the EU's energy mix by 2030 could not only meet the EU's emission reductions goals, but also save up to € 113 billion (US$139 billion) per year in health and environmental costs, significantly increase renewables employment, and trigger additional investments of € 368 billion (US$ 453 billion).

The report, developed at the request of the European Commission, highlights that all EU Member States have additional cost-effective renewable energy potential. Among its key findings are:

- Doubling the share of renewables in the EU's energy mix to 34% by 2030 could: save between € 44 and 113 billion per year in health and environmental costs; reduce carbon emissions by a further 15 per cent by

2030, equivalent to Italy's total annual emissions; significantly increase renewables employment in the EU from its current level of € 1.2 million; and trigger additional investments of € 368 billion, equivalent to 0.3 of the EU's annual GDP.

- Reaching a 34% renewable share by 2030 would require an estimated average investment in renewable energy of around € 62 billion (US$ 76 billion) per year.

- 17% of Europe's transport energy, 34% of its heating and cooling, and 50% of its power generation could be met with renewable energy.

- Reducing the EU's carbon emissions by 15% by 2030 will bring it in line with its goal to reduce emissions by 40% compared to 1990 levels.

- Heating and cooling account for more than one-third of the EU's untapped renewable energy potential.

- All renewable transport options, including electric vehicles and biofuels, are needed to realize long-term EU de-carbonization objectives.

Tapping the additional renewable energy potentials identified in the study would propel the EU further on a de-carbonization pathway compatible with the 'well-below' 2°C objective established in the Paris Agreement.

Source:
https://irena.org/publications/2018/Feb/Renewable-energy-prospects-for-the-EU

GDF Latin America Won the European Geothermal Innovation Award 2018

During the opening ceremony of the GeoTHERM Exhibition and Congress 2018, the European Geothermal Innovation Award 2018 was awarded to the Geothermal Development Facility (GDF) Latin America, the first multi-donor climate initiative offering risk mitigation for surface studies and appraisal drillings during the exploration phase of geothermal projects in Latin America.

GDF is an innovative financial mechanism that fosters geothermal development in Latin America, both in South America and Central America. It has been operational for two years and is mainly funded by the European Union and Germany.

"On behalf of the Geothermal Development Facility for Latin American I am very proud to receive this award," said Christoph Sigrist, Head of Division, Energy and Financial Sector, Latin America, at KFW, who has followed the project since the beginning. "Currently we are working on getting additional funds from the Green Climate Fund and on preparing a second call for proposals. About eight financing contracts came out of the first call. We are very proud that the fund is being received so well, both by the industry and by the developing financial institutions."

The other nominees were: GPC Instrumentation Process (France), for the design and implementation of the first sub-horizontal well in a geothermal project, a technique so far only used for oil drilling that allows to drain more hot water over a long length; Politecnico di Torino (Italy), for their system ENERTUN, that allows transforming a tunnel lining into a low enthalpy geothermal system; PORCIÓ Ltd. (Hungary), for the Gyopáros Production and Reinjection Geothermal System, in operation at Gyopáros Thermal SPA; RWTH Aachen University (Germany), for the development of their Temperature Sensor Module (TSM) for detecting groundwater flow velocity and direction near a borehole heat exchanger.

A total of 19 nominations were received from around Europe. These included submissions from a wide range of companies and research institutes.

The European Geothermal Innovation Award is an initiative from EGEC, the European Geothermal Energy Council, in collaboration with Messe Offenburg, organizers of the GeoTHERM fair and congress. The award is given to entities that have made an outstanding contribution towards the field of geothermal energy.

Source: https://www.egec.org/gdf-latin-america-geothermal-innovation-year/

Award ceremony conducted by Ruggero Bertani, President of EGEC.

Belgium: Geothermal Heating Plant Inaugurated in Ghlin

On middle February, the intercommunal economic development group IDEA in Belgium inaugurated its second geothermal heating station in Ghlin, near Mons. The plant is now supplying geothermal heating to companies in the area. It is the first Belgian area of economic activity (40 ha) to be powered by geothermal energy.

The hot aquifer in the region was discovered by chance, at the beginning of the twentieth century, when digging galleries to extract coal. Then, in the 1970s, the Geological Survey of Belgium began research and the intercommunal IDEA then invested in geothermal energy.

IDEA has a long experience in this field. For three decades, it has been promoting the geothermal water resources of the Mons basin. Its geothermal network supplies hot water, for heating and hot water production needs, two hospitals, three schools, a swimming pool and 355 public housing, Saint-Ghislain station as well as private companies like AW Europe, located in the zoning of Ghlin-Baudour.

The Ghlin well produces water at a temperature of 65 degrees Celsius, at a depth of 1500 meters. "This allows us not to use fossil fuels and to offer 100% renewable energy with no CO2 emissions." explains Caroline Decamps, IDEA's Managing Director.

"The price of fossil fuels is relatively low at the moment, we are offering similar prices, but we can guarantee price control, which is not the case with fossil fuels," says David Charlet, mines engineer at IDEA.

The Walloon Minister for Ecological Transition, Carlo Di Antonio (CDH), applauds the project in Mons. "Zoning with renewable energy production is the future, they will have a lesser impact on their environment and they will allow companies to control the cost of energy."

The intercommunal IDEA is developing another project. Through European and Walloon co-financing, it received funding of €14 million (US$17.5 million) to drill two other wells to a depth of 2500 meters in order to set up an urban heat network feeding the hospital Ambroise Paré. Drilling is expected to begin in 2020.

Source: http://www.thinkgeoenergy.com/new-geothermal-heating-project-starts-operation-in-mons-belgium/

Location of the project. (Source: https://www.rtbf.be/info/societe/detail_le-premier-zoning-belge-alimente-par-la-geothermie-attend-ses-entreprises?id=9835833)

France: Doublet of Sub-horizontal Geothermal Wells Completed

On late March, a second sub-horizontal geothermal well has been completed on the Paris suburban Cachan site by GPC Instrumentation Process (GPC IP) for its customer Dalkia, which is part of the EDF Group.

The new well, which will serve as the injection unit of the local Geothermal District Heating doublet, is similar in design to the production well achieved in late December 2017, recorded as a world premiere in geothermal well engineering. It features an open-hole drain, 8 1/2 inches in diameter and 1005 m long.

The first sub-horizontal well was considered a world premiere in geothermal engineering, as it achieved 1001 meter long, 87° slanted, and 8 1/2 inches open-hole drain in the Dogger/Bathonian, Mid Jurassic, oolithic limestone, target reservoir, at a 1550 m true vertical depth.

The concept was first published in February 2011 at the Stanford Geothermal Workshop, proved rewarding, further to well tests, evidencing a 450 m^3/hour nominal discharge and a 16 MW_{th} rated capacity.

The new doublet, managed by a Dalkia/City of Cachan JV (Dalkia operator) will replace two, 34 year old, existing geothermal district heating doublets, with a capacity of 350 m^3/h.

Source: http://geothermalresourcescouncil.blogspot.mx/2018/03/france-geothermal_20.html

Germany: Taufkirchen Plant, Small Modular Plants & Tomatoes Produced with Geothermal Heat

Stable Power Production in Taufkirchen Geothermal Power Plant - The geothermal

power plant of GeoEnergie Taufkirchen GmbH & Co. KG, a subsidiary of the drilling technology and geothermal specialist Daldrup & Söhne AG, has started electricity production in Taufkirchen. This was preceded by successfully completed system tests of the components of the power generation plant in recent days. This means that, for the first time and in parallel to the district heating supplied to the communities of Taufkirchen and Oberhaching, environmentally friendly electricity generated at the power plant will now be fed into the public grid.

With the weather-related decline in district heating production, the power production of the plant is being ramped up further. A further heat exchanger will be connected in the second half of 2018. Thus, from today's perspective electricity production will then gradually switch to full load operation. For the further planning of the 2018 financial year, the management board assumes that corresponding feed-in revenues can be generated from power generation, more than from heat production.

Source: http://www.4-traders.com/DALDRUP-SOEHNE-AG-471189/news/Daldrup-Sohne-AG-Successful-test-operation-and-stable-power-production-in-Taufkirchen-geothermal-26216669/

Small Modular Power Plants to Use Excess Geothermal Heat - The Swedish company Climeon AB has received its first major order for a geothermal power plant in Germany, which will operate on original oil and gas infrastructure from the Bavarian energy provider Geoenergie Kirchweidach (GEK).

On November 29, 2017 Climeon entered a Letter of Intent with GEK, and now GEK decided to proceed and placed the order for 16 heat power units to be delivered within 12 months, with a value of over €5 million (US$6.2 million). The order marks an important step in replacing fossil fuels with a sustainable geothermal baseload.

The deal will enable GEK to utilize the excess heat of the geothermal plant that today delivers heat to the local greenhouse business and the city of Kirchweidach. The geothermal resource was originally identified through the exploration drilling for oil and gas in the area.

The modular Climeon Heat Power system will work in conjunction with the heating and it is estimated that the first phase will annually deliver 14,000 MWh of electricity to the grid. The order is for 16 modules, with an option for GEK to order additional modules in a second phase to expand the production to more than 20,000 MWh annually. Baseload Capital Sweden AB will be involved in the financing of the deal.

The Climeon Heat power system's ability to create energy from low temperature water offers a possibility for extensive use of geothermal energy in most geographical areas. The deal with GEK shows that geothermal heat power could play a major role in Germany's strong commitment to shift into sustainable, clean energy solutions.

"To invest in geothermal heat power is good for many reasons. A long-term electricity contract (PPA) as strong financial base and a reliable 24/7 power production makes this an attractive and low risk project at the same time as we can accelerate the transformation from fossil to green energy", said Magnus Brandberg, Founding partner, Baseload Capital Sweden AB

"We are very excited with this breakthrough order. Germany is leading renewable energy in Europe and geothermal heat power especially at low temperatures has every property to become the dominating source of renewable energy", said Thomas Öström, Founder and CEO of Climeon.

Source:
https://climeon.com/insights/climeon/climeon-wins-breakthrough-geothermal-order-in-germany

Acreage of Strabena Tomato Doubled - Through the use of geothermal energy, vegetable producer Steiner has been distinguishing itself for several years with its sustainable production, high product quality and exclusive supply to the regional Rewe branches. Four years after the opening of the first geothermal-heated greenhouse area of 11.4 hectares, the greenhouse complex now consists of more than 20 hectares.

"The tomato season is year-round here. In addition to 9.6 hectares of conventional tomatoes, we also have 2.2 hectares with artificial lighting, where we grow the Brioso variety over the winter months," says Wolfgang Steiner.

An expansion of six hectares is planned for next year, only for organic products. The field is currently in the conversion phase and construction is expected to be completed in December 2018. This will be followed by

planting, and the first harvest of regional organic tomatoes, peppers and cucumbers will take place at the beginning of April 2019.

Source:
http://www.freshplaza.com/article/191196/Acreage-of-Strabena-tomato-doubled

Iceland: Small Geothermal Power Units & Construction of New 5MW Power Plant

Local Community to Install Small Geothermal Power Units - The municipality of Hrunamannahreppur and the local heat utility in Flúðir have reached an agreement with the company Varmaorkur for a co-operation for the production of low temperature geothermal electricity. The partners recently established a new company called Flúðaorka, which plans to start production of hot water in the area in the second quarter of 2018.

The intention is to produce up to 600 kW of electricity to be fed into the system of power distribution company Rarik. "It's about the technique that it's taking the hottest part water, or from 115 degrees Celsius, and bringing it down to 75 degrees and producing electricity from it. In this case, the idea is to utilize about 20 liters per second in the electricity production, while the capacity of the hole is 45 liters per second," says the municipality mayor of Hrunamannahreppur, Jón G. Valgeirsson.

The power generation system is made up of small, flexible units that produce up to 150 kW of electricity. Each unit is independent so it's simple to increase or decrease the output. During production, the water temperature decreases without changing its amount or quality. The activities of the new company are much anticipated, says Valgeirsson.

"Yes, this is a very exciting task and completely new for us to produce electricity from hot water. It's also great because it's exploiting geothermal resources that generate clean and renewable electricity with technologies that make it possible to utilize geothermal energy much better than before," says the local government.

Source: http://www.thinkgeoenergy.com/local-community-in-iceland-to-install-four-small-geothermal-power-generation-units/

Construction of New 5MW Power Plant Started - In March 2017, Green Energy Geothermal (GEG), headquartered in London, UK, was awarded a contract to design, manufacture and supply a replacement back-pressure turbine and generator for the Bjarnarflag geothermal power plant of Icelandic national power company Landsvirkjun in Iceland. The plant has been in operation since 1969 and is now being updated.

While the old plant has seen a decrease in production, it has been a reliable and important source of power for the Myvatn region in the North of Iceland.

Construction work is now underway, with sufficient arrangements to make sure there is no interference with related activities in the area, which particularly concerns the operation of the local heating plant and the supply of water to the geothermal spa operation at Myvatn.

There is no decision yet on what will happen to the old hardware of the plant, which was built in 1934 representing a significant piece of history. For the beginning it will be stored in Landsvirkjun's facilities on site, but there are plans to use it as a showcase of the first geothermal power plant in Iceland.

Source: http://www.geg.co.uk/construction-at-bjarnarflag-project-in-iceland-under-way/

Italy: New Geothermal Plant with 'Zero-Emissions' to Be Built in Castelnuovo

On late January, a Development Agreement was signed between the Italian energy firm Graziella Green Power and the global energy player ENGIE, through its subsidiaries Storengy and ENGIE Italia, starting a cooperation to realize an innovative binary cycle geothermal plant, located in Castelnuovo Val di Cecina (Tuscany Region, Italy).

The project, whose main works are set to begin in 2019, consists in developing, building and operating a geothermal

power plant of 5MW net capacity. It will be a zero-emission plant thanks to an innovative solution: after generating electric power, the previously extracted geothermal fluid will be re-injected in the same reservoir together with non-condensable gases (CO_2 and others), sustaining a production cycle without atmospheric emissions.

When it is fully operational, the geothermal plant will reach an energy production estimated at around 40,000 MWh per year (enough to supply electricity to 14,000 families), generating also important economic benefits for the local communities. To ensure a minimal environmental impact on territory and population, the plant layout has been designed to limit its land footprint, with a low visual impact and without evaporative cooling towers.

Once the administrative authorizations have been obtained, civil works and drilling activities will begin on site. ENGIE will provide its industrial background for the project management and operation of power plants, and through its subsidiary Storengy, an internationally recognized expertise in subsurface knowledge, for drilling execution and geoscience activities. Graziella Green Power will support the underground exploration and drilling activities and will be an active actor on the territory for the site and project management activities.

Iacopo Magrini, Chief Executive Officer of Graziella Green Power, said "Our company was seeking a big statement partner to realize innovative projects linked to geothermal power, and ENGIE has shown its intention to extend its commitment in this kind of renewable energy. The work that we have carried out so far, together with ENGIE's and its subsidiary Storengy's competences and knowledge, will allow to reach a new step for the future of the Italian geothermal sector."

"Committed to the energy transition, geothermal energy is a key component of Storengy's strategy. This partnership with Graziella Green Power is a fantastic opportunity for us to be part of a very innovative project, with our first geothermal plant in Italy," declared Cécile Prévieu, Chief Executive Officer of Storengy.

"This project is a concrete example of our vision of the 3D world (Decarbonized, Decentralized, Digitalized)," said Olivier Jacquier, Chief Executive Officer of ENGIE Italy. "ENGIE wants to be an actor of this vision, through the development of renewable sources and energy efficiency, with the fundamental push of innovation, the main driver of all our solutions".

"Tuscany is one of the most important geothermal pole in the world. So, our project is oriented to enhance this richness with a compatible plant, without emissions and in harmony with the landscape context, which will open in Italy new frontiers for the geothermal sector, with the ambition to keep realizing in the future, other stations like the one based in Val di Cecina", said Gianni Gori, President of Graziella Green Power.

Source: http://www.4-traders.com/news/Storengy-ENGIE-Storengy-and-Graziella-Green-Power-together-for-the-first-geothermal-power-plant-i--25906345/

The Netherlands: Zwolle and Trias Westland Geothermal Projects

Exploration Permit for Geothermal Project in Zwolle - The Dutch Ministry of Economic Affairs and Climate has granted the municipality of Zwolle a license for drilling for geothermal heat. The permit gives the municipality the exclusive right to apply geothermal energy in the provincial capital.

The granted exploration license covers a large part of Zwolle with a total surface area of 75 square kilometers. The area that was considered promising by the municipality in December 2017, between the Dijklanden and the Stadskolk at the Zwarte Water, is also included.

Zwolle had to wait almost two years for the ministry's promise, since it submitted the application in March 2016. The TNO Advisory Board, the State Supervision of Mines, the Provincial Executive of the province of Overijssel and the Mining Council issued their opinions during this period.

The license granted applies for the next four years. A location in Hanzeland, that for years seemed to be the most promising location to drill, was not suitable because the geological structure of the soil proved unsuitable, after studies finished in last December. Due to the changed area, further research is needed. "It has not yet been decided whether, and if so, when, it is going to be drilled", the municipality said in a written

Drilling rig at the Trias Westland Project.

statement. The current research is financed from the funds already provided.

Source: http://www.thinkgeoenergy.com/zwolle-in-the-netherlands-receives-exploration-permit-for-geothermal-project/

Well Drilled at almost 4000 Meters Depth - The drilling for the Trias Westland geothermal project reached the Triassic layer, at 4000 meters depth, at the end of January 2018. The casings were placed and the borehole was firmly cemented. This was the most exciting section of the project and, despite a number of technical challenges, it was completed successfully.

Then it was investigated the section considered as the reservoir section. This was done with special measuring equipment lowered deep into the borehole. Among other things, the permeability of the rock, the chemical properties of the water and the strength of the rock were measured. Also core samples were retrieved.

Based on that info, it was concluded that the Triassic layer, turned out not to be suitable for cost-effective heat recovery. The permeability of the Triassic layer is by far not sufficient to pump water upwards. According to project manager, Floris Veeger, water flow is almost impossible in this rock. In addition, traces of gas have been found, which make a production test very complex. These factors led to the decision to leave the Triassic layer. The lower part of the hole was closed off with cement plugs.

The Lower Cretaceous layer instead, or more specifically the Delft sandstone layer, appears to be even better than originally thought. In the third section the casing perforations have been made through which the water can flow.

On early March it was performed the production test in the Lower Cretaceous Reservoir. Water from a depth of 2.3 kilometers was pumped up. The test went very well. The hot water flowed very smoothly into the basin and the gas in the water was flared off. Samples were taken and measurements were made to determine, among other things, the pressure and temperature. With this information the project team has started the realization of the heat network. The exact potential of the geothermal doublet will be known at the end of April, when the second well has been drilled and tested.

The Trias Westland geothermal project is a partnership between Flora Holland, HVC, Westland Infra and the Municipality of Westland. It is the first geothermal project in the Netherlands drilled up to the Triassiac layer, situated at a depth of 4 kilometers. T&A Survey Group B.V. is a Dutch company who has been involved in the Trias Westland project from the beginning, and now provides the drilling management.

Sources: http://www.ta-survey.nl/index.php?lang=EN, http://www.ta-survey.nl/nieuws.php?id=399&lang=EN, http://www.ta-survey.nl/nieuws.php?id=400&lang=EN

Spain: Canary Islands to Explore Geothermal Potential

The Tenerife Government is proposing that the Spanish Government undertakes drilling exploration to identify the potential of geothermal energy in the Canary Islands, and the only region in Spain where this could possibly exist, and requires around 20 million euros to explore the subsoil.

Similar initiatives have been simultaneously presented in Gran Canaria and La Palma, because these three islands specifically have previously made joint efforts to evaluate the geothermal potential of the Canary Islands with direct involvement, but with little success in support from the Spanish Government.

It is suggested that three drilling sites should be sufficient for Tenerife geothermal energy exploration with a third of these costs covered by the island government, one third covered by a private initiative that has an interest, and the need for state aid to cover the final third of costs.

Nemesio Pérez, scientific coordinator of Involcan, said that the Division of Volcanism and Environment of the Technological and Renewable Energy Institute, and the Volcanic Energy Centre have carried out previous projects to search for geothermal resources of high temperature (more than 150°C) in Ecuador, El Salvador, Ethiopia, Iceland, Kenya, Morocco, New Zealand and Rwanda.

The special case of the Canary Islands is remarkable as geothermal power could produce virtually emission-free and continuous production, allowing improvements in the security and stability of the existing electric power supply.

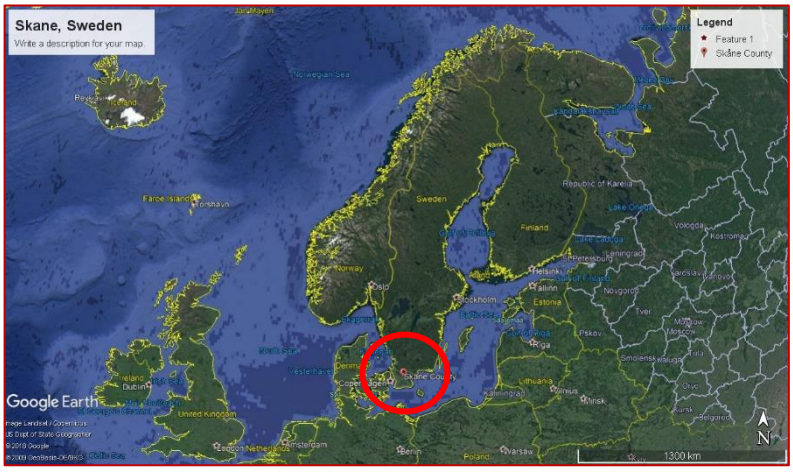
In Tenerife, there are five mining areas or domains of over 100 square kilometers for geothermal exploration including Guia de Isora, Santiago del Teide, Garachico, Icod de los Vinos, Arona, Adeje, Vilaflor, San Miguel de Abona, Granadilla de Abona, Arico, Fasnia, Guimar, Candelaria and Arafo.

The Geological and Mining Institute of Spain (IGME) has widely studied the Canary Islands for its great geothermal potential due to active underground volcanic activity between 1970 and 1980 with favorable results, and it was considered the only region of Spain with high enthalpy geothermal resources was the Canary Islands. However, over the last 20 years no progress has been made in geothermal research in these islands.

Source:
http://canaryislandsreport.com/?post_id=363&title=%E2%80%8Bcanary-islands-exploring-potential-of-underground-geothermal-energy

Sweden: Study on Deep Geothermal Energy in Skåne

Geothermal energy could have great potential and be an important component in achieving the energy and climate goals in Skåne, the southernmost county of Sweden across the sea from Copenhagen, the capital of Denmark.



The Swedish company E.ON announced its participation in a preliminary study on the conditions for using geothermal heat and thermal power in the future.

The preliminary study on energy from deep geothermal energy started in December 2017 to be completed in May 2018, and is run by the County Administrative Board in Skåne. The aim is to investigate the geothermal conditions in Skåne and how a combination of geothermal heat and thermal power could be used to provide a continuous flow of both heat and electricity. Geothermal was selected due to its continue availability, unlike many other renewable energy technologies that are variable depending on the weather, which thus place demands on energy storage.

The project analyzes, both technically and economically, how modern geothermal technology combined with thermal power could be used on a larger scale in Skåne. The study also includes a study of geological conditions, energy potential, risks, challenges, environmental impact and how the results from the preliminary study could be implemented in an implementation project with regard to, for example, green jobs and the development of a geothermal knowledge center.

Participants in the project are E.ON, Againity, Climeon, Geoop, County Administrative Board of Skåne and Malmö city.

Financiers are the European Regional Development Fund (ERDF) and the Region of Skåne.

Source: http://www.thinkgeoenergy.com/e-on-participating-in-study-on-deep-geothermal-energy-in-sweden/

Turkey: Kizildere III U-2, Construction of Small Plant & Ambitious Plans for Geothermal

Commissioning of Kizildere III, Unit 2 - Zorlu Dogal Elektrik, a subsidiary of Turkey's Zorlu Enerji, has commissioned the 65.5 MW second unit of its US$320 million Kizildere III plant on the border between the southwestern provinces of Aydin and Denizli.

With the second unit now generating the plant currently has an installed capacity of 165 MW – making it the largest in Turkey.

Zorlu now operates a portfolio of five geothermal plants, totaling 329.9 MW. Overall the company holds some 31% of Turkey's total geothermal capacity across 40 sites totaling 1100 MW.

The company also holds a so-called "pre-license"

for the 50-MW Alasehir III geothermal plant, for which it held a public consultation meeting last month, in line with the requirements of the environmental impact assessment submitted for the plant. The project is currently under consideration by Turkey's Ministry for Environment and Urban Affairs.

Turkey ranks fourth in the world in terms of installed geothermal capacity, and with its 1100 MW of installed geothermal capacity has already exceeded its official target of 1000 MW by 2023.

Turkey's main geothermal steam resources are located the central Aegean region, stretching inland from Izmir to Usak, the north Aegean region around Balikesir, as well as further sites in north central Anatolia around the capital Ankara and smaller reserves in the far east and north-east of the country.

Estimates for the country's total geothermal potential vary and are subject to frequent increases as new reserves are discovered. However, the figure of 4500 MW is often quoted as a theoretical potential for overall installed geothermal power generation capacity, while estimates for geothermal heating capacity may extend anywhere up to 60,000 MW.

Source: https://newsbase.com/topstories/zorlu-completes-turkey%E2%80%99s-largest-geothermal-plant

Somewhere Over the Rainbow: Kizildere Power Plant. By Erdinç Sentürk. GRC Photo Contest.

New 12.6 MW Power Plant to Be Built - The Italian company Exergy signed a new contract for the delivery of a 12.6 MW geothermal power plant to GCL ND Enerji A.S.

Located in Alasehir, Manisa region, the plant will exploit a medium enthalpy resource at approximately 150°C with an Organic Rankine Cycle system equipped with the Radial Outflow Turbine technology developed by Exergy and utilizing an air cooled condensing system. Some of the power plant components will be manufactured domestically in the Exergy's Turkish workshop based in Izmir and thanks to an exclusive partnership with Nidec ASI for the supply of the generators. Made-in-Turkey production will allow GCL to benefit from an additional total incentive of US$0.02/kWh on top of the basic feed-in-tariff rate of US$0.105/ kWh, thus the increase of 19% in revenue for the client.

Golden Concord Group Limited (GCL) is an integrated energy service provider whose business covers Power, PV and Clean Energy, Oil & Gas, Green Smart City, semiconductor materials, new energy vehicles and Finance.

ND Group, based in Eindhoven, the Netherlands, is a privately owned holding and investment company operating in multiple sectors and industries worldwide, investing and encouraging entrepreneurial start-ups with potential for long-term growth. The company looks for innovative ideas and businesses with a focus on key markets such as Energy, Technology, Services, Fashion, Food and Beverages. Since 2015, GCL and ND Groups started their collaboration to develop a geothermal power plant in Turkey.

Source: http://www.thinkgeoenergy.com/exergy-signs-contract-on-supply-of-plant-for-new-12-6-mw-geothermal-plant-in-turkey/

Turkish Company Plans to Double its Geothermal Capacity – Turkish company Turcas Petrol AS plans to double its geothermal installed capacity in the mid-term said Batu Aksoy, the Turcas Petrol CEO. He added that geothermal investors are awaiting details of a replacement of the current Turkish Renewable Energy Resources Support Mechanism (YEKDEM).

Aksoy underlined the importance of seeing an innovative mechanism in order that investors can take a serious and strong position for future undertakings.

He also pointed out that a vital request from lawmakers on the YEKDEM mechanism is to see sustainable support from Turkey's Energy and Natural Resources Ministry.

Currently, YEKDEM offers a feed-in tariff of US$0.073 per kilowatt-hour (kWh) for wind and hydropower projects, US$0.105 for geothermal facilities and US$0.133 for solar energy and biomass thermal plants.

However, Turkey's Energy and Natural Sources Minister Berat Albayrak announced on Nov. 1, 2017 that the YEKDEM mechanism would not meet the demand from the clean energy sector, and would not continue after 2020.

Aksoy hailed Turkey's position in geothermal developments in recent years and said that Turkey

achieved fourth place globally in installed geothermal energy capacity.

Turkey is geographically located in an active tectonic zone, and is therefore rich in terms of geothermal energy resources, he explained.

According to Turkey's Energy and Natural Resources Ministry's official web page, the country has approximately 1000 geothermal springs of various temperatures located across the country. In theory, Turkey's geothermal potential could reach 31,500 thermal megawatts.

Furthermore, 90 percent of the country's geothermal resources are in low and medium enthalpy geothermal areas, which are suitable for direct applications of heating, thermal tourism, and the output of minerals, etc., while the remaining 10 percent is suitable for power generation.

Currently, geothermal energy is used for electricity production, both greenhouse and residential heating, thermal and health tourism, industrial mineral mining and for drying purposes.

Source: https://aa.com.tr/en/energy/finance/turcas-petrol-to-double-geothermal-capacity-in-mid-term/19226

UK: Coal Mines as Geothermal Sources and Energy Storages

As mines are abandoned, pumps switched off and mines flood. Geothermal heat, transmitted from the underground find the mining legacy ideal conduits and warms this mine water to temperatures typically 20-40°C. Calculations suggest that the flooded mine workings are now a source of heat –with an estimated 2.2 million gigawatt hours of harvestable heat being produced per annum. That is enough to heat five times the number of homes in the UK, and with over one quarter of UK homes being in the coalfields the opportunity is enormous.

Mine heat is low grade, which means it is unsuitable for generating electricity as steam, but ideal for cost effectively heating homes, warehouses, leisure centres and offices. With approximately 45 per cent of heat in England and Wales used for heating, and 55 per cent in Scotland, this is a significant proportion of UK energy demand. To harvest the heat requires the use of heat exchangers and pumps. These work the same as the refrigerators we have at home. They use electricity to remove heat and cool the heat source.

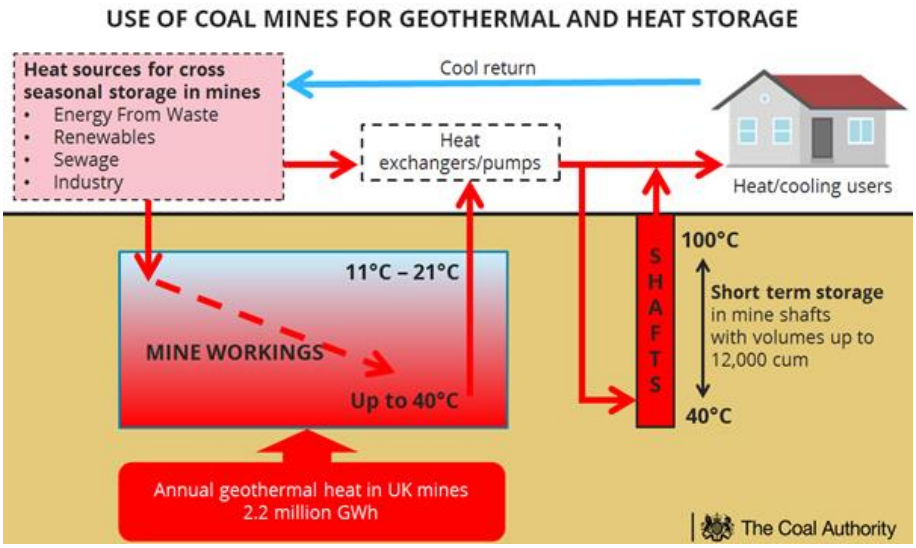
This is a highly efficient process, for every 1kW of electricity 5-10 kW of heat equivalent are produced (depending on source temperature), this represents a cost and carbon advantage over public supply gas. If the electricity used in the heat pumps is supplied from renewables, the mine heat would be virtually carbon free.

UK mines come in all shapes and sizes. Some are ideal as a continuously recharging source of geothermal energy. Others could see a reduction in temperature if the rate of withdrawal exceeds natural recharge. This is where storing of energy in the mine comes into its own as a means of holding significant quantities of energy across-seasons for later use. This concept comes into its own as a means of assisting the balancing the electricity grid, not only across seasons, but also through daily peaks.

The Coal Authority, an executive non-departmental public body that manages around £3 billion (US$4.22 billion) worth of coal mining issues, are particularly interested in promoting a district heating scheme using thermal panel on residents roofs as a source of heat for long term storage. Thermal panels are 95 per cent efficient and can produce up to 60 per cent of a home's heat requirement per annum.

The difficulty is they produce high temperature hot water mostly during the summer and most efficiently between peak usages. If this heat was stored in mines, residents would benefit from be able to draw their heat back when they most need it.

The Coal Authority is currently working with Midlothian Council, Scotland, on the use of an abandoned mine shaft as a heat storage vessel of some 12,000 cubic meters being charged from surplus heat from an Energy from Waste Plant currently under construction. Stored heat will feed into a district heating



Graph credit: UK's The Coal Authority

scheme providing operational and energy savings to the scheme and plant operator.

The Coal Authority is keen to see the building of commercial scale pilot schemes to kick-start an industry. One of the first to be the Bridgend Council, Wales, Caerau district heating scheme in which pilot boreholes have found 20.5°C in a roadway at just 220m below ground level.

Source: https://utilityweek.co.uk/coal-mines-energy-storage/

Oceania

New Zealand: Hydrogen Pilot Project & Alpine Fault Study

Joint Māori and Japanese Hydrogen Pilot Project with Geothermal Energy - A project to pilot the commercial production of hydrogen using renewable geothermal energy has been announced. Taupō-based Tuaropaki Trust and Japanese construction company Obayashi Corporation, have signed a memorandum of understanding (MoU) to start producing hydrogen, a fuel which produces no carbon emissions.

Tuaropaki Trust opened the 113MW Tuaropaki geothermal power station, near Taupō, in 2000, and has other farming and engineering assets in the North Island.

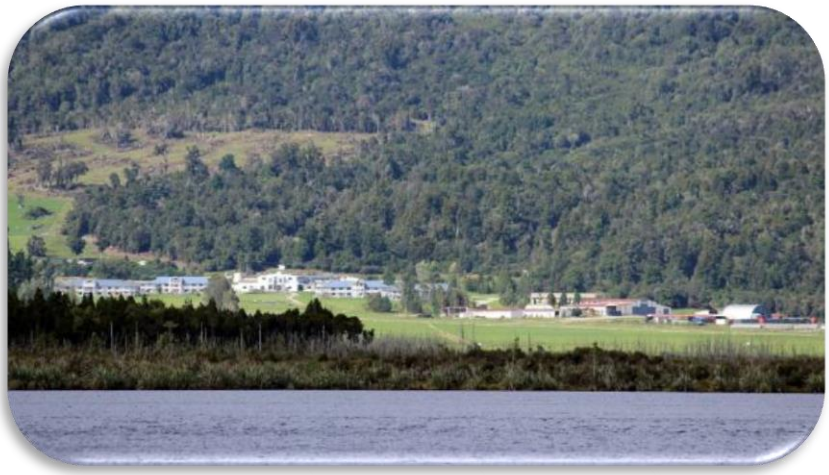
The new venture MoU was signed in Tokyo in December 2017 between Obayashi Corporation President, Toru Shiraishi and Tuaropaki Trust Deputy Chairman, Jamie Ataria.

Obayashi Corporation is one of the world's leading construction companies and a global heavyweight known for its expertise and technological innovation. Obayashi President, Toru Shiraishi, welcomed the new venture with Tuaropaki. He said they had a "medium-to-long-term environmental vision" called Obayashi Green Vision 2050 and they were committed to reducing CO_2 emissions to help achieve a sustainable society.

Tuaropaki Chairman, Tumanako Wereta said Tuaropaki has long been committed to renewable energy. "We are very interested in other 'green energy' alternatives which align with our strategy and core values. We look forward to working with Obayashi Corporation to explore the potential for commercial hydrogen production using renewable geothermal energy to create a CO_2-free fuel."

Source: https://www.stuff.co.nz/business/101292443/joint-iwi-and-japan-hydrogen-pilot-project-for-taup

Community Invests in Geothermal Alpine Fault Study – Gloriavale's Christian Community has invested NZ$20,000 (US$14,600) in a geothermal study. The community, which sits near the Alpine Fault at Haupiri, West Coast of the South Island, is composed of more than 90 families (around 600 inhabitants) who are members of the Church at Gloriavale in New Zealand.



View of the Gloriavale community. Photo taken from the source.

The community runs the drilling company Ocean Harvest International, which prospects for oil and gas on the West Coast and hires out drilling equipment. Now they have already bought a drilling rig to access hot water deep underground.

GNS Science business development manager Dave Jennings said NZ$160,000 (US$ 117,200) funding had been secured for the study so far. The lead funder was Development West Coast.

GNS Science had enough funding to make a start on the six-month project – the first of three stages into using geothermal resource. It wanted to find uses for geothermal heat such as horticulture, hot pools, accommodation facilities, and industrial applications. The possibility of small-scale electricity generation would also be considered.

The six-month study – the first of three stages – would investigate how the water could be used, he said. Depending on the study's outcome, phase two would involve fieldwork on high priority sites and the final phase would be to develop pilot projects that businesses could tap into. The second and third stages would each take up to 18 months and include drilling, consent and seeking funding from potential users and investors.

The study would come up with potential commercial uses of low temperature geothermal heat at several

locations. Interested parties and potential stakeholders included Scenic Hotels, Ngāti Waewae and Westpower.

Source: https://www.stuff.co.nz/the-press/news/west-coast/101669735/gloriavale-invests-in-geothermal-alpine-fault-study

Other

Financing: Geothermal Energy and Cryptocurrencies

Energy Demand Soar in Iceland for Bitcoins – Iceland is expected to use more energy mining bitcoins and other virtual currencies this year than it uses to power its homes. With massive amounts of electricity needed to run the computers that create the precious bitcoins, large virtual currency mining companies have established a base in Iceland, a chilly North Atlantic island blessed with an abundance of renewable energy from geothermal and hydroelectric power plants.

The relatively sudden growth of the new industry has prompted Smari McCarthy, a lawmaker for Iceland's Pirate Party, to suggest taxing the profits of bitcoin mines. The initiative is likely to be well received by Icelanders, who are skeptical of speculative financial ventures after suffering a catastrophic banking crash in 2008.

"Under normal circumstances, companies that are creating value in Iceland pay a certain amount of tax to the government," McCarthy told. "These companies are not doing that and we might want to ask ourselves whether they should."

The energy demand has increased because of the soaring cost of producing virtual currencies. Computers are used to make complex calculations that verify a running ledger of all the transactions in virtual currencies around the world. In return, the miners claim a fraction of a coin not yet in circulation. In the case of bitcoin, a total of 21 million can be mined, leaving about 4.2 million left to create. As more bitcoin enter circulation, computers need to get more powerful to keep up with the calculations — and that means more energy.

Keflavik has over the past months boomed as an international hub for mining bitcoins and other virtual currencies. That has spawned oversize construction sites on the outskirts of town. Among the main attractions of setting up bitcoin mines in this city, is the natural cooling for the computer servers and the competitive prices for Iceland's abundance of renewable energy.

At the largest of three bitcoin 'farms' currently operating within Keflavik, high metal fences surround 50 meter-long warehouse buildings stacked with computer rigs. The data centers here are specially designed to utilize the constant wind on the bare peninsula. Walls are only partial on each side, allowing a draft of cold air to cool down the equipment.

Johann Snorri Sigurbergsson, a business development manager at the energy company Hitaveita Sudurnesja, said he expected Iceland's virtual currency mining to double its energy consumption to about 100 megawatts this year. That is more than households use on the island nation of 340,000, according to Iceland's National Energy Authority.

Pirate Party legislator McCarthy has questioned the value of bitcoin mining for Icelandic society, saying residents should consider regulating and taxing the emerging industry. "We are spending tens or maybe hundreds of megawatts on producing something that has no tangible existence and no real use for humans outside the realm of financial speculation," he said. "That can't be good."

Source: http://www.decaturdaily.com/news/other_news/international/new-gold-rush-energy-demands-soar-in-iceland-for-bitcoins/article_6205f432-ddd8-5fe7-af34-0bb215127bae.html

More Electricity Demand for Mining Cryptocurrencies? - Morgan Stanley analysts said miners of Bitcoin could use as much as 140 terawatt-hours of electricity in 2018. That's nearly 1 percent of global demand and enough to seize the limelight from electric cars as the explosive new source of power consumption. However, Credit Suisse Group dumped cold water on the notion that Bitcoin would create 'uncontrolled growth' in power demand. The bank's

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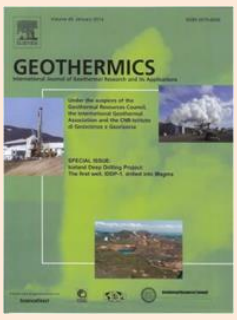


analysts recalled overly bullish predictions about demand from marijuana growers and data center operators who later found ways to curb their electricity use. Credit Suisse predicted a similar buzzkill for cryptocurrencies.

"This is a far cry from the power and environmental Armageddon that some have feared," the analysts, led by Michael Weinstein, wrote in the report.

The debate underscores how difficult it's been to project demand from a cryptocurrency craze that already has utilities and renewable energy developers worldwide marketing their supplies to the sector. When Bitcoin skyrocketed in 2017, the electricity demand associated with it climbed to about 20.5 terawatt-hours a year, according to a report by Bloomberg New Energy Finance. Miners earn Bitcoin-denominated rewards for performing complex, energy-intensive calculations needed to confirm transactions in the cryptocurrency.

While higher prices have spurred more mining, it's impossible to know where the market is headed, said Isabelle Edwards, a BNEF analyst. If prices remain high, energy consumption will do the same. But the amount of electricity needed to mine Bitcoins could fall if there are improvements in computing technology. Meanwhile, if prices fall, it's "almost inevitable that some miners will go out of business," Edwards said.

Morgan Stanley cautioned that demand projections are "clearly not an exact science" but suggested that Bitcoin mining could fuel the growth of renewable energy from the U.S. to China.

A Canadian utility has already voiced enthusiasm. Hydro-Quebec has said it's in "very advanced" talks with miners about relocating to the province and that it envisions the miners soaking up about five terawatt-hours of power annually --equivalent to about 300,000 Quebec homes-- from the surplus created by the region's hydroelectric dams.

Credit Suisse urged caution for investors hoping to "benefit significantly" from the growth in electricity demand. While Bitcoin miners currently use about as much electricity as Ireland, they are "very unlikely" to reach the "ultra-high-end" threshold of 350 terawatt-hours a year --a level that would amount to 1.4 percent of global demand, according to the analysts, and similar con Mexico's consumption last year.

At current Bitcoin and electricity prices, power and fuel suppliers may have as much as US$5 billion in "global annual revenue opportunity." That compares to the more than US$6 trillion of global energy expenditures each year.

"This is a small portion of global electric usage and an even smaller portion of total global energy expenditures," the report said.

Source:
https://www.bloomberg.com/news/articles/2018-01-16/bitcoin-s-power-needs-may-be-overblown-recalling-pot-growing

Financing: IRENA's Report on Generation Costs in 2017

On late January, the International Renewable Energy Agency (IRENA) released their report Renewable Power Generation Costs in 2017, which is a comprehensive cost report that highlights the latest trends for each of the main renewable power technologies, based on the latest cost and auction price data from projects around the world.

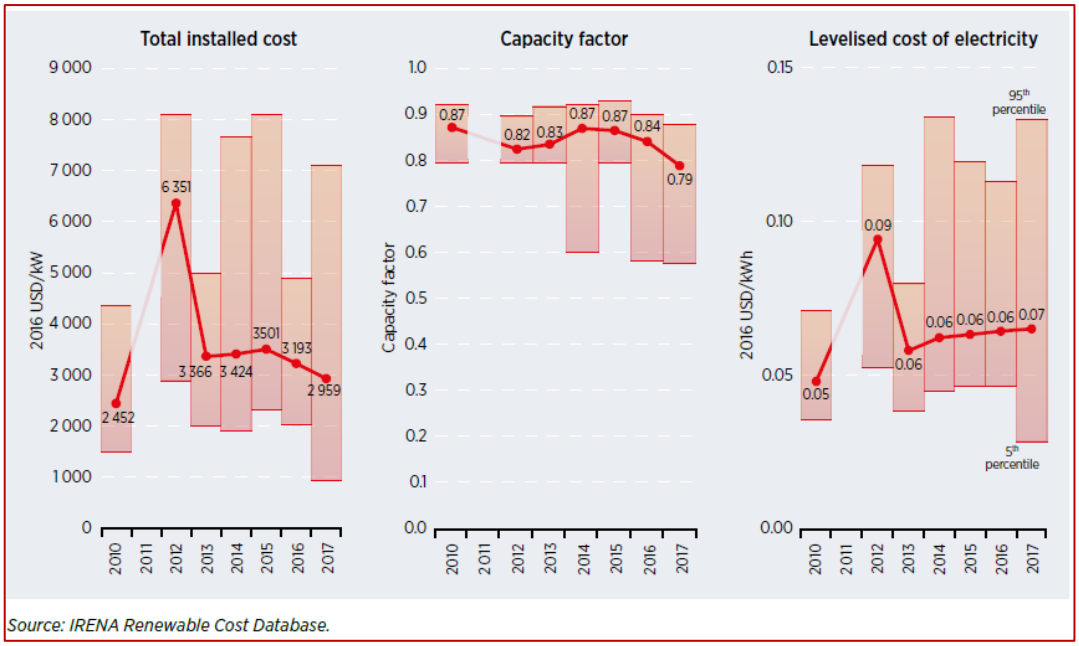
The IRENA Renewable Cost Database includes 15000 data points for levelized cost of energy (LCOE) from projects around the globe, representing over 1000 gigawats (GW) of power generation capacity. An additional auctions database encompasses over 7,000 projects with nearly 300 GW of capacity.

The study finds that renewable power generation costs continue to fall and are already very competitive to meet needs for new capacity, and that global competition is helping to spread the best project development practices, reducing technology and project risk and making renewables more cost-competitive than ever before.

In the case of geothermal energy, the report indicates that the weighted installed cost in 2017 was almost US$ 3,000 per kilowatt, ranging between US$ 1,000 and 7,000, and that the LCOE was US$ 0.07 per kilowatt-

hour, ranging since ~US$ 0.035 up to 0.14 (see attached graph). In all cases, values refer to 2016 US$.

Source:
http://irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017



Source: IRENA Renewable Cost Database.

Climate Change: North Pole Surges above Freezing in the Dead of Winter

The third weekend of last February an extraordinary and possibly historic thaw swollen at the North Pole. Analyses show that the temperature warmed to the melting point as an enormous storm pumped an intense pulse of heat through the Greenland Sea.

Temperatures may have soared as high as 35 degrees Fahrenheit (2 degrees Celsius) at the pole, according to the U.S. Global Forecast System model. While there are no direct measurements of temperature there, Zack Labe, a climate scientist working on his PhD at the University of California at Irvine, confirmed that several independent analyses showed "it was very close to freezing," which is more than 50 degrees (30 degrees Celsius) above normal.

The warm intrusion penetrated right through the heart of the Central Arctic, Labe said. The temperature averaged for the entire region north of 80 degrees latitude spiked to its highest level ever recorded in February. The average temperature was more than 36 degrees (20 degrees Celsius) above normal. "No other warm intrusions were very close to this," Labe said in an interview, describing a data set maintained by the Danish Meteorological Institute that dates back to 1958. "I was taken by surprise how expansive this warm intrusion was."

Such extreme warm intrusions in the Arctic, once rare, are becoming more routine, research has shown. A study published last July found that since 1980, these events are becoming more frequent, longer-lasting and more intense.

"Previously this was not common," said lead author of the study Robert Graham, from the Norwegian Polar Institute, in an email. "It happened in four years between 1980 and 2010, but has now occurred in four out of the last five winters."

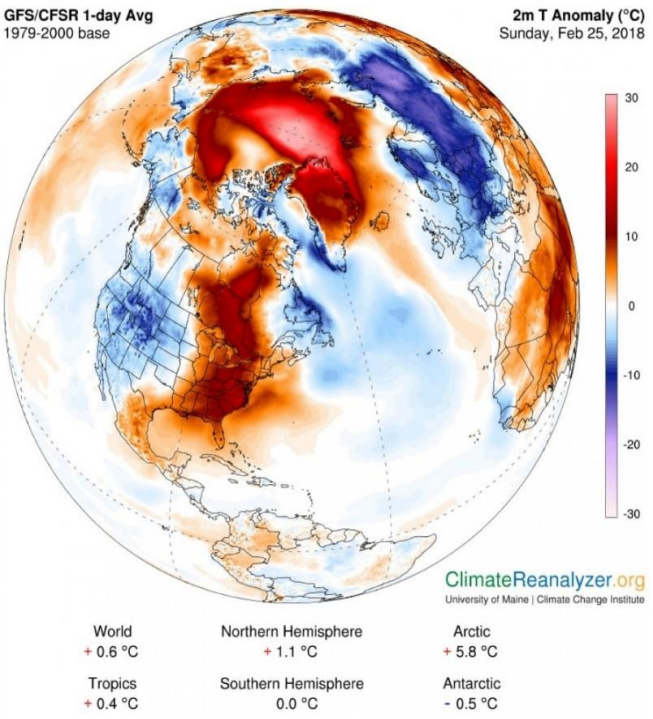
Graham explained that these warming events are related to the decline of winter sea ice in the Arctic, noting that January's ice extent was the lowest on record. "As the sea ice is melting and thinning, it is becoming more vulnerable to these winter storms," he explained. "The thinner ice drifts more quickly and can break up into smaller pieces. The strong winds from the south can push the ice further north into the Central Arctic, exposing the open water and releasing heat to the atmosphere from the ocean."

Scientists were shocked in recent days to discover open water north of Greenland, an area normally covered by old, very thick ice. "This has me more worried than the warm temps in the Arctic right now," tweeted Mike MacFerrin, an ice sheet specialist at the University of Colorado.

The rise in Arctic temperatures is probably also tied to a sudden warming of the stratosphere, the atmospheric layer about 30,000 feet high (~9,144 meters) —above where most weather happens— that occurred several weeks ago, Moore said. Why these stratospheric warming events happen is poorly understood, as are their consequences. However, they tend to rearrange warm and cold air masses, and this latest one has also been linked not only to the Arctic warmth but also to the "Beast from the East" cold spell over Europe.

Source:
https://www.washingtonpost.com/news/capital-weather-gang/wp/2018/02/26/north-pole-surges-above-freezing-in-the-dead-of-winter-stunning-

scientists/?utm_medium=email&utm_source=digg&utm_term=.66e3ff23dd3c



GFS model analysis of temperatures (in Celsius) on 25th February over the Arctic. (University of Maine Climate Re-analyzer; taken from the source).

Climate Change: Main Takeaways from the Draft IPCC Next Report

Under the Paris Agreement, governments worldwide (excepting the U.S.) agreed to hold global warming "well below 2°C" and to aim for 1.5°C. The Intergovernmental Panel on Climate Change (IPCC) agreed to produce a special report on the 1.5°C threshold, summarizing all the available evidence.

The website Climate Home News *has obtained an early version of the five-chapter report, which is due to be finalized in September 2018. The IPCC stressed it was a work in progress and may change substantially, and it is open for review by experts and governments. What is clear from the content so far, though, is there is not much time left. Here are some of the main takeaways.*

- We're close to the line

The world has already warmed 1°C since pre-industrial times. At the current rate, we will pass 1.5°C in the 2040s. This is based on a 30-year average global temperature, centered on the year in question, compared to 1850-1900. Parts of the world, for shorter periods of time, are almost certain to exceed 1.5°C warming sooner than 2040.

- 1.5°C is risky

The fingerprints of climate change are already visible on extreme weather events, sea level rise and related impacts on ecosystems and human society. Each notch of warming brings more disruption.

At 1.5°C, tropical reefs are at "high risk" of no longer being dominated by corals. The Arctic could become nearly ice-free in September. There will be "fundamental changes in ocean chemistry" that could take millennia to reverse.

- 2°C is riskier

The next half-degree ramps up the risk of flood, drought, water scarcity and intense tropical storms. There are knock-on effects: reduced crop yields, species extinction and transmission of infectious diseases like malaria. And these pressures multiply the threat of hunger, migration and conflict.

An extra 10 cm of sea level rise is predicted this century with 2°C compared to 1.5°C. It also raises the risk of Greenland and West Antarctic ice sheets collapsing over the long term, dooming future generations to multi-meter sea level rise.

- Poor and coastal communities will be hit hardest

Vulnerable communities are already experiencing threats from climate change. At both 1.5°C and 2°C these effects scale up.

- "Rapid and deep" emissions cuts are needed, and negative emissions… and luck

Meeting the 1.5°C goal is a huge ask. It implies cutting greenhouse gases faster than ever before across all sectors of the economy.

At the same time, carbon dioxide needs to be sucked out of the atmosphere. Depending on the scenario, 380-1130 gigatons of CO_2 should be removed. The more emissions cuts are delayed, the more rests on negative emissions technology, which could be problematic.

Scenarios that give a 66% chance of holding temperature rise below 1.5°C throughout this century are "already out of reach", according to the draft summary. That leaves a narrow path to walk to stay within the 1.5°C threshold, or the prospect of overshooting and using negative emissions to restore the balance by 2100.

- Radical action has trade-offs

Scaling up negative emissions in line with the 1.5°C goal may clash with efforts to end hunger. "There is a high chance that the levels of CO_2 removal implied in the scenarios might not be feasible due the required scale and speed of deployment required and trade-offs with sustainable development objectives," the draft states.

- Beware techno-fixes

The draft takes a skeptical line on solar geoengineering, a prospective technology to cool the planet by reflecting heat into space. Ethical implications, governance issues and public resistance could make it "economically, socially and institutionally infeasible".

- Prepare for social change

As much as any technology, 1.5°C depends on people changing their behavior. That means the rich eating less meat, using energy sparingly and forgoing private cars. And it means tackling institutional barriers to action like public attitudes, lack of resources or special interests.

Source:
http://www.climatechangenews.com/2018/02/13/11-takeaways-draft-un-report-1-5c-global-warming-limit/

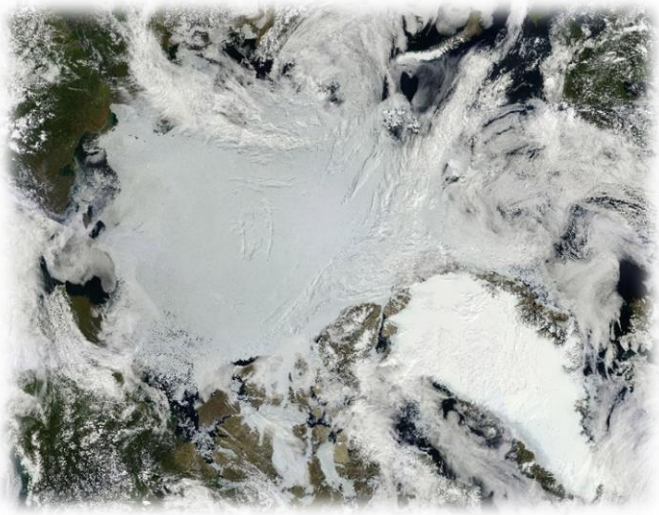
Climate Change: New NASA Space Sensors to Address Key Earth Science Questions

Why is the Arctic warming faster than the rest of the planet? Does mineral dust warm or cool the atmosphere? NASA has selected two new, creative research proposals to develop small, space-based instruments that will tackle these fundamental questions about our home planet and its environment.

The Polar Radiant Energy in the Far Infrared Experiment (PREFIRE) will fly a pair of small CubeSat satellites to probe a little-studied portion of the radiant energy emitted by Earth for clues about Arctic warming, sea ice loss, and ice-sheet melting. Tristan L'Ecuyuer of the University of Wisconsin, Madison, is the principal investigator.

The Earth Surface Mineral Dust Source Investigation (EMIT) will use a sensor mounted to the exterior of the International Space Station to determine the mineral composition of natural sources that produce dust aerosols around the world. By measuring in detail which minerals make up the dust, EMIT will help to answer the essential question of whether this type of aerosol warms or cools the atmosphere. Robert Green of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, is the principal investigator.

The Arctic helps to regulate Earth's overall temperature by radiating back into space much of the excess energy from the Sun that is absorbed at lower latitudes. Current satellite instruments do not detect all of the wavelengths of this energy radiating from our planet. PREFIRE will fill in the current data gap at far-infrared wavelengths, collecting information that will help scientists diagnose the impact of this outgoing radiation on the Arctic region's energy balance.



This 2011 composite satellite image shows the expanse of Arctic sea ice (center) and the Greenland Ice Sheet (lower right). Credit: NASA

The composition of airborne dust particles is largely unknown, but it is a critical factor in determining whether mineral-based dust has a cooling or warming effect on the atmosphere. Scientists do not currently have a global inventory of the natural mineral sources of dust, and as a result the global impacts of dust on weather, atmospheric circulation, and other aspects of Earth's environment are not well established.

EMIT's hyperspectral instrument will measure the different wavelengths of light emitted by minerals on the surface of deserts and other dust sources to determine their composition. The EMIT sensor is based in part on NASA's Moon Mineralogy Mapper instrument aboard the Indian Space Research Organization's Chandrayaan-1 spacecraft.

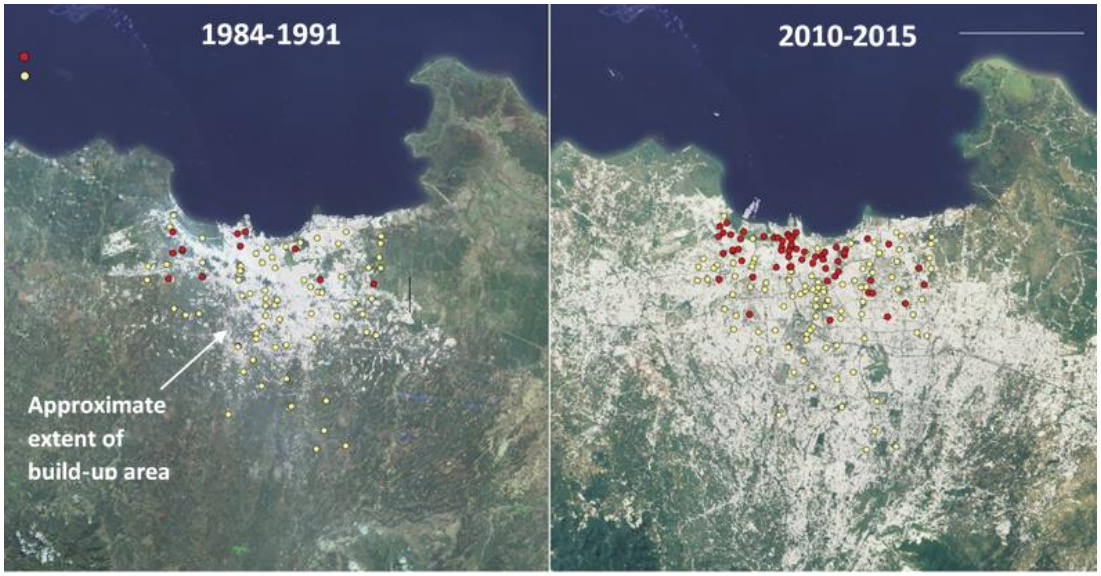
Source: *NASA News Releases*, February 05, 2018, RELEASE 18-006

Climate Change: Jakarta Is Sinking Fast

With climate change, the Java Sea is rising and weather is becoming more extreme. In early December 2017 another freakish storm briefly turned Jakarta's streets into rivers and brought this vast area of nearly 30 million residents to a virtual halt.

One local climate researcher, Irvan Pulungan, an adviser to the city's governor, fears that temperatures may rise several degrees Fahrenheit, and the sea level as much as three feet in the region, over the coming century.

But global warming in not turned out not to be the only culprit behind the historic floods that overran much of the rest of Jakarta in 2007. The problem, it turned out, was that the city itself is sinking. In fact, Jakarta is



Subsidence in Jakarta. Red dots: more than 5 cm/year, yellow dots: less than that. (Figure by The New York Times, taken from the source. Subsidence data courtesy of Irwan Gumilar of Geodesy Research Group of ITB. Satellite images via Landsat 5 and Landsat 8)

sinking faster than any other big city on the planet, faster, even, than climate change is causing the sea to rise —so surreally fast that rivers sometimes flow upstream, ordinary rains regularly swamp neighborhoods and buildings slowly disappear underground, swallowed by the earth. The main cause: illegal wells that have been draining the underground aquifers on which the city rests —like deflating a giant cushion underneath it. About 40 percent of Jakarta now lies below sea level.

Climate change acts here as it does elsewhere, exacerbating scores of other ills. Hydrologists say the city has only a decade to halt its sinking. If it can't, northern Jakarta, with its millions of residents, will end up underwater, along with much of the nation's economy. Eventually, barring wholesale change and an infrastructural revolution, Jakarta won't be able to build walls high enough to hold back the rivers, canals and the rising Java Sea.

And even then, of course, if it does manage to heal its self-inflicted wounds, it still has to cope with all the mounting threats from climate change.

Source:
https://www.nytimes.com/interactive/2017/12/21/world/asia/jakarta-sinking-climate.html?utm_source=digg&utm_medium=email

Technology: 'Green' Fracking Fluid Developed by the PNNL

Scientists at U.S. PNNL (Pacific Northwest National Laboratory), Washington, developed an environmentally friendly 'green' fracking fluid, called StimuFrac™. Rather than using large volumes of water and an immense amount of pressure to create fractures underground, this green fracking fluid relies on a safe chemical process to do the hard work.

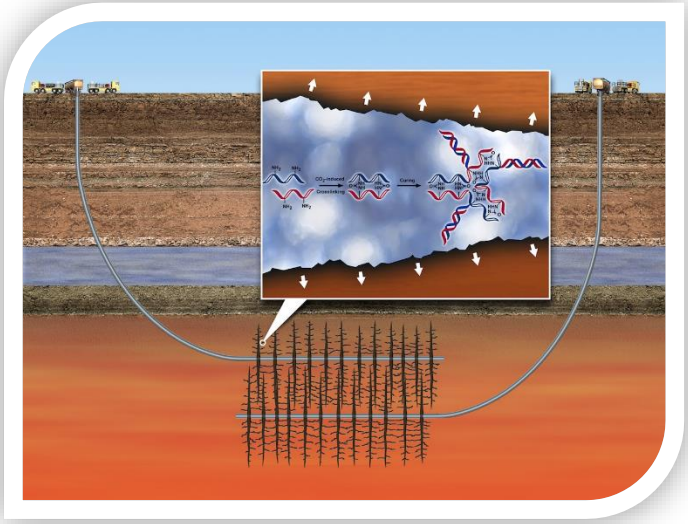
The process is a chemical reaction that occurs when poly (allylamine) and carbon dioxide (CO_2) are combined. CO_2 is added to the green fracking fluid and then reacts with the poly (allylamine) expanding in volume and creating pressure in addition to what already occurs during conventional hydraulic fracturing.

Not only could PNNL's StimuFrac™ use significantly less water compared to conventional hydraulic fracturing methods —making it more environmentally friendly— it is expected to also significantly reduces costs. The additional pressure created when using PNNL's fluid means less mechanical pressure is required, potentially less water is used, and fracturing can be done more quickly. All of these factors combined could reduce operating costs by 60 percent while increasing permeability up to 10,000 times compared to conventional fracturing methods.

StimuFrac™ was proven in the laboratory, but PNNL scientists wanted to see their technology in action. More specifically, they wanted to know if this technology would work anywhere, not just in the controlled spaces of their laboratory. They tested the fluid under many different chemical and geomechanical conditions with different pressures, temperatures, and pH environments. StimuFrac™ consistently outperformed conventional methods and even worked under a range of 3-10 pH, confirming the feasibility of the fluid at various locations worldwide.

PNNL scientist, Varun Gupta explains, "PNNL's StimuFrac™ has outperformed conventional fracking fluids; however, all the different mechanisms responsible for its efficiency are yet to be understood. The research team also thinks that in addition to the overpressure generated by StimuFrac™, it has lower critical pore invasion pressure that provides further advantage over conventional fracking fluids."

Not only could the fluid be used in EGS applications, but it can also be used in the oil and gas industry. PNNL scientist Carlos Fernández says "Though we initially designed the fluid for geothermal energy, it could also make unconventional oil and gas recovery more cost-effective and environmentally friendly."



Source:
https://energyenvironment.pnnl.gov/highlights/highlight.asp?id=2912

Technology: Creating Geothermal Heat Flow Maps with *Heat Needles*

Several years ago, the Australian company Hot Dry Rocks (HDR) reported on its development of a heat needle appliance. Now, Graeme Beardsmore, Technical Director of HDR, has announced in his LinkedIn page that after more than 10 years of R&D on the appliance, the tool has now been successfully introduced.

Surface heat flow data provide the most direct evidence of subsurface heat of any geophysical technique. Historically, though, surface heat flow has failed as a routine geothermal exploration method because of the prohibitive cost of obtaining targeted data in areas of real interest. Furthermore, heat flow in hydrothermally active regions (volcanoes, extensional zones, etc.) can vary greatly over short distances, so interpolating heat flow between widely spaced data points can very easily miss prospective targets.

Surface heat flow maps at 'prospect' scale would be incredibly value for geothermal exploration. But collecting new heat flow data is expensive. Heat flow data can be obtained by indirect or direct methods. Indirect methods use geochemical equations and are basically two: the silica geothermometer and the isotopic ratio of Helium. Direct methods are physical measurements of thermal gradient and thermal conductivity, which are correlated in the Fourier equation f = K dt/dz, where K is thermal conductivity, t is temperature and z is depth. So, dt/dz is the thermal gradient, which expresses the variation of temperature with depth.

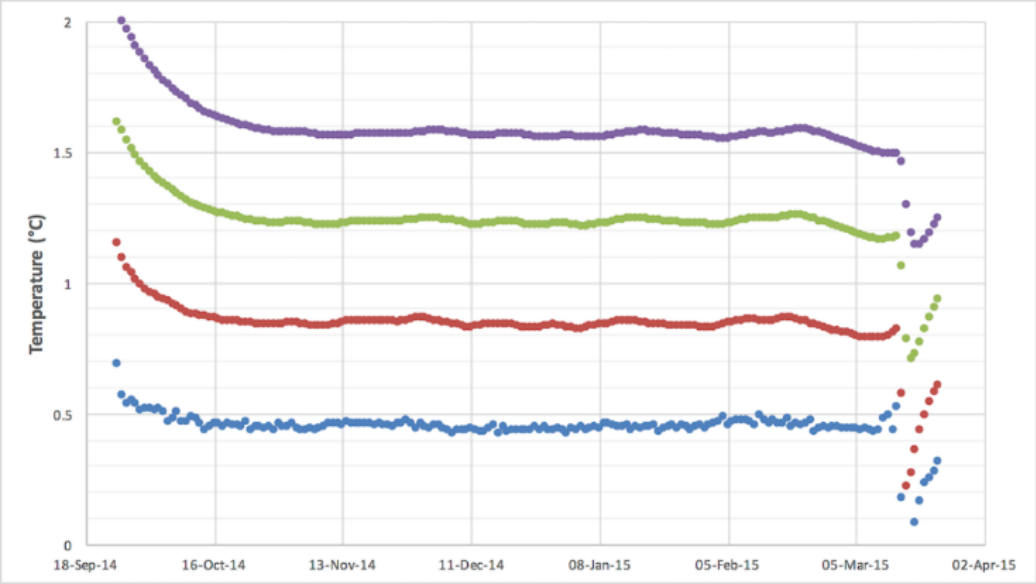
Thermal gradient in the shallow subsurface is heavily disturbed by solar and atmospheric heating cycles, so boreholes 100 m deep or more are usually required to obtain 'undisturbed' gradient values. Thermal conductivity over the same interval is best measured on core samples in a laboratory, another relatively expensive exercise. In the latter stages of geothermal exploration, more than a million dollars might be spent to drill a small handful of gradient or heat flow wells, as an intermediate step to justify deep appraisal drilling. But conductive heat flow is otherwise ignored as a tool.

Thus, producing a surface heat flow map over an entire geothermal prospect for less than the cost of a single heat flow well would be a breakthrough advance in geothermal exploration. After 10 years of R&D, Graeme Beardsmore says his company Hot Dry Rocks has demonstrated a tool that can do just that. They call it the *Heat Needle*.

The method works by placing a one meter long rod into the ground with an off-the-shelf electric drill, and insert a set of highly sensitive and accurate thermal sensors. These sensors passively record the temperature in the top meter of the ground four times each hour for several months. When processed in the frequency domain, these records of ground temperature indicate the thermal diffusivity of the ground to a precision of ~±1%. The method also correlates the site-specific records of surface temperature against more diffuse but long-term satellite-derived records of surface temperature. That allows extend the surface temperature record many years into the past.

The next step is to forward model the diffusion of the historical surface temperature signal into the ground, using the value of thermal diffusivity in the site. The processing ends up with a prediction of the near-surface temperature disturbance due to solar and atmospheric causes. Subtracting that predicted disturbance from the ground temperature observations reveals the subtle, but constant, subsurface thermal gradient.

The final piece in the puzzle is that the Heat Needle also contains an active heating coil that allows to conduct an in situ thermal conductivity test. Multiplying the inferred thermal gradient by the measured thermal conductivity results in a surface heat flow value. Experience to date suggests an accuracy on the order of ±0.05 W/m² (±50 mW/m²).



Reduced subsurface temperatures at 50 cm (blue), 70 cm (red), 90 cm (green) and 110 cm (purple) depth after removing the surface temperature signal. A clear gradient of about 1.9°C/m is defined after an initial equilibration period. The Heat Needle is sensitive to much lower gradients than this (Graph by G. Beardsmore, taken from the source).

The Heat Needle is ready for pilot deployments. Depending on the location, up to 15 units might be concurrently deployed across a region for three months to achieve geothermal exploration goals such as:

- Quantify the total natural thermal recharge of geothermal systems (when added to convective loss from springs, fumaroles and steaming ground)

- Delineate the boundaries of geothermal systems

- Discover 'blind' geothermal systems (could be particularly useful in extensional settings)

- Trace outflow fluid conduits back to their 'source' (understand the plumbing)

- Rule out inappropriate 'gradient well' locations

- Determine whether a resistivity anomaly coincides with a thermal anomaly (discriminate between current and 'fossilized' clay caps)

- Locate 'upflow' zones, even though they may be several kilometers from surface manifestations

The ability to produce new conductive heat flow data and maps precise enough to characterize the thermal features of geothermal reservoirs at typical depths of 1-2 km, using a relatively cheap and portable surface instrument, represents a significant advancement for geothermal exploration.

Source: http://www.thinkgeoenergy.com/creating-geothermal-heat-flow-maps-at-prospect-scale-with-heat-needle-appliance/

Technology: Geothermal Lab at 1500 Meters Underground

The collaborative Enhanced Geothermal Systems project, or EGS Collab, is funded by the U.S. DOE's Geothermal Technologies Office, and led by Lawrence Berkeley National Laboratory (LBNL). It is a US$9 million multi-lab project designed to perform field experiments and numerical simulations to understand the creation of fracture networks and fluid flow through those networks deep underground.

Some locations such as active volcano centers or areas with very high temperature gradients, are not typically conducive to conventional geothermal energy production. Scientists need to have a keen understanding of subsurface fractures and fluid flow —key elements for producing geothermal systems —at these locations. They also need to better understand how to enhance permeability—the ease at which fluid flows through subsurface rock.

The EGS Collab, a three-year project that began in early 2017, is working to gain this understanding, using the Sanford Underground Research Facility (SURF) in Lead, South Dakota, as its underground laboratory. The SURF —considered the deepest underground laboratory in the United States— is formerly a gold mine with infrastructure that can transport a collection of researchers 5000 feet (~1500 meters) underground. Temperatures within the SURF's subsurface are 100 degrees Fahrenheit (38°C) —elevated enough to react to the injection of cold water.

Here, the collaborative team —which includes Pacific Northwest National Laboratory (PPNL)— is working to enhance useful permeability in crystalline rock by stimulating hydraulic and natural fractures that will allow them to study fluid flow through those networks.

With its national lab partners, PNNL has lent modeling expertise to the effort. Ahead of experiments scheduled for this spring, the entire EGS Collab modeling and simulation working team identified and quantified the nature of planned experimental work, such as hydraulic fracturing and stress alteration due to thermal cooling.

Members of the team studied rock surfaces within the SURF prior to selecting where to drill boreholes (Photo credit: PNNL)

The modeling considered aspects such as preferred orientation of boreholes most compatible with the rock structure and the potential number and magnitude of seismic events associated with hydraulic simulation.

"We encountered a lot of unknowns at the start of the modeling effort, especially with temperature," said PNNL's Mark White. "We didn't immediately foresee the thermal conditions within the experimental volume. For example, over the life of the mine, cold air blown in for ventilation has changed the temperatures from a uniform state in the rock to a gradient from the drift wall into the mine."

The research team also worked to design and prepare the subsurface test bed. They performed core logging to understand the geology of the crystalline rock and identify natural fractures. They drilled a series of eight 4-inch outside diameter boreholes —which typically takes one week per borehole— that will be equipped with electrodes and monitoring equipment to ultimately glean the experimental data. The network of fractures will be created between sets of boreholes, where the monitoring equipment within the boreholes can shed light on fracturing and fluid flow at such sites.

The research team sees this point in the EGS Collab as a time to learn. Characterization data from the boreholes have been collected, and now the numerical simulators can re-simulate knowing there is variability in the stress state of the rock to make a more accurate prediction of what the experiments will look like.

The knowledge gained from these experiments will provide needed data to the Frontier Observatory for Research in Geothermal Energy Project (FORGE), which is tasked with developing technologies to harness and use this energy source.

Other national labs besides Lawrence Berkeley and PNNL involved with the EGS Collab are Sandia, Lawrence Livermore, Idaho, Los Alamos, Oak Ridge, and National Renewable Energy Laboratory.

Source:
https://energyenvironment.pnnl.gov/highlights/highlight.asp?id=2953

Science: Team Mapped Temperature and Viscosity of Earth's Lower Crust in Western U.S.

Everything on the surface of the Earth rests on massive tectonic plates that resemble a jelly sandwich, with two rigid pieces --the upper crust and the upper mantle-- enclosing a gooey middle layer of very hot rocks, which is the lower crust. The plates move ever so slowly around the globe over a deeper hot layer called the asthenosphere.

Temperature plays a fundamental role in determining the strength, thickness, and buoyancy of the lower crust. A research team led by the U.S. Colorado State University has mapped the temperature and viscosity of the lower crust for the first time and found that, under much of the western United States, the layer is hot enough to be near its initial melting point and, therefore, quite runny.

This new research shows that significant regions of the lower crust have little strength, and that over several million years, could lead to many mountains in the western U.S. being flattened.

Scientists generally think of tectonic plates, or lithosphere, as being made up of the crust and a cold uppermost mantle. But in this new analysis, the team saw something akin to ball bearings slipping between the crust and mantle. While not unexpected, this study was able to map the extent of the areas resembling ball bearings.

"The 'ball bearings' keep separate what's happening in the mantle from what's happening in the crust," said Derek Schutt, associate professor in CSU's Department of Geosciences.

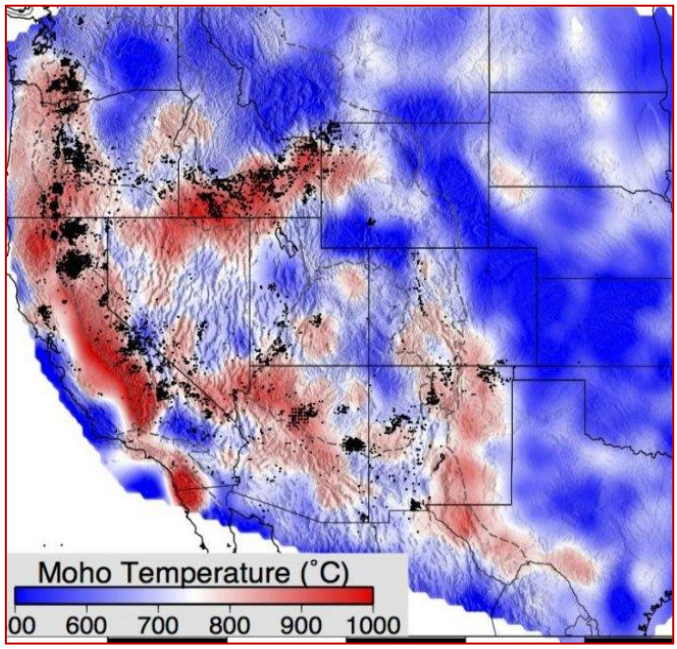
Researchers calculated temperatures at the bottom of the crust, which varies in thickness, by measuring the velocity of seismic waves that travel near the interface between the lower crust and uppermost mantle.

In the western U.S., the crust is very hot, which is what makes it so weak.

"We know in general that the lower crust in the western United States seems hot," said Schutt. "But this is the

first time we've been able to really ascribe a temperature to a specific location."

Source: https://www.sciencedaily.com/releases/2018/01/180117135133.htm



Moho temperature at depths varying from 20 to 50 km. Credit: Colorado State University

Science: A Novel Way to Track Magma Flow

Following is a reproduction of the blog published by Emily Underwood on 21 February 2018, and hosted by EOS.org, which presents a novel technique that can accurately predict volcanic eruptions using sparse seismic data.

In August 2014, after traveling for weeks through subterranean channels, molten rock surged through cracks in the 84-square-kilometer Holuhraun lava field north of Iceland's most voluminous glacier. It was the largest volcanic eruption in Europe in 230 years and was recorded in detail by a dense network of seismic sensors deployed by the University of Cambridge to monitor volcanic activity in the area. Now, a new study shows that scientists can accurately track underground lava flow with far fewer sensors, a boon in regions with scarce seismic data.

In the 2-week period leading up to the eruption, magma snaked its way through fissures in the rock, forming a moving structure called a dike. From the tip of one dike rippled migrating swarms of more than 30,000 earthquakes. The dense network of more than 70 traditional seismic monitoring stations recorded the earthquakes, providing a convenient baseline for testing alternative measurement systems.

Traditional earthquake sensors rely on two types of seismic waves, called P waves and S waves, to determine where an earthquake occurred. The farther away the earthquake is, the greater the distance is between the arrivals of these two wave types, which travel at different speeds. Here Caudron et al. used a novel method called seismic amplitude ratio analysis (SARA) to track the melting rock's underground path.

In contrast to traditional methods, SARA requires only the background amplitude of seismic waves to locate where an earthquake originates. Although previous studies have shown that the method can complement the traditional approach and reveal the path of traveling magma, it has never been directly compared with such a high-resolution set of traditional sensors. Using just 15 stations, the team was able to track the magma's trajectory with remarkable accuracy, they report. The SARA technique also revealed new dynamics in the magma's flow. The technique could help scientists track volcanic activity in settings where there aren't many monitoring stations, the team says. (Journal of Geophysical Research: Solid Earth, https://doi.org/10.1002/2017JB014660, 2018)

Source: https://eos.org/research-spotlights/a-novel-way-to-track-magma-flow

Science: Scientists Find Seismic Imaging Is Blind to Water

When an earthquake strikes, nearby seismometers pick up its vibrations in the form of seismic waves. In addition to revealing the epicenter of a quake, seismic waves can give scientists a way to map the interior structures of the Earth, much like a CT scan images the body.

By measuring the velocity at which seismic waves travel at various depths, scientists can determine the types of rocks and other materials that lie beneath the Earth's surface. The accuracy of such seismic maps depends on scientists' understanding of how various materials affect seismic waves' speeds.

Now researchers at Massachusetts Institute of Technology (MIT) and the Australian National University have found that seismic waves are essentially blind to a very common substance found throughout the Earth's interior: water.

Their findings, published in March 2018 in the journal *Nature*, go against a general assumption that seismic imaging can pick up signs of water deep within the Earth's upper mantle. In fact, the team found that even

trace amounts of water have no effect on the speed at which seismic waves travel.

The process of melting at tens of kilometers below the surface removes tiny amounts of water that are found in rocks at greater depth. Scientists have thought that seismic images showed this 'wet-dry' transition, corresponding to the transition from rigid tectonic plates to deformable mantle beneath. However, the team's findings suggest that seismic imaging may be picking up signs of not water, but rather, melt —tiny pockets of molten rock.

The team is leaded by Christopher Cline, along with Emmanuel David, Andrew Berry, and Ian Jackson, of the Australian National University, and by Ulrich Faul, of the MIT's Department of Earth, Atmospheric, and Planetary Sciences.

To measure the extent to which water affects seismic wave speeds, the team produced different samples of olivine. They trapped various amounts of water within each sample, and then placed the samples one at a time in a machine engineered to slowly twist a rock, in a furnace at high pressures and temperatures, in order to simulate conditions deep within the Earth.

"This simulates propagation of seismic waves through the Earth. The magnitude of this strain is similar to the width of a thin human hair —not very easy to measure at a pressure of 2,000 times atmospheric pressure and a temperature that approaches the melting temperature of steel", said Faul.

The team expected to find a correlation between the amount of water in a given sample and the speed at which seismic waves would propagate through that sample. When the initial samples did not show the anticipated behavior, the researchers modified the composition and measured again, but they kept getting the same negative result. Eventually it became inescapable that the original hypothesis was incorrect.

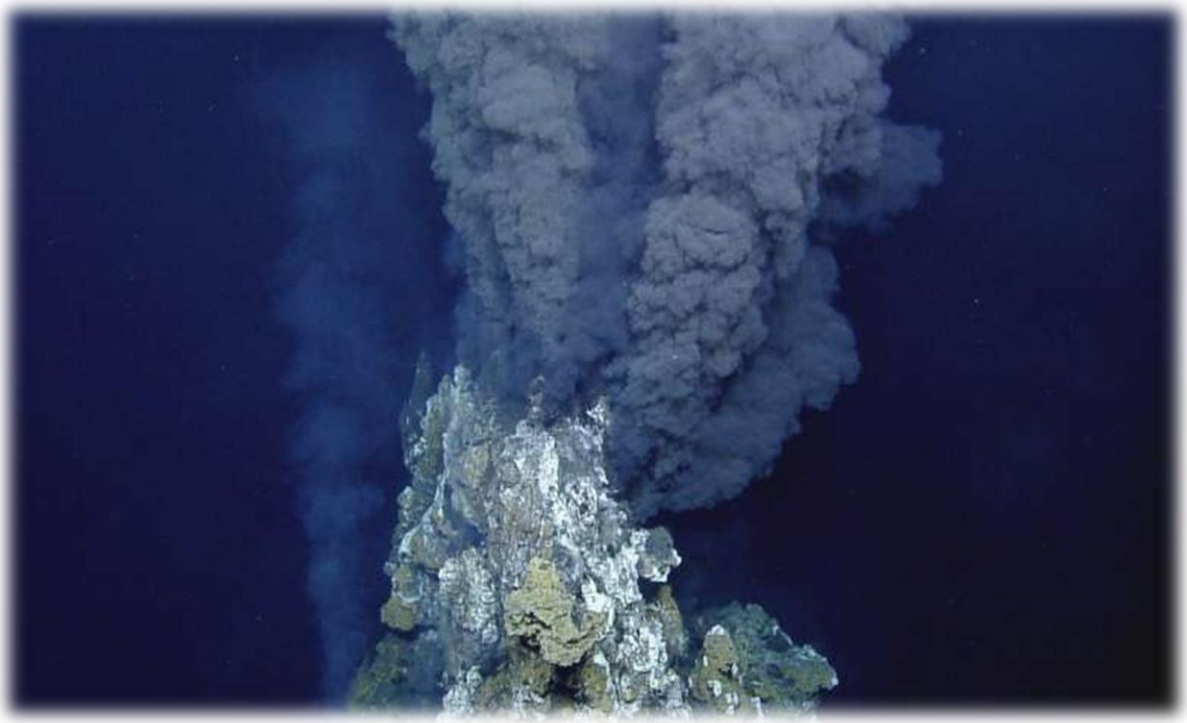
Another unexpected outcome of the experiments was that seismic wave velocity appeared to depend on a rock's oxidation state. All rocks on Earth contain certain amounts of iron, at various states of oxidation, just as metallic iron on a car can rust when exposed to a certain amount of oxygen. The researchers found, almost unintentionally, that the oxidation of iron in olivine affects the way seismic waves travel through the rock.

Faul says that the group's findings suggest that seismic waves may be used to map levels of oxidation, such as at subduction zones — regions in the Earth where oceanic plates sink down into the mantle.

"An underlying question is what lubricates tectonic plates on Earth," Faul says. "Our work points toward the importance of small amounts of melt at the base of tectonic plates, rather then a wet mantle beneath dry plates. Overall these results may help to illuminate volatile cycling between the interior and the surface of the Earth."

Source: http://news.mit.edu/2018/scientists-find-seismic-imaging-blind-water-0314?

Geothermal & Life: Deep-Sea Fish Use Hydrothermal Vents to Incubate Eggs



Eggs of deep-sea skates have been discovered near the hottest type of hydrothermal vents, where super-heated water emerges out of the sea floor. These vents, called black smokers, emit dark, sulfurous plumes. (Photo credit: Ocean Exploration Trust)

Some deep-sea skates —cartilaginous fish related to rays and sharks— use volcanic heat emitted at hydrothermal vents to incubate their eggs, according to a new study in the journal Scientific Reports. Because deep-sea skates have some of the longest egg incubation times, estimated to last more than four years, the researchers believe the fish are using the hot vents to accelerate embryo development. This is the first time such behavior has been seen in marine animals.

"Hydrothermal vents are extreme environments, and most animals that live there are highly evolved to live in this environment," said Charles Fisher, Professor and Distinguished Senior Scholar of Biology at Penn State and an author of the paper. "This study is one of the few that demonstrates a direct link between the vent environment and animals that live most of their life elsewhere."

Among the least explored and unique ecosystems, deep-sea hydrothermal fields are regions on the sea floor where hot water emerges after being heated in the ocean crust. In their study, an international team of researchers, led by Pelayo Salinas-de-León of the Charles Darwin Research Station, used a remotely operated underwater vehicle (ROV) to survey in and around an active hydrothermal field located in the Galapagos archipelago, 28 miles north of Darwin Island.

The researchers found 157 egg cases in the area and collected four with the ROV's robotic arm. DNA analysis revealed that the egg cases belonged to the skate species Bathyraja spinosissima, one of the deepest-living species of skates that is not typically thought to occur near the vents. The majority —58 percent— of the observed egg cases were found within about 65 feet of the chimney-like black smokers, the hottest kind of hydrothermal vents, and over 89 percent had been laid in places where the water was hotter than average. The researchers believe that the warmer temperatures in the area could reduce the typically years-long incubation time of the eggs.

While several species of reptiles and birds lay their eggs in locations that optimize soil temperatures, only two other groups of animals are known to use volcanically heated soils: the modern-day Polynesian megapode —a rare bird native to Tonga— and a group of nest-building neosauropod dinosaurs from the Cretaceous Period.

"The deep sea is full of surprises," said Fisher. "I've made hundreds of dives, both in person and virtually, to deep sea hydrothermal vents and have never seen anything like this."

Source:
https://sciencebulletin.org/archives/20248.html

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