IGA NEWS

Newsletter of the International Geothermal Association

Quarterly No. 109

IGA ACTIVITIES

Message from the Executive Director

Greetings to all members of the IGA and to those that are reading this newsletter. As mentioned in our previous writing, the IGA Board has developed a new strategy which will help us to strengthen the role of our members and the wider geothermal energy community not only for our sector, but also in the wider context of the ongoing renewable energy and climate change debate.

The IGA has been very busy over the past months to initiate strategic activities aligned with our four Pillars: **Visibility**, **Authority**, **Independence** and **Membership**. In this newsletter I focus on Pillar Visibility: it is with great pride that I can show you our new logo and visual identity for the IGA (*see* the right upper part of this page). We thank Team Visibility (Andy Blair, Jane Brotheridge, Kristin Vala Matthiasdottir, and Bjarni Bjarnasson) for their great work and support. The designer, Hvita Husid, has done a fantastic job and we are all keen to take our new visual identity further and re-design our website before the next Board Meeting in Santiago, Chile (27-29 November 2017). To increase our online visibility we have adopted #lovegeothermal, initiated a few social media campaigns (*see* photo 1) to express our love for geothermal, and once completed our new website will be hosted under www.lovegeothermal.org. To raise our profile and increase our offline Visibility, we have had a busy summer with attending many events. In August, our president Alex Richter attended the 5th Indonesian Geothermal Convention in Djakarta and the IRENA workshop in El Salvador: "IRENA is our valued partner to raise the Geothermal flag in the Renewable Energy scene and I am grateful to be invited, as President of the IGA, to promote IGA at these important fora".

In September, I was invited to be a panelist in the Economic Forum in Poland together with Board Member Beata Kepinska (*see* photo 2) and present our views on Geothermal Energy in Eastern European countries. Luis Gutiérrez-Negrín represented IGA at the MEXIREC event in Mexico (*see* separate note). Together with the President and Secretary of the IGA (Bruno Della Vedova) I attended the Global Geothermal Alliance meeting in Florence, organized by

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IRENA (*see* photo 3). Margaret gave the openings speech at the GeoHeat conference in Kamchatka (Russia), and Karolina and Gregor attended the EAGE event in Malmö (Sweden) where both of them held interviews with key geothermal speakers (*see* photo 4) which will be channeled online. In Munich Karolina and me attended the German Geothermal Conference, where we launched our beautiful calendar 2018 showing the winning photos of our IGA photo competition: our 12 reasons to #lovegeothermal.

The coming months will be intensive as well, as we will be completing the redesign of our website, gradually starting to implement new technology for membership management, and preparing the BoD meeting in Santiago, Chile. From a strategy perspective we will be focusing on Pillar Independence, in which governance and finances will play a key role. In November we will be present during COP23 in Bonn, Germany, at several side events featuring our new slogan 'cool the Earth – stay hot with Geothermal'. I wish you happy reading and do not hesitate to connect with me and share your reasons to love geothermal.

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

41st GRC Annual Meeting

Luis C.A. Gutiérrez-Negrín, Editor

Geothermal Resources Council (GRC), the largest national association affiliated to IGA, held its 41st Annual Meeting. Over 1,000 attendees gathered at the world's largest annual geothermal energy event that included the GEA (Geothermal Energy Association) GeoExpo+, at the Salt Palace Convention Center in Salt Lake City, Utah from October 1-4, 2017.

Utah Governor Gary Herbert addressed the Opening Session of the meeting on Monday, October 2. He was joined by other special guests and energy experts, like Jackie Biskupski, Mayor, Salt Lake City, Maria Richards, President of the GRC, Joe Greco, GEA Chairman, Susan G. Hamm, Director of the Geothermal Technologies Office, U.S. Department of Energy, John White, Executive Director of Center for Energy Efficiency & Renewable Technologies, Kathleen Benedetto, Special Assistant to the Secretary of the Interior, and Jon Cox, Vice President of Government Affairs of Rocky Mountain Power. There was also a panel moderated by Laura Nelson from the Utah's Governor Office of Energy Development, and panelists Nick Goodman (Cyrq Energy), Doug Glaspey (US Geothermal), Rahm Orenstein (Ormat Technologies Inc.), Rhonda Mills (Geothermal Energy Association), and a special speech by Joe Moore from the University of Utah's Energy and Geoscience Institute and the GRC Annual Meeting Chair.

Joe Moore recalled that on 1847 a wagon train of pioneers arrived in the valley of the Great Salt Lake. From the back of his wagon, the Mormon leader Brigham Young, who was ill with mountain fever, looked out at the vast desert below and declared, "This is the right place". He added there is still a pioneering spirit in the present Utah inhabitants to make the desert blossom and they have turned to renewable energy to achieve this.

Just over a year ago, Salt Lake City Mayor Jackie Biskupski, announced an initiative to transition the community to 100% renewable energy sources by 2032 and to reduce carbon emissions citywide by 80% by 2040. Joe Moore stressed that the geothermal community can help realize this goal, since three geothermal developers currently produce 73 MW of geothermal electricity, and this is only a small percentage of the estimated 1300 MW of untapped potential in the state, enough to power a third of Utah.

The Opening Session attracted leading researchers, academics, students, state and federal agency officials, and executives from over 200 companies, such as CYRQ Energy, Coso Energy, ENEL Green Power, Ormat Technologies, Inc., U.S. Geothermal Inc., and others that develop, build, maintain and operate geothermal plants around America and the world.

The GRC Annual Meeting featured over 70 hours of technical presentations, workshops, fieldtrips, a plenary session, and networking events. The GRC Technical Session programs covered a wide array of topics pertaining to geothermal energy, with around 270 papers were presented both oral and/or poster sessions, the highest number in the last decade. These papers highlighted geothermal developments and investigations in more than 30 countries.

Opening session. Photo by GRC.

On Friday and Saturday prior to the start of three full days of technical sessions, meeting attendees participated in two workshops on Geothermal Resource Decisions and Operations & Maintenance.

The GEA GeoExpo+ featured exhibits by leading companies who are paving the way for geothermal development through new projects, products, services, and technology. Over 70 exhibitors had the opportunity to present their products and services. The exhibit hall was opened October 2 through October 4.

An International lunch and session provided the latest updates from abroad U.S. It included an Assessment of Mexico's Geothermal Market by Francisco Flores-Espino from the National Renewable Energy Laboratory, and a Global Geothermal Investment Perspective by Magnus Gehringer from Content Energy. But there were also presentations from Austral/Asia Region – Innovation Down-under by Andrea Blair from GNS Science, Indonesia region by Abadi Poernomo from the Indonesian national geothermal association, Philippine region by Paul Cerrulo from Energy Development Company, Japan by Hiroshii Asanuma from Advanced Industrial Science and Technology, China by Kewen Li from China University of Petroleum, Central America region by Gustavo Cuéllar Jr. from CASYS S.A., South America region by Warren Dewhurst, East Africa region by Andrew Palmateer from USEA, and the Middle East region by Tevfik Kaya from GeothermEx / Schlumberger.

There was a field trip at the end of the congress, on Wednesday October 4, to see the southern Utah geology & geothermal power plants in operation in the state, and some other activities like the GRC Charity Golf Tournament, GRC Ambassador Program Workshop, GEA Board and Members Meeting, GRC Mixer (called *A Night at the Museum*), Lunch & GRC Awards, GRC/GEA Networking Reception, GRC Membership Meeting and GRC BoD Meeting, and a couple of activities organized by Women in Geothermal (WING Yoga Class and WING Fun Run).

It was announced the next Annual Meeting will be held on 14-17 October 2018, in Reno, Nevada.

Second Annual General Assembly of GEMex Project

Luis C.A. Gutiérrez-Negrín, Editor

The Mexican and European consortia of the GEMex project met in Akureyri, Iceland, during the 1st and 2nd of October and held their second annual general assembly, hosted by the Icelandic geological survey (ÍSOR)–one of the consortium partners. Around 110 participants from Belgium, France, Germany, Greece, Iceland, Italy, The Netherlands, Mexico, Norway, Poland, and the United Kingdom gathered in the Hof Cultural Center of this northern city of Iceland.

The Mexican delegation was composed of around 25 persons from the universities of Michoacán (UMSNH) and Mexico (UNAM), CICESE, INEEL, a couple of private companies (Geominco, Geocónsul), and two representatives from the CFE –which holds the exploitation concession of the Los Humeros geothermal field and the exploration permit on the Acoculco geothermal zone, areas where the project is being developed.

The meeting agenda was as follows.

Monday 2 Oct. 2017	
8:30-9:00 8:45	Registration & Coffee PhD coffee table – Meeting point for GEMex PhD students.
9:00-9:05	Welcome from the host. Ólafur G. Flovenz, ÍSOR Director.
9:05-9:20	News from the EU Coordinator. David Bruhn.
9:20-9:35	News from the Mexican Coordinator. Aída López Hernández
9:35-9:45	Progress reports – Interim report and upcoming periodic reports to the EC- Katrin Kieling
9:45-10:00	Importance of GEMex for the EC and expected next steps and results. Upcoming fundind opportunities in the next work program. Filippo Gagliardi, DG RTD of the EC
10:00-10:40	Milestones reached by Work Packages 3 & 4, presented by WP responsible.
10:40-11:00	Coffee break
11:00-12:00	Progress report in the Work Packages 5, 6, 7/9, and 8, presented by WP responsible.
12:00-13:00	Lunch
13:00-17:30	Breakout meetings on thematic topics in five parallel sessions: 1) Geological Basis and Models. Domenico Liotta & Víctor Hugo Garduño (WP3 & WP4) 2) Geophysical Survey. Gyfli Pall Hersir & Claudia Arango (WP5). 3) Reservoir modelling and design of concepts. Paromita Deb, Jan van Wess, Lies Peters, Eduardo González & Abel Hernández (WP6, WP7 & WP8). 4) Dissemination. Eugenio Trumpy (WP2). 5) Public engagement Zayre González, Eleonoro Annunziata & Alessandro Scuillo (WP9/Task 7.4)
17:30-18:30	Executive board meeting of the two consortia (Mexico-EU).
19:00	Dinner at HOF

Tuesday 3 Oct. 2017	
9:00-11:00	Breakout meetings on thematic topics: 1) Geological Basis and Models. Domenico Liotta & Víctor Hugo Garduño (WP3 & WP4) 2) Geophysical Survey. Gyfli Páll Hersir & Claudia Arango (WP5 & WP6).
11:00-12:00	Wrap-up, and official end of the assembly.
12:00-13:00	Lunch break
13:00-17:00	Self-organized meetings, for EU-Mexican work teams to coordinate joint activities. Four rooms available: 1) Task 4.3. Anna Jentsch. 2) Task 7.3. Environmental hazards. Zayre González, Lies Peters & Massimo Angelone. 3) Task 3.1. Geological models of Los Humeros & Acoculco. Philippe Calcagno & Eugenio Trumpy. 4) WP6. Fracture and faults characterization. Paromita Deb.
18:30-20:00	Telephone conference with EC & CONACyT. Coordinators of Mexico and EU & Filippo Gagliardi.

Before the meeting, on Sunday October 1 the host organized an optional field-trip from Reikjavik to Reykjanes high-temperature area, its power plant and the drill site of the IDDP-2, the deepest well in Iceland. The departure was at the ÍSOR offices, at 8.30 am, returning to Reykjavík around 14.00 hours. Around 65 participants in the GEMex meeting attended the field trip in two buses, leaded by experts from ÍSOR.

The buses stopped at the location of the IDDP-2 well, and then moved to the area of hot superficial manifestations. After that, the participants went to the bridge between the Eurasia and North America plates, and the area where the cooling fluids of the Reykjanes power plant are discharged to the beach. Finally the participants jointed in the excellent exhibit area of the power plant, which is exhibiting the theme 'Energy is Life', and got the lunch.

The entrance to the exhibition starts with the Big Bang occurred 13.7 billion years ago, with many interactive touchscreens. Then the exhibition presents the solar system, the relationships between men and energy since prehistory up to now, alternative energy sources, and finalizes with geothermal energy in Iceland. The Reykjanes power plant is currently operated by HS Energy, and it is composed of two 50 MW each turbines that can be seen since the exhibition area.

The general impression of the European and Mexican partners was that the outcome of this first general assembly was very positive, since it allowed a wide range of personal interactions and technical discussions

View of the Reykjanes plant, at the bottom (Photo by the author).

between both teams. In spite of a number of teleconferences held by several WP teams along the last year, nothing seems to be better than a live-meeting.

MEXIREC 2017 and the REN21 Steering Committee Meeting in Mexico City

Luis C.A. Gutiérrez-Negrín, Editor

The International Renewable Energy Congress (IREC) was held in September 25 through 27 in the Santa Fe Convention Center and Expo, in Mexico City. This time the conference was called MEXIREC 2017. IREC is a biennial event organized by REN21 and a local host in different places and countries, with a substancial support from the German government. MEXIREC was the seventh conference. The first IREC was held in Bonn, Germany (2004), and the following conferences were in Beijing (2005), Washington, D.C. (2008), New Delhi (2010), Abu Dhabi (2013), and Cape Town (2015). The 2017 host was the Mexican Ministry of Energy (SENER). The event was held within the framework of Strategic Dialogues for Future of Energy in Mexico (DEMEX).

REN21 (Renewable Energy International Network for the 21st Century) is the global renewable-energy, multi-stakeholder policy network connecting a wide range of key actors. Its goal is facilitating knowledge exchange, policy development, and joint action towards a rapid global transition to renewable energy. REN21 brings together governments, nongovernmental organizations, research and academic institutions, international organizations and industry to learn from one another and build on successes that advance renewable energy. REN21 is an international non-profit association and is based at the United Nations Environment Programme (UNEP) in Paris, France. The IGA is an official member of the REN21 and has a seat in the Steering Committee, currently with about 50 members.

MEXIREC attracted more than 1,600 participants from 44 countries as well as representatives from the private sector and the general public, including NGOs, academia, business, industry and international organizations. According with the final report, presented by Executive Secretary Christine Lins in the closing plenary session, MEXIREC was composed of two ministerial sessions and 25 parallel sessions held over two days with more than 180 speakers from around the world.

On the first day, MEXIREC held a series of side events highlighting the importance of conversations about the subjects mattering most. A total of 27 events took place and organizations involved in the renewable energy sector highlighted their work and discussed their goals, future plans, and ways they are bringing innovation to the table. At the end of the day, participants gathered in the main hall for an icebreaker and to discuss how people from around the world are designing future solutions for today's situations.

The second day began at 10 am, when Mexico's Energy Minister, Pedro Joaquín Coldwell, officially kicked off the activities with an impassioned speech on Mexican Energy Reform. He pointed out that thanks to a strong legal framework, this paradigm shift recently in laws passed by Mexico's Executive body goes well beyond the use of traditional energy sources. He said the energy transition is a priority that needs to be accelerated to achieve significant changes.

MEXIREC was opened by Leonardo F. Beltrán, SENER's Deputy Minister of Planning and Energy Transition, who spoke about Mexico's vision four years after the approval of Energy Reform, which includes a strong commitment to the international community by the signing of many treaties. He noted that Mexico is the first middle-income country with climate change laws.

Arthouros Zervos, Chair of REN21, began his speech by sharing an important message: "REN21 was founded in 2004. Back then no one could possibly imagine that 60% of production capacity would be renewable. To solve the issue of global warming, a complete de-carbonization of energy sources is needed".

Two main panels were presented on the second day—Ministerial and High Level 1 and 2. The main topics

discussed were the roles of the energy sector in the Paris Agreement, specifically in the implementation of NDCs (Nationally Determined Contributions to achieve the goals of the Paris Agreement); and the renewable energy transition, both global and in Latin America and the Caribbean, where the paths may be different but goals are shared. Among the speakers were Rainer Baake, Germany's Federal Minister for Economic Affairs and Energy, Fatih Birol, Executive Director of the International Energy Agency, and Li Farong, Deputy Minister of the China National Energy Administration. After the sessions, the more than 3,000 attendees enjoyed a taste of Mexican culture.

1MEXIREC's last day of activities urged the world's energy players to adapt and adopt renewable and efficient energy generation. In the Parallel Sessions, participants learned geothermal energy is an extraordinary asset—a source of clean, baseload energy. Geothermal development is underway, even with little government regulatory encouragement as a clean energy source. Conversation on wind power focused on its ability to provide large amounts of energy. Participants talked also about the multiple roles of solar energy in providing distributed energy and creating new jobs and commercial opportunities. Is renewable energy a utopia? This question was asked and answered—one cannot answer such a question in general terms since energy (its provision, use, etc.) is situation-specific. But it is clear the transport sector must engage more fully in the transition, given its share of final energy consumption.

MEXIREC's closing event came with the reading of the Conference Declaration by Ambassador Irene Giner-Reichl. The audience received the statement with a warm round of applause, marking the end of the program. REN21's Chair, Arthouros Zervos, closed MEXIREC after Rainer Baacke, Germany's Secretary of Energy, thanked the Mexican Government for the warm reception throughout the three days. The final farewell came from Efraín Villanueva, SENER's Director of Clean Energies.

Taking advantage of MEXIREC, the REN21 Steering Committee (SC) met on September 14th in Mexico City, the day after the conference ended. The agenda included the following topics:

Topic	Presentation by
1. Welcome and Review of MEXIREC	Arthouros Zervos, Chair, REN21
	Efraín Villanueva, Director-General, SENER
2. Approval of REN21 annual accounts 2016	REN21 Secretariat
3. REN21 Bureau elections	All
4. REN21 Work plan 2018, including decision about IREC 2019 hosting proposals	REN21 Secretariat
Lunch	
5. Brainstorming for REN21 strategy 2019-21 to be adopted at SC 2018	All
End of meeting	

A total of 22 members of the SC gathered for the meeting, including the representative of the IGA, Luis C.A. Gutiérrez-Negrín, on behalf of Marit Brommer, the IGA's Executive Director. The general consensus was that MEXIREC was very successful due in part to the efforts of the Secretariat and the Mexican host, particularly Efraín Villanueva. After the REN21 accounts of the past year were unanimously approved, the SC elected the Bureau.

Efraín Villanueva addresses to the REN21 SC.

The REN21 Bureau is composed of the Chair and seven Vice-Chairs of the SC as well as the Executive Secretary. The Bureau makes decisions and exercises executive authority between SC meetings. In accordance with the REN21 Statutes, the term of Bureau members is two years. Since the past Bureau was elected in October 2015, the SC had to elect a new Bureau. There were nine candidates. The seven with the most votes were elected. Luis Gutiérrez-Negrín presented the candidacy of Marit Brommer, and she earned enough votes to become a member of the Bureau. Effective September 14th, the IGA has become part of the REN21 Bureau. The other new Bureau members for the 2017-2019 term are the representatives of the International Energy

Agency (IEA), the International Renewable Energy Agency (IRENA), the Global Wind Energy Council (GWEC), the Alliance for Rural Electrification (ARE), the World Wind Energy Association (WWEA), and the German Government.

The SC discussed the work plan for 2018, whose general outline had been approved as part of the REN21 triennial strategy of 2016-2018. One important element of this work plan was the selection of the venue for the 2019 IREC. There were two proposals, one from Australia and the other submitted by the Korea Energy Agency on behalf of the new government of the Republic of Korea. After a short discussion, the SC approved Korea as the venue of the next international conference, to be held 23 through 26 October 2019 in Seoul. After that, the decision was officially communicated to Dr. S.K. Gavin Yu and his team, who thanked them for the choice and offered a general outline of the preliminary draft plan of the conference.

Participants offered general ideas for the REN21 strategy for 2019-2021. It will be incorporated by the Secretariat in the final version and presented at the SC meeting next year.

AFRICA

Djibouti: Kuwaiti Grant for Geothermal Program

Kuwait has granted US$27 million to support the geothermal development program in Djibouti. According to a statement from the Djiboutian Geothermal Energy Development Office (ODDEG), the Kuwaiti Development Fund (FKD) will provide a US$27 million loan for drilling 10 wells (eight production boreholes and two re-injection boreholes) and a geothermal power plant with a capacity of 15 MW by the year 2021.

The agreement, signed in late July, is hailed by both sides as helping to propel the national geothermal development program in Djibouti.

"The signing of this agreement is mainly the result of two weeks of intensive work between the FKD and ODDEG officials, who focused on the financial and technical evaluation of the Gale le Koma geothermal project in the region of Lake Assal, located in the north of Djibouti.

Launched in October 2016 by Djibouti President Ismail Omar Guelleh, the project has been fully funded by the Djibouti government and executed by the ODDEG. Djibouti has acquired two drilling rigs (a first in the country) capable of drilling more than 2 km deep and greatly strengthening the training of its human skills.

The first results of the project, the first slim-hole well in the country, confirmed an intermediate geothermal reservoir on the site, according to the ODDEG.

"With these results in line with our expectations and the expectations of a whole country, we were finally able to carry out a feasibility study for the construction of a geothermal power station with a capacity of 15MW in its first phase, which will reach 50MW in its final phase," the statement said.

The Djiboutian president has made the development of clean energy, permanent and accessible to all and everywhere one of the priorities of the road map of its new five-year plan. The President of Djibouti said the energy independence of his country will be "… based on renewable energies and especially geothermal energy whose potential is estimated at over 1,000MW".

The Republic of Djibouti, with a population of 923,000 persons and surface area of 23,200 square kilometers, currently uses 65% hydroelectric power generated in neighboring Ethiopia. Djibouti aims to become the first African country to use 100% green energy by 2025.

Source: http://www.thinkgeoenergy.com/djibouti-secures-27m-loan-from-kuwait-for-geothermal-drilling-campaign/

Ethiopia: Japanese Grant, and the Corbetti and Tendaho Geothermal Projects

Japan Extended Grant for Power Plant in Aluto Langano - Shinichi Saida, Japanese ambassador to Ethiopia, and Admasu Nebebe, Ethiopia's State Minister for Finance and Economic Cooperation, signed the Exchange of Notes for three Grant Assistance Projects. The grant is worth US$51 million. One of these projects is the 'Installation of a geothermal wellhead in Aluto Langano'.

After the signing ceremony, Ambassador Saida said the government of Japan is determined to contribute to Ethiopia's vision of becoming a lower middle-income country by 2025, as outlined in the Second Growth and Transformation Plan of the country.

The Installation of Geothermal Wellhead system in the Aluto Langano project will help diversify power sources. The project is expected to benefit 300,000 people. Considering the grant size, the plant to be installed at the wellhead seems likely to be a 5MW flash power plant.

Last May the Ministry of Water, Irrigation and Energy (MoWIE) said the country was preparing to begin a 75 MW geothermal project in the Aluto Langano field and that the World Bank had provided financial assistance of about US$126 million. The amount is insufficient for this capacity.

Ethiopia has the longest section of the 7,000 km East African Rift Valley, which boasts an estimated geothermal potential of 10,000MW.

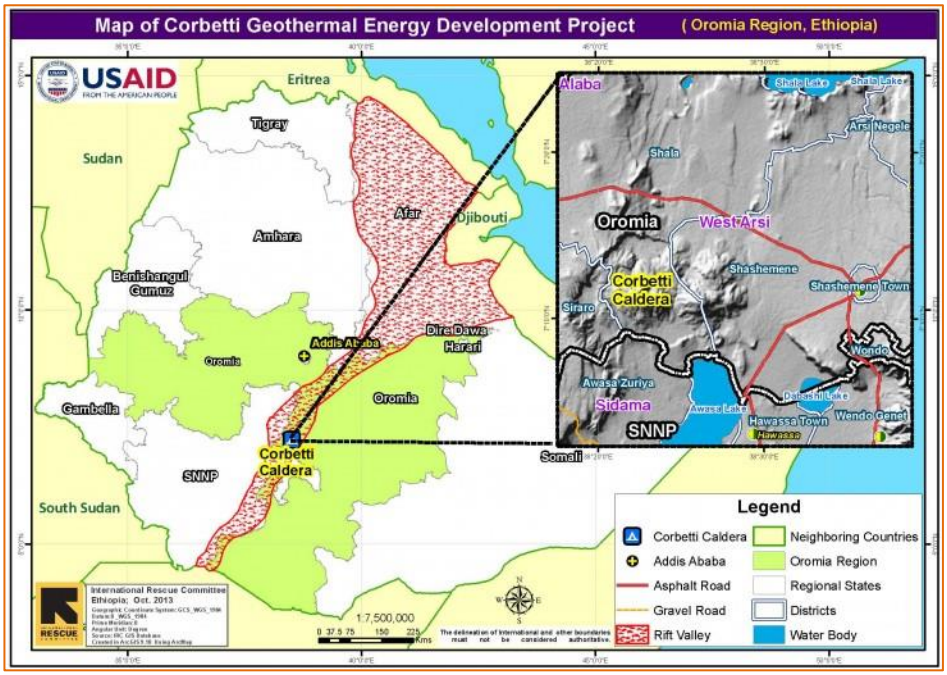
Sources:
http://apanews.net/index.php/en/news/japan-extends-51m-grant-to-ethiopia,
http://news.xinhuanet.com/english/2017-05/26/c_136315335.htm

Corbetti Project Resumed - The much delayed two billion dollars Ethiopian geothermal development project Corbetti near Shashemene, is ready to begin. Corbetti Geothermal, a multi-national energy company working to develop 500MW of electric power from geothermal sources in the Corbetti Caldera in the East Arsi Zone, and the Ethiopian government have resolved their differences over implementing the project. Corbetti Geothermal, the Ethiopian Ministry of Water, Irrigation (MoWIE) and Electricity and the Ethiopian Ministry of Finance and Economic Cooperation finalized negotiations to sign the final agreement to enable the company to embark on Africa's largest geothermal project.

Reykjavik Geothermal (RG), an Icelandic company specializing in geothermal energy development projects, signed a framework agreement with the then Ethiopian Electric Power Corporation in October 2013 enabling it to develop 1,000MW of electricity from geothermal energy sources in Corbetti, Tulu Moye, and Abaya in the southeastern part of Ethiopia. RG, with its local partner Rift Valley Geothermal, established Corbetti Geothermal Plc and brought along two major investors –Berkley Energy and Iceland Drilling– who have shown a keen interest in investing in the geothermal development project.

After lengthy negotiations, Corbetti Geothermal and the Ethiopian Electric Power signed a conditional power purchasing agreement in July 2015. Though the implementation agreement was supposed to be signed in August 2016, it was delayed because of some differences between the company and the Ethiopian Government. But now the two parties have resolved their differences and hope to sign the project implementation agreement by end of 2017. The implementation agreement will be ratified by the Ethiopian Parliament.

RG split the 1,000MW geothermal development project into two phases –the 500MW Corbetti project and the 500MW Tulu Moye and Abaya project– each costing two billion dollars. Corbetti Geothermal Plc has been working on the Corbetti geothermal development project located 270 km south-east of Addis Ababa in East Arsi Zone, Shalla Woreda, Corbetti Kebele. RG owns a 28.5 percent stake on Corbetti Geothermal Plc, Berkley Energy 53.5 percent and Iceland Drilling 18 percent.



Corbetti Geothermal secured funding from major international financiers, including the African Development Bank and European Investment Bank. Many other public and private investors from the US, the UK and other European countries are behind the Corbetti geothermal project. The project is also backed by the US Power Africa Initiative.

Once the implementation agreement for the Corbetti geothermal project is signed, negotiation for Tulu Moye and Abaya geothermal development project would commence, with a

capacity of 500MW. RG considers Tulu Moye and Abaya as second phase project that will kick off once the PPA and IA are signed. RG has notified EEP and its partner, an American company called Meridian that will finance the Tulu Moye and Abaya geothermal projects.

The first 20MW of the project could be in operation in the last quarter of 2017.

The country's total generation capacity has reached 4,280 MW of which 92% is hydro, 6% wind, and 2% thermal. Ethiopia's maximum geothermal potential is estimated to be 10,000 MW. The hydro power generation capacity could reach 45,000 MW.

Sources:
https://www.ezega.com/News/NewsDetails/4544/Ethiopia-Reykjavik-Geothermal-RG-Resolve-Differences-over-Largest-Geothermal-Project-in-Africa,
http://allafrica.com/stories/201709191094.html

EEP to Develop Tendaho Geothermal Power Project - The Ethiopian Electric Power (EEP) company invited qualified bidders to express interest for the procurement of full drilling services at the Dubti Field for the Tendaho Geothermal Power Project, with deadline past October 2nd.

The Tendaho Geothermal Power Project will develop resources in the project area in two phases. The main objectives of the Tendaho Phase I Project include the successful completion of the first round of shallow production well drilling and the finalization of relevant feasibility studies. They will define and develop the shallow reservoir, allowing near-term exploitation of the shallow resource at the maximum sustainable capacity (presently estimated to be about 10 to 12MW). An additional objective is to drill two deep (up to 2500 m) wells to investigate the deep reservoir. It could increase the field capacity to an estimated 100MW, or more.

The drilling services required for Tendaho Phase I include drilling six high-temperature, shallow wells (up to about 600 m depth) aimed at reaching the desired initial energy output and the drilling of two deep exploration wells (up to about 2500 m depth) to investigate the deep reservoir for future expansion.

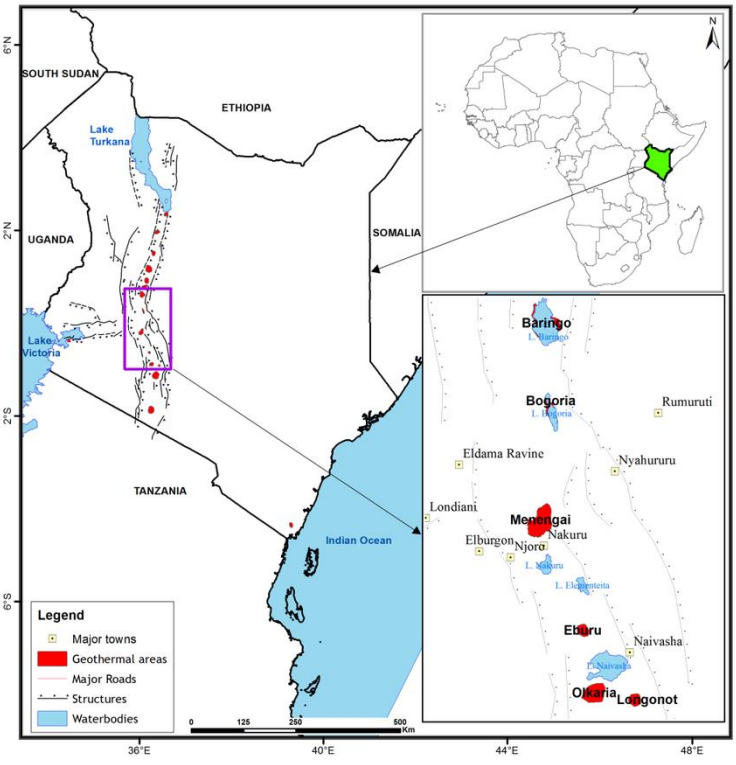
Source: https://www.esi-africa.com/tenders/ethiopia-tendaho-geothermal-power-project/

Kenya: Transmission Line, Baringo-Silale, Application for Exploration Licenses, another Well-head Plant, and Feasibility Study in Olkaria

400 kV Transmission Line Is Completed - A new 480 kilometer, Mombasa-Nairobi electricity line meant to deliver geothermal power to Mombasa has been completed. The 400 kilovolt line, a Vision 2030 flagship project, was initiated in August 2011 and scheduled for completion in three years. Vandalism led to delays. James Mutemi of Kenya Electricity Transmission Company said the upgrade would boost power supply in the country. "The line will enable electricity generated from the geothermal power plant at Olkaria to be transmitted to Mombasa," said Mutemi.

Source: http://www.kdrtv.com/geothermal-power-line-to-be-commissioned-in-mombasa/

Progress in the Baringo-Silale Geothermal Block - Geothermal Development Company (GDC) has made significant progress in phase one of a key power generation project in Baringo County. Phase one of the Baringo-Silale Geothermal block is expected to supply 300MW to the national grid on its completion in three years.



Some geothermal areas in Kenya. Map by Marietta Mutonga, taken from https://www.researchgate.net/profile/Marietta_Mutonga/publication.

George Kinyanjui, the GDC general manager in charge of drilling and infrastructure, said the firm had already opened a road network to the area. Work on more than 120 kilometers has been completed. "We're installing steam fields, three in each of the project areas," Kinyanjui said.

The company has already installed community distribution systems and nine storage tanks, each with a capacity of 4.5 million liters. The water will be pumped through two-inch pipes from the source at Lake Baringo.

In total, the Bogoria-Silale Geothermal block will generate more than 3,000 MW once the work is completed. GDC has identified Silale, Paka, Korossi/Chepchuk and areas around lakes Baringo and Bogoria as potential sites for geothermal energy development.

The project has so far attracted 36 bidders, who are expected to provide services such as casing and well cementing, rig moving, drill pipe inspection, directional drilling, and aerated drilling.

Johnson ole Nchoe, GDC managing director, said the firm set aside Sh300 billion (US$2.89 billion) for the project in the first phase, with another Sh600 billion to be injected into the project in the second phase.

"There are various [other areas] that GDC is interested in, including Suswa which is still in its early stages," said Paul Ngugi, GDC regional manager Central Rift.

In addition, GDC has been drilling in its flagship field of Menengai, where three Independent Power Producers (IPPs) are expected to build power plants and use the steam to generate a combined 105 MW. Quantam Power East Africa, Orpower Twenty Two, and Sosian Energy each will develop a geothermal plant with a capacity of 35MW.

The sale of steam is a critical revenue stream for GDC, earning it Sh3 billion (US$28.9 million) per year. The entity is trying to wean itself from government funding. Other than the partnerships for the generation of power where IPPs will pay for the steam supplied, the firm is considering putting up industrial parks within its project areas. The parks are expected to help absorb excess capacity that will be produced when more plants coming online.

Sources: http://www.nation.co.ke/news/Firm-makes-steady-progress-in-construction-of-power-plant/1056-3996930-y48houz/index.html, https://www.standardmedia.co.ke/business/article/2001246483/kengen-gdc-in-plans-to-venture-outside-olkaria-and-menengai-in-developing-geothermal-power

KenGen Applies for Further Geothermal Exploration Licenses - An official from the Kenya Electricity Generation Company (KenGen) has announced that the national power utility seeks to broaden its geothermal exploration scope. The resource-development manager at KenGen's Olkaria project, Peketsa Mangi, said that along with the Geothermal Development Company (GDC), they plan to further geothermal exploration outside the two traditional areas of Olkaria and Menengai.

The power company has applied for a license to explore and develop geothermal power in Eburru and Lake Magadi. "We have made an application to the ministry of energy to start exploration and development of more geothermal fields in the Rift Valley. At the moment we want to move to Eburru and have made an application for Lake Magadi," Mangi said. He added: "There are 20 geothermal prospects in Kenya with a capacity to produce over 10,000 MW, and we are trying to identify where we can prospect next and make an application to the Ministry of Energy."

Source: https://www.esi-africa.com/news/kengen-applies-geothermal-exploration-licence/

Chinese Firm to Construct another Wellhead Power Plant - KenGen has awarded a consortium led by a Chinese firm a Sh9.4 billion (US$18.3 million) contract to build a wellhead power plant at Olkaria in Naivasha. Yantai Jereh Oilfield Services Group (YJOSG) announced it has bid to construct a modular power plant at one of the wells ready to start delivering steam.

UPCOMING EVENTS

IGC – Invest Geothermal
7 November 2017, Frankfurt/Main, Germany

Geothermal Energy Development for a Green Economy
7-14 November 2017, Hanoi, Vietnam

New Zealand Geothermal Workshop
22-24 November 2017, Rotorua, New Zealand

43rd Annual Stanford Geothermal Workshop
12-14 February 2018, Stanford, CA, U.S.

GeoTHERM – Expo & Congress
1-2 March, 2018, Offenburg, Germany

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

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

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

Note: Please check the IGA website for more events.

YJOSG participated in the bid in a joint venture that included local contractor H Young. The project entails the installation of wellhead generators.

The wellheads technology will use small power units that are fitted next to the wells. Generation can take place within as little as nine months from the time the well is tested. Using one of the original six wells first commissioned in 2012, KenGen now generates 2.52MW of wellhead geothermal power from the Eburru plant.

This is usually a short-term measure for wells undergoing testing or awaiting construction of permanent and larger plants. It was reported in December 2016 that KenGen was generating 83MW using wellhead generators. They have accelerated its investment in geothermal electricity as it seeks to increase the contribution of renewable energy in the country's power mix.

Source:
https://www.standardmedia.co.ke/business/article/2001249321/chinese-firm-gets-sh9-45b-geothermal-contract, http://theargeo.org/July/kenya4.html

Feasibility Study to Enhance the Use of Geothermal Fluids in the Olkaria Wells - Langson Energy, Inc. (LEI), a USA energy equipment manufacturer, was selected by KenGen to conduct a green technology feasibility study for the Olkaria Geothermal Power Plant. KenGen has been searching for a specialized generator set that can be installed upstream as a topping unit capable of accepting high-pressure geothermal wellhead pressures to capture the waste energy and generate additional clean electricity.

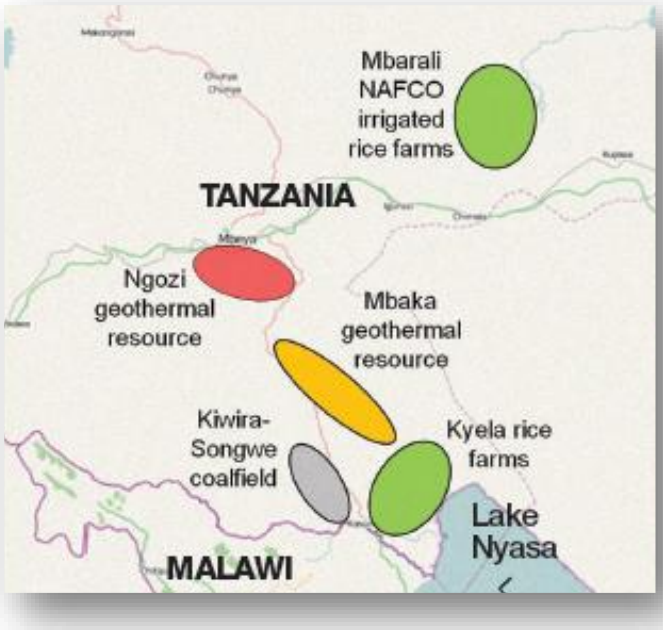
This study already begun and partially funded by the United States Trade and Development Agency, will be used to evaluate the technical, commercial, financial, and environmental viability of Langson Energy's 5MW Total Flow Generator™ to make more efficient use of the geothermal resource at Olkaria. If the study results are successful, KenGen and LEI will have the opportunity to install a number of additional units at more than 275 wells to optimize power plant efficiency, greatly impacting the electric footprint in the country.

Langson Energy's Senior Engineer, Ronald DiPippo, will be the Geothermal Expert on the project and work with a team of 10 other experts. As author of four major books, DiPippo is the foremost world authority and consultant on Geothermal Power Plants. He stated, "The advantages of a thermodynamically equivalent Total Flow Generator will lie in its simplicity, lower capital cost, ease and rapidity of installation, reliable operation, lower cost of electricity, and ability to operate on lower-temperature reservoirs, compared to either flash-steam or binary systems."

Source:
http://langsonenergy.com/archives/category/news/recent-news

Tanzania: CIF to Fund the Starting of the Ngozi Project

The Climate Investment Funds (CIF) has approved US$21.7 million for the United Republic of Tanzania to finance its Geothermal Energy Development Project. This project serves as a significant step in advancing the country's plans to transform the national economy with an affordable and baseload sustainable energy technology. It will develop the Ngozi geothermal steam field in southwestern Tanzania (*see* IGA News 108, p. 8) and ultimately showcase the technology's broader potential in the country's energy transformation.



Some geothermal areas in Tanzania. Source: Geothermal Energy in Africa, by Geothermal Power Limited (GPL).

The project is funded under the CIF's Scaling-up Renewable Energy Program (SREP) and will receive US$5 million as a loan and US$16.73 million as grant resources to be implemented by the African Development Bank (AfDB). Tanzania has made significant economic and social progress over the past 20 years and is today one of Sub-Saharan Africa's best economic performers. However, the country still wrestles with poverty and an under-developed energy sector. Half of its electricity is generated by fossil-based technologies and half by hydro.

The country is committed to transforming its energy sector through a more diversified mix of technologies tapping into its renewable resources. Geothermal energy is a particularly promising technology for the country,

which has around 15 geothermal sites with an untapped estimated potential of 650 megawatts (MW). A sixth of this potential can be developed in the Ngozi site.

Leandro Azevedo, AfDB's Senior Climate Finance Officer and CIF Coordinator, said this is "…the first step in the transformation of Tanzania's energy sector, a transformation that is being built on a sustainable energy source… Developing geothermal capacity in Tanzania is an essential part of that transformation and we hope that this project's success will lead downstream to the installation of a 100MW power plant and help create the conditions for the development of other geothermal sites in the country."

The project involves exploratory test drilling and installing the required steam gathering infrastructure in the Ngozi geothermal site. This SREP highly concessional finance will be instrumental in mitigating the high-risk nature of geothermal prospection and field development. Ultimately, the project is also expected to transform not only Tanzania and its energy sector but also the African Rift Valley Region.

The project's 100MW generation will be added to the country's energy mix adding up to 823 GWh per year to the grid. Electricity from these fields will increase the country's energy security and reduce its dependence on electricity imported from Uganda, Zambia, and Kenya. In addition, a more diversified energy mix will strengthen the power sector's resilience to future shocks. The project will also contribute downstream to capital mobilization from both public and private investors by creating an enabling environment for unlocking both public and private funds. The total contribution expected from private sector is estimated at US$300 million. Households and businesses will benefit from the supply of clean and reliable green energy, thereby creating urgently needed jobs.

Source: https://www.afdb.org/en/news-and-events/tanzania-wins-us-21-7-million-from-climate-investment-funds-to-advance-geothermal-exploration-and-transform-its-energy-sector-17202/

AMERICAS

Chile: Can Chile Become a Hotspot for Investment in Geothermal Energy?

Following are some excerpts from a comment published in a blog by IRENA.

Chile's abundant geothermal potential provides a good renewable energy option to further diversify the country's power generation mix – something consistent with Chile's Energy Policy, which aims for at least 70% of national electricity generation to come from renewable sources by 2050.

Chile has long been the leader of Latin America's renewable energy market. In 2015, investment in renewables (including small hydropower projects of <50MW) was around US$2.6 billion.

The rate of growth of investment in renewable energy has increased in the past few years, and competition has lowered electricity costs.

But geothermal energy is lagging. Chile's only geothermal plant, Cerro Pabellón, which opened earlier this year, is South America's first operating plant. The government has tried to develop geothermal energy, but despite a promising start, several issues are preventing further investments in exploration. ESMAP's Global Geothermal Development Plan (GGDP) was instrumental in mobilizing a US$50 million grant through the Inter-American Development Bank from the Clean Technology Fund (CTF) to stimulate additional investments in the sector. In addition, the CTF approved a grant of US$3 million through the bank –of which US$1.78 is bank-executed to provide technical assistance to the government in addressing key legal, social and market barriers and contribute to the development of tradeable geothermal resources.

In October 2016, renewable energy producers in Chile had won more than a 50% share of Chile's power tender, with falling costs for renewables driving the average bid price down. This results will have an impact on Chile's electricity system, starting in 2022, and positioning geothermal energy to enter the electricity market will be crucial.

A key aspect of the project is bringing together the government and the geothermal industry to discuss the technical and economic impacts of geothermal energy within the unified electricity system in Chile with an increasing intake of non-conventional renewable energy. To ensure that the government and the private sector remained committed to geothermal efforts, ESMAP supported a geothermal roundtable with the objectives of: (i) estimating the cost of geothermal energy in Chile; (ii) analyzing the impact of geothermal energy on the Chilean electricity sector, in the short and long term; and (iii) identifying potential policies to promote geothermal development. The results of the roundtable will be critical for the continued support to geothermal energy in terms of investment and policy.

ESMAP also supported a study tour where Chilean government officials and indigenous communities visited Nicaragua to learn about the country's experience with geothermal development. Discussions focused on how those living in geothermal project areas, including indigenous populations, can benefit from industrial services, employment and better connectivity,

and other gains associated with the sector's development. The exchanges with peers helped communities shift their mind-sets about geothermal and support its development.

To add to this, an ESMAP-funded study helped identify the main barriers to geothermal development and understand the magnitude of the challenge. It aims to help Chile create a favorable environment to boost investment in the geothermal sector. The study analyzed the measures required to stimulate the geothermal drilling market, with a focus on risk reduction in drilling activities for geothermal developers. The actions identified include:


Photo by ENAP.

- Higher non-conventional renewable energy goals to include higher percentages of geothermal energy before 2025

- Fiscal incentives in the first phases of project development as well as loan guarantees

- Risk mitigation funds that provide capital during first phases of project development

- Direct injection of capital during first phases of project development

- Cost reductions due to reductions in rig crew and standby days of drilling operations

- Regulation reform to shorten project development time

- Increase in human resources in all relevant institutions handling actions within the regulatory process, like procuring licenses and developing EIAs

- Public aid to infrastructure in remote mountain areas

- Information dissemination to all stakeholders within the geothermal industry, including private developers, the public, regional governments, and agencies

Source: https://esmap.org/node/74446

Chile: Official Inauguration of the First Geothermal Power Plant in South America

On September 12th, Enel and ENAP (Empresa Nacional de Petróleo) inaugurated Cerro Pabellón, which is the first geothermal power plant in South America and the world's first large-scale facility of this kind to be built at 4500 meters above sea level. The inauguration ceremony, which follows the start of operations at the second of the plant's two 24MW units, was opened by Chile's President Michelle Bachelet and attended by Chile's Energy Minister Andrés Rebolledo, the country's Environment Minister Marcelo Mena, Enel CEO and General Manager Francesco Starace, ENAP CEO Marcelo Tokman and Antonio Cammisecra, Head of Enel's renewable division Enel Green Power.

"We are proud to inaugurate Cerro Pabellón, which is a milestone not only for us, but for all of South America and will help Chile to diversify its generation mix", said Enel CEO Francesco Starace. "The construction of Cerro Pabellón represented a technical and human challenge that we have been able to successfully tackle thanks to the effort of a highly specialized team that worked in the midst of the beauty and harshness of the desert. We hope that this milestone will be for Chile the starting point of a new path in energy development to boost the growth of its geothermal sector which can leverage on a significant potential and resource availability."

Marcelo Tokman, CEO of ENAP said: "Today we close a chapter in the quest to use geothermal energy in Chile and we begin a new stage. An effort of almost a hundred years, including the first geothermal committee created by CORFO and ENAP five decades ago, and which illustrates precisely the role our company has

today to articulate projects and solutions that promote a sustainable energy future".

During the ceremony the Environment Minister Marcelo Mena awarded Cerro Pabellón's base camp with the *Sello de Excelencia en la Gestión de Gases de Efecto Invernadero* (Seal of Excellence for Greenhouse Gas Emissions Management) as part of the Ministry's Huella Chile program. This is the first time that a project in Chile receives this award which recognizes the measures implemented at the base camp throughout the development of the project to quantify, reduce and neutralize the emissions of greenhouse gases.

Cerro Pabellón is located in the Atacama Desert, in the Ollagüe district, Antofagasta region, and is composed of two units with a gross installed capacity of 24MW each for a total capacity of 48MW. Once fully operational, it will be able to produce around 340 GWh per year, avoiding the annual emission of more than 166,000 tons of CO^2 to the atmosphere.

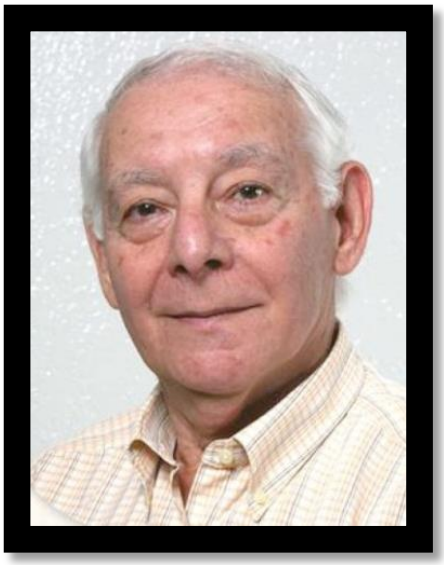
Cerro Pabellón is a high-enthalpy binary cycle plant and incorporates the most advanced geothermal technologies to guarantee an optimum performance against the extreme conditions of its location, characterized by high temperature variation and high altitude. In addition, the geothermal fluid extracted from the production wells, once completed the generation cycle into the plant, is re-injected into the reservoir ensuring the long-term availability and sustainability of the geothermal resource. One of the particular characteristics of geothermal energy is its ability to produce energy continuously, 24 hours a day.

The facility, whose construction required an investment of around US$320 million, is owned by Geotérmica del Norte S.A. (GDN), a joint venture controlled by Enel's Chilean renewable subsidiary Enel Green Power Chile (83.65%) and participated by ENAP (16.35%). The first 24MW unit started to deliver energy to the Norte Grande transmission system (SING, Sistema Interconectado del Norte Grande) at the end of March, while the second unit is fully operational since October.

Source:
https://www.enel.com/es/medios/press/d201709-enel-and-enap-inaugurate-south-americas-first-geothermal-power-plant-cerro-pabelln.html

Costa Rica: Miravalles Field Renamed, Geothermal Loan in Risk

ICE Names Miravalles Field after Geothermal Pioneer - The country's national utility company, the Costa Rican Electricity Institute (ICE: *Instituto Costarricense de Electricidad*) has announced the decision to name Campo Miravalles in the province of Guanacaste in honor of the pioneer of geothermal energy in Costa Rica, Dr. Alfredo Mainieri-Protti. The change was implemented in early July, with an official act in the geothermal field, with presence of his relatives and his former colleagues.



Alfredo Mainieri led geothermal research in Costa Rica since the 1970s and was involved in the development of the geothermal projects Miravalles I, II, III, IV and V, Las Pailas I and II, as well as the future Borinquen I and II geothermal plants. He was born in Punta-renas in 1934 and died in San José, the capital of Costa Rica, in 2013. One of his slogans was to develop electrical projects in coexistence, recovery and preservation of the environment.

In the statement, ICE recalled that Mainieri was a profound advocate for the socio-economic, labor and infrastructure well-being of the communities in the geothermal fields developed by ICE, such as Miravalles and Guayabo and Fortuna de Bagaces.

One of the last public speeches of Dr Mainieri was at the formal inauguration of the Las Pailas I geothermal plant. Then he said, "In all these years we have produced clean energy, we have formed our own technicians and professionals, we have installed six geothermal power plants --including this commissioned today-- that have been efficiently operated, we have acquired equipment, machinery and tools of advanced technology, we have innovated new technologies, some unique in the world such as the use of steam produced by acid wells which are unable to be used in other countries… thanks to the ingenuity, innovation and devotion of our people…"

In related news, the Geothermal Resources Council (GRC) announced it grants a GRC Special Citation Award to Alfredo Mainieri Protti, "For his lifelong pioneering work and enduring achievements in Costa Rica's geothermal power development." The award was presented in the GRC Annual Meeting held in Salt Lake City, Utah, October 1 through 4.

It is worth to recall the Mexican Geothermal Association also granted a Special Award to Alfredo Mainieri in its 21st Annual Congress and General

Assembly, held in Morelia City, Mexico, in October 2013, "As a posthumous homage to his great contribution to the geothermal development in Latin America." The award was accepted by his widow, Elizabeth Mora, and his eldest son, Alejandro Mainieri Mora, in an emotional ceremony (*see* IGA News No. 94, pp. 10-12).

Sources: http://www.elmundo.cr/campo-miravalles-del-ice-honrara-al-padre-la-geotermia-costa-rica/, https://geothermal.org/PDFs/News_Releases/2017/September_11-Global_Geothermal_Awards_Announced.pdf

US$500 Million Loan for Geothermal Is at Risk - The Costa Rican Congress decided not to approve a US$500 million loan that the state-run power company, *Instituto Costarricense de Electricidad* (ICE), wants to take out with the Inter-American Development Bank (IDB) to finance geothermal power generation projects in the country.

The deputies argued that they were not clear about the financial situation at ICE, which would receive the loan, for which the State would act as guarantor. The decision to halt the loan approval comes two days after President Solis announced he is facing a liquidity crisis.

Deputy Mario Redondo stated that, "...This is about an entity (ICE) for which we have no clarity about its financial statements. The Legislative Assembly must seek transparency regarding a loan such as the one in which we are now involved… It is a cooperation agreement with the IDB to finance investment projects for a program for renewable energy and the transmission and distribution of electricity signed on February 5, 2016, by the international entity. The Government of Costa Rica is acting as guarantor."

With the loan, the state power company was planning to complete the Borinquen I and Las Pailas II geothermal projects and improve the transfer line from Guanacaste and its connection with Central America. The construction project for the geothermal plants will require a total investment of US$374 million, of which $240 million will be covered by the loan from the Government of Japan and the remaining amount, with funds from the IDB and resources from the ICE.

Source: http://www.centralamericadata.com/en/article/main/500_million_for_Geothermal_is_At_Risk

Ecuador: Exploratory Drilling Started in the Chachimbiro Project

In accordance with the schedule established with Mitsubishi Materials Techno Corp., a Japanese consultant contracted by JICA (Japan International Cooperation Agency), on late August a drilling rig was assembled on the first pad at the Chachimbiro Project. The drilling equipment was transported to the site in 91 partial loads, some from Colombia and some from cities in Ecuador.

The operation was supported by the highest authority of the city, the National Police, Traffic Agents, and the Urcuquí Fire Department. It was necessary to improve and adapt several roads and construct the pad, necessitating four months of uninterrupted work.

Transport of part of the drilling rig (taken from the source).

The Chachimbiro Project has a potential estimated at 50MW and is financed by JICA through a non-reimbursable technical cooperation. It includes the transfer of technical-scientific knowledge to young Ecuadorian professionals by Mexican and Japanese experts who, supported by the knowledge of companies with extensive experience in this field, make it possible that Ecuador will count not only with this valuable energy source but also can generate capacities for the use of its geothermal resources throughout the country.

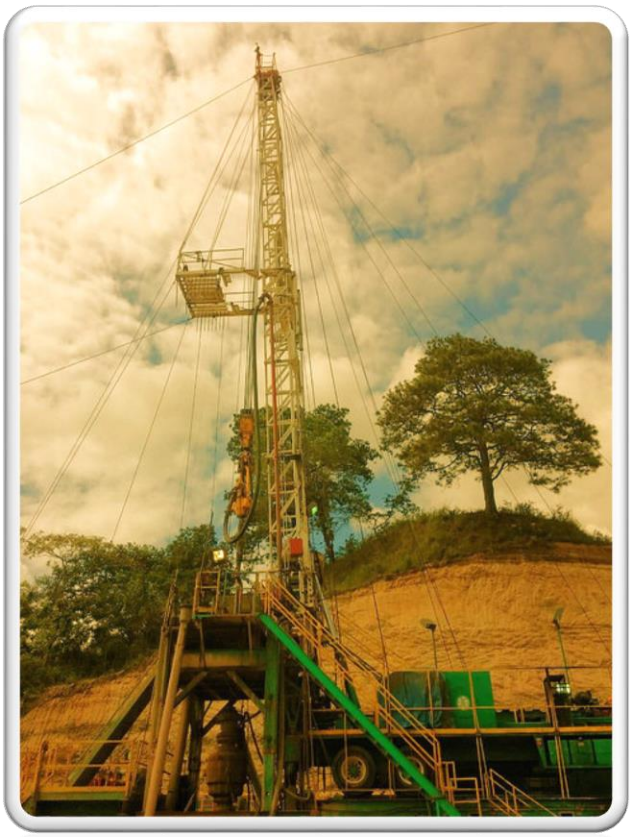
The results at the end of this exploratory drilling phase will determine the way forward for the development stage of the geothermal field and the subsequent construction of the power plant.

Source: https://www.celec.gob.ec/termopichincha/index.php/noticias-termopichincha/494-inician-actividades-de-geotermia

Honduras: First Geothermal Power Plant Starts to Operate

First tests were conducted at the Platanares geothermal power project in La Unión, Copán, in Honduras, Central America. The plant has a binary cycle and an

installed capacity of 35MW. The estimated investment cost was US$ 200 million, and the plant is expected to be under commercial operation in October 2017.



Drill rig in the Platanares project. 'Rig Sky', photo by Steven Fercho, GRC 2017 Photo contest.

This is the first project of its kind operated in Honduras by Geotérmica Platanares, SA de CV (Geoplatanares) and its parent company, Ormat Technologies, Inc.

Luis Fernando Suazo, consultant and expert on energy issues, said the project will bring tremendous economic benefits to the national electrical power company (ENEE: *Empresa Nacional de Energía Eléctrica*) and greatly improve the quality of energy services in the western region of the country, especially Santa Rosa de Copán and Ocotepeque.

Suazo indicated that the Platanares plant is undergoing final tests and expects to have a certificate of commercial operation by ENEE. "Since the tests began, the plant went into operation and already adds power to the interconnected system. The country benefits," said the expert. The energy generated by Platanares will be marketed as part of the 30-year power purchase agreements signed with the national power company of Honduras.

The Platanares geothermal project is regulated by the Law for the Promotion of the Generation of Electric Energy with Renewable Resources, enacted in 2007 to benefit from an income tax exemption during the first 10 years of operation.

Elsia Paz, president of the Honduran Association of Renewable Energy (AHER), stressed that this project will benefit a large region of western Honduras facing energy supply problems. She said the expected value per kWh is around $0.102 (102 US$/MWh).

In 2013, Ormat signed a Build, Operate, and Transfer (BOT) contract with *Electricidad de Cortés* (Elcosa), a privately owned Honduran energy company, for about 15 years from the commercial operation date. In December 2015, Ormat concluded the drilling activity and extensive tests that support the decision to construct a 35MW project, one larger than initially estimated.

Sources: http://www.thinkgeoenergy.com/the-first-geothermal-power-plant-in-honduras-starts-operations/, http://www.laprensa.hn/honduras/1107644-410/operaciones-platanares-planta-geotermica-honduras

Latin America: 8 Projects to Be Granted by the GDF

On October 3rd, the Geothermal Development Facility for Latin America (GDF) announced grant awards for the first call of proposals (*see* IGA News 108, p. 10). The results include four Confirmation Drilling Grants approved for geothermal projects in Colombia (2), Guatemala and Honduras, and four Surface Studies Grants approved for another projects in Bolivia, Chile, Ecuador and Guatemala, as it is presented in the following table.

Region	Country	Projects	Estimated Power MW
South America	Colombia	2	115
	Chile	1	60
	Ecuador	1	20
	Bolivia	1	15
Central America	Guatemala	2	55
	Honduras	1	20

These awards total an approximate cumulative funding of 22 million EUR (US$ 26 million) from GDF, leveraging up to 1.6 billion EUR in future investments and generating at least 285 MW of projected capacity. Grant Agreement proceedings will begin immediately with approved applicants and the GDF looks forward to a successful round of negotiations. The 2nd round shall begin during the 4th quarter of 2017.

Source: http://gdflac.com/about/press-release/

Mexico: Old Geothermal Well Flows, Portable Small Power Plant

Spontaneous Flow of an Old Geothermal Well in Ixtlán de los Hervores - Several news agencies have reported that the 'geyser' at the Ixtlán de los Hervores geothermal area had reactivated on June 25, 2017; *see* for example, https://meganoticias.mx/morelia/noticias-morelia/27885-atiende-pc-estatal-rebrote-de-geiser-en-ixtlanixtlan.html.

Actually, the so-called 'geyser' is one of a group of abandoned exploratory wells drilled by CFE in the fifties. In late June, it began discharging a water-steam mixture, including some solids, creating an about 30 m column. Gradually the flow diminished, ceasing completely on July 7, although some noise could still be heard, probably due to subsurface boiling. Because of the potential danger, a 200 m diameter area around the 'geyser' was restricted to the public.

Photographic sequence of the flow of the well in Ixtlán. Left, the column on June 25; right, on July 7. Photo taken from a report by Garduño et al. (2017).

Chemical analyses of the solids ejected by the well detected the presence of calcite ($CaCO_3$). It is probable the old well had been plugged by carbonates.

The discharge/reactivation of the well was most likely related to the infiltration of rain water into the aquifer feeding the well. When the water came into contact with hot subsurface rocks, it began to boil, over-pressurizing the producing layer. The increased pressures removed deposits obstructing the well pipe, expelling them along with the fluids. Gradually, the pipe was plugged again by carbonate deposits, stopping the flow.

Ixtlán de los Hervores is located in the northeastern portion of the Mexican State of Michoacán, at an elevation of 1530 meters above sea level. There are hot springs and wells with temperatures ranging from 85 to 90°C. The chemical composition of the waters is sodium-chloride to sodium-bicarbonate. Corresponding, average, deep-geothermometers temperatures range from 180 to 221°C. Most of the springs are related to the NW-SE Ixtlán-Encinal fault, which extends for 30 km.

Currently, this area is one of the 13 geothermal zones for which exploration permits were granted to the Comisión Federal de Electricidad (CFE) by the Mexican Energy Ministry. According to the terms of the grant, the CFE must develop this zone and drill new exploration wells in the next four years, maximum. *Note by Luis C.A. Gutiérrez-Negrín and Marcelo J. Lippmann.*

Portable 500 kW Power Plant Developed in Mexico – The Mexican company, Grupo Enal, has recently developed a portable, easy-to-install, distributed-generation plant that can be fitted on exploratory wells to start production before a main geothermal plant is finished.

Gerardo Hiriart, Director General of the company, said, "High costs are involved in geothermal, a 100MW [geothermal] project can cost up to US$300 million. Of that price, almost half is for the central power producing unit, 40 percent for the development of the wells, 5 percent for the exploration phase, and 5 percent for engineering and management."

Geothermal projects can take several years to be constructed. During those years, developers must continue injecting capital. Meanwhile, the geothermal energy that could be used just sits there, unproductive. Hiriart says Enal's plant offers a solution. "We came to this solution while working for a producer that needed to start generating energy to support the development of its geothermal projects. Our client was considering either diesel generators or solar roofing. However, we decided to take advantage of the existing geothermal resource placed there. After some engineering, we created the first geothermal plant for distributed generation with a production capacity of 20kW." After further engineering and hard work, Enal has now developed a 500 kW geothermal portable power plant that is ready to be tested under real-life conditions.

This portable plant can be used to start what Hiriart calls pre-production, a phase in which a small amount of energy is produced—while characterizing the wells in real-time by acquiring data such as pressure, temperature, enthalpy and pH. This additional data allows for an easier engineering phase. The electric energy produced in pre-production can be either used

by the project developer or sold to the grid under the distributed generation scheme, therefore helping project developers economically.

For now, Hiriart wants to prove the concept with the help of project-development companies. "Our idea for this phase is to find a partner that is developing a well, and offer our 500kW plant as a power-producing unit that will also help characterize the well while the main power plant is being built. In this way, project developers can start selling energy months or even years before the plant is fully operational. Turkey is among the countries that is highly interested in participating with Enal in this testing phase," he said.

In the future, Hiriart wants to use the plant to bring distributed energy to remote places where the use of other energies is not feasible.

The project was recently awarded the PRODETES Gold Prize ('Premio Oro') in a ceremony held on September 14 in Mexico City, within the framework of the events MEXIREC 2017 (*see* separate note) and DEMEX (*Diálogos Estratégicos para el Futuro de la Energía en México*). PRODETES is the acronym of *Proyecto de Desarrollo de Tecnologías de Energía Sustentable* (Project of Development of Sustainable Energy Technologies), and is promoted annually by Mexico's Ministry of Energy (SENER), the World Bank, and the Global Environment Facility (GEF).

The goal of the prize is to promote development of clean energy technologies through economic incentives for innovative proposals from companies, universities, research center and/or entrepreneurs.

This was the second time the prize was awarded. The project was submitted by Enal (Energías Alternas, Estudios y Proyectos, SA de CV) and the University of Guanajuato, who received US$2 million.

Sources:
http://www.renewableenergymexico.com/geothermal-to-go/, https://www.gob.mx/sener/prensa/se-anuncian-los-ganadores-del-premio-prodetes-2017

Enal's 500 kW Portable Power Plant. Photo by Grupo Enal.

United States: DDU Studies, Newberry, Play Fairway, Patua, Project Cancelled, Calpine, Eclipse, Lithium Extraction, New Plant, Supercritical Fluids

DOE Announces Funds for DDU Feasibility Studies - The U.S. Department of Energy (DOE) announced in early July up to US$4 million in funding for six geothermal Deep Direct-Use (DDU) research projects to conduct feasibility studies of large scale, low-temperature, deep-well geothermal systems and cascaded surface technologies. The projects will extend the reach of geothermal energy into previously untapped regions of the country.

DDU is an emerging technology that has been underused in the U.S., and if feasible, could deliver direct geothermal energy from lower-temperature resources across the country. It is expected to use low-temperature, thermal resources in subsurface reservoirs in U.S. regions lacking conventional hydrothermal resources. DDU wells used to directly power buildings would be deeper than ground source heat pump boreholes and shallower than wells used for enhanced geothermal systems created for electrical generation.

On a large scale, DDU applications can possibly be used to replace conventional district heating and cooling systems in military installations, hospital complexes, office buildings, hotels, and other large energy end-users. The DOE defines large-scale as a space conditioning area greater than 10,000 square feet (929 m^2) or having an annual thermal-energy demand equal to or more than 125 million British Thermal Units (MMBTU). The goal is to significantly expand the reach of geothermal energy into geologically distinct parts of the country. Using relatively low-temperatures, direct-geothermal energy has the potential to diversify the nation's energy supply, help meet environmental goals, and provide cost-effective, renewable thermal energy in large portions of the U.S.

A U.S. Geological Survey assessment estimates that 46,000 MW_{th} of total beneficial heat is available from geothermal resources below 90°C (~195°

Farenheit) in the U.S. DDU promotes large scale, commercially viable systems that optimize the value stream of lower-temperature resources through a cascade of uses.

The research teams who have been selected represent a range of partners who will share the cost of performing the feasibility analysis with DOE. The organizations receiving awards include Cornell University (Ithaca, New York), National Renewable Energy Laboratory (Golden, Colorado), Portland State University (Portland, Oregon), Sandia National Laboratories (Albuquerque, New Mexico), University of Illinois (Champagne, Illinois, and West Virginia University Energy Institute (Morgantown, West Virginia).

Source: https://energy.gov/eere/articles/energy-department-announces-4-million-geothermal-deep-direct-use-feasibility-studies

Workshop to Explore Drilling Project at Newberry Volcano - An international group of geoscience experts convened in Bend, Oregon, on September 10-14 to develop a proposal for drilling one of the hottest wells in the world at Newberry Volcano in central Oregon. More than 40 scientists and engineers met at the Oregon State University-Cascades campus in Bend to explore options for the geothermal energy project, as well as potentials for funding. The workshop was sponsored by the International Continental Drilling Program, a non-profit organization that supports international science teams pursuing land-based drilling.

The event was organized and coordinated by the NEWGEN consortium, which was formed in 2015 by Pacific Northwest National Laboratory, AltaRock Energy, Oregon State University, and Statoil to develop a research observatory on geothermal energy at Newberry Volcano.

The Newberry Geothermal Test Facility, located on the western flank of the caldera rim of Newberry Volcano, is one of the largest geothermal heat reservoirs in the Western United States. Hot rock is relatively close to the surface at the site, making it easier to drill super-hot wells and carry out enhanced geothermal system research, according to Adam Schultz, an OSU geologist and geophysicist involved with the effort.

"There is enormous geothermal energy potential in the United States, with the greatest concentration of resources in the West," Schultz said. "Our test site at Newberry Volcano represents one of the most promising geologic settings for geothermal power in the West, where super-hot rock could produce a high yield of stable, baseline electric power production that – unlike other renewable energy sources– doesn't vary with sunlight, wind, or wave conditions".

The site has been studied for 40 years and millions of dollars have been invested there by the U.S. Department of Energy and private geothermal developers, resulting in a ready-to-use facility with the necessary infrastructure, environmental permits, land commitments, and monitoring plans.

An idle geothermal exploration well drilled in 2008, at 3500 meters depth, reached temperatures of 320°C. Researchers are evaluating plans to deepen the well another 1500 meters to reach temperatures above 450°C.

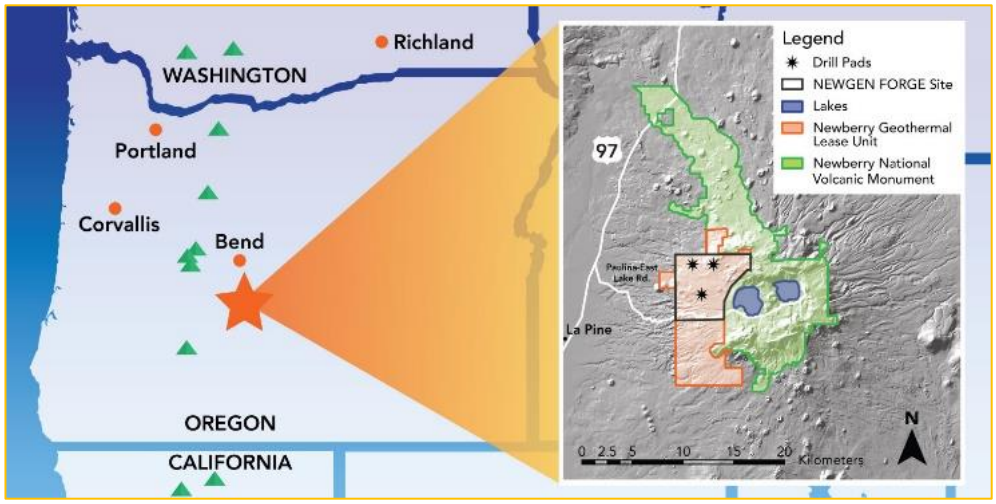


Image source: http://www.newberrygeothermal.com/site/.

The workshop was attended by scientists and engineers with expertise in geothermal energy, high-temperature drilling, seismology, and volcanology from the U.S., Canada, Japan, Norway, Iceland, France, and Italy.

Source: http://osucascades.edu/news/september-workshop-set-explore-drilling-project-newberry-volcano

GTO Announces Play Fairway Analysis Phase III Selections - The U.S. Department of Energy's Geothermal Technologies Office (GTO) announced it will continue funding five projects aligned with Phase III Play Fairway Analysis (PFA) activities. The GTO will award up to US$5 million in additional funding to five of the original 11 projects from the 2014 PFA Funding Opportunity Announcement. The awards will address the overarching theme of uncertainty quantification and reduction in geothermal exploration, specifically through the development of Geothermal Play Fairways.

The concept of 'play fairway analysis' has been used to identify potential locations of blind hydrothermal

systems in the western U.S. A play fairway analysis defines levels of uncertainty with respect to the presence and utility of geothermal system elements, translating them into maps to high-grade the geographic area over which the most favorable combinations of heat, permeability, and fluid are thought to exist. Phase III moves the projects into an exploratory drilling campaign that will test the Phase I and II models' abilities to discover new resources. Once identified, hydrothermal resources can be brought online quickly with current technologies, supporting the near-term expansion of renewable energy in America.

This systematic approach early in the exploration process can reduce costly drilling and improve the probability of successfully tapping the vital mix of high temperatures and sufficient water flows necessary to generate electricity from geothermal energy. By improving the success rates for exploration drilling, this data mapping tool will help attract investment in geothermal projects and significantly lower the costs of geothermal energy.

The selected Phase III awardees are:

1) Nevada Bureau of Mines and Geology, University of Nevada-Reno – Reno, Nevada

2) Utah State University – Logan, Utah

3) University of Hawaii – Honolulu, Hawaii

4) University of Utah - EGI Great Basin – Salt Lake City, Utah

5) Washington Division of Geology and Earth Resources – Olympia, Washington

Source: https://energy.gov/eere/geothermal/articles/geothermal-technologies-office-announces-play-fairway-analysis-phase-iii

Drilling in Nevada's Play Fairway Project - The University of Nevada, Reno, received funding to begin drilling geothermal test wells in the final phase of a multi-year research project to refine exploration strategies and reduce the risks in developing new geothermal systems capable of producing commercial electricity in Nevada's Great Basin.

The Department of Energy (DOE) announced funding for the continuation of the Nevada Play Fairway Project, which seeks to find geographic areas over which the most favorable combinations of heat, permeability and fluid are thought to exist, but no obvious surface signs would indicate an underground geothermal reservoir. Known as 'blind' or 'hidden' geothermal systems, they are thought to represent the bulk of the region's geothermal resources. These blind systems don't have wet marshy areas or other surface clues, such as hot springs or fumaroles spouting steam.

Phase III moves the project into an exploratory drilling campaign that will test the ability of the models developed in Phase I and II to discover new resources. The University, through their Nevada Bureau of Mines and Geology, received US$1.5 million from the DOE to finish the third and final phase of the renewable energy project.

The Play Fairway project, administered by the DOE's Geothermal Technologies Office, has the promise of yielding significant results to target geothermal well sites with temperatures greater than 130 degrees Celsius, the typical temperature for a productive well to produce electricity. The project seeks to identify new, economically viable geothermal systems in the state of Nevada.

"There is potential in the Great Basin for much greater amounts of geothermal energy than the current 670 MW produced from the 25 power plants already in place," said Jim Faulds, lead scientist on the project and director of the University's Nevada Bureau of Mines and Geology. "The geothermal wealth of this region can be attributed to its active faulting that allows hot fluids to rise more quickly to levels accessible through drilling. The Play Fairway project can potentially provide a catalyst for accelerating geothermal development in the region."

"Due to its tectonic setting, Nevada is richly endowed in geothermal resources," continued Faulds. "However

many of the obvious sites, for example ones near surface hot springs, have already been discovered. Because most of the geothermal resources in the Great Basin region are blind, it's important to characterize the favorable characteristics of the known systems and use that information to discover new systems hidden beneath the surface."

The Play Fairway Project began in 2015 with the mapping and analysis of a 40,000 square mile section of the Nevada Great Basin that identified a few hundred viable sites for geothermal activity using nine critical parameters. In the second phase of the study, Faulds and his team –which includes several other faculty members plus university graduate and undergraduate students– scoured the geothermal potential map and narrowed the study to 24 of the most promising sites in several areas. These were further narrowed down to five particularly promising areas. Evidence was found for commercial-grade geothermal systems at all five sites. Phase III will test the methodologies by drilling wells at two or possibly three of the sites.

To choose the final drilling sites, the team noted their proximity to existing electrical transmission corridors, excluded sensitive habitat and wilderness areas, and reviewed permeability factors and other geological, geophysical, and geochemical features indicative of geothermal activity.

"In Phase III, we'll drill to test the methodologies that we've used in the first two phases," Faulds said. "We'll be drilling temperature gradient wells to see if we have hot water from about 500 to 750 feet deep (~150 to 230 m). Full development of a geothermal system usually requires drilling to much greater depths (a mile or more) and is much more expensive. However the presence of commercial-grade systems can usually be identified at 500 to 750 feet deep. If proven effective, the play fairway methodology can be adopted by companies that can invest more confidently in exploration and development." The team expects to deliver its final report in March 2019.

Source: http://www.energycentral.com/news/drilling-begin-university%E2%80%99s-great-basin-geothermal-exploration-project

Solar Plant Added to Patua Geothermal Power Plant in Nevada - Empower Energies, Inc., announced the completion of the Patua solar power project, a 14.5MW DC solar array in Churchill County, Nevada. The project supplements an existing geothermal power plant owned by Cyrq Energy. The solar plant was completed by late July, ahead of schedule and under budget–according to the Empower press release. The solar equipment includes about 45,360 photovoltaic (PV) solar panels.

"We look forward to continuing to work with Empower on other solar projects to support our geothermal activities in the U.S." said Nick Goodman, CEO of Cyrq Energy.

The Patua Geothermal Power Plant produces up to 25MW of geothermal energy, sold to the Sacramento Municipal Utility District (SMUD). Apparently, both plants (solar and geothermal) are operating independently from each other, so it is not a hybrid project where the solar array pre-heats the geothermal steam to improve its yielding, like the Stillwater plant operated by Enel.

Patua geothermal power plant. Photo by Cyrq

Source: http://www.prnewswire.com/news-releases/empower-energies-completes-145mw-solar-project-for-cyrq-energy-in-utah-300504605.html, http://www.cyrqenergy.com/projects/the-patua-geothermal-power-plant/

Geothermal Plant Project at Salton Sea Cancelled by CalEnergy - CalEnergy, owned by Warren Buffett's Berkshire Hathaway Energy, asked the California Energy Commission earlier this summer to terminate its license for Black Rock. The company had requested and received extensions of the construction start deadline in 2007, 2011 and 2014, but this time decided to move on rather than pay a US$27,678 annual compliance fee that would have been due at the end of June.

The Black Rock geothermal plant was initially approved for development about 14 years ago, which would have tapped into a large geothermal reservoir at the Salton Sea in California. It was never built and now the plug has been pulled. Many challenges must be overcome when developing geothermal power projects in the Imperial Valley.

The initial license, secured in 2003, covered the development of a single, 215MW geothermal power plant. When the plan was modified in 2009 to three

smaller units generating a total of 159MW, the project found it difficult to secure financing and to secure a Power Purchase Agreement from a utility.

Source: http://www.thinkgeoenergy.com/geothermal-plant-project-at-salton-sea-cancelled-by-warren-buffets-owned-calenergy/

Calpine to Be Sold - Calpine Corporation, a U.S. power company focused on generating electricity from natural gas and geothermal plants, announced it will change its ownership under a US$5.6-billion deal valued at more than US$17 billion, including debt.

The private equity and credit investment firm of Energy Capital Partners (ECP), and a group of investors led by Access Industries and Canada Pension Plan Investment Board (CPPIB), have agreed to buy Calpine for US$ 15.25 per share, in cash. The price is a roughly a 51% premium to Calpine's unaffected share price on May 9, 2017.

Under the terms of the deal, Calpine had 45 days to seek and evaluate superior proposals, but will need to pay a US$142 million fee to the investor consortium if this process leads to signing a deal with another party, or only US$65 million if a deal is inked with certain exempted persons.

"This transaction is the result of an exhaustive review of strategic alternatives undertaken by our Board, with the assistance of outside advisors, to maximize shareholder value and unlock the company's intrinsic value, while eliminating execution risk," said Frank Cassidy, chairman of Calpine's board of directors.

In addition to natural gas-fired plants, Calpine operates 13 geothermal steam turbine-based facilities in the world's largest geothermal field, The Geysers, located in Northern California. These geothermal power stations have a combined generating capacity of about 725MW, or 634.1MW net. The company has one solar photovoltaic (PV) park.

Tyler Reeder, a partner at ECP, said the buyers do not plan to make changes to the way Calpine operates its business, its financial policy, or the previously announced US$2.7 billion deleveraging plan. The company will also keep its current headquarters in Houston, Texas, and its management team.

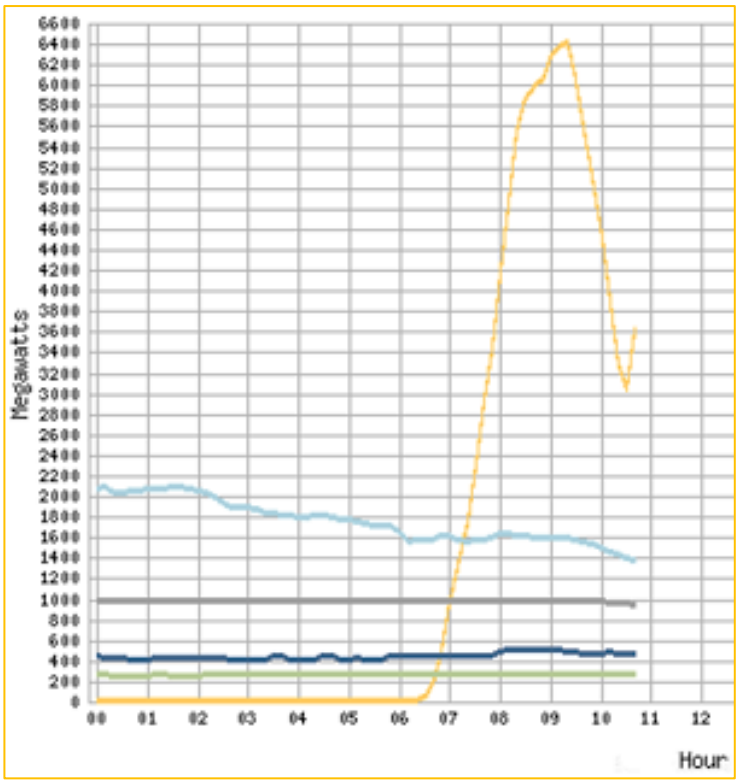
The transaction is pending regulatory and stockholder approvals and is expected to close in the first quarter of 2018. It is not subject to a financing condition.

Source: https://renewablesnow.com/news/natural-gas-and-geothermal-co-calpine-to-be-sold-in-usd-56bn-deal-580255/

Eclipse and Power Generation in California - Although Northern California didn't experience a total solar eclipse on August 21, the eclipse did affect the supply of solar energy to the grid. Starting at about 9:15 am, the grid suffered a drop of over 3,000 MW generated by solar arrays. The power began returning after 10:17 am as the eclipse waned.

However, geothermal energy was not affected, continuing to generate just under 1,000 MW to the grid managed by the California Independent System Operator (CAISO).

Source: https://geothermalresourcescouncil.blogspot.in/2017/08/usa-california-solar-eclipse-geothermal.html



Geothermal energy, marked by the grey line, helps make up for the loss in solar, the yellow line in supplying renewable energy to the California grid (Taken from the source).

MOU on Joint Lithium Extraction and Geothermal Power Project in Nevada - Dajin Resources Corp. announced it has signed a Memorandum of Understanding (MOU) with Geothermal Development Associates (GDA), Reno, Nevada. GDA is a geothermal development corporation with geothermal leases in the Teels Marsh Valley, Nevada, that overlies Dajin's placer claims. GDA's principle line of business is the development of geothermal resources for electrical generation. As a result of the MOU, GDA and Dajin will share exploration data with the aim of supporting the development of a lithium brine extraction facility and developing a geothermal plant for electrical generation and the production of direct-use thermal water. The agreement outlines a non-competitive

relationship where both companies are focusing on their key strengths, while working together on their exploration program during development.

Key attractions of Dajin's Teels Marsh valley lithium brine project include the identification of near-surface, lithium-bearing brines that been granted water rights and have minimal land fragmentation. The basin beneath the playa is up to 8,200 feet (2,500 meters) deep. Prior geothermal exploration results indicate favorable geochemistry and shallow sub-surface temperatures of up to 206°F (97°C) at 131 feet (40 meters) deep at the northwestern end of the valley. In March, the U.S. Bureau of Land Management accepted Dajin's notice to proceed with civil works and drilling as part of its exploration for lithium brines.

In further news, Dajin Resources announced that it has signed a non-binding MOU with Enirgi Group Corporation, headquartered in Toronto, Canada. This firm has developed a new, efficient, cost effective technology for extracting lithium carbonates from lithium bearing brines using its Direct Extraction Process Technology (DXP Technology). With this technology, the use of invasive, solar evaporation-pond networks is not required. Through their Innovation Division, based in Sydney, Australia, Enirgi Group is in the final stages of commissioning a commercial-scale, demonstration plant capable of producing one ton per day of battery grade lithium carbonate from their flagship lithium project at the Salar del Rincón located in the Province of Salta, Argentina. The MOU gives Dajin exclusive access to the Enirgi Group's DXP Technology and future processing facilities constructed in the United States.

Sources: http://dajin.ca/files/aug-23-2017-dajin-press-release-1.pdf, http://www.dajin.ca/files/press-releases/september-7-2017-enirgi-dajin-mou-press-release-final-2.pdf

New Plant to Be Built in New Mexico - Turboden, a group company of Mitsubishi Heavy Industries (MHI), signed an order with Cyrq Energy Inc. for the supply of an ORC turbo-generator that uses geothermal brines from existing wells to generate electricity.

Lightning Dock Geothermal HI-01 is located in the Animas Valley of southwestern New Mexico, in Hidalgo County. In 2013, a first 4MW plant was manufactured to deliver electricity to Public Service Company of New Mexico, with plans to further enlarge it to 10MW. Due to performance difficulties related to availability and efficiency of the existing plant, the second phase of the development was never completed.

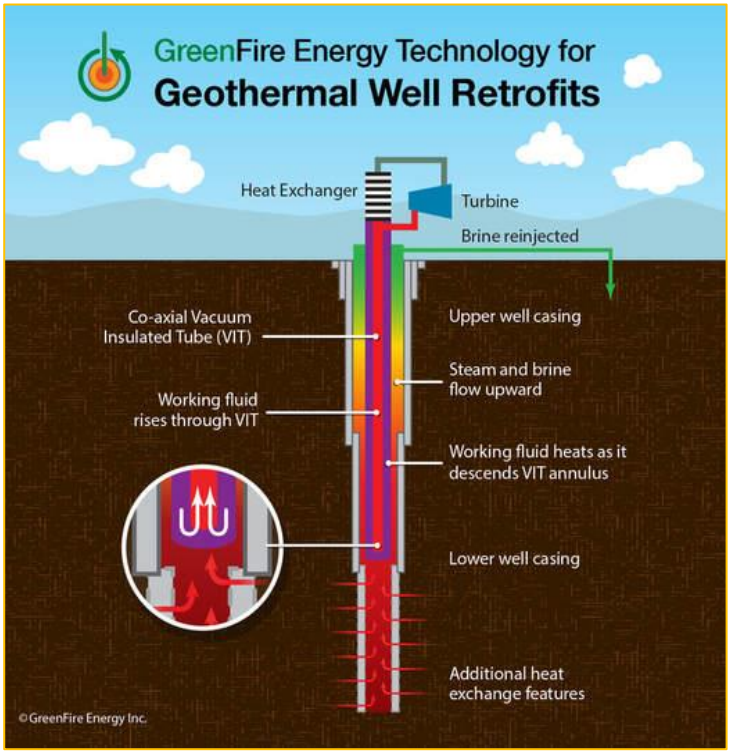
Now, Lightning Dock Geothermal –owned by Cyrq Energy— has chosen Turboden to design and supply a new, more efficient plant that can guarantee the additional electricity. The use of a single axial turbine as proposed by Turboden allows the nominal output to increase to 13.7MW and the design up to 15.2MW. The energy produced is expected to reach 91.6 GWh, with a turbine, isentropic efficiency of about 90% (including all of the stage losses). The plant design will maximize the yearly production per site ambient conditions, with an expected, efficiency de-rating of 1% during summer operation and 4% during winter operation.

The plant is currently under construction and it is planned to be operating in the first quarter of 2019.

Source: https://www.turboden.com/press/press-releases/1961/turboden-first-geothermal-power-plant-in-the-us-for-cyrq-energy-inc

Project Demonstrating Geothermal Power Generation Using Supercritical Fluids Set to Begin - GreenFire Energy announced that it has selected Veizades & Associates to serve as the Project Management team for the world's first field demonstration of closed-loop geothermal power generation.

Funded in part by a grant by the California Energy Commission, this project will be conducted in collaboration with the Coso Operating Company near Ridgecrest California. The purpose of the project is to demonstrate the ability of GreenFire's proprietary ECO2G™ technology to allow an unused marginal well to supplement generation. The project is slated to be completed by October 2018. GreenFire Energy is proprietary of the ECO2G™ technology that allows access to extremely large, hot and deep geothermal resources that have been previously unreachable. ECO2G's modular scalable architecture fully exploits



deep geothermal resources to provide grid-scale power generation. According to the company, ECO2G also provides continuous yet flexible power that quickly responds to the grid's dynamically changing power.

Chris Ellis, General Manager of Coso Operating Company, stated "GreenFire's technology presents a unique and viable approach toward producing energy from underground heat sources like we have at the Coso project, so we are an enthusiastic sponsor of this project."

Source: https://geothermalresourcescouncil.blogspot.is/2017/09/USA-California-geothermal.html

ASIA/PACIFIC RIM

China: Two New Geothermal Fields, and HDR Project in Gonghe Basin

Two Geothermal Fields Found on the Pamir Plateau – After an eight-year survey, two geothermal fields have been identified on the Pamir Plateau in northwestern China's Xinjiang Uygur Autonomous Region. One field at Quman village in Tashkurgan Tajik Autonomous County, covers eight square kilometers, noted Wang Hong, deputy chief engineer of the regional department of land and resources.

"Analysis of geological structure, temperature and pressure show that the Quman field can promise stable yields for more than 100 years," Wang said.

Another field covering seven square kilometers of low-temperature geothermal resources was also found in the county, suitable for hot spring therapy and leisure pursuits.

Tashkurgan, on the Pamir Plateau, endures long, harsh winters. The local government usually imports coal from Urumqi, Xinjiang's capital, and Aksu Prefecture at high cost. Winter heating has always been a heavy burden for the residents.

In 2010 Xinjiang began to explore geothermal resources in Tashkurgan, spending 48 million yuan (US$7 million) on the survey.

The department estimates that the Quman field could provide heating for 12,000 residents, reducing heating costs by 30 million yuan each year.

Hot springs in the low-temperature field could become a profitable tourist resort, creating jobs for residents and opportunities for local entrepreneurs.

Source: http://news.xinhuanet.com/english/2017-07/24/c_136468440.htm

Well Finds 236°C at 3705 Meters in HDR Project - Chinese scientists have extracted 236°C hot dry rock (HDR) from a well 3,705 meters deep in the Gonghe basin in China's northwestern Qinghai province, according to the state-owned broadcaster, CCTV, through its official Wechat account in early September.

This marks the first time a hot dry rock mass has been penetrated in China. It is a significant breakthrough for the country's HDR exploration.

China holds 856 trillion tons of hot dry rock, about the same as the U.S., said a spokesperson for the Geological Survey of China's Ministry of Land and Resources. Some 2 percent of the reserves, or 17 trillion tons, are considered recoverable.

The nation's southeastern coastal areas, Songliao Plain in the northeast, North China Plain, and the Qinghai-Tibet Plateau region are key potential areas for exploration and development. The southern plateau, in particular, is said to hold the largest volume of resources with the highest temperatures.

Source: https://www.yicaiglobal.com/news/chinas-landmark-extraction-hot-dry-rock-could-accelerate-its-geothermal-energy-development

United Arab Emirates: First Geothermal Exploration Survey

A research study is looking at the potential use of geothermal energy as a new source of clean and renewable energy for the UAE. The project, which is being undertaken by researchers at UAE University (UAEU), has studied geological sites in both Al Ayn and Ras Al Khaimah, examining the hot water spring reservoirs and analyzing their temperatures and sizes.

"This project started in January of this year (2017) with the goal of understanding the possibility of using geothermal energy in the UAE. We wanted to study the geothermal areas, gathering as much data as possible," explained Dr Hakim Saibi, associate professor of geophysics at UAEU, and one of the project researchers.

"Geothermal sites in Al Ain and Ras Al Khaimah were visited and different types of surveys were made in the areas. The surveys included a magnetic survey, the measurement of the magnetic field in the area. It allows us to understand the geological structure of the site," he added.

"The second thing we did was to collect and sample the water in these places. The water was analyzed in the laboratories, giving us important information about their chemistry and helping us to understand their temperatures," he said.

The information collected from site visits revealed the water temperatures located in the groundwater reservoirs reached around 120 degrees Celsius, and the reservoirs were 3km deep. According to Dr Saibi, the findings pointed 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 1,000MW using the geothermal energies from these areas," he said.

Dr Saibi noted the next stage of the project will see all their findings published in a respected, scientific journal. The published results will provide crucial data for any organization perhaps wishing to build a power plant on the sites in the near future.

"Even if we are not going to start using geothermal energy tomorrow, just having this research and data available is helpful, because it means we can start to work on getting to the point where we do finally use geothermal energy," he added.

Source:
http://gulfnews.com/news/uae/environment/study-explores-geothermal-energy-option-for-uae-1.2078798

Indonesia: Sarulla, Governmental Fund, Auction, Assignment of WKP, and Geothermal Expectations

Second Unit of Sarulla Started Commercial Operation - The second unit of the Sarulla geothermal power plant, with 110 MW of installed capacity, started its commercial operation in October 2nd, according to a press release by Ormat Technologies Inc. This is one of the world's largest power plants, located in Indonesia's North Sumatra.

The Sarulla power plant includes three units of approximately 110 MW each, utilizing both steam and brine extracted from the geothermal field to increase the power plant's efficiency. SIL, the first unit of the power plant, commenced commercial operation on March 17, 2017 and is performing well. The second unit, NIL 1, has completed successfully its testing and commenced operations on October 2, 2017 selling additional 110 MW to the state-owned Indonesian power company PT Perusahaan Listrik Negara (PLN) under a 30 years Energy Sales Contract. Sarulla power plant is operated by Sarulla Operations Ltd. (SOL). The third unit, NIL 2, is under construction and SOL expects the unit to commence operation in 2018.

SOL is a consortium composed of Medco Energi Internasional Tbk, Inpex Corporation, Itochu Corporation, Kyushu Electric Power Co. Inc., and Ormat subsidiary that hold 12.75% equity interest.

Source:
http://investor.ormat.com/file/Index?KeyFile=390588153

Governmental Fund to Finance Geothermal Exploration Drilling - Indonesia has laid the groundwork for a US$270 million fund to finance geothermal exploration as part of the country's efforts to boost renewable sources of energy. The government has allocated Rp 3 trillion (US$224 million) in the 2017 state budget for the so-called Government Drilling Fund, which will be used to finance geothermal exploration around Indonesia. The World Bank will also chip in with a US$55.25 million loan to shore up the fund.

Sarana Multi Infrastruktur, the government's infrastructure investment arm, will be responsible for managing the fund under the supervision of the Ministries of Finance and Energy. Rida Mulyana, director general of renewable energy and energy

conservation at the Ministry of Energy and Mineral Resources, said the fund will help reduce exploration risks borne by geothermal producers.

Under the scheme, the government will conduct a survey of potential geothermal resources and drill exploration wells, activities that are usually capital intensive. "So now, the risk in the exploration stage will be borne by the state," Rida said. "The IPP [independent power producers] just need to take over the already proven resources... they just need to pay the cost of exploration, to be used again by the government for other explorations," he added.

Yunus Saefulhak, director for geothermal at the Energy Ministry, said his ministry and the Ministry of Finance are working on an agreement to establish a geothermal exploration committee. The committee will consist of officials from of the Energy Ministry, Geological Agency and the Finance Ministry. "The committee will be responsible for ensuring that the fund is used in an accountable and measurable way," Yunus said.

Source: http://jakartaglobe.id/business/govt-lays-groundwork-geothermal-exploration-fund/

Auction for Six Geothermal Projects - The government has started to auction off six geothermal projects worth US$1.02 billion in September. This will expand Indonesia's renewable energy capacity as part of its plan to become the world's largest geothermal producer by 2021.

Local companies and foreign investors from the United States, Italy, Japan, South Korea, Turkey, and China have expressed interest in the projects, which will have a combined capacity of 255MW.

"This auction is quite attractive, but we have to wait for the result because the auction process usually takes four to five months," said Yunus Saefulhak, geothermal director at the Ministry of Energy and Mineral Resources.

The projects are Kapahiang in Bengkulu with a capacity of 110MW, Simbolon Samosir in North Sumatra with 110MW, Borapulu in Central Sulawesi with 10MW, Lamiding in North Maluku with 10MW and Oka Ile Ange and Mount Sirung in East Nusa Tenggara with capacities of 10MW and 5MW, respectively.

"The amount of investment in each geothermal region varies, depending on the region and local conditions. But on average, the investment for geothermal development is around US$4 million per megawatt," Yunus said.

Indonesia expects to have a total geothermal capacity of 3,559.5MW within the next four years. The country's total geothermal capacity amounted to 1,643.5MW last year.

This year, Indonesia will add an additional 215MW capacity from the Sarulla geothermal power plant in North Sumatra, 30MW from Karaha in West Java, 20MW from Sorik Marapi in North Sumatra and 55MW from Ulubelu Unit 4 in Lampung.

Source: http://jakartaglobe.id/business/indonesia-to-auction-off-geothermal-power-projects-worth-1b/

Assignment of Geothermal Working Areas – During the 5th Indonesia International Geothermal Convention & Exhibition (IIGCE) in Jakarta, the Indonesian Vice President witnessed the signing of a memorandum of understanding and the assignment of Geothermal Working Areas (WKP) to developers. The areas include:

- Mount Arjuno Wilerang in East Java with a capacity of 110MW and Telomoyo Temple of Central Java with a capacity of 55MW, assigned to PT Geo Dipa Energi (Persero).

Installations of PT Geo Dipa Energi. Photo by Reuters.

- Atadei with a capacity of 10MW, Songa Wayaua in North Maluku with 10MW and Gunung Tangkuban Parahu, West Java, with 60MW capacity, all assigned to PT PLN (Persero).

- Ratai in Lampung with a capacity of 55MW assigned to PT-Enel Green Power Optima Way Ratai.

- Gunung Lawu in Central Java and East Java with a capacity of 110MW—involving PT PGE Lawu.

- Gunung Talang-Bukit Kili in West Sumatra with a capacity of 20MW—involving PT Hitay Daya Energy.

For his part, the Director of Strategic Procurement PT PLN (Persero), Nicke Widyawati, said Persero has received US$640 million from PT *Sarana Multi Infrastruktur* (SMI), to find the source of geothermal steam and build a PLTP. "Six WKP already have the assignment and the decision letter has been received," he said. Among them are the aforementioned Atadei, Songa Wayaua, and Gunung Tangkuban Parahu.

The loan for PLN comes from the SMI-managed Geothermal Fund. The fund total is only Rp 3.8 trillion

(US$ 282 million). The monies come from the State Budget (APBN), worth Rp 3.1 trillion (US$230 million), and the World Bank at Rp 711 billion ($US53 million). After obtaining the loan funds, PLN will conduct further survey and drilling activities.

In addition, PLN is preparing the development of eight other WKP, and plans to have a third party become a member of the consortium.

Sources: http://www.thinkgeoenergy.com/several-new-geothermal-working-areas-assigned-in-indonesia/, http://www.thinkgeoenergy.com/pln-receives-640m-for-geothermal-development-of-six-projects-indonesia/

Indonesia Expects to Become World's Largest Geothermal Producer in 2021 – Head of Bureau of Communications, Public Information Service, and Cooperation at Indonesia's Ministry of Energy and Mineral Resources, Dadan Kusdiana, said this projection can occur with the growing installed capacity of geothermal power plants that increases rapidly from year to year.

"Based on our analysis, Indonesia's geothermal capacity will beat the world's largest geothermal power producers, the United States and the Philippines, by 2021," Dadan said in Jakarta in early September.

Next year, Indonesia will surpass the Philippines to become the world's second largest geothermal energy user in the world by generating geothermal electricity of 2023.5MW through the addition of capacities from Sarulla Geothermal Power Plant (2 x 110MW), Karaha Geothermal Plant (30MW), Sorik Marapi Geothermal Plant (2 x 20MW) and Lumut Balai Geothermal Plant (55MW).

Based on the constructed roadmap, Indonesia will become the world's largest geothermal energy producing country, defeating the United States in 2021 with geothermal electricity capacity reaching 3559.5 MW.

Currently, the utilization of geothermal energy for the purposes of new power generation is 1698.5MW or about 10 percent of the existing reserves.

In fact, as many as 331 geothermal potential locations that have spread in the territory of Indonesia are very strategic for investments and meet national energy needs in accordance with the National Energy Policy (KEN).

"We have 17,506 MW of geothermal reserves and 11,073 MW of resources but have not been optimized, so it is an opportunity for investors to meet the national energy needs," said Dadan.

Source: http://www.en.netralnews.com/news/business/read/11059/indonesia.expected.to.become.world...s.largest.geothermal.producer.in.2021

Philippines: Better Permitting Process, Critical Proposed Law, and EDC

***Executive Order 30* Will Shorten Permitting for Significant Power Projects -** Industry players will now only need 30 days —from the current 1,340 days— to secure the necessary permits and licenses to start a big-ticket power project, thanks to Executive Order (EO) 30 issued by President Duterte on June 30.

The EO 30 states concerned government agencies shall act upon applications for permits involving Energy Projects of National Significance (EPNS) not exceeding a 30-day period. If no decision is made within the specified processing time frame, the application is deemed approved by the concerned agency.

"It is the policy of the state to ensure a continuous, adequate, and economic supply of energy. Hence, an efficient and effective administrative process for energy projects of national significance should be developed to avoid unnecessary delays in the implementation of the Philippine Energy Plan [PEP]," the EO 30 said.

According to Sherwin T. Gatchalian, chairman of the Senate Committee on Energy, it takes 1,340 days to secure a permit, 329 signatures to sign the permits, and 74 agencies are involved, including the Department of Energy (DOE). "This is only for the predevelopment stage, which is apart from building the power plant," Gatchalian said in an interview.

The private sector welcomed the development. "This is

very promising development. The key is to have the right organization to execute it," said AC Energy President, Eric John Francia.

To be considered within the EPNS, power-generation and-transmission projects must have a capital investment of at least P3.5 billion (US$69 million); make a significant contribution to the country's economic development; have significant, consequential economic impacts; make a significant, potential contribution to the country's balance of payments; have a significant impact on the environment; and involve complex, technical processes and engineering designs; and have significant, infrastructure requirements.

The EO also calls for the creation of an Energy Investment Coordinating Council (EICC) to spearhead and coordinate national governmental efforts to harmonize, integrate, and streamline regulatory processes, requirements, and forms relevant to the development of energy investments in the country. The council, to be led by the DOE, will maintain a database of information and a web-based monitoring system for information exchange and updates, to uphold transparency and accountability.

The EICC shall be composed of representatives from various national government agencies and relevant energy institutions. Within 30 days from the start of the EO, the EICC must prepare rules governing the resolution of interagency issues affecting the timely and efficient implementation of EPNS and other energy projects.

Source: http://www.businessmirror.com.ph/eo-cuts-red-tape-in-issuance-of-permits-for-power-projects/

Proposed Law Deemed Critical by the National Geothermal Association - At the 14th Annual General Assembly of the National Geothermal Association, Attorney Fernando 'Ronnie' Peñarroyo presented implications to geothermal exploration and development in the proposed mining engineering profession bill in the Philippines.

The so-named Mining Engineering Law of the Philippines was proposed in July 2016 with the following reasoning: "…unauthorized activities have caused confusion in the Philippine Mining Industry, particularly among Registered Mining Engineers, because such activities tend to discriminate against the majority of Registered Mining Engineers and eliminate many of the rights and privileges already granted to them by RA4274 or the Mining Engineering Act of 1965."

Ronnie Peñarroyo said the new proposed bill refers to geothermal in the mining context, and clearly defines 'geothermal fluids' as 'energy resources'. The bill also requests the adoption of a "Code of Ethics, Reporting Codes and a Code of Professional and Technical Standards for the practice of the Mining Engineering Profession." Since the world geothermal sector is developing a major effort to implement reporting codes and other standards developed internationally in the context of geothermal development and reporting, Ronnie makes a clear case against including geothermal in this proposed bill, as it essentially would stop all creation or work on reporting codes for the geothermal sector.

He provided some detail on other international activities. One was the Working Group on globally applicable harmonized standards for reporting Geothermal Energy Resources, prepared by the UN Economic Commission for Europe (UNECE) and the International Geothermal Association (IGA).

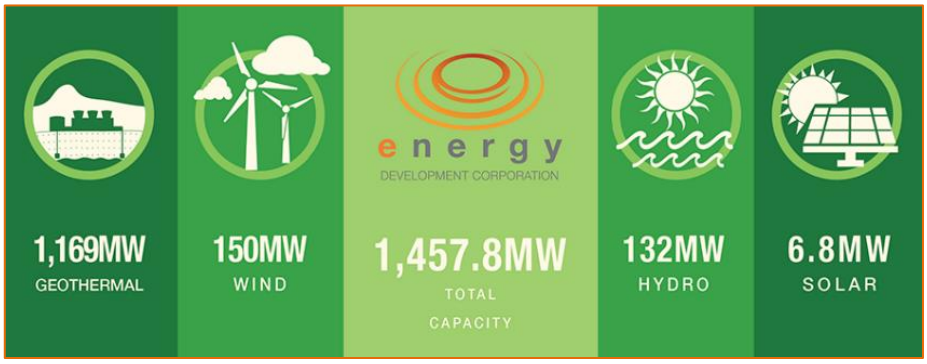
On behalf of the National Geothermal Association of the Philippines, Ronnie suggests the bill change Section 4 (b), excluding the term 'energy resources' from the definition of 'mine', and deleting Section 4 (e) that defines energy resources and includes geothermal fluids.

Source: http://www.thinkgeoenergy.com/proposed-mining-profession-law-in-the-philippines-seen-critical-by-geothermal-sector/

A Third of EDC to Be Acquired by Australian Company - Macquarie, a global investment banking and diversified financial services group headquartered in Australia, is ramping up its renewable energy investments by joining with Singapore's GIC –formerly known as the Government of Singapore Investment Corporation— to bid for a one-third stake in the Filipino power producer Energy Development Corporation (EDC).

The bank's most powerful division, Macquarie Infrastructure and Real Assets, has teamed up to lodge the offer for $US1.3 billion. Macquarie stated it was keen to add EDC to its renewable energy investments portfolio and to its experience in the sector.

EDC is the Philippines' largest producer of geothermal energy, with 1,169MW delivered to the country. EDC



also generates electrical energy from hydro and wind power. The company is considered the second-largest geothermal firm in the world.

Source:
http://www.theaustralian.com.au/business/dataroom/macquarie-gic-in-bid-for-filipino-power-producer-edc/news-story/

Taiwan: New Feed-in Tariff for Renewables

Taiwan's Bureau of Energy (BOE) has set tentative feed-in tariffs for renewable energy in 2018, lowering the rates by 11.82-13.45% for PV power and 0.73-4.61% for wind power.

PV power stations or rooftop systems to be established in northern Taiwan will be given an extra 15% increase in feed-in tariffs and those consisting of high-efficiency PV modules will be entitled for a 6% markup.

The feed-in tariff for geothermal will be 5.1956 NT$/kWh (0.033 US$/kWh), which represents an increase of 5.11% on 2017 rates.

Before finalizing feed-in tariff rates, BOE will hold a public hearing to collect opinions from all parties concerned in early November.

Source:
http://www.digitimes.com/news/a20170921PD200.html

EUROPE

Press Release: Joint Efforts to Strengthen Geothermal Energy

Geothermal heat is a promising source to enrich and significantly contribute to the renewable energy mix in a long-term perspective. To foster the use of geothermal energy in a secure, clean, and efficient way, the European Commission (EC) supports twelve projects within the Horizon 2020 Programme (H2020) and pursues one project of the former 7th Framework Programme (FP7). This brings together almost 20 countries and numerous stakeholders, providing a wide range of knowledge and expertise to strengthen the use of geothermal energy.

Geothermal energy offers a sheer infinite resource for heat extracted from the underground, combining a constant and reliable supply with low carbon emissions. Within the EU, in 2015 geothermal energy contributed 3.1% to the total primary production of renewable energy. To exploit the full potential of geothermal energy for heating and cooling, as well as for generating electricity, the EU is funding several research and demonstration projects. The H2020 and FP7 projects on geothermal energy address different challenges and research areas. The focus lies on the development, improvement, and demonstration of technologies for shallow and deep geothermal energy exploitation, with an emphasis on safety, sustainable responsibility, and cost optimization.

The drilling technology used to extract geothermal energy is one important field of innovation, as it can account for up to half of the total expenses required to fund a geothermal project. The projects known as GEOTech, Cheap-GSHP, and ThermoDrill work on novel drilling technologies to improve the reliability of geothermal systems, facilitate their handling, and enhance the rate of penetration.

Another core area is the performance of wells, addressed by the projects GeoWell and SURE. GeoWell develops technologies optimized to complete and monitor high-temperature geothermal wells. SURE investigates how to increase the performance of geothermal wells with a higher degree of control and a minimized environmental impact compared to conventional stimulation technologies. Finding the right place to drill is an emphasis of IMAGE, which enhances the accuracy of a siting process. DESCRAMBLE also focuses on site characteristics by targeting high-temperature and pressure conditions with the aim to demonstrate safe drilling based on best practices from oil and gas production. All these developments help to

Production test at Venelle well, 06/05/2017, Descramble Project (source: http://www.descramble-h2020.eu/)

substantially reduce costs and minimize undesirable side-effects. Cheap-GSHPS aims to reach these goals in the context of shallow geothermal systems with an emphasis on public and historical buildings. It strives to raise awareness for geothermal energy technology throughout Europe.

Other innovations are uncovered by CHPM2030 and MATChING. CHPM2030 aims to invent a novel and potentially disruptive technological solution, helping to satisfy the European need for energy and strategic metals in a single, interlinked process. Meanwhile, MATChING aspires to reduce the cooling water demand in the energy sector through technological innovations to be demonstrated in thermal and geothermal power plants. The testing of such developments and the publication of the results are a fundamental factor for the success of future projects. EoCoE investigates a case study for the use of geothermal energy for city quarters by high-performance computing simulations, providing guidelines for incorporating geothermal energy in the future energy mix. DESTRESS, DEEPEGS, and GEMex will examine advanced technologies at several geothermal sites with different geological settings. Whereas DESTRESS demonstrates soft stimulation treatments, DEEPEGS focuses on innovative technologies to be deployed in deep wells. GEMex emphasizes unconventional geothermal systems. A collection of good practices will be assembled from the outcomes for public distribution.

The EU funding phase of these ongoing geothermal projects is four years; it will end in 2020. The results are expected to make a substantial contribution to the promotion of geothermal energy in Europe and beyond.

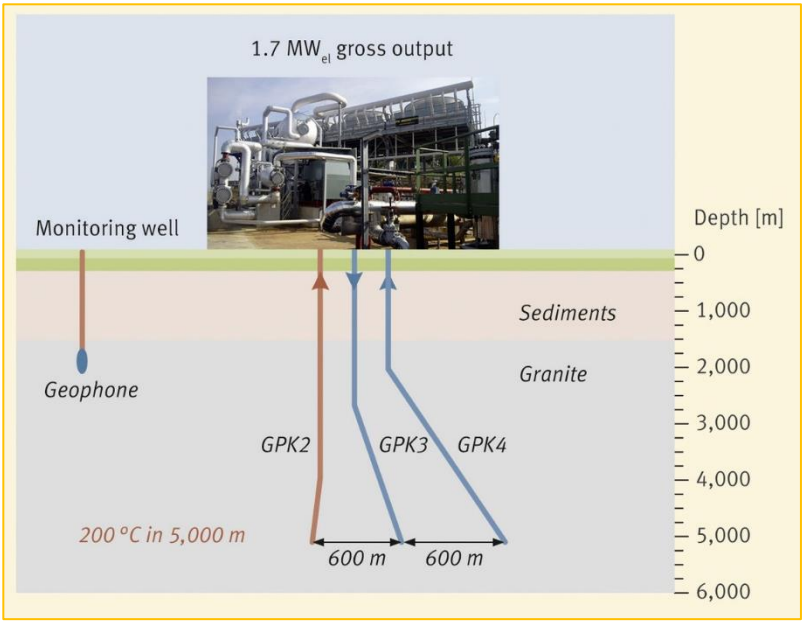
More information is available: Geothermal research projects funded by the EU programs: www.geothermalresearch.eu

European Commission on geothermal energy: www.ec.europa.eu/research/energy/eu/index_en.cfm?pg=research-geothermal

France-Germany: Soultz-sous-Forêts Commercial Power Plant Completed

In the Upper Rhine Graben, natural, geological thermal deposits can be tapped by wells at comparatively low depths. In a Franco-German research project in Alsace, scientists have been researching the process of utilizing heat from crystalline rock for years —and have optimized the concept and technology. At the research facility site, two power companies opened a new commercial power plant in 2016. The electricity is fed into the French grid. In Germany, around 95% of geothermal resources are found in deep rock and 5% in natural, thermal water strata.

Soultz-sous-Forêts in Alsace, on the Upper Rhine Graben, has particularly good geological conditions for producing geothermal energy. The temperature prevailing at a depth of 1000 meters is two and a half times the average for central European countries. This geothermal heat anomaly, the largest in central Europe, is caused by highly fractured rocks at great depth from which thermal waters rise. In the mid-1980s, these conditions provided the impetus for setting up a European research facility for utilizing the heat contained in the deep rock, i.e. petrothermal geothermal energy.



Three wells for the deep reservoir. © BINE Information Service based on BESTEC 2008 (Source: http://www.bine.info/en/publications/publikation/deutsch-franzoesische-geothermieanlage-vollendet/).

The German-French project, in which the European Union was also involved for a period, investigated the scientific and technical bases for petrothermal geothermal energy. In 2016, the two energy suppliers, Electricité de Strasbourg (ES) and EnBW Energie Baden-Württemberg AG, replaced an old research power plant in Soultz dating from 2008 with a new power plant. It is intended to feed about 12 million kWh into the French electricity grid every year. In France, the feed-in tariff for geothermal electricity amounts to 22.19 cents/kWh (US$ 0.26/kWh) and is based on the gross output of the power plant generator minus the electricity requirement of the ORC power plant. The power requirement of the production pumps is not taken into account.

In 2015, the two energy suppliers, ES and EnBW, decided to transform the Soultz geothermal power plant from a research facility into a commercial operation. They renewed the entire power generation plant to enable stable, economical operation. The results obtained during the course of the research phase also considerably helped in dealing with corrosive salt water and gaseous thermal waters plus sustainably managing a geothermal reservoir.

The geothermal heat is converted using a special power plant process, the Organic Rankine Cycle (ORC). The new power plant replaces the former research power plant (2008–2015). Its main focus was to test and optimize components in conjunction with the manufacturers. The pilot plant was designed for a wide range of operating conditions to be used in as many different ways as possible for research.

With the step taken toward commercial use, the operating parameters and power plant design were then precisely defined. The new ORC system operates more efficiently than the pilot facility and the power plant entered into regular operation in 2016.

Source:
http://www.bine.info/en/publications/publikation/deutsch-franzoesische-geothermieanlage-vollendet/

Germany: New Power Plant in 2019, and Workshop in the DGK 2017

New 3.4 MWe Power Plant to Be Completed in 2019 in Upper Bavaria - *Geothermie Holzkirchen GmbH* is a wholly owned subsidiary of the Holzkirchen utility. The town located just south of Munich, in upper Bavaria, Germany. Geothermie Holzkirchen GmbH originally planned to realize a deep geothermal project in 2015, to feed the local grid of renewable electric energy, and to provide clean thermal energy for households connected to the district heating network. In 2017, the company has chosen Turboden to supply a binary cycle power plant, including the complete ORC geothermal power station and its equipment, power plant control system, construction at site, and commissioning.

The geothermal reservoir is composed of geothermal brine delivered by a deep geothermal well to generate electricity and heat for the district heating network. Turboden will employ a double pressure level process, with a proprietary turbine, process, and air-cooled condenser. To provide a turnkey solution, a consortium will be established with the partner company, Th. Arens Anlagenbau GmbH.

While pure heat geothermal energy projects are less profitable during the summer, due to lack of heat demand, more electricity can be produced in a combined heat and power project in the summer and heat supply in the winter. This means an optimum economic exploitation of the available geothermal water, providing the best advantage for the citizens.

The Holzkirchen plant of 3.4MWe is under construction and is planned to be in operation in first quarter of 2019.

Source: https://www.turboden.com/press/press-releases/1958/turboden-awarded-a-new-geothermal-power-plant-in-germany-for-geothermie-holzkirchen-gmbh

Crossover Workshop EAGE-IGA-BVG at the German Geothermal Congress DGK2017 - As a side event to the DGK2017, EAGE (European Association of Geoscientists and Engineers), IGA and BVG (*Bunderverand Geothermie*, the German Geothermal Association) organized by the first time a scientific crossover workshop on 'Detailed exploration of carbonate reservoirs', bringing together experts from the hydrocarbon and the geothermal industry and academia.

Carbonate layers are important geological reservoir targets in the geothermal and in the hydrocarbon industry. However, interpretation of carbonate deposits in the subsurface is challenging due to its heterogeneous character (lateral facies changes, karstification, dissolution features) and is often being hard to (seismically) image. From a production perspective, a porous and permeable carbonate reservoir is often a result of large-and small-scale fractures. Due to the less predictable nature of fractures and fracture networks it remains difficult to de-risk the exploration portfolio based on a few case studies alone.

Dr Horst Rüter, member of the IGA BoD, during his participation in the workshop.

This workshop intended to offer a learning curve to geoscientists from both industries and academia by sharing their respective knowledge base in carbonate exploration. Seismic experts from the oil and gas industry presented workflows and lessons learned in seismic interpretation of challenging reservoirs,

geologists from R&D departments and geoscientists from the geothermal industry illustrated sophisticated exploration methods that developed to describe and map effects of carbonate uncertainty in the subsurface.

The audience combined geoscience professionals engaged in the exploration of carbonate reservoirs. The oil and gas was presented by experts from Shell, UFRN, TU Delft, Natal, PDS, and Schlumberger.

Experts presented geothermal cases from GTN, Erdwerk, LIAG, DMT. Marit Brommer, the IGA Executive Director, and Horst Rüter, member of the IGA BoD, jointly chaired the event.

The crossover will be repeated annually and cover different topics of interest in both industries. *Note written by Horst Rüter.*

Hungary: Turawell Geothermal Project, Completed

In early September, Eiríkur Bragason, CEO of KS Orka, posted a notice in LinkedIn that the project team in Hungary was beginning the commissioning procedures for the first geothermal power plant in Hungary. The power plant has a $3MW_e$ and $7MW_{th}$ heating capacity. He also posted a video showing the plant almost finished (https://www.youtube.com/watch?v=7W1PIGpg75U).

Turawell Kft is a project company of which 51% is owned by KS Orka Renewables Pte Ltd. of Singapore (KS ORKA) and 49% by the Hungarian Entrepreneurs, Miszori Laszlo and Szanto Laszlo. The project was partially financed by Erste Bank Hungary. The Power Plant is a combined heat and power plant CHPP that produces 3MW of electricity and $7MW_{th}$ of heat for house heating. The renewable, clean energy is extracted from the ground and, sustainably, returned to the ground after the heat is used.

Turawell plant. Screenshot taken from the video produced by KS Orka.

Eiríkur Bragason stated that, "KS Orka is prioritizing investments in geothermal power plants in Asia and in Europe and aims to build up further 400MW of combined heat and power plants in Europe over the next three years."

KS Orka is a joint venture between Hugar Orka ehf, an Icelandic company, and Zhejiang Kaishan Compressor Co., Ltd (Kaishan). KS Orka combines Hugar Orka's geothermal and project development expertise with Kaishan's power plant technology and manufacturing expertise to form Asia's only vertically integrated, geothermal and waste energy company.

Sources: https://www.linkedin.com/pulse/ks-orka-hungary-turawell-combined-heat-power-plant-eir%C3%ADkur-bragason/, http://ksorka.com/first-geothermal-power-plant-hungary/

Iceland: Blue Lagoon, Theistareykir Project, and Distributed Geothermal Project

Deferred Sale of a Third of Blue Lagoon - HS Orka had received offers for a 30 percent stake in the Blue Lagoon geothermal spa in Iceland. The share of HS Orka was placed in a sales process in mid-May 2017. Offers received from foreign enterprises reached ISK 10 billion (or around US$96 million). The offers put the market value of the Blue Lagoon at over ISK 30 billion (or around US$288 million), which was in line with the expectations of the seller. Although Alterra was prepared to sell under this preferred offer, Alterra's partner at HS Orka, Jarðvarmi slhf, whose consent was required, decided against selling the stake at this time. HS Orka may revisit the process at a later date.

The Blue Lagoon is a geothermal spa on the Reykjanes peninsula on the southwestern tip of Iceland, about 45 km from the capital Reykjavik. It is one of the largest tourist companies and destinations in Iceland.

Blue Lagoon revenues increased by 43 percent in 2016. The profit before EBITDA was EUR 28.2 million (US$31 million) in 2016, increasing by almost EUR 7 million (US$ 8 million) from the previous year. In just five years, the Blue Lagoon's EBITDA profit has almost tripled. According to market sources, estimates assume that the EBITDA will continue to increase this year.

The company's income totaled EUR 77.2 million (around US$81 million),

based on the average exchange rate of the euro in 2016, increasing by more than 43 percent between years. In 2012, the Blue Lagoon's income amounted to only EUR 25 million. For the first time in 2016, the number of visits reached over a million, with 1,122,000 visitors or about 200,000 more than the previous year.

The Blue Lagoon's equity was EUR 53.6 million at the end of last year, with a capital ratio of over 49 percent. Return on equity amounted to just under 44 per cent last year and the company's interest-bearing debt amounts to only EUR 34 million.

The share company Hvatning is the largest owner of the Blue Lagoon, with a 39 percent stake. Fund Framtak II, owned by pension funds, financial institutions and other institutional investors, owns 49.45% of Hvatning, while Kólfur holds around 50.55%. The owners of Kólfur are Grímur Sæmundsen, CEO and Founder of the Blue Lagoon (75 percent), and Eðvard Juliuson (25 percent).

Magma Energy, a subsidiary of the Canadian energy company Alterra, owns a 66.6 percent stake in HS Orka while the joint venture, Jarðvarma, which owns fourteen pension funds, owns 33.4 percent. In turn, the largest shareholders of Jarðvarma, each with a 20 per cent holding, are the two pension funds, Lífeyrissjóður verslunarmanna and Gildi Lífeyrissjóður. On the board of the Blue Lagoon are Ásgeir Margeirsson, CEO of HS Orka, and Anna Skúladóttir, board member of HS Orka.

Furthermore, the holding company Keila owns 9.2 percentage points in the Blue Lagoon. Other shareholders are Úlfar Steindórsson, CEO of Toyota Iceland, and Deputy Chairman of the Blue Lagoon Board, and various Blue Lagoon Managers.

Source: http://www.thinkgeoenergy.com/acquisition-offers-put-286m-value-on-icelandic-geothermal-spa-blue-lagoon/, http://www.newswire.ca/news-releases/alterra-power-announces-termination-of-blue-lagoon-sales-process-638306173.html

Drilling Finished at the Theistareykir Geothermal Project - The Icelandic engineering firm, Mannvit, announced in late August that drilling activities have been finished at the Theistareykir geothermal project in Northern Iceland.

Tests on the first, installed turbine unit have begun. Sufficient power for the first unit of the 45MW geothermal power plant will be provided by existing wells. Over the past two years, 10 wells have been drilled, one in the nearby Krafla geothermal area. In total, 18 wells have been drilled at Theistareykir.

Mannvit has provided hollow design and helped in drilling surveillance. Through its subsidiary, Mannvit-Verkís, Mannvit provides the design for connections to steam supply systems for the power plant. The steam generator is operational and used to prepare for the startup of the first unit assembly.

The project will generate 90MW. The owner is Landsvirkjun, Iceland's national energy company and the country's largest electricity generator, processing 75% of all electricity used in Iceland from hydroelectric power, wind, and geothermal energy. Fuji Electric has manufactured the turbines and Balcke-Durr the cooling end. Installation of the second unit has begun and the machinery is running. Work has been done on laying out the equipment. The first unit is expected to be operational on 1 December 2017 and the second on 1 April 2018.

The electricity generated will be fueling a new silicon plant by PCC at Bakki near Húsavík, plus strengthening the electrical distribution in the northeastern corner of Iceland.

Mannvit supervises the installation of the unit assembly and support systems, along with technical assistance in the tests and driveway of the power plant through Mannvit-Verkís. Previously, Mannvit-Verkís had worked on the plant design and tender documents.

Source:
http://www.thinkgeoenergy.com/commissioning-for-90-mw-theistareykir-geothermal-plant-about-to-start/

Units 1 & 2 of Theistareykir. Photo by Mannvit.

Distributed Geothermal Power Project – The Icelandic company, CP Energy Holding, has made a conditional order to Sweden's Climeon AB regarding equipment and services delivery for a two-phase, 15MW distributed geothermal power project. Under the terms of the US$37.3 million order, Climeon will supply 100 units of its heat power modules for installation across 10 to 15 individual sites in Iceland over a period of 30 months. In Phase I, the Swedish firm will deliver seven modules to build the pilot plant in the first half of 2018. Climeon will assist CP Energy Holding with complete funding for this phase, including a supplier credit and a promissory note.

In Phase II, Climeon will provide the remaining 93 modules for installation on new sites. CP Energy Holding has not found a financing plan for that phase and expects to seek financing from private investors and banks.

The sales order is subject to certain conditions such as undertaking a pre-study, signing construction and commissioning contracts with third parties, and securing the needed approvals. All modules will be operated by the newly established Icelandic sector player, Varmaorka.

The ultimate goal is to install a large-scale, distributed, geothermal power plant without subsidies or grants, Climeon noted.

Source: https://renewablesnow.com/news/swedens-climeon-engages-in-15-mw-geothermal-project-in-iceland-583449/

The Netherlands: 'Ultra-deep' Geothermal Drilling Project in Almere

The city of Almere in the Netherlands is planning to utilise geothermal energy for heating. The plans are underway. The project aims to drill wells over 4,000 meters deep to an 'ultra-deep' area. Cool waters pumped down to the area will heat up, be returned to the surface, and used for heating homes.

Research from TNO revealed last year that the subsurface beneath the municipality is suitable for this kind of geothermal heat. For Almere and the province of Flevoland, this is the reason to continue development. There are now three pilot projects planned for Almere. No date is set for drilling to begin.

In the Netherlands, there is little knowledge about drilling this deep or even deeper. The Ministry of Economic Affairs is broadly researching ultra-deep geothermal energy with other institutions. The same ministry's supervisory body, the State Supervision of the Mines, issued a serious warning last month. There is insufficient attention being paid to drilling risks which, in the case of ultra-deep wells, loom higher. These include the possibility of earthquakes, events that have happened in Germany and Switzerland. The warnings have been described as too sensational and not deeply founded.

Geothermal energy has been used in the Netherlands for about the last 10 years. So far, wells no deeper than 2,000 to 3,000 meters have been drilled into water 60 to 80°C. That heat is used by the horticulture industry. Almere needs higher-temperature water from deeper resources to heat homes.

Source: http://www.thinkgeoenergy.com/dutch-ultra-deep-geothermal-drilling-project-in-almere-netherlands/

Switzerland: Geneva to Proceed with Exploration Phase of GEothermie 2020 Project

The Swiss canton of Geneve is entering the exploration phase of its geothermal GEothermie 2020 project. First five drilling zones were identified and an application for authorization to continue was filed in the Official Notice (FAO) Bulletin concerning the Mandement area.

Industrial Services (SIG) and the State of Geneva mapped the canton for two years using seismic methods, including vibrating trucks. Next, the information collected on the surface needs to prove favorable. "As much as we get to know the geology from the surface, we are unable to determine a flow of water without drilling and pumping tests," said cantonal geologist, Jacques Martelain last July.

The hope is to find a very permeable zone straddling limestones (which contain water) and a network of faults that would increase the permeability. "This may allow us to find a sufficient quantity of water to have the flows necessary for geothermal energy," Martelain explained.

One of the vibrating trucks used during the seismic survey (Photo from the source).

These exploratory drilling will not exceed 1,000 meters of depth, and if the results are positive, geothermal energy can eventually be utilized.

The seismicity is relatively low in Geneva; the method used makes it possible to limit the risks. Martelain said, "It's a program, not just a project where you drill 4,000 meters and see what's going on. We begin with less deep drilling, we learn from these drilling activities and this technique, and then we will go further. "

The ultimate goal is to heat two thirds of the households in Geneva, thanks to geothermal energy. But not immediately: if all goes well, it will take some 15 years.

Source: http://www.thinkgeoenergy.com/geneva-in-switzerland-to-proceed-with-exploration-phase-of-geothermal-development/

Turkey: Direct Uses, Investments, and Kizildere III Unit 1

Potential for Geothermal Energy Direct Uses beneath Istanbul - Studies determining the risk of earthquakes in Istanbul have revealed that the city has a potential for using geothermal energy. The Yediyol Group of Companies, which has geothermal investments in Aydin's Kusadasi district, has 13 geothermal exploration licenses throughout the province and plans to commercially utilize geothermal resources in Istanbul.

The Company Group Chairman, Muhammet Tuheyp Mandi, said, "Geothermal will help to lower gas bills for heating, and, even more important, geothermal is greener than other sources of heating because there are fewer emissions."

In Istanbul, the company has started building residential projects with thermal pools heated by geothermal energy.

Mendi pointed out that Istanbul's most important urban transformation project is over the geothermal richness of Fikirtepe. He said a central heating project based on geothermal is being built in this part of the area. The project, which envisages the construction of thermal pools in the region, will be copied in residential projects in Kagthane Cendere Valley and Atasehir.

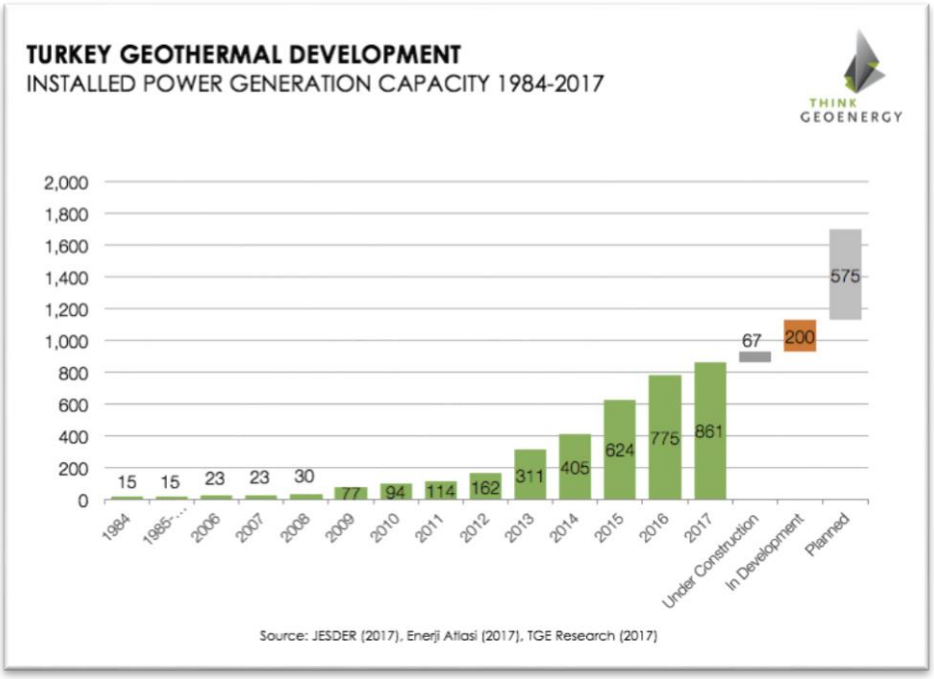
Yediyol Group of Companies has started building the first project of 60 apartments in Kadiköy Acibadem. The slogan is: 'Heating and thermal facility free, no dues' using geothermal resources.

Mendi explained they planned to build thermal cure centers in geothermal areas. "Millions of people every year will come to the feet of the Istanbulites, spending their money on thermal centers to find healing".

Source: http://www.thinkgeoenergy.com/study-finds-potential-for-geothermal-energy-utilisation-beneath-istanbul-turkey/

Geothermal Sector Aims to Double Investments by 2020 – Turkey's geothermal energy sector aims to more than double investments to US$7 billion by 2020 from the current level of US$3.2 billion, Ufuk Senturk, the president of Turkey's Geothermal Electricity Power Plant Investors Association (JESDER) said in mid-August.

Senturk said Turkish geothermal electrical generation has experienced a massive rise in recent years and continues to grow year by year. Turkey's geothermal sector has seen growth in power generation capacity, going from 30MW in 2008 to the current 870MW – equivalent to 19 percent of the country's potential for geothermal power production, currently estimated at 4.5 gigawatts.



Graph prepared by ThinkGeoEnergy.

"Turkey, the seventh largest geothermal country in the world, with 870MW of installed geothermal capacity, has increased its capacity by 50 percent every year for the last five years," he explained.

According to Senturk, the contribution from geothermal power as a national, local and environmentally-friendly energy source, needs to increase for the economy and such development should be backed by governmental support.

He added that on the association's behalf, along with sector officials, the matter has been made known to public authorities.

The risks and costs are very high for geothermal investments, especially for low-temperature geothermal resources, falling second to investments in nuclear power, he asserted.

"For resources with heat under 140°C to contribute to the economy, we expect some regulations," he declared.

The larger share of the monies is needed for geothermal drilling —at US$3 million per well, Senturk said. He explained that a 1000-meter well requires an investment of US$300 per meter. But at further depths, the cost rises. For example, a well drilled to a depth of 3,000 meters would require US$1,000 per meter to drill.

Together with other expenditures, the costs of drilling a 4000-meter deep well could reach US$6 million, he said.

"The amount of investment in geothermal energy today is US$3.2 billion. When the 1.75 thousand megawatts of geothermal power plant projects licensed and scheduled for 2020 are finalized, the investment amount will reach US$7 billion," Ozturk noted.

He concluded that the purchase guarantee scheme for geothermal energy, currently set at US$0.105 cents per kilowatt-hour, should continue for five years after the year 2020 for the future of this energy source.

The country has pledged to develop 30 percent of its total installed capacity from renewable sources by 2023. The objective is to add 34 GW of hydropower, 20 GW of wind energy, 5 GW of solar energy, 1 GW of biomass and 1 GW of geothermal power.

Source:
http://aaenergyterminal.com/searchdetail.php?newsid=12809845

First Unit of Kızıldere Plant III Started to Operate – The first unit of the Kizildere III geothermal power plant has become operational, the Turkish energy company Zorlu Enerji said in late August. This first unit has an installed capacity of 99MW and a cost of US$320 million, according to the company. "The first unit of the Kızıldere III geothermal power plant will produce 720 million kilowatt-hours of electricity per year," said Sinan Ak, CEO of Zorlu Energy Group. "The Kızıldere III geothermal power plant will have a total capacity of 165MW. When it is completed next year, it will be the biggest geothermal power plant in Turkey," Ak added. The power plant is located in Denizli, in southwestern Turkey.

Source: http://aa.com.tr/en/economy/zorlus-kizildere-iii-geothermal-plant-starts-operation/891879

UK: Lithium in Cornwall, and Two Projects in Scotland

Lithium from Geothermal Brines to Be Exploited in Cornwall - Cornish Lithium, a privately owned company, has raised £1 million (US$1.3 million) to push forward with a rather unique project –exploring for underground lithium bearing hot spring brines in southwestern England.

Cornish Lithium said, "The funds raised will enable the company to commence exploration activities in Cornwall". To this end, Cornish Lithium plans to explore a 15-mile (~27 km) stretch of the region's peninsula, the land rights to which it secured earlier this year.

Jeremy Wrathall, the CEO of Cornish Lithium, is a mining engineer who graduated from Camborne School of Mines in Cornwall. He said the county is the only known lithium source in the United Kingdom and the company will use data to "prioritize the best locations for subsequent drilling and sampling". Experienced mining consultant, Chris von Christierson, director of Southern Prospecting, and Peter Smedvig, an investor in small cap natural resources firms, complete the investing trio.

Incoming shareholder Liddell said: "Given the extensive historic readings of lithium in geothermal brines as well as the recent advances in technology, we see a real potential for lithium production in Cornwall".

If successful in extracting lithium from hot spring brines in granite, it would make the county the United Kingdom and Europe's only major source of the valuable metal. Lithium is a key component of higher spec batteries that power everything from laptops to electric cars. "We hope to be the domestic source of lithium for the United Kingdom".

Wrathall said Cornish Lithium has synergies with a hoped-for mining revival in Cornwall and with development of geothermal energy, which could be used in processing activities.

Source:
http://expressnewsline.com/2017/08/14/lithium-start-up-finds-backers-for-cornish-project.html

Plans for a New Geothermal Research Field in Glasgow, Scotland - With an estimated cost of around £9 million (around US$12 million), there are two sites being evaluated for a geothermal research field in Glasgow: a site on the Clyde Gateway area in the east end of the city, or a site in Rutherglen.

The site is one of two proposed in the £31 million UK Geoenergy Observatories Project led by The Natural Environment Research Council (NERC) and the British Geological Survey (BGS). A further project would be built in England.

Glasgow's research field aims to assess whether geothermal energy would be able to warm waters in the unused coal mines under the city that may be able to heat homes and businesses.

Professor John Luddon, executive director of the British Geological Survey, said, "This has the potential to be a world-class research site attracting globally leading scientists and engineers, building on Glasgow's history as a trailblazing city of science.

"Realizing the potential of geothermal energy in Clyde Gateway may create opportunities for the UK to lead the way in providing safe and sustainable energy for former mining communities around the world. We are very keen to hear what the community think about this proposed project," Professor Luddon said.

Source: http://www.glasgowlive.co.uk/news/glasgow-news/plans-proposed-9-million-geothermal-13472908

Geothermal District Heating to Be Developed in Western Scotland – The Scottish Government has allocated £1.8 million (US$ 2.43) of grant funding to support the creation of Scotland's first low carbon, renewable deep-geothermal, district heating network at The HALO Kilmarnock development in the West of Scotland. The delivery of heat to the network will be from a deep geothermal single well (DGSW) which will be developed by Geon Energy Ltd –a joint venture between Geothermal Engineering Ltd and Arup.

The DGSW is a single geothermal well that is drilled to a depth of two kilometers. Water heated by the surrounding rock is drawn up from depth using a small pump. The heat is then transferred to water in the heating system.

This innovative technology will generate sustainable heat for the redevelopment of the former Johnnie Walker bottling plant in Kilmarnock. The HALO Kilmarnock community-led regeneration project will deliver a mixed-use development, whose funding comes from the Scottish Government through the Low Carbon Infrastructure Transition Programme (LCITP), UK Government, East Ayrshire Council, Diageo and private sector investors.

The lead developers will be The HALO Kilmarnock, Ltd in partnership with entrepreneur, Marie Macklin of Macklin Enterprise Partnerships, the Klin Group, Ross Developments & Renewables Ltd (RDRL), East Ayrshire Council and Diageo plc. The well is scheduled to be drilled and installed in the first half of 2018.

Source: https://www.arup.com/news-and-events/news/scotlands-first-deep-geothermal-district-heating-network-given-backing

Oceania

New Zealand: Climate Bonds, Expansion of Geothermal Plant, and Support for Direct Uses

First Climate Bonds Certification of Geothermal Assets - Contact Energy Ltd., a New Zealand company, has gained Climate Bonds Certification of geothermal assets as part of its new, Green Loan Borrowing Program for NZ$1.8bn (US$1.3bn). This is the first Climate Bonds Certification gained by a New Zealand company. In a statement, the company noted its Green Borrowing Program Framework had been developed to align with the GBP. It announced the Climate Bonds Initiative Certification under Standard V2.1.

Dennis Barnes, Contact Chief Executive, said, "Our Green Borrowing Program is a first for a New Zealand corporation and enables debt investors and lenders to access a broad range of certified green debt instruments issued by a New Zealand company." Louise Tong, Contact Head of Capital Markets & Tax, said, "Contact's Program plays an important role in developing opportunities for global lenders and investors who are seeking certified green investments in New Zealand."

Sean Kidney, CEO Climate Bonds Initiative, said. "This NZ$1.8bn (US$1.3bn) Green Borrowing Program from Contact Energy includes one of our single largest certifications to date and is a significant global boost for best practice standards in green finance. It is demonstrating the kind of corporate leadership on green finance we need to see replicated by more listed companies, both in Trans-Tasman capital markets and internationally."

Source: http://reneweconomy.com.au/contact-energy-large-scale-climate-bonds-certification-77637/

Ngawha Geothermal Plant Would Double its Current Capacity - As part of a public statement on the good finance results of the company Top Energy, which increased revenue by NZ$5 million (US$3.6 million) over the last year, the chairman Murray Bain said the Ngawha geothermal power plant would soon have the capacity to generate 50MW of electricity, which could supply more than 80 percent of the Far North's needs and would contribute significantly to group's profits. The company has been weighing to expand the current capacity of the Ngawha plant, which is 25MW, and utilize all the available geothermal resources. The expected commissioning in 2020 is timed to forecast increased national-electricity demand. Depending on the New Zealand electricity market conditions, Top Energy plans to build and test the operation of one power station at a time, with the first power station expected to be commissioned around 2023. Top Energy is seeking to have resource consents finalized by mid-2017 to meet this deadline.

Ngawha geothermal power station. Photo by Top Energy.

Sources: http://www2.nzherald.co.nz/the-country/news/article.cfm?c_id=16&objectid=11904559 , http://topenergy.co.nz/ngawha-expansion-project/

Governmental Fund for Geothermal Direct Uses in Bay of Plenty - The New Zealand Government will invest NZ$150,000 (US$109,600) in stimulating demand for geothermal heat resources in the Bay of Plenty region, Economic Development Minister Simon Bridges announced in August.

The investment will be used for a Geothermal Business Development Lead to support work in stimulating demand for geothermal heat resources, including attracting investment from industry and promoting the value proposition and commercial opportunities.

"The costs of renewable geothermal energy are often comparatively cheaper than gas and coal. New Zealand could be at the forefront of this as we have a secure and renewable energy source at our fingertips," stated Judith Collins, MP for Papakura.

"If used for high-value products, geothermal heat could add millions to the local and national economy, growing industries in timber drying, aquaculture/tourism, horticulture, and milk drying," she added.

The project will be led by the region with central governmental support from the Regional Growth Program.

Source: http://www.scoop.co.nz/stories/PA1708/S00400/funding-to-look-at-geothermal-opportunities.htm

Other

Global: Governments Adopt 'Florence Declaration' in GGA Meeting

On 12 September 2017, governments agreed to work together to identify and implement measures that will significantly increase the speed of geothermal energy development around the world, following a milestone meeting between public and private leaders in Florence, Italy. Under the terms of the 'Florence Declaration' – an outcome of the Global Geothermal Alliance (GGA) meeting – governments will actively pursue a collective ambition to realize geothermal potential.

The meeting, entitled: 'Working Together to Promote Geothermal Energy Towards a Sustainable Energy Future' –the largest such meeting of ministerial representatives to discuss geothermal energy– was marked by the release of a new report from the International Renewable Energy Agency (IRENA), coordinator of the GGA, in which access to capital for surface exploration and drilling was cited as the main barrier to geothermal development. The report also noted that more "transparent government regulations that avoid project delays" were needed to provide sufficient certainty to developers and investors.

Minister of Environment, Mr. Gian Luca Galletti stated: "Italy considers the Paris Agreement to be irreversible and non-negotiable and therefore strives to promote geothermal and other renewable energy sources as a vital component for the planet's sustainable development."

"Geothermal's vast potential is currently untapped," he continued. "We must develop new technologies and

encourage new investments to ensure we cover this gap. The Alliance will multiply its efforts to guide this process, and Italy will provide its contribution with its long experience and know-how."

View of the GGA meeting in Florence. Photo: IRENA.

Ms. Teresa Bellanova, Italy's Vice Minister of Economy and Development, said: "Geothermal Energy's consistent and continuous availability make it a highly precious source of renewable energy both in Italy and many countries all over the world. Through our knowledge of the industry, Italy can play an important role in achieving the ambitions of the Paris Agreement, in addition to stimulating sustainable job creation."

Director-General of IRENA, Mr. Adnan. Z. Amin, said: "This meeting has, without question, allowed both the policy and industry communities to identify common ground in the pursuit of what is a renewable energy source with tremendous potential.

"If we can identify and implement mechanisms that deliver a greater level of certainty to investors and developers, then we will move beyond meaningful dialogue to decisive action that accelerates geothermal production," continued Mr. Amin, "contributing significantly to de-carbonization of the global economy, while creating jobs and supporting growth around the world."

"Access to low carbon forms of energy that support economic development while mitigating climate change, is a core priority for the African Union," said H.E. Dr. Amani Abou-Zeid, African Union Commissioner for Infrastructure and Energy. "Geothermal energy is emerging as a hidden gem of Africa's renewable energy resources and we must work together, across nations, to ensure this resource achieves its potential.

"Through partnerships and the Geothermal Risk Mitigation Facility, the African Union is currently supporting 26 projects in East African countries that will generate more than 1,500MW of power," continued H.E. Abou-Zeid. "We aim to build on this, supporting sustainable exploration through the work of this Alliance."

The GGA meeting was attended by more than 200 high-level public, intergovernmental, non-governmental, and senior private-sector representatives committed to scaling up geothermal energy deployment worldwide.

Mr. Carlo Pignoloni, Head of Renewable Energies Italy, Iberia, rest of Europe and North Africa at ENEL, said: "Geothermal power can play a significant role in promoting sustainable and clean development globally. Stable regulatory frameworks, long-term licenses, and bankable PPAs, in addition to transparent and public tenders, are key to if we are to take full advantage of the vast global geothermal potential."

The GGA membership is composed of 42 countries and 29 partner institutions, including multilateral organizations, development partners, international and regional organizations, global financial institutions, academia, research institutions, and the and private sector.

The Alliance aims to enhance multilateral efforts towards a more favorable environment to achieve a 500 percent increase in global installed capacity for geothermal power generation and a 200 percent increase in geothermal heating by 2030.

Source:
http://sweetcrudereports.com/2017/09/12/governments-adopt-florence-declaration-agree-to-advance-geothermal-energy/

Climate Change: The East African Climate Paradox

Despite models predicting increased rainfall with climate change, the east Africa region has collapsed into drought. Why?

The long rains, one of two wet seasons that quench the thirst of the East African region, failed this year for the second time in a row. Lack of water, withering crops and starving cattle plunged Somalia, Ethiopia, and parts of Kenya into a food crisis that the countries are not prepared for.

Humanitarian assistance has helped and will be needed far into 2018. But in war-affected Somalia and South Sudan, famine has emerged; in Ethiopia, aid money is

running short after repeated droughts; and in Kenya, the shortage of resources is giving rise to land conflicts.

For these countries, the ability to plan ahead is undermined by a mystery that has climate scientists puzzled. Most models suggest that global warming should be making the Horn of Africa wetter than in pre-industrial times. But as local weather data and dry streams on the ground testify, year after year the region is getting drier.

What has become known as the 'East African climate paradox' is a quirk that has been puzzling scientists for the best part of a decade, but is still far from being explained. Why do models project more rain while data on the ground show less and less by the year?

Scientists have come up with an array of different explanations for the paradox, ranging from natural variability of the climate that models struggle to capture, to patchy observational data due to poor infrastructure and records in the region.

Precipitation adds a further layer of complexity because rain is the end point of a long chain of climatic and weather processes. In planetary terms, clouds are tiny, elusive objects that move and evolve on an extremely small scale. "The available models still struggle to capture them" says Marsham, climate scientist with the University of Leeds in the UK, "but equally science is rapidly advancing and I am confident that in coming years we will have better information."

Lewis Glacier, the largest glacier on Mt Kenya, has shrunk by 90% since the 1930s (Photo: Chris 73/Wikimedia Commons; taken from the source.)

Although many questions remain open, the paradox doesn't dent the scientific community's trust in their research methods. "There is always the risk that someone will use the uncertainty as an excuse for not acting, and that to my mind is the opposite of what we should do," says Marsham. "On the contrary, we are well aware of the challenge of predicting rainfall in the tropics and this mismatch doesn't mean that the models are wrong. This is an interesting mystery to solve, and in doing so we will understand a lot more about the climate system in East Africa."

Source:
http://www.climatechangenews.com/2017/07/13/scientists-say-east-africa-will-get-wetter-drying/

Climate Change: Dying Gods in Kenya

Following are excerpts from a note by Daniel Wesangula, titled, Dying gods: Mt Kenya's disappearing glaciers spread violence below.

Mwangi Gitaru remembers his childhood well. He remembers the childhood games. He remembers the songs he and his friends used to sing while tending family goats. He remembers the stream that ran across his father's parcel of land, cutting it in half.

But most importantly, Gitaru remembers how each day his grandfather would wake up and face Mount Kenya and pray.

"He believed the mountain was the source of life," Gitaru says. "At that time, its whole peak was white as cotton wool. We were told as young boys, that was where the gods were. And we believed it."

From the snow-capped mountain came folklore; came tales of bravery and bounty handed down from generation to generation. But more importantly, from the glaciers near the summit, which rises to more than 5,000m above sea level, came streams that fed into bigger streams that fed into rivers that gave life to everything that lay around the mountain; including Gitaru, his neighbors in Karatina region, friends and some enemies too.

Gitaru belongs to the Kikuyu tribe, Kenya's most populous according to the most recent census. The Kikuyu refer to the mountain as Kirinyaga ('Mountain of Whiteness') and traditionally revere it as home to their omnipotent deity, Ngai. But lately the deity appears to have forsaken them.

"The ice is melting away. The rivers flowing from the glaciers are not as full as they used to be. Some have

dried up. And this is causing conflict downhill," says Kenyan environmentalist and chairman of Kenya's Water Towers Management Authority, Isaac Kalua.

The United Nations Environment Program estimates that only 10 of the 18 glaciers that covered the mountain's summit a century ago remain, leaving less than one third of the previous ice cover. The Lewis Glacier, the largest on Mt Kenya, has decreased by 90% in volume since 1934, with the highest rates of ice volume loss occurring around the turn of the century.

"When the melting starts, rivers first experience high flows because of the melting ice," says Kalua. "But this subsequently reduces because the glaciers never really recover like they did before climate change became a reality. Because of this, there is less and less water in the rivers in the years that follow."

Kenya, like many African countries, is highly vulnerable to climate change because of its exposure to rising temperatures and rainfall variability and its dependence on agriculture.

"Any change in anything that could affect this subsistence agriculture almost always ends in conflict," Kalua says.

The drainage pattern from the Mt Kenya's glaciers is radial. Despite this, all streams eventually end up as tributaries to one of two rivers; the Tana River that runs tirelessly south and eventually into the Indian Ocean and the more sporadic Ewaso Ng'iro River in the eastern lowlands.

But the River Liki, stretching from the northern side of the mountain, was traditionally depended on by the Borana community. It no longer flows all year round.

"It has now become seasonal, flowing for only 8 months of the year," said water manager Kalua. "It is during these months that conflict between the Meru and Borana communities flares up."

Before a mountain hiker gets to the fast disappearing glaciers of Mt Kenya, he or she will go through a succession of distinctive, elevation-based vegetation zones. The grasslands first, then at about 6,000 feet (1,830 m) a ring of dense forest covering the slopes up to about 10,000 feet (3,050 m).

Then the slightly ticklish scent of cedar and yellowwood. From 8,000 feet (2,440 m), with the air getting thinner and thinner, one would walk into a row of bamboo forest that noticeably becomes shorter as you go higher. At 12,000 feet (3,660 m), you'll be on a moor where the ground becomes slippery due to the moss and lichen covering the ground. Then at 15,000 feet (4,570 m), the glaciers announce their majesty in between bare rock, slate and ice, sitting on top of the mountain like icing on a massive cake.

In 1893, the famous British geologist, John W. Gregory, led the first scientific expedition up Mt Kenya but could not make it past the glaciers to reach the summit.

Now, the climb and descent to the highest mountain peak and one of two remaining glacier capped mountains in East and Central Africa takes a total of five days.

"If I were to kneel and pray facing Mt Kenya, my children will think I am growing mad," Gitaru, the farmer from the little village in Nyeri says. "Very many things have changed in very little time," says the 73-year-old, the sun setting behind the god of his forefathers, whose disappearance has turned neighbors against one another.

Parallel to that, the turnout for a fiercely contested presidential election appeared to be high among the 19.6 million registered voters. Opposition leader Raila Odinga alleged the results were manipulated by hackers.

Source:
http://www.climatechangenews.com/2017/08/02/dying-gods-mt-kenyas-disappearing-glaciers-spread-violence/

Elephants crossing the Ewaso Ng'iro River in Samburu. Original Photo by Lucy King/Save the Elephants (https://voices.nationalgeographic.org/2013/01/31/time-running-out-to-save-elephants-from-ivory-trade/eles/)

Climate Change: U.S.' Crop Yields Could Be Curbed by 2050: MIT

Climate change could deplete some U.S. water basins and dramatically reduce crop yields in some areas by 2050, according to researchers at the Massachusetts Institute of Technology. A study by a group of MIT scientists and economists is one of the first to examine how the warming climate could affect the availability and distribution of the water basins that farmers depend on for irrigation.

If no action is taken to combat climate change, the team predicts that by 2050, numerous basins used to irrigate crops across the country will either start to experience shortages or see existing shortages "severely accentuated."

Elodie Blanc, the lead author for the study, said certain regions in the southwest already are seeing a drop in the amount of water available for irrigation and other regions could follow.

"If we mitigate, this could prevent added stress associated with climate change and a severe decrease in runoff in the western United States," Blanc said. "But it will be even worse in the future if we do nothing at all."

Erwan Monier, a coauthor on the study, said researchers will now seek to examine the ways reduced crop yields could influence the country's agricultural landscape. Under some scenarios, researchers actually project higher yields for irrigated crops such as wheat, soybean, and sorghum in the southern plains, expected to receive more rainfall because of climate changes.

But farmers could feel the impact in other areas.

"In the real world, if you're a farmer and year after year you're losing yield, you might decide, 'I'm done farming,' or switch to another crop that doesn't require as much water, or maybe you move somewhere else," Monier said.

The information provided in the study could prompt farmers, and others outside the agricultural sector, to adapt before they start experiencing water shortages and problems with irrigation.

"We hope there will be adaptation ahead of time so that the impact on the economy is as limited as possible," Monier said. "We want people to realize the way the world is at this moment is not going to be sustainable in the future."

Source:
https://www.bostonglobe.com/metro/2017/07/13/climate-change-could-curb-crop-yields-mit-study-says/Xd7OBO7XCMi92rcXkDwl4M/story.html

Clean Energy: 139 Countries Could Easily Be 100 Percent Powered by Clean Energy

The latest roadmap to a 100% renewable energy future from Stanford's Mark Z. Jacobson and 26 colleagues is the most specific global vision yet, outlining infrastructure changes that 139 countries can make to be entirely powered by wind, water, and sunlight by 2050 —after the electrification of all energy sectors.

Such a transition could mean less worldwide energy consumption due to the efficiency of clean, renewable electricity; a net increase of over 24 million long-term jobs; an annual decrease in 4-7 million air pollution deaths per year; stabilization of energy prices; and annual savings of over US$20 trillion in health and climate costs. The information appeared August 23, 2017, in the journal *Joule*, Cell Press's new publication focusing on sustainable energy.

The challenge of moving the world toward a low-carbon future in time to avoid exacerbating global warming and to create energy self-sufficient countries is one of the greatest of our time. The roadmaps developed by Jacobson's group provide one possible endpoint. For each of the 139 nations, they assess the raw, renewable energy resources available to each country; the number of wind, water, and solar energy generators needed to be 80% renewable by 2030 and 100% by 2050; how much land and rooftop area these power sources would require (only around 1% of total available, with most of this open space between wind turbines that can be used for multiple purposes); and how this approach would reduce energy demand and cost compared with a business-as-usual scenario.

The analyses specifically examined each country's electricity, transportation, heating/cooling, industrial, and agriculture/forestry/fishing sectors. Of the 139 countries —selected because they were countries for which data were publically available from the International Energy Agency and collectively emit over 99% of all carbon dioxide worldwide— the places the study showed with a greater share of land per population (e.g., the United States, China, the European Union) are projected to have the easiest time making the transition to 100% wind, water, and solar. The most

difficult places to transition may be highly populated, very small countries largely surrounded by oceanic waters, such as Singapore, which may require an investment in offshore solar to convert fully.

As a result of the transition, the roadmaps predict a number of collateral benefits. For example, by eliminating oil, gas, and uranium uses, the energy associated with mining, transporting, and refining these fuels is also eliminated, reducing international power demand by around 13%. Because electricity is more efficient than burning fossil fuels, demand should go down another 23%. The changes in infrastructure would also mean countries wouldn't need to depend on one another for fossil fuels, reducing the frequency of international conflict over energy. Finally, communities currently living in energy deserts would have access to abundant, clean, renewable power.

The *Joule* paper is an expansion of 2015 transition roadmaps created for each state in the U.S. to 100% clean, renewable energy —and with an analysis of whether or not the electric grid would remain stable upon such a transition. Not only does this new study cover nearly the entire world, there are also improved calculations on the availability of rooftop solar energy, renewable-energy resources, and jobs created versus lost.

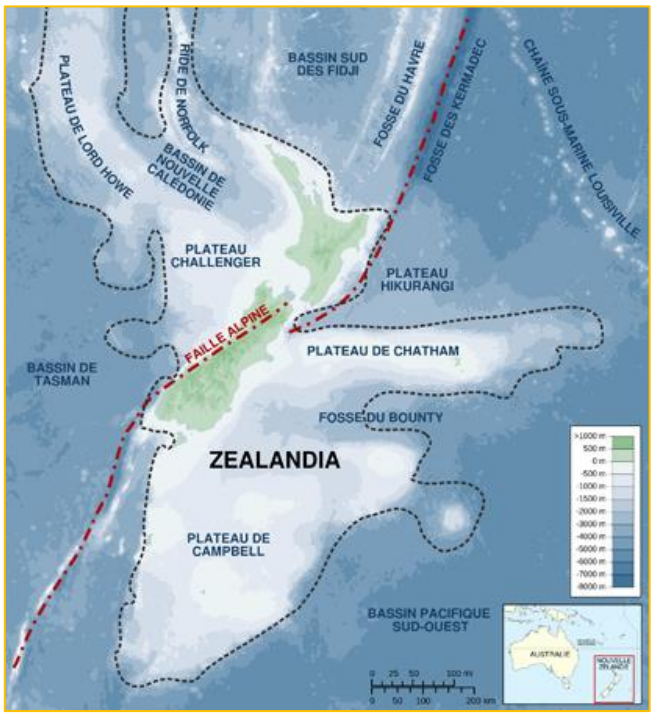
The 100% clean, renewable-energy goal has been criticized by some for focusing only on wind, water, and solar energy and excluding nuclear power, 'clean coal', (geothermal) and biofuels. However, the researchers intentionally excluded nuclear power because of its 10-19 years between planning and operation, its high cost, and the acknowledged risks of meltdown, weapons proliferation, and waste sites. 'Clean coal' and biofuels are neglected because they both cause heavy air pollution, which Jacobson and coworkers are trying to eliminate, and emit over 50 times more carbon per unit of energy than wind, water, or solar power.

The 100% wind, water, solar studies have also been questioned for depending on technologies such as underground heat storage in rocks, which exists only in a few places, and the proposed use of electric and hydrogen fuel cell aircraft, which currently exist only in small planes. Another criticism is the massive investment it would take to move a country to the desired goal. Jacobson counters that wind, water, and solar can face daily and seasonal fluctuation, but these stability concerns can be addressed in several ways. Jacobson says also that the overall cost to society (the energy, health, and climate cost) of the proposed system is one-fourth of that of the current fossil fuel system.

Source: https://www.pvbuzz.com/press-releases/countries-100-percent-powered-clean-energy/, http://thesolutionsproject.org/resource/139-country-100-infographics/

Science: Expedition to Submerged Continent Zealandia

Surrounding New Zealand is a mass of the earth's crust about half the size of Australia, the continent Zealandia. What makes Zealandia different from other continents is that more than 90 percent of it is submerged.



Zealandia surrounds New Zealand. Image Credit: International Ocean Discovery Program (IODP).

Increasingly detailed seafloor maps have attracted attention to Zealandia. On late July, 30 researchers started sailing on a two-month ocean drilling expedition to search for clues to Zealandia's history.

Participants in International Ocean Discovery Program (IODP) Expedition 371, sponsored by the U.S.' National Science Foundation (NSF) and its international partners in IODP, will sail from Townsville, Australia, aboard the JOIDES Resolution, one of the world's most sophisticated scientific drill ships.

IODP is an international research collaboration that coordinates seagoing expeditions to study the history of the earth recorded in sediments and rocks beneath the ocean floor.

Expedition 371 scientists will join more than 20 crew members in drilling at six Tasman Sea sites at water depths ranging from 1,000 to 5,000 meters.

At each site, the scientists will drill from 300 to 800 meters into the seafloor to collect core samples of sediments deposited over millions of years. The cores hold fossil evidence the scientists will use to assemble a detailed record of Zealandia's past.

"If you go way back, about 100 million years ago, Antarctica, Australia, and Zealandia were all one continent," said expedition co-chief scientist Gerald Dickens, a geoscientist at Rice University. "Around 85 million years ago, Zealandia split off on its own, and for a time, the seafloor between it and Australia was spreading on either side of an ocean ridge that separated the two."

"Some 50 million years ago, a massive shift in plate movement happened in the Pacific Ocean," said Jamie Allan, a program director in NSF's Division of Ocean Sciences, which supports IODP. "The pacific plate dove under New Zealand; New Zealand was lifted above the waterline; and a new arc of volcanoes was created. The IODP expedition will look at the timing and causes of these changes, related changes in oceanic circulation patterns, and finally climate changes on our planet."

"We're looking at the best place in the world to understand how plate subduction initiates," said Dickens. "This expedition will answer a lot of questions about Zealandia."

Prior to the shift, Australia and New Zealand were spreading apart. After the shift, the area that separated them was under compression for millions of years.

Then, in the final stage, the Pacific Plate dove beneath Zealandia, forming a new subduction zone.

"What we want to understand is why and when the various stages from extension to relaxation occurred," Dickens said. "The core samples will help tell us that. They'll be analyzed for sediment composition, microfossil components, mineral and water chemistry, and physical properties."

He said the research may also answer questions about the way earth's climate has evolved in the last 60 million years.

Source:
https://www.nsf.gov/news/news_summ.jsp?cntn_id=242506&WT.mc_id=USNSF_51&WT.mc_ev=click

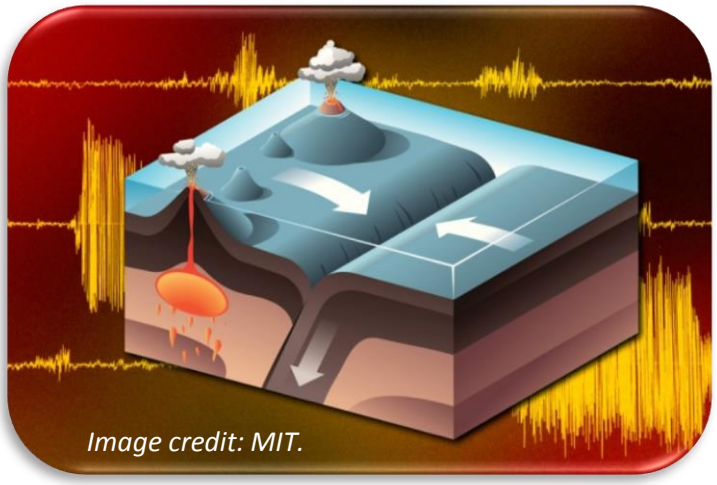
Science: Ancient Earth's Hot Interior Caused Tectonic Plates to Sink

Plate tectonics has shaped the earth's surface for billions of years as continents and oceanic crusts have pushed and pulled on each other, continually rearranging the planet's façade. As two massive plates collide, one can give way and slide under the other in a process called subduction. The subducted slab slips down through the earth's viscous mantle, like a flat stone in a pool of honey.

For the most part, today's subducting slabs can only sink so far, about 670 kilometers below the surface, before the mantle's makeup turns from a honey-like consistency, to that of paste —too dense for most slabs to penetrate further. Scientists have suspected that this density filter existed in the mantle for most of earth's history.

Now, however, geologists at the Massachusetts Institute of Technology (MIT) have found that this density boundary was much less pronounced 3 billion years ago in the ancient earth's mantle. In a paper published in *Earth and Planetary Science Letters*, the researchers note that the ancient earth had a mantle as much as 200°C hotter than today's —temperatures that may have brewed up more uniform, less dense material throughout the entire mantle.

The researchers also found that, compared with today's rocky material, the ancient crust was composed of much denser stuff enriched in iron and magnesium. The combination of a hotter mantle and denser rocks likely caused subducting plates to sink all the way to the bottom of the mantle, 2,800 kilometers below the surface, forming a 'graveyard' of slabs atop the earth's core.



These results paint a very different picture of subduction than that of today. They suggest that the earth's ancient mantle was much more efficient in drawing down pieces of the planet's crust.

"We find that around 3 billion years ago, subducted slabs would have remained denser than the surrounding mantle, even in the transition zone, and there's no reason from a buoyancy standpoint why slabs should get stuck there. Instead, they should always sink through, which is a much less common case today," says

lead author Benjamin Klein, a graduate student in MIT's Department of Earth, Atmospheric and Planetary Sciences (EAPS). "This seems to suggest there was a big change going back in earth's history in terms of how mantle convection and plate tectonic processes would have happened."

"There's this open question as to when plate tectonics really started in the earth's history," Klein says. "There's general consensus it was probably going on back at least 3 billion years ago. This is also when most models suggest the earth was at its hottest."

To estimate the density of ancient slabs, Klein and his co-authors compiled a large dataset of more than 1,400 previously analyzed samples of both modern rocks and komatiites —classic rock types that were around 3 billion years ago but are no longer produced today. These rocks contain a higher amount of dense iron and magnesium compared to today's oceanic crust. Klein used the composition of each rock sample to calculate the density of a typical subducting slab, for both the modern day and 3 billion years ago.

The team used a thermodynamic model to determine the density profile of each subducting slab, or how its density changes as it sinks through the mantle, given the mantle's temperature, which they took from others' estimates and a model of the slab's temperature. From these calculations, they determined the depth at which each slab would become less dense than the surrounding mantle.

The team found that their estimates for where this boundary occurs in the modern mantle —about 670 kilometers below the surface— agrees with actual measurements taken of this transition zone today, confirming that their method may accurately estimate the ancient earth.

For the ancient earth 3 billion years ago, the researchers found that, because the ancient mantle was so much hotter than today, and the slabs much denser, subducting slabs would have sunk straight to the bottom of the mantle to their final resting place just above the earth's core.

Source: http://news.mit.edu/2017/ancient-earth-hot-interior-graveyard-continental-slabs-0822

Financing: IRENA's Analysis on Renewable Energy Auctions

On late July, the IRENA (International Renewable Energy Agency) published Renewable Energy Auctions - Analyzing 2016. *The following excerpts are from the Executive Summary.*

Over the past decade, auctions have spread quickly as a means of eliciting supplies of energy from renewable sources, growing faster in the past few years than feed-in tariffs (or premiums) and quotas (or renewable portfolio standards). The spread of auctions can be ascribed to the increasing maturity of technology and other developments in the sector.

The potential of auctions to achieve low prices has been a major motivation for their adoption, worldwide. Price results for solar and wind auctions have shown a decreasing trend over recent years. In 2010, solar energy was contracted at a global average price of almost US$ 250/MWh, compared with the average price of US$ 50/MWh in 2016. Wind prices have also fallen by 2010, albeit at a slower pace, as the technology was more mature.

The evolution of prices resulting from auctions and their key determinants are basically: 1) Access to finance and country-specific conditions; 2) Investors' confidence and the presence of a conducive environment; 3) Other policies aimed at supporting renewable energy development; and 4) The design elements of the auction.

Renewable energy auctions passed several important milestones in 2016. Countries such as Argentina, Canada, Mexico and Zambia kicked off auction-based programs for promoting renewable power. Auctions for technologies less mature than onshore wind and solar photovoltaics (PV) have emerged –with offshore wind auctions held in Denmark and the Netherlands, biogas capacity auctions in Argentina and Peru, and an auction for solar thermal power announced in Dubai in the United Arab Emirates. Several price records were set during the year: in Chile and the United Arab Emirates for solar PV, Morocco for onshore wind, and Denmark for offshore wind. In countries such as Chile and Mexico, renewables were more competitive than conventional energy technologies and won a large share of contracts at record-breaking prices. The main results of the 2016 auctions for 16 countries are presented in the table in the following page, whose data were taken from the IRENA's report, excepting the data from geothermal energy in Mexico.

As shown in the table, only one geothermal project was offered in all the public auctions —the Los Azufres III, Phase 2 project, submitted by the Comisión Federal de Electricidad in Mexico and mentioned in the IGA News v. 105, p. 14. The project, still under construction, is the first Mexican geothermal project granted in a public-power auction. It has to be mentioned that the final prices submitted for this plant didn't include the cost of the feeding wells, because the plant is actually an expansion project that will replace three old and smaller back-pressure geothermal plants of 5MW in capacity each, and then will use the already available steam. But anyway the power plant, with 25MW of firm electrical generating capacity, accounting for the low energy price

Country	Wind		Solar		Hydro		Biomass		Geothermal	
	MW	Price*	MW	Price*	MW	Price*	MW	Price*	MW	Price*
Argentina-1	707	<59.5	400	<60			1.2	118		
Argentina-2	1038	<53	1853	<55						
Brazil					500	<57.5	198	<60.2		
Canada	1300	<66	140	<120	15.5	<135				
Chile	**	<45.2	***	29.1						
China			1000	<73						
Denmark	600	53.9								
Germany			130	<81						
India			6500	<73						
Mexico-1	620	<54.3	1100	<44						
Mexico-2	1038	<36.2	1853	<32.8					25	<37
Morocco	850	<30								
Netherlands	700	<80.4								
Peru	162	<37	184.5	<48	80	<46				
Russia	610	?								
UAE-1			800	29.9						
UAE-2			350	24.2						
United States			26	26.7						
Zambia			73	>67						

** US$/MWh, ** 4400 GWh/year, ***580 GWh/year.*
In the cases of Argentina, Mexico and the UAE, 1 & 2 refer to the first and second auctions in 2016.

and representing a milestone for Mexican geothermal-electrical projects.

Source:
http://www.irena.org/DocumentDownloads/Publications/IRENA_REAuctions_summary_2017.pdf

Financing: Negative Electricity Prices

Between March and July 2017, there were over 100 hours when wholesale prices of the California Wholesale Electricity Market were below zero. These negative prices have received a lot of attention, and the discussion has almost universally attributed the negative prices to California's emphasis on solar generation.

Solar is indeed part of the story, but another explanation is at least as important. Over the last decade, hydro, not solar, has been the primary driver of negative electricity prices in the United States. The year 2017 is no exception. Spring 2017 was among the rainiest in history, and this combination of hydro and solar has pushed prices below zero.

So far in 2017, California wholesale electricity prices have been negative in 2.5% of the hours, more than 130 in total.

Increased solar generation is definitely part of the explanation for what's happened in California in 2017. Solar capacity in California, including both distributed and utility-scale systems, has grown from less than 1GW in 2007, to 14 GW today. Also, the timing of negative prices in 2017 points squarely at solar. Negative prices peaked in March and April between noon and 5 pm on sunny days with high levels of solar generation.

But the big surprise in the attached figure is 2011. Although it didn't receive as much attention, there were over 100 hours during 2011 with negative electricity prices in California. But why? Back in 2011, just a fraction existed of the solar generation that we have today. So what pushed prices below zero?

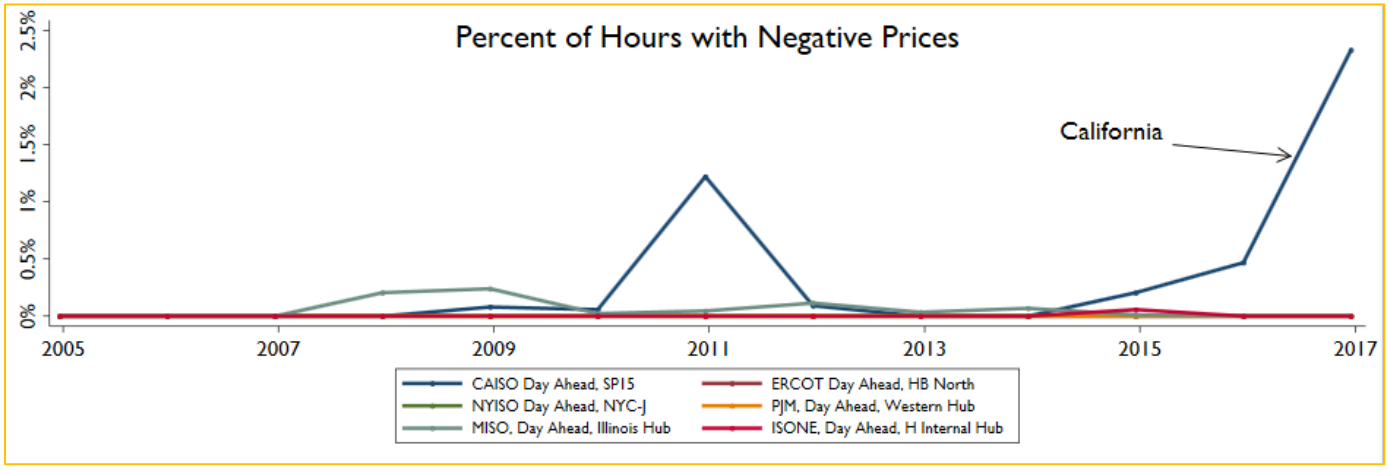
The answer is hydro. The two wettest years in the last decade: 2011 and (probably) 2017. During just the first 5 months of 2017, California had already generated 22 million MWhs from hydro, about equal to typical hydro-generation for an entire year. If the rest of 2017 matches hydro-generation from last year, 2017 will end up being the second highest hydro year in the last decade.

But why don't hydro operators just leave the water in the reservoir or "spill" waters without running the generators? During these negative price hours, hydro owners are paying money to produce electricity – why? Why, for example, on April 9th of this year was so much hydro operating in the middle of the day, even while wholesale prices were negative?

Part of the answer is that many hydro facilities are "run of the river", i.e. small-scale facilities in which the river's flow itself is used to generate electricity. Negative prices weren't envisioned when these facilities were built, so many lack the ability to "spill" water when necessary. Presumably it is very expensive to retrofit such facilities.

But large facilities like Shasta Dam are more puzzling. While it is true these facilities are limited in how much water they can store, it is not clear why this should matter. Nor should it matter if there are minimum and maximum flow constraints. When prices are negative, large hydro-facilities should always be able to "spill" water and this would seem to be preferable.

Thus it seems to be something else: operational, legal, or contractual matters keeping these facilities running even when prices are negative. In the northwest, dam operators have limits on how much they can "spill" because spilling churns air into the water, which is bad



This figure was constructed by Lucas Davis (UC Berkeley) using hourly wholesale prices from SNL Financial. The underlying data are complete for NYISO, MISO, PJM, and ISONE, but start in 2009 for CAISO, and in 2010 for ERCOT so there may have been negative prices in those markets prior to those years. Also, data for 2017 is only available until mid-August, so the percentage is calculated over only part of the year.

for fish. Perhaps there is some similar regulation for California dams.

Water does have a lot to do with negative prices. Solar alone would not have driven such levels of negative prices this year if it hadn't happened on top of near-record levels of hydro-generation. So in some sense, hydro can be even harder to turn off than wind and solar.

Source:
https://energyathaas.wordpress.com/2017/08/28/is-solar-really-the-reason-for-negative-electricity-prices/

Book Reviews: *Geothermal Power Generation: Developments and Innovation* --a Review

Paul Gipe, Wind-Works.org

Geothermal energy is one of the dark horses of renewable energy. Few 'renewable energy advocates' know much —if anything— about it. They don't know what geothermal contributes today and have no clue what its role could be in a 100% renewable energy future. This is a grave mistake. Where the resource exists…, geothermal should be an essential part of the generation mix…

That's why I was happy to get a copy of *Geothermal Power Generation: Developments and Innovation* by Ron DiPippo [editor]. The book is a tour de force for geothermal engineers. DiPippo is Chancellor Professor Emeritus of Mechanical Engineering and the former Associate Dean of Engineering at the University of Massachusetts in Dartmouth, Mass.

The 854-page tome is a companion to DiPippo's previous *Geothermal Power Plants*, one of the definitive texts on geothermal technology. The new book is a continuation of his work, this time in collaboration with other experts in the field.

As a generalist, I found Part Four the most useful. There are eight case studies, beginning with the birthplace of geothermal: Larderello in Tuscany. This is followed by a review of geothermal in California, including the Geysers, a giant field in Northern California. Famous fields in New Zealand, Mexico, Indonesia, and Central America are also covered.

I was hooked as soon as I opened up the book to the chapter on Larderello. The subtitle described the history of the "boraciferous region" in what the Italians call the Colline Metallifere between Pisa and Florence. It was here geothermal fluids boiled to the surface carrying solutions of borates.

It's obscure, very obscure, but borates from Tuscany's geothermal fields are linked to the history of California and specifically the region where I live.

Borates are one of the major mineral products of California and the mining for borates —the search for them, and their exploitation-- are integral to many famous tales from California's period of European settlement.

Death Valley National Park is a direct result of the borate boom as is the famous 20 mule team wagon trains that carried the borates from Death Valley to Mojave, California. One of the world's largest borate mines is not far from Mojave…

And it was competition from California's abundant borates that led inexorably to the collapse of Larderello's borate industry and the rise of geothermal power generation. As the Italians continued to refine their mining of the borate solutions to stay competitive with California, they began drilling deeper and deeper

wells. They also began using the hot geothermal fluids for the industrial process of concentrating the borates. Subsequently, they began electrifying the fields and when they could no longer sell the borates they turned to selling the electricity that they generated from geothermal energy. Today, the geothermal plants in and around Larderello generate from 5 TWh to 7 TWh per year for almost 2% of Italy's total generation.

The 'Geysers,' as they are called, remain one of the world's largest geothermal fields. The region in Northern California has been producing electricity from geothermal energy since the 1960s!

I'd written about the Geysers long ago —in the mid-1980s. See Geysers Losing Steam: a Finite Resource After All? At the time the field was in steep decline. As geologist Carl Austin said at the time, there were simply too many 'straws in the bottle' for the field to maintain its pressure. The solution was known: reducing the number of wells and the extraction rate.

Two authors from California's geothermal industry describe in this case study how the solutions were eventually implemented and thoroughly document the results.

While the field has never recovered its previous glory, the steps taken in the 1990s have arrested its rapid decline. The field's depletion rate has dropped from a high of 4.8% per year in the 1980s to 2% per year in the 2000s. Nevertheless, steam production has been halved from its peak in the late 1980s, illustrating how much the field had been overdeveloped.

The data in this case study is the most succinct and up-to-date I've found for production from the Geysers. Companies operating in California are notoriously secretive about their generation. It was a sign of how serious the problem had become that the companies 'mining' the geothermal resource in the Geysers had to share data and work together to prevent a complete collapse of the industry —and their costly investments.

Though the case study on the Geysers doesn't disprove whether or not geothermal energy is a finite resource, it does address the question —with 55 years of stats— of how to successfully manage the resource with an eye toward sustainability.

DiPippo and his co-authors have produced a comprehensive reference work for those working in the geothermal industry and should be a reference work on the shelf of every environmental organization pursuing a 100% renewable energy supply.

Ron DiPippo, editor. *Geothermal Power Generation: Developments and Innovation*. London: Woodhead Publishing, 2016. 854 pages. ISBN: 9780081003374 cloth. $210.00, ISBN: 9780081003442, e-pub. $210.00. 9.5 x 6.25 x 1.75 inches. 1.5 lbs. Printed in England.

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