IGA NEWS

Newsletter of the International Geothermal Association

Quarterly No. 105

IGA ACTIVITIES

Message from the President

Dear IGA members,

I finish the term of my Presidency at the end of October this year, so this is my last newsletter as IGA President.

I have greatly enjoyed having input to guiding the IGA forward over the last three years, working with the Secretariat, and with the Board. I really appreciate the support I have received and the lessons I have learned from so many people.

Working with the Executive Director, Marietta Sander and her assistant Karolina Andersson has been particularly positive. Marietta has lead the IGA on the international stage and established high-level connections necessary to ensure that the geothermal industry has the notice of decisionmakers worldwide. Thus it is with great regret that the IGA announces that Marietta is resigning her post as Executive Director. The IGA is grateful to Marietta for all her hard work in the last six years, and hope that she will maintain a connection with the geothermal industry.

I want to thank Contact Energy Ltd and the New Zealand Geothermal Association for their support of my participation in the IGA.

The partners of Board members deserve special mention for tolerating the demands the IGA has made on their lives. I especially thank Maria de los Angeles Bernal Davila, for her friendship; Maria, let's ensure it continues.

Finally, words cannot express how much I appreciate the support of IGA Past President Roland Horne, who provided me thoughtful insights and advice. Thank you Roland.

In November I will be taking up an appointment as the Director of the Iceland School of Energy, Reykjavik University. I am proud and privileged to have had the opportunity to work with friends and colleagues at Wairakei for the past five years. I can honestly say that it is hard to leave.



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I have just returned from the recent European Geothermal Congress in Strasbourg. I and two other members of the WING Global Team were supported by Nalco Water, to attend the Congress to promote gender equality in the European geothermal industry. Using the IGA booth at the Exhibition as a base, we continued the WING membership drive, surveyed congress attendees about gender equality in the geothermal industry, spoke about the history of women in the New Zealand geothermal industry, and about the Iceland WING Roadmap to 2020.' (www.womeningeothermal.com). It is heartening to see that the IGA membership are open to promoting diversity, demonstrated by their strong support of Women in Geothermal (WING). We thank all those who people who gave us their time and attention.

The new IGA Board for 2016 to 2019 will meet for the first time in Addis Ababa, Ethiopia. This Board has seven women members (which includes myself as Past President) which is the highest number ever for an IGA Board. This prompted me to investigate the numbers of women directors on IGA Board since 1988 (the start of the IGA). The results presented in Figure 1 show that the number of women on the IGA Board increased to six in 2004, but has then been variable between four and five, and now is back up to seven. From 2010 to the end of this year, the IGA has also had a women Executive Director, who participates in Board meetings, which I



Figure 1. Number of women on the IGA Board, 1988 to 2016.



Figure 2. 2013 – 2016 IGA Board at the Harpa Conference Centre, Reykjavik, Iceland, April 2016.

have included as a separate dataset. I thank Arni Ragnarsson for providing the data.

It would be encouraging to see this data for Boards of national geothermal associations presented in a World Geothermal Congress session on women in the geothermal industry. This is a relevant topic, with an increasing number of organisations are acknowledging that greater board diversity (including gender diversity) has a positive effect on performance. My message to women in the geothermal industry is – represent your industry on the Board of your national geothermal association.

Finally, I want to congratulate Professor Ruggero Bertani on his election to President of the European Geothermal Energy Council (EGEC). We look forward to an era of continued co-operation between the IGA and EGEC.

Ngā mihi nui ki a koutou katoa (Best wishes to you all), and Sjáumst fljótlega (See you soon).

Juliet Newson, President International Geothermal Association

New IGA Board of Directors 2013-2016

Marietta Sander, IGA Executive Director, & Luis C.A. Gutiérrez-Negrín, Chair of the Information Committee

The new IGA Board of Directors (BoD) for the period 2016-2019 has been elected. In May 2016, the IGA Secretariat sent out personal e-mails to all members with voting rights informing them about the election procedures and individual voting passwords for the IGA online voting platform.

The election was also announced in the last IGA News No. 103 in early April 2016 and on the IGA website. The voting platform was open from 20 May until 19 July 2016. All votes were processed by the IGA IT administrator at the Secretariat. The number of eligible voters was 4,650 IGA members, out of which 1,394 valid votes were received. That represents a participation of 30%, which is still low but higher than the participation in the previous election in 2013, when only 880 members cast their votes—out of a total of 5212 members (17%).

Geographically, most votes came from the national associations in the U.S. (159 votes or 11% of the total), Indonesia (146, or 10.5%), Philippines (140, or 10%), New Zealand (139, or 10%) and Iceland (96, or 6.9%).

Members from these five countries cast almost a half (48.7%) of the total. Not all of them participated the most, however, when we consider what percentage of their total membership participated in the election. From this viewpoint, the most involved in the election were the national associations of Hungary (Hungarian Geothermal Association) with 76%, Iran (70%), Japan and Poland (58% each), Iceland (53%), Romania and Russia (50% each) and Italy (49%).

The IGA President approved the results and the candidates were notified. The following table shows the names and countries of the members of the new Board for 2013-2016.

Blair, Andy* New Zealand
Bracke, Rolf Germany
Brophy, Paul USA
Brotheridge, Jane* New Zealand
Capuano, Jr, Louis* USA
Darma, Surya* Indonesia
Della Vedova, Bruno Italy
Fronda, Ariel D.* Philippines
Genter, Albert France
Georgsson, Ludvik S. Iceland
Harvey, Colin* New Zealand
Izquierdo-Montalvo, Georgina* Mexico
Kepinska, Beata Poland
Matthíasdóttir, Kristín Vala* Iceland
Meier, Peter* Switzerland
Morata, Diego* Chile
Moya, Paul* Costa Rica
Newson, Juliet** New Zealand
Omenda, Peter* Kenya
Poernomo, Abadi Indonesia
Richter, Alexander Iceland
Rueter, Horst* Germany
Sabin, Andrew* USA
Salonga, Noel* Philippines
Svalova, Valentina* Russia
Szita, Gábor* Hungary
Uchida, Toshihiro Japan
Verdoya, Massimo* Italy
Yamada, Shigeto Japan
Zarrouk, Sadiq New Zealand

*First term. **President 2013-2016, Member exoficio.

After the election of the new board, an internal election took place among its members to define the President, Vice President, Secretary and Treasurer. By the time of closing this edition, Alexander Richter, from Iceland, has been elected as the new President for the term 2016-2019, being in process the election of the other officers. Our best wishes to Alex and all the new officers.

Latin America Symposium by IGA and IEA Geothermal at the Next GeoTHERM

On 14-15 February 2017, the IGA partners with the International Energy Agency - Geothermal Technology Collaboration Programme (IEA Geothermal TCP) and the Exhibition Centre Offenburg to offer a Latin America Symposium with distinguished Latin American and international experts. The Symposium is to be held one day prior to the GeoTHERM 2017 – Expo & Congress, which officially opens in the morning of Wednesday, 15 February 2017.

Insights into the Latin American geothermal market, resources, research activities, risk mitigation mechanisms and technology transfer opportunities will be provided at the Symposium. The dialogue on



Tuesday, 14 February will lead to a late afternoon gettogether at the fair where guests are invited to meet Latin American and other German/international colleagues. Registration for both events is very affordable and managed by the Exhibition Centre Offenburg:

www.geotherm-germany.com/en/registration.

The IGA also plans to offer a matchmaking event during the GeoTHERM - Expo & Congress where Latin American representatives can meet with German companies who provide geothermal services and products.

Under the auspices of the International Energy Agency, the IEA Geothermal TCP provides an excellent framework for international cooperation, sharing the latest technical and policy developments. IEA Geothermal promotes the sustainable use of geothermal energy worldwide through its website, country and statistical reports, workshops, seminars, publications and by personal networking. Through high quality information, widely communicated, IEA Geothermal contributes to the mitigation of climate change and the development of geothermal technology worldwide. Participants in IEA Geothermal benefit by integrating international developments in the market, research, and policy strategies. IEA Geothermal was established in 1997 and includes 13 countries, the EU commission, one geothermal association and one enterprise. It is open to new members.

IGA Executive Director – Vacancy from 2017

The International Geothermal Association is seeking for a new IGA - Executive Director from beginning of 2017. The position is based at the IGA Secretariat in Bochum, Germany. A vacancy announcement for this multifaceted task for a well experienced networking professional from the geothermal community will be published shortly by the Bochum University of Applied Sciences and the GZB – International Geothermal Centre, on the IGA Website.

For further information please contact GZB-Director Rolf Bracke: rolf.bracke@hs-bochum.de.

New Geothermal Specifications Approved by the UNECE

In late September, the UNECE (United Nations Economic Commission for Europe) Committee on Sustainable Energy approved the document ECE/ENERGY/2016/5 – Specifications for the application of United Nations Framework Classification for Fossil Energy

and Mineral Resources and Reserves (UNFC-2009) to geothermal energy resources. The UNFC-2009 is applicable to all extractive activities worldwide and now also renewable energy and injection projects. It is developed by the UNECE Expert Group on Resource Classification. The IGA is represented in the Expert Group and its Bureau. The Expert Group provides a forum for stakeholders, including governments, industry, the financial reporting sector, international professional organizations and societies and associations, to assist in defining the needs to be met by the classification, its definitions, specifications and guidelines, and a vehicle for recommending their application. The work on application of UNFC to renewable energy resources is undertaken by a dedicated Task Force of the Expert Group. The Task Force has developed generic specifications for applying UNFC to renewables and is now focusing on the development of renewable commodity-specific specifications, including for bioenergy, hydropower, solar and wind.

Following is the press release produced by IGA and UNECE.

UNFC is now applicable to geothermal energy resources

Geothermal energy could play a significant role in ensuring access to affordable, reliable, sustainable and modern energy for all, but production today is only at 7% of the estimated global potential. Geothermal energy exists in almost 90 countries, but only 24 of them produce electricity from geothermal sources. In 2011 the International Energy Agency (IEA) produced a Technology Roadmap for Geothermal Heat and Power that showed that the world could increase production of heat and electricity from geothermal energy at least 10fold by 2050. Geothermal energy's potential as a viable energy option with global scale has been constrained to date by a lack of clear global assessment guidelines and standards.

Now, however, a globally-applicable, harmonized standard for reporting geothermal resources has become operational. At its 25th session on 30 September 2016, the UNECE Committee on Sustainable Energy approved the Specifications for Application of the United Nations Framework for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC) to Geothermal Energy Resources.

The Director of the Sustainable Energy Division of UNECE, Scott Foster, noted "The 2030 Agenda for Sustainable Development has just celebrated its first anniversary. Application of UNFC to renewable energy resources is a priority for our member States, and inclusion of geothermal energy in UNFC will help to attain Sustainable Development Goal #7 by improving

UPCOMING EVENTS

5th Polish Geothermal Congress

11-14 October 2016, Mszczonow, Poland Held by the Polish Geothermal Society (Mainly in Polish)

40th GRC Annual Meeting & GEA Geothermal Energy Expo

23-26 Oct 2016, Sacramento, California, U.S.

6th African Rift Geothermal Conference (ARGeo-C6)

2-4 Nov 2016, Addis Ababa, Ethiopia

38th New Zealand Geothermal Workshop 23-25 Nov 2016, Auckland, New Zealand

German Geothermal Congress (DGK 2016) 29 Nov-1 Dec 2016, Essen, Germany

<u>42nd Stanford Geothermal Workshop</u> 13-14 Feb 2017, Stanford, California, U.S.

GeoTHERM 2017 Expo & Congress 15-16 February 2017, Offenburg, Germany

8th European Geothermal PhD Days 1-3 March 2016, Bochum, Germany

Note: Please check the <u>IGA website</u> for more events.

the positioning of geothermal within the policy and investment communities."

Having an international system and a standardized terminology for reporting geothermal resources will build trust and understanding of the geothermal industry with investors, regulators and the general public alike. The work to develop the UNFC geothermal specifications was carried out under UNECE's Memorandum of Understanding with the International Geothermal Association (IGA). UNFC is applicable to all extractive activities, renewable energy and injection projects.

The President of IGA, Juliet Newson, stated "The IGA aims to encourage, facilitate and, when appropriate, promote the coordination of activities related to worldwide research, development and application of geothermal resources. In a manner consistent with the aim of the IGA, and led by Professor Gioia Falcone, the UNFC Geothermal Working Group of the IGA Resources and Reserves Committee has now produced a set of Specifications for classifying, comparing and reporting estimates of geothermal potential, resources

and reserves. The Specifications will now be maintained through regular review, through a transparent governance structure, and process, that allows input from all stakeholders. On behalf of the IGA, I thank Professor Falcone, and all stakeholders and collaborators involved in the development of the Specifications. In particular, I want to extend our thanks to the Chair of the IGA Resources and Reserves Committee, Dr. Graeme Beardsmore, for his dedication and hard work."

Achieving a successful sustainable development agenda requires partnerships between governments, the private sector and civil society, as called for in SDG17 "Revitalize the global partnership for sustainable development". Professor Gioia Falcone underlined "This work has only been possible due to productive partnerships with all stakeholders. In particular, the collaboration with IGA as the international geothermal umbrella has proven to be of strategic relevance, allowing for a high degree of interaction and engagement with the World Bank-ESMAP, IRENA, IEA-GIA, US DOE, GEA, GRC, EGEC, UGI, and more. After only 20 months from the appointment of a 12-person Working Group of volunteers to draft the geothermal specifications from scratch, we are pleased to see them becoming operational."

For further information about UNECE, UNFC and IGA, please consult the respective websites: http://www.unece.org, http://www.unece.org/ie/se/reserves.html and http://www.geothermal-energy.org.

Source. Press Release

The IGA in the European Geothermal Congress 2016

The European Geothermal Congress 2016 (EGC2106) was held in Strasbourg, France, on September 19-23 (see separate note in the Europe section). The IGA offered a series of international coffee break talks at the IGA booth in this congress. Topics covered:

1. Roadmap to Iceland, 2020: WING (Women in Geothermal) Five Year Targets, by Abbie Dean.

2. Her-story: Women in the New Zealand Geothermal Industry, by Juliet Newson.

3. The Rittershofen Geothermal Success Story in the Upper Rhine Valley, by Albert Genter.

4. Waste not, Want not: Cascade Systems, Every Degree Used, by Helen Robinson.

Also in the frame of this congress, on 22 September the IGA launched the new book Geothermal Exploration - Global Strategies and Applications. It introduces the subject of geothermal energy and its development around the world and was written by Colin Harvey, Graeme Beardsmore, Inga Moeck and Horst Rüter (see IGA News 104, pp. 5-6).

The book defines a series of 'geothermal play types' based on geological setting and presents strategies and methodologies appropriate for each play type to move a geothermal exploration program to the stage of committing to exploration drilling. The methodologies permitting, environmental, include geology, geochemistry, geophysics and remote sensing techniques used throughout the world for specific play

types. The book covers a large number of geoscientific techniques and focuses on their applications to both convective and conductive geothermal systems, with extensive reference to the international literature. It can be purchased online at a price of €55.64 (including tax and shipping), via: https://www.geothermalenergy.org/iga-shop/.

AFRICA **Ethiopia: New Bill, Exploration** Activities, **Agreement with** Toshiba

Abbie Dean talks about the WING targets for 2020 at the IGA booth in the EGC 2016. Photo by Juliet Newson.

STH FGPD



New Bill on Geothermal Resources - In late July, the Ethiopian Parliament approved a bill on geothermal resources that exempts royalty payments for companies engaged in geothermal exploration and development in the country. The Parliament, which was dissolved on 8th July 2016, was summoned for an urgent session and unanimously approved a number of bills, including the *'Geothermal Resources Development Proclamation 2016'*.

Before the new bill, geothermal resources were considered as any other extractable mineral resource, with no consideration to the peculiar characteristics of this energy source. It was governed by legislation designed for other minerals. Investment in geothermal resource development was subjected to Mining Proclamation No. 52/1993 and administered by the then Ministry of Mines and Energy (MoME).

Under the new bill, geothermal resources are classified under the renewable-energy resources category that also includes solar, wind and water resources, and falls under the administration of the Ministry of Water, Irrigation and Energy (MoWIE).

The resource is abundant throughout the country's Rift Valley region. Though Ethiopia can generate as much as 10,000 MW of electricity from geothermal resources, it has thus far utilized just 7 MW from the Aluto-Langano plant.

Ethiopia has made plans to develop geothermal resources along the Rift Valley. However most remain of them remain unrealized with the exception of the geothermal development project. The Corbetti Ethiopian government signed a deal in 2015, during the historic visit of U.S. President Barak Obama, to purchase electricity generated from Corbetti, approximately 240 km south of Addis Ababa, with the US-Icelandic firm, Reykjavik Geothermal, which was going to invest a total of four billion US dollars to develop the site.

The risky nature of developing geothermal resources has also been taken into consideration in exempting it from royalty payments. Moreover, the market limitation for energy generated from geothermal plants gave impetus to the government to create a tailored legislative framework for geothermal energy generation. This policy shift from the government to utilize geothermal resources as a secondary focal point, following hydropower generationin the coming years, has also led to creating a legal environment conducive to encouraging private companies to actively participate.

The government will issue licenses for reconnaissance, exploration, development and use of geothermal resources to companies that fulfil the requirements according to the proclamation. The areas excluded are reserved for cemeteries, religious sites, national monuments or archaeological remains, national parks, physical infrastructure or buffer areas for the transmission of electricity or other infrastructure— among other uses.

The government plans to raise the country's electric power to 17,000 MW from the existing 4,000 MW by 2020 –when the second Growth and Transformation Plan (GTP-II) is concluded. Ethiopia, with the potential to produce 50 GW from hydropower, 1300 GW from wind farms and 10 GW from geothermal power, has ambitions to be an East African power hub. And though it started the exploration of geothermal power in 1969, the country lags way behind neighboring Kenya and other African countries in developing its geothermal resources.

Source:

http://allafrica.com/stories/201608030493.html



Fumarole in a ravine within the Corbetti Caldera. Photo credit: Nena Terrell, USAID Ethiopia.

Exploration Drilling to Start in Three Geothermal Areas - In other news, by late August it was unveiled that preparations are underway to begin drilling 12 geothermal wells at Airobera, Alelobeda and Dubti in the Afar Regional State, according to the Geological Survey of Ethiopia (GSE). Tamiru Mersha, Communication Director at GSE, said well drilling for an expected development up to 325 MW will begin this Ethiopian budget year. According to him, six wells will be drilled at Airobera and Alelobeda with the financial and technical assistance of Geothermal Risk Management Fund (GRMF) and the government of Japan. Ethiopian Electric Power (EEP) and the Geological Survey of Ethiopia (GSE) will jointly drill the remaining six wells at Dubti using €16.4 million obtained from the African Development Bank (AfDB), he added.

Source:

http://www.fanabc.com/english/index.php/news/item

/6775-preparations-underway-to-drill-12-geothermalwells

EEP & Toshiba Partnership on Geothermal Development - Ethiopian Electric Power (EEP) has signed a deal with the Japanese Toshiba Corporation for a comprehensive partnership in geothermal power that will see the parties collaborate in power generation projects and personnel development. EEP is a publicly owned utility, engaged in the development of geothermal resources and the construction of power plants. Through the partnership, Toshiba will draw on its long-standing experience and expertise in geothermal systems to contribute to projects in Ethiopia. The company will, more specifically, develop and manufacture major equipment, create operation and management guidelines, co-operate in personnel development and start a waste-heat utilization business.

Source: http://www.4-traders.com/TOSHIBA-CORP-6493713/news/Toshiba-signs-geothermal-powergeneration-deal-in-Ethiopia-23055286/

Kenya: Development in Suswa, Funds for Drilling Rigs

Imminent Development of Suswa -The governmental Geothermal Development Company (GDC) soon will start developing geothermal fields in Suswa. In a new business model, GDC will explore and develop the steam fields, while private companies will compete for licenses to build the power plants. GDC managing director Johnson ole Nchoe said they expect to get requisite funding and the necessary approvals in the coming months. "We have already finalized on the exploration side. Our scientist tells us the site could inject between 600-1,000 MW to the national grid," he said. Nchoe said the Italian government has pledged to fund the project. GDC has already received Sh51 billion (US\$443 million) in loans and grants. The Suswa Geothermal Project is situated at the intersection of Narok, Kajiado and Nakuru counties. The project has an estimated potential of 750 MW. GDC has already obtained an EIA (Environmental Impact Assessment) license for the project and community engagement has commenced. Phase I will develop 150MW.

Sources: http://www.thestar.co.ke/news/2016/08/12/gdc-to-developgeothermal-fields-in-suswa_c1402183, http://www.gdc.co.ke/suswa.html

Funds from the ADB for GDC to Buy Drilling Rigs - The African Development Bank will lend US\$60 million to finance a geothermal power project in Kenya. The funds will go to state-owned Geothermal Development Co. (GDC) to buy three drilling rigs, according to Gabriel Negatu, regional director at the Abidjan, Ivory Coast-based financial institution.

Source:

http://www.bloomberg.com/news/articles/2016-09-22/kenyan-geothermal-gets-60-million-from-africandevelopment-bank

Uganda: Company and a New Agreement to Boost Geothermal Development

Sustenersol - Sustenersol Uganda Limited is a 'specific project vehicle' (SPV) and an independent producerlimited liability company, registered in Uganda on April 2015. It is in charge of developing small and minihydropower and geothermal power resources. Ralph K.B. Nyakabwa-Atwoki is its Technical Director. In a recent interview with ESI Africa, he stated important opinions. Some of them follow.

- Sustenersol is currently carrying out a prefeasibility study for developing a mini-hydropower station on the Aringa River and a geothermal power plant in the Nebbi District, both in northern Uganda.

- Successful stories for East Africa developers to copy in order to develop their geothermal resources, include the so-called 'Kenyan Model' of development using the National Resources (Government) for a complete cycle, i.e. from exploration to construction, commissioning to operation and any modifications. Another successful model is simply granting the geothermal site concessions to interested local or international developers, which has worked miracles for many countries, especially those with good polices and regulatory framework regimes. Ormat's geothermal plants in Kenya and elsewhere are good examples.

- Geothermal energy will be a real game changer if all the regional members include geothermal energy in the respective energy mixes while implementing 'Power Visions 2030, 2040' targets. Using today's technologies, Eastern Africa has the potential to generate about 2,500-6,500 MW of energy from geothermal power.

- "I am a believer of regionally integrated, geothermal development as a means of addressing energy resource development imbalances across Africa, overcoming national financial and associated risks, investors' reluctances to invest in capital intensive exploration projects, optimizing regional and international facilities in addition to triggering private investments and protection; and curing chronic poverty, environmental destruction and responses to the impacts of climate change that greatly affect African economies and attendant climate risk management and adaptation."

Source: <u>https://www.esi-africa.com/features/exclusive-interview-ralph-k-b-nyakabwa-atwoki-technical-director-sustnersol-uganda/</u>

MEMD-Toshiba Agreeement - For its part, Toshiba Corporation has signed a MOU with Uganda's Ministry of Energy and Mineral Development (MEMD) creating a comprehensive partnership in geothermal power. The agreement will see the parties collaborate in power generation projects, including personnel development. Toshiba will collaborate in the development and supply of major equipment for a geothermal power plant, create operation and management guidelines and cooperate in personnel development, the statement said.

"We are very confident that the Government of Uganda and Toshiba will create a strong Public-Private-Partnership to develop geothermal energy resources", said Fred Kabagambe-Kaliisa, Permanent Secretary at the Ministry of Energy and Mineral Development, at the signing ceremony.

Toyoaki Fujita, Business Development Executive of Toshiba's Energy Systems & Solutions Company, said, "We hope to build a strong partnership with Uganda and to contribute to the development of sustainable power supply there. Toshiba's Energy Systems & Solutions Company is a world leader in geothermal power generation, and I believe that our established expertise can contribute to the geothermal power supply in Uganda."

Uganda, lying west of the Great Rift Valley, has a rich geothermal potential, equivalent to 500 megawatts. Currently, about 60% of power generation capacity is from hydroelectric power, and the country has long promoted construction of hydro power plants.

Source:

http://www.newvision.co.ug/new_vision/news/14338 56/toshiba-corporation-invest-uganda-geothermalpower#sthash.AieyGHdY.dpuf

AMERICAS

Canada: Carbon-Converting Technology that Uses Geothermal Heat

Team CleanCarbon Energy is a Canadian company based in Calgary, Alberta, that announced recently its participation in the US\$20 million NRG COSIA Carbon XPRIZE, a contest challenging teams to develop breakthrough technologies that convert the most CO₂ into products with the highest net value. The company has developed carbon-converting technologies using geothermal energy with a laboratory team at Alberta's Olds College Centre for Innovation.

"Our team has substantial experience in energy production, drilling and completions, petrochemicals and carbon conversion with two patents pending that can enable the large scale conversion of greenhouse gas emissions to value-added products," said Jane Bouey,



the team project manager. The two patents are the Downhole Flexfuel Gasifier and the **DualCycle** Geobioreactor, and both convert carbon dioxide into biomass used to produce

Jane Bouey (Source: CleanCarbon Energy).

sustainable fuels, power and chemicals.

"Recent explorations into deep-sea environments have uncovered natural processes of carbon dioxide fixation without the need for sunlight. Team CleanCarbon Energy's technology combines these natural processes with geothermal energy available within the Earth's subsurface to convert carbon dioxide to a high volume of biomass," added team leader Craig Pichach. "The complete process occurs without the need for fresh water or a substantial surface footprint," said Pichach.

CleanCarbon Energy is an Alberta company formed in 2016 to commercialize the mentioned patented processes. Its mission is to enable the profitable production of sustainable fuels, power and chemicals from underutilized biomass and carbon dioxide by using our advanced proprietary technologies.

Forty-seven teams from seven countries have entered the Carbon X Prize contest and the road to winning the top prize is a long one. Judging is currently in the first round with semi-finalists to be announced by 15 October 2016. The final demonstrations and testing round will begin in 2017, with the winners announced at an awards ceremony in March 2020.

Sources:

http://www.calgarysun.com/2016/07/31/calgary-teamguns-for-carbon-x-prize, http://www.cleancarbon.energy/?p=5612

Caribbean: Exploration in Antigua and Barbuda, Agreement in Dominica

The government of Antigua and Barbuda is partnering with the Texas-based private company, Thermal Energy Partners (TEP), to prospect for geothermal energy in the southwestern part of the country. The Prime Minister, Gaston Browne, has been authorized to sign a Memorandum of Understanding (MoU) with the company, which would drill wells up to two miles deep (3200 m). TEP said that a geothermal power plant in the country could produce 10 megawatts of electricity, which would be cheaper than solar power. The company has received funding from U.S. Governmental agencies to undertake the mapping needed to determine where the hot rocks can be found in a place like Antigua that has no steam vents or other surface manifestations.

According to the Prime Minister, "This project will see the investment of about US\$55 million..." In his remarks, Daniel Pfeffer, President of TEP, said the founding of the project "...is not coming from the government of Antigua & Barbuda; we will bring the financing for the entire project including the exploration." Browne added that the government was working on "innovative" strategies to come up with the US\$50 million to fund the project if they choose to or if it becomes necessary.

Almost immediately after the announcement, a regional environmentalist urged the public to push for consultation before embracing the technology. The former attorney general of Dominica, Bernard Wiltshire, said the project implies the risk of taking production of energy out of the public's control. "It is extremely expensive, and its puts your electricity firmly in the hands of foreign multinational companies. There are other forms of renewable energy that we can use that put the power directly in the hands of the people," he said.

Sources: http://antiguaobserver.com/geothermalenergy-exploration-on-antigua/, http://antiguaobserver.com/govts-plan-for-geothermalenergy-draws-concerns/

Geothermal Agreement Dominica-New Zealand -The Government of the Commonwealth of Dominica and the Government of New Zealand expanded their cooperation in geothermal energy development with the signing of a NZ\$ 2.05 million (US\$ 1.5 million) Partnership Agreement to support the construction of a 7MW geothermal power plant in Dominica. The agreement was signed in September between the Ministers of Foreign Affairs, Francine Baron of Dominica and Murray McCully of New Zealand.

Since 2014, the Government of New Zealand has been providing the Government of Dominica with Technical Assistance for the development of Dominica's geothermal resources. The new Partnership will expand the technical assistance and be based on an implementation timeframe of 2016 to 2019. It will include:

• Technical advice for the front end engineering and design;

• Project management support to help progress the Project through tendering and award of contracts so that construction can commence;

• An Environmental and Social Impact Assessment, Management Plan and Management System; and

• A project manager, to be seconded into the Dominica Geothermal Company to coordinate all activities to execute the Project for a period of up to 24 months once the EPC contract has been signed, commencing in 2017 and concluding in 2019.

The assistance from the Government of New Zealand will provide the Government of Dominica with the technical expertise required to realize the construction of the 7MW geothermal power plant to be commissioned in 2019.

Source:

http://dominicanewsonline.com/news/homepage/new s/economy-development/new-zealand-invests-indominicas-exploration-of-geothermal-energy/



Foreign Minister Baron with New Zealand's Murray McCully (Photo by Dominica News Online).

Previously, the Dominica's Prime Minister stated in late July that the government will establish a company (SPV: Special Purpose Vehicle) to build a 7MW geothermal plant in two stages of 3.5 MW each. Over US\$ 46 million will be allocated to cover the project costs during a two year period. The Minister for Energy, Ian Douglas, stated that "We have tremendous technical assistance from consultants around the world. The New

Zealand Government continues to work with us and (...) the Clinton Climate Initiative who worked with us in the past provided legal consultants..." He added that the power will be sold to the power utility DOMLEC at a reasonable price, "because if the price of electricity from geothermal energy is more than the consumer can afford then you have defeated the purpose of geothermal development."

The Prime Minister also explained that that once the plant is operational the services of a qualified operation and maintenance contractor will be secured.

The geothermal development bill will establish the legal framework for the development of geothermal energy in Dominica and will be submitted to parliament at its first sitting after the budget.

Source: <u>http://news.gov.dm/index.php/news/3835-</u> government-to-construct-domestic-geothermal-plant

Central America: Insights in a Recent ECLAC Report

The Economic Commission for Latin America and the Caribbean (ECLAC; CEPAL, Spanish for Comisión Económica para América Latina y el Caribe), released in August the report entitled 'Statistics of Electricity Production by Countries in the Central American Integration System (SICA)'. This document contains statistical data on the electrical industry –mainly on the production of electricity within the Central American Integration System (SICA, its Spanish acronym). The SICA sub-region is comprised of eight countries: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Belize and the Dominican Republic. The first six countries have been grouped under SIEPAC (Electrical Interconnection System for Central American Countries), the first regional electricity market

Countries), the first regional electricity market established in the Americas.

According to the report, the 2015 production of electricity in the eight SICA countries amounted to 64,076 GWh, an amount that has been broken down into the following percentage shares: The Dominican Republic (23.3%); Costa Rica (16.7%); Guatemala (16.1%); Panama (14.8%); Honduras (13.2%); El Salvador (8.8%);Nicaragua (6.5%) and Belize (0.5%). The installed capacity of the sub-region was 18,744 MW, of which 19.9% was installed in Guatemala; 19% in the Dominican Republic; 16.4% in Costa Rica; 15.9% in Panama; 12.3% in Honduras; 8.7% in El Salvador; 7.1% in Nicaragua and 0.8% in Belize.

The power produced in the SICA sub-region by renewable sources was 34,629 GWh, or 54% of the total. From that, the geothermal energy

produced in Costa Rica, Guatemala, El Salvador and Nicaragua represented 11%. The other renewable sources were: hydropower (68%), cogeneration in sugar mills (11%), wind (9%), and wind and biogas (1%). The full document (in Spanish) can be accessed from: http://repositorio.cepal.org/bitstream/handle/11362/4 0325/1/S1600761 es.pdf.

Costa Rica: Agreement with Japan, 100% Renewable Energy

Agreement of Understanding with Japan - In late August, the governments of Costa Rica and Japan signed an agreement of understanding regarding the financing for three geothermal power projects. The agreement includes the construction program, the investment scheme and the procurement plan, among other technical, legal, environmental and financial issues. According to local press, "The sectorial loan for geothermal energy, approved in yen by JICA, is composed of three parts, whose approximate amounts are \$167 million for Las Pailas II (which is already under construction), and another \$234 million for Boringuen I and \$157 million for Boringuen II which have not yet been handed over." It was also unveiled that the funds JICA is providing for ICE are being awarded with a 40year term and fixed interest rate of 0.6%. JICA and the ICE will sign the loan agreement in February 2017 after an assessment mission visits Costa Rica in December. Borinquen I and II will have a 55MW power plant each. Borinquen I is planned to start operation in 2023 and Boringuen II in 2025.

Source:

http://www.centralamericadata.com/en/article/main/



Ceremony of agreement signing. Photo by ICE.

Costa Rica 224 Million for Geothermal Plant?u=aab 8b4488d77652c0c67fedfccf1ed2a&s=n&e=3&mid=[M ESSAGEID]

100% Renewable Energy for Two Months Straight (and Counting) - Costa Rica ran on 100 percent renewable energy for 76 days straight between June and August this year, according to a new report, thus demonstrating life without fossil fuels is possible –for small countries, at least. This is the second time in two years that the Central American country has operated for more than two months straight on renewables alone, and it brings the 2016 total to 150 days and counting.

According to Costa Rica's National Centre for Energy Control (CENCE), 16 June 2016 was the last day this year that fossil fuel-based energy was used on the national grid. (Data for September is still forthcoming.) Since then, the country has been powered by a mix of hydro, geothermal, wind and solar energy, with hydro power providing about 80.27% of the total electricity in the month of August. Geothermal plants contributed roughly 12.62% of electrical generation in August, while wind turbines provided 7.1% and solar 0.01%. Just like last year when Costa Rica managed to power itself for a total of 299 days without burning oil, coal or natural gas, the 2016 milestone was helped along by heavy rainfalls near the country's four hydroelectric power facilities.

Source: <u>http://www.sciencealert.com/costa-rica-has-</u> been-running-on-100-renewable-energy-for-2-monthsstraight

El Salvador: LaGeo Seeks Financing for Geothermal

Through the company LaGeo, the Salvadorian Government has announced that US\$250 million is needed to start exploration in new areas and to change a geothermal turbine plant in Berlin. Authorities at the Executive Commission of the Lempa River (CEL Group) explained that they have formed closer ties with institutions such as the World Bank and the CABEI to negotiate possible financing.

David López Villafuerte, president of CEL, said in early September that investments will focus during the rest of the year on new fields, and during next year on making changes to a turbine in the geothermal power station at Berlin Geothermal Field. The turbine was installed by the former partner of LaGeo, the Italian firm Enel Green Power. Unit 3 in Berlin, CEL's president said, is an "inefficient piece of machinery that uses more steam than required to produce the same amount of power as other turbines."

According to Lopez, CEL has "various projects" planned, which could add up to about US\$800 million in investment. Of these, they expect to get US\$250

million in the coming months through loans from international financial institutions—thus continuing the expansion of LaGeo.

Source:

http://www.centralamericadata.com/en/article/main/ El Salvador Seeks Financing for Geothermal Energy ?u=aab8b4488d77652c0c67fedfccf1ed2a&s=n&e=3&m id=[MESSAGEID]



Berlin power plant, El Salvador. Photo by Enex.

Honduras: Approval for Financing the Platanares Project

The Board of Directors of the Overseas Private (OPIC), Investment Corporation the U.S. Government's development finance institution, approved in mid-September its support for new development projects in Sub-Saharan Africa, India, the Caribbean and Central America. One of the projects is the Platanares geothermal project, located in western Honduras and sponsored by Ormat Technologies. OPIC approved up to US\$135 million for the development, construction, and operation of a 35MW geothermal baseload power plant in the geothermal field of the same name. This project will be the first utilityscale geothermal project in Honduras and is expected to generate sustainable, reliable, and cost-effective power, while contributing to the Honduran Government's goal of generating 80 percent of its energy from renewables by 2032.

OPIC is the U.S. Government's development finance institution. It mobilizes private capital to help address critical development challenges. OPIC works with the U.S. private sector and provides investors with financing, political risk insurance and support for private equity investment funds when commercial

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funding cannot be obtained elsewhere. Established as an agency of the U.S. Government in 1971, OPIC operates on a self-sustaining basis. All OPIC projects adhere to high environmental and social standards and respect human rights, including worker's rights. OPIC services are available for new and expanding business enterprises in more than 160 countries, worldwide.

Source: <u>https://www.opic.gov/press-</u> releases/2016/opic-board-directors-approves-over-1-<u>billion-support-investments-developing-countries</u>

México: Exploratory Drilling, more Exploration Permits, Second Electricity Auction

Luis C.A. Gutiérrez-Negrín, Chair of the Information Committee

Drilling to Start at the Ceboruco Geothermal Area -El Ceboruco, a huge stratovolcano located in the Mexican state of Nayarit, last saw volcanic activity (an andesitic-basaltic lava flow) in the nineteenth century. There are some hot springs and fumaroles associated with this volcano and in late 2104, the area was the subject to a geothermal exploration permit to explore and define its geothermal potential and eventually install a power plant. The exploration permit, issued by the Energy Ministery under the new Geothermal Energy Law, was awarded to Mexxus RG, a joint venture between Mexico's Mexxus Drilling International and Iceland's Reykjavik Geothermal. It was the first exploration permit in Mexico awarded to a private investor. The previous 13 exploration permits were awarded to the state-owned Comisión Federal de Electricidad (CFE). Ceboruco's exploration permit is valid for three years and can be extended for three more years. It establishes the obligation to drill at least one exploration well for each 50 km² of the granted area.

In mid-August, Mexxus RG stated it has finished the drill pad for the first exploration well, plus other civil works and access roads, and they expect to start drilling by the end of the year. If all runs as planned, the current objective of Mexxus RG is to install a geothermal power plant up to 30 MW, with an estimated cost of US\$115 million. This will be the second, privately developed and operated geothermal-electric project in Mexico.

Source: Personal communication with Mexxus RG.

Three more Exploration Permits - In late August, the Ministry of Energy awarded three new geothermal exploration permits to private companies, Grupo ENAL and Grupo Dragón. Both are Mexican companies specialized in the development of geothermal power projects from early phases of development until the installation and operation of geothermal power plants. Grupo Dragón is the owner and operator of the Domo San Pedro geothermal field, located in the State of Nayarit, with 35 MW of installed capacity. This is currently the only private geothermal field being developed in the country. The other four fields are owned and operated by the state-owned utility, Comisión Federal de Electricidad (CFE).

The three permits were granted under the new Geothermal Energy Law (GEL) that regulates the reconnaissance, exploration and exploitation of geothermal resources in Mexico. Two zones were awarded to Grupo ENAL, one located in the northern State of Baja California (with 145 km²) and the other in the central State of Guanajuato (with 144 km²). The zone awarded to Grupo Dragón is located in the west-central State of Jalisco, covering an area of 105.45 km². Up to now through its Clean Energies Direction, the Ministry of Energy has awarded six geothermal exploitation concessions for six geothermal fields, and 18 geothermal exploration permits with a potential estimated at over 500 MW.

Thirteen of the permits are for CFE, two for Grupo Dragón, two for Grupo ENAL and one for Mexxus RG. According to the GEL, all these exploration permits are valid for three years and can be renewed for another three years. In each case, the awarded company should drill at least one exploration well for every 50 km² of area granted.

Source:

https://www.gob.mx/sener/prens a/otorga-sener-tres-nuevospermisos-a-empresas-privadaspara-realizar-actividades-deexploracion-de-recursos-



View of the Ceboruco Volcano. Photo by Lcagn.

geotermicos

Results of the Second Electricity Auction - In late September, the Secretary of Energy unveiled the results of the second long-term electricity auction in Mexico. In total, 8.9 million megawatt-hour (MWh) and 9.3 million Clean Energy Certificates (CEL) were preliminarily awarded to solar, wind, geothermal and hydroelectric projects. PV projects got 4.8 million MWh of energy (54% of total) and 4.9 million CEL (53% of total). Wind represented 43% of energy and 41% of CEL. This time a geothermal power plant of 25 MW net in capacity was awarded around 190,000 MWh (2.2% of the total) and the same amount of CEL per year (2.1% of the total).

Capacity power was also dealt in the auction, with 1187 MW-year awarded in this category. Out of that, 850 MW-year (71.6%) was awarded to energy-efficient combined-cycle gas plants, 184 MW-year to PV projects (15.5%), 128 MW-year (10.8%) to wind projects, and 25 MW-year (2.1%) to the mentioned geothermal power plant. This seems to be the project Los Azufres III, Phase II, which is under construction by the Comisión Federal de Electricidad (CFE) in the geothermal field of the same name in central Mexico (*see* IGA News 102, p. 15).

According to the Secretary of Energy, the average price for the combination of energy and CEL was US\$33.47 per megawatt-hour. This average price is 33% lower than the average price obtained in the first auction, held in last March, which was around US\$50 per MWh + CEL (*see* IGA News 104, pp. 15-16).

As for capacity, the average price was US\$32,258 per megawatt per year. This price resulted 64% lower than the maximum set by the CFE at US\$90,016 per MW-year.

Like in the first auction, the only buyer of energy, CEL and capacity, is the state utility CFE through one of its subsidiary companies. But CFE also participated in the offer side of this auction through other subsidiaries engaged in electric generation, one of which includes its geothermal division. These are legally separated companies, and is worth mention that CFE had participated also in the first auction with no success.

Sources: http://www.pvmagazine.com/news/details/beitrag/renewables-comein-at-3347-mwh-in-mexicos-secondauction 100026238/#ixzz4LUFo3rhF, http://www.gob.mx/sener/prensa/con-preciosaltamente-competitivos-se-anuncian-los-resultadospreliminares-de-la-2-subasta-electrica-de-largoplazo?idiom=es

Nicaragua: IADB Funding for Geothermal Exploration

According to the Inter-American Development Bank (IADB), 50.6% of the country's energy generation last year (2015) came from renewable sources, of which 30% was geothermal. Nicaragua's estimated geothermal potential is 1,500 MW, of which only 10% is currently exploited. Meanwhile, energy demand has been on the rise in recent years, growing 2.6% in 2014 and 4.6% in 2015.

Thus in late July, IADB proposed carrying out a project to explore and certify geothermal energy reserves in the country. This proposal was presented by Carlos Melo, IADB's representative in Nicaragua. The purpose of the project is the promotion of alternatives for the generation of renewable energy, as well as the consolidation of the sector and the promotion of foreign investment in the country. Melo estimated that the project will have an approximate cost of up to US\$60 million and said that public and private partnerships are expected for its execution.

The execution of this project will allow Nicaragua to present a more attractive and reliable offer to potential investors, national or foreign. They will have access to a specialized study of the available reservoirs, potential capacity and other specific conditions of the reservoirs, which consequently, should expedite obtaining financing for geothermal exploration and exploitation, as well as the required permits and authorizations, among other resulting benefits.



View of the top of the Cosigüina Volcano (Photo taken from Pinterest).

In early September, the IADB announced Nicaragua will enhance its renewable energy generation capacity and improve its power transmission system under a

\$103.4 million project, which will be partially financed (US\$51.4 million) by the bank. Among other activities, the project will support site investigation to help determine the technical viability of exploiting the geothermal potential of the Cosigüina field in northwestern Nicaragua, including activities such as commercial-width well exploration. It will also develop mechanisms to attract private investment to help stimulate geothermal generation.

Sources:

http://www.lexology.com/library/detail.aspx?g=ca4641 f2-8a18-473f-ba52-f0dbe39a174b, http://www.iadb.org/en/news/news-releases/2016-09-09/nicaragua-to-develop-geothermalpotential,11555.html

United States: The Geysers & Valles Caldera, New R&D Geothermal Projects, Support for Salton Sea

The Geysers Almost at Full Capacity - The Geysers is the world's largest geothermal resource for electric power. It is located 75 miles north of San Francisco, California and has 17 power plants in operation, 14 of which are operated by Calpine Corporation. The California Energy Commission (CEC), which certifies thermal power plants that are 50 megawatts (MW) and larger in California, has jurisdiction over six of them. The plants can produce roughly 725 MW of electricity.

Four of the six Calpine facilities under the jurisdiction of the CEC were among the hardest hit by last year's Valley Fire (see IGA News 101, pp. 12). The fire, which killed four people and burned a total of 76,000 acres (almost 310 km2), tested the resiliency of operations at The Geysers. The fire caused US\$100 million in damages. Cooling towers were destroyed and power transmission wires, pump stations and piping were damaged. Nine months afterwards by early July 2016The Geysers is almost back to full capacity. Fireresistant cooling towers made of fiberglass replaced the burnt ones. The Geysers power output in June 28 was 653 MW, just shy of the 685 MW produced in September 12, 2015-the day the fire started. Calpine officials said The Geysers is expected to be at full capacity by the end of the year.

On late September a new wildfire erupted amid hot, dry conditions and gusty winds in Sonoma County that forced evacuation of one of the 14 plants in The Geysers. All employees were safe and accounted for but the evacuated plant was not operating. The employees were allowed to return to the plant the following day.

Sources: http://calenergycommission.blogspot.mx/2016/07/geo

thermal-power-at-geysers-proves.html, http://www.seattletimes.com/business/californiawildfire-forces-geothermal-plant-evacuation/



One of the new cooling towers. Photo by the CEC.

Officials Weigh Geothermal Energy Leases near Valles Caldera, New Mexico - Parts of the Santa Fe National Forest could be leased for exploration and development of geothermal energy in 2017. The U.S. Geological Survey has identified 195,000 acres (789 km²) west and north of the Valles Caldera National Preserve, New Mexico, as having significant geothermal potential. Not all of the 195,000 acres in the project area are available for leasing. Some land is private or owned by the state and other governmental entities. And 32,000 acres are protected by conservation statutes, leaving 136,650 acres as potential leasing options.

Modeling studies have indicated hot rock exists that could be tapped into, but have not determined if it is accompanied by water or would require water to be injected to create steam, according to Larry Gore, a geologist with the Santa Fe National Forest. "The big question right now," said Gore, "Is there a resource north of the Caldera that could be developed? And that is completely unknown at this time."

New Mexico territories were first explored for geothermal potential in the late 1960s, identifying areas, predominantly around the Jemez range known for boiling natural hot springs, with high geothermal potential. Projects were also proposed in the 1980s but failed to move forward.

But development interest was reawakened over the past four years, when Ormat Technologies Inc. notified the Bureau of Land Management (BLM) the company would like to lease land in New Mexico for development. According to the environmental impact statement, there has been interest in leasing 46,000 acres (186 km²) in the Santa Fe National Forest.

In mid-July, the Santa Fe National Forest released a statement draft on the environmental impact to help guide forest managers determine the viability of geothermal energy development on public lands. A public meeting on the proposed project and the potential effects outlined in the draft was held, and members of the public had until late August to submit comments on the draft. The forest manager, Maria Garcia, is expected to make a final decision on whether leasing will occur by early 2017.

Source:

http://www.santafenewmexican.com/news/local_news/officials-weigh-geothermal-energy-leases-near-vallescaldera/article_24d6d8a0-efe9-5e24-be7aa37b8425762a.html



Three R&D Geothermal Projects to be Funded by the DOE - The U.S. Department of Energy (DOE) has announced the selection of eight new research and development projects to receive a total of US\$11.5 million in federal funding under DOE's Subsurface Technology and Engineering Research, Development, and Demonstration Crosscut initiative. The new projects are focused on furthering geothermal energy and carbon storage technologies.

Those projects, "...will advance our ability to store captured carbon pollution from the burning of fossil fuels and improve our understanding of renewable geothermal resources – both of which will help us achieve our nation's climate and clean energy goals," said DOE's Under Secretary for Science and Energy, Franklin Orr.

Many opportunities exist to use the rocks beneath the earth's surface to improve the way we use energy – including next generation of geothermal energy; safely storing greenhouse gases that are contributing to climate change; mitigating the impacts of fossil energy development; and nuclear waste storage and disposal.

Across those varied challenges, the Subsurface Crosscut addresses a number of common technical issues. In particular, it plans and implements research, development, and field demonstrations emphasizing: Wellbore Integrity, Subsurface Stress and Induced Seismicity, Permeability Manipulation, and New Subsurface Signals.

Three of the eight projects were selected with the aim of identifying and validating new subsurface signals to characterize and image the subsurface, thus advancing the state of knowledge in geothermal exploration. These projects are:

Development of a Novel, Near Real Time Approach to Geothermal Seismic Exploration and Monitoring via Ambient Seismic Noise Interferometry: Baylor University (Waco, TX), the University of Nevada-Reno, and Hi-Q Geophysical Inc. will advance the state of the art in geothermal exploration and monitoring through the development of new computer hardware and software. The team will build a 150-node seismic system consisting of commercial, off-the-shelf digitizer / recorders and geophones augmented by a device called the RaPiER, which is based on the Raspberry Pi singleboard computer. The team will integrate the RaPiERbased seismic system with ambient-noise signal processing software developed at the University of Nevada-Reno and then perform validation tests at Baylor University and at two geothermal sites in Nevada. Funds from DOE: US\$ 879,802.

Geothermal Fault Zone Dilatancy and Fluid Imaging Integrated Geophysical, through Geological, Geochemical and Probabilistic Analysis: The University of Utah (Salt Lake City, UT), Quantec Geoscience Inc., and Geotech Ltd. will advance geothermal energy development by improving technologies that map fluidbearing, permeable subsurface fractures connected to high-temperature heat sources. Drawing upon several new in-house technology developments, the team will integrate electromagnetic and seismic geophysics, structural geology, and isotope geochemistry to demonstrate that it is possible to discriminate among the fault zones in the subsurface carrying hightemperature geothermal fluids. Funds from DOE: US\$ 620,000.

A Novel Approach to Map Geothermal Permeability Using Passive Seismic Emission Tomography and Point Inversion of Active Seismic and EM Data: U.S. Geothermal Inc. (Boise, ID), Lawrence Berkeley National Laboratory, and Optim Inc. will work to advance the imaging and characterization of geothermal permeability. Geophysical techniques have advanced, yet still fail to consistently image permeability, and no technique to effectively and robustly map subsurface permeability of geothermal resources has been developed. The techniques developed by the team will

be validated at the San Emidio Geothermal Plant in Nevada, where the current geothermal resource produces 9 MW, net, and at Crescent Valley, NV, where a commercial geothermal resource has yet to be identified. Fund from DOE: US\$ 1,497,016.

Source: <u>http://energy.gov/under-secretary-science-and-energy/articles/doe-investing-115-million-advance-geologic-carbon</u>

Two Teams Selected for the Second Phase of FORGE – In late August, the Department of Energy (DOE) announced US\$29 million in funding under the Frontier Observatory for Research in Geothermal Energy (FORGE) program for projects awarded to teams at Sandia National Laboratories and the University of Utah. The funding will be for each team to



Geothermal Research Observatory

fully instrumentalize, characterize and permit candidate sites for an underground

laboratory to conduct cutting-edge research enhanced on geothermal systems Sandia (EGS). The team will be working on a site in Fallon, Nevada, and the University of Utah team will be working at a site in Milford, Utah.



Both teams were the winners of the FORGE's first phase, in which five selected teams with EGS projects prepared during the last year technical and logistical tasks that demonstrate site viability and show the team's capability of meeting FORGE objectives and developing plans for Phase 2. The five teams and sites competing in the first phase were as follows. The Idaho National Laboratory, with location in Snake River Plain, Idaho; Pacific Northwest National Laboratory, with location proposed at Newberry Volcano, Oregon; Sandia National Laboratories with two locations, one in Coso, California, and the other in Fallon, Nevada both on grounds located on air stations of the U.S. Navy; and the University of Utah, located in Milford City, Utah (*see* IGA News No. 100, pp. 19-20).

The Energy Department, with the support of the National Energy Technology Laboratory (NETL), awarded funding to the teams working on the Nevada and Utah sites after a competitive first research phase to

evaluate potential EGS underground research sites. The candidate sites announced in Nevada and Utah will use this new funding to prepare for the competitive third phase of the FORGE effort, which will designate one of the sites as headquarters for the future underground field lab.

EGS is the technology with which geothermal resources are accessed from deep beneath the surface of the earth where there are hot rocks ideal for geothermal wells but little naturally occurring liquid to generate steam. Pumping fluids into the hot rocks creates pathways that carry heat to the surface through wells where the fluids become the steam that drives turbines and generates electricity. It is estimated that EGS technologies could eventually lead to more than 100 gigawatts (GW) of economically viable electric generating capacity in the continental United States, representing an increase of two orders of magnitude over present geothermal capacity, which currently stands at 3.5 GW.

Source: <u>http://energy.gov/articles/energy-department-announces-29-million-investment-enhanced-geothermal-systems-efforts</u>

President Obama Announces Support for Salton Sea Restoration and Plans for Geothermal Energy Development – Speaking at the 20th Anniversary of the Annual Lake Tahoe Summit, President Obama announced in late August a package of actions in support of the communities surrounding the Salton Sea, California's largest lake, which is facing a tipping point in environmental degradation. The announced actions, in close partnership with the State of California, will support implementation of the State's Salton Sea Task Force Agency Action plan to help boost the region's climate resilience through innovative conservation approaches, spur economic growth by developing new clean energy resources, and improve public health while providing a path forward for the Sea.

Among those actions is the Advance Collaboration on Renewable Energy Development in the Imperial Valley/Salton Sea Area. The Department of Energy's (DOE) Federal Energy Management Program (FEMP) has published a Request for Information (RFI) on identifying pathways for aggregating a power purchase between 100 and 250 MW of new geothermal energy from around the Imperial Valley's Salton Sea. Another important action is the focus on Technology Adoption and Breakthroughs to boost the Salton Sea economy and clean energy generation. In addition to evaluating approaches to purchase clean power from the region, the DOE is advancing technology adoption and breakthroughs by convening key geothermal experts for a first-ever forum on the Salton Sea renewable potential. The DOE will lead a targeted, technical forum with the State of California and the Geothermal Resources Council in October 2016 to accelerate development of

geothermal energy resources in California, particularly around the Imperial Valley's Salton Sea. The forum will convene a diverse group of stakeholders from government, industry, and research to lay out solutions for new geothermal development while remaining consistent with critical Federal and state conservation planning efforts at the Salton Sea.

Source: <u>https://www.whitehouse.gov/the-press-office/2016/08/31/fact-sheet-lake-tahoe-summit-obama-administration-underscores-importance</u>

ASIA/PACIFIC RIM

China: Tibet Considers Geothermal to Solve Power Shortage

Renewables make up 43% of Tibet's energy mix, which includes three times more clean energy than the rest of China. The main Tibetan renewable energy source is hydro, which means there is a power shortage in winter. The Tibetan Yangbajing geothermal plant is the first and biggest geothermal power plant in the country. The plant production is enough to power 50,000 Tibetan households.

Tibet's power challenges are manifold. The high altitude and difficult climate take a toll on power equipment and the people who operate it. Tibet's residential power usage is a much bigger portion of the total than is industrial usage, which means less tariff revenue is collected for power plants. Difficulties aside, the potential for geothermal power is enormous.

Because China is going big on geothermal power, private firms want to invest. Developing energy has been welcomed by locals, because they're the first to benefit. The Tibetan autonomous government plans to double investments in generating capacity and grid construction over the next five years. That could open a good opportunity to develop the vast geothermal potential of the region.

Source: <u>http://www.cctv-</u> america.com/2016/08/19/tibet-pushes-geothermal-tosolve-power-shortage

Djibouti: Memorandum of Understanding on Geothermal Power Generation

The Japanese Toshiba Corporation has concluded a memorandum of understanding (MOU) with the Office Djiboutien de Développement de l'Energie Géothermique (ODDEG), the government organization responsible for developing Djibouti's geothermal power capabilities, now envisioning a comprehensive collaboration within the geothermal power-generation business. Under the terms of the MOU, ODDEG and Toshiba will develop Djibouti's extensive geothermal resources and provide training for personnel working in plants.



Dr. Kayad Moussa Ahmed and Mr. Toyoaki Fujita have signed a memorandum of understanding. Photo by Toshiba Corp.

ODDEG was established in 2014. It reports directly to the Presidency of Djibouti and is responsible for the long-term development of Djibouti's geothermal resources, under the country's plans to promote renewable resources for a sustainably green economy. Working with Toshiba will allow ODDEG to draw on Toshiba's comprehensive capabilities as the world's single largest provider of geothermal energy equipment. The collaboration will include the creation of guidelines for plant operation and management, the development and supply of generation systems and support in training personnel to operate plants.

Djibouti currently has an installed generation capacity of 120 MW, mostly from thermal power that it supplements with power imports from Ethiopia. However, many sites in Djibouti are suitable for geothermal power generation and current plans envisage constructing geothermal power stations with a base capacity of about 50 MW. The MOU provides Toshiba with the opportunity to work with ODDEG to develop a highly promising, low CO₂ renewable source that will contribute to a green Djibouti, and supply geothermal power generation equipment in the future.

Last December, the company concluded an MOU with the Tanzania Geothermal Development Company

Limited for comprehensive collaboration in the geothermal power-generation business.

Source:

http://www.toshiba.co.jp/about/press/2016_08/pr090 1.htm

United Arab Emirates: Probable Use of Geothermal Energy for Desalination

Dubai Electricity and Water Authority (Dewa) is requesting proposals for an early-stage feasibility study on producing electricity from geothermal energy and for its use in desalination, i.e., removing salt from water to make it potable.

Dubai's Clean Energy Strategy includes the generation of 75 per cent of its electricity from clean energy sources by 2050. Geothermal energy needs to be at temperatures of more than 200°C to be a prime candidate for power generation. The UAE's geothermal temperatures are much lower than this, making geothermal more suitable for applications such as desalination rather than power generation, according to experts.

Steve Griffiths, the vice president for research at Abu Dhabi's Masdar Institute, which has been studying the potential for geothermal in the UAE, said that using this kind of energy for desalination was the most viable option, as the geothermal resources, averaging about 100°C, were only suitable for low-temperature applications.

Source:

http://www.thenational.ae/business/energy/dubai-toexplore-feasibility-of-geothermal-energy

Indonesia: Exploration Permits, more Working Areas, PLN to Acquire PGE, Probable FiT, Bonus to Local Governments

Geothermal License for EGP and Contract for Ansaldo - Enel Green Power (EGP), in consortium with the Indonesian geothermal developer PT Optima Nusantara Energi (PT ONE), has been awarded the right to hold the license to explore for geothermal resources and develop the 55MW Way Ratai geothermal power project. The project is located in the Way Ratai area, in Indonesia's Lampung province. The award follows the tender launched by the Indonesian Ministry of Energy and Mineral Resources in December 2015, which is part of the country's efforts to diversify its energy mix by increasing the share of renewables to up to 23% by 2025 from the current 12%.

The Way Ratai project will be the first to be developed by Enel in the country, marking the company's entry into Indonesia's renewables market. Enel will invest up to US\$30 million dollars for the exploration phase of the project. The construction of the geothermal power plant depends on the results of the exploration phase, but the plant itself is expected to be completed and enter operation in 2022. EGP and PT ONE will jointly establish and own a special purpose vehicle (SPV) holding the project, with EGP having the majority stake in the SPV. In line with the tender rules, the energy produced by the geothermal power plant, expected at around 430 GWh per year, will be sold to the national utility PLN under a 30-year power purchase agreement (PPA).

Recently, Enel signed a Memorandum of Understanding (MoU) with the Indonesian power utility PT PLN Persero to evaluate possible cooperation opportunities on projects in electricity generation in Indonesia, starting from the joint assessment of the local market for renewables, conventional technologies and minigrids.

Source: <u>https://www.enel.com/en-</u> gb/Pages/media/press/detail.aspx?source=media&cur Page=1&Title=&id=1602

In other news, the Italian engineering firm Ansaldo Energia said it has received a notice to proceed on a contract to upgrade a geothermal plant in West Java, Indonesia. The company signed the contact last year. Ansaldo Energia will refurbish a 30MW geothermal plant in Kamojang. The company will act as the engineering, procurement and construction manager and will supply the geothermal steam turbine and relative air-cooled generator. The customer is PT PLN. Ansaldo Energia recently opened a branch office in Jakarta during a ceremony attended by the Italian ambassador to Indonesia, Vittorio Sandalli.

Source:

http://www.renewableenergyworld.com/articles/2016/ 08/italian-firm-to-upgrade-30-mw-geothermal-plant-inwest-

java.html?cmpid=renewablegeothermal08112016&eid= 291021978&bid=1493202

The Target for Geothermal Power will Be Exceeded in 2016 - In early August, the Directorate General of Renewable Energy and Energy Conservation (EBTKS) of the Ministry of Energy and Mineral Resources (ESDM), Rida Mulyana, said that "the realization of the power supply from geothermal power plants in the first half of 2016 amounted to 1,493.5 MW. The achievement means that electricity from geothermal power plants has reached 90 per cent of the target of

2016, equaling 1,657.5 MW and is expected to exceed the target by year's end". Rida explained that the "installed capacity was 1,438.5 MW, despite an additional 55 MW that started generation on July 15, 2016. This amount has not been officially added, so the corrected total is 1,493.5 MW".



Sarulla geothermal project. Photo taken from <u>http://www.itochu.co.jp/en/business/machinery/</u> <u>project/02/</u>

The General Director also mentioned that there is an additional capacity of 215 MW of geothermal power expected to begin generation this year, comprised of the 55MW Ulubelu plant, the 110MW Sarulla geothermal power plant, the 20MW Lahendong plant and the 30MW plant at Karaha Bodas. If these four geothermal power plants begin operating this year, the supply of electricity from geothermal energy will exceed the target for 2016.

Rida commented on the recent issuing of licenses to the consortium formed by PT ONE and Enel Green Power for the Way Ratai project (55 MW) in Lampung Province. He said, "The recent investment from Italy shows that Indonesia remains an attractive market for geothermal energy, despite the current market conditions in the oil and gas sector and a weak global economy... We should be proud of a lot of investors who want to come to Indonesia, like now with the Way Ratai project with an estimated potential of 55 MW," he said.

Source: <u>http://www.thinkgeoenergy.com/four-</u> geothermal-plants-expected-to-start-operation-inindonesia-thisvear/?utm_source=ThinkGeoEnergy+List&utm_camp

<u>aign=261f4a1d1a-</u>

<u>TGE_Newsletter_RSS1_12_2015&utm_medium=email</u> &utm_term=0_657e42f767-261f4a1d1a-415210497

The Government will Offer 28 Geothermal Working Areas in 2016-2018 - The Energy and Mineral

Resources Ministry's director of geothermal energy said the government is planning offer the following geothermal working areas through a bidding process from 2016 to 2018:

Aceh (1), North Sumatra (2), West Sumatra (2), Jambi (1), South Sumatra and Lampung (1), Bengkulu (3), West Java (3), Banten (1), Central Java (1), East Java (4), West Nusa Tenggara (2), East Nusa Tenggara (2), Central Sulawesi (2), Southeast Sulawesi (1), Gorontalo (1) and North Maluku (3).

However, for those areas, the government has already appointed the public utility firm PT Perusahaan Listrik Negara (PLN) to develop the two working areas of East Nusa Tenggara, which are Ulumbu and Mataloko, with capacities of 50 MW and 22.5 MW, respectively. PLN president director Sofyan Basir is committed to completing the assignment by early 2020.

Source:

http://www.thejakartapost.com/news/2016/08/12/go vt-offers-up-30-geothermal-working-areas-until-2018.html

PLN to Acquire 50% Stake in PGE - State electricity company PLN is set to acquire a 50% stake in the state energy giant, Pertamina in PT Pertamina Geothermal Energy (PGE), as part of efforts to speed up the geothermal power supply to the electricity firm. Pertamina currently holds a 100% stake in PGE. Pertamina president director Dwi Soetjipto said the company was currently conducting due diligence on the acquisition, highlighting its willingness to sell some of its stake in PLN for the greater good of the nation. It is expected that the acquisition will help accelerate the development of geothermal power plants in Indonesia.

Soetjipto said Pertamina's goal was to help PGE grow and help the government tap into the country's 29,000 MW of geothermal energy potential. "Currently, PGE itself has only installed 450 MW. We are targeting an amount over 1,000 MW in the next three to four years," Dwi said on the sidelines of the 4th Indonesia International Geothermal Convention and Exhibition (IIGCE) on August 10.

PLN President Director Sofyan Basyir said the acquisition plan was partly to meet the 7,000 MW geothermal power plant target set by the government, and then PLN "...will have a greater ability to conduct geothermal explorations," he said, adding that the plan would likely decrease the high prices of geothermal power.

About that target, the Indonesian Geothermal Association (INAGA) chairman, Abadi Purnomo, acknowledged that the 7,000 MW geothermal power plant target was quite ambitious because Indonesia's current total geothermal capacity stood at only 1,493.5

MW. Hence, there was a shortfall of 5,500 MW, which must be obtained within 10 years, or 550 MW per year, he went on. "Of course, this large target requires a very large investment, which amounts to US\$4 million to \$5 million per MW," he said during the IIGCE at the Jakarta Convention Center.

To attract investment in the geothermal sector, Abadi said, innovations are needed, including attractive electricity rates for geothermal developers, a guarantee that the state power company PLN would act as an offtaker and purchase the electricity, and legal certainty. Abadi reminded the audience that exploration was a key activity in the geothermal business chain. He believes Government Regulation (PP) No. 59/2007 on indirect exploitation would encourage investors to carry out exploration drilling activities.

He further said PLN had conveyed its commitment to realize the target set by the government by purchasing power in accordance with the rates set by the government, and that INAGA will continue to work with the government to develop geothermal energy in Indonesia.

About the planned acquisition of PGE by PLN, INAGA said that geothermal companies are opposed. Abadi explained that geothermal exploration and development costs will not drop because of an acquisition. "The acquisition plan is nothing but a plan to spend money. That fund is better off being used for

expanding electricity distribution or building new power plants," he added. Abadi considers that the acquisition was not decided based on in-depth analyses. "Anywhere in the world, geothermal energy projects are undertaken by oil and gas companies because the two industries have similar stages of development. Just look at Chevron, Star Energy, Philippine National Oil Company," Abadi said.

Pertamina president director Dwi Soetjipto said there is no certainty about PLN's plan to acquire PGE. The decision depends on the process of due diligence and feasibility studies.

Sources:

http://www.thejakartapost.com/news/2016/08/10/pln -plans-to-acquire-pge-to-boost-geothermaldevelopment.html, http://www.thejakartapost.com/news/2016/08/10/inn ovations-needed-to-achieve-7000-mw-geothermalpower-target-association.html, http://en.tempo.co/read/news/2016/08/19/05679718

7/Geothermal-Companies-Against-PGE-Acquisitionby-PLN

Government Prepares a FiT Mechanism - The government is preparing a Feed-in Tariff mechanism to assist geothermal developers in a bid to boost the development of the geothermal energy sector in the country, according to the Energy and Mineral Resources Ministry's geothermal director Yunus Saefulhak. He said the Feed-in Tariff (FiT) mechanism was better economically in facilitating geothermal developers as this new tariff regime has a fixed-price system. In a fixed-price system, energy suppliers do not have to negotiate with state-owned electricity firm PLN as the power-off taker.

He further said the FiT mechanism is aimed to assist power plants with capacities ranging between 5 to 220 MW and accommodate tariff variables. Yunus said the ministry, along with a consortium of researchers consisting of Arup, Japan International Cooperation Agency (JICA) and geothermal engineers, was currently studying the FiT scheme. He further said the government had made some innovative breakthroughs in the geothermal sector by harmonizing regulations and removing geothermal from the list of mining activities. "We have simplified geothermal business permit request procedures by establishing a one-stop service and giving fiscal incentives for geothermal development such as a tax allowance and import duty facility," he added.



Source:

http://www.thejakartapost.com/news/2016/08/11/go vt-prepares-feed-in-tariff-mechanism-to-boostgeothermal-energy.html

Production Bonus to Be Paid by Geothermal Companies to Local Governments – Indonesia's President Joko Widodo signed Government Regulation No. 28/2016 on 14 July 2016. This states that a production bonus is the financial obligation of the

holder of a permit for a geothermal project and the company that operates the project. This obligation also applies to geothermal energy business joint operating contracts and geothermal energy business permit holders. "Geothermal permit holders are obliged to provide a production bonus from the time the first unit starts producing commercially," says Article 2 Paragraph (1) of this regulation. The production bonus will be given to the local administration where the geothermal project is located. It amounts to one percent of the gross income from the sale of geothermal energy, or 0.5 percent of the gross income from the sale of electricity derived from geothermal power plants. To determine the production bonus, the Energy and Mineral Resources Minister will reconcile the sale of geothermal energy and/or electricity from geothermal power plants and the production bonus that will be paid to the local administration. The outcome of this reconciliation will determine the production bonus amount.

Source:

http://en.katadata.co.id/news/2016/08/05/geothermal -companies-must-give-production-bonuses-to-localgovernment

Japan: Domestic and International Promotion of Geothermal Energy

Events to Promote Geothermal Energy in Several Regions - A Japanese committee called the Chinetsu Marché Executive Committee held a Chinetsu Marché (geothermal market), between February and March 2016. The Chinetsu Marché provides people with hands-on experience related to geothermal power and promotes greater understanding about the development of this clean energy source among Japanese people. In Japan, geothermal power is increasingly expected to fill



Volcanic belts and geothermal plants (green dots) in Japan. Source: Agency for Natural Resources and Energy.

the role of a domestic, baseload power source because stable power generation is possible regardless of natural conditions, and Japan has the world's third largest potential for geothermal power generation (23,470 MW, according to the New Energy and Industrial Technology Development, NEDO)

In order to make best use of geothermal power, which is common property in Japan, it is important to make the development of geothermal power generation go smoothly and use the surplus heat to revitalize local communities, thus ensuring the development is mutually beneficial. For this reason, the committee held a series of four Chinetsu Marché events in the Hokkaido, Tohoku, and Kyushu –regions with large potentials for geothermal power generation— as well as in Tokyo. The event venues were designed using the marché (market) concept. Programs included a local produce market selling local vegetables grown by using geothermal power, an event stage on which local groups danced and performed and workshops intended to raise interest in geothermal power.

Source:

http://www.japanfs.org/en/news/archives/news_id03 5602.html

Geothermal Plans in Akita Prefecture - Akita Prefecture has launched an initiative to create new industries utilizing local energy resources such as wind power since fiscal 2016. The initiative aims to double installed power generation capacity from renewables over the next 10 years. The prefecture intends to enthusiastically expand generation of power from geothermal heat and biomass, in addition to power from wind and solar.

Targeting the areas around and in Yuzawa City, a famous hot springs spot located in south Akita Prefecture, several projects are underway to develop

geothermal power generation. Here in Yuzawa, the Uenotai Geothermal Power Plant has been operating since 1998, with a capacity of 29 MW. The capacity factor of the plant is high, hitting 70 percent, standardized.

Plans are underway to construct geothermal power plants at three sites surrounding the Uenotai plant. The project farthest along is development of the Wasabisawa geothermal power plant. In addition to three production facilities for taking in steam and hot water from underground, two return facilities will be constructed around the production facilities to return hot water remaining after power generation to the ground in order to reduce the environmental impact.

Source:

http://www.japanfs.org/en/news/archives/n

ews_id035650.html

Japan to Support African Geothermal Power -Japan's government will provide financial assistance for geothermal power projects in Africa, with Japanese trading houses and plant builders eyeing new business opportunities in this relatively underdeveloped area. Prime Minister Shinzo Abe announced the aid initiative at the sixth Tokyo International Conference on African Development (TICAD), held in Nairobi, Kenya.

The Japanese government will provide both financing and know-how for African geothermal projects from the initial stage, hoping to improve the odds of success in exploration. Grants will cover a portion of preconstruction-stage costs, which can run to US\$100 million. For starters, the government will appropriate more than 1 billion yen (US\$9.97 million) for grant provision as part of a supplementary budget for the current fiscal year.

In addition, Tokyo will make low-interest loans from the Japan International Cooperation Agency and other financing available for African geothermal projects that have reached the construction stage. The government announced in May that it would provide US\$200 billion through such channels to support infrastructure exports. Some of this will go to projects in Africa.

Twenty-two Japanese companies and organizations, including Toyota Tsusho Corp., concluded a total of 73 memorandums of understanding (MOU) with African governments, businesses and others on providing financial and technological assistance. The agreements were concluded on the sidelines of the mentioned summit TICAD VI. The deals, signed in the Kenyan capital of Nairobi in August 28, will cover projects including geothermal power generation and urban transportation system development.

The private-sector aid is in line with the government's policy of promoting Japanese-style assistance--in an attempt to counter China, which has expanded its influence in the region with large-scale financial support. Prime Minister Shinzo Abe announced the establishment of the Japan-Africa Public and Private Economic Forum.

Toyota Tsusho, a trading house, concluded MOUs with the governments of Kenya and Ethiopia to strengthen cooperation in ground-surface surveys for the development of geothermal power generation. From the early stages of development, the company will provide the two countries with proprietary technology that raises the success rates of test drilling.

Japan's three megabanks, including Sumitomo Mitsui Banking Corp., the core banking arm of Sumitomo Mitsui Financial Group Inc., signed memorandums of understanding with the African Development Bank to expand cooperation. Prime Minister Abe also announced at the TICAD summit a bold new African infrastructure plan worth US\$10 billion over the next three years to be implemented by the African Development Bank (AfDB). The Japanese Prime Minister said the support package aims to increase the electricity generation capacity by 2,000 MW as well as the geothermal power generation using Japanese technologies. The increased power-generation capacity is planned to reach 3 million households by 2022.

Japan has pledged to work together with the African leaders towards achieving developmental objectives for a range of principles -quality, resilience and stability. The quality principle will focus on building the infrastructure elements based on Japan's preferred work ethos, known as kaizen, or 'continuous learning'. This is a system aimed to empower factory foremen and plant managers and leaders of worksites under a new plan to be known as the African Business Education Initiative for Youth (ABE) Initiative. This will allow business executives from Africa to study in Japan. Japan aims to reach at least 1,500 experts. Japan has also pledged to put the advances of its domestic education policies at the disposal of African industries. Japan hopes to provide access to its educational system to African students by promoting engineers to learn from its kosen, or 'colleges of technology'. This system aims to train at least 30,000 engineers to support the foundations of Africa's industrialization.



Secretary F. Kabagambe-Kaliisa and Toshiba's T. Fujita, in the signing ceremony.

Japanese groups Toshiba, Mitsubishi Hitachi Power Systems and Fuji Electric already hold a significant share of the global geothermal power business. The Africa's

biggest concentration of geothermal power capacity is located in the Olkaria region of Kenya. Trading house Toyota Tsusho and Toshiba, which won a 2011 contract for geothermal power facilities in Olkaria, may provide additional capacity. Other pairs of contenders include Mitsubishi Corp. and Mitsubishi Hitachi Power, and Marubeni and Fuji Electric. Meanwhile, Toyota Tsusho and the national utility, Kenya Electricity Generating, are planning feasibility studies for geothermal installations beyond that region.

Sources: http://the-japannews.com/news/article/0003179764, http://www.afdb.org/en/news-andevents/article/japan-chooses-afdb-to-implement-boldnew-infrastructure-plan-for-africa-16039/, http://asia.nikkei.com/Politics-Economy/International-Relations/Tokyo-switching-onaid-for-African-geothermal-power

Malaysia: First Power Plant to Be Installed in 2018

Following a site inspection in early August, the Malaysian Energy, Green Technology and Water Minister Datuk Seri, Maximus Ongkili, disclosed that Sabah will be home to Malaysia's first geothermal power plant, slated to be developed by the Tawau Green Energy Sdn Bhd (TGE) at a proposed site in Apas Kiri, Tawau. The minister was accompanied of senior Sustainable Energy ministry officers, including Development Authority (Seda) Malaysia Chairman Datuk, Yee Moh Chai. "As of today, two geothermal well pads are completed, and the third well pad is under construction. The geothermal power plant is scheduled to achieve commercial operation by June 2018. Once operational, Malaysia will rank 16th in the world in geothermal energy generation," said Ongkili.

After extensive research, followed by geological, geophysical and geochemical analyses and modeling by GeothermEx Inc. and Jacobs, they indicated the existence of an active geothermal system centered around the flanks of Mt Maria on Apas Kiri. The plant is set to produce 30 MW. The power will be sold to Sabah Electricity Sdn Bhd (SESB) via 132 kV interconnection to the grid under a 21-year renewable powerpurchase agreement (PPA) applying the Feed-in Tariff (FIT) scheme.

The plant is estimated to cost some MYR 600 million (US\$149 million) total investment with an initial grant of MYR 35 million (US\$8.7 million) from the Federal Government.

As of June 2016, Seda had approved a total of 9,570 FiT applications with a total capacity of 1,308.55 MW. In the same period, 6,201 FiT applications have achieved commercial operation with a total capacity of 364.02

MW. By the end of 2020, the 11th Malaysia Plan estimates that renewable energy installed capacity will reach 2,080 MW or 7.8 per cent of total generating capacity in peninsular Malaysia and Sabah.

Sources:

http://www.thestar.com.my/metro/community/2016/ 08/08/steaming-up-some-extra-energy-malaysias-firstgeothermal-power-plant-to-open-in-tawau/, http://www.themalaymailonline.com/malaysia/article/ minister-malaysias-first-geothermal-plant-to-beoperational-by-2018#sthash.8xd5wIV0.dpuf

Philippines: Expansion Plans, Asking for FiTs, Chevron Assets

Plans for 60MW Expansion in Southern Negros – The Energy Development Corp. (EDC) said by mid-August, the 60 MW expansion of the Southern Negros Geothermal Power Plant (SMGP) in Valencia, Negros Oriental will not encroach into a biodiversity area. EDC, the country's biggest geothermal energy producer, is expanding Southern Negros Geothermal's capacity to 282.5 MW from 222.5 MW to meet the region's growing electricity needs.

"We will confine our expansion within SNGP's existing geothermal production block in Valencia," EDC's Negros Integrated Geothermal Business Unit head Jay Joel Soriano said. Some reports have said EDC's expansion required an additional 5,163 hectares that would encroach into Mount Talinis, considered a key biodiversity area in Negros Oriental. EDC, however, said the expansion involved an increase in capacity, not the area. The current SNGP's steam field and power plant occupy less than 200 hectares, and EDC assured the expansion would be confined within the existing development block of 5,163 hectares.

EDC is awaiting the release of the environmental compliance certificate (ECC) from the Environment Department for the 60MW geothermal expansion. The company said the proposed expansion went through public consultations and hearings for the ECC application and received the strong endorsement for an ECC from the host communities and local government of Valencia. "But pending the release of the ECC, EDC has not begun any activity for its proposed geothermal expansion project," Soriano said.

Source:

http://thestandard.com.ph/business/213284/edcplant-expanding-within-geothermal-site.html

NGAP Asks the Government for FiT to Include New Geothermal Technologies - A group of geothermal developers has urged the government to cover under the Feed-in Tariff (FiT) program the

emerging geothermal technologies that were not yet commercially viable under existing market and pricing structures. This is expected to help address the barriers related to the high costs and resource exploration risks faced by geothermal energy developers, the National Geothermal Association of the Philippines (NGAP) said in a statement.



According to NGAP, the DOE strategy should apply new development technologies to what previously were considered to be second-tier resources, such as technologies that could use acidic and young geothermal systems, development of low-heat geothermal systems and the direct use of small-scale geothermal energy technologies.

Exploration using these technologies was deemed to become more feasible should the DOE allow the coverage of these emerging technologies and new geothermal sources under the FiT program, which provides guaranteed payment to investors through a universal charge.

NGAP called on the government to expedite the regulatory and approval processes as well as ensure the peace-and-order situation in some of the more remote prospects. It also called for the prompt implementation of the Renewable Portfolio Standard and Green Energy Option under the Renewable Energy Act, which will give incentives to utilities to buy geothermal power.

The government, it added, also needed to address the special technical challenges faced by firms in tapping undeveloped geothermal resources that require adapting emerging technologies like binary-cycle generation, ground source heat pumps and corrosion-resistant alloys. Aboitiz Power, Chevron Geothermal Services, Department of Energy, Emerging Power Inc., Energy Development Corp., Maibarara Geothermal Inc. and Philippine Geothermal Production Co. Inc., are among the NGAP members.

Source: <u>http://business.inquirer.net/213590/group-</u> seeks-perks-for-new-geothermal-technology

Firms Interested in the Chevron Geothermal Assets

- The Aboitiz group plans to team up with Japanese business house Marubeni to bid for the geothermal assets of American energy giant Chevron Corp. in the Philippines and Indonesia. Luis Miguel Aboitiz, Chief Operating Officer and Executive Vice President at Aboitiz Power Corp., said in early September the group was interested in the Asian geothermal assets to be sold by Chevron. Aboitiz said the auction was being structured in such a way that these Asian assets would be sold as one block. As such, he said the Aboitiz group would join with Marubeni in this big undertaking.

Chevron is unloading its geothermal assets in Indonesia and the Philippines with estimated value of \$2.5 billion, industry sources said.

Other Filipino groups, like Ayala Corp. and Energy Development Corp., are likewise keen on getting a piece of Chevron's geothermal assets.

It was unveiled that China General Nuclear Power Corp., the country's biggest nuclear power operator, has been invited to make a second-round bid. Medco Group is considering partnering with a Japanese company and a Philippine company, while the sovereign fund China Investment Corp., Malaysia's power producer Malakoff Corp., Japan's Mitsubishi Corp. and Ormat Technologies Inc. were among the companies that considered making offers.

Chevron has a 40% interest in Philippine Geothermal Production Co. Inc. (PGPC), which develops and produces steam energy for third-party owned and operated Tiwi and Mak-Ban geothermal power plants in Southern Luzon, with a combined generating capacity of 692 MW. Chevron also has an interest in the Kalinga geothermal prospect area in northern Luzon. In July, the company reported its third straight quarterly loss, the longest slump since at least 1989, according to data compiled by Bloomberg.

Sources: http://business.inquirer.net/214761/aboitizmarubeni-team-vying-for-chevronassets#ixzz4Jp7Pcg9u, http://www.bloomberg.com/news/articles/2016-09-16/chevron-said-to-narrow-bids-for-3-billion-asiangeothermal-sale

Taiwan: Exploration Well Is Being Drilled in Chinhsui

The local government of Yilan began exploratory drilling in mid-July in Sanshin Town for what it hopes will be Taiwan's first geothermal power plant. The geothermal zone is located in the Chinhsui River Valley, south of Chinhsui Village in Shanshin (Three Stars) Town. Hot springs with surface temperatures of up to 95°C are currently used for a resort called Chinhsui Geothermal Energy. The drilling is expected to take six months.

It was reported that a geothermal plant was developed in Datong Town in Yilan in the 1980s, and that the project closed in 1993. There's no confirmed data about this plant, but a geothermal well at 178 m depth was drilled in 2009 at Yangao County, about 52 kilometers to the west of Datong. This well was part of a program by the county government to tap local geothermal resources for the development of spa services and tourism, and produced around 40 tons per hour of water at 104°C.



Chinhsui Geothermal Energy resort (photo: Eva隨 手拍)

Previous records showed that local hot springs contained heavy amounts of calcium carbonate and 28 trace mineral supplements. The hot springs come from the extinct Datong volcanic cluster, which covers a geothermal field of 2.3 square kilometers.

Sources: http://www.totaltaipei.com/yilan-beginswork-geothermal-power-plant/, http://en.people.cn/90001/90776/90882/6850573.htm 1

EUROPE

Horizon 2020 – A Unique Opportunity for the Geothermal Community in Europe

Introduction and compilation by Thomas Reinsh, GFZ German Research Centre for Geosciences

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Multinational geothermal research initiatives have been growing significantly over the past few years. Within the framework of the EC funded horizon 2020 initiative, in the past two years, 11 geothermal projects were positively evaluated, 10 already started. Together with two on-going projects granted within the seventh framework programme FP7, the European Commission granted about €92 million (~U\$103 million), whereas the total project costs are up to €145 million (~U\$162 million) for the coming years. In addition, there are a few projects, where geothermal related topics are being investigated in individual work packages. A list of currently active as well as finished EC-funded projects can be accessed under www.geothermalresearch.eu.

In order to explore synergies between the different activities across project and national boundaries in Europe and worldwide, an initiative was started to define cross-topics and research needs vital for each project. It is intended to join forces in order to overcome the major bottlenecks for geothermal development today. To give the reader a concise overview of the various projects investigating topics ranging from exploration over drilling and stimulation technologies to monitoring aspects, on-going Horizon 2020 projects are presented below. All the projects have received funding from the European Union's Horizon 2020 research and innovation programme. For grant agreement numbers, please see https://ec.europa.eu/inea/en/horizon-2020/fundedprojects/geothermal.

Cheap-GSHPs - Cheap and efficient application of reliable ground source heat exchangers and pumps

The Cheap-GSHPs Project is an EU co-funded project under the Horizon 2020 Programme. The acronym stands for 'Cheap and efficient application of reliable Ground Source Heat exchangers and Pumps', and is very relevant for the project's objectives.

The project's consortium is composed of 17 partners, research centers and universities, ground source heatexchanger material suppliers, drilling machines and heat pump constructors, engineering companies and installers. All these consortium partners are specialized and expert in specific parts of constructing low-enthalpy geothermal systems.

CheapGSHPs is a particularly valuable tool for energy efficiency in the buildings sector, which is developing many innovative technologies related to: Ground Source

Heat Exchanger designs (GSHE) in combination with developments in drilling machine components and installation technologies, heat pumps with increased efficiencies at higher temperatures, and a decisionsupport tool (DSS) for holistic optimization and design.

All these new technologies will be tested at several demonstration sites in different European climate zones in both historical and modern buildings.



Project web site: http://www.cheap-gshp.eu

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CHPM 2030 - Combined Heat Power and Metal Extraction

CHPM 2030 aims to develop a novel technological solution that can help satisfy European needs for energy and strategic metals in a single, interlinked process. Working at the frontiers of geothermal resource development, minerals extraction and electrometallurgy, the project aims at converting ultra-deep metallic mineral formations into an 'ore body-EGS' that will serve as a basis for the development of a new type of facility for "Combined Heat, Power and Metal Extraction" (CHPM). In the technology envisioned, the metal-bearing geological formation will be manipulated in a way that the co-production of energy and metals will be possible, and able to be optimized according to the market demands at any given moment.

The work plan has been set up in a way to provide proof-of-concept for the following hypotheses: 1. The composition and structure of ore bodies have certain advantages that could be used to our advantage when developing an EGS; 2. Metals can be leached from the ore bodies in high concentrations over prolonged periods of time and may substantially influence the economics of EGS; 3. The continuous leaching of metals will increase a system's performance over time in a controlled way and without having to use highpressure reservoir stimulation, minimizing potential detrimental impacts of both heat and metal extraction.

As a final outcome, the project will deliver blueprints and detailed specifications of a new type of future facility that is designed and operated from the very beginning as a combined heat, power and metals extraction system. The horizontal aim is to provide new impetus to geothermal development in Europe by investigating previously unexplored pathways at a low-TRL. This will be achieved by developing a Roadmap in support of the pilot implementation of such systems before 2025, and full-scale commercial implementation before 2030.

For further information please visit <u>www.chpm2030.eu</u>, and be updated as we progress.



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DEEPEGS - Deployment of Deep Enhanced Geothermal Systems for sustainable energy business

The DEEPEGS project is a demonstration project supported by the European Commission. The goal is to demonstrate the feasibility of enhanced geothermal systems (EGS) for delivering energy from renewable resources in Europe. It is a four year project led by HS Orka Iceland, in cooperation with partners from Iceland, France, Germany, Italy and Norway.

The project will test stimulating technologies for EGS in deep wells in different geological situations that will deliver new, innovative solutions and models for wider deployments across Europe of EGS reservoirs with sufficient permeability for delivering significant amounts of geothermal power. The project demonstrates advanced technologies in three geothermal reservoir types that provide all the unique conditions for demonstrating the applicability of this 'tool bag' under different geological conditions. It will demonstrate EGS for the widespread exploitation of high enthalpy heat (i) beneath existing hydrothermal field at Reykjanes (a volcanic environment) with temperatures up to 550°C, and (ii) very deep hydrothermal reservoirs at Valence (a crystalline and sandstone environment) and Vistrenque (a limestone environment) with temperatures up to 220°C.

The consortium is industry driven by five energy companies that will implement the project goals through cross-fertilization and sharing of knowledge. The companies are all highly experienced in energy

production, and three of them already are delivering power to national grids from geothermal resources.



Project web site: <u>http://www.deepegs.eu</u>, Project Facebook: <u>http://www.facebook.com/deepegs/</u>, Twitter account: twitter.com/DEEPEGS_demo.

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Project office: GEORG, Grensasvegur 9 – 108 Reykjavik – Iceland; <u>info@deepegs.eu</u>

DESCRAMBLE - Drilling in dEep, Super-CRitical AMBient of continentaL Europe

The DESCRAMBLE project is meant to drill in continental crust, super-critical geothermal conditions, to test and demonstrate novel drilling techniques to control gas emissions in aggressive environments and in the high temperatures/pressures expected from deep fluids and to characterize the chemical and thermophysical conditions of the reservoir. The demonstration will be performed in Larderello, Italy, where very high temperatures (>375°C) and high pressures (>22 MPa) are expected at depths of about 4-5 km. Expected extreme conditions will be a challenge for actual drilling technology, but will also ensure that the energy output from such wells can be as much as ten times greater than from standard geothermal wells. The success of this project will open new market frontiers for exploiting similar resources at deeper depths. The combination of shallow depths for super-critical conditions and the possibility of deepening an existing well reduces the costs of drilling and focuses the project on drilling into formations with super-critical conditions and their related challenges.

The project will demonstrate safe drilling in high temperature and pressure condition by combining the best practices of oil & gas and deep geothermal drilling and using innovative materials. DESCRAMBLE will also reduce pre-drill uncertainty in the exploration of deep geothermal wells by improving knowledge of the physical and chemical conditions in deep geothermal formations in the continental crust and applying the latest seismic processing, imaging and interpretation technology for exploring supercritical reservoirs prior to drilling. Eventually, studies will be made of the economic potential of exploiting chemicals and minerals



by analyzing fluid samples for valuable materials.

The consortium is led by industry and includes companies (both geothermal and oil & gas) and research units from Italy, Germany and Norway. Started on May 2015, the project will end in April 2018. Project web site: http://www.descramble-h2020.eu

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DESTRESS - Demonstration of soft stimulation treatments of geothermal reservoirs

DESTRESS demonstrates methods of Enhanced Geothermal Systems (EGS). The aim is to expand knowledge and to provide solutions for a more economical, sustainable and environmentally responsible exploitation of underground heat. EGS allows the enormous untapped potential of geothermal energy to be put to widespread use. DESTRESS will improve the understanding of technological, business and societal opportunities and risks related to geothermal energy. Existing and new project sites of different geological settings have been chosen to demonstrate the DESTRESS concept.

The concepts explored in DESTRESS are based on experiences in previous projects (e.g. GEISER) and on scientific progress and developments in other fields, mainly the oil and gas sector. Recently developed stimulation methods will be adapted to geothermal needs, applied to new geothermal sites and prepared for market uptake. The main focus is on various stimulation treatments with minimized environmental hazards that address site-specific geological requirements. The overall objective is to develop good practices for creating reservoirs with increased transmission, sustainable productivity and a minimized level of induced seismicity.

DESTRESS brings together an international consortium comprised of major academic and research institutions and key industrial players from Europe and South Korea to ensure enhanced EGS-technology performance and accelerated market penetration.

More Information: <u>www.destress-</u> <u>h2020.eu</u>

Contact:



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GEMex - Cooperation in Geothermal energy research Europe-Mexico for development of Enhanced Geothermal Systems and Superhot Geothermal Systems

The GEMex project is a complementary effort of a European consortium with a corresponding consortium

from Mexico that submitted an equivalent proposal for cooperation. The European consortium will be funded through the International Cooperation Programme within the framework of Horizon 2020, while the Mexican partner project is funded by the Mexican Government (Conacyt). The joint effort is based on three pillars:

1. Resource assessment of two unconventional geothermal sites in Mexico: EGS development at Acoculco and a super-hot resource in Los Humeros. The work will focus on understanding the tectonic evolution, the fracture distribution and hydrogeology of the respective regions, and on predicting in-situ stresses and temperatures at depth.

2. Reservoir characterization using techniques and approaches developed at conventional geothermal sites, including novel geophysical and geological methods to be tested and refined for their application at the two project sites: passive seismic data will be used to apply ambient noise correlation methods and anisotropy by coupling surface and volume waves; newly collected electromagnetic data will be used for joint inversion with the seismic data. For the interpretation of these data, high-pressure/high-temperature laboratory experiments will be performed to derive the parameters determined on rock samples from Mexico or equivalent materials.

3. Concepts for Site Development: all existing and newly collected information will be applied to define drill paths, recommend a design for well completion including suitable materials selection, and investigate optimum stimulation and operation procedures for safe and economic exploitation with control of undesired side-effects. These steps will include appropriate measures and recommendations for public acceptance and outreach as well as for the monitoring and control of environmental impacts.

The European consortium was formed from the EERA joint programme of geothermal energy (<u>www.eera-set.eu</u>) in regular and long-time communication with the partners from Mexico. The close interaction of the two consortia is planned to continue beyond the duration of the project.

Start date: 1st October 2016, duration: 3 years. Website not yet available.

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GEOTeCH - Geothermal Technology for Economic Cooling and Heating

Geothermal Technology for Economic Cooling and Heating (GEOTeCH) is a project funded by the European Union within the Horizon 2020 program, corresponding to the topic 'demonstration of renewable electricity and heating / cooling technologies'.

The project introduces improvements in different fields of application. It improves the current drilling technology by introducing a waterless drilling system that requires less complex systems and reduces risks. The project also develops an improved integration of the heat pump elements during installation and an innovative heat exchanger that obtains high yields without loss of pressure. This system uses a coaxial configuration and spiral flow of fluid that improves thermal resistance compared to the U-shaped tubes commonly used.

The project also implements an economically efficient geothermal system maximizing the use of foundations for obtaining energy in tertiary buildings. Foundations as piles, diaphragm walls or footings are used as heat exchangers in the project and. together with the optimization of hybrid systems, are integrated in the geothermal systems; this technology will be included in both large and small buildings. This optimization of the geothermal system is achieved with the development of a dual source heat pump (ground and/or air) that will be attractive to both users and construction companies.

Thus, the aim of the project is to improve the drilling and geothermal technologies, along with the development of an Energy Management System that will be used to automatically control the systems.

Further information can be found at <u>www.geotec</u> <u>h-project.eu</u>.



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GeoWell - Innovative materials and designs for long-life high-temperature geothermal wells

The project aims to develop reliable, economical and environmentally friendly technologies for design, completion and monitoring of high-temperature geothermal wells with the intent to expedite the development of geothermal exploitation globally. GeoWell will address all relevant steps in the geothermal well completion process to enhance the lives of hightemperature geothermal wells. These include cement and sealing technologies, material selection and casing couplings. Methods of temperature and strain measurements in wells plus using optic fiber

technologies to monitor well integrity will be developed—plus methods for assessment of risk related to design and operation of high-temperature geothermal wells.

To ensure the quality of the approach and the final results of the project, the research is based on traditional production wells as well as deeper wells where the pressure is as high as 150 bars and the temperature exceeds 400°C. This new technology will be tested both in laboratories where real situations will be simulated, and also, partly, in existing geothermal environments.

Since this three-year project started in February 2016, work has been initiated in all work packages. Cement samples from the IDDP-1 well in Iceland have been analyzed and this will be useful for further developing the technology of cementing casings. Work on the design of a flexible coupling to mitigate the effects of thermal expansion of casings in high-temperature geothermal wells is ongoing and a prototype will be ready soon for laboratory testing. A study of casing materials has started--mainly metallic materials but also composite materials. Also, experiments have started of temperature and strain measurements in a geothermal well using fiber optic cables, as well as work on developing risk assessment methods for the geothermal industry.

Participants in the project, apart from ÍSOR who leads the project, are the research institutions IRIS in Norway, GFZ in Germany, TNO in the Netherlands and BRGM in France, as well as the industrial companies Statoil in Norway, HS Orka in Iceland and Akiet in the Netherlands.



Website: www.geowell-<u>H2020.eu</u>

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MATChING - Material innovations for the optimization of cooling in power plants

The MATChING goal is the reduction of cooling water demand in the energy sector through innovative, technological solutions to be demonstrated in thermal and geothermal power plants. The project targets include an overall saving of water withdrawal of 30% in thermal power generation and a decrease of evaporative losses up to 15% in the geothermal sector. It is funded by the NMP 15 – 2015.

The use of advanced and nanotechnology-based materials will be leveraged to make economically affordable water saving in power plants and pave the way for the market uptake. All technological areas of plant cooling systems will be affected: the cooling tower, steam condenser, cooling water circuit and water conditioning. The use of alternative cooling fluids will be investigated to develop advanced hybrid cooling towers for geothermal, high-temperature power plants and hybrid cooled binary cycles for low-temperature geothermal fields, combining dry/wet cooling and closed loop groundwater cooling. To increase available effective water supply at reasonable costs, alternative water sources will be exploited: different membranebased technologies will be used to re-cycle or re-use municipal process and blow-down waters.

To improve cooling equipment, robust advanced materials and coatings for cooling towers and condensers will be investigated, allowing increased concentration cycles or directly used aggressive fluids. Demonstrations will take place at partner-owned industrial sites, operating pilot plants in intended environments, and/or at demo scales, guaranteeing the achievement of TRL 6 for all the technologies. The demonstration activities and the partnership composition ensures the validation of suitable business models and the finalization of business plans, guaranteeing technological transfer from industry to market, increasing the competitiveness at European levels and impacting water use in the power-generation sector.

The geothermal test site for the MATChING project will be the cooling tower of the Nuova San Martino plant in Larderello, Italy. To allow the use of hybrid towers in geothermal fields, advanced tower filling (e.g. splash 3D packing), able to reduce the volume of packing but not the thermal efficiency, will be installed in the wet section. The dry section will be strengthened by means of advanced nanocoatings, applied on internal and external surfaces to increase the robustness of the dry section and avoid the fouling and clogging phenomena without reducing the thermal exchange efficiency between geo-fluid and air.

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SURE - Novel Productivity Enhancement Concept for a Sustainable Utilization of a Geothermal Resource

The EC funded Horizon 2020 project SURE, for radial water-jet drilling (RJD), started last March. The RJD technology will be investigated and tested as an alternative stimulation method to increase inflow in insufficiently producing geothermal wells. Radial water jet drilling uses the power of a focused jet of fluids applied to a rock through a coil inserted in an existing well. This technology is likely to provide much better control of the enhanced flow paths around a geothermal well and does not involve the same amount of fluid as does conventional hydraulic fracturing, considerably reducing the risk of induced seismicity. Therefore RJD will be applied to access and connect the highly permeable zones within geothermal reservoirs initially not connected to the main well.

SURE will investigate the RID technology for deep geothermal reservoir rocks in different geological settings, like deep sedimentary basins and magmatic regions at micro, meso and macro-scales. Laboratory tests will include the determination of parameters like elastic constants, permeability and cohesion of the rocks, as well as jetting experiments into large samples at ambient and simulated reservoir conditions. Samples will be investigated in 3D with micro CT scanners and with standard microscopy approaches. In addition, advanced modeling will help explain the actual mechanism leading to rock destruction at the tip of the water jet. Last but not least, experimental and modeling results will be validated by controlled experiments in a quarry (meso-scale) that allows precise monitoring of the process, as well as in two different geothermal wells in the Netherlands and in Iceland, respectively (at a macro-scale). Further information can be found on www.SURE-H2020.eu.

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ThermoDrill – Fast track innovative drilling system for deep geothermal challenges in Europe

Europe urgently needs renewable energy sources producing heat and electricity on a permanent basis to supplement the intermittent energy supply of wind and solar power. This can only be achieved by tapping into the enormous potential of geothermal energy. In most areas in Europe, however, suitable geothermal reservoirs lie at depths of 5000 to 6000 meters and consequently involve high drilling costs. A smart and efficient technological solution is therefore required to exploit these resources. The goal of the ThermoDrill project is to develop an innovative drilling system which will enable faster and cost-efficient drilling. The new system will be suitable for drilling hard and abrasive rock types. It will withstand the extreme temperature and pressure conditions involved in geothermal drilling and meet the most stringent standards in terms of health, safety and environmental protection.

The project will be carried out in a three stage process. First investigations and laboratory tests will be performed to examine the relevant rock and fluid parameters and thus provide a sound scientific framework for subsequent developmental work.

These preliminary investigations will be followed by a concept and design phase focusing on component development, including vertical jetting tools, innovative bit designs and new jetting and drilling fluids for hard crystalline rock suitable for high temperature and pressure conditions. All these technologies will be combined into a fast track, innovative drilling system taking into account casing and cementing issues.

In the final stage, the laboratory results will be validated in a small-scale field test. The project team will build a test facility and prototypes of the drill and fluids and test them on a range of crystalline rock types under realworld conditions.



More information: <u>www.thermod</u> <u>rill-h2020.org</u>

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Highlights of the European Geothermal Congress (EGC) 2016

Over 1,000 participants from more than 34 countries joined the European Geothermal Congress (EGC) 2016, held in Strasbourg, France, from 19 through 23 September. The event, organized every three years by the European Geothermal Energy Council (EGEC), brought together stakeholders from the entire geothermal community for sessions covering science, markets, and social issues, an exhibition, courses, and side events.

Geothermal in Europe is growing and the sector maintains its technological leadership. Today, 88 power plants with a total installed capacity of 2.28 GWe are in operation, with an increasing number of innovative

binary turbines. There are also 527 district heating plants with a total capacity of 4.7GWth; new designs and IT techniques will revolutionize the sector, creating modern, adaptable systems for future communities.

Around 1.7 million ground source heat pumps are providing sustainable heating, cooling and hot water to homes and businesses across Europe, making it the leader in this technology. This growth has been supported by both European and national measures for climate, energy and innovation, which have triggered interest and private investment in geothermal.

Still, the potential for geothermal energy to provide renewable, clean, local, safe, and reliable energy is much larger, but barriers still exist.

Clear and strong signals are needed at a European level. In the legislative framework for the period after 2020, to be unveiled by the commission by the end of the year, investors must be reassured of stability in regulatory and planning systems over the next 15-20 years. New legislation should include requirements for a minimum share of renewables in new buildings, remove incentives for fossil fuel systems, and grant Member States the flexibility to develop their own instruments which will allow the next generation of technologies to develop.

Local, national, and international political and industrial leaders opened the EGC 2016, describing how Europe is leading the world in innovation and scientific excellence. Strasbourg provides an excellent stage for this event; famous since Roman times for its geothermal spas, it is now at the vanguard of geothermal development as the home of the first demonstrated EGS plant at Soultz-sous-Forêts, and the first EGS plant providing heat to industry. Centre. In the meeting, a new Board was elected, including a new President. Burkhard Sanner, the President since 2004, had announced his intention to not stand for a new election. Sanner, one of the founders of EGEC in 1998 and active in getting EGEC running since then, said that it was "time to hand over the helm to others." The new board is comprised of

President: Ruggero Bertani (ENEL Green Power)

Vice President: Miklos Antics (GPC IP)

Vice president: Javier Urchueguia (Energesis)

Treasurer: Attila Kujbus (Geothermal Express)

Board Member: Marco Baresi (Turboden)

Board Member: Robert Gavriliuc (Romanian Geoexchange Society)

Board Member: Thor-Erik Musaeus (Rock Energy)

Sources: http://egec.info/wp-

content/uploads/2016/08/EGEC-Newsletter-Summer2016.pdf,

http://europeangeothermalcongress.eu/thegeothermal-community-meets-in-strasbourg-for-theeuropean-geothermal-congress-2016-to-celebrateeuropean-excellency-calls-for-clear-structural-signalsand-tailored-tools-for-further-expansion/

Germany: Geothermal Congress, New Energy Law

German Geothermal Congress Offers a Full-time English Program - The German Geothermal Congress (29th November – 1st December, Essen) is broadening its offers for international guests. On the workshop day (29th November) and both congress days (30th November and 1st December) there will be

presentations and workshops on drilling and downstream technologies as well as on global issues. Further information on the English offers you may find here: http://www.geothermie.de/aktuelles /der-geothermiekongress-2016/information-in-english.html.

The full program including the presentations in German language are available here:

http://www.geothermie.de/fileadmin /useruploads/aktuelles/Geothermiek ongress/2016/DGK_2016-Programm_Stand_05.09.2016.pdf

New Energy Law with No Auctions for Geothermal - The

Bundestag and the Bundesrat in early July approved a new energy law outlining the annual auctions for renewable power capacity over the coming years. With

As one of the side events of the congress, EGEC held its annual general meeting on 21 September in the same venue, the Strasbourg Convention and Exhibition



the Renewable Energy Sources Act (EEG 2016), the country turns to renewable energy auctions to replace the feed-in tariff (FiT) program. The law will come into force at the start of 2017, subject to receiving the EU's blessing.

For onshore wind, EEG 2016 announces annual installation capacities of 2,800 MW in 2017-2019, which increase to 2,900 MW in2020. Offshore wind willreach 15,000 MW by 2030, with 500 MW in each of 2021 and 2022, followed by 700 MW per year in 2023-2025, and 840 MW per year from 2026 on. In 2021, offshore wind parks will be built only in the Baltic Sea because of available grid capacity.

The amended Renewable Energy Sources Act sets a 600 MW annual auctions target for big solar systems. Biomass power tenders, on the other hand, will involve 150 MW per year in 2017-2019 and 200 MW/year in 2020-2022. There is to be no auction for hydropower or geothermal.

Source:

http://renewables.seenews.com/news/germany-okaysnew-energy-law-annual-targets-for-renewable-auctions-532144#

Iceland: IDDP-2 Starts Drilling in Reykjanes

On early September, drilling of a 5000 meter deep well was started in the Reykjanes Peninsula in SW Iceland. This was the beginning of the IDDP-2 (Icelandic Deep Drilling Project), which is a joint effort of the IDDP-Consortium and the European Union-supported project DEEPEGS (Deployment of Deep Enhanced Geothermal Systems for Sustainable Energy Business). Jardboranir, the Iceland Drilling Company (IDC), has been contracted for drilling the well on a daily rate basis using a Bentec 350 ton rig with an electrical top drive, better known as Thor. The rig has previously been used in Iceland at the Hellisheidi geothermal site.

The plan is to take over an existing well, RN-15, which is 2.5 km deep, deepen the well to 3 km, set casing, and then continue drilling to 5.0 km depth to continue exploring for a supercritical geothermal resource. The well will be deviated 16° SW with a kick-off point at 2750 m to intersect the deep target zone. Conventional down-hole motors and gyros will be used from the kickoff point to 3150 m. Then high-temperature, downhole directional drilling equipment, recently developed by Baker Hughes, will also be employed. Lithological logging of drill cuttings samples taken at 2 m intervals will be carried out by ISOR and both cores and cuttings will be scanned and the core descriptions and lithological logs will be entered into an ICDP Drilling Information System (DIS) to disseminate the data expeditiously.

Completing the well to its total depth is estimated to take about 150 days, including about 30 days needed for taking 10 m core samples. The available funding should allow 20-25 core runs to be attempted using equipment, techniques and personnel that have already successfully extracted cores from geothermal wells at Reykjanes. Funds for coring and their scientific studies have been augmented by the U.S. National Science Foundation (NSF) award EAR 05076725 to Wilfred A. Elders and co-workers in the U.S.



Drilling rig at the site. Photo taken from: <u>http://www.pennenergy.com/articles/pennenergy</u> <u>/2016/09/statoil-and-icelandic-partners-drill-the-</u> <u>world-s-hottest-geothermal-well.html</u>

The IDDP-2 is significant not only for the development of new geothermal resources in Iceland but internationally. Not only do aqueous geo-fluids at supercritical condition have more than five times the power producing potential than hydrothermal liquid waters of 225°C, but there is a singularity in the transport properties of water at the critical point. Modeling indicates that a supercritical well could have ten times the power output of a conventional geothermal well. Potential sites for supercritical geothermal resources occur worldwide, both on and offshore, wherever young volcanoes occur.

Source: <u>http://iddp.is/wp-</u> content/uploads/2016/07/SAGA-REPORT-No-<u>10.pdf</u>

Italy: Official Inauguration of Bagnore 4 Geothermal Power Plant

Last July, Enel Green Power (EGP) inaugurated its Bagnore 4 geothermal power plant in Tuscany, Italy. The plant started operation in 2014 (see IGA News 98, pp. 22-23). It's located near Mount Amiata, between the towns of Santa Fiora and Arcidosso, and has a total installed capacity of 40 MW, in addition to the existing plant of 20 MW Bagnore 3 built in 1998.

Bagnore 4 has a sophisticated active monitoring system, tele-diagnostics and well adjustments that prevent steam spillage into the atmosphere in case of a halt by a production team. The control unit is equipped with two AMIS (mercury abatement and hydrogen sulfide) and an innovative system for the removal of ammonia operating at both Bagnore 3 and Bagnore 4. All the technology of the Bagnore geothermal complex is Italian, from exploration and drilling, construction –all material is made in Italy– to production and maintenance.



Photo: ENEL (<u>https://www.enel.it/it-it/eventi-news/Pagine/Innovazione-dal-sottosuolo-.aspx</u>)

The Bagnore 4 plant will also become a sort of open-air energy school, thanks to an innovative tourist trail that winds around the plant. The trail will also involve Bagnore 3 and give citizens and visitors alike the opportunity to experience up close, the operation of power plants and the opportunities offered by the exploitation of the earth's heat. Those interested can choose between two modes, both free: a free visit without a guide or one led by EGP staff, ready to answer questions and respond to the curiosity of visitors. The guided tour allows entry inside the center to learn more about the operation of the system, the engine room suppressants like AMIS and ammonia, placement of the electricity network, the steam cooling process and district heating. The Santa Fiora administration has chosen to include the visit within the central municipal offer to tourists, confirming the importance of geothermal energy not only for energy production but also as an environmental and tourist resource in the territory of Amiata.

Source: http://www.thinkgeoenergy.com/enelofficially-inaugurates-bagnore-4-plant-in-tuscanyitaly/?utm_source=ThinkGeoEnergy+List&utm_camp aign=33007ccd9c<u>TGE_Newsletter_RSS1_12_2015&utm_medium=email</u> <u>&utm_term=0_657e42f767-33007ccd9c-415210497</u>

The Netherlands: Extraordinary Growth of Geothermal Uses, and One Current Example

Rapid Growth of Geothermal Heat Applications in the Country - Geothermal energy has been developing

rapidly in the Netherlands in the last years. Niek Willemsen, of IF Technology, explains the reasons for this growth, in these excerpts taken from *ThinkGeoEnergy*.

There are several reasons for the extraordinary growth of geothermal energy in the Netherlands. One of the biggest is the excellent regulatory framework implemented by the Dutch government over the past years. The Dutch government has developed policy instruments that... have facilitated the rapid development of geothermal energy in The Netherlands. The most important of these instruments are listed below.

- NLOG public subsurface data. The Netherlands Oil and Gas (NLOG) portal is a public database that holds all subsurface data (e.g. well logs and geophysical surveys) gathered under a mining permit. This includes data from the oil and gas industry plus mining and scientific research. The

Dutch mining law obliges all parties operating under a mining permit to deliver the acquired data to the governmental organization, TNO. This data will be made public five years after acquisition. This system is of vital importance to the geothermal industry as it all but eliminates the need for exploratory drilling. Based purely on the available data in The Netherlands, it is possible to get a 90% certainty estimate (P90) of the power output of a projected well pair. This high degree of certainty means up to 70% bank financing is possible without the need for additional exploration activities. This significantly reduces the up-front costs and risks for geothermal project developers.

- State owned risk mitigation fund. The Dutch government set up a fund to mitigate the geological risks within geothermal projects. This risk mitigation fund pays out 85% of well costs in case the thermal power output is less than the previously mentioned P90 estimate. The fee is 7% of the costs covered.

- Feed-in premium for renewable heat. The Netherlands has a feed in premium for renewable heat to stimulate the transition from a fossil-based energy system to a renewable energy system. This program is called SDE+ and it pays out the difference between the costs of fossil

energy and renewable energy. There is a set amount of subsidy each year and the cheapest forms of renewable energy get subsidized first. So far, geothermal heat is one of the cheapest forms of renewable energy per MWh in The Netherlands.

The result of these measures is that the Dutch geothermal market is now the fastest growing in Europe by a large margin as shown below (see attached graphic). The Dutch geothermal sector has seen a steady 50% annual growth-rate in output over the past 4 years.

Source: http://www.thinkgeoenergy.com/the-rapiddevelopment-of-geothermal-energy-in-thenetherlands/?utm_source=ThinkGeoEnergy+List&utm _campaign=397d2a1559-TGE_Newsletter_RSS1_12_2015&utm_medium=email &utm_term=0_657e42f767-397d2a1559-415210497

Start of Drilling at the Aardwarmte Vogelaer Project

- After months of preparation, on 12 August the geothermal project Aardwarmte Vogelaer has started drilling in Poeldijk, Holland. The seven participating glasshouse companies are expected to begin using the geothermal energy station located at the Wateringseweg and the heat distribution network to be set up at the end of 2016.



Drilling pad at Aardwarmte Vogeler (Photo from <u>http://www.aardwarmtevogelaer.nl/424460745</u>)

The company DrillTec GUT GmbH is drilling the production well, planned to reach 2,500 m in depth and expected produce hot water at 85°C from the aquifer composed of a sand layer. The heat from this water will be used to heat greenhouse farms in a sustainable manner and the cooled water will be pumped back to the same aquifer through an injection well to be drilled at the same depth. This way the related horticultural companies expect to annually emit approximately 23 kilotons less of CO2 and save more than 13 million m3 of natural gas. This is equivalent to the consumption by approximately 8,000 households. The participating companies are Optiflor, Fachjan, Kwekerij Apartus, Amazone Plants, Gebr. Grootscholten Handelskwekerij, Kwekerij Barendse and Zuidgeest Growers, who have made a conscious choice towards the sustainable cultivation of their products and a cleaner, healthier future.

Source:

http://www.hortidaily.com/article/28215/Start-ofdrilling-at-Aardwarmte-Vogelaer

Poland: Pros and Cons of Geothermal Heating

The Polish government intends to fund up to 700 million Polish Zloty (US\$185 million) supporting drilling and construction of geothermal plants. Following failed plans for shale gas development, the planned funding could help to adapt abandoned wells. As noted previously (see IGA News No. 103, p. 22), Poland's new minister of Environment stated in February that, "Geothermal energy, not wind energy, will definitely be the priority of this government...' Now, Jacek Zimny from the Academy of Mining and Metallurgy and head of the Polish Geothermal Association, said, "With heating by geothermal energy, Poland could become completely independent from foreign energy sources". In February this year, the country's President, Andrzej Duda, appointed him to the National Development Council. In June, he was one of the main speakers at the conference organized by the National Fund for geothermal energy. There he talked about his thesis on Polish energy self-sufficiency based on the abundant resources of geothermal.

However, there is some opposition. Michael Wilczynski, a former chief geologist of the country, says that only in a few places in Poland do water wells have sufficient temperatures (above 60°C), pressures and chemical compositions to be used for heating. And even then, says Wilczynski, it is impossible to build a heating plant without public subsidies, because drilling one well costs more than 30 million Polish Zloty (US\$8m). The subsequent operation is also expensive because the water from the ground is usually highly saline, destroying pipes and equipment.

Source: <u>http://www.thinkgeoenergy.com/geothermal-heating-part-of-ambitious-plans-of-polish-government/</u>

Sweden: Novel Pilot Hybrid Solar PV-Geothermal System

Research out of the SP Technical Research Institute of Sweden has provided proof of concept for a novel hybrid renewable-energy system featuring a combination of hybrid solar PV and geothermal power.

The new concept is based on a system integrating hybrid solar PV, ground-source heat pump (GSHP) and borehole thermal energy storage (BTES) technologies.

The result is a system in which outputs from each technology are highly complementary to one another, and carry the potential to increase energy efficiency and cost effectiveness of individual components.

A critical feature of the system is the role played by the hybrid solar PV. Unlike conventional solar PV, hybrid solar PV, sometimes referred to as hybrid solar photovoltaic/thermal (PV/T), is a popular, wellestablished method for cooling PV cells. Hybrid solar PV modules consist of conventional PV cells with embedded systems containing some form of cooling agent, typically water or air, which is circulated through PV panels. The intention here is to reduce PV cell temperatures, as it is known that overheating —through either solar radiation or ambient temperatures reduces PV cell efficiency significantly.

The new system advances the hybrid solar PV concept by making use of the output water within a vertical loop GSHP system through which it flows. Pernilla Gervind, one of the lead researchers on the project, explained: "Having passed through the PV panels, water is heated to around 10-degrees Celsius; it is then directed into the cold side GSHP system and used as heat source; if there is a surplus of heat, this is then directed down into boreholes. Here, the thermal energy of water is absorbed by the surrounding ground as result of a temperature differential that arises from the ambient temperature of the ground being between 2 to 3 degrees Celsius. The now-cooled water is then cycled back up the system, and re-used in the cooling of PV panels in a closed-loop system."

Heating boreholes with direct heat is not new —it's a process referred to as 'recharging,' and is a common method for increasing efficiency of heat pumps in response to temperatures surrounding boreholes declining over time, in part through absorption of thermal energy. Commonly, however, direct heat is generated through more conventional means or through concentrated solar power (CSP). Using hybrid solar PV in this recharging context is unique.

The system may be used for the purposes of seasonal storage of thermal energy, as Gervind explains: "In Sweden, seasonal temperatures vary greatly, providing options for how the system can be used accordingly. In the summer we can generate solar thermal energy, but it's not required for anything —so we can use boreholes to store this excess energy for use during the winter when it is required."



Photo by Pernilla Gervind and Jessica Benson, taken from the source.

The system stands to be especially useful in Sweden, where geothermal energy is dominated by lowtemperature, shallow systems featuring GSHPs used for space heating and domestic hot-water heating. About 20 percent of Swedish buildings use GSHPs, according to the International Geothermal Association.

In the study, which was supported by the Swedish Energy Agency together with Energiförbättring Väst, the system was piloted through 2015 on the western coast of Sweden in over 70 terraced houses. Monitoring system performance allowed the researchers to make mid-study adjustments. Owing to the relative success of the pilot project, the researchers are looking towards future studies.

Source:

http://www.renewableenergyworld.com/articles/2016/ 09/novel-hybrid-solar-pv-geothermal-energy-systempiloted-insweden.html?cmpid=renewablegeothermal0982016&eid =291021978&bid=1520985

Turkey: Toshiba Turbo-



October-December 2016

generators for Unit 2 of Kizildere III

Toshiba Corporation announced it has won a major order to supply a flash steam turbine system and generator, of 50.7 MW, gross, for Unit 2 of the Kizildere III Geothermal Power Plant in Turkey. Zorlu Energy, an independent power producer and member of Turkey's Zorlu Energy Group, will construct the plant in Kizildere, in the Aydin province of West Anatolia, Turkey. Toshiba will deliver the generation equipment in July 2017 and the plant is scheduled to start generating electricity in December 2017.

Energy consumption in Turkey is growing fast, driven by population growth and economic development. Both the government and the private sector are promoting projects to increase capacity. Toshiba concluded a memorandum of understanding (MOU) with Zorlu Energy Group in January 2016, covering the construction of geothermal, thermal and hydro power plants.

Unit 2 of the Kizildere III Geothermal Power Plant is a 70 MW, high-efficiency triple flash, combined-cycle geothermal power plant. It will integrate two systems: an approximately 50.7 MW flash steam generation system driven by steam under high pressure; plus an approximately 19.3 MW binary cycle, power-generation system that uses a flash turbine exhaust steam to vaporize a working fluid with a lower boiling point and to drive a turbine.

Toshiba delivered a flash power generation system for the Zorlu Energy Group's Alasehir Geothermal Power Plant in 2014, its first in Turkey. Following smooth progress in installation work and proving tests, the plant started commercial operation ahead of schedule, in September 2015. After that, Toshiba received a further order for a flash-power generation system for Unit 1 of the same Kizildere III plant in 2015, which is being manufactured. This is the third order that Toshiba has received from the Zorlu Group.

Toshiba said in its press release that the company is strongly focused on expanding its geothermal turbogenerator business, promoting a strategic collaboration agreement (SCA) with US-based Ormat Technologies, Inc., a maker of binary systems, and offering a range of assistance measures, including financing by the Japanese Government under its 'quality infrastructure export' policy. Toshiba noted it is expanding the scope of its business beyond manufacturing to include operation and maintenance of geothermal power plants.

Source:

http://www.toshiba.co.jp/about/press/2016_09/pr130 1.htm#PRESS

Australia: Final Activities in the First Demonstration EGS Project

The Australian company, Geodynamics Limited, has entered a new stage of its transition to a clean energy product and service company. The company has ceased all geothermal energy development projects and materially completed the plugging and abandonment of wells and remediation activities in the Cooper Basin. The Cooper Basin is the site where the company conducted the only EGS (Enhanced or Engineered Geothermal System) pilot project in Australia that could produce electrical energy. The 1MW Habanero pilot plant operated for 160 days in 2013. Prior to the closure of the trial, the plant was operating at 19 kg/s and a 215°C production well head temperature. The next stage of the project investigated the use of geothermal energy to provide process heat to future natural gas developments in the Cooper Basin. Mainly due to the low oil prices, the project did not proceed to the next stages of demonstrating this application of geothermal energy, given there would not be a potential end user co-located. The project was closed on 10 December 2015.



Steam at night. Photo taken from https://www.cleanenergycouncil.org.au/technologies/ geothermal.html.

Since then, the remediation of the Cooper Basin has been a key focus for Geodynamics. Geothermal wells Celsius 1, Jolokia 1, Savina 1, Habanero 1 and Habanero 2 are all plugged and abandoned with surface remediation completed. Habanero 3 and Habanero 4 are currently undergoing monitoring after having the cement plugs set. Plans for the final well barriers, surface plugs and well caps for Habanero 3 and 4 are in place and will be executed once the monitoring period is successfully completed. The remaining surface

Oceania

remediation of the Cooper Basin site, removal of power lines and the transfer of operating assets to third parties is expected to be completed in 2016.

Geodynamics also unveiled it has implemented the exit of all interests in Pacific island geothermal projects, with no material financial liabilities associated with the projects.

Geodynamics reported a closing cash balance of AU\$14.41 million for the year ending 30 June 2016. A proportion of the cash outlay for the financial year was attributable to the remediation activities in the Cooper Basin. However, after the completion of remediation activities, Geodynamics will prepare an R&D tax incentive claim, expecting to receive around AU\$3.47 million by the end of the calendar year.

According to ARENA (Australian Renewable Energy Agency), the total cost of the Habanero EGS project was AU\$144.22 million (US\$ 198.26 million at the current exchange rate), of which the federal government provided 23%.

Sources:

http://www.geodynamics.com.au/getattachment/59adc 258-fd12-4860-8346-7afe239c08a1/Geodynamics-Company-Update.aspx, http://arena.gov.au/project/cooper-basin-enhancedgeothermal-systems-heat-and-power-development/

Fiji: Pilot Plant Geothermal Freezer in Vanua Levu

Klaus Regenaur-Lieb, University of New South Wales, Australia

The Vanua Levu project is a Strategic Research Theme Project (SRT) by the University of the South Pacific (Holger Sommer) in collaboration with UNSW Australia (Klaus Regenauer-Lieb). This pilot project aims at demonstrating a clean geothermal power solution for off-grid use in the South Pacific. The long term aim is to integrate multiple uses of naturally available geothermal heat for electric power, cooling solutions and fresh water and other direct-heat uses to local communities.

The pilot project develops a central freezing and geothermal absorption chilling facility for Natewa Bay —the first step in using a comparatively low risk direct-heat technology. The project seeds international collaboration through a conference^[1], with the aim of establishing an alliance for a cleaner developing world by supporting the cascaded use of natural geothermal heat as the main energy source for industrial and domestic use.

The project will use a hot spring locally known as the 'Waikatakata' (hot water) spring (*see* figure attached), located at 16°33.8' S, 179°44.8' E. It issues from a

hillside into a creek bed. The spring had a temperature of 64.4°C in 1898 and 66.0°C in 1972^[2]. The geothermal freezer facility plans to service the traditional landowners of Vusasivo Village and adjoining Natewa Village, in coordination with the Nambu Conservation Trust of Natewa (~1000 villagers). The villagers have a basic infrastructure (post office, church, small clinic) but lack any possibility for keeping food fresh and have no clean water and sewerage installations. This leads to significant provision problems and enhances the risk of food poisoning and diseases. A central Cool Store powered by a geothermally driven ammonia-water chiller could solve these issues. Technically the project is identical to the Chena Hot Spring installation in Alaska^[3] that provides ice for an ice museum. The timing of lending international development support appears to be just right.



References:

1. Conference, http://www.g eothermalcitie s.com/index.p hp/en/, in Geothermal Energy for the South Pacific. 2017: Vanua Levu.

2. Woodrow, P., Geology of South East Vanua Levu, in *Bulletin* No. 4, 1976.

Waikatakata Spring.

3. Chena, http://www.c

henahotsprings.com/ice-museum-renewables/

New Zealand: Agreement with Indonesia, Contribution of Geothermal in 2015

Agreement with Idonesia - In middle July, Prime Minister John Key met the Indonesian President, Joko Widodo, in Jakarta. Key and President Widodo discussed a wide range of issues, launched two new educational initiatives and signed a renewable energy agreement. "New Zealand and Indonesia have a strong and growing relationship," says Key. "New Zealand helped build Indonesia's first geothermal power plant in the 1980s. Today we signed a renewable energy and energy conservation agreement that will see New Zealand assist Indonesia in its ambition to increase

renewable energy to 25 per cent of its total energy supply by 2025... The New Zealand Government will contribute up to US\$30 million over the next five years for geothermal training and technical assistance, and help Indonesia access renewable energy in Maluku, Eastern Indonesia."

Source: http://www.voxy.co.nz/politics/5/257795

Geothermal Produced 22% of TPES and 17% of **Power Generation -** The Ministry of Business, Innovation and Employment released late September its official report Energy in New Zealand 2015. Among other relevant data, it reports that 80.8% of the annual electricity generation came from renewable sources, which also produced 40.1% of the Total Primary Energy Supply (TPES). In particular, geothermal energy accounted for 22% of New Zealand's TPES, and 17.3% of power generation, being the second energy source just behind hydro (see Fig. F.4 taken from the report). Geothermal plants generated 7,411 GWh along the year, which is a new record. The total New Zealand generation of electricity was 42,876 GWh, with the firms Meridian Energy producing 33%, Contact Energy 22%, Mighty River Power 17%, Genesis Energy 14%, and Trustpower 5%. The remaining 9% was produced by other minor companies and local providers.

Source: <u>http://www.mbie.govt.nz/info-</u> services/sectors-industries/energy/energy-datamodelling/publications/energy-in-new-zealand

Figure F.4: Electricity Generation by Fuel Type, 2014 and 2015 Years

17.3%

16.3%

15.0%

15.6%



Other Climate Change: Philippines to Withdraw the Paris

Agreement, while the EU Has Ratified it

The Philippines will not honor commitments it made under the Paris climate change deal, President Rodrigo Duterte said in middle July. "You are trying to stifle us," President Duterte said. "That's stupid, I will not honor that. You signed... That was not my signature."

Agreed by 195 countries including the Philippines last December, the UN pact aims to limit warming to well below 2°C from pre-industrial levels. It comes into force when 55 countries covering 55% of global emissions formally join. The Philippines accounts for less than 1% of the world's emissions, and has not ratified the deal.

President Duterte said he felt like attacking an ambassador to the Philippines at a recent meeting, after he was asked about plans to cut the country's greenhouse gas emissions. "I'm mad at this ambassador. I want to kick him," he said. Limits on carbon emissions for the Philippines were "nonsense," he added.

It is not the first time President Duterte has criticized the international climate agreement. He previously accused the UN of being "hypocrites" for fixing a pact that requires all countries –not just the rich– to make greenhouse gas cuts.

The UN deal also encourages countries to develop better climate resilience strategies, vital for a nation as

56.7%

57.1%

2014

vulnerable to extreme weather as the Philippines.

By the other hand, the European Parliament, the European Union's executive arm, ratified the Paris Agreement on climate change on 4th October, triggering global approval of the accord.

The 28-nation bloc approved the pact, the most sweeping effort to combat global pollution, at a session in Strasbourg, France. The vote indicates the threshold for ratification –approval by at least 55 parties accounting for 55 percent of global emissions-- was reached. The EU, which seeks to be

regarded as a leader in the fight against climate change, came under pressure to endorse the plan, codified in 2015, after the United States, China and India did so.

Parliament President Jean-Claude Junker, who in September noted slow delivery on promises has

undermined the EU's credibility, said, "Today the European Union turned climate ambition into climate action. The Paris Agreement is the first of its kind and it would not have been possible were it not for the European Union. Today we continued to show leadership and prove that, together, the European Union can deliver."

The EU has set a goal of reducing heat-trapping gases by at least 40 percent, compared to 1990 levels, by 2030.

Sources:

http://www.climatechangenews.com/2016/07/18/phili ppines-wont-honour-un-climate-deal-says-president/, http://www.upi.com/Top_News/World-News/2016/10/04/European-Union-ratifies-Parisclimate-change-agreement/7831475579820/

Climate Change: First Signs of Healing in the Antarctic Ozone Layer

Scientists at MIT and elsewhere have identified the "first fingerprints of healing" of the Antarctic ozone layer, as was published in early July in the journal Science. The team found that the September 2015 ozone hole has shrunk by more than 4 million square kilometers —about half the area of the contiguous United States— since the year 2000, when ozone depletion was at its peak. The team also showed for the first time that this recovery has slowed somewhat at times, due to the effects of volcanic eruptions from year to year. Overall, however, the ozone hole appears to be on a healing path.

The authors used 'fingerprints' of the ozone changes with season and altitude to attribute the ozone's recovery to the continuing decline of atmospheric chlorine originating from chlorofluorocarbons (CFCs). These chemical compounds were once emitted by dry cleaning processes, old refrigerators and aerosols such as hairspray. In 1987, virtually every country in the world signed on to the Montreal Protocol in a concerted effort to ban the use of CFCs and repair the ozone hole.

"We can now be confident that the things we've done have put the planet on a path to heal," says lead author Susan Solomon, Professor of Atmospheric Chemistry and Climate Science at MIT. As chlorine levels continue to dissipate from the atmosphere, Solomon sees no reason why, barring future volcanic eruptions, the ozone hole shouldn't shrink and eventually close permanently by mid-century.

"What's exciting for me personally is, this brings so much of my own work over 30 years full circle," says Solomon, whose research into chlorine and ozone spurred the Montreal Protocol. "Science was helpful in showing the path, diplomats and countries and industry were incredibly able in charting a pathway out of these molecules, and now we've actually seen the planet starting to get better. It's a wonderful thing."



A simulation of the Antarctic ozone hole, made from data taken on October 22, 2015. Image: NASA's Goddard Space Flight Center (taken from MIT News).

Source: http://news.mit.edu/2016/signs-healingantarctic-ozone-layer-0630

Technology: New Zeolitic Cement for Geothermal Wells Casings

One of the most critical components of geothermal development is the drilling process and the integrity and longevity of a geothermal well's casing cementation. The gap between the casing and the walls of the well is filled with cement, which locks the casing into place. Within geothermal wells, cement and casing integrity challenges are increased by the harsh conditions of high temperature, high pressure and a chemical environment that can degrade conventional cement.

With assistance from the U.S. DOE's Geothermal Technology Office (GTO), Trabits Group, LLC has successfully developed a cement that performs strongly in harsh geothermal conditions and is easy to use. In partnership with University of Alaska Fairbanks, Trabits Group has developed a novel, zeolite-containing, lightweight, high-temperature, high-pressure cement for use in casing geothermal wells. Zeolites are a naturally occurring clay mineral readily dehydrated and rehydrated. This cement reduces the complexity and cost of well cementing, which will help enable the widespread development of geothermal energy.

The main features of the cement are:

- Thermal stability with little strength retrogression to 300° C.

- Tensile strength to withstand temperature and pressure changes.

- Low-density, low-viscosity slurries with low-equivalent circulating densities (ECD) without the need for air or nitrogen foaming.

- A single cement blend allowing density adjustments without adversely affecting slurry properties to eliminate the need for separate blends for lead and tail slurries.

- Resistance to carbonation.

- Accurate downhole densities throughout cement placement without significant changes in viscosity.

- Water absorption capacity without retaining free water.

- Good bonding to casing and formation.

- Adequate compressive strength.

The main benefits include cost savings by reducing time and complexity of well cementing, lowering the overall cost of well completion, compatibility with all common additives (e.g., retarders and accelerators), minimizing the effects of down-hole temperatures and reducing greenhouse gas emissions, compared with Portland cement production, by using naturally occurring pozzolanic zeolites.

Trabits Group has started to commercialize the cement under the trademark of FlexCemTM.

Sources: http://energy.gov/eere/successstories/articles/eere-success-story-geothermal-wellsadvancing-technology, http://www.trabitsgroup.com/geocement.html

Technology: Downhole Hammer for High Temperatures

Sandia National Laboratories and the commercial firm, Atlas Copco, have designed a drilling tool that will withstand the heat of geothermal drilling. The downhole hammer attaches to the end of a column of drill pipe and cuts through rock with a rapid hammering action similar to that of a jackhammer. Downhole hammers are not new —the oil and gas and mining industries have used them since the 1950s— but the older design, with its reliance on oil-based lubricants, plastic and rubber Orings, isn't suited for the hotter temperatures of geothermal drilling.

"The technology behind the new hammer is fundamentally the same, but Sandia worked with Sweden-based Atlas Copco in material selection and dry lubricant technology that will work in the hightemperature environment," said mechanical engineer Jiann Su, Sandia's principal investigator for the project with Atlas Copco, which operates worldwide and makes specialized equipment and systems for drilling, mining and construction.



Technologist Elton Wright assists as mechanical engineer Jiann Su inspects a downhole hammer used to drill at Sandia National Laboratories' high operating temperature (HOT) test facility. Sandia and Swedish firm Atlas Copco designed, built and tested the drilling tool that will withstand the heat of geothermal drilling. (Photo by Randy Montoya)

The Department of Energy (DOE) Geothermal Technologies Office funded Atlas Copco as prime contractor on the project, and the company partnered with Sandia as the subcontractor.

"Part of what the DOE's Geothermal Program is looking to do is help lower the cost of getting geothermal energy out to customers," said Su, a researcher in Sandia's geothermal research department. "Some of reducing the cost is lowering exploration and development costs, and that's one of the areas we're helping to tackle."

"We developed a tool that can be used in hightemperature environments that can help increase the drilling rates and the rate of penetration to maybe 5 to 10 times that of conventional drilling operations, so that's a big plus for drillers," he said. "It adds to the available options drillers have. This is not necessarily the final option for every drilling situation but it does provide a good option for the right situation."

A critical piece of the project was developing lubricious coatings, which help reduce friction between parts important in geothermal operations. "As temperatures increase, the oils essentially cook and you get this sooty mess inside. It's like running your car too long without changing your oil," Su said. The hammer has internal moving components that require lubrication, similar to a piston in a car engine. Su's team worked with a formula tailored to the operating conditions and base materials.

Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corp. for the U.S. Department of Energy's National Nuclear Security Administration. With main facilities in Albuquerque, N.M., and Livermore, Calif., Sandia has major R&D responsibilities in national security, energy and environmental technologies and economic competitiveness.

Source:

https://share.sandia.gov/news/resources/news_release s/downhole_hammer/#.V5lg9fl9601

Science: Some Earthquakes on San Andreas Fault Are Triggered by Gravitational Tug of Sun and Moon

The gravitational tug between the sun and moon is not just a dance of high and low tides: It can also trigger a special kind of earthquake on the San Andreas Fault.

This phenomenon has fascinated scientists for years.



The San Andreas fault in California (Photo by the U.S. Geological Survey.)

Like sea levels, the surface of the Earth also goes up and down with the rhythm of the tides, flexing the crust and stressing the faults inside. Further study found that during certain phases of the tidal cycle, small tremors deep underground —known as low-frequency earthquakes— were more likely to occur.

"It's kind of crazy, right? That the moon, when it's pulling in the same direction that the fault is slipping, causes the fault to slip more –and faster," said Nicholas van der Elst, a U.S. Geological Survey geophysicist and lead author of a new study on the subject published by middle July 2016 in the Proceedings of the National Academy of Sciences. "What it shows is that the fault is super weak –much weaker than we would expect– given that there's 20 miles of rock sitting on top of it."

Studying how these low-frequency earthquakes respond to the tides can reveal new information about the San Andreas and what it might mean for larger earthquakes, researchers say. The data offer a window into deeper parts of the fault –as much as 20 miles underground– that would otherwise be inaccessible.

Scientists first discovered these deeper tremors on the fault about 10 years ago, along a particularly sensitive section in Parkfield, California, where the San Andreas transitions from its northern section, where it gently releases tectonic energy, to its southern portion that is locked and capable of producing the so-called Big One.

Like ocean tides, the strongest Earth tides occur when the sun and moon are aligned and the weakest occur when they are 90 degrees apart. The same gravitational forces stretch and compress the Earth's crust (though the rock moves less dramatically than seawater).

Some faults are more susceptible to tidal triggering than others, like offshore faults such as the Cascadia subduction zone off the Pacific Northwest coast, scientists say. Other characteristics of the fault, such as

its orientation or how close it is to the Earth's crust, also affect the tidal response.

Low-frequency earthquakes tend to have magnitudes of less than 1.0, occurring about 15 to 30 kilometers below ground while nearing the deepest part of the crust where it transitions to the Earth's mantle.

Source:

http://www.latimes.com/science/sciencenow/la-sci-sn-la-me-earthquakes-tides-san-andreas-20160718-snap-story.html

Science: New, Massive Earthquake Threat Could Lurk Under South Asia

A new GPS study of Bangladesh, India, and

Myanmar (Burma) has found startling evidence that the northeastern corner of the Indian subcontinent is actively colliding with Asia, potentially posing a major earthquake risk to one of the world's most densely populated regions.

The years-long analysis is the first to incorporate GPS data from Bangladeshi tracking stations. It is now the latest volley in a long-running academic debate over if and how the geologically complex region is seismically active.

If the new study's models are correct, the region home to more than 140 million people— could be sitting atop an active megathrust fault, the same kind of geologic feature that caused the catastrophic magnitude 9.0 earthquake in Japan in 2011.

What's more, the models suggest that the fault is stuck and has been accumulating stress for more than 400 years, since before the Mughals made the Bangladeshi city of Dhaka the regional capital in the early 1600s. That means that an area more than 124 miles (200 kilometers) wide may be spring-loaded with significant levels of tectonic strain, researchers warn in Nature Geoscience. If the entire fault were to give way at once, the team estimates that it could spawn earthquakes up to magnitude 9.0, causing vast devastation in a region underprepared for seismic catastrophes.

However, researchers do not know if and when the fault will give way.

"Whether this region actually will slip in one single earthquake, nobody can say yes or no," says Vineet Gahalaut, a geologist at India's National Geophysical Research Institute and an expert on the region's seismicity who wasn't involved with the study. "We don't have enough data to prove or disprove this."

For more than 40 million years, the Indian subcontinent has been crashing slowly into Asia in a geological pileup that created and continues to feed the Himalayas. As the mountains erode, sediment washes into the Ganges and Brahmaputra, among the world's largest rivers, and flows into the Bay of Bengal at a current rate of a billion tons a year. Over millions of years, piled-up sediment has extended the continental margin near Bangladesh by about 250 miles (400 kilometers). Some parts of the region's crust are caked with more than 19 kilometers of material.

While the region's sediments take up some of the strain along the newly proposed fault, they're not especially stable, particularly around the rapidly developed eastern outskirts of Dhaka. If a major earthquake strikes, the sediments could even amplify the seismic waves.

"Dhaka's basically like a city built on a bowl of Jell-O," says geologist Michael Steckler of Columbia University's

Lamont-Doherty Earth Observatory, who led the team that installed and monitored from 2013 to 2014 the 26 GPS tracking stations laid across Bangladesh to see how the country's western half was moving relative to the Indian Peninsula.

Meanwhile, building codes in the rapidly growing city have long gone ignored, and the public remains unsure of what to do during an earthquake.



Area under significant earthquake risk. Figure slightly modified. Original by Lauren C. Tierney, NG Staff.

Source:

http://news.nationalgeographic.com/2016/07/earthqua kes-mega-thrust-dhaka-bangladesh-geologyscience/?utm_source=NatGeocom&utm_medium=Em ail&utm_content=wild_science_20160815&utm_campa ign=Content&utm_rd=151541

Science: Mantle Heat Convection Is Bigger than Previously Thought

A global map of the convective currents inside Earth's mantle, compiled by the first time, shows that convective currents are moving roughly ten times faster than previously thought.

"In geological terms, the Earth's surface bobs up and down like a yo-yo," geologist Mark Hoggard of Cambridge University said in a statement. Hoggard is lead author on a paper published in Nature Geoscience (Global dynamic topography observations reveal limited influence of large-scale mantle flow, by M.J. Hoggard, N. White & D. Al-Attar, Nature Geoscience 2016, doi:10.1038/ngeo2709; see sources).

Our planet's deep interior is an enduring scientific mystery. Having never drilled more than a few miles

beneath the surface of the Earth, geologists rely on indirect measurements and models to get a sense of what's happening further down. The mantle is a nearly 3000 kilometer layer of gooey, compressed rock, and convective activity within it has a big impact on Earth's surface.

"In addition to the normal plate tectonics, the interior of the plates which should be quite boring are being forced up and down by mantle convection," Hoggard said. "People have known that this occurs for a long time, but for the past 30 years we haven't had the data to measure it."

That is changing, thanks to new high-resolution seismic reflection profiles created by the oil industry. Seismic reflection profiling is a technique geologists use to peer deep into Earth's crust, by measuring the reflection and refraction of seismic waves as they travel downwards. The method can reveal fine-scale changes in the thickness of the crust, which in turn relates to mantle convection.

By analyzing over 2,000 seismic reflection measurements taken across the world's oceans, Hoggard and his colleagues constructed the first global database of mantle convection. They were surprised to discover frequent changes in the thickness of seafloor crust, indicating that mantle convection is occurring far more frequently than we thought.

Mantle convection can also have a surprising impact on Earth's climate, by affecting the large-scale ocean circulation patterns that move heat around the world. The Gulf Stream, for instance, carries warm water from the Gulf of Mexico to the coast of Western Europe, before chilling out and sinking around Iceland.

"There are these narrow channels around Iceland that allow water to sink," Hoggard explained. "If you elevate or depress them, you could really affect ocean circulation."

Finally, mantle convection is responsible for forming geothermal systems, like Yellowstone, and island archipelagos, like Hawaii, that crop up in the middle of tectonic plates. Hoggard's findings will shed light on how and why parts of the crust located far from plate boundaries are rising, falling, and 'cooking'.

Hoggard said: "It is really a shift in view point. A lot of geologists will look at places far away from plate boundaries and think they should be very stable. What we've shown is that regions that are often ignored are probably very active."

Sources: http://gizmodo.com/we-were-totally-wrongabout-whats-happening-inside-eart-1775495644, http://www.nature.com/ngeo/journal/vaop/ncurrent/ full/ngeo2709.html

IGA News

IGA News is published quarterly by the International Geothermal Association. The function of IGA News is to disseminate timely information about geothermal activities throughout the world. To this end, a group of correspondents has agreed to supply news for each issue. The core of this group consists of the IGA Information Committee: Luis C.A. Gutiérrez-Negrín, Mexico (Chairman) Rolf Bracke, Germany Paul Brophy, USA Varun Chandrasekharam, India Surya Darma, Indonesia Lúdvík S. Georgsson, Iceland José Luis Henríquez, El Salvador Susan F. Hodgson, USA Eduardo Iglesias, Mexico Marcelo J. Lippmann, USA Alfredo Mañón-Mercado, Mexico Fernando (Ronnie) Peñarroyo, Philippines Paul Quinlivan, New Zealand Alexander Richter, Iceland Horst Rueter, Germany Benedikt Steingrímsson, Iceland Koichi Tagomori, Japan Shigeto Yamada, Japan The members of this group submit geothermal news from their parts of the world, or relevant to their areas of specialization. If you have some news, a report, or an article for IGA News, you can send it to any of the above individuals, or directly to the IGA Secretariat. Please help us to become essential reading for anyone seeking the latest information on geothermal worldwide. While the editorial team makes every effort to ensure accuracy, the opinions expressed in contributed articles remain those of the authors and are not necessarily those of the IGA. The editorial team does not assume any liability for external content taken from public sources and websites, or endorse the products or services mentioned. Send IGA News contributions to the editor (l.g.negrin@gmail.com) and/or: International Geothermal Association (IGA) c/o Bochum University of Applied Sciences Lennershofstr. 140, 44801 Bochum, Germany Tel.: +49 (0)234 32 10712, Fax: +49 (0)234 3214809 E-mail: iga@hs-bochum.de This issue of IGA News was edited by Luis C.A. Gutiérrez-Negrín. Marcelo J. Lippmann & Susan Hodgson proofread the articles. Distributed by Marietta Sander for the IGA Secretariat. Design

layout by François Vuataz.

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