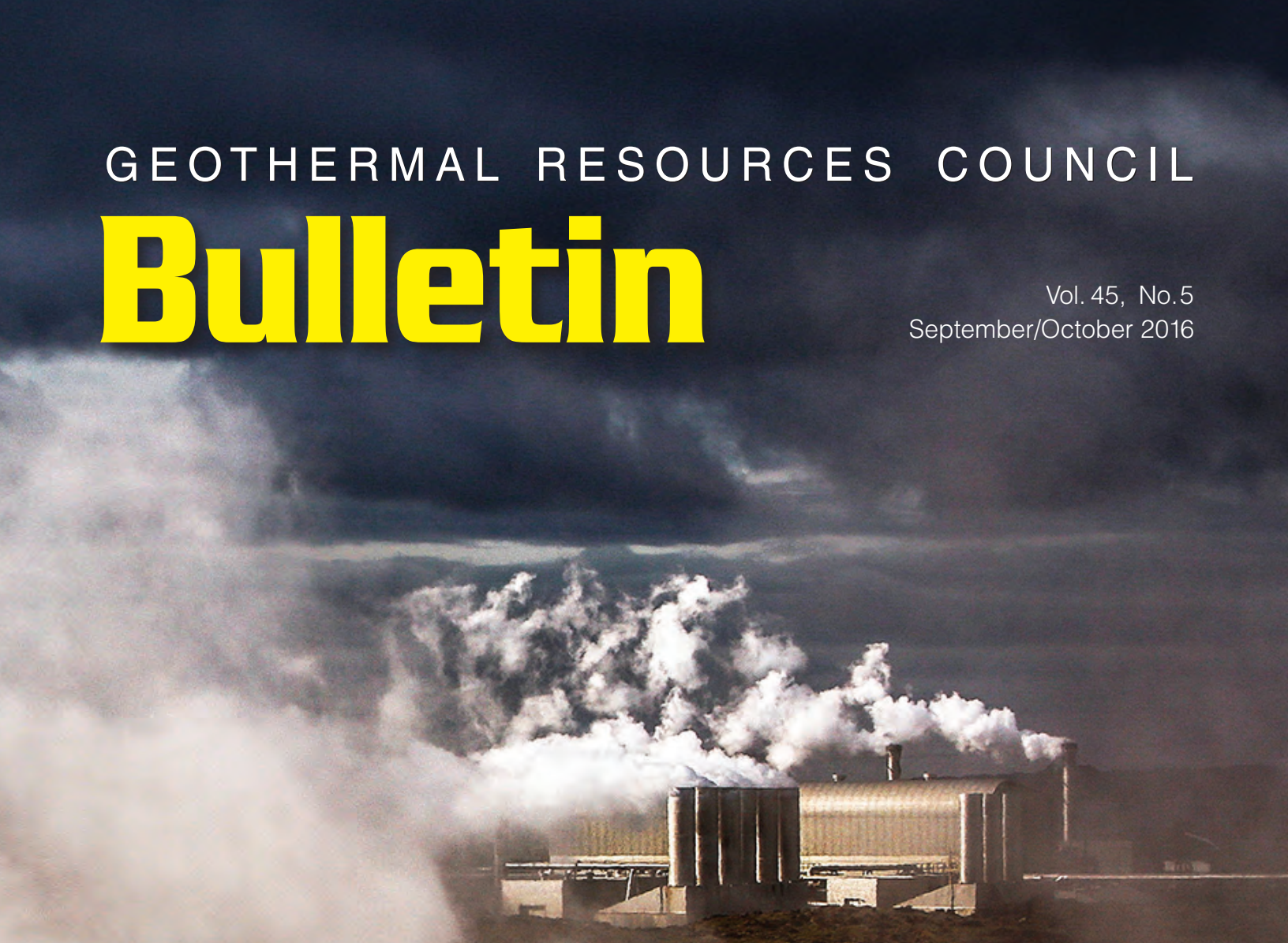
GEOTHERMAL RESOURCES COUNCIL

Bulletin

Vol. 45, No. 5
September/October 2016



40th GRC Annual Meeting
Geothermal Energy, Here and Now: Sustainable, Clean, Flexible

Investigating Flexible Generation at The Geysers

Boom Times Ahead for Geothermal in California?

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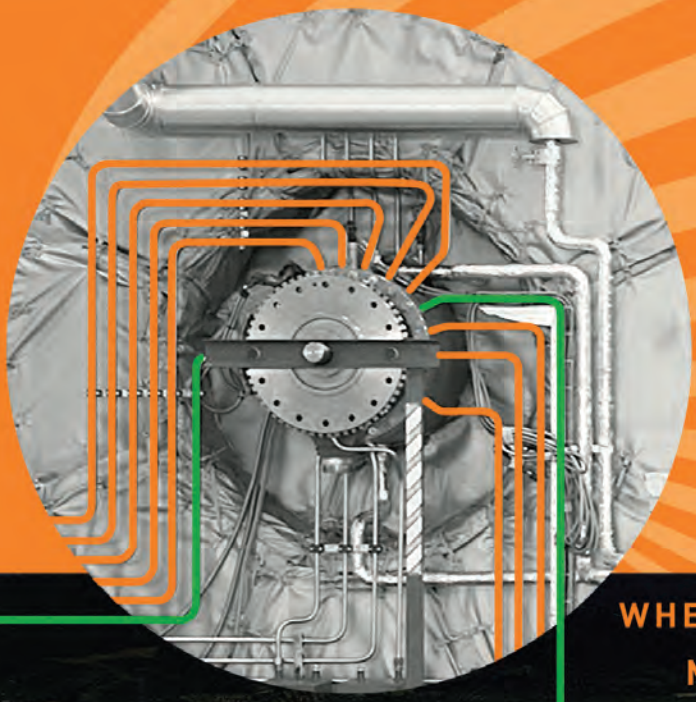

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Bulletin

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COVER: "Geothermal Mist" by Paweł Krok, Lubawka, Poland. Svartsengi geothermal power plant – near Reykjavik, Iceland, 2015. 2nd Place in the 2015 Amateur Geothermal Photo Contest.

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The Geothermal Resources Council (GRC) *Bulletin* (ISSN No. 01607782) is published as a service to its members and the public, with six issues per annual volume. The GRC is an international, non-profit educational association whose purpose is to encourage research and environmentally sound exploration, development, and utilization of geothermal-energy resources worldwide through cooperation with governmental agencies, academic institutions, and the private sector. The GRC *Bulletin* provides a forum for information transfer to the public and among professionals in many fields related to geothermal resources, including geology, exploration, development, electric-power production, and direct-use technologies. The views and opinions expressed by authors in this publication do not necessarily reflect those of the GRC or its members. For changes of address or membership information, please contact us.

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President's Message

by Paul Brophy

GRC Annual Meeting and GEA Expo

By the time most of you get to read this we will be very close to the GRC Annual Meeting and GEA GeoExpo+. I want to welcome you all to the Sacramento meeting which promises to be a great event. Thanks are due to this years' Annual Meeting Committee headed, most ably, by Danielle Matthews Seperas of Calpine Corporation. This is Danielle's first year as a GRC Board member and she has jumped in to the position as Annual Meeting Chairperson with gusto and enthusiasm and has done a magnificent job. This year we have many new innovations in our program including a revamped Plenary Session, replacing our old Banquet with a new style, off-site mixer (at the nearby MIX Downtown location), and continuing with our meeting app which we started last year and which we hope you will use to give us feedback on how we can further improve the meeting. Of course, there will still be the established base of the event such as the four workshops, four fieldtrips, the Networking Reception, the GEA trade show and of course, the many and varied Technical Sessions. We hope you all will all enjoy the meeting.

Many of you may know that the 2017 GRC Annual Meeting will be in Salt Lake City – the first time in that location since 1994. Because of the need to confirm GRC locations a couple of years in advance, the GRC Board has approved two future locations. In 2018 our Annual Meeting will be back at the Peppermill Hotel in Reno, Nevada and we expect to also be back in Reno in 2020, which is our standard location for years of a World Geothermal Conference which in 2020 will be in Reykjavik, Iceland. I know this seems a long time ahead but in the world of conference planning these timeframes are becoming the norm if we want top class facilities.

Bylaws Amendments

The GRC Board had a telephonic meeting in late April, primarily to recommend the approval of amendments to the existing GRC Bylaws. It had come to the Board's attention that our current bylaws did not permit digital communication of meetings and other formal notifications. Richard Campbell, our Legal and Bylaws Chair, together with assistance from attorney John McKinsey, has made the necessary changes. However we do need to get approval from the general membership for this bylaw change which we will do at the Membership meeting, held every year as part of the Awards Luncheon on the last day of the Annual Meeting. We hope you will consider attending this luncheon, congratulate the awardees and approve the changes to the bylaws.

Strategic Plan Update

We have now finished Phase 1 of the Strategic Plan which is essentially a broad overview of how we see the GRC progressing in the future and it will guide our decision making over the next few years. At the time of writing, Phase 1 of the Strategic Plan has not been finally approved by the Board but I expect that to happen at our Board meeting immediately before the Annual Meeting. At that time the Plan will be available to view on the GRC website. It will include Goals, Objectives and our Core Values together with our Mission and Vision Statements. The next step in the planning process will be the establishment of a Work Plan along with the strategies for implementation. It would not be strictly true to say this planning process has been achieved without any difficulties but I really appreciate Board members efforts to get to where we are today. There is still a lot of work to be done and while it may appear we are moving at a relatively slow pace it is worth remembering that all Board member time is on a volunteer basis and we all have other job responsibilities. Thank you again to both Board and to GRC staff for their considerable efforts in this planning process.

Again I hope you all have a memorable Annual Meeting in Sacramento.

Please feel free to contact me at any time by phone at (707) 544 0955 or by email at pbrophy@envgeo.com if you have any suggestions or ideas on how we can improve the GRC experience for you. ■

Executive Director's Message

by Steve Ponder

GRC Membership Committee Is Roaring Their Terrible Roars

The GRC Board is wrapping up its first ever Strategic Plan, including a plan to provide more and better services to our members. The GRC Membership committee, led by GRC Board Director Marcelo De Camargo, has become very active in this effort and is beginning to roar. The results of this good work are now available.

The GRC has updated the membership pages of the GRC website, making it easier to share information about yourself and conduct business with the GRC. Anh Lay, GRC staff, has put in the creative effort needed to produce this valuable tool. A brief overview of some of the new features of the website are highlighted on the next page and your suggestions for improvements are encouraged. This will help us attract new members and better serve existing members

A membership survey is also being prepared. We hope that all of you will participate in giving your answers. The more we know about your interests and preferences, the better we can serve you. The result of this entire effort should be increased membership, better services to our members and more revenue to fund other GRC programs.

Marcelo's committee and the GRC staff are also organizing a search party (phone callers) to find "lost members," who have stopped renewing their GRC membership. The GRC Board will call these lost members, determine the reason why they left the GRC and suggest activities to encourage them to rejoin.

All of this activity and planning does not occur in a vacuum. The leadership has been provided by Marcelo De Camargo, the committee chair. Anh Lay provided staff support and leadership. This good relationship between the committees and the staff leads to progress at the GRC. ■

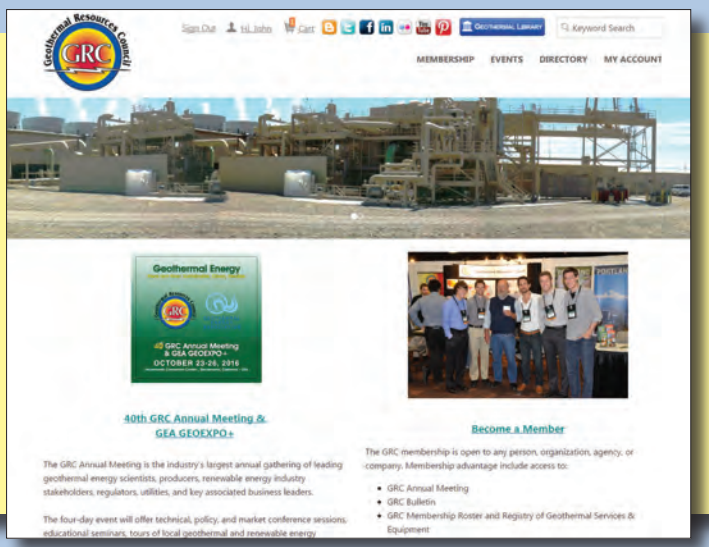
The New GRC Membership Website is also available from the GRC Event App!

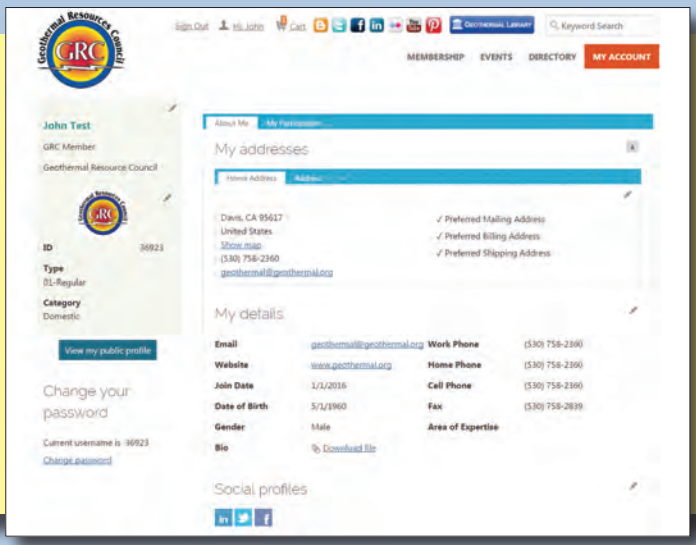
The New GRC Membership Website

www.my.geothermal.org

Highlights Include:

- **Events:** Allows you to register for GRC Events such as the GRC Annual Meeting.
- **Directory:** Allows you to search and view other GRC members' public profile. Only available to current members.
- **My Account:** Allows you view your profile, update your information, renew your membership and pay invoices.
- **Shopping Cart:** You can now pay all your dues and invoices together.





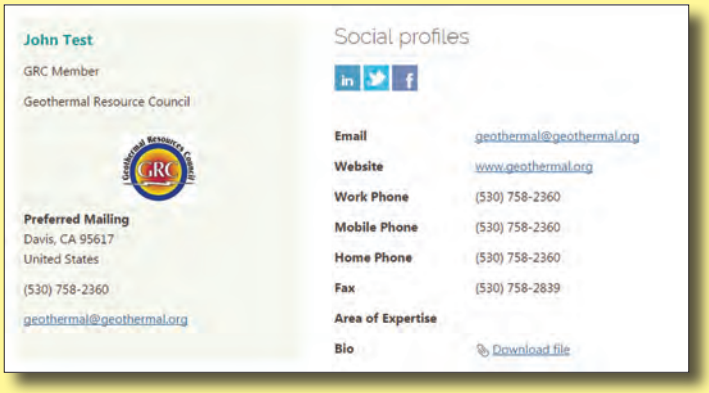
My Account:

- **Photo:** You can now upload a headshot of yourself
- **Bio:** Allows you to upload your bio or resume that can be viewed and downloaded by other GRC members.
- **Social Media Links:** You can now link your personal social media sites to your profile for other members to view.

Update Your Profile Today!

Public Profile:

- **Exclusive Access:** Restricted to current GRC Members only.
- **Advertise Your Services:** Members can find your information and download your bio/resume.
- **Stay Connected:** Allow members to follow you on your social media links.



Communication from the GRC

by Ian Crawford, Director of Communications

GRC Awards Announced

The GRC has announced awards honoring the best and brightest of the global geothermal energy community. These prestigious awards have been a highlight of the geothermal calendar since the late 1970's.

This year's AWARDS ***WINNERS*** *are:*

Joseph W. Aidlin Award

Anna Carter - For untiring efforts and contributions to the geothermal industry on across many facets, and her decades of commitment to the GRC.

Geothermal Pioneer Award

Wilfred Elders - For a career of outstanding contributions and ground breaking research in petrology, geochemistry, conceptual modeling and high-profile geothermal project management.

Henry J. Ramey Jr. Award

John Pritchett - For distinguished, technical advancements in geothermal reservoir simulations applied to a wide variety of fields.

Ben Holt Award

Dan Hoyer - For outstanding achievements in the development of geothermal resources worldwide.

Geothermal Special Achievement Award

Dale Merrick - For outstanding accomplishments within Direct-Use and Direct-Use outreach worldwide.

Geothermal Special Achievement Award

Paul Spielman - For over 30 years of outstanding geothermal field measurements and production management contributions to the industry.

Geothermal Special Achievement Award

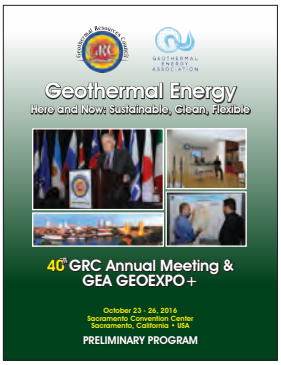
Aroha Campbell - For outstanding achievement of geothermal development on Maori lands and the dramatic increase in value these efforts have brought to New Zealand.

The GRC will present the prestigious Aidlin, Pioneer, Henry J Ramey Jr., Ben Holt, and Special Achievement awards at the **Annual Membership Meeting & Awards Luncheon,** the climax to the **GRC Annual Meeting**, in Sacramento, California, USA, **on Wednesday, October 26**.

Registration is Now Open

By the time you receive this issue of the *GRC Bulletin* **the GRC Annual Meeting & GEA GEOEXPO+** will be just a few short weeks away. It is not too late to join the global geothermal community in Sacramento, California, USA. Time to start packing!

Preparations are almost complete. The latest information is available on the GRC website at: www.geothermal.org/meet-new.html.



The *Preliminary Program* is available to view, download and print-out if you wish. However, we strongly urge you to view all the information on your computer or mobile device using the **Event App**.

San the QR code to view the PDF on your mobile device.

Registration can be made online at: http://my.geothermal.org/ – look for the link from the front page of the GRC website at: www.geothermal.org – or by completing and returning the *Registration Form*, also found on the front page of the GRC website. **Early bird registration expires September 23.**

From September 24 the rates are the following:

- Current **GRC members pay $945** to attend all three days. **Non-members pay $1095** *which includes complimentary GRC partial 2016 and full year membership for 2017.*
- **Students**, with current academic identification or class schedule, **pay just $5!** *This also includes the complimentary GRC partial 2016 and full year membership for 2017.*
- **One day registration is $475 each day.**

Register Online at: http://my.geothermal.org/

OR

Register now using the GRC Annual Meeting *Registration Form* available on the GRC website at: www.geothermal.org/meet-new.html

The App is Back! Download Now

The GRC is again providing a Mobile app for the GRC Annual Meeting & GEA GEOEXPO+. It is now available to download to an iPhone, Android or Windows Smartphone, tablet or laptop computer giving event attendees better access to information and networking.

The mobile app also allows the GRC to post more information online and **avoid print costs**.

We strongly encourage you to download the mobile guide to enhance your experience at the GRC Annual Meeting & GEA GEOEXPO+. You'll be able to plan your day with a personalized schedule and browse exhibitors, maps and general show info. *You can browse all the essential information* **even without internet access.**

After a simple download and installation the app can be personalized with your own schedule and notes on activities. **When you sign-in to the app you will be able to interact with other attendees and build an on-site network.** Attendees will also be able to post their own photos and comments to the app for all to see on the "activity stream".

Download the app from the GRC Annual Meeting website at: www.geothermal.org/meet-new.html

Or scan the QR code to access the download webpage directly:

Speakers Announced

An updated list of speakers at the **Opening Session** of the GRC Annual Meeting on Monday morning, October 24 has been announced including major names in the international geothermal community and regional politics:

Invited Speakers: **Paul Brophy**, President Geothermal Resources Council; **Dr. Susan G. Hamm**, Director, Geothermal Technologies Office, U.S. Department of Energy; **Jan Smutny-Jones**, CEO, Independent Energy Association; **Jim Kluesener**, Vice President - Geothermal, Calpine Corporation; **Dennis Gilles**, CEO, US Geothermal, Inc.; **Randy Keller**, Director of Delveopment, CalEnergy; **The Honorable Eduardo Garcia**, California 56th Assembly District; **Andrew Palamateer**, Director, US Energy Association; **Bob Sullivan**, Executive Vice President – Business Development, Ormat; **Mike Long**, Senior Project Manager, POWER Engineers; **Pierre Audinot** , PhD, World Bank; **Gabriel Negatu**, Regional Resource Center Director, African Development Corporation; **V. John White**, CEO, Center for Energy Efficiency and Renewable Technologies, **Kevin Kelly**, General Manager, Imperial Irrigation District ; **The Honorable Mike McGuire**, California State Senate, 2nd District; **The Honorable Ben Hueso**, California State Senate , 40th District (Invited); **Micah Mitrosky**, Environmental Organizer, IBEW Local 569; **Steve Ponder**, Executive Director, Geothermal Resources Council

Book your Room!

The room blocks at the **Hyatt Regency Sacramento** and the **Sheraton Grand Sacramento Hotel** are almost full. Book your room now to avoid disappointment!

There is a link to the dedicated booking website on the front page of the GRC Annual Meeting web page at: www.geothermal.org/meet-new.html.

Make sure you book through the special website created by the hotels for GRC and GEA – using another method might result in a more expensive rate and exposure to possible scams!

Flying to Sacramento

Sacramento International Airport (SMF) has nonstop and direct flights (one stop without changing planes) throughout North America and connecting flights to almost anywhere in the world. The airport serves the following Non-Stop Destinations:

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Baltimore	Los Angeles
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Boston	Mexico City
Burbank	Minneapolis
Charlotte	New York/JFK
Chicago/Midway	Ontario
Chicago/O'Hare	Orange County
Dallas/Fort Worth	Phoenix
Dallas/Love Field	Portland
Denver	Salt Lake City
Guadalajara	San Diego
Honolulu	San Francisco
Houston	Seattle
Las Vegas	Washington, DC/Dulles

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Download the Event App to your mobile device and get all the up-to-date meeting information at your finger-tips.

https://attendify.com/app/f7n78p/

Help us go paperless!

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*Use the hash-tag **#GRCAM2016** on Twitter at twitter.com to share news about the 40th GRC Annual Meeting. Are you or your company attending? Invite your colleagues to attend. Share news about the meeting and the venue.*

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More information on the GRC Annual Meeting & GEA GeoExpo+ can be found at: www.geothermal.org/meet-new.html. Check back online for the most up-to-date information.

Register Now!

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Have Your Say!

If you would like to comment on any column or article in the *GRC Bulletin* or have an opinion on a topical subject that will interest our readers, please email the editor, **Ian Crawford** at icrawford@geothermal.org or mail to Geothermal Resources Council, P.O. Box 1350, Davis, CA 95617-1350.

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Emeritus (non-voting)
Bob Greider

John W. Lund

Photos of the Board of Directors can be seen on the GRC website at: www.geothermal.org/bod.html

Correction

There was some incorrect information posted in the last issue of the *GRC Bulletin.* In the Electric Youth article on the CarbFix Sequestration Project, the author should have been listed as Cari Covell, E.I.T., Reykjavik University '16, MSc Sustainable Energy Engineering. We apologize to Cari for the error.

Special Forum - Overcoming Technical Challenges to Developing Geothermal Energy Resources in The Golden State

October 20, 2016, Sacramento, California

Building on the successful announcements by President Obama at the 2016 Lake Tahoe Summit to catalyze collaboration and action between the State of California and the Federal Government for conservation and renewable energy development in the Salton Sea, the **U.S. Department of Energy, California Energy Commission,** and the **Geothermal Resources Council** are convening a forum on October 20, 2016 in Sacramento, CA that will focus on overcoming technical challenges to develop geothermal energy resources statewide.

This forum will feature a diverse group of speakers from government, industry, and research that will help facilitate discussions to target solutions for new geothermal development while remaining consistent with critical Federal and State conservation planning efforts, particularly at the Salton Sea.

Look for further announcements about the workshop in GRC emails and on the *Global Geothermal News* website at www.globalgeothermalnews.com. ■

Inside Geothermal

Eight GRC Members Elected to IGA Board

The **International Geothermal Association (IGA)** have announced the results of the election for the IGA Board for 2016-2019.

31 IGA members were elected, including **8 members of the GRC:**

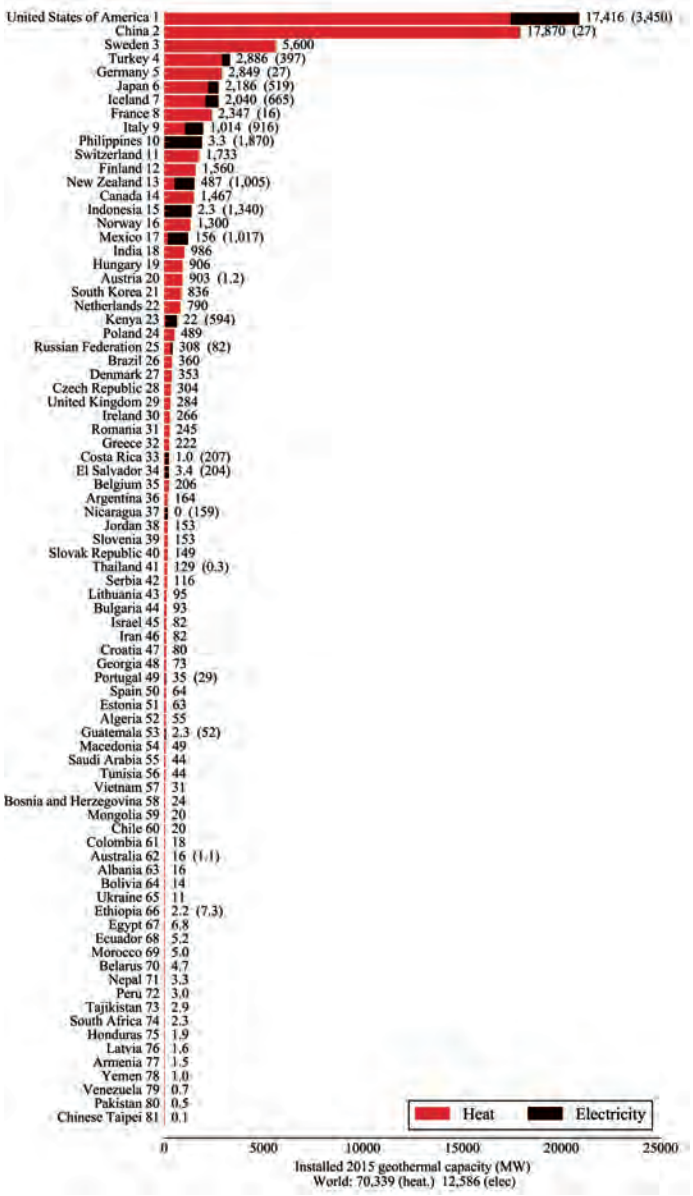
- **Paul Brophy**, (USA) - GRC Board Member
- **Louis Capuano, Jr**, (USA) - GRC Board Member
- **Andrew Sabin**, (USA) - GRC Board Member
- **Paul Moya**, (Costa Rica)
- **Abadi Poernomo**, (Indonesia)
- **Horst Rueter**, (Germany)
- **Toshihiro Uchida**, (Japan)
- **Shigeto Yamada**, (Japan)

According to the website of the IGA, the **Geothermal Resources Council** provides just under **24 percent of the members of the IGA**. The 2016 **IGA Annual General Meeting** will be held at the at the United Nations Conference Centre (UNCCC) in **Addis Ababa**, Ethiopia, Monday, **31st October**.

Ranking of Geothermal Energy Countries

As part of a project to provide all-sector clean and renewable energy roadmaps for 139 countries around the world, **M.Z. Jacobson, M.A. Delucchi, Z.A.F. Bauer, S.C. Goodman, W.E. Chapman, M.A. Cameron** *et al*. have published a table of all the countries that use geothermal, both for heat and electricity.

According to the authors **81 countries use geothermal** either for heat or electricity, **23 produce electricity** from geothermal resources. **The USA is the leading geothermal energy electricity producer with 3,450 MWe**, China is the top geothermal heat user with 17,840 MWth.



NORTH AMERICA

Geothermal Energy is the Lowest Cost Dispatchable Technology - Report

The U.S. **Energy Information Administration (EIA)** has released the latest update of data for the **National Energy Modeling System** for the **Annual Energy Outlook 2016**. A paper based on the data looking at the levelized cost of electricity (LCOE) and levelized avoided costs (LACE) of future generation technologies provides another positive valuation of geothermal energy.

The EIA has developed a standard for predicting how economical every technology will be when added to the grid. There are two standards: 1) **levelized cost of electricity (LCOE)**, and 2) **levelized avoided costs (LACE).** Levelized costs

measure the cost per kilowatt over the life of the plant. Levelized avoided costs indicate the costs that are avoided by not building another form of generation. **If LACE exceeds LCOE, then the technology is judged economical.**

In the paper *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2016*, average values of LCOE and LACE are forecast for 2018, 2022 and 2040. For generation facilities entering service in 2020 those running on geothermal energy have **the lowest average LCOE, the second lowest LACE and the greatest difference between the LCOE and LACE** (see table below). Clearly geothermal energy is a winning renewable energy.

The paper can be downloaded at: www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf. In addition, **the paper can also be viewed on the GRC Annual Meeting & GEA GeoExpo+ mobile app.**

Comparison of capacity-weighted[1] LCOE with tax credits and capacity-weighted LACE (2015 $/MWh)

Plant Type	Average LCOE	Average LACE	Average Net Difference[2]
Dispatchable Technologies			
Advanced Coal with CCS[3]	N/A		
Natural Gas-fired			
Conventional Combined Cycle	56.4	61.5	5.1
Advanced Combined Cycle	55.8	61.5	5.6
Advanced CC with CCS	N/A		
Advanced Nuclear	99.7	61.4	-38.3
Geothermal	39.5	56.6	9.9
Biomass	N/A		
Non-Dispatchable Technologies			
Wind	50.9	53.7	1.5
Wind – Offshore	N/A		
Solar PV[4]	58.2	67.4	8.5
Solar Thermal	N/A		
Hydroelectric[5]	63.7	58.8	-4.9

Difference between capacity-weighted levelized avoided costs of electricity (LACE) and capacity-weighted levelized costs of electricity (LCOE) for plants entering service in 2022. COURTESY EIA

DOE Announces Phase Two FORGE Projects

The U.S. Energy Department (DOE) has announced **USD 29 million** in funding under the **Frontier Observatory for Research in Geothermal Energy (FORGE)** program for projects to teams at **Sandia National Laboratories** and the **University of Utah.**

The funding will be for each team to fully instrument, characterize and permit candidate sites for an underground laboratory to conduct cutting-edge research on enhanced geothermal systems (EGS).

The Sandia 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**.

The Energy Department, with the support of the **National Energy Technology Laboratory (NETL)**, awarded funding to these two teams after a competitive first phase of research to evaluate potential EGS underground research sites.

The candidate sites will use this new funding to prepare for the competitive third phase of the FORGE effort, which will designate one of the sites as the headquarters for the future underground field lab.

President Obama Announces Support for Salton Sea Restoration Including Plans for Geothermal Energy Development

President Barack Obama attended the **Lake Tahoe Summit** in late August and announced initiatives to help restore the **Salton Sea**, including support for the geothermal energy industry in the area.

The Obama administration announced a package of actions to marshal strong partnership and innovation in support of the communities surrounding the Salton Sea, California's largest lake, which is facing a tipping point in environmental degradation. **New geothermal energy development could help pay for the restoration.**

A new partnership will be established between the federal government and California to accelerate conservation in the Salton Sea. In particular there will be increased collaboration on renewable energy development, including geothermal energy, in the Imperial Valley focusing on technology adoption and breakthroughs to boost the Salton Sea economy and clean energy generation.

To kick-off the effort the DOE along with the GRC will convene key geothermal experts for a first-ever **forum on Salton Sea renewable potential** to be held in Sacramento just before the GRC Annual Meeting (see notice on page 15). Look for further announcements from the GRC as information becomes available.

Inside Geothermal

Feds Announce Interest in 250 MW of Geothermal Energy Developments at Salton Sea

On the same day as President Obama's announcement the U.S. DOE asked for feedback on the possibility of **developing up to 250 MW** of geothermal energy at the Salton Sea.

The **Federal Energy Management Program Office** at the DOE has announced a *request for information* on the availability of **new construction geothermal electricity in the Salton Sea area** to serve regional federal load.

The purpose of the request is to gather industry input on options available to the federal government for a potential aggregated power purchase of **100 MW–250 MW of new construction geothermal electricity** generated in the Salton Sea area, within Riverside and Imperial counties, California, for delivery over a ten-year or twenty-year contract period to serve regional federal load.

Interested parties are to submit comments electronically to **Tracy (Logan) Niro** at tracy.niro@ee.doe.gov. Please include "August 2016 Geothermal RFI" in the subject of the message. Download the request for information at www.energy.gov/sites/prod/files/2016/08/f33/geothermal_rfi_final.pdf

Written comments and information on the request are requested on or before September 29.

Four Geothermal Projects Get a Boost from DOE

The U.S. **Department of Energy (DOE)** has announced that 43 small businesses will participate in the second round of the **Small Business Vouchers (SBV),** pilot including **four geothermal energy projects.** The vouchers allow access to resources at the U.S. national laboratories.

Anactisis, Pittsburgh, Pennsylvania: Work with the national labs to further its selective extraction technologies for energy critical materials. This work will allow Anactisis to diversify and strengthen high risk commodity markets by exploiting unconventional resources. Working with **Oak Ridge National Laboratory.**

Elko Heat Co., City of Wells, Nevada: Utilize geologic data collected since the early 1980s, including data collected following the 2008 Wells earthquake, to develop an integrated conceptual model of the region's geothermal resources using spatial and subsurface analytical tools. This work aims to produce a resource model of the area that will reveal the most productive sites for drilling targets and direct use applications. Working with **Lawrence Berkeley National Labs** and the **National Energy Technology Laboratory.**

Greenfire Energy, Emeryville, California: Receive assistance modeling the creation and behavior of a small fracture system in hot, impermeable rock as part of its CO^2-based geothermal power system. Working with **Lawrence Livermore National Laboratory.**

Hyperlight Energy, La Jolla, California: Involve thermal modeling, assessment, and evaluation in support of thermal battery storage options for use in solar thermal/geothermal hybrid power plants. Working with **National Renewable Energy Laboratory.**

U.S. DEPARTMENT OF ENERGY

DOE Grants USD 3 Million to Develop New Approaches to Characterize and Image Subsurface Geothermal Systems

The U.S. **DOE** has also announced the selection of eight new research and development projects to receive a total of USD 11.5 million in federal funding under DOE's **Subsurface Technology and Engineering Research, Development, and Demonstration (SubTER) Crosscut initiative**, including funding for three geothermal energy projects.

The new projects are focused on furthering geothermal energy and carbon storage technologies, and will be funded by the Office of Energy Efficiency and Renewable Energy (EERE)'s **Geothermal Technologies Office (GTO)** and the **Office of Fossil Energy's (FE) Carbon Storage program:**

- *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.** DOE Grant: USD 879,802.

- *Geothermal Fault Zone Dilatancy and Fluid Imaging through Integrated Geophysical, Geological, Geochemical and Probabilistic Analysis:* The **University of Utah** (Salt Lake City, UT), **Quantec Geoscience Inc.,** and **Geotech Ltd.** DOE Grant: USD 620,000.
- *A Novel Approach to Map Geothermal Permeability Using Passive Seismic Emission Tomography and Joint Inversion of Active Seismic and EM Data:* **U.S. Geothermal Inc.** (Boise, ID), **Lawrence Berkeley National Laboratory**, and **Optim Inc.** DOE Grant: USD 1,497,016.

In addition, the **Office of Basic Energy Sciences (BES)**, in support of the DOE Office of the Under Secretary for Science and Energy's **SubTER Crosscut Initiative**, has announced a **Small Business Innovation Research (SBIR)** and Small Business Technology Transfer (STTR) funding opportunity that seeks to develop advanced methods to access the subsurface.

Grant applications are sought in **Development of Advanced Methods to Access the Subsurface in High-Temperature and High-Pressure Environments.** The Maximum Phase I Award Amount is **USD 150,000** rising to a Maximum Phase II Award Amount of **USD 1,000,000**.

Grant applications are sought to research, develop, and deploy new and original processes, techniques, tools, and/or sensors that support the SubTER crosscut initiative's thrust areas of wellbore integrity and drilling technologies. Geothermal energy resources are often more difficult to access compared to other subsurface energy resources due to deep drilling through high-temperature, high-pressure, hard crystalline lithologies.

Responsive applications to this subtopic could include techniques to address wellbore instability, reduce lost circulation, or drill in the presence of CO^2 (or other gasses). The innovations sought range from well log/petrophysical analyses to new packers, liners, and other completion tools.

Applications are due Monday, October 17, 2016. More information is available at: http://science.energy.gov/sbir/funding-opportunities/

U.S., Mexico, Canada Pledge 50 Percent Clean Energy by 2025

The **United States, Mexico** and **Canada** have struck a new regional deal to produce **50 percent of their electricity by 2025 from clean energy sources**, *Reuters* reports.

The deal is most ambitious for Mexico, which got less than 20 percent of its electricity from renewables and nuclear last year. The U.S. currently sources about a third of its power generation from renewable and nuclear resources, and Canada is over 80 percent. The agreement also includes language to **limit methane emissions 40 percent to 45 percent by 2025** and provisions to ease power trading across borders.

Plan to Reduce Greenhouse Gases in California Should Help Renewable Energy

California lawmakers have passed a bill that will help sustain the state's efforts to reduce greenhouse gas emissions, reports the *Sacramento Bee.*

Senate Bill 32, would require California to **reduce greenhouse gas levels to 40 percent below their 1990 levels by 2030**, extending the state's authority to enact sweeping climate policies beyond an approaching 2020 limit. **Governor Jerry Brown** has signed the bill into law.

Closure of Diablo Canyon Nuclear Power Plant Could be a Boon for Geothermal

Ralph Cavanagh, Co-director, Energy program, **Natural Resources Defense Council (NRDC)** wrote in August that operating Southern California's **2,240 MW Diablo Canyon nuclear power plant** past its 2025 license expiration would cost more than twice what many had anticipated.

According to an analysis submitted to the **California Public Utilities Commission (CPUC)** by the plant owner, **Pacific Gas & Electric Company (PG&E)**, this would cost significantly more than replacing it with energy efficiency and renewable resources.

The NRDC believes that substituting zero-carbon resources (such as geothermal energy) for Diablo Canyon will **save electricity users at least USD 1 billion**. *Less than 340 miles away there is more than 2,000 MW of geothermal resources that can be developed at the Salton Sea.*

Plans for Expanded Western Imbalance Market Put On Hold

Utility Dive reports that California **Governor Jerry Brown** has hit pause on his state's attempt to integrate **PacifiCorp's** operations into the **CAISO** run regional **Energy Imbalance Market (EIM)** and then possibly expand further, informing the governors of Utah, Wyoming, Idaho, Oregon,

Washington that plans for a regional market is on hold for now.

It is not necessarily a lengthy delay however; Brown said in a letter to the other governors that he anticipates having a proposal for them to consider by January.

While there are benefits to a regional market, many have worried it could set California back from progress made on greenhouse gas emissions, and the state would also lose the total control over its markets it currently enjoys.

There will be a GRC Fieldtrip to the headquarters of CAISO from the GRC Annual Meeting & GEA GEOEXPO+, October 23-26, Sacramento, California.

New Tarriff Agreement for CalEnergy's 171 MW Geothermal Energy in Imperial Valley

According to *Imperial Valley Press,* the Imperial **Irrigation District (IID)** Board of Directors voted unanimously to approve the transmission service rollover to a new tariff for **CalEnergy's 171 MW of Salton Sea geothermal facilities.**

The proposed change would move CalEnergy from a *Funding and Construction Agreement* (FACA) to IID's *Open Access Transmission Tariff* (OATT).

In the late 1980s, Imperial Irrigation District entered into a funding and construction agreement by which the 230kV KN/KS line was constructed. A number of generators were participants in that transmission project. CalEnergy owns a number of those generating facilities and desired to roll its plants from the FACA format to the IID's OATT format.

For consistency, **IID desires to have all of its generating facilities and transmission service provided under one tariff.** Accordingly, effective July 1, 2016, CalEnergy's existing FACA transmission service agreements will be transitioned to the IID OATT.

Southern California Utility Might be Forced to Procure More Renewable Energy

The **California Public Utilities Commission (PUC)** has proposed that **San Diego Gas & Electric** (SDG&E) increase its renewable energy procurements to make up for **a 102 MW generation shortfall**, according to *SNL.*

The PUC said SDG&E was required to procure 164.7 MW to meet its most recent targets in the state's **renewable auction mechanism (RAM)**, but only agreed to procure 62.7 MW.

SDG&E said that only one of the bids it received in the auction was cost competitive and that it already has enough renewable energy on its system to meet other state targets, notably the renewable portfolio standard (RPS). *Despite building a transmission line to the Imperial Valley in 2012, SDG&E currently has no geothermal energy in its portfolio.*

Geothermal is for the Birds!

Representatives of the California chapter of the **National Audubon Society**, the U.S. society for bird preservation, visited the **John L. Featherstone Plant** by the Salton Sea in Southern California in July. They came away with a new appreciation of the benefits of geothermal energy to both man and bird!

"One of the problems with solar and wind is that they can leave gaps in electricity production at night or when the wind isn't blowing," explained **Garry George**, Audubon California's Renewable Energy Director. "By comparison, **geothermal provides a stable baseload.**"

Providing this stable baseload means that the grid will always have enough energy to stably provide electricity. **But geothermal is also advantageous because it takes up relatively little space**. As Audubon California's Director of Bird Conservation **Andrea Jones** put it, "**we like geothermal because it has such a small land footprint in such a delicate desert habitat.**"

Live in a Geothermal Power Plant!

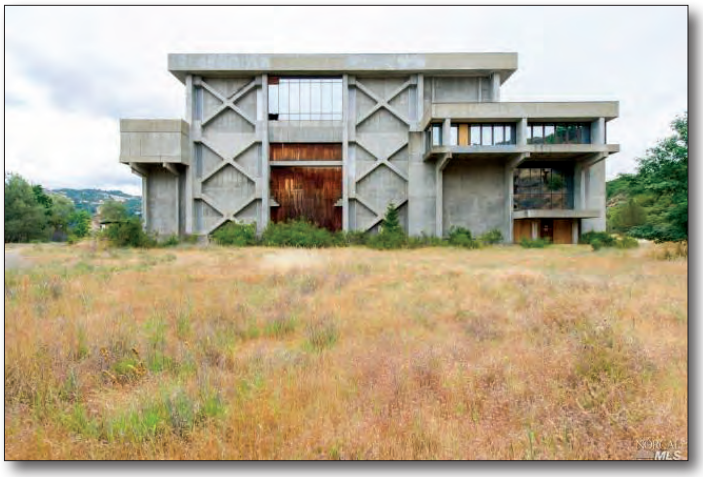
For all those who have a real passion for the geothermal energy industry here is a chance to *actually live in a geothermal power plant!*

The structure was completed but the internals were never installed and plant was never brought online. The new owner has a great view of the Calpine McCabe (Geysers Units 5 & 6) geothermal power plant on the other side of Big Sulphur Creek.

From the online listing: "This remarkable concrete structure was originally built to be a state-run geothermal facility. 3+ floors, multiple rooms per floor, large 450,000+/- gallon water cistern,

bridge crane, 3 phase power drop, 20 gal. per minute well drilled (2002), 57 acres on 3 parcels, Lots of possibilities." Oh, and very short commute to work if you work at The Geysers!

The 60,000 square feet building is being sold for just USD 3,700,000. The address is 12855 Geysers Rd, Geyserville, 95441 - More information at: http://greathomes.org/mls/property/21614744



The imposing building is set in 57 acres in the Mayacamas Mountains. COURTESY GREATHOMES.ORG

The geothermal mansion has a great view of the McCabe geothermal power plant across the Big Sulphur Creek valley. COURTESY GREATHOMES.ORG

Two Deepened Wells Extend Size of San Emidio Phase II Geothermal Reservoir

US Geothermal Inc. has announced it has deepened two wells at the **San Emidio project** in north-western **Nevada**. Both wells intersected high temperature geothermal fluid and high permeability.

In a follow up to the five well temperature gradient drilling program completed last year, two wells were deepened based on their high thermal gradient and bottom hole temperature.

Well 17-21, intersected the geothermal resource at 1,766 feet and has a measured **flowing temperature of 319°F. Well 25-21** intersected the geothermal resource at 2,206 feet and has a measured **flowing temperature of 322°F**. Both wells flow under artesian pressure.

Both wells will undergo further testing to obtain data to be used to optimize the numerical reservoir model.

US Geothermal also announced it had received a draft *Generator Interconnection Agreement* from **Nevada Energy** for the **10 MW San Emidio II expansion**, increasing San Emidio interconnection allowed from 16 MW to **19.9 MW**.

Tesla Opens Lithium-Ion Battery Production Facility

Electric car company **Tesla** has opened a **USD 5 Billion car battery 'gigafactory'** in Sparks, Nevada, just east of Reno, reports *CBC*.

When it is finished the factory will be about 93 hectares (10 million square feet), or about the size of 262 NFL football fields making it **one of the largest buildings in the world.** The gigafactory could nearly double the world's production of lithium-ion batteries.

The location is strategically placed near sources of lithium in Nevada and Southern California that could be produced from geothermal brine.

Salt Lake City Commits to 100 Percent Renewable Energy by 2032

Salt Lake City **Mayor Jackie Biskupski** has launched the Utah capital's initiative to transition to **100 percent renewable energy sources by 2032** and to **reduce carbon emissions citywide by 80 percent by 2040.**

The commitment, called **Climate Positive 2040**, comes as a result of a *Joint Resolution* signed by Mayor Biskupski and the Salt Lake City Council in July.

The GRC will host next year's Annual Meeting & Expo in Salt Lake City from October 1-4.

Inside Geothermal

Drilling Begins at 30 MW Ceboruco Geothermal Power Project

Mexxus RG, a joint venture between Mexico's **Mexxus Drilling** and Iceland's **Reykjavik Geothermal**, has begun drilling for the **30 MW Ceboruco geothermal power plant**, reports *Industrialinfo.com.*

The power plant is located about 17 kilometers northwest of **Ixtlan Del Rio**, in the state of **Nayarit**, Mexico, about 60 miles north-west of **Guadalajara**. The total estimated value of the investment is about USD 115 million.

Netherlands, Mexico to Collaborate on Advancing Geothermal Exploration Techniques

European and Mexican Earth scientists, including from the **University of Utrecht** and the Netherlands Organization for applied scientific research, or **TNO**, have started the **Gemex Project**, aiming to understand the potential of geothermal energy in the Dutch low-country.

The Earth's crust in Mexico is different to that of the Netherlands. In Mexico, it takes a depth of just one to two kilometers to reach about 130 to 300°C, whereas in the Netherlands it takes at least a depth of 4 km to reach that temperature.

The Gemex Project will research **how relatively shallow boring can provide sufficient knowledge** for the development of ultra-deep geothermal energy in the Netherlands at a low cost.

CENTRAL AND SOUTH AMERICA

Chilean Geothermal Potential

What do we know about the world's greatest untapped geothermal potential, which is in Chile, and how can we learn more?

One path to lower uncertainty in geothermal exploration is to know better where to drill. We already know the Andes is hot, but where exactly are the geothermal resources needed to operate a power plant? With limited data available for review, the Andean Geothermal Centre of Excellence (CEGA) has assessed the location of 659 MWe in 9 geothermal areas, but hundreds more exist that can be developed in the future. Can you imagine how much energy we can obtain from over 3,000 volcanoes and 300 hot springs?

Even though geothermal exploration started almost a century ago in Chile, the efforts were not coordinated and geothermal heat maps still remain unavailable for the country. Efforts to explore the resource resumed 16 years ago with the creation of a geothermal law, placing the development responsibility in private hands with scarce state support—showing no thought to the Andean weather and geography. No special terms or financial support were offered ameliorating the difficult access to the geothermal sites.

However geothermal development in Chile was helped six years ago with the creation of the Andean Geothermal Centre of Excellence (CEGA), a public university research center funded for 10 years to foster geothermal energy as a sustainable, environmentally friendly and economically competitive resource—one able to contribute to the energy requirements of Chile and other Andean countries.

Despite the fact that CEGA, associated with the University of Chile, has state-of-the-art lab facilities and a fair amount of human and economic resources, another huge barrier remains, greater than our mountain range, preventing us from moving further: geothermal exploration companies come and go, some flourish, many drop out, dozens of companies have been granted exploration and exploitation concessions, and almost none of them share the information they assemble, making country-wide assessments very hard.

Of course, it is a private company's right to keep its information confidential for the sake of business. Nonetheless, it is also in everybody's interest to develop the largest untapped geothermal potential

in the world, and sharing information is key for improved geological understanding by everyone of the unique, geothermal features in the Andes. With the minimal public information available, CEGA has done its best to assess Chile's high-enthalpy geothermal resources and promising areas with high geothermal potential (*see* the diagram below). But with this said, vast amounts of our geothermal resources remain undiscovered.

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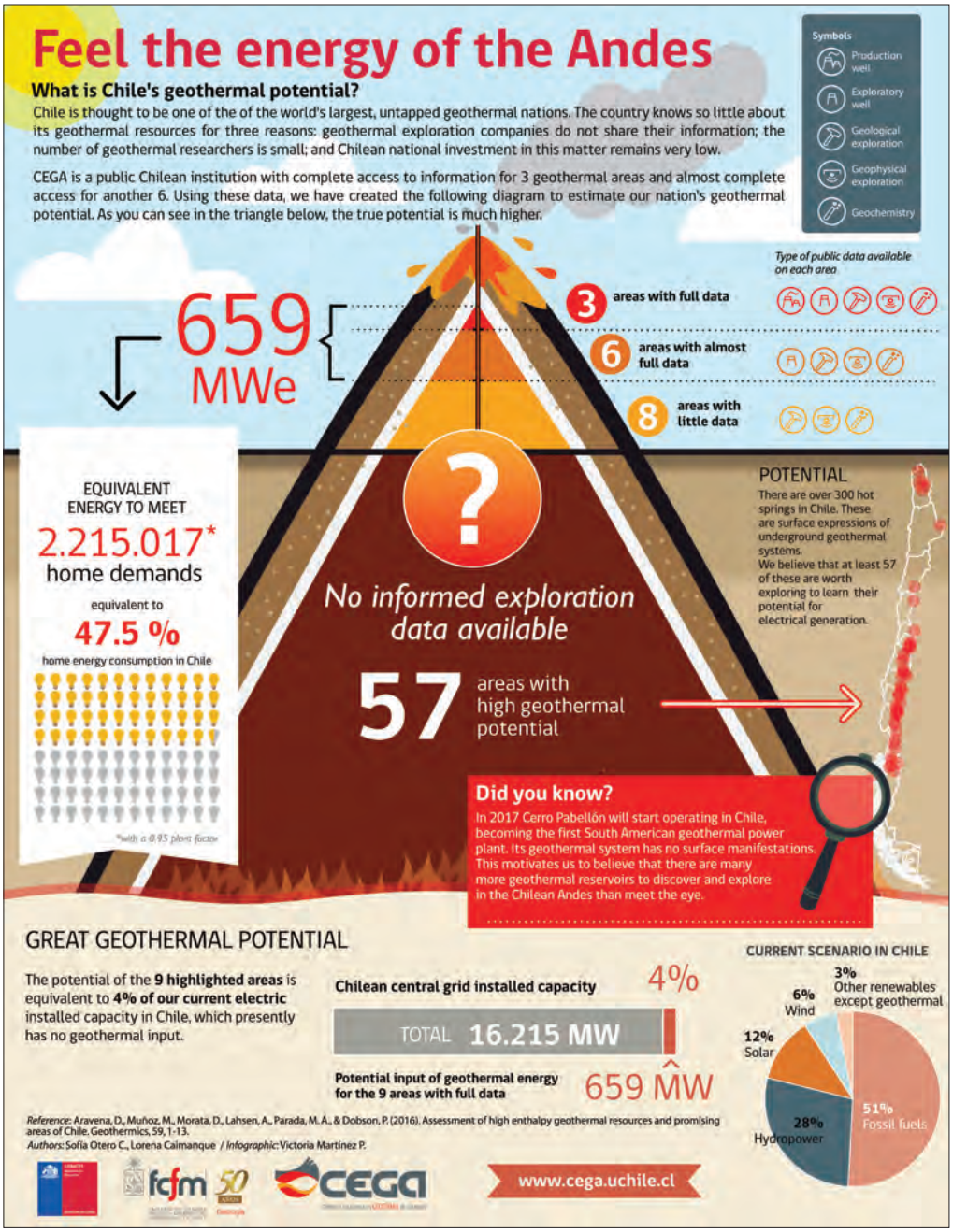
The diagram and essay are from CEGA, the Andean Geothermal Centre of Excellence.



Dominica Government Will Build 7 MW Geothermal Power Plant

The Minister for Energy in the **Commonwealth of Dominica, Ian Douglas**, has declared that the island state has the resources to build a geothermal development program.

The Energy Minister supported the decision made by the Prime Minister and Finance Minister, **Dr. Roosevelt Skerrit**, to establish a domestic geothermal plant through a special purpose vehicle. The **7 MW geothermal plant** is planned to be built in two stages of 3.5 MW each.

Nevis Geothermal Project Nears Final Design

Thermal Energy Partners, LLC (TEP) announced through its affiliate, NRE International, that it has begun a series of final design reviews and analysis of utility interconnection points for its **Nevis geothermal power plant.** TEP also announced that **Clemessy**, a subsidiary of Eiffage, has joined **Turboden** in a Joint Venture to provide Engineering, Procurement and Construction services for the project.

New Well at San Jacinto Geothermal Project Connected

Toronto, Canada-based **Polaris Infrastructure Inc.** has provided an update on operations at the **72 MW San Jacinto geothermal project** in **Nicaragua**.

Following the completion of temporary piping and steamfield infrastructure, **new production well SJ 9-4 was successfully connected** and is contributing **incremental power generation of approximately 10 MW.**
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In light of temporary operational throughput constraints, Polaris has **not yet been able to open SJ 9-4 to 100 percent of its capacity.** The company anticipates further opening the well in a phased approach over the balance of 2016, and expect to have relieved throughput constraints following completion of a planned maintenance program in February of 2017.

Bank Proposes Funding Geothermal Exploration in Nicaragua

The **Inter-American Development Bank (IADB)** has proposed funding further exploration and certification of geothermal energy reserves in **Nicaragua**, reports *Lexology*.

Carlos Melo, IADB's representative in Nicaragua, said that the project will have an approximate cost of up to **USD 60 million dollars** and that public and private partnerships are expected for its execution.

Drilling Begins of a New Large Diameter Well at El Ceibillo Geothermal Project

US Geothermal Inc. has announced that drilling of a new large diameter well, **EC-5** at **El Ceibillo geothermal project** in **Guatemala, began June 9.** Well EC-5 is targeting the production zone previously encountered in **Well EC-2A**.

Well EC-5 will be used to test the geothermal reservoir's flow characteristics and provide critical data required for the numerical reservoir model being developed by **Mannvit Engineering** of Iceland. The reservoir model will be used to determine the size, production characteristics, and power production capability of the reservoir.

AUSTRALASIA

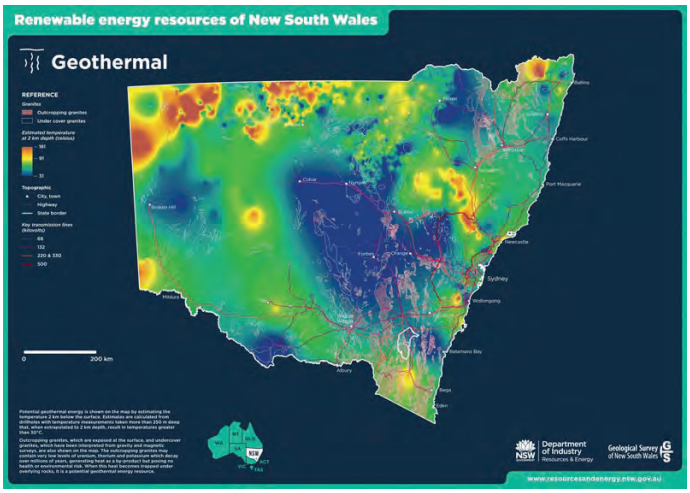
New Map of Renewable Energy Resources Including Geothermal

The **New South Wales (NSW)** government has launched a renewable energy map to help drive investment to the Australian state, reports *Bioenergy Insight Magazine*.

The **NSW Renewable Energy Resource Map** provides renewable energy project developers with free access to geospatial data and information on the state's renewable energy resources, highlighting more than 201 sites across NSW.

The application is apparently the first comprehensive renewable energy resource map covering the entire state, detailing its resources potential and detailing existing infrastructure for solar, wind, **geothermal**, bioenergy, hydropower and marine resources.

The NSW Renewable Energy Resource Map can be downloaded at: www.resourcesandenergy.nsw.gov.au



The geothermal map indicates that the potential for geothermal energy is greatest in the north and west of New South Wales. COURTESY NEW SOUTH WALES GOVERNMENT

Australian Geothermal Energy Generation to Increase by 250%

The *Herald Sun* reports that the Queensland town of **Birdsville**, population 115, will soon be completely powered by an expanded geothermal power plant.

Ergon Energy will spend up to AUD 4.5 million expanding the town's unique **80 kilowatts geothermal power station to 200 kW**.

It will cut diesel use by up to 80 percent, provide up to 70 percent of Birdsville's electricity and **save AUD 340,000 a year on diesel fuel**.

The Birdsville geothermal plant remains **the only geothermal energy facility in all of Australia**.

Geothermalist is Kiwi Energy Engineer of the Year

Professor Rosalind Archer, Head of the Department of Engineering Science at **University of Auckland**, the **Mighty River Power Chair** in geothermal reservoir engineering and director of the **Geothermal Institute**, has been presented with the inaugural **Energy Engineer of the Year** Award at the 2016 **Deloitte Energy Excellence Awards** in New Zealand.

Professor Archer sees her win as "a wonderful surprise – the award also recognizes the energy and support of a large cast of staff and students at the University whom I have the pleasure to work with. It raises the profile of the University in the energy sector, which is helpful for many of us."

New Zealand Government Report Forecasts Possible 2,000 MW Geothermal by 2035

A study on the electricity market by the New Zealand **Ministry of Business Innovation and Employment** suggests that demand will continue to grow in New Zealand, unless the Southland aluminum smelter closes.

The paper explores the long-term future for electricity in New Zealand, presenting modeling results to 2040.

The study concludes that **access to New Zealand's low-cost geothermal resource is likely to be a key factor in limiting wholesale price increases.** Generators, land owners (including iwi) and government will need to continue to work together to maximize the economic, environmental and cultural benefits from geothermal resources.

As a result of the study the **High Geothermal Access scenario** sees the greatest potential for the industry: **996 MW** Installed Capacity in 2016; 1266 MW by 2020; 1741 MW by 2030; 2143 MW by 2040, and **2308 MW by 2050**.

The study, New Zealand's Energy Outlook - Electricity Insight - Preview of key insights can be downloaded at: www.mbie.govt.nz.

Efficiency Improvements Adds 70 GWh Geothermal Energy For Contact Energy

The *Otago Daily Times* reported that New Zealand electricity generator **Contact Energy** made a statutory loss for the year ended June 30 and stated that the **Taheke geothermal resource** near Rotorua on the North Island was unlikely to be developed in the foreseeable future.

However, the company reported **an additional 70 GWh of geothermal generation** with improved efficiency and optimization of its power plants (99 percent in FY16 compared to 94 percent the year before).

Mighty River Power is Now Officially Mercury

Mercury is the new name for **Mighty River Power**, which operates five geothermal plants generating **446 MW** in the central North Island of New Zealand. It has adopted the name of its retail arm and ditched Mighty River Power, which was deemed "**too multi-syllabic and had insufficient marketing zing**", reports *Radio New Zealand*.

However, Mercury thinks it is **unlikely to build any new power stations for several years**. Instead, it is increasing output from its existing electricity generating systems. The comments match others who have said for several years that **New Zealand has enough electricity** to make any new power stations economically risky.

As a possible result of this change in strategy, Mercury director and geothermal expert **Mike Allen** advised that **he will step down** from the company's Board on November 3, 2016, after seven years' service. He had been the major instigator of Mercury's recent geothermal developments in New Zealand.

Instead, Mercury is working on a quieter way of increasing its supply of electricity than building entirely new power plants. It is doing this **by raising the productivity of power plants that already exist**.

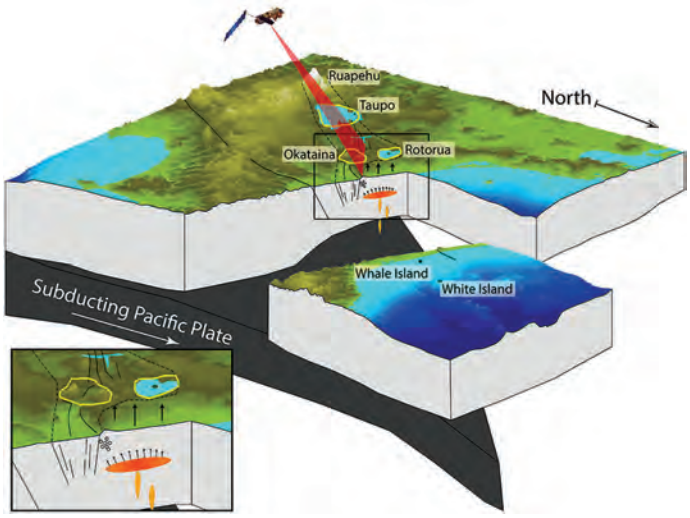
"One of our geothermal power stations, Kawerau, was originally built for 90 MW and at full capacity would now produce 103 to 104," said chief executive **Fraser Whineray**. "That is north of a 10 percent increase."

The last year of geothermal generation for Mighty River Power was a record. In FY16, the company recorded the highest ever at **2,830 GWh (up 2 percent on FY15)** due to availability of 95.5 percent over the year and the impact of the **turbine replacement at Nga Awa Purua.**

Inside Geothermal

New Magma Body Discovered Below Taupo Geothermal Area

In an article published by SPIE, the international society for optics and photonics, **Ian Hamling** of **GNS Science** reports how global positioning satellite and satellite radar interferometry measurements has indicated the birth of a new magma chamber along the **Taupo Volcanic Zone (TVZ)**, an important geothermal field on the North Island of New Zealand.



Schematic block diagram of a large-scale inflating body beneath the Bay of Plenty region, which results in crustal uplift along the coast and triggering of earthquake swarms in the Matata region. The figure shows the subducting Pacific plate beneath the North Island of New Zealand and the outline of the modern TVZ, with the main volcanic centers labeled. COURTESY SPIE AND IAN HAMLING, GNS SCIENCE

The TVZ is an active continental rift and arguably the world's most productive region of silicic volcanism. Along the TVZ, conductive bodies—imaged at depths of about 6–10km—are thought to be zones of interconnected melt. **The geology underlies the Taupo geothermal region where most of New Zealand's installed geothermal generating capacity of about 750 MWe is situated.**

Measurements from leveling lines (placed across the region between the 1950s and 1970s), and from other historical geologic data, also provide evidence that the region may have been undergoing uplift for up to about 1700 years. **The inflation rate that have been observed during the 2000s, however, is more than** double the long-term average.

ASIA

Geothermal Power Plant Has No Interference With Hot Spring Operations

Reno, Nevada-based **ElectraTherm** has announced that its **Power+ Generator™ 4400** geothermal power generator commissioned in April 2016 in the city of **Beppu**, Japan has had **zero environmental impact** or imposition on the neighboring onsen's primary function as a community resource. The power generated is sold to the local utility at an attractive feed-in-tariff rate for renewables.

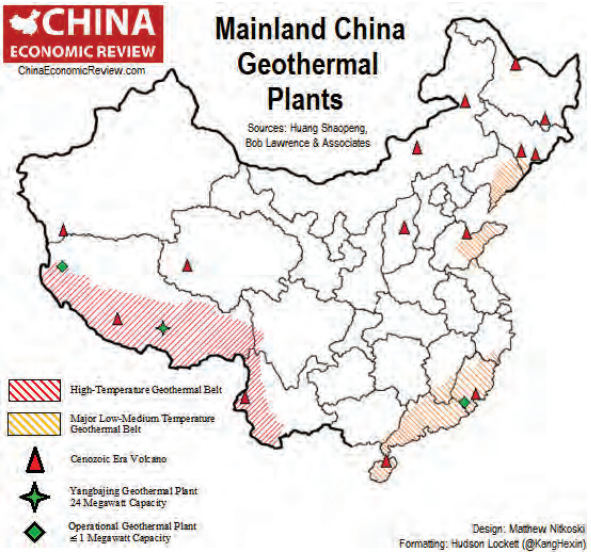
ElectraTherm utilizes Organic Rankine Cycle (ORC) and proprietary technologies to generate up to **110kWe** from low temperature water ranging from **77-122°C**.

Chinese Government Calls on Companies to Explore Potential 800 MW Geothermal in Tibet

According to *China Daily*, the country will speed up the development of clean energy including geothermal, in the **Tibet Autonomous Region** from 2016 to 2020, under the principle of "putting the environment first".

The government is calling on companies to explore the abundant geothermal sources in Tibet in the 5-year plan.

We reported in the March/April *GRC Bulletin* that Southwest China's Tibet Autonomous Region has detected **672 geothermal sites** with a combined power generation potential of 800 MW.



COURTESY CHINA ECONOMIC REVIEW

In addition, **Cao Yaofeng**, an academician of the **China Engineering Academy**, has stated that China is expected to **more than triple geothermal power consumption** by 2020 to 72.1 million tonnes of coal equivalent. By 2020, geothermal power will likely account for about **1.5 percent of the country's total energy consumption**, Cao said, helping to reduce carbon dioxide emissions by 177 million tonnes.

Exploratory Drilling Begins for Taiwans First Geothermal Power Project

The local government of **Yilan** in the north-east of the island, has began exploratory drilling in **Sanxing Township** for what it hopes will be **Taiwan's first geothermal power plant**, the *Central News Agency* reports. The drilling stage is expected to take six months to complete.

Philippines Update

According to *The Standard*, the Philippines **Energy Regulatory Commission** has approved the application of **Energy Development Corp. (EDC)** to develop a dedicated point-to-point facility to connect the **31 MW Bac-Man 3 geothermal project**, in the Bicol region, to the Luzon grid.

In addition, EDC announced wholly-owned subsidiary **Bac-Man Geothermal Inc.** and Scottish contractor **Weir Engineering Services Ltd.** had settled their respective claims on the rehabilitation works of the Bac-Man geothermal facility.

Bac-Man Geothermal agreed to **return USD 1.89 million to Weir** and both parties "have agreed to jointly take steps to cause the discontinuance of the arbitration."

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The consortium of **Basic Energy Corp.** and **Trans-Asia Oil and Energy Development Corp.** reports the completion of initial drilling at the **Mabini geothermal power project** in **Batangas**, reports *The Standard*.

Now that drilling has reached a depth of 1,500 meters, testing will follow.

Basic Energy senior vice president **Anthony Cuaycong** said, "The well is projected to validate the geothermal resource that would be capable of fueling **a 25 MW power plant**".

Trans-Asia Oil and Energy Development Corp. also announced that it is changing its name to **Phinma Energy Corp.** to better reflect its current activities.

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According to *Sun Star*, the exploration plan by **Aboitiz Power Corp.** to tap resources near **Mt. Apo** and **Mt. Sibulan** on **Mindanao** island in the Philippines for geothermal energy has been put on hold.

Manuel Orig, Aboitiz Power Corp. first vice president for Mindanao Affairs, said that the decision to suspend the geothermal plant project was made after the company decided to **focus first on their power venture in Indonesia.**

As reported in the November/December 2015 *GRC Bulletin*, Aboitiz Power announced they are partnering with **PT Medco Power Indonesia**, on a project to explore and develop **a potential 100 MW geothermal plant** in **East Java** province in Indonesia.

When asked on the fate of the Mt. Apo and Mt. Sibulan geothermal project, Orig siad they will resume exploration dependent on the outcome of the Indonesian geothermal project.

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Energy Development Corporation (EDC) is proceeding carefully with its proposed **60 MW geothermal expansion** of the **222.5 MW Southern Negros Geothermal Power Plant** in **Valencia, Negros Oriental.** Despite the location being outside a protected conservation area, EDC still wants to calm fears about harming the local environment.

The *Visayan Daily Star* reports that **for every tree that is cut, the geothermal company is planting 100 seedlings.** EDC has reforested 1,100 hectares in the Mount Talinis area with almost 800,000 trees planted.

"We cannot exist without forests because we rely heavily on healthy watersheds to recharge our geothermal reservoir," **Vicente Omandam**, senior manager for EDC's Negros Island Geothermal Business Unit said. "Without them, our steamfields will dry up and will not be able to supply geothermal energy to our power plants."
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Inside Geothermal

Indonesia Update

The Indonesian government is hoping to see **30 geothermal working areas** tendered between 2016 and 2018 to speed up geothermal development in the country, reports the *Jakarta Post*.

Yunus Saefulhak, the Energy and Mineral Resources Ministry's Director of Geothermal Energy, said Indonesia's **potential geothermal power** amounted to 29,000 MW spread across 300 locations.

"As of today, of a total of 69 working areas, only nine produce power installed with a capacity of **1,493 MW. At the end of 2016, we expect to achieve 1,653 MW** from three (additional) geothermal power plants," Yunus said at the **4th Indonesia International Geothermal Convention and Exhibition.**

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According to the *Jakarta Post*, the Indonesian government is seeking to **streamline business permits in the geothermal sector** in an effort to attract investments and advance the industry.

Under a recent **Energy and Mineral Resources Ministerial Regulation**, which named geothermal a priority sector, the geothermal industry is entitled to priority investment services and investors can **obtain necessary permits within three hours** at the Investment Coordinating Board (BKPM), a privilege other industries already enjoy.

The three-hour service aims to speed up the various permit processes to create a business-friendly environment in selected industries.

Further, geothermal investors are also entitled to **the one-stop service** at the board, in which documents like the geothermal business license and temporary electricity supply permits can be completed without visiting other related institutions.

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State-owned power company **PT PLN (Persero)** has expressed interest in acquiring **a 50 percent stake in Pertamina Geothermal Energy (PGE)**. PLN president director **Sofyan Basir** said the plan has been approved by the Ministry of State-Owned Enterprises.

According to Sofyan, through a joint-shareholding together with Pertamina, PGE can be more expansive in the geothermal sector, which is in line with the government's target to develop 500 MW of geothermal energy each year.

Sofyan said the acquisition of PGE will also cut the cost for supplying geothermal energy, because PLN will no longer have to make power purchase agreements with PGE.

However, member companies of the **Indonesian Geothermal Association (INAGA)** are against the plan, reports *Tempo.co.* INAGA argues that PLN's reason to acquire PGN is just an excuse to spend money.

INAGA chair **Abadi Purnomo** said geothermal exploration and development costs will not drop because of an acquisition. The reason is because geothermal business chains depend on investment climate, which is determined by oil and gas factors. The money should be used for expanding electricity distribution or building new power plants.

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Indian company **Tata Power** has announced that its Singapore-based subsidiary **Tata Power International Pte. (TPIPL)** has completed the sale of its **50 percent stake in OTP Geothermal Pte. (OTP)** to **KS Orka Renewables** for USD 30 million.

OTP is a 50:50 joint venture between **Origin Energy Ltd** and Tata Power International Pte (TPIPL). The company is developing the **240 MW Sorik Merapi geothermal power project** in **North Sumatra**, Indonesia.

KS Orka has already mobilized two drilling rigs for the project by issuing a *Notice To Proceed* to the drilling contractor **Dati Parker. The first pilot power plant is planned for operation in 2017.**

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Australian company **Xped Ltd** and Indonesian firm **PT Bakrie Power Corp** have signed a deal to sell their combined 95 percent interest in the **30 MW Sokoria geothermal project** on **East Nusa Tenggara** island in Indonesia to **KS Orka Renewables**.

Under the terms of the agreement, Xped will sell its entire 45 percent stake in the project company, **PT Sokoria Geothermal Indonesia**, and Bakrie will reduce its interest to 3 percent from 53 percent. **KS Orka** has agreed to lend up to USD 1.5 million for working capital to expedite the project and meet regulatory deadlines.

Xped, previously known as **Raya Group Ltd**, is selling its interest in the project to focus on its new Internet of Things technology business, it said.

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Italian company **Ansaldo Energia** has won a contract to refurbish **a 30 MW geothermal plant** in **Kamojang** in western **Java**, reports *POWER magazine.*

Ansaldo Energia is acting as the agent for Engineering, Procurement, and Construction (EPC) and is supplying the geothermal steam turbine and relative air-cooled generator. The customer is **PT PLN** company **Indonesia Power**.

The company recently opened a branch office in Jakarta to seize opportunities in the Southeast Asian market

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Another Italian company, **Enel Green Power (EGP),** in consortium with the Indonesian geothermal developer **PT Optima Nusantara Energi**, has been awarded a license to explore geothermal resources and develop the **55 MW Way Ratai geothermal power project** in Indonesia's **Lampung province** in **South Sumatra**.

The 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 be investing up to 30 million US dollars in the exploration phase of the project.

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The first phase in the **Sarulla geothermal power plant**, the **110 MW** unit I, is scheduled to achieve its **commercial operation date (COD) in December, 2016**, the consortium has announced.

Units two and **three**, with an additional capacity of **110 MW each**, will begin operation in **2017 and 2018** respectively, making **a total of 330 MW**. The Sarulla geothermal power plant will then be **the world's largest single-contract geothermal power plant.**

The project requires roughly USD 1.5 billion of investment, financed by private sector participation—lead by **Medco Energy**, in a consortium with **Itochu, Kyushu**, and **Ormat**—encompassing 20 percent equity and 80 percent loan financing from the **Japan Bank for International Corporation (JBIC)**, through an independent power producer (IPP) scheme.

Malaysia's First Geothermal Power Plant In Operation by June 2018

The first geothermal power plant in Malaysia is being developed by T**awau Green Energy Sdn. Bhd. (TGE)** at a site in **Apas Kiri, Tawau**, on the north-east coast of the island of **Kalimantan**, reports *The Star Online.*

Exploration, followed by geology, geophysics and geochemistry analysis and modeling by GRC Member **GeothermEx Inc**, of USA, and **Jacobs**, of New Zealand, indicates the existence of an active geothermal system on the flanks of the **Mt. Maria** volcano. The geothermal power plant is slated for operation **by the summer of 2018.**

AFRICA

Japan to Aid Development of Renewable Energy in East Africa

Japanese **Prime Minister Shinzo Abe** and an entourage of Japanese companies came to Kenya in late August and announced business deals and aid packages at the **Sixth Tokyo International Conference on African Development (TICAD VI) Summit**, that will hopefully boost renewable energy in East Africa.
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Inside Geothermal

Prime Minister Abe announced a new African infrastructure plan worth **USD 10 billion** over the next three years to be implemented by the **African Development Bank (AfDB)** focusing on modernizing electricity, power and urban transport systems in order to improve connectivity. It aims to increase electricity generation capacity by 2,000 megawatts, including **increasing geothermal power generation using Japanese technology**.

At the summit, 22 Japanese companies and organizations signed a total of 73 *Memorandums of Understanding (MOU)* with African governments, businesses and others on providing financial and technological assistance, reports *The Japan News*.

The deals, signed in the Kenyan capital of Nairobi, covered geothermal power generation and urban transportation system development projects.

Toyota Tsusho 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 rate of test drilling.

Power Africa Launches New Partnership With The Government Of Japan

Just before the TICAD summit, U.S. government agency **Power Africa** announced a new partnership arrangement with the **Government of Japan** focused on reducing energy poverty and increasing access to sustainable energy in sub-Saharan Africa.

The *Memorandum of Cooperation* (MOC) between the United States and Japan - signed by the **United States Agency for International Development (USAID)** and the **Ministry of Foreign Affairs of Japan (MOFA)** - includes commitments to share strengths, expertise and resources in an effort to accelerate access to renewable energy in Africa.

The collaboration announced that USAID and MOFA seek to further align the Power Africa initiative and Japan's relevant efforts in the TICAD process and will provide a foundation for cooperation in the energy sector. Through this MOC, the Government of Japan is committing to bring an additional 1,200 MW of power to sub-Saharan Africa by the end of 2018.

In particular, **Power Africa and the government of Japan will collaborate on advancing the geothermal sector in East Africa**. Recognizing that geothermal is an integral aspect of sub-Saharan Africa's renewable energy supply, Power Africa and MOFA endeavor to support sub-Saharan African governments in developing their geothermal potential. Support may include co-leading a stakeholder coordination group, facilitating private sector-led investments, working to improve the enabling environment, and conducting strategic assessments.

Rwanda, Djibouti and the Union of Comoros Get Funds to Develop Geothermal Energy

The East African countries of **Rwanda, Djibouti** and the **Union of Comoros** are getting funding to commence surface studies and drilling operations from the **Geothermal Risk Mitigation Facility (GRMF) fund**, administered by the **African Union (AU),** reports *Renewable Energy World*.

Alongside Kenya and Ethiopia, the countries have jointly won **USD 36.7 million in funding** for a total of seven different projects, part of third round of funding applications from the GRMF established in 2012.

Rwanda, through its state **Energy Development Corporation Ltd.,** and Comoros, through state company **Bureau Géologique des Comores**, received funding for drilling, while Djibouti government corporation **L'Office Djiboutien de développement de l'Energie Géothermique** won funding for surface studies.

Toshiba to Help Develop Geothermal Energy Resources in Djibouti

Toshiba Corporation has concluded a *memorandum of understanding* (MOU) with **Office Djiboutien de Développement de l'Energie Géothermique (ODDEG)**, the government organization responsible for developing Djibouti's geothermal power capabilities, to collaborate in the geothermal power generation business.

Under the terms of the MOU, ODDEG and Toshiba will cultivate Djibouti's extensive geothermal resources and provide training for personnel working in plants.

Ethiopian Government Exempts Geothermal Energy From making Royalty Payments

According to *AllAfrica.com*, a newly approved bill on geothermal resources in Ethiopia **exempts royalty payments** for companies engaged in geothermal resource development and exploration in the country.

Before, geothermal resources were treated like other extractable mineral resources. Investment in geothermal resource development was subject to **Mining Proclamation No.52/1993** and administered by the then Ministry of Mines and Energy (MoME). However, the **Ethiopian government now recognizes that geothermal is a unique**, renewable source of energy.

Kenya Update

The **Geothermal Development Company (GDC)** has started development of geothermal fields in **Suswa**, in the Great Rift Valley just 30 miles from Nairobi.

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, reports *The Star*.

In early August, new GDC managing director **Johnson Ole Nchoe** said they expected 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 600-1000 MW** to the national grid," he said.

Phase I will develop 150 MW of geothermal energy, **the total capacity could be around 750 MW.**

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The Board of Directors of the **European Investment Bank**, has approved **EUR 9.4 billion** of new financing for 56 projects around the world, including the **70 MW Unit 6 extension of Olkaria I geothermal power plant**.

Toshiba to Help Develop Potential 500 MW of Geothermal Energy in Uganda

According to *New Vision*, Japan's **Toshiba Corporation** has signed a *Memorandum of Understanding* (MOU) with Uganda's **Ministry of Energy and Mineral Development (MEMD)** on a comprehensive partnership in geothermal power.

The agreement will see the parties collaborate in power generation projects in the east African country, 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.

Toshiba American Energy Systems Corporation will be exhibiting at the GRC Annual Meeting & GEA GeoExpo+, October 23-26 in Sacramento, California, USA.

EUROPE

Drilling of 5,000 Meter Well at Reykjanes Geothermal Plant Has Commenced

Alterra Power Corp. has given an update on the deep drilling project by **HS Orka** in Iceland. A contract was signed for a deep drilling program at the **Reykjanes** plant; the **Jardboranir** rig "Thor" has been deployed to the site and drilling commenced in August. The existing 2.5 km **well #15**, will be deepened to around 5 km to tap a **potential resource of 500°C**.

The contract realizes the next step of the **Icelandic Deep Drilling Project (IDDP)**. The purpose of the project is to demonstrate the possibility of harnessing deep hydrothermal high enthalpy reservoirs in order to augment the current conventional geothermal fields.

British District Heating Networks to Include Geothermal Sources

An estimated **GBP 320 million** is to be pumped into British district heat network schemes **over the next five years** to supply homes and businesses with low carbon heat, some of which could come from geothermal sources, reports *Building Design & Construction Magazine.*

Labeled as 'central heating for cities', the UK government believes that **heat networks could reduce heating costs by over 30 percent** in some households.
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Inside Geothermal

New Geothermal Power Plant will Blend in With the Countryside

U.S. company **GE Oil & Gas** announced it will be supplying Italy's **Graziella Green Power (GGP)** with technologies for a geothermal power station in the **Val di Cecina** area of the **Tuscan geothermal district.**

Spot the power plant! Artist rendering of the next-generation geothermal power station being built by GGP in the Val di Cecina region of Italy. COURTESY GE OIL AND GAS

It is a new application for GE's **ORegen** Organic Rankine Cycle (ORC) binary system technology, which has previously only been used for waste heat recovery in hydrocarbon-based plants.

Once up and running in 2018, the plant is expected to generate approximately 40,000 MWh of electricity per year.

However, the most impressive aspect of the proposed project is **the possible design for the new plant.** An artist's impression of the site shows a structure covered with living plants next to green cooling towers. The site blends in like camouflage with the surrounding forest.

USD 110 Million for Turkish Renewable Energy Projects Including Geothermal

In response to growing demand, the **European Bank for Reconstruction and Development (EBRD)** is providing **USD 110 million** in new funds to Turkish lender Akbank to finance private companies investing in renewable energy and resource efficiency projects in Turkey, reports *The Financial*.

The financing – supported by the **Turkish Ministry of Energy and Natural Resources** and a **EUR 1.9 million grant** from the **European Union** – will benefit renewable energy and resource efficiency projects in Turkey, **including geothermal projects**, according to EBRD.

Kızıldere III Geothermal Power Plant Wins Financing Award

The *Hurriyet Daily News* reports that **Zorlu Energy** won the "Best Energy Infrastructure Financing" award from **EMEA Finance**, a leading finance magazine for Europe, the Middle East and Africa, for the financing of the **Kızıldere III Geothermal Power Plant project**. The contest assesses the financing for the best sustainable energy projects.

Construction of the plant in **Denizli Province**, southwestern Turkey, is being conducted by **Zorlu Doğal Elektrik Üretimi Inc.**, 100 percent owned by Zorlu Energy.

The project will have **95.2 MW** of installed geothermal power upon completion, with an expected investment cost of USD 320 million.

EDUCATION

Abstract Submission Now Open for 2017 Stanford Geothermal Workshop

Abstract submission is now open for the 2017 Stanford Geothermal Workshop to be held 13-14 February, 2017, at the Frances C. Arrillaga Alumni Center, Stanford, California. **Submissions will close on Tuesday, October 18, 2016.**

The goals of the conference are to bring together engineers, scientists and managers involved in **geothermal reservoir** studies and developments; provide a forum for the exchange of ideas on the exploration, development and use of geothermal resources; and to enable prompt and open reporting of progress.

More information at: https://pangea.stanford.edu/researchgroups/geothermal/stanford-geothermal-workshop

Congratulations to Carnegie Mellon University - Winner of Geothermal Design Challenge 2016

Earlier this Spring, the U.S. Department of Energy (DOE) **Geothermal Technologies Office (GTO)**, in partnership with the **Center for Advanced Energy Studies (CAES)** and **Idaho National Laboratory (INL),** launched a competition for high school and university students to design an infographic that illustrates the value and potential of geothermal energy.

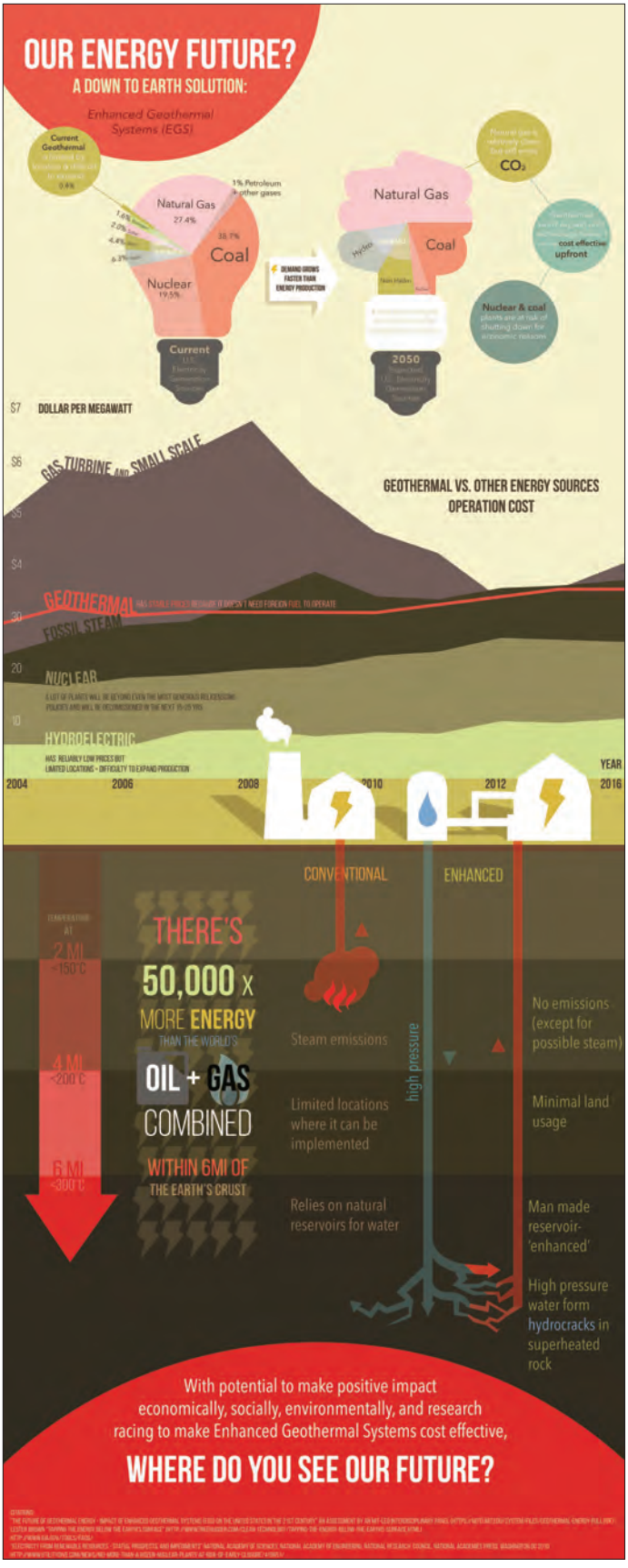
More than 100 teams from across the United States, comprised of 2-3 students each, submitted their infographics, and the **top eleven were chosen** by a committee of engineers, energy experts, and creative professionals.

Three teams, chosen as official winners by the DOE's Office of Energy Efficiency and Renewable Energy (EERE), **will receive USD 2,500 each.** The grand prize winner, *Infinity and Below* from **Carnegie Mellon University**, Pittsburgh, Pennsylvania, received an **all expenses paid trip to the Geothermal Resource Council's 40th Annual Meeting** on Oct 23-26 in Sacramento, California to present their infographic.

The three winning teams are:

- **Grand Prize Winner** - *Infinity and Below*
  Tiffany Lai, Susie Lee, Marisa Lu of Carnegie Mellon University, Pittsburgh, Pennsylvania.
- **University 1st Place Winner** - *YalEnergy Rockstars*
  Dana Patterson, Christopher Paolini, Daniel Shapiro of Yale University, New Haven, Connecticut.
- **High School 1st Place Winner** - *Team Roosevelt*
  Edward Belsoi, Rokhaya Niang, Hunter Whaples of Eleanor Roosevelt High School, Eastvale, California.

The top 11 posters in the Geothermal Design Challenge 2016, together with 34 other technical poster presentations, are on view at the ***GRC Annual Meeting****. Look for them in the 3rd Floor Lobby of the Sacramento Convention Center throughout the event.*



The winning poster.

Inside Geothermal

Geothermalist Features in New Toy Collection!

LEGO has partnered with GRC Member and National Geographic explorer, **Andres Ruzo** for its latest LEGO City play-set, reports *Toy News*.

Part of the toy firm's new **Volcano Explorers** campaign, Ruzo will feature in the new sets that are being incorporated into school teaching plans as part of the initiative to encourage kids' into scientific exploration.

The campaign launched on September 29th, when Ruzo attended a media event at The Geological Society of London in Piccadilly.

"I loved playing with LEGO since I was a kid, so the chance to work with LEGO City Volcano Explorers is a boyhood dream come true," said Ruzo.

"As a geothermal scientist heavily involved in science education, the announcement of a geology inspired LEGO theme was a thrilling surprise I was not expecting.

"I have been taking the sets into the field with me and the combination of LEGO and volcanoes presents endless possibilities for **hands-on educational opportunities** to show kids how amazing our home planet is."

A scene from the LEGO Volcano Explorers campaign. Which one is Andres Ruzo? COURTESY LEGO

SCIENCE & TECHNOLOGY

Research Develops Cement that Performs Strongly in Harsh Geothermal Conditions

The U.S. Department of Energy **Geothermal Technology Office (GTO)** has reported on the progress in geothermal cement technology. One of the most critical components of geothermal resource development is the drilling process and the integrity and longevity of a geothermal well's cementation of casings.

After a geothermal production well has been drilled, the well must be **stabilized with a casing**, a large diameter pipe that is assembled and inserted into a recently drilled section of a borehole, in order to prevent the well walls from collapsing. **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 GTO, **Trabits Group, LLC** of Alaska, USA has successfully developed a cement that performs strongly in harsh geothermal conditions and is easy to use. Containing **zeolites**, a naturally occurring mineral that can be readily dehydrated and rehydrated, this cement reduces the complexity and cost of well cementing, which **will help enable the widespread development of geothermal energy in the United States.** *(Thanks to EERE/GTO for the information)*

Jackhammer Design for Geothermal Drilling

Sandia National Laboratories and a commercial firm have designed **a drilling tool that will withstand the heat of geothermal drilling**, reports the U.S. national lab.

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 O-rings, 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 high-temperature environment," said mechanical engineer **Jiann Su**, Sandia's principal investigator on the project with Atlas Copco.

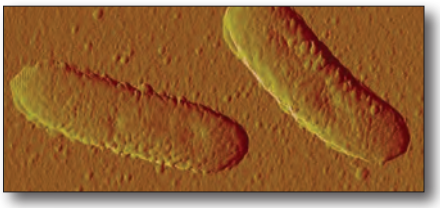
Technologist Elton Wright assists as mechanical engineer Jiann Su inspects a downhole hammer. PHOTO BY RANDY MONTOYA

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

Possible Use of $H2_s$ and CO^2 from Geothermal Emissions to Make Renewable Fuel

Recent research news may be of interest to the geothermal industry, as some H_2S and CO^2 is co-produced with geothermal steam.

Berkeley Lab scientists at the **Joint BioEnergy Institute (JBEI)** have demonstrated a promising biological approach to convert nuisance chemicals in municipal wastewater (sewage) treatment plants into renewable fuels or chemicals. **The technology may also be applied to emissions from geothermal power plants.**



Thiobacillus denitrificans soil bacterium CREDIT JOSEPH TRINGE (JBEI)

JBEI scientists have engineered a common soil bacterium, *Thiobacillus denitrificans,* which **naturally consumes hydrogen sulfide** and nitrate (another problem chemical), and **fixes CO^2** (a greenhouse gas), to simultaneously overproduce fatty acids; these can be further converted to **biofuels** or **value-added chemicals.**

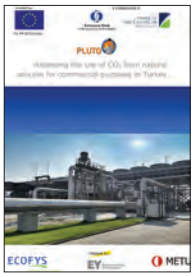
(Thanks to GRC Member Marcelo Lippmann, Staff Scientist (retired) at Lawrence Berkeley National Laboratory for the submission.)

CO^2 From Geothermal Power Plants Could Be Used to Produce Fertilizers

A new study by Dutch renewable energy consultant **Ecofys**, commissioned by the **European Bank for Reconstruction and Development (EBRD)**, analyzed the use of carbon dioxide in producing urea, an important ingredient in many fertilizers.

According to Ecofys **the use of CO^2 from geothermal power plants (GPPs) for these purposes would lead to efficiency improvements** (in the case of urea yield boosting) or may avoid fossil fuel combustion to produce CO^2 (as in greenhouses).

This study provides an overview of international experiences in the commercial use of CO^2 presenting a range of technologies with varying stages of maturity, economic potentials and global demand.



The report specifically mentions Turkey, as the country's geothermal power plants have higher than normal CO^2 emissions.

The report, Assessing The Use Of CO^2 From Natural Sources For Commercial Purposes In Turkey can be downloaded from www.ecofys.com.

Magnetic Nanoparticles Separate Rare Earth Elements from Geothermal Brine

As reported in the July/August *GRC Bulletin*, the U.S. Department of Energy's (DOE) **Geothermal Technologies Office (GTO)** is exploring unique ways to extract valuable resources that are sometimes dissolved in the large fluid volumes brought to the surface by geothermal plants. The GTO has allocated **USD 4 Million** in total funding to **four projects**.

In one of the projects, **Pacific Northwest National Laboratory (PNNL)** scientist, **Pete McGrail**, and his team have developed a new process using **magnets** and a **unique nanomaterial**. The new method introduces magnetic nanoparticles that have a shell made of metal organic frameworks (MOFs) into the geothermal brine.

The MOF outer layer carries molecules that are attractive to rare earth elements, causing the elements to stick to the nanoparticle. **The brine is then passed through a magnetic separator to remove the nanoparticles**, which are then treated to extract the attached rare earth elements. The now nanoparticle-free brine is then re-injected back underground, as is normal in a geothermal plant.

Using this method, PNNL **test results showed a nearly perfect rare earth element extraction rate - 99.99 percent,** and attractive economics overall. A possible lucrative revenue stream for geothermal power plants?

A video describing the process can viewed on You Tube at: https://youtu.be/ceX_bO3L0Po. ■

Investigating Flexible Generation at The Geysers

Karl Urbank and Alyce Jorgensen, Calpine Corporation
Photography: John Grice, Calpine Corporation

As California advances towards achieving its goal of increased use of renewable energy, it is recognized that the state's electric grid is changing as a substantial amount of new, non-baseload renewable resources such as solar and wind come on line. The ability of the grid to adjust to these intermittent sources is limited during the periods when the production of solar energy is the highest or when the peak wind energy is produced. Because of this grid limitation, flexibility is needed from other generation sources on the grid during certain hours of the day. The California Independent System Operator (CAISO) maintains reliability and access to the grid. The CAISO has illustrated future predicted grid conditions on a typical spring day in its "duck chart", shown in **Figure 1.**

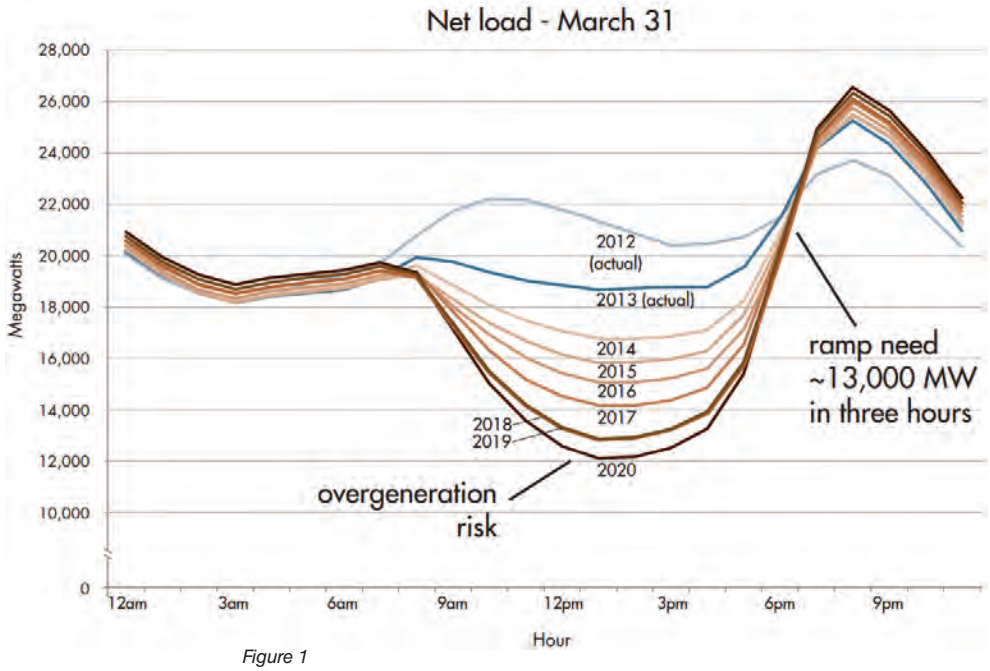


Figure 1

Load serving entities, grid operators, and policy makers are appropriately concerned about how large quantities of these intermittent renewable energy sources will be reliably integrated onto the grid. As these sources increasingly penetrate the resource mix, flexibility from other resources, even those that have traditionally been baseload supply, will be required to help reliably manage grid fluctuations.

Geysers Power Company (GPC) is engaged in a study to investigate how geothermal generation facilities may be modified in order to address the demands imposed on the grid by the integration of intermittent renewable energy. In this case, GPC needs to develop a way to adjust how much energy can be produced and put onto the grid when needed. Traditionally, The Geysers has been a stable baseload energy producer, with a few exceptions for market or resource conditions. The conditions now created by intermittent renewables will demand deeper and more frequent curtailment. Adjusting operations and procedures to become more flexible will produce physical and operational challenges. The study will advance GPC's understanding of the range of operating scenarios that can be reliably dispatched, as well as the associated costs, risks and effects to the physical

operation of the above-ground facilities and the geothermal reservoir.

In July of 2014, GPC applied for a grant to help support this study under California Energy Commission (CEC) Program Opportunity Notice PON-13-303. This grant is funded by the Electric Program Investment Charge (EPIC), an electricity ratepayer surcharge authorized by the California Public Utilities Commission. The grant was awarded to GPC and work commenced in April of 2015. Work was suspended in September of 2015 after the devastating Valley Fire, due to the demands on GPC personnel as they supported the fire recovery effort. With the approval and support of the CEC, work resumed on the study in September 2016.

Geysers Power Company, LLC (GPC)

GPC is the largest producer of geothermal energy in the United States and is committed to developing technologies and processes that will improve the ability of its facilities to respond to changing demands in the California electrical generation market. GPC is a wholly-owned subsidiary of Calpine Corporation and owns The Geysers generating assets that are operated by Calpine Operating Services Company. GPC's Geysers facilities have provided a reliable source of renewable, low-carbon, baseload geothermal energy for 56 years. These facilities produce up to approximately 10% of California's renewable electrical energy, using 327 production wells, 80 miles of steam lines, and 52 water injection wells. Plant condensate is augmented by up to 20 million gallons per day of treated wastewater from Sonoma and Lake Counties to keep the reservoir charged.

Modeling Effort

GPC is developing an integrated computer-based model that simulates the effects of flexible generation on the reservoir, wells, pipelines, and power plants. The model will be verified through tests on isolated well(s), pipelines and power plants to determine the effects on the larger steamfield. During this pilot testing, data resulting from various flexible generation scenarios will be collected and analyzed in order to determine potential risks that may result to the geothermal facilities from flexible generation. Some of these risks include casing and pipeline corrosion, wellbore scaling and sloughing of the wellbore formation (rock from the open hole becoming unstable and plugging up the wellbore). A comprehensive analysis will be performed to identify the methods and associated costs needed to flexibly operate while optimizing and protecting the geothermal resource.

The modeling project will identify problems and solutions that would allow GPC to overcome steam production and delivery issues. The modeling will increase the understanding of the risks associated with wellbore damage, low flow conditions that can increase condensation (causing acid dew-point corrosion), water hammer and the build-up of non-condensable gases.

In addition to the modeling work, GPC is performing physical modifications to the field and plants to verify the effectiveness of several techniques to make the facilities more flexible. **Figure 2** illustrates these.

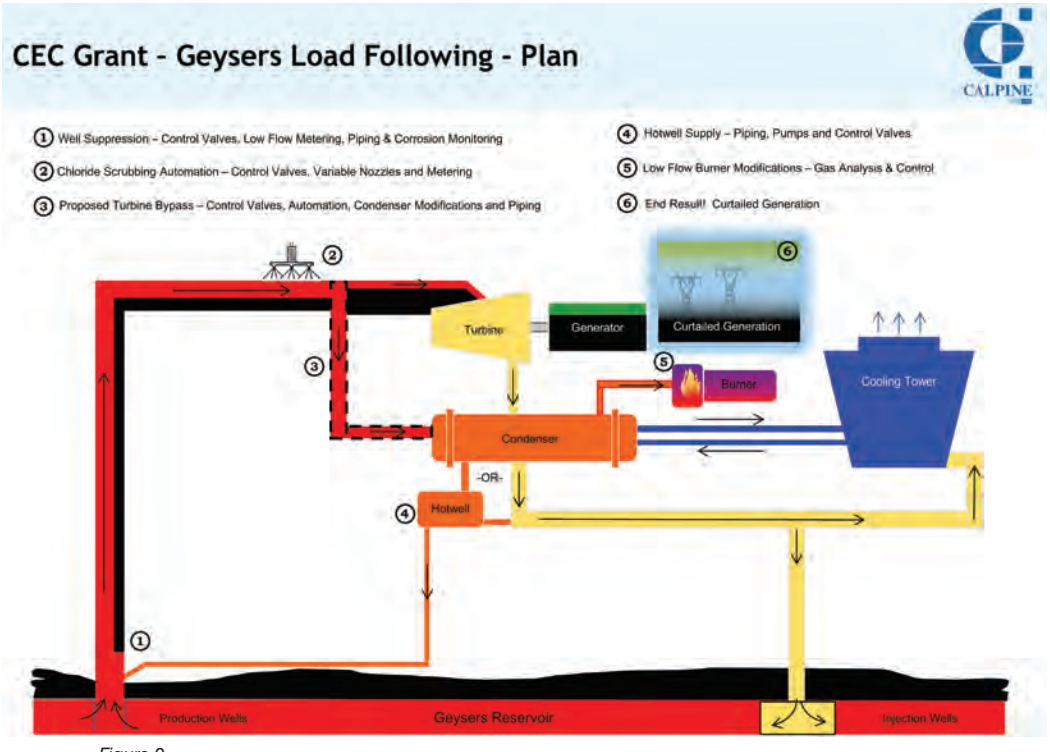


Figure 2

Well Flow Suppression

The GPC steam field has 327 steam wells, most of which were drilled decades ago. GPC is evaluating upgraded electric actuators on existing well flow control valves **(Figure 3)**. These actuators will be installed and tested to ensure we have maximum steam field flexibility and reliability. Tests are also being run on vortex-shedding flow meters **(Figure 4)**, which have a better turn-down ratio than the orifice plate differential pressure devices that have traditionally been used for steam flow measurement.

Figure 3: *This new steamflow control valve actuator is designed to allow remote reduction of steamflow to plants.*

Figure 4: *This vortex-shedding flow meter measures flow rates at a better turndown ratio than an orifice plate. It is currently being evaluated to determine its turndown accuracy.*

Chloride Scrubbing Automation

GPC reduces the amount of chlorides in its main steam to the plants by injecting hotwell condensate that has not been contaminated with oxygen into the steamline upstream of the main separator **(Figure 5).** The chlorides are absorbed into the scrub water which is then removed in the separator. If the well flows are significantly reduced during periods of generation curtailment, then the scrub water flow also needs to be reduced and, in some cases, relocated. Tests will be run to evaluate an automated scrub water flow control system that tracks fluctuations in main steam flow. The system needed for load following will introduce a controller, a series of nozzles sized for various flow rates, and automated valves to direct flow to the nozzles. This would allow GPC to become more flexible in its ability to manage and control steam flow.

Figure 5: *Injecting condensate upstream of a separator to scrub chlorides.*

Turbine Bypass

The well suppression part of the study will indicate a minimum flow from the steamfield that must be maintained to avoid well damage and low-flow condensation leading to acid-dew point corrosion. Further reductions in the Geysers output would require turbine bypass capability. Several of The Geysers plants that have surface condensers were originally built with turbine bypasses to allow for H_2S abatement capability during turbine trips. This portion of the project will involve the retrofitting of two turbine bypass systems, one at a surface condenser plant at Lakeview Unit 17 (see **Figure 6**) and one at a direct-contact condenser plant (McCabe Unit 5). These will each involve a controller working in conjunction with both the turbine and existing condenser level control systems. It will also involve large control valves and pressure drop devices in order to dissipate this large amount of energy in a controlled manner.

Modifications will need to be made to the condenser internals in order to provide a pathway for this bypassed steam that does not affect turbine performance. These bypasses are needed to respond to the sharp edge of the duck curve at dusk when solar output falls off.

Hotwell Supply

As stated earlier, GPC uses hotwell water from units that have surface condensers for various processes across the steam field. If the flowrate of steam arriving at these units is reduced due to steam field suppression, an intertied system needs to be developed so that make-up water can still be provided to systems that rely on this water. This would involve a controller, pumps, additional piping cross-ties and possibly tankage to make sure this system is robust and can respond when load cycling is underway. This concept will be developed and tested as part of the study.

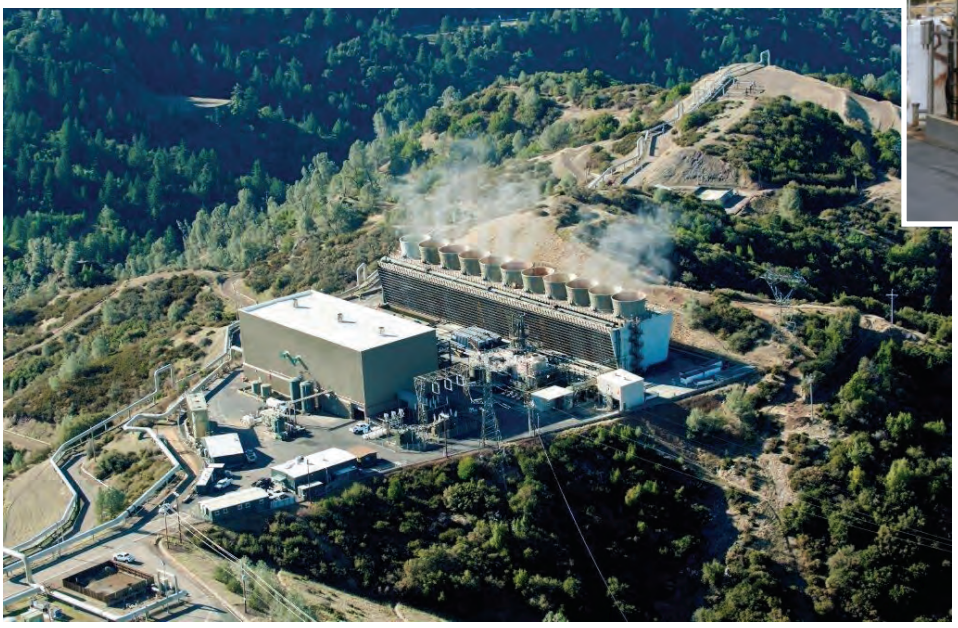


Figure 6: *Lakeview Unit #17*

Low-Flow Burner Modifications

The H_2S abatement burners (**Figure 7**) were set up for some variation in the non-condensable gas throughput. However, if the steamfield is suppressed by 50%, the flow of gasses to the burner will be reduced to point that will be outside the normal turndown ratios of existing burner control equipment and schemes. A new control system will need to be developed that can follow, measure and react to these changes in conditions as GPC cycles output.

Figure 7: *Abatement burner at McCabe Power Plant*

The Next 24 Months

GPC personnel are fully engaged in the above study elements. Our new schedule for the CEC Grant has us completing our final reports in the summer of 2018. GPC wishes to express its gratitude for the CEC's support of the study and willingness to accommodate schedule changes. ■

California Geothermal Update

California Division of Oil, Gas, and Geothermal Resources
www.conservation.ca.gov/dog

Changes at DOGGR

The Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) oversees geothermal well drilling and operations on private and state lands throughout 20 of California's 58 counties, including low-temperature wells not used for the production of electricity (**Figure 1**). There are approximately 860 production and injection wells used for electrical production in the state, including resources regulated by the federal Bureau of Land Management (BLM).

Figure 1. Known geothermal Resource Areas in California. Courtesy California Energy Commission.

The Division has gone through many changes since the last GRC Annual Meeting, including the appointment of Ken Harris as State Oil and Gas Supervisor. Harris, a geologist/hydrologist, was previously the Executive Director of the Central Coast Regional Water Quality Control Board. The Division was reorganized from six districts to four, and the geothermal districts have joined the oil and gas district offices. The Division's Northern District is now managed by former GRC Board member and current GRC Member Charlene Wardlow, who is also the Geothermal Program Manager for the state. She has moved from Reno, where she worked for Ormat Technologies, Inc., to Sacramento.

The Northern District extends from the San Joaquin River in the middle of the state to the Oregon border and includes oil, gas, two-thirds of California's gas storage, and geothermal -- specifically The Geysers, Mammoth Lakes (Casa Diablo), and the many low temperature resources throughout the north. The Santa Rosa geothermal office was closed, and manager Joe Austin is now based in Sacramento. The additional staff in the Northern District, including five field engineers, are assisting Joe with geothermal oversight as well as other operations in the District. This will help expand the geothermal knowledge base within the District.

The Division's Southern District, located in Cypress, Orange County, now oversees the geothermal operations in the southern part of California, including the extensive resources in Imperial County. Longtime El Centro engineer Cliff Parli retired at the end of 2015 and the El Centro office will close effective January 2, 2017.

Engineers and field engineers from the Cypress office (moving to Long Beach in 2017) will support all operations. Southern District Deputy Dan Dudak is very familiar with geothermal issues, as he was the geothermal engineer at the State Lands Commission before coming back to the Division. State Oil and Gas Supervisor Harris toured the Imperial Valley operations in June (yes, it was hot!) and was very impressed with the geothermal operations in Imperial County. He plans to tour The Geysers soon!

The Division is working on revisions to geothermal regulations, including bonding requirements, the fluid temperature definition for Division oversight, and allowing new technologies such as LiDAR to be used for subsidence monitoring instead of just surveying. It is also revising language to ensure regulations adequately cover new technologies that are being developed, such as those used in enhanced geothermal systems (EGS). Public meetings to receive comments on the revisions will be announced.

The Division has more than 200 years of experience among its geothermal staff in the four district offices. Staff helps to ensure that wells are safely drilled, injection does not impact drinking or surface water, and wells are plugged and abandoned properly to protect the citizens of California. The Division is also working with the California Energy Commission, which plans to use some of the Geothermal Resource Development Account (GRDA) funds to plug and abandon orphaned wells drilled under its program over the last 30-plus years.

California - The World Geothermal Energy Leader

California has developed its geothermal resources for the production of electricity more than any country in the world. Since 1960, with the first commercial geothermal power plant at The Geysers geothermal field, the state has been a world-leader in harvesting energy from underground hot water and steam. While many may think that geothermal has reached its full potential in the state, exciting projects are still being developed for the future.

Geothermal was once the leader in renewable electricity generation in California. This is no longer the case. With the California Renewables Portfolio Standard (RPS) requiring 50 percent of electricity retail sales be served by renewable energy resources by 2030, solar and wind electrical production have experienced a rapid increase overtaking geothermal (**Figure 2**).

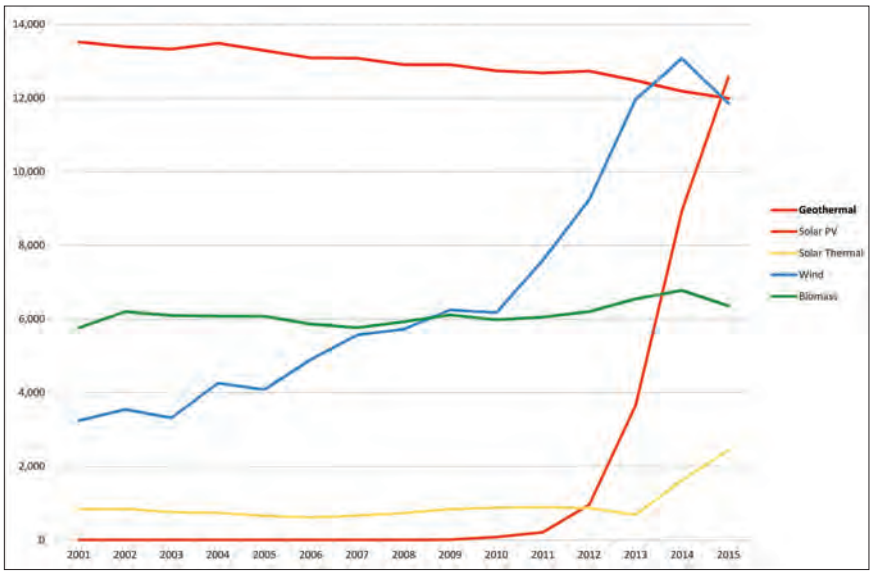


Figure 2. California's in-state electric generation by fuel type. Data from the California Energy Commission.

In 2015, solar and wind both surpassed geothermal, in terms of in-state electrical power generation. Solar accounted for 7.7 percent, wind 6.2 percent, and geothermal 6.1 percent (**Figure 3**). Natural gas remained the largest source of electricity, providing 59.9 percent.

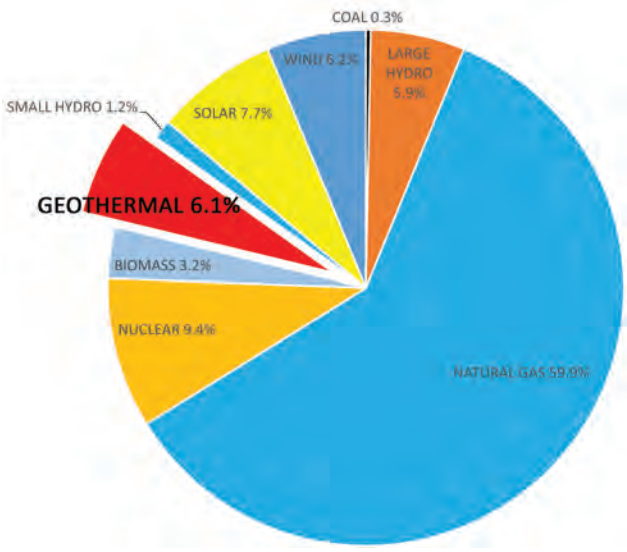


Figure 3. 2015 Percent of California's in-state electric generation. Data from the California Energy Commission.

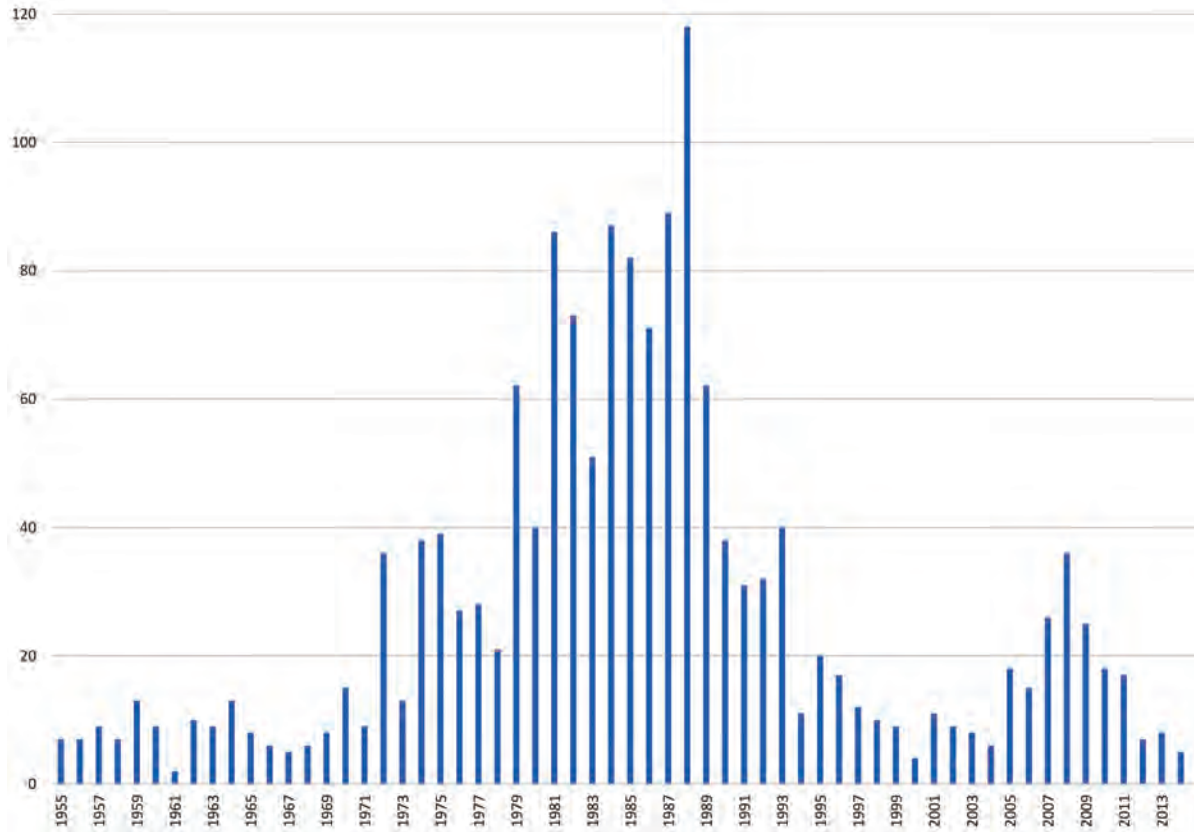


Figure 4. Number of geothermal wells (not counting temperature gradient holes) drilled in California by year, 1950-2015. Data from DOGGR.

California has not seen a new geothermal power plant constructed since the John L. Featherstone facility was opened by EnergySource at the Salton Sea field in 2012. Plans exist for new power plants at The Geysers, Casa Diablo, and the Salton Sea fields, but none have broken ground yet. However, President Obama recently announced a goal to procure 100 to 250 MW of geothermal from the Salton Sea area, a renewed recognition of the value geothermal energy brings in jobs, taxes, reduction in greenhouse gases, grid stability and attaining Renewable Portfolio Standard goals.

California has 46 geothermal power plants with a total capacity of 2,708 MW. This makes California the leader in installed geothermal capacity, with 21 percent of the world's and 77 percent of the United States' share. California has 4.4 times the installed capacity of Nevada, which ranks second in the U.S. (1) (2).

Only seven geothermal wells were drilled in California in 2015. Two were low-temperature wells in Desert Hot Springs, four were injection wells at The Geysers, and one was a production well at Heber.

California saw its largest number of wells drilled in 1988, with drilling occurring at Coso, East Mesa, Heber, and The Geysers. The peak of drilling was in the 1980s. (**Figure 4**)

References

1. Matek, Ben. *2015 U.S. & Global Geothermal Power Production Report.* Geothermal Energy Association, 2015.

2. Shevenell, Lisa. "Nevada Geothermal Update - 30 Years of Power Production, 2015." *Geothermal Resources Council Bulletin,* Vol. 44, No. 4 (2015): 28-37. ■

Electric Youth: The GRC Student Committee

As part of a regular series of columns the members the GRC Student Committee updates readers on the good work of the committee and news for the young and aspiring members of the global geothermal community.

Student Committee Updates and GRC Annual Meeting Young Professional Opportunities

by Cari Covell and Daniel "Burke" Brunson

The GRC student committee is composed of graduate students from around the world that represent the geothermal industry on an international level. Each member of the committee, selected from students who volunteer and are chosen for a 1-year term, is part of one or more subcommittees that work on new projects and improvements intended to advance student opportunities. The subcommittees provide structure in creating improvements for current GRC student chapters, as well as give opportunities for new chapters to emerge. Students on the committee also work towards engaging young professionals to become involved in sharing knowledge and experiences. In this issue of the *GRC Bulletin*, the student committee would like provide an update on recent activities and announce some exciting opportunities that will be highlighted at this year's GRC Annual Meeting.

The "Articles" subcommittee has written two interesting "Electric Youth" pieces thus far about student participation and achievements in the geothermal industry. Students at the University of North Dakota (UND) were involved in the initial stages of implementing a new power plant nearby the university. Some UND students participated in negotiations of the *Power Purchase Agreement*, while others worked on optimization of the Organic Rankine Cycle generator. Additionally, students at the Iceland School of Energy at Reykjavik University were recently featured in an electric youth article for their work on the CarbFix Sequestration project. Two master's students provided an economic assessment of the Carbon Capture and Storage method (CCS) at the Hellisheidi geothermal power plant while accounting for transport and monitoring.

The "Chapter Facilitation" subcommittee has made great strides in creating an improved framework for student chapters. A model constitution will be made available to established chapters to provide suggestions for updates and to new chapters that need a starting point for the development of a constitution. An improved welcome package for newly established chapters, which provides helpful tools that encourage active engagement within the organization and in the community, is still under development. An initiative related to engagement of students and young professionals being explored is to create a "Geothermal Expert Speaker Circuit," available to those of the University that the speaker visits and also available by webinar to those in other localities. Present plans include hosting experts who are already traveling in an area nearby a particular school, with hopes in the future of being able to actively recruit those same professionals to schools for the sole purpose of conducting a seminar. The forum would be a platform for presentations, interesting discussions, workshops, and Q&A. It is intended that these improvements and others concerning student chapters will be better highlighted in the "Students" section of the GRC website, once the majority of the work is completed.

The "Annual Meeting" subcommittee would like to bring attention to some events at the GRC Annual Meeting geared towards students and young professionals. The Student Network Reception will take place on Monday, October 24 from 5 to 7 PM. In addition, the GRC Mixer and Networking Social is open to young professionals on Monday from 6:30 to 9 PM. Workshops and fieldtrips, which take place at various times before, during and after the Annual Meeting, are still open for registration. This subcommittee is also responsible for helping run the GRC booth in the GEA Expo. More information will be provided on the improved student chapter framework being developed, including physical copies of the model constitution and other associated documents in a convenient take-home. The "Case Study Challenge" Competition, being re-established under the direction of the GRC with help from the Student Committee, will be announced at the Annual Meeting, where students have the opportunity to test their abilities of geothermal resource assessment against those of their colleagues for prizes and recognition. More information on the official rules will be provided at the GRC booth, where all students and young professionals are encouraged to learn more about opportunities and activities in the geothermal industry. ■

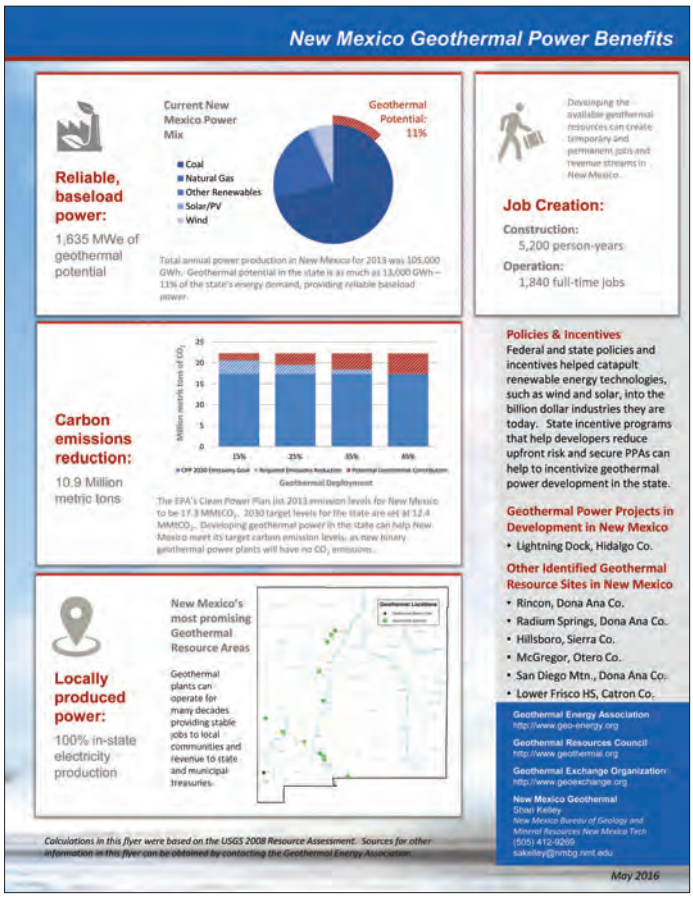
Publications, Websites, Videos & Maps

by Ian Crawford

New Mexico Added to US State Geothermal Energy Collection

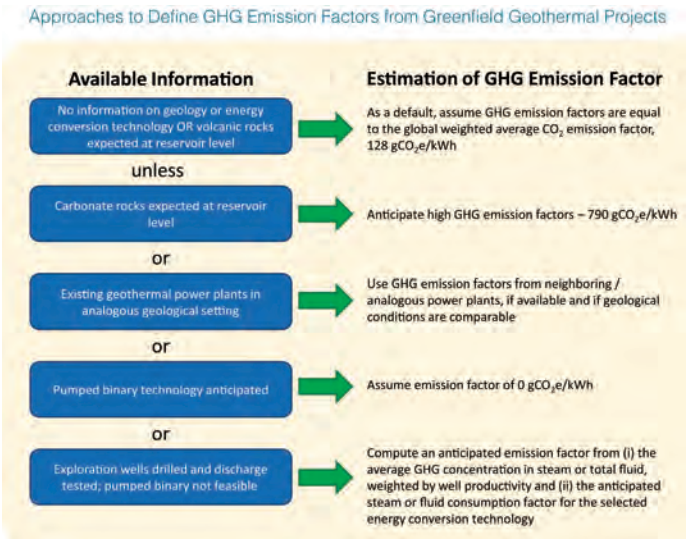
The Geothermal Resources Council (GRC), Geothermal Energy Association (GEA) and Geo-Exchange Organization (GEO) have released guidance for another state on **meeting new clean energy standards** from the **U.S. Environmental Protection Agency (EPA).**

The free state-by-state guides walk through the benefits and uses of three major types of geothermal applications: power generation, direct use and heat pumps, and initially cover **Arizona, California, Oregon, Montana, Nevada, Idaho, Colorado** and **Utah**. A guide for **New Mexico** is now available. All the State-by-State Guides are available on the GRC Website at: https://geothermal.org/states.html.



Guidance On To How To Estimate Emissions From Geothermal Power Projects

A report from the **Energy Sector Management Assistance Program (ESMAP)** of the **World Bank Group** gives guidance to project developers and financial institutions on to how to **estimate emissions**, *ex ante*, from geothermal power projects, especially those being considered for financing by The World Bank and other multilateral development banks, or even the private sector.



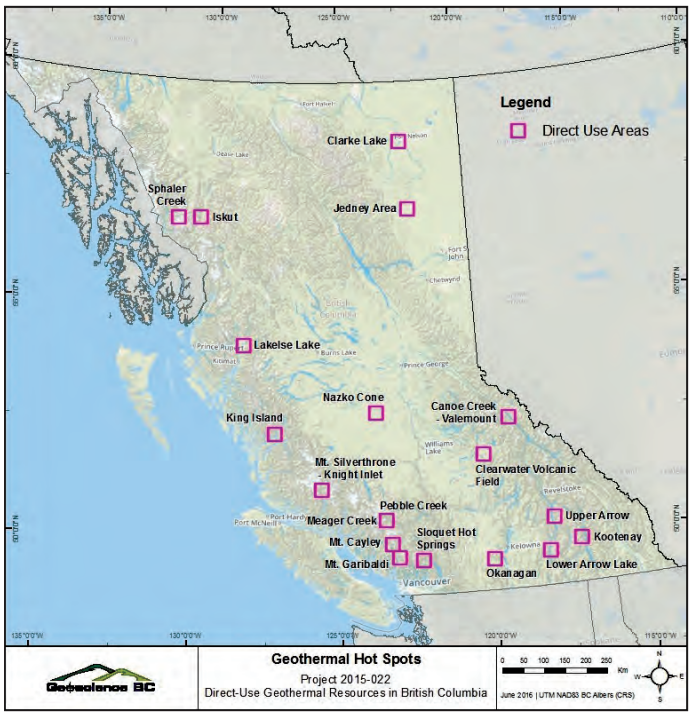
COURTESY ESMAP

The ESMAP Technical Report 009/16 *Greenhouse Gases from Geothermal Power Production* makes recommendations towards closing identified knowledge gaps relating to effects of production on greenhouse gas emissions (GHG) emissions over time. More importantly, the report offers insights on how concessional financing for investments in gas capture and treatment can be considered where GHG emissions from geothermal exceeds the national grid emission factor.

Download the report from the ESMAP website at: www.esmap.org/node/57064

Guide to Direct Use Geothermal Applications in BC

Geoscience BC has released its *Direct-Use Geothermal Roadmap*, a comprehensive guide for communities and businesses to help them evaluate and develop **local geothermal energy projects** to stimulate economic development and reduce greenhouse gas emissions.

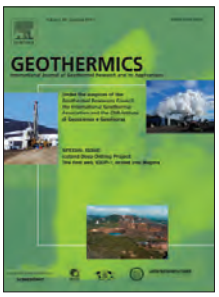


COURTESY ESMAP

The **Direct-Use Geothermal Roadmap** contains practical guidelines for communities on geothermal surface exploration, land acquisition and permitting, drilling and testing wells required for the design and development of direct-use geothermal resources in British Columbia, Canada.

Download the Geoscience BC Report 2016-07 *Direct-Use Geothermal Resources in British Columbia* at: www.geosciencebc.com/s/Report2016-07.asp

Geothermics, November 2016



The Table of Contents for Geothermics Volume 64 follows:

"Improving the temperature predictions of subsurface thermal models by using high-quality input data. Part 2: A case study from the Danish-German border region", by S. Fuchs and N. Balling, pp. 1-14.

"Compositions of hydrothermal silicates and carbonates as indicators of physicochemical conditions in the Reykjanes geothermal system, Iceland", by R.B. Libbey and A.E. Williams-Jones, pp. 15-27.

"A simple model of gravitationally-driven water flow in a semicircular aquifer to estimate geothermal power potential: Examples from Arizona and Colorado", by P. Morgan, pp. 28-41.

"Improving the temperature predictions of subsurface thermal models by using high-quality input data. Part 1: Uncertainty analysis of the thermal-conductivity parameterization", by S. Fuchs and N. Balling, pp. 42-54.

"Keeping inventory of carbon dioxide in liquid dominated geothermal reservoirs", by F.B. Hosgor et al., pp. 55-60.

"Lithogeochemical approaches in geothermal system characterization: An application to the Reykjanes geothermal field, Iceland", by R.B. Libbey and A.E. Williams-Jones, pp. 61-80.

"A semi-analytical correlation of thermal-hydraulic-mechanical behavior of fractures and its application to modeling reservoir scale cold water injection problems in enhanced geothermal reservoirs", by S. Wang et al., pp. 81-95.

"Turkish geothermal fields as natural analogues of CO^2 storage sites: Gas geochemistry and implications for CO^2 trapping mechanisms", by N. Güleç and D.R. Hilton, pp. 96-110.

"Geothermal power plants with maximized specific power output: Optimal working fluid and operating conditions of subcritical and transcritical Organic Rankine Cycles", by N. Chagnon-Lessard et al., pp. 111-124.

"Mapping lithology and hydrothermal alteration in geothermal systems using portable X-ray fluorescence (pXRF): A case study from the Tauhara geothermal system, Taupo Volcanic Zone", by K. Mauriohooho et al., pp. 125-134.

"Numerical modelling of thermal convection in the Luttelgeest carbonate platform, the Netherlands", by L. Lipsey et al., pp. 135-151.

"Free thermal convection in heterogeneous porous media", by V.T. Nguyen et al., pp. 152-162.

"Mechanical behaviour of the Rotokawa Andesites (New Zealand): Insight into permeability evolution and stress-induced behaviour in an actively utilised geothermal reservoir", by P.A. Siratovich et al., pp. 163-179.

"Amides as thermo-sensitive tracers for investigating the thermal state of geothermal reservoirs", by M. Schaffer et al., pp. 180-186.

"Improvement of calculating formulas for volumetric resource assessment", by S.Takahashi and S.Yoshida, pp. 187-195.

Publications, Websites, Videos & Maps

"Modeling the impact of temperature on the saturation state and behavior of minerals in the Soultz-sous-Forêts geothermal system", by V.V. Ngo et al., pp. 196-208.

"The influence of facies heterogeneity on the doublet performance in low-enthalpy geothermal sedimentary reservoirs", by R.A. Crooijmans et al., pp. 209-219.

"Modelling viscous fingering during reinjection in geothermal reservoirs", by A. Mcdowel et al., pp. 220-234.

"Geothermal implications for fracture-filling hydrothermal precipitation", by L. Griffiths et al., pp. 235-245.

"Experimental study of static and dynamic interactions between supercritical CO^2/water and Australian granites", by C. Zhou et al., pp. 246-261.

"Changes in aerial thermal infrared signature over the Rotorua Geothermal Field, New Zealand: 1990–2014", by R. Reeves and L. Rae, pp. 262-270.

"Risk assessment of the Groningen geothermal potential: From seismic to reservoir uncertainty using a discrete parameter analysis", by A. Daniilidis et al., pp. 271-288.

"Extracting past atmospheric warming and urban heating effects from borehole temperature profiles", by P. Bayeret et al., pp. 289-299.

"Assessment of complex well architecture performance for geothermal exploitation of the Paris basin: A modeling and economic analysis", by V. Hamm et al., pp. 300-313.

"Stable isotopes (d13CDIC, dD, d18O) and geochemical characteristics of geothermal springs of Ladakh and Himachal (India): Evidence for CO^2 discharge in northwest Himalaya", by S.K. Tiwari et al., pp. 314-330.

"CO^2 injection for heat extraction and carbon sequestration in a geothermal site: Huizhou Sag, the Pearl River Mouth Basin", by Z. Sun et al., pp. 331-343.

"Coastal thermal springs in a foreland setting: The Santa Cesarea Terme system (Italy)", by F. Santaloia et al., pp. 344-361.

"A hybrid discrete/finite element modeling study of complex hydraulic fracture development for enhanced geothermal systems (EGS) in granitic basements", by H. Hofmann et al. pp. 362-381.

"Uncertainty analysis of geothermal well drilling and completion costs", by M.Z. Lukawski et al., pp. 382-391.

"Life cycle assessment of Organic Rankine Cycles for geothermal power generation considering low-GWP working fluids", by F. Heberle et al., pp. 392-400.

"Numerical modelling of Pohutu geyser, Rotorua, New Zealand", by N. Saptadji et al., pp. 401-409.

"The Borinquen geothermal system (Cañas Dulces caldera, Costa Rica)", by F. Molina and J. Martí, pp. 410-425.

"Direct utilization status and power generation potential of low-medium temperature hydrothermal geothermal resources in Tianjin, China: A review", by Q. An et al., pp. 426-438.

"GPR investigation of the near-surface geology in a geothermal river valley using contemporary data decomposition techniques with forward simulation modeling", by C-S. Chen and Y. Jeng, pp. 439-454.

"Thermal breakthrough calculations to optimize design of a multiple-stage Enhanced Geothermal System", by T. Li et al., pp. 455-465.

"Geochemical and isotopic characteristics of structurally controlled geothermal and mineral waters of Mugla (SW Turkey)", by Ö. Avsar et al., pp. 466-481.

"Geothermal wellbore heat transmission: Stabilization times for 'static' and 'transient' wellbore temperature profiles", by A. Satman and O.I. Tureyen, pp. 482-489.

"Unravelling the relative contributions of climate change and ground disturbance to subsurface temperature perturbations: Case studies from Tyneside, UK", by R. Westaway and P.L. Younger, pp. 490-515.

"Exploring the shallow geothermal fluid reservoir of Fang geothermal system, Thailand via a 3-D magnetotelluric survey", by P. Amatyakul et al., pp. 516-526.

"Three-dimensional geo-electrical structure in Juncalito geothermal prospect, northern Chile", by K. García and D. Díaz, pp. 527-537.

"Reference data sets for validating and analyzing GSHP systems based on an eleven-year operation period", by F. Ruiz-Calvo et al., pp. 538-550.

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Through affiliation with the **International Geothermal Association (IGA)** the GRC offers a discount to the professional journal *Geothermics*, which publishes articles on the theory, exploration techniques and all aspects of utilizing geothermal resources.

Members can contact the publisher Elsevier at JournalsCustomerServiceEMEA@elsevier.com in order to subscribe to the journal. Upon request Elsevier will send a *proforma* invoice to the member e-mail ID.

Members can make their payment via bank transfer, fax their card details or call Elsevier with the information provided in their invoice.

The discounted price details for IGA/GRC members is $285. ■

In Memoriam

Dr. M. Lee Allison (1948–2016)

GRC Member Dr. M. Lee Allison, Arizona State Geologist and Director of the Arizona Geological Survey, passed away August 16th after suffering a critical head injury from a fall at his home.

Lee Allison was appointed State Geologist and Director of the Arizona Geological Survey in December, 2005. Previously, he served as State Geologist in Utah (1989-1999) and Kansas (1999-2004). During 2004-2005, he was Policy Advisor for Science and Energy to Governor Kathleen Sebelius of Kansas, and chaired the Kansas Energy Council from its inception in 2002 to 2005. He helped to marshal the energy and resources of 48 state surveys to build the National Geothermal Data System and steered the development of the US Geoscience Information Network.

He held BA (University of California, Riverside), MS (San Diego State University), and PhD (University of Massachusetts, Amherst) degrees in geology. He was active in science policy and public policy, especially related to natural resources, geologic hazards, and public engagement. He had extensive experience in petroleum and geothermal exploration throughout the U.S. (*Arizona Geological Survey*)

Alan Bailey (1961-2016)

GRC Member Alan Bailey passed away in Reno on August 12th. He ran Bailey Consulting in Reno, Nevada and worked for the Geothermal Resource Group.

He was born July 13, 1961 in Emporia, Kansas, the son of George Ralph Bailey and Janet Commeree Bailey. He graduated from Emporia High School and the University of Kansas.

Alan worked internationally as a geothermal engineer, designing geothermal wells to provide alternative energy sources in such varied places as Turkey, Chile, Djibouti, Mexico, and throughout the western US and Hawaii.

He developed a world-wide reputation as the "go-to" guy for geothermal project design and was also proud of his reputation as "the Red Adair of blown geothermal wells". A musician, a storyteller, a good friend and a kind man, he will be missed by those who knew him and loved him throughout the world. (*Emporia Gazette*) ■
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GRC New Members

New Members of the Geothermal Resources Council

The 2016 edition of the GRC *Membership Roster and Registry of Geothermal Services and Equipment* has been sent to all GRC members.

The "Phone Book" for the world geothermal industry, the *GRC Membership Roster* provides contact information for more than 1,000 corporate and individual members of the GRC in cross-referenced lists for speedy access. In addition, this premier publication offers contact information for additional geothermal associations and a number of federal and state geothermal offices. This valuable publication is also available to non-members for a low price of $25. More information on ordering at: www.geothermal.org/roster.html

The following have recently joined the global community of the GRC and are not listed in the *GRC Membership Roster*:

Arias, David	USA
Carroll-Bradd, Randy	USA
Colwell, Rod	USA
Easley, Elisabeth	USA
Gunnarsson, Arni	Iceland
Mendoza, John Paul	Philippines
Lara Gomez, Daniel	Colombia
Leighty, Bill	USA
Limesand, Rylan	USA
Osvald, Karl	USA
Sullivan, Josiah	USA
Warren, Michael	USA

Contact information for these and all other GRC Members can be found in the online GRC Member Database at http://my.geothermal.org (access for Members only).

More information on Membership of the GRC can be found online at: www.geothermal.org/membership.html ■

Calendar of Events

International Conference on Geo-Mechanics, Geo-Energy and Geo-Resources (IC3G 2016)
28-29 September, Melbourne, Australia
www.ic3g.com/

V Polish Geothermal Congress
11-14 October, Mszczonów, Poland
www.globenergia.pl/kongresgeotermalny

California Geothermal Energy Forum
20 October, Sacramento, California, USA
https://geothermal.org/forum.html

GRC Annual Meeting & GEA GEOEXPO+
23-26 October, Sacramento, California, USA
www.geothermal.org/meet-new.html

38th New Zealand Geothermal Workshop
23-25 November, Auckland, New Zealand
www.geothermalworkshop.co.nz

Der Geothermie Kongress (DGK 2015) - German Geothermal Congress
29 November - 1 December, Essen, Germany
www.geothermie.de/aktuelles/der-geothermiekongress-2015/impressionen.html

16th World Renewable Energy Congress
3-8 December, Bahrain
www.wrenuk.co.uk

4th Expo Geothermal
12-14 January, 2017, Istanbul, Turkey
www.powernextfair.com

Stanford Geothermal Workshop
13-14 February, 2017, Stanford, California, USA
https://pangea.stanford.edu/researchgroups/geothermal/stanford-geothermal-workshop

International Geothermal Association (IGA) Annual General Meeting
31 October, Addis Ababa, Ethiopia
www.geothermal-energy.org

6th African Rift Geothermal Conference (ARGeo-C6)
2-4 November, Addis Ababa, Ethiopia
http://theargeo.org/C6/

11th Asian Geothermal Symposium
17-20 November, Chiang Mai, Thailand
www.aist.go.jp/fukushima/en/AGS11/index.html

15th World Renewable Energy Congress (WREC) 2016
19-23 November, Jakarta, Indonesia
www.wrec2016indonesia.com/

GeoTHERM - Expo & Congress
15-16 February, 2017, Offenburg, Germany
www.geotherm-germany.com

GRC Annual Meeting & Expo
1-4 October 2017, Salt Lake City, Utah, USA
www.geothermal.org/meet-new.html ■

This Just In...

Late breaking news from the global geothermal community

by Ian Crawford, GRC Director of Communications

Department of Interior Approves Phase 1 of Desert Renewable Energy Conservation Plan

U.S. Secretary of the Interior **Sally Jewell** has announced **approval of Phase I of the Desert Renewable Energy Conservation Plan (DRECP)**, an innovative, landscape-level renewable energy and conservation planning effort covering 10.8 million acres of public lands managed by the **Bureau of Land Management** in the California desert.

The plan designates **Development Focus Areas** with high-quality solar, wind and **geothermal energy potential** and access to transmission, sited in low conflict areas. Applications in these areas will benefit from a **streamlined permitting process**, predictable survey requirements, and simplified mitigation measures.

The federal plan for these 10.8 million acres of public lands is detailed in the BLM's *Record of Decision and Land Use Plan Amendment*. To view these documents as well as additional DRECP information, visit www.drecp.org or www.blm.gov/ca/drecp

BLM Issues Permit for 25 MW Idaho Geothermal Project

The U.S. **Bureau of Land Management (BLM)** has issued a permit to **Walker Ranch Energy** for a **25 MW geothermal energy project** near **Malta, Idaho.**

The Walker Ranch Energy project will build **a binary geothermal plant** exploiting a medium enthalpy geothermal source (140°C, 285°F) for an installed capacity of **25 MWe. Agua Caliente LLC**, a company majority owned by **AMG National Trust Bank**, is the main project sponsor.

The Walker Ranch geothermal power plant will be a close neighbor to U.S. Geothermal Inc.'s **Raft River Energy project.**

Production Well and Two Injection Wells Completed at Te Ahi O Maui Geothermal Project

Drilling of the production well and two injection wells has been completed at the **Te Ahi O Maui geothermal project,** near **Kawerau** on the North Island of **New Zealand**.

Project manager, **Ben Gibson**, said the drilling process targeted known sources of geothermal fluid, which could be as hot as 200-300°C, he said.

The project focus now shifts to the construction of the power plant, transmission line and steamfield. **The new plant is planned to be operational in 2018.**

OPIC Approves Financing for 35 MW Platanares Geothermal Project

The Board of Directors of the **Overseas Private Investment Corporation (OPIC)**, the U.S. Government's development finance institution, has approved support for a geothermal energy project in **Honduras**.

OPIC approved up to USD 135 million in financing to **Geotérmica Platanares**, S.A, sponsored by Reno, Nevada-based **Ormat Technologies, Inc.**, for the development, construction, and operation of a **35 MW** geothermal baseload power plant in **Western Honduras**.

U.S. and China Formally Join the Paris Global Climate Agreement

BBC News reports that the **U.S. and China** - together responsible for 40 percent of the world's carbon emissions - have both **formally joined the Paris global climate agreement.**

CO^2 emissions are the driving force behind climate change. Last December, countries agreed to cut emissions in a bid to keep the global average rise in temperatures below 2°C.

The Paris deal is the world's first comprehensive climate agreement. **It will only come into force legally after it is ratified by at least 55 countries**, which between them produce 55 percent of global carbon emissions.

This is a big step towards turning the Paris climate agreement into reality. This will put pressure on other G20 nations to move faster with their pledge to **phase out subsidies to fossil fuels**. ■

GRC Annual Meeting & GEA Expo

The official GRC Annual Meeting & GEA Expo application is available for download to iOS and Android devices. This app has everything you need to navigate your way through the upcoming event! Install it to have full access to the detailed guide and social functionality.

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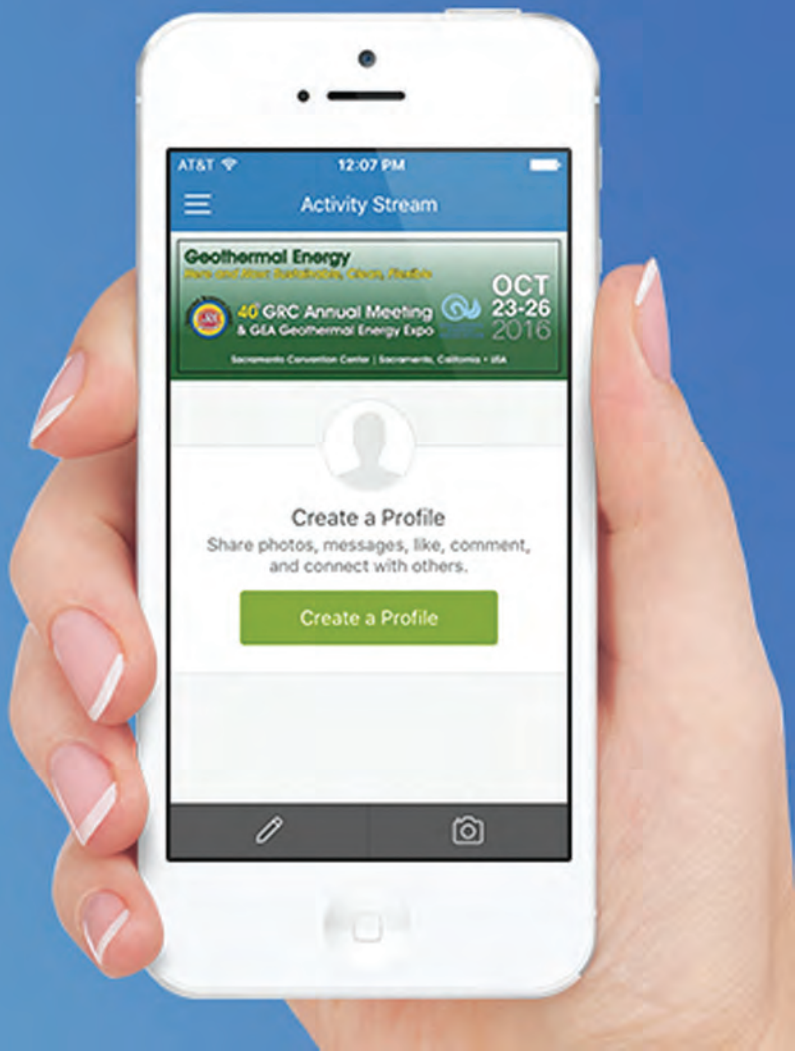


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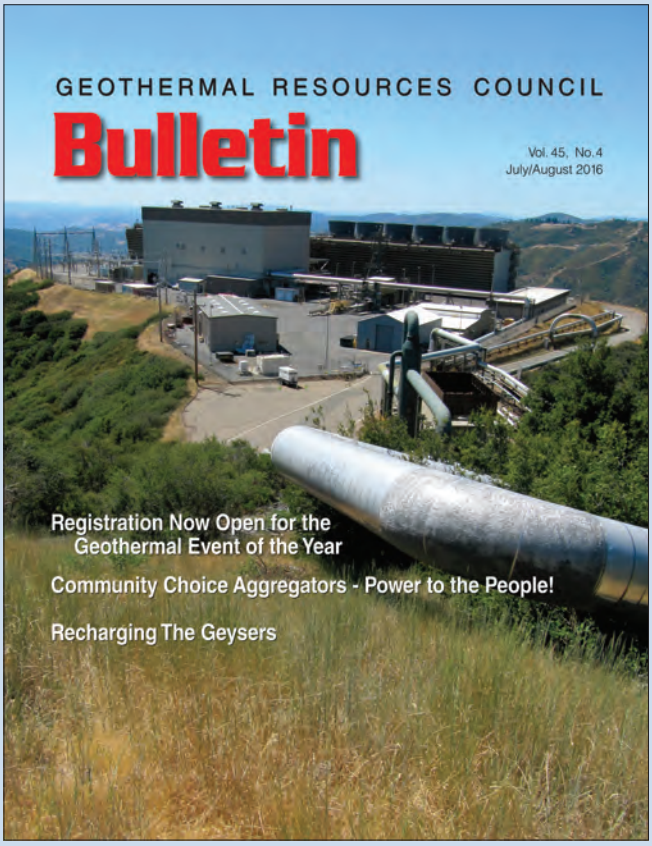

The GRC Bulletin

The premier geothermal energy magazine

The Geothermal Resources Council *(GRC) Bulletin* is a periodic publication (6 issues per year) that reaches the association's worldwide membership and paid subscribers. Current circulation is 1,200.

The GRC *Bulletin* provides a technology and issues forum for professionals involved in geothermal resource research, exploration, development and utilization. The GRC *Bulletin* also provides news and information that highlights the environmental and economic benefits of geothermal resource development.

Keep up-to-date with news from the global geothermal community by becoming a member of the GRC and receive your GRC *Bulletin* free, or subscribe for six issues a year.

Annual Subscription rates are:

Domestic - $90

International - $140 (includes additional cost to cover postage)

Back issues are available for $10 per issue.

THE BEST OF SACRAMENTO

> Farm-to-Fork Capital
No major city in America is more centrally located amid such a diverse range of high-quality farms, ranches and vineyards. 70 percent of the region's land is agricultural, forest or other open space. Additionally, the region contains 7,000 to 8,000 acres of boutique farms and provides numerous public sales platforms at more than 50 regional farmers markets, many of which are year-round fixtures. In September, a weeklong culinary festival will make its debut bringing together the regional restaurant and farming communities.

> Old Sacramento Historic District
28-acre historic riverfront district with more than 125 boutique shops, restaurants and attractions

> California State Railroad Museum
North America's most popular railroad museum features 21 restored locomotives and railroad cars.

> Crocker Art Museum
A 125,000 sq. ft., $100 million expansion is the new jewel of Sacramento. The Crocker displays Californian, European and Asian works of art.

> California State Capitol, Museum and Grounds
The museum features changing exhibits and historical rooms that offer a view of California's political past; the rest of the building acts as a living museum.

> The California Museum
The home of the California Hall of Fame is a cultural destination dedicated to telling the rich history of California and its unique influence on the world of ideas, art and culture.

> Outdoor Recreation:
23-mile American River Parkway is a biking/walking trail surrounded by natural protected habitats, scenic bridges, acres of parks, fishing spots, kayaking and tubing areas. White water rapids of every class are just minutes from Sacramento, and white water rafting companies 'deposit' you right into the parkway.

> Northern California's Other Wine Country
The region is home to one of California's oldest wine-producing areas. Over 200 wineries in the region and most offer free tastings and intimate access to the winemaking process and the winemakers. Visit **sacramentowineguide.com**

> Urban Sacramento
Cool without the pretention – that's Downtown and Midtown Sacramento where the city's main theaters, art galleries and cultural venues are found, plus boutique shops and entertainment venues.

> Dining & Nightlife
Surrounding farmers and growers keep Sacramento restaurants serving up the freshest ingredients via creative and unbelievable menus. After dinner, take a walk Downtown where you'll find mermaids and mermen, wine bars, dancing and mechanical bulls. Seriously.

> The Delta
Popular boating and recreation area features thousands of miles of navigable waterways and is home to hundreds of species of birds, fish and other wildlife.

> Gold Country
Famous Hwy 49 lies only 45 minutes outside of Sacramento, taking you to picturesque Gold Rush-era towns and cities. Today, many celebrate their heritage of both gold and agriculture while showcasing their modern era, with wineries, shopping areas and restaurants serving local foods.

SACRAMENTO 365 .COM

What's Happening in Sacramento
Visit Sacramento365.com the year-round source for Sacramento events.

HOW TO GET TO SACRAMENTO:

Car	Highways 5, 99 and 80
Plane	Direct flights into Sacramento International Airport
Amtrak	Capital Corridor, San Joaquin, Coast Starlight, California Zephyr
Boat	San Francisco Bay up through the Delta

For More Information
Sacramento Convention & Visitors Bureau
1608 I St., Sacramento, CA 95814
800-292-2334
www.visitsacramento.com

Old Sacramento Visitors Center
1002 Second St., Sacramento, CA 95814
Open daily 10 a.m. – 5 p.m.
916-442-7644

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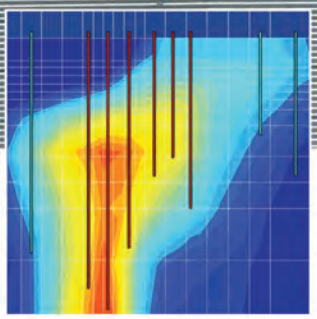

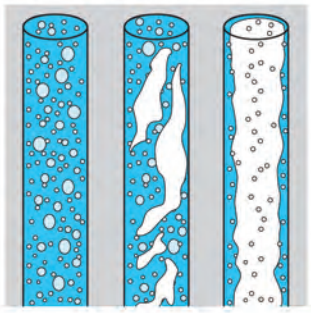

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