Renewable Energy Magazine

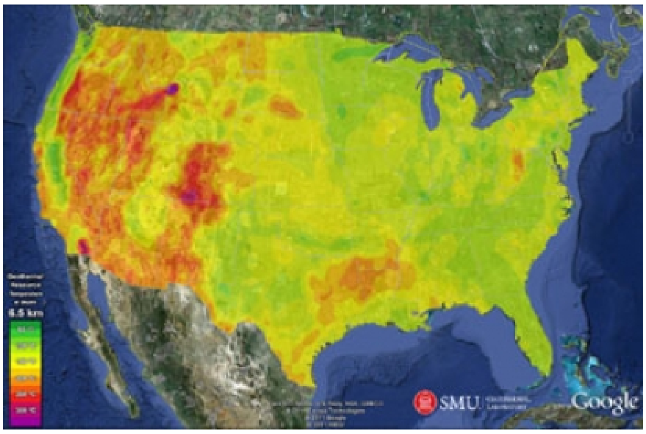
interviews

Inside the Google-backed geothermal mapping project that's likely to broaden the sector’s reach in the US

Monday, 07 November 2011

Dan McCue

When Southern Methodist University’s Geothermal Laboratory released its latest map showing the renewable energy potential locked beneath the United States, most of the publicity the October announcement received revolved around Google, and the support the internet search engine giant’s philanthropic arm gave the three-year project.



But beneath the banner headlines and opening graphs, lay a much more interesting story. For decades now, SMU has been the epicenter of geothermal research in the US, and even to these seasoned researchers, the findings depicted in the map –aided by access to a wealth of new data and statistics – proved a real eye-opener.

What the map shows is that there are enough recoverable resources in the ground under the US – much of it in existing oil and gas fields – to equal 10 times the amount of coal in use across the nation today.

The project also was more than a philanthropic undertaking for Google, with two Googlers, Dan Reicher, a well-known energy expert who has since moved on to Stanford University, and Charles Baron, the company’s geothermal project lead, who is now at Harvard Business School, became equal partners to the Dallas-based scientists, championing a project that takes geothermal analysis in the US further than it’s ever gone before.

“Our partners at the SMU Geothermal Lab recently conducted a new study on the potential for EGS in the continental US, incorporating tens of thousands of new thermal data points to create the most data rich maps of U.S. geothermal resources to date,” Google wrote on its blog. “The results are compliant with the new global geothermal mapping protocol, which is now recognized by the International Energy Agency and the International Geothermal Association. The project estimates that Technical Potential for the continental U.S. exceeds 2,980,295 megawatts using Enhanced Geothermal Systems (EGS) and other advanced geothermal technologies such as Low Temperature Hydrothermal."

On Monday morning, Renewable Energy Magazine caught up with Maria Richards, staff researcher and coordinator of the SMU Geothermal Laboratory, to talk about the project and the sector as a whole.

In addition to her work on the new map, Richards' research includes the resource assessment for the MIT Report on the Future of Geothermal Energy, the Temperature-at-depth maps on Google.org/EGS, eastern Texas geothermal resources and the use of oil and gas wells for geothermal development.

You guys have been working in the geothermal realm for decades now, but for those who might nonetheless be unfamiliar with your work, could you describe what the SMU Geothermal Lab does and why you do it where you do?

[Laughs] We are all here because Dave is the best of the best. David D. Blackwell [W.B. Hamilton Professor of Geophysics at SMU] is one of the top heat flow researchers in the world, and he's also one of the researchers who worked with Francis Birch at Harvard University, and really, that was the beginning of the field in some respects.

The geothermal lab coalesced around David?

Yes, very much so. He's actually serving as keynote speaker today at a symposium on geothermal energy production in sedimentary basins being hosted by the National Science Foundation in Salt Lake City, Utah.

How many of these geothermal maps of the United States have you done?

There was one that was published in 1992, and then one in 2004… and then this one. The original impetus behind the creation of the map was a project called DNAG, the Decade of North American Geology, an effort promulgated by the Geological Society of America.

They put out a series of maps where they looked at heat flow, magnetism, gravity… there was one depicting basic geology. Really, they looked at all aspects of geology. And Dave was asked to coordinate the heat flow, or geothermal, map.

Was this done for the sake of finding renewable energy resources?

No, at that time it was truly for the sake of research.

Does most of your research still kind of reside in that research-centric area, or has it morphed over time to be more concerned with renewable energy?

I think it has definitely moved from being pure research to looking for energy that we can tap into, and I say that because it was Google, not the government, that paid for the last version of this map. That's an example of a company looking to understand the resources better – above and beyond the philanthropic aspect of it.

That makes sense given how energy-intensive Google's data centre operations are; as I understand it, that was one reason you not only updated the map, but really looked at a lot of data that you hadn't factored into the creation of the earlier maps…

The new map, as you correctly stated, is a mixture of old data that weren't included in the original maps because they had either just been missed [in the past], or because the computing power wasn't available…

And when I say missed, what I mean is it was data that was out there, but back in the 1980s, if there was some small group that was working on an area and you didn't realized they published it, you didn't have it. There was no Google out there to find all the publications that are available as we can today.

But also, the other thing that we did for this map was we really began to bring in the oil and gas data, which are their bottom-hole temperature data, and by using that, along with new thermal conductivity estimates, we have calculated heat flow in much more detail.

It might be important to point out here that "geothermal map" is what we call this research product for the lay person, but "heat flow" is what the scientific community calls it. What's happening is heat is moving through the Earth and heating up rocks and water and things like that, whereas, geothermal is more descriptive of what happens at the surface. At the surface we generate geothermal energy using the heat flowing through the Earth.

So instead of depicting what I might have thought of as pools of heat, what you are really talking about are rivers of heat…

Um… yes. In some respects. Because if you think about it, the fault zones are often what are being tapped into – especially in the western United States. The heat flow in that area is fault driven because the faults allow the water to flow up them and go from really deep in the ground to a shallower position, which makes it more viable for drilling.

Also bear in mind that you need a lot of fluid, so the faults are where that fluid is being directed upwards.

But there are other places, even in sedimentary basins, where you have structures that are -- I'm thinking up in [the state of] Wyoming at the RMOTC (Rocky Mountain Oilfield Testing Center) site – that's where you have a formation that starts out deep and then the sediment layer starts to shallow, so it gets closer to the surface. It's basically angled from deep on one side to shallow on the other. And the fact that it trends that way allows for the heat to be transferred closer to the surface and then it can be tapped into more easily.

We are also finding areas where it is hotter than we expected, and so now the goal is to find where there are … like you were saying, almost like a river, these zones of higher temperature, and see if there is a mechanism, such as a fault, bringing it closer to the surface and in the process, making it more economically viable.

It's funny to hear your speak of faults as being beneficial; I think most of us outside your trade think of them as fairly dangerous and the cause of great calamities like some of the historic earthquakes we've seen in San Francisco and other places out west…

In the world of geothermal, they [faults] are really good. We love faults. [laughs] You know, we have this big controversy as well that tapping geothermal energy could generate earthquakes. Oil and gas wells generate earthquakes also and no one really complains about that.

Geothermal is a controlled experiment. You know, it's like that now-infamous case in Basel, Switzerland that everybody talks about. The people doing the project drilled down about three miles (4.8 kilometres) and are blamed for setting off a 3.4 magnitude earthquake, shaking the town and shutting down the operation.

In that case, they overdid it. They didn't follow the experiment like they were supposed to, but when you think about it… that's the first real problem that we've heard about in 50 years of drilling. In all the years we've been drilling, that's the only time when it just went wrong. So that's a very good record.

We're speaking on a Monday morning. Just this past weekend, the state of Oklahoma experienced a series of about 10 earthquakes. That's oil country. Were those drilling related?

I don't know. That was actually my first question – I wonder if there's any drilling for oil or natural gas up in that area? There was also just an earthquake in the San Antonio area about three weeks ago and that was right over an oil field, but don't know if was related.

That's so interesting. I never knew this happened…

It's not the pulling up of the fluids, it is the re-injecting of fluids… they are pushing in the water… but let's not get ahead of ourselves. There are over a million wells in Texas alone, and out of that number, somewhere around – I can't give you an exact number, but somewhere around five wells in 40 years actually generated an earthquake. It's such a small percentage. And it is not like they are damaging earthquakes, knocking down huge buildings or tearing up roads.

And that's another problem, people hear the word earthquake and immediately think, "Oh my, the San Andreas fault – highways are going to crumble and things like that." The reality is far from that.

I like to use the analogy of sugar. We all need to have some sugar in our blood to make our bodies work. That's why when you give blood they give you orange juice and candies to help rebuild your blood cells, but you don't want to eat too much sugar because that's not good for you and you could develop diabetes.

In the case of earthquakes, you need some movement. The Earth has stress, naturally. Every single day there are approximately 1,000 earthquakes that will occur, and they aren't even mentioned because they are of such a low magnitude and happen all the time in certain places. The Earth needs to have earthquakes just to readjust itself because it is moving all the time. But you don't want the big earthquake, the diabetes.

Did this map identify any new areas as being very promising for geothermal or reveal that some known places were even better than previously thought?

One of them is the Raton basin in Southeastern Colorado and northeastern New Mexico. Southeastern Colorado has a really high temperature sedimentary basin.

And what it did was, for instance, if you look at the state of Michigan, previously Michigan was a completely green state with no differential coloring, whereas now it has a variety of different levels, and what we've found is that there are areas of higher temperature than we ever realized. By having all of these different data points, you can see a lot more of what's happening in the ground and the way different formations are working.

But it's also interesting on a very small scale. There was a site in eastern Ohio that looked like a gridding remnant and originally we didn't believe it, and then when we started to look at what the underlying rocks were, we realized, "Oh, there is gabbro down there." Places like that can be highlighted when you have additional data points. Even when you have data that isn't obviously hot but is giving you an unusual reading, you can dig deeper and say, "Yes, that reading makes sense" or "No, it doesn't."

The obvious question is, what will Google do with this data, but let me broaden it and ask, if I'm a developer or someone interesting in tapping this resource… how do I use this new map?

This map shows you areas to start focusing on. It doesn't say, "drill here"; it says, "research here." And from our perspective, you've got to put something out there for the community to dig into. By having this map out there with so much new information on a state and even local basis, the goal is to give people a chance to say, "Hey, I want to develop geothermal and I live in Nebraska. Well, where would I want to start looking," and from there you can go to the map and see that there are hotter zones and cooler zones. By having the temperature-at-depth maps on Google.org/EGS gives everyone the chance to see what the temperatures are right below their feet.

When I think of geothermal in the US, I think of the west; what is the actual distribution of geothermal resources in the US?

Well, when you look at the map, there's little doubt that the redder or warmer colors are mainly in the western US – the exception being along the Gulf Coast, [the southern states and Texas, which line the Gulf of Mexico]. The Gulf Coast geopressure zone is, without question, a high temperature area that has a lot of potential. And West Virginia is an area that has a lot of potential. But the idea is that if there is a concentrated community where you need electricity, and depending on the cost of electricity, you can generate geothermal pretty much anywhere – and that's part of the reason for this map. It points out that there are places where geothermal energy is easier to get to, but that doesn't mean that they are the only places that you can tap into geothermal energy. After all, you're just drilling into the ground and pulling up the heat.

There's also the issue of -- once you've got a renewable resource that you're tapping, whether it be geothermal, wind, solar or what have you –connecting that resource to the grid. Does this map have a built-in overlay of grid connectivity?

This is truly a resource map, and since we are the geology department, we have not done that; but obviously, an electric grid map already exists out there and I think companies like ESRI have them. I don't know if Google includes them as a layer, but I know those maps do exist.

But that's part of it as well. If you are close to a grid and you have a demand for the heat, the geothermal energy, you can spend more money on drilling the wells and less money on building the transmission lines, trying to get the energy form the middle of nowhere to the center of a city. This helps open up the east coast of the US.

Now that you've done the map, what's the next step?

Well, I was just in the other room working with the students on just that; part of it is to disseminate the information so that more users can be working with it and using it, because as that happens, obviously you'll have people looking at it from different perspectives and angles and with different ways of manipulating the data – and that's a good thing.

And then, really the next step is to work at a more local level and to find specific sites that are zones or areas of interest. That's how the Raton basin that I just mentioned showed up. It started off being an area of interest, and then the students, specifically graduate student Ryan Dingwall, said, "I'll do some more work on this," and did some more research. He worked with people from Pioneer Natural Resources and the Colorado Geological Survey, who were already working on this area. In doing so, we can help define how much heat really is in an area. So that's what's next –taking what it shows us and digging deeper.

You know, as you were talking something you said brought me back to the new data set, specifically the bottom-hole temperature data you got from the oil and gas industry. Can old wells be converted to use as geothermal wells?

Yes! In fact, that's my research area. For the past five years I've been specifically looking at the conversion of an oil and gas field to geothermal energy. You have all of these wells already drilled. You're upfront cost of exploration is already hugely decreased, but you've already explored for the siting of the oil and gas well, so it's just really a case of understanding the best methodologies of conversion. Do you go back in and retro-fit the well? Pull from the zones where the water is? Is it better to go back in and drill a wider well that's designed specifically for geothermal?

Here's a situation where up to 60 percent of oil and gas can be left in the ground because it gets too expensive to pull it out due to water coming in… so, let's keep pulling out oil and gas and let's pull out the water with it and generate a renewable energy.

I've been focusing more on Texas resources and working with companies, and now the US Department of Energy has a program looking at sedimentary basins – it's considered low-temperature geothermal because oil and gas wells tend to be in the 200 degree to 300 degrees F temperature range, but you can find wells that go up quite a bit higher, to 400 degrees F.

I mentioned that Dave is a keynote speaker at an event today and that's because the National Science Foundation is considering funding geothermal research in sedimentary basins, which is where oil and gas is.

And really, this research came out of when we did the 2004 map, the difference between the 1992 and 2004 map, was how much more heat there was in the Gulf Coast than we had previously realized. As we looked at that and realized that Texas was the energy state and that we were shutting down fields – this was before shale gas took off – there were more fields closing than opening… and we thought, well, this is a great opportunity to take those wells and start reusing them.

How huge an undertaking is that?

There are some wells that produce enough fluid and there's some small, binary geothermal equipment, such as ElectraTherm's Green Machine, that can be put at the well head so that the fluid runs directly through the binary technology to produce electricity. This is happening right now in Mississippi. If you want a larger scale system – 1 MW or bigger – you really need to go back in and perforate the zones where water exists.

There are some challenges to scale this – you have to go in and re-perforate the zones, you have to make sure you have casings that are strong enough to hold up to perforating, [etc.] – so there is some retrofitting that has to occur with most wells, but a lot of the reason why it hasn't taken off seems to be the legal aspect of development.

These fields have surface owners, mineral rights owners… the fact that if it's another company coming in to work on a field where part of the field is still producing oil and gas… then you have a mixture of corporate entities on site. Basically, you have an oil and gas field with multiple owners and then, individual wells that have multiple owners. So that part of it seems to be as difficult to deal with as the physical resource itself.

The technology at the surface has come a long way in the past five years. For example, Pratt and Whitney Power Systems has a great binary technology that's ready to go, and they even designed it so that it can be mass produced using a similar platform to their Carrier Air Conditioners. My understanding is that, by using that platform, they were able to design a system that could be maintained by the same people who maintain air conditioners. Pratt and Whitney did an outstanding job of coming up with the technology and other companies have as well.

So what's the future of geothermal, from your perspective?

The people in the geothermal community think that it has more than enough potential to meet the needs of the US energy demand. But we understand that it faces many challenges. If you look at the number of students who are going into the sciences, and then pair it down to those going into geology and geothermal… although, it was exciting for me just recently to be at a geothermal conference and realize during lunch that I was surrounded by young people and I was the oldest person at the table.

I think the geothermal community itself has made the situation more challenging, because originally it was always just focused on the western United States and they weren't trying to branch out. Because of that, they tended to limit themselves, whereas with solar and wind, bio-fuels and biomass, all of those can go almost anywhere; so from the very beginning, advocates for those technologies have had a whole US focus. It's only in the last few years that geothermal folks have begun to look into developing in other parts of the country.

That was one of the great things about Google. They said, "Hey, we have all this information about the western US, let's get some information about the eastern US." And it really did work because as we developed and pulled in more data for the eastern US, we are finding that there are definitely places where you could develop geothermal energy right away.

The thing about geothermal that's so important is it is considered base load, so it can compete with a coal plant because it can run 24 hours a day, and that's what differentiates it from other renewables, which are much more intermittent. Geothermal is truly the one renewable resource that will always be there for us day and night.

For additional information:

Google Blog: A Googol of Heat Beneath Our Feet

SMU Geothermal Lab

TAGS: Geothermal , Oil , Grid , Renewable energy , United States , Wind , Electricity , Solar , Hydro , Fuel , Biomass