Clean Electricity from Geothermal Energy

The problem of what to do with oil and gas wells at the end of their life-cycle is one that increasingly requires attention. With significant 'sunk' costs and no method of reinstatement, wellbores are abandoned after use and fall into disrepair leaving a potential environmental headache.

Current estimates suggest approximately 2.5 million wells sit abandoned in the US, with a global count in the tens of millions. These figures will continue to rise as the wells drilled over the last 20 years reach the end of viable production.

Developing a novel approach, a study by Neil Wight and Dr Nick Bennett at the Institute of Mechanical, Process and Energy Engineering at Heriot-Watt University has identified a potential opportunity from these abandoned wells. This allows them to take on a second life; producing clean electricity using the wellbore structure for its geothermal potential. Crucially this approach operates in a self-contained manner, independent of the surrounding environment and has no requirement for naturally occurring geothermal fluid. Analysing data for 2,500 land wells in Texas, the team evaluated geothermal gradient and the potential for their approach to produce electricity effectively in combination with abandoned wells across various well depths. Net power outputs of between 109 kW and 630 kW were found for systems capable of continuous operation.

Although originally focused on abandoned wells, the approach offers interesting potential for the production of geothermal energy in areas considered to have low geothermal potential in the traditional sense.

Drilling wellbores specifically for the production of energy in this way using existing technical knowhow, equipment and methods from the oil and gas industry – a sector which is a speciality in Scotland – could allow generation to take place in areas with no previous drilling for hydrocarbons or an available resource of wellbores.
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Additionally, up-coming drilling programs could be modified to provide a wellbore offering maximum potential for electricity production at end of life; something of particular use for operators developing wells with short life cycles or those drilling exploration wells. While initially applied to Texas, the average geothermal gradient in the UK is 26 °C per km with local gradients of up to 35 °C per km; meaning the development of such an approach in Scotland could be both possible and practical.

If this approach to geothermal energy sounds interesting, please do get in touch with either Neil (nmw30@hw.ac.uk) or Nick (n.bennett@hw.ac.uk) who will be happy to discuss further, including the straight-forward step of adapting this model for testing and identifying suitable sites in Scotland.

To learn more about the work of Nick Bennett go to http://www.hw.ac.uk/schools/engineering-physical-sciences/staff-directory/nick-bennett.htm

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**Thrive for Energy Club**

Date: Friday 24th April  
Venue: The Scotsman Hotel, Edinburgh  
Start Time: 8am  
Finish Time: 10am  
VIP Speakers:

Brenda Park, Senior Consultant - Solar, AMEC Foster Wheeler  
Mike Hogg, BDM, Clearfleau

Click here for full details of the meeting: http://www.thriveforbusiness.co.uk/networking-event/clearfleau-amec-foster-wheeler

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**The pan-university Energy Academy**

Energy excellence ranges from solar energy and energy-focused materials through to energy economics, use, policy and logistics.

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**EN^RG**

EN^RG is THE European Network for Research in Geo-Energy. Its membership comes from 29 European countries with long experience in basic and applied research and technological activities related to exploration and production of the underground energy sources, CO₂ and natural gas storage within many national and international projects.

In 2014, EN^RG produced a position paper to examine scenarios for the development of ‘energy uses of the underground’ and to “give guidance on new research needed for the integrated and sustainable use of the underground in relation to natural gas (shale gas, coalbed methane, gas hydrates), shale oil, geothermal energy, CO₂ capture and storage, CO₂ capture, utilization and storage, nuclear energy and waste disposal and energy storage, while preserving groundwater.”

The first Chemistry in Energy conference, organised by the Energy Sector of the Royal Society of Chemistry, is being hosted by Heriot-Watt University next July and will bring together scientists and technologists with an interest in the application of chemistry in the energy industry.

The event will cover all aspects of energy-related research, where chemistry and the chemical sciences play a key or underpinning role in solving the UK’s combined energy challenges of carbon emissions, energy costs and security of supply. The scope of the conference will be broad and will include all energy forms and technologies.

For more information:  
http://www.sccs.org.uk/events/1st-chemistry-in-energy-conference

To register:  
http://www.maggichurchouseevents.co.uk/cec/index.htm

Local organizer: Mercedes Maroto-Valer  
(M.Maroto-Valer@hw.ac.uk)

Meet the Energy Academy at All Energy 2015

All Energy http://www.all-energy.co.uk/  is considered the **largest renewables event in the UK** and takes place at the SECC in the renewables hub of Glasgow for the first time on Wednesday 6 and Thursday 7 May 2015.

Heriot-Watt will once again be exhibiting at All Energy. Registration is free and is now open  
https://www.livebuzzreg.co.uk/2015/alle15/?_ga=1.187512360.1638166610.1397049479

To meet with the Energy Academy team, either send an e-mail to energy@hw.ac.uk and arrange to meet us at the Heriot-Watt University stand or if you have registered use the MyEvent facility  
https://www.all-energy.co.uk/en/MyEvent/Website-Sign-Up-login-form/?RetUrl=xSfsSxMyEventsSfsSxWebsite-Sign-Up-view-profilexSfsSx to book a meeting. We look forward to seeing you there!
Experimental Geochemistry Investigation of CO\textsubscript{2} Induced Damage of Wellbore Cement-Rock Systems

Carbon Capture and Storage (CCS) has a key role to play in curbing CO\textsubscript{2} emissions from thermal-power generation and industrial processes alongside renewables, energy efficiency, nuclear and other mitigation options. However, there are still challenges that need to be overcome before CO\textsubscript{2} storage can be deployed to substantially reduce carbon emissions.

The idea behind subsurface storage is that CO\textsubscript{2} could be injected into deep (>800m) suitable geological formations entering the host rock pore space initially occupied by fluids. It’s thought that its fate depends on specific circumstances: for example, injected CO\textsubscript{2} could migrate upwards as a separate phase, due to buoyancy and get physically trapped; alternatively, it could fully dissolved in the in-situ fluids within the rock, leading to changes in pH, redox states and density. These changes could lead to fluid motion, or to in situ precipitations of solid carbon-bearing minerals, along complex process pathways.

When CO\textsubscript{2} is injected into storage sites, it may affect the wellbore cement integrity by altering (weakening) the cement properties, which could potentially lead to CO\textsubscript{2} leakage along the wellbore track. Furthermore, it may be possible that CO\textsubscript{2} injections may develop local stress changes, due to the adding chemical loads to the pre-existing thermo-mechanical loading of the reservoir. This could create new fractures or re-activate pre-existing faults that might be distant from the injection well either within the reservoir or in the overlying sealing cap rocks. Potential CO\textsubscript{2} seepage through fractures, faults and wells could then be a critical issue affecting the long-term security of the store.

Through Fledge Funding from Heriot-Watt’s Energy Academy, Dr Elli-Maria Charalampidou, Dr Susana García, Dr Helen Lewis and Professor Mercedes Maroto-Valer will investigate the impact of CO\textsubscript{2}-induced geochemical reactions on wellbore integrity and the mechanical integrity of cement-carbonate rock systems by looking at the chemical reactions between CO\textsubscript{2} and carbonate rock-cement assemblies and the emerging deformation processes on such assemblies in simulated reservoir conditions. In order to achieve this, two research groups have been brought together by the Energy Academy (EGIS-IPE and EPS-IMPEE) to bring to bear expertise from across Heriot-Watt University.

The research team will develop an experimental system that mimics conditions underground and in bore holes. This will allow the identification of the deformation processes that develop in the carbonate rock and cement assemblies due to the chemical, thermal and mechanical (isotropic) loading. Environmental Scanning Electron Microscopy (ESEM) of high-resolution digital images, covering cross-sections of interest (e.g. rock-cement interfaces), will be used to understand the mineral changes and the deformation features at the micro-scale (grain-pore deformation and micro-fracture creation) in the tested rock-cement assemblies.

The research team will also compare the rock-cement assembly pore networks before and after laboratory deformation using digital image analysis techniques and the use of in-house software based on stochastic modelling aiming also at calculating porosity changes in regions of interest.

If you are interested in subsurface carbon capture and storage or want to understand more about this work, contact Dr Elli-Maria Charalampidou E.Charalampidou@hw.ac.uk, Dr. Susana Garcia S.Garcia@hw.ac.uk, Helen Lewis H.Lewis@hw.ac.uk or Professor Mercedes Maroto-Valer (M.Maroto-Valer@hw.ac.uk)