Annex 2 - Energy Test Bed

Business Case title	**Energy test bed: multicomponent sub-surface monitoring to underpin the UK energy industry**
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Background

Global energy security throughout the next century will continue to depend significantly on fossil fuel and nuclear, whilst unlocking the potential of renewable as well as unconventional sources. The UK government's industrial strategy highlights the importance of continuing support for the oil and gas and nuclear sectors. Furthermore, within the 8 Great Technologies, it is clear that "big data" represents an opportunity for the UK to gain competitive advantage in a range of industry sectors. This proposed test bed will generate data-driven opportunities to address the challenges and opportunities of the energy sector.

We propose an infrastructure to allow the subsurface to be monitored at time scales that are consistent with our use of the subsurface, to increase efficiency and environmental sustainability but also to act as a catalyst to stimulate investment and speed new technology energy options to commercialisation.

It will thus act as a bridge from ideas to application and would attract support and possible co-funding from oil and gas companies, utilities and energy and environment consultancies.

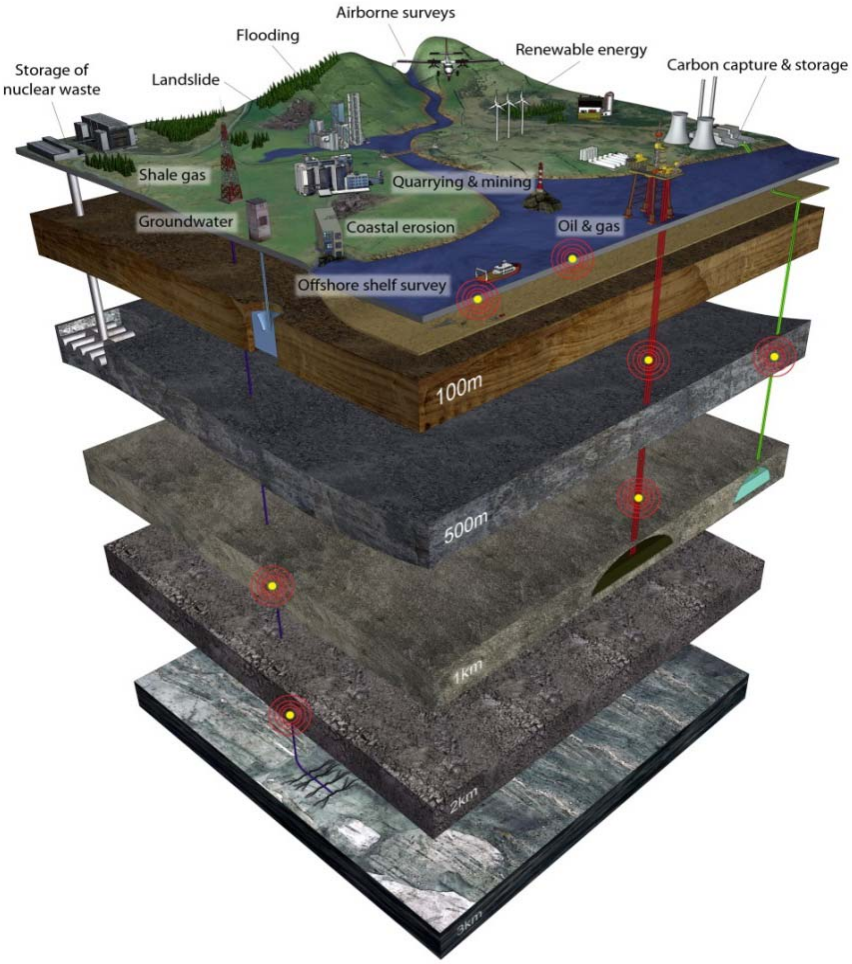
Objectives

Our future use of the subsurface, particularly for energy (subsurface gas storage, compressed air energy storage, shale gas, coal bed methane, underground coal gasification, enhanced oil recovery, geothermal) and waste disposal relating to energy (carbon capture and storage, radwaste) – depends on much greater understanding of subsurface flow and processes. This is particularly pertinent to low-carbon energy as the feasibility of three low carbon energy solutions rely on understanding of subsurface geological containment or flow: carbon capture and storage (CCS), shale gas and radwaste. Lack of understanding and uncertainty feeds through to lack of confidence amongst policy makers and industrial investors, and most of all to lack of public confidence. The latter might be a show stopper for much low carbon technology where subsurface management is needed[5].

[5] See (http://www.newstatesman.com/energy/perspectives-energy/2012/11/are-we-closing-technology-options-low-carbon-future).

An integrated multi-component sub-surface monitoring infrastructure linked with the European Plate Observing System (EPOS) and the European Carbon Capture and Storage Laboratory Infrastructure (ECCSEL) will allow research into:

1. the impact of deep shale gas drilling and hydraulic fracturing on shallow groundwater and surface water, on seismic activity, and on ground stability and subsidence;
2. processes relating to the containment, confinement, and rates of solution and carbonation of subsurface stored CO^2 in carbon capture and storage;
3. processes relating to the containment and confinement of subsurface nuclear and other types of waste; movement of fluids (gas, water, solutes);
4. studies on the impact of coal combustion products on the environment both from surface and subsurface operations (eg underground coal gasification);
5. the role of biological mediation in the subsurface in shallow to deep environments;
6. processes at basin and reservoir scale in reservoir stimulation and enhanced oil recovery (EOR);
7. ground deformation and induced seismicity associated with enhanced geothermal systems in hot-rock-dry-rock environments.



The UK would develop a unique package of monitoring capability where monitoring at the surface and in the critical zone will be coupled with deep borehole monitoring of variables such as pressure, temperature, heat flow, seismicity, tilting, strain accumulation, fluid chemistry, pH and biological properties. Monitoring will also include satellite and remote sensor data such as InSAR (Interferometric synthetic aperture radar) and gravity, electrical, spectral and magnetic data.

Infrastructure that underpins research into subsurface activity will make us better at monitoring and managing these new and continuing activities safely and sustainably. Industry would benefit in being able to access state-of–the–art monitoring data to maximise efficiency of extraction and subsurface management, as well as maximising environmental sustainability. The knowhow and data would also stimulate outside investment and speed new technology energy options to commercialisation, for example compressed air energy storage (CAES) and underground coal gasification (UCG). This would become a competitive advantage in developing British expertise for use in the international energy market.

Outcomes

The research infrastructure will underpin the UK energy industry building on and linking with HEI and industry and existing distributed RIs for example EPOS[6], ECCSEL[7], Seis – UK[8], Big-F GPS[9], and BritGeothermal[10].

The **economic impact** is potentially very large in developing (1) untapped energy resources like shale gas, CBM, UCG, geothermal; (2) methods to sustain fossil fuel reserves e.g. EOR; (3) understanding of storage processes including CCS, gas storage and radioactive waste disposal; and (4) subsurface energy storage such as compressed air energy storage (CAES). Economic value will also stem from management and minimisation of environmental impacts which will protect the environment, ecosystem services, property and infrastructure.

New energy activities are likely to contribute considerably to the economy. Shale gas could create 5,600 jobs in the UK and an 'Aberdeen Effect', in the northwest of England. CCS may generate £3 to 6.5 billion a year by the late 2020s sustaining more than 30,000 jobs by 2030[11]. Coal bed methane and underground coal gasification have been slow to start, despite the country having considerable potential for both[12], but analysis indicates that the global UCG market will reach $570m in 2012[13], with CBM reaching $5.3bn in 2013[14]. Estimates suggest that EOR could enable a further three billion barrels of oil from the North Sea – worth £190 billion[15]. Grid scale storage is the key to unlocking renewables because of the need to store energy in periods of low renewable output. A number of energy storage

[6] The European Plate Observing System (EPOS) is the integrated solid earth sciences research infrastructure (RIs) approved by the European Strategy Forum on Research Infrastructures (ESFRI). EPOS is a long-term integration plan of national existing RIs. The EPOS Preparatory Phase (EPOS PP) is the planning phase of this research infrastructure and e-science for data and observatories on earthquakes, volcanoes, surface dynamics and tectonics.

[7] The ECCSEL consortium teams up selected Centres of Excellence on Carbon Capture and Storage research (CCS) from 10 countries across Europe. The mission is to develop a European distributed, integrated Research Infrastructure (RI), involving the construction and updating of CCS research facilities.

[8] http://www.le.ac.uk/seis-uk/

[9] http://www.bigf.ac.uk/

[10] http://www.bgs.ac.uk/research/energy/geothermal/britGeothermal.html

[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48317/4899-the-ccs-roadmap.pdf

[12] UK COAL RESOURCE FOR NEW EXPLOITATION TECHNOLOGIES 2004. Report No. COAL R271 DTI/Pub URN 04/1879

[13] https://www.asdreports.com/news.asp?pr_id=920

[14] http://www.prnewswire.co.uk/news-releases/coalbed-methane-cbm-market-to-be-worth-53bn-in-2013-says-visiongain-report-206407491.html

[15] http://www.offshoreenergytoday.com/uk-censeor-co2-to-help-unlock-usd-300-bln-worth-of-north-sea-oil/

options require geological understanding, including CAES in salt caverns and thermal storage in subsurface aquifers. The value of grid scale geological energy storage could therefore be considerable.

Greater understanding of subsurface processes, if communicated properly, will also allow better public buy-in to subsurface usage and therefore more efficient, streamlined development.

The **scientific impact** of this new infrastructure will be far reaching, including understanding of subsurface flows, geochemistry and physics of rock matrices, and the interaction of surface carbon and other geochemical cycles and subsurface flows.

The new infrastructure will act as a catalyst for industry both onshore and offshore to stimulate investment and speed new technology options to commercialisation, for example CAES and UCG. It will thus act as a bridge from ideas to application and would attract support and possible co-funding from oil and gas companies, utilities and energy and environment consultancies.

Governance

The proposal involves a suite of activities managed by BGS and HEI partners many of which will be developed with industry and with international partners. Data will be stored and managed at BGS and HEI data centres.

The infrastructure will be distributed in five key regions of Britain with the aim of creating regional-sized subsurface natural laboratories. One per year would be established. Each region would be chosen for its particular energy challenge and subsurface geology type. The full 5 natural laboratories would cover a representative range of geological and energy-related conditions for UK development, and may allow consideration of monitoring methodology abroad. We estimate that each regional subsurface laboratory will require capital and resource totalling £12M (details available). Five will cost £60M and a further £12M will be spent each year across the 5 regions on ongoing monitoring, science/societal deliverables and further targeted investigations.

Further information

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