

Unconventional hydrocarbons in the UK energy system: environmental and socio-economic impacts and processes

Announcement of Opportunity

Issued on 4 September 2017

Notification of intent to submit deadline: 16.00 on 3 November 2017

Full proposals deadline: 16.00 on 30 November 2017

1. Summary

Proposals are invited for a new £8m research programme on unconventional hydrocarbons in the UK energy system: environmental and socio-economic impacts and processes. The programme is jointly supported by the Natural Environment Research Council (NERC) (£6m contribution) and the Economic and Social Research Council (ESRC) (£2m contribution).

The outcome of this research programme will be the provision of an updated independent scientific evidence base to understand potential environmental and socio-economic impacts of unconventional hydrocarbon development.

Research proposals are sought for:

- **Cross-cutting consortium addressing Challenge 1**
 - **Challenge 1: The evolving shale gas landscape**
One multi-institutional consortium bringing together environmental science and social science with support totalling up to £1m (80% FEC) for four years' duration.

- **Discipline specific projects addressing Challenges 2-5**
 - **Challenge 2: Shale resource potential, distribution, composition, mechanical and flow properties**
 - **Challenge 3: Coupled processes from reservoir to surface**
 - **Challenge 4: Contaminant pathways and receptor impacts**
Three multi-institution consortium projects (one project per Challenge 2, 3 and 4) that may include research studentships, with support totalling up to £1.7m each (80% FEC) for up to four years' duration.

 - **Challenge 5: Socio-economic impacts**
£1.5m (80% FEC) is available to fund three to six projects in the social sciences (consortium or single-institution) for up to four years' duration.

The closing date for proposals is 16:00 on 30 November 2017.

Proposals for this call are invited from eligible UK researchers (see [RCUK eligibility for Research Council](#) funding for criteria) and will be subject to standard NERC terms and conditions as the lead council¹.

A town hall meeting will be held on the **4 October 2017** in Birmingham. The purpose of the day will be twofold: a) to provide a forum for discussion of the science challenges and possible approaches to undertaking the research and b) to provide an opportunity to broker potential collaborations and

¹ For full details see [NERC research grants and fellowships handbook](#)

partnerships. The event will also ensure the research community is aware of the NERC National Capability available to support this research where appropriate, including the recently confirmed UK Geoenergy Observatories field site infrastructure.

Those interested in submitting proposals are invited to register to attend the town hall meeting by midday Wednesday 20 September 2017. Please complete the [online form](#) to register interest in attending the meeting. Please note that not everyone who registers may be able to attend the meeting due to the venue size. NERC and ESRC also reserve the right to limit attendance to ensure a balance of institutions and expertise. NERC and ESRC will inform registrants whether they have secured a place at the meeting by 26 September 2017.

Whilst attendance at the meeting is encouraged, it is not a prerequisite for submitting a proposal to this call.

In order to address any matters that may arise at the town hall meeting the funders reserve the right to reissue the AO following the meeting.

2. Background

The UK is committed to implementing a transition to a low carbon energy system, reflected in the 2008 Climate Change Act, which includes both a long-term target for reducing greenhouse gas emissions by 80% between 1990 and 2050 and a commitment for the UK to a series of 5-year carbon budgets informed by advice from the Committee on Climate Change. Furthermore, the Paris Agreement to reduce global CO₂ emissions has been ratified by the UK. Alongside these commitments to emissions reduction, the UK government has emphasised a number of other important policy goals – particularly commitments to maintaining energy security and to ensuring that the low carbon transition is implemented so that it is affordable and feasible for consumers and businesses alike.

A range of energy resources, infrastructures and technologies are likely to be required as part of the UK's transition to a low carbon energy system^{2 3}. Many of these resources are likely to have environmental and socio-economic impacts on a local, regional and national scale. There is, however, significant uncertainty about the mix of resources and technologies that will, and could, be used.

Whilst this transition will involve a shift from fossil fuels to non-fossil sources of energy, it is anticipated that fossil fuels will remain part of the UK's energy mix for several decades. Unconventional extraction of natural gas, in particular from shale, may be one potential source of gas for the UK in future.

There is an active debate currently about whether shale gas exploitation in the UK has the potential to provide a secure supply of domestic natural gas and displace the use of coal in our energy mix. This activity is not without concern. Despite the widespread use of the technology (300,000 fracked wells in the US, 2 million worldwide), the development of unconventional hydrocarbons remains controversial as questions regarding possible groundwater contamination, induced seismicity, air quality and greenhouse gas emissions (among others) remain and require a greater level of independent evidence. Moreover, recent work⁴ has highlighted a number of key interconnected topics where further development of the underpinning science and evidence would assist decision-making around national planning applications, the development of regulation and management of exploratory activities in the UK. There is an urgent need for independent and academically rigorous

² Committee on Climate Change (2015) The fifth carbon budget – The next step towards a low-carbon economy. London, CCC.

³ Ekins, P., I. Keppo, et al. (2013) The UK energy system in 2050: Comparing Low-Carbon, Resilient Scenarios. UKERC Research Report. London, UKERC.

⁴ Reible and Davies 2016. Report on [Joint US-UK Workshop on Improving the Understanding of the Potential Environmental Impacts Associated with Unconventional Hydrocarbons](#)

research into the environmental and socio-economic impacts of unconventional hydrocarbon development in the specific context of the UK⁵.

The focus of this programme is to improve our understanding of the options for unconventional hydrocarbon development, taking a holistic, interdisciplinary approach to understanding the environmental, economic, governance, public/political acceptance and wider societal aspects of this approach on a national level. This programme will thereby contribute to addressing the 'Benefitting from Natural Resources' challenge in the NERC strategy. The programme will make a contribution to our understanding of solutions for managing climate change in the context of energy security, in line with ESRC strategy.

The Research Councils have funded research previously that contributes to the understanding of the environmental and socio-economic impacts of unconventional hydrocarbon development. Proposals to this programme are expected to take into account, and build on previous research, such as that carried out by the UK Energy Research Centre. Successful proposals will be encouraged to engage with such investments. Other research, including that not funded by the Research Councils, should also be taken into account where relevant.

3. Scope of Call

3.1 Programme objectives

The overarching objective of the research programme is to significantly improve the scientific evidence base on shale gas as a potential energy resource for the UK. Therefore, all proposed activities must be demonstrably applicable to the UK energy research landscape.

Programme funding will not be available to support the extraction of unconventional hydrocarbons. Applicants may propose to collaborate with project partners to monitor or observe commercial enterprises undertaking unconventional hydrocarbon extraction in line with any relevant licensing/planning rules and in keeping with any relevant laws.

The call recognises that unconventional hydrocarbon extraction is a complex issue requiring a holistic approach encompassing knowledge from both the environmental and social sciences.

In order to meet the overarching objective NERC and ESRC have identified five challenges:

Challenge 1: The evolving shale gas landscape

One proposal to be funded up to £1m (80% FEC) by Research Councils.

The role of the cross-cutting consortium will be to:

- A. Provide evidence on the current status of the shale gas landscape
- B. Monitor how the shale gas landscape changes and evolves through the programme
- C. Conduct cross programme coordination and synthesis activities

- A. Provide evidence on the current status of the shale gas landscape

An initial activity of the cross-cutting consortium will be to conduct benchmarking of the current landscape to identify the key stakeholders, the key issues, the differing positions of those stakeholder groups and the evidence base that is being used to support their particular positions. Equal emphasis should be placed on the environmental, political, economic and social dimensions. This initial benchmark will provide an essential starting point for the programme, identifying and bringing to the fore the key issues of concern in each of these areas. It is expected that the benchmarking will take

⁵ Whitmarsh, L. et al. 2015. UK public perceptions of shale gas hydraulic fracturing: the role of audience, message and contextual factors on risk perceptions and policy support. *Applied Energy* 160, pp. 419-430. (10.1016/j.apenergy.2015.09.004)

into consideration the broader economic and political context, for example the Industrial Strategy and EU exit. This benchmarking exercise will involve both environmental science and social science members of the team and should produce a report/review as an early output (within first six months of grant start date).

B. Monitor how the shale gas landscape changes and evolves through the programme

In addition to this initial benchmarking, the cross-cutting consortium is expected to continuously monitor and consider the evolution of the shale gas landscape through the lifetime of the programme. This should provide understanding of the landscape in relation to policy and public acceptability as well as highlighting key changes in the relative position of the stakeholders, the dimensions of the wider debate and the evidence base. It is expected that the consortium will consider both the external context and the consequences of the research findings that this programme will deliver.

C. Conduct cross programme coordination and synthesis activities

It is expected that the successful consortium project will play a coordination role, integrating knowledge from across all the funded projects to ensure the programme is greater than the sum of its parts. It is expected that this coordination activity will feed into the rest of the consortium activities around understanding the shale gas landscape. Proposals should clearly demonstrate how the coordination aspect will be managed and delivered.

Applicants to Challenge 1 must demonstrate a fully integrated interdisciplinary approach, bringing together understanding from both the environmental and social sciences to understand the wider issues associated with shale gas extraction, including, but not limited to, the environmental impact, policy, economic feasibility, governance related issues, and ethical and wider societal aspects.

Applicants must outline plans for programme level synthesis activities, which could include combined data analysis of project outputs, synthesising the outputs/data from the consortia and projects into common frameworks to jointly deliver against the objectives of the programme. Synthesis activities are not intended to re-shape existing research objectives and priorities but to add value across the portfolio of activity. NERC and ESRC recognise that description of synthesis activity within proposals will not be fully defined at this stage, and as such the successful applicant will have the opportunity to further develop the proposed approach once grants are awarded and the details of the other successful grants are known.

It is requirement of the funders that projects under all the other challenge areas will work collaboratively with the cross-cutting consortium.

Challenge 2: Shale resource potential, distribution, composition, mechanical and flow properties

One proposal to be funded up to £1.7m (80% FEC) by NERC.

Challenge 2 will focus on improving our understanding of the geology of UK fine-grained fissile mudrock (broadly termed shales) including resource potential, distribution, composition, mechanical and flow properties.

This challenge aims to improve understanding of the coupled processes in UK shale systems which would in turn increase understanding of fluid flow and fractures.

There are a number of fundamental scientific problems that we expect this challenge to address that are unique to the shales that host unconventional hydrocarbons. Proposals may be expected to consider, but are not limited to:

- Comprehensive baseline studies of rock properties and structure to allow interpretation of observations during and after hydraulic fracturing.

- Understanding the controls on flow behaviour, including questions around porosity, permeability and geomechanics of shales, as well as the sorption and desorption properties of mineral and organic matter.
- The sensitivity of larger-scale geophysical properties of shales to micro-scale properties.
- Overcoming challenge of length scales: from the nano-scale porosity structure, through micro-facies and natural fracture networks to meso-scale heterogeneities to understand the formation, retention and subsequent flow of hydrocarbon gases.
- Transport of fluids and gases by diffusion at the pore scale, flow through the porosity networks and transport along fractures.
- The chemical reactions between the fluids and minerals, how they impact fluid chemistries, and the sorption and desorption of gases from organic materials.

Research funded through this challenge is expected to inform decision-makers and/ or regulatory bodies (and others) with evidence of environmental impact including in issues related to safety such as the distances between hydraulic fracturing and faults, the environmental impact of fluid additives and proppants, the fate of injected waters which remain in the subsurface, the impact of injection pressures and the safe preservation of internal seals. In order to address this challenge an appropriate range of field measurements, laboratory experiments, novel rock characterisation techniques, and theoretical studies are expected.

Challenge 3: Coupled processes from reservoir to surface

One proposal to be funded up to £1.7m (80% FEC) by NERC.

Challenge 3 aims to develop a practical understanding of the overburden, informing the development of a scientifically robust approach to risk assessment of leakage and induced seismicity in future exploration targets, as well as an evaluation of the impact of shale gas extraction on microbial communities.

The focus of most sub-surface research to date has been on petroleum reservoirs, and thus our knowledge of the overburden (below a few hundred metres) is very limited. Shale rocks targeted for natural gas extraction occur 1-4km below the surface. Above these systems the heterogeneous and anisotropic sediments, the overburden, form a natural geological barrier preventing leakage of injected fluids and hydrocarbon gases. A fundamental scientific question, and one which is of major concern both to the UK public and to regulators, is the extent to which the integrity of the overburden might be compromised through the process of hydraulic fracturing.

Proposals to this challenge should produce measurement and characterisation of the large-scale geomechanical properties of the overburden, which in turn will provide a thorough understanding of the geomechanical response of the overburden to changes in stress fields (both through geological time and as a result of hydraulic fracturing).

This challenge will seek to better understand the overburden and its responses to hydraulic fracturing through, but not limited to:

- Collection of fundamental data from core samples with regard to (a) pore- to core-scale transport and (b) dynamic and static geomechanical properties of both intact and deformed/deforming sediments.
- Measurements of the rates of geochemical reactions between potentially leaking fluids and minerals.
- Integration of laboratory and field studies to develop predictive models of the key risk factors by which the overburden may be compromised.
- Understanding the impacts of confining pressure, pore size, stress and strain on microbial communities, and on fluid flow and mineral-fluid reactions.

- Characterising the lithological structure (using imaging techniques and others) and the occurrence/nature of pre-existing faults and fracture networks to better understand the propensity of faults to induced seismicity.
- Quantifying the fluxes in fluid and gas flow.

In addition, this challenge will seek to better understand the potential impact of hydraulic fracturing on the microbial communities that exist at depth, through, but not limited to:

- Understanding the forms of metabolism that support deep life.
- Obtaining baseline information on the microbial communities present at depth (and their spatial variability).
- Identifying the biochemical energy flow within this system.
- Better understanding the carbon cycle in the deep subsurface, and its coupling to other processes including the sulphur cycle.
- Quantifying the potential for biofilms to grow in these systems, and determining their relationship to fluid and gas flow.
- Understanding the potential impacts and polluting effects of extant and microbes introduced via hydraulic fracturing.

Proposals are encouraged to make use of new tools, sensors and imaging techniques to better address this challenge, including utilising recent technological advances that have enhanced the ability to monitor mechanical/stress/pressure changes both from the surface and within wellbores, e.g. passive seismics, seismic interferometry, geoelectrical methods, novel thermal imaging and borehole breakout. Additionally, from a monitoring perspective the knowledge and evidence produced through this challenge is critical, and should provide recommendations to improve future UK decision-making and/ or regulation, monitoring and environmental protection.

Challenge 4: Contaminant pathways and receptor impacts

One proposal to be funded up to £1.7m (80% FEC) by NERC.

Challenge 4 will focus on contaminant emissions to the shallow geosphere and atmosphere from both direct and indirect fugitive pathways associated with stimulated shale reservoirs and infrastructure. Under this challenge indirect geospheric pathways are a priority as these represent the largest scientific uncertainty. To progress knowledge in this area requires a better physical understanding of fluid properties, migration and geological processes, coupled with knowledge of deep surface and near-surface physical and chemical environment baselines and their perturbation during both hydraulic fracturing and long-term production.

This challenge will seek to better understand the source-pathway-receptor linkage in relation to shale gas through, but not limited to:

- Top-down quantification of contaminant flux and emissions from shale gas operational activity.
- Assessment of the relative contributions of different fugitive source pathways.
- Characterisation of the baseline atmospheric and near-surface environments prior to any shale gas activity (allowing for relevant impact differentiation).
- Characterisation of hydrogeological properties of subsurface media through which transmission of contaminants may occur.
- Evaluation of the sensitivity of environmental and human receptors.
- Differentiation of stimulated reservoir source fluids, gases and other contaminants from alternative (extraneous) sources in measured groundwater, soil gas or atmospheric samples.

Proposals to this challenge should aim to produce new scientific knowledge of pathways and innovative technologies that can be used to quantify fugitive flux, its component source types and processes and representation in whole system models that take into account uncertainty. Proposals

should facilitate improved estimates of short-lived air pollutant emissions and long-term contaminant fluxes in the geosphere which are central to risk assessments and possible local impacts on health and the surface/near-surface environment. This new knowledge is critical for the UK in terms of the validation of theoretical assessments of contaminant emissions by measurement and modelling as required to fulfil a range of commitments associated with national emissions legislation and environmental protection objectives. It is also anticipated that outputs from Challenge 4 will facilitate life cycle assessment for UK-specific operational practice and its future development.

In order to address this challenge, a comprehensive surface or near-surface programme of ground motion monitoring and gas and groundwater monitoring in a UK setting is expected. InSAR, GPS and other geodetic techniques could be used to monitor long term strains, with seismic networks tracking induced seismicity. Careful consideration needs to be given to the trade-off between induced and naturally occurring activity, which necessitates good baseline monitoring and de-convolution of natural and anthropogenic change factors.

Challenge 5: Socio-economic impacts

Three to six proposals to be funded in total up to £1.5m (80% FEC) by ESRC.

Proposals are sought to provide updated evidence on the potential role of shale gas as a source of energy for the UK, taking into account a range of socio-economic factors. Proposals should aim to provide an updated evidence base addressing key questions relating to energy security, competitiveness and sustainability, and should demonstrate how they contribute to whole systems energy research. It is expected that proposed research will take into consideration the broader economic context, for example the Industrial Strategy and EU exit.

Proposals to this challenge are encouraged to focus on and across (but are not restricted to), the three areas set out below around policy, economics and communities, including issues relating to public acceptability. Research should take into consideration the range of scales at which these apply, from local to regional to national. It is expected that proposals will take into consideration the role of engagement and communication, which is intrinsic to all three areas. Proposed research should seek to provide an understanding of engagement methods that could be used to explore the evidence on the impacts, benefits and consequences of shale gas with a range of different audiences, from local community to government decision-makers.

Public perceptions/community understanding

Understanding public and community attitudes to shale gas development is a key social science research area. This is required at both a national and local scale. At a national scale, it is important to understand how public attitudes to shale gas are evolving. Understanding issues relating to local acceptance or opposition is also important and research relating to the emergence of a “social license to operate” between developers and local communities would be relevant to this challenge. There will be similarities to past research that has been carried out in relation to nuclear power and onshore wind, and proposals are expected to draw on such examples. Proposals should set out to understand attitudes to shale gas, and the impacts and risks of exploration held within communities, what information has been used to form those opinions and what their perception of key stakeholders is, as well as to gain an understanding of the effectiveness of the community engagement carried out by operators. Proposals should also consider if and how community engagement has affected plans from operators and policy makers at the national and local levels.

Policy

There is a need to better understand the effect that different shale gas development trajectories could have for both energy security and climate change policies. It is expected that proposals addressing this would synthesise existing information and explore the consequences of different shale gas development scenarios. Proposals are encouraged to use this understanding to feed into an analysis of the consequences of different scenarios for the UK's carbon budgets. The

effectiveness of the current planning regime and regulatory framework across the national, regional and local scale should be considered, including issues relating to environmental justice and inequalities.

Economic impact

Better understanding is required of how the shale gas industry could develop in the UK and what the economic impacts could be, as well as the nature of the shale gas business model that is emerging. For example, there is a need to build a comprehensive understanding of the economic geography of the emergent shale gas industry, the key licence-holders, planning applications, the companies involved in exploration and the supporting supply chain, and to understand this against the existing socio-economic geography of the licence areas. There is also a need to consider the impact of global gas prices on the potential competitiveness of UK shale gas production, and the impact that shale gas production could have on UK manufacturing and productivity as part of a low carbon economy. Consideration should be given to where the key economic costs and benefits from a shale gas industry could be, for example at the domestic or commercial level.

3.2 Proposal requirements

Research proposals are sought to address single Challenges:

- **Cross-cutting consortium addressing Challenge 1**
 - **Challenge 1: The evolving shale gas landscape**
One multi-institutional consortium bringing together environmental science and social science with support totalling up to £1m (80% FEC) for four years' duration.
- **Discipline specific projects addressing Challenges 2-5**
 - **Challenge 2: Shale resource potential, distribution, composition, mechanical and flow properties**
 - **Challenge 3: Coupled processes from reservoir to surface**
 - **Challenge 4: Contaminant pathways and receptor impacts**
Three multi-institution consortium projects (one project per Challenge 2, 3 and 4) that may include research studentships, with support totalling up to £1.7m each (80% FEC) for up to four years' duration.
 - **Challenge 5: Socio-economic impacts**
£1.5m (80% FEC) is available to fund three to six projects in the social sciences (consortium or single-institution) for up to four years' duration.

All proposals funded through Challenges 2-5 will be expected to work together with the cross-cutting consortium to share the fundamental understanding gained within each in order to deliver to the wider programme objectives. The cross cutting consortium will be expected to lead collaborative working between all projects funded through the programme.

3.2.1 Facilities

Where appropriate, applicants may use the recently confirmed £31m UK Geoenery Observatories infrastructure programme, which is currently being commissioned.

The UK Geoenery Observatories programme aims to provide scientific 'test beds' in two geologically-different locations in the UK. Each site will comprise a network of deep and shallow boreholes, enabling geoscientists to undertake long-term observation of the subsurface for the first time and in unprecedented detail, delivering new information to interpret, model and monitor the environment from the surface down to 1,500m.

A site in Cheshire is a potential location for public domain research on monitoring and observation of shale gas extraction and carbon storage. The second location is in central Scotland and is

expected to focus on geothermal energy. For the purpose of this call, applicants are only permitted to use the UK Geoenergy Observatories site which is expected to be in Cheshire.

Further information is available on the [UK Geoenergy Observatories website](#). For enquiries related to UK Geoenergy Observatories, please contact ukgeosenquiries@bgs.ac.uk.

Please note there is no requirement for applicants to use UK Geoenergy Observatories.

3.2.2 *Location*

Fieldwork funded through the programme must be compliant with any relevant local, regional, devolved government and/ or national planning laws. It is the responsibility of those funded through the programme to ensure that any appropriate permissions have been obtained.

3.2.3 *Studentships*

Applicants submitting proposals to address Challenges 2, 3 and 4 are eligible to apply for up to three associated studentships per proposal under this call. The cost for the studentship should be included within the total requested funds. Each studentship should constitute a distinct project providing added value to the parent grant. The main grant research should still be viable without the studentship and should have distinct objectives that are not reliant on the requested studentship.

All studentships must meet the following NERC Success Criteria:

- Research excellence: the training and training environment must include scientifically excellent and original research within NERC's remit.
- Training excellence: students should acquire both research and transferable skills. There is a strong and active community of students that are able, and encouraged to integrate, work and learn together.
- Multidisciplinary training environments: the training must be embedded in multidisciplinary training environments to enrich the student experience and to encourage the knowledge-sharing and interconnectivity, which benefits research within the environmental sciences. This does not mean that individual PhD topics are required to be multidisciplinary.
- Excellent students: attracting the right student. NERC funding should go to the right or 'best-fit' student: the individual whose previous training, experience and skills best suit the type of training being undertaken.

In order to be successful, applicants must demonstrate within their proposal how these success criteria will be met.

NERC encourages applicants to engage with its Doctoral Training Partnerships and Centres for Doctoral Training where appropriate to manage and deliver the training programmes of students supported through this opportunity.

More details on associated studentships can be found in Section D of the [NERC Research Grants Handbook](#).

4. Programme requirements

4.1 Programme funding

Up to £7.6m is available for this call to fund research projects to address Challenges 1-5 as outlined below:

Challenge 1 - £1m
Challenge 2 - £1.7m
Challenge 3 - £1.7m
Challenge 4 - £1.7m

Challenge 5 - £1.5m

Additional funding will be provided centrally to cover data management. Proposals should include formal requests (and access costs) for any NERC Services and Facilities (e.g. aircraft, HPC, isotope analyses), where relevant.

Projects should be prepared to start between 1 June 2018 and 1 September 2018 and will not be able to delay the start of their project beyond three months of the requested date without discussion and approval with the funders. Exceptionally, the start date of grants using the UK Geoenergy Observatories infrastructure may be delayed by more than three months (due to any delays in the UK Geoenergy Observatories timeline).

The Research Council funding contribution for proposed projects will be at 80% of FEC (with the standard exceptions paid at 100% FEC). Indexation at the prevailing rate will be applied at the time of award.

An associated studentship includes the student's maintenance grant (stipend) and university fees. These must be requested on the proposal form as an Exceptions cost and will be paid at 100% FEC. All students must receive the minimum research council stipend ([RCUK Funding for Research Training](#)) but this figure could be enhanced from other funding sources. Additional costs should be requested for items such as fieldwork expenses, conferences and consumables, as Directly Incurred costs and will be paid at 80% FEC. Applicants may request studentship funding for up to 48 months. It is expected that associated studentships will commence at the latest 6 months after the start date of the parent research project grant to ensure they occur within the lifetime of their parent award. No further funding is available for associated studentships beyond that requested on the grant proposal. Full information on terms and conditions can be found in the [RCUK Conditions of Research Council Training Grants](#).

4.2 Implementation and delivery

All proposals to Challenges 1-4 are required to involve a minimum of two, but preferably more, eligible institutions. Proposals will also be encouraged to include a range of both senior and early career scientists. Proposals to Challenge 5 may be single institution or consortium.

Proposals may be up to 48 months in duration and will be expected to start between 1 June 2018 and 1 September 2018. However, as stated previously, exceptionally, the start date of grants using the UK Geoenergy Observatories infrastructure may be delayed by more than three months (due to delays in the UK Geoenergy Observatories timetable).

All proposals must include milestones and deliverables to ensure that NERC and any Programme Executive Board can monitor the delivery of the science outputs.

4.3 Knowledge Exchange and Impact

Knowledge exchange (KE) is vital to ensure that environmental research has wide benefits for society, and should be an integral part of any research.

All applicants must consider how they will or might achieve impact outside the scientific community and submit this with their application as a [Pathways to Impact](#) statement, with associated delivery costs where relevant. Pathways to Impact activities do not have to be cost-incurring; it is not a requirement to include funded activities. Any funds required to carry out any proposed, outcome-driven activities identified within the Pathways to Impact **must** be fully justified within the Justification of Resources statement.

The Pathways to Impact will identify those who may benefit from or make use of the research, how they might benefit or make use of the research, and methods for disseminating data, knowledge and skills in the most effective and appropriate manner.

An acceptable Pathways to Impact is a condition of funding. Grants will not be allowed to start unless unacceptable Pathways to Impact are enhanced to an acceptable level within two months of notification of the panel outcome.

All funded projects may also be required to engage with programme-wide KE activities, in which case appropriate funding will be provided by the programme.

4.4 Data Management

The [NERC Data Policy](#) must be adhered to, and an [outline data management plan](#) produced as part of proposal development. NERC and ESRC will ensure that data management costs are paid directly to the appropriate data centres. Applicants should ensure they request sufficient resource to cover preparation of data for archiving by the research team.

4.5 NERC Facilities

Prior to submitting a proposal, applicants wishing to use a NERC service or facility must contact the facility to seek agreement that they could provide the service required. Applicants wishing to use a NERC facility will need to submit a mandatory 'technical assessment' with their proposal (including aircraft but excluding ships and HPC). For NERC, this means a quote for the work which the facility will provide. A [full list](#) of the Facilities requiring this quote can be found here on the NERC website. The costs for the service or facility (including NMF costs) must be included within the Directly Incurred Other Costs section of the Je-S form and also within the facilities section of the Je-S form. Further information on [NERC services and facilities](#) can be found on the NERC website.

Where appropriate, applicants may use the recently confirmed £31m UK Geoenergy Observatories (UK Geoenergy Observatories) infrastructure programme, which is currently being commissioned. Any applicants proposing to use UK Geoenergy Observatories are required to identify this in their submitted Notification of Intent form. In addition, applicants will be required to discuss and agree the proposed use of the facility with the UK Geoenergy Observatories team (as per instructions in the notification of intent form) and include costs associated with the use in their full application. The costs for using UK Geoenergy Observatories should be included as a single line under Directly incurred other costs. In addition, a quote for these costs must be submitted as an attachment in Je-S and within this quote a breakdown of the costs should be included

4.6 Programme management

It will be a condition of grant awards that the lead Principal Investigators (PI) of the awarded grants will work closely for the life time of the programme with the defined Programme Management arrangements. In addition, all Principal Investigators will be responsible for ensuring adherence to any agreed programme wide communication strategy.

5. Application process

5.1 How to apply

Notification of intent

A notification of intent to submit must be emailed to UH@nerc.ac.uk by 16:00 3 November 2017. Tell us the challenge you plan to apply for, the institutions, investigators and project partners that are expected to be involved, whether you are intending to use UK Geoenergy Observatories, the names of up to three nominated reviewers and include a title and abstract of your planned work. The abstract should be a maximum of 1 side A4, including references, in minimum font size 11 point (Arial or other sans serif typeface of equivalent size), with margins of at least 2cm. A notification of intent template can be found alongside this announcement of opportunity. The abstract will not be

assessed, but NERC and ESRC will use the information to plan the proposal assessment. Full Je-S proposals submitted without a prior notification of intent will be rejected.

Full proposals

Full proposals must be submitted using the Research Councils' Joint Electronic Submission system (Je-S). Applicants should select Proposal Type - 'Standard Proposal' and then select the Scheme – 'Directed' and the Call – 'Unconventional Hydrocarbons'.

Applicants must ensure that their proposal is received by NERC by 16:00 30 November 2017. Applicants should leave enough time for their proposal to pass through their organisation's Je-S submission route before this date. Any proposal that is received after the closing date, is incomplete, or does not meet NERC's eligibility criteria or follow NERC's submission rules (see [NERC Research Grants Handbook](#)), will be returned to the applicant and will not be considered.

All attachments, with the exception of letters of support and services/facilities/equipment quotes, submitted through the Je-S system must be completed in single-spaced typescript of minimum font size 11 point (Arial or other sans serif typeface of equivalent size to Arial 11), with margins of at least 2cm. Please note that Arial narrow, Calibri and Times New Roman are not allowable font types and any proposal which has used either of these font types within their submission will be rejected. References and footnotes should also be at least 11 point font and should be in the same font type as the rest of the document. Headers and footers should not be used for references or information relating to the scientific case. Applicants referring to websites should note that referees may choose not to use them.

Applicants should ensure that their proposal conforms to all eligibility and submission rules; otherwise their proposal may be rejected without peer review. More details on NERC's submission rules can be found in the [NERC Research Grants Handbook](#) and in the [submission rules](#) on the NERC website.

Proposals addressing Challenges 1, 2, 3 or 4 should be submitted in large grant format following the requirements outlined in section F of the [NERC Research Grants Handbook](#).

Proposals addressing Challenge 5 should be submitted in standard grant format following the requirements outlined in section F of the [NERC Research Grants Handbook](#). Please note that although NERC Standard Grants allow for the Case for Support to be up to 10 pages, given the smaller value of the grants under Challenge 5, the funders would expect the Case for Support to be 6-8 pages.

Please note that on submission to council ALL non PDF documents are converted to PDF, the use of non-standard fonts may result in errors or font conversion, which could affect the overall length of the document.

Additionally, where non-standard fonts are present, and even if the converted PDF document may look unaffected in the Je-S System, when it is imported into the Research Councils Grants System some information may be removed. We therefore recommend that where a document contains any non-standard fonts (scientific notation, diagrams etc.), the document should be converted to PDF prior to attaching it to the proposal.

5.2 Eligibility

This opportunity is open to individuals and organisations eligible for research grant funding from NERC, and ESRC, i.e. applicants in UK Higher Education Institutions (HEIs), RC-supported Research and Collaborative Centres, and Independent Research Organisations (IROs) (RCUK eligibility for Research Council funding). Consortium proposals should include researchers from at least two eligible institutions. Potential applicants should contact NERC well in advance of the submission deadline if they have any queries concerning their eligibility.

If direct financial support for a non-eligible partners' involvement is considered necessary, this may be included as a subcontract (for full details see Section E of the [NERC Research Grants Handbook](#)).

Research roles and eligibility

With the exception of project partners and 'staff' such as researchers and technicians, individuals may be named on a maximum of two proposals submitted to this call, and may be named as a lead PI on only one. The total time commitment across the applications with which they are involved should not exceed 100%. If individuals are named on more than two submitted proposals then additional proposals will be rejected. Proposals will not be accepted where a student is the only dedicated research/staff member on a grant, including component grants of joint proposals. Note that NERC rules apply on individual eligibility. Full information on individual eligibility and role descriptions can be found under Section C of the [NERC Research Grants Handbook](#).

6. Assessment process

Full proposals will be internationally peer-reviewed and final funding recommendations made by a moderating panel consisting of independent experts and members of the NERC Peer Review College and ESRC Peer Review College where possible. Applicants will be given the opportunity to provide a written response to peer review comments prior to the moderating panel. Applicants may be invited to give a presentation at the moderating panel.

The assessment criteria to be used for the full proposal stage will be as follows:

- Research Excellence
relates to the originality and quality of the proposed research and the importance of the questions being addressed
- Fit to Programme Requirements
relates to the degree to which the proposed research addresses the objectives of the programme

Associated Studentships will be assessed against the following criteria:

- Research excellence
- Training excellence
- Multidisciplinary training environments
- Recruiting excellent students

Feedback will be provided to both successful and unsuccessful applicants.

NERC and ESRC will use the recommendations of the moderating panel along with the overall call requirements and the available budget in making the final funding decisions.

7. Timetable

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| • 3 November 2017: | Closing date for notification of intent |
| • 30 November 2017: | Closing date for full proposals |
| • Late February/early March 2018: | PI response (provisional) |
| • March 2018: | Moderating Panel |
| • Spring 2018: | Award letters issued |
| • 1 June 2018: | Earliest start date |
| • Summer/ Autumn 2018: | Kick-off meeting |

8. Contact

For all enquiries, please contact UH@nerc.ac.uk.