**Materials for energy applications**

This research area focuses on the synthesis, characterisation and theoretical understanding of functional materials to be used in energy applications.

This area covers fundamental materials research, across the whole energy landscape, into the synthesis, characterisation and theoretical understanding of functional materials to be used in energy applications.

It focuses on research into new and novel materials related to energy applications, including:

* alternative energy vectors
* thermoelectrics
* semiconductors
* photovoltaics (PV)
* fuel cells
* energy storage.

Materials can include, among others, polymeric, complex oxide, nanoionic, caloric and porous materials for potential future energy applications.

This area only includes research into fundamental new and novel materials for current and future energy technologies, up to proof-of-principle validation of the new material properties. Research at higher technology readiness levels (TRLs) – building on proof-of-principle (for example, optimisation of materials and devices, or technology development), structural materials development and materials engineering – are not included in this area, and are covered in related research areas.

This is a very active area of research that will have increasing relevance to key real-world challenges – especially the need to generate energy more sustainably and cost-effectively to meet UK carbon reduction targets and aid economic growth.

### Aims

#### Stronger interdisciplinary links

The community will develop stronger interdisciplinary links. Researchers will work with research areas across the physical sciences portfolio (for example, [catalysis](https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/catalysis/) and [functional ceramics and inorganics](https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/functional-ceramics-and-inorganics/)), in conjunction with areas across the energy portfolio (including [solar technology](https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/solar-technology/), [fuel cell technology](https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/fuel-cell-technology/), [energy storage](https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/energy-storage/) and [UK magnetic fusion](https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/uk-magnetic-fusion-research-programme/)).

They will do this through networks in the Supergen Programme and centres for doctoral training, and through the Faraday Institution and Sir Henry Royce Institute, to go on supporting design and evolution of new and existing materials for energy applications – and ensuring full exploitation of novel materials.

#### Supporting UK skills

The community will be flexible enough to adapt to significant challenges in energy demand and to retain recognised expertise within the UK. Development of materials for energy applications will make a significant contribution to ensuring the resilience and sustainability of future UK energy supply, for example by underpinning enablers for renewable energy.

Training is also key to this area, as well as to the wider energy industry. People with the right skills are needed in both industry and academia.

#### International facilities

Researchers will continue to succeed in applying for access to international facilities (an important consideration in a constrained capital environment), and to forge strong collaborations with international groups across the materials for energy field. This includes opportunities to contribute to ensuring global access to renewable energy and materials through the [Global Challenges Research Fund](https://www.ukri.org/our-work/collaborating-internationally/global-challenges-research-fund/).

#### Industry links

Researchers will foster strong links with the UK energy sector and industrial end-users, and support the strategies of the [Advanced Materials Leadership Council](https://ktn-uk.org/news/introducing-the-reconvened-advanced-materials-leadership-council/), the [Faraday Institution](https://www.faraday.ac.uk/) and the [Sir Henry Royce Institute](https://www.royce.ac.uk/) in the sphere of energy materials.

#### Building the research network

Growth in this area will be delivered through community coordination activities which will help to expand into a more unified, interdisciplinary network of researchers and industrial end-users (as in recent efforts in advanced materials for energy generation and transmission). This will enable a more systematic approach to materials development and discovery.

Significant changes are required in the current energy system to transition to a low carbon energy mix and meet the government’s 2050 greenhouse gas emissions targets. The required changes encompass energy storage technologies, efficient energy conversion devices, cost effective renewable generation technologies, new nuclear capability and management of nuclear waste.

Materials science has a key role to play in the future development of these technologies and fundamental materials and chemistry research undertaken in the UK is vital to maintaining this country’s competitive edge in the wider energy research landscape.

Research is particularly strong in certain areas, including solar photovoltaics (PV) materials and devices, materials for fuel cells and energy storage. In nuclear fission, our internationally competitive understanding of materials that can cope in extreme conditions is essential to new nuclear reactors, as well as to treatment and disposal of nuclear waste.

Further development of technologies to improve efficiency, energy density or power conversion relies on the underpinning materials science, with a need for new or modified materials to deliver the next step-change in the field. Without them, UK capabilities will be limited.

The fundamental discovery and emergence of novel materials for energy applications makes a significant contribution to the UK’s energy sector and the future of its energy infrastructure. For example, in 2013 the government published a strategy on solar energy which highlighted the opportunities for developing next-generation solar PV materials. Similarly, in 2016 the government announced plans to invest £250 million in a nuclear research and development programme.

Innovation and involvement of other key technologies can help create numerous UK-based business opportunities in this area and also contribute to the future of the UK economy. This research area is of major interest to a number of companies across a spectrum of sectors, from energy to chemicals and manufacturing.

There has been steady growth in UK leadership and knowledge in this area and support across the various career stages is well-distributed. Training in this area has increased and should remain adaptable to accommodate changes within the energy sector, enabling researchers at both the fundamental materials level and the applied end of the research spectrum to feed into technological advances as the field evolves.

The research community does, however, face difficulties in scaling up its investigations due to the low number of large-scale testing facilities available nationally for demonstrating and modelling new materials technologies. Nevertheless, researchers are successfully applying for access to international facilities and this level of interaction with other countries should be maintained.