Government's Review of the Balance of Competences Between the United Kingdom and the European Union, Call For Evidence on Research and Development

The Royal Society of Chemistry welcomes the opportunity to respond to the Department for Business, Innovation and Skills consultation on the review of UK and EU balance of competences in research and development.

The Royal Society of Chemistry is the largest organisation in Europe for advancing the chemical sciences. Supported by a network of 47,000 members worldwide and an internationally acclaimed publishing business, its activities span education and training, conferences and science policy, and the promotion of the chemical sciences to the public. This document represents the views of the Royal Society of Chemistry. The Royal Society of Chemistry has a duty under its Royal Charter "to serve the public interest" by acting in an independent advisory capacity, and it is in this spirit that this submission is made.

Impact on the national interest

1. Where has EU action had a positive impact for the UK on research, technological development, innovation or space? What evidence is there for this? Has EU action encouraged national action in any areas?

Areas of positive impact are discussed below; reference to the examples is provided in the annex.

i) Higher Impact in Addressing Global Challenges

EU action on delivering programmes of research that address global challenges offer the UK the opportunity to participate in consortia that can have a higher overall impact in carrying out research that addresses grand challenges.

Research and technological development is critical in developing solutions to global challenges. In recent years EU research priorities related to global challenges have closely mirrored UK priorities. Such alignment offers significant opportunity for the UK to leverage further gains (both financial and knowledge-based) by cooperating more closely with the European Union. The forthcoming Horizon 2020 programme represents a vast opportunity in this respect with an estimated budget of €70 billion. The programme aims to focus on three key priorities; excellent science, industrial leadership and societal challenges.[1] Within the societal challenges strand, themes such as health, transport, energy and resource efficiency are common to both Horizon 2020 priorities and those of the Technology Strategy Board. This alignment of priorities, coupled with a significant funding package presents a huge opportunity for UK research, development, innovation and space.

ii) Complementary streams of research funding

Europe represents a significant source of funding for UK research.

The UK is highly successful at leveraging European funding; as part of framework programme 7 (FP7), only Germany received a greater share of funding than the UK.

The European Research Council (ERC) represents a particularly important source of funding within Europe for fundamental research, as grants are awarded solely on the basis of scientific excellence. Researchers that the Royal Society of Chemistry has consulted have commented on the importance of such a scheme, suggesting that it is an effective route for funding basic research that is supported by the community.

[1] - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Horizon 2020 - The Framework Programme for Research and Innovation, November 2011

ERC grants are awarded to researchers by career stage (starting, consolidator or advanced grants), for collaborative projects (synergy grants) or support for bridging the gap between research and commercialisation (proof-of-concept grants). The UK has consistently achieved a higher success rate per ERC call in both starting and advanced grants than for each call overall.[2] Six of the top twenty European institutions hosting at least 25 ERC Grantees (starting grant and advanced grant) are UK institutions; more than any other nation.

Significantly, ERC grant recipient data shows the importance of the UK as a destination for attracting the best overseas researchers. Between 2007 and 2012, the UK had the largest number of ERC grant holders (starting and advanced) who are non-UK nationals, highlighting the UK's status as an attractive prospect for the world's best international researchers.

Funding for riskier research and innovation activities is an important objective for current and future European funding programmes. Facilitating *access to risk finance* is a key aim within the Industrial Leadership strand of Horizon 2020. There are mechanisms within EU funding (e.g. the SME guarantee scheme, Eurostars) for supporting riskier research and innovation in businesses of all sizes, which represent an important source of funding to test innovative UK ideas.

For some UK academics, EU funding *via* the framework programmes has proved to be an important source of funding for research. This can be particularly important for niche research areas which have an active UK community; being able to leverage significant amounts of money from the EU allows such researchers to contribute to overall UK research outputs.

Another advantage of some European funding schemes is that they can offer greater flexibility in the use of funding within projects. An example is the reassignment of funding to cover the purchase of new equipment due to changes in research direction.

iii) Training future research leaders

Research into grand challenges will require multidisciplinary solutions. Opportunities to partake in multidisciplinary research are vital to develop the next generation of UK research leaders.

Within the EU, there are well-established mechanisms to undertake trans-national, multidisciplinary research. Under the EU programme of COST actions, there is a domain which specifically funds projects which are defined as 'Trans-Domain' allowing the formation of networks that are truly multidisciplinary. An example of a multidisciplinary EU research project involving UK researchers is the COST action TD1007.[3] This project examines bimodal PET-MRI molecular imaging technologies and how these can be applied for monitoring disease in patients. This consortium includes chemists, physicists, biologists and clinicians from across Europe who are working towards a common goal of developing new tools and methods for imaging.

For UK participants, such actions provide an excellent opportunity to develop collaborations with research leaders with complementary expertise in other nations. For early-career researchers in particular, involvement in European network programmes provides an important opportunity to build networks and enhance their training through the availability of funding for short 'research missions'. The latter allow researchers to spend from between 2 weeks and 6 months working in another laboratory, affording access to novel equipment, techniques and methods that can be applied to their research.

European funding provides an important resource to train the next generation of UK researchers in a number of areas. In the area of astrochemistry, for example, European funding is providing scientists with the skills to undertake laboratory work that will support the collection of data from international observatories (see Annex, Example A, LASSIE). Moreover, in some disciplines, it is important that training mechanisms within the UK align

[2] - The ERC: Overview of FP7 and Looking Ahead to H2020, presentation by Fiona Kernan, Ph.D, of the ERC Executive Agency at the UKRO Annual Conference, June 2013
[3] - http://www.pet-mri.eu/description.html

with those in other countries to ensure that the UK remains competitive on a world stage. Access to training materials across the EU means that UK researchers are trained to the same level as their European counterparts, and so our scientists are equipped to work effectively in trans-national teams (see Annex, Example B EMTRAIN).

iv) Staying competitive on a global stage

The UK needs to take advantage of the opportunities that Europe offers with respect to knowledge, training and collaboration to stay competitive in the global market.

Whilst the UK contains diverse, excellent and productive research communities, these communities cannot work alone in the search for solutions to global challenges such as health, energy and food. UK scientists must link up with world-leading researchers across the globe to exchange ideas and knowledge. Participation in EU programmes is a purpose-built mechanism that can facilitate collaborative, as well as, competitive advantage.

European programmes that provide support and access to finance to UK SMEs can help such businesses to compete in the international marketplace. An example is the provision of information on international venture capital for UK start-up companies (see Annex, Example D BIOCHEM).

In some areas, for example, in the area of drug invention, to compete on a global stage (with Asia and America), the UK must work cooperatively with other EU member states. By sharing knowledge, expertise and resources across the EU, we can increase our chances of success in the context of the global market (see Annex, Example B, EMTRAIN and Example C, Open PHACTS).

2. Where has EU action had a negative impact for the UK in these fields? What evidence is there for this? Has EU action prevented potentially useful national action in any areas?

See answer to question 7.

EU action has a potential for negative impact upon research and innovation, in the development of over-prescriptive regulation that is based solely upon the avoidance of risk; this approach in general, is inimical to innovation. However, it should be noted that there are opportunities to address potential negative impacts and the UK has the opportunity to be proactive in leading dialogue at EU level in order to minimise these.

3. How and where has UK engagement with partner countries or international bodies, both within and outside the EU, been helped or hindered by EU involvement?

Many European funding instruments stipulate cooperation across nations. Such instruments undoubtedly assist UK engagement with partner countries and international bodies. UK participation as part of one EU funded project can lead to opportunities to be involved in subsequent international partnerships. For example, in the case of one project involving the National Nuclear Laboratory, the interaction led to opportunities to work on further projects with European partners and/or customers, including the European Space Agency (see Annex, Example E, ACSEPT).

4. What benefits or difficulties has the objective of a European research area (ERA) delivered for the UK?

A number of senior academic researchers that the RSC contacted in connection with this consultation spoke highly of the advantages of being able to draw upon a pan-European talent pool within the chemical sciences. Such recruitment has additional advantages, for example introducing new research approaches into a UK research group or helping to foster collaborations between UK and European research groups. The objective of an ERA has resulted in the UK benefitting greatly from being able to attract students and researchers from across Europe to study and work in the UK. UK research institutes benefit from a less

hierarchical research environment in comparison to some elite European institutions, providing an attractive option to talented overseas students and researchers.

Another important advantage of the ERA is the access to non-UK infrastructure it affords, through agreements, to UK scientists. Specific funding is often made available to assist researchers to carry out experiments using this equipment. Whereas EU schemes can provide funding for scientists to cover travel, subsistence and some consumables to perform experiments in facilities across Europe (e.g. at the European Synchrotron Radiation Facility), UK researchers' access to equipment in other countries outside the EU (e.g. the USA, Japan and Australia), often demands additional funding from other sources.

5. How has the EU sought to coordinate the policy instruments at its disposal across different policy areas to create an enabling environment for researchers and innovators? How successful has this been?

EU instruments in research and development have aimed to cover the entire innovation chain to help create an enabling environment for researchers and innovators. The development of separate schemes for different parts of the research and development chain (e.g. ERC for fundamental research, a specific programme on Research for the Benefit of SMEs in FP7) is a positive step towards creating an enabling environment. However, in some instances, the coordination between instruments or streams could be improved (see answer to 6a below).

The F^3 Factory[4] project is an example of a programme that has created an enabling environment for innovation in manufacturing across several chemical processing industries, including pharmaceuticals and materials (see Annex, Example F, F^3 Factory). KYROBIO is another European project that has created an enabling environment that is contributing to the development of novel products (see Annex, Example G, KYROBIO). The Innovative Medicines Initiative (IMI) is a transformative public-private-partnership which has over 40 major projects running, including EMTRAIN and Open PHACTS, as well as CHEM21. CHEM21[5] commenced at the beginning of 2013, and is coordinated from the UK by GlaxoSmithKline. Key areas of this project include 'smarter synthesis' coupled with an aim to produce cheaper medicines for patients. The project is important to the future health of green, sustainable and wealth-creating manufacturing in the UK and represents an example of the EU creating an enabling environment for researchers and innovators to create UK advantage.

Future opportunities and challenges

6. What could the EU most helpfully do to promote scientific and technological progress and innovation (including in the space sector)?
- How could the EU use its existing competence differently to deliver more in your area?
- How might a greater or lesser degree of EU competence deliver more in your area?
- How could improvements to existing EU activities make them more effective and efficient?

a) Ensuring that EU funding streams are effectively coordinated. For example, adequate provision of transitional funding streams to aid progress between networking actions and full research projects would be valuable in maintaining momentum in research.

b) A greater degree of EU competence in areas relating to grand challenges would help both the UK and EU to deliver innovative solutions to major technological challenges - such as sustainable agriculture, energy and resource management - as well as providing a competitive edge for Europe as a whole in relation to the rest of the world.

EU competence is also vital in areas where the resource of a single nation will not suffice.

[4] - http://www.f3factory.com/scripts/pages/en/home.php
[5] - http://www.chem21.eu/project/

The EU has the scope and scale to create international networks that address global challenges. A key aspect of this is large scale infrastructure that involves multiple nations (e.g. CERN).

c) Some refinement of the application and auditing processes for EU funding could help make them more effective and efficient. Despite the UK's high success rate in securing EU funding, many still find the application and auditing processes onerous. An interim evaluation of FP7 found the reporting structure to be too complicated, it concluded a *'too high level of detail is required for audit certificates and the upshot is a 'zero-trust' policy'*.[6] Reform of the current processes to develop a system based on greater trust, with a higher tolerance of risk, could help to encourage engagement more widely, particularly from industry.

7. Where might future EU level action be detrimental to your work in this area?

With respect to scientific research and innovation in the UK, over-prescriptive and over-cautious regulation has the potential to impact negatively on the development of the chemical sciences.

While it is imperative to protect health and the environment it is not possible to design out all risks over the life cycle of chemical substances and products. Legislation needs to strike a balance between maximising the benefits to society and reducing risk so far as is possible. For a chemical substance to cause harm requires exposure to its hazardous properties. So, legislation based solely on a chemical's hazardous properties and disregarding the risk and level of exposure can, and has, led to a reduction in chemical diversity; this impacts negatively on innovation[7], economic growth and competitiveness. We strongly support proper regulation and responsible care, but we also maintain that chemicals control legislation should be evidence-based, proportionate, workable, and sustainable.

Increasingly, there is a perception that the EU is uncomfortable to engage with industrial scientists when formulating policy, an issue highlighted recently by the Chief Scientific Adviser to the EU, Professor Anne Glover.[8] Industrial scientists often have extensive knowledge and expertise relating to particular subjects, chemicals or processes; their potential conflict of interest should be duly noted and communicated in a transparent manner, but their input should not be ignored if it is sound and of a high quality.

The Royal Society of Chemistry advocates and promotes an approach of continuous engagement and dialogue between scientists and policy makers both within the UK and also within the EU. In June 2013, the Royal Society of Chemistry co-hosted, with the Cross Parliamentary Informal Group on Risk, a one-day *Risk Precaution and Innovation* workshop in the European Parliament. The workshop considered how different interpretations of the *precautionary principle* and its practical implementation in EU legislation have impacted on the exploitation of new discoveries. We believe that a reasoned and well-informed dialogue at the European level will help to create and maintain a supportive regulatory environment for the chemical sciences, innovation and economic growth.

8. Where might action at national rather than EU level be more appropriate / effective?

Three areas where national interests may come to the fore are: energy security, food security and water security. Given the UK's particular geographic situation, energy presents some specific opportunities. A focus on scalable alternative and renewable energy sources – wave, tidal, wind - may need specific attention.

9. How could EU and national policies and funding streams interact better?

There are some good examples of very positive interactions between the EU and national initiatives in the UK. The work of the Technology Strategy Board (TSB) in the area of

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[6] - Interim Evaluation of the Seventh Framework Programme, European Commission, November 2010

[7] - Nanotechnology Position Document, Royal Society of Chemistry, October 2012

[8] - http://www.euractiv.com/science-policymaking/chief-scientist-calls-standards-news-519033

sustainable manufacturing is one example. Provision of matched funding by UK research councils is another way that EU and national initiatives can link up to provide greater impact in an area of mutual priority; the participation of the Biotechnology and Biological Sciences Research Council (BBSRC) in the European Science Foundation's EuroSolarFuels programme exemplifies this; the programme includes collaborative research projects involving UK researchers.[9]

Future programmes under Horizon 2020 present an important opportunity for UK businesses to participate in public-private partnerships (PPPs) that will help to deliver a positive impact on the economy. Two proposed PPPs where chemistry plays an important role are SPIRE and BRIDGE. SPIRE is dedicated to achieving resource and energy efficiency in process industries,[10] whilst BRIDGE aims to create growth in the European bio-based market through the development of bio-based value chains.[11] These programmes offer significant opportunities to businesses within the growing UK biotechnology sector (BRIDGE), as well as sectors looking to become more efficient and sustainable. The UK government, through agencies like the TSB, has a role in encouraging UK participation in EU programmes such as these. The government should look to actively encourage UK-owned industries to participate as part of the public-private partnerships that are established in the forthcoming Horizon 2020 programme. Currently, active participation of UK companies in SPIRE and BRIDGE is low.

10. What impact would any future enlargement of the EU have on this area of competence?

No comment

11. Are there any other points you wish to make which are not captured above?

No comment

[9] - http://www.esf.org/coordinating-research/eurocores/running-programmes/eurosolarfuels.html
[10] - http://www.spire2030.eu/
[11] - Biobased and Renewable Industries for Development and Growth in Europe, Strategic Innovation and Research Agenda (SIRA), BRIDGE, March 2013

Annex – Examples of EU projects that have affected the UK in research, development, innovation and space.

Example A) LASSIE – Laboratory Astrochemistry Surface Science in Europe (Heriot-Watt University & partners)

LASSIE is an example of an initial training network (ITN) within Europe that aims to bring together research groups and also MSMEs (micro, small and medium enterprises) to *examine the role of the gas-grain interaction in the evolution of the Universe.* The network aims to train researchers in the field of astronomy and astrochemistry; however, training in a network with industrial connections means that they are equipped with skills that can be applied to other knowledge-based enterprises.

As an interdisciplinary subject, astrochemistry is an area that covers aspects of chemistry, physics and maths, with a well-established UK research community. The formation of the EPSRC AstroSurf network in 2004 acted as a mechanism to strengthen the community in this field both in the UK and overseas. However, as a solely networking programme, opportunities for research and training were limited.

LASSIE was formed as part of the FP7 programme in 2010 and was funded to a value of €6.1 million. It aims to train 28 Early Stage Researchers (PhD students) and 4 Experienced Researchers (Post-doctoral research assistants) over its 4 year duration. LASSIE is coordinated by the UK, reflecting the standing of the discipline within the UK and its place within the international astrochemistry community. Such a programme is needed to ensure that there is an adequate supply of skilled researchers who can undertake future laboratory-based astrochemistry research that will complement observational data collected through large facilities.

The benefits for the UK of this European programme are:

- **Maintaining UK excellence** – the programme has supported the training of a cohort of students who are equipped to work in this field across Europe, as well as strengthening the UK's standing in the international astroscience community.
- **Maximising investment in infrastructure** - without researchers who can conduct laboratory research on the evolution of the universe, we risk not garnering the maximum benefit from UK investments in large infrastructure, such as the ALMA observatory in Chile.
- **Knowledge** - continued participation in large scale European programmes will help the UK research community build up knowledge that can contribute to the goal of the UK becoming a world leader in commercial applications of space technology, as envisioned by the Chancellor late last year.[12]

[12] - Speech by the Chancellor of the Exchequer, Rt Hon George Osborne MP, to the Royal Society, November 2012

Example B) EMTRAIN - European Medicines Research Training Network

EMTRAIN is part of the Innovative Medicines Initiative, which is Europe's largest public-private partnership that aims to develop new medicines.

The aim of EMTRAIN is to provide support to scientists working across the entire medicines pipeline from drug invention to pharmacovigilance, throughout their career. It aims to strengthen this community by:[13]

- integrating education and training programmes across the EU into a single network
- helping European scientists navigate the host of courses available across Europe
- aiding mobility of students and scientists across Europe

EMTRAIN has three main components:

- PhD Programme – a programme of public-private PhD workshops that ensure that students become more 'industry-aware' and have the requisite skills needed by industry.
- on-course®- a comprehensive catalogue of postgraduate, biomedical courses available across Europe.
- LifeTrain – support for CPD, skills and competency development.

In addition, there has been a series of interviews with representatives from academia and industry across 21 countries in Europe (including the UK) to understand the changing drug discovery capacity and needs. In undertaking these strands, the programme is developing uniform standards for training and development across Europe in the field of medicines discovery.

The benefits for the UK of this European programme are:

- **Knowledge** - greater access to information across Europe, particularly with respect to training courses delivered in other nations. This saves time and prevents duplication of efforts within member states.
- **Building UK research capacity** – the nature of the public-private PhD programme means that there are UK students who are trained with a unique set of medicines discovery skills, coupled with industry awareness, to the same standard as researchers in Europe.
- **Attracting the best talent** – the UK must attract the best scientists from Europe and from across the world to work in fields such as drug discovery. Working towards a unified training and CPD framework in medicines discovery enables mobility of researchers across the continent, as researchers would not have to undertake repeat training exercises, where they may differ by nation.

[13] - http://www.emtrain.eu/index.php/about/mission

Example C) Open PHACTS - Open PHArmacological Concepts Triple Store (Royal Society of Chemistry & partners)

Open PHACTS provides an integrated platform of publicly available pharmacological and physicochemical data. It aims to integrate data from multiple sources making it accessible *via* one freely available interface. Often such data integration is repeated by multiple pharmaceutical companies in-house. The platform aims to bring together different, but interlinked sources of data together in a single place. For example, the physiochemical properties of a particular molecule, as well as its action as a drug.

The Royal Society of Chemistry is one of the 28 European consortium members who are part of this project and provide technical support to enable chemical data integration, as well as being responsible for wider community engagement and the sustainability of the project in the longer-term.

To ensure the longevity of the Open PHACTS Discovery Platform a not-for-profit successor organisation, the Open PHACTS Foundation, has been established. The Open PHACTS Foundation will offer membership, the subscription of which will safeguard platform sustainability and allow it to act as a hub of relevant academic research.

The benefits for the UK of this European programme are:

- **Access to data** - an integrated tool like Open PHACTS would be invaluable to academia and also small to medium enterprises (SMEs), which have historically enjoyed little access to integrated platforms.
- **Reduce drug discovery attrition rates** - an integrated and comprehensive interface to publicly available data would help initial drug screening stages and limit expensive late-stage trial failure.
- **Awareness in the community** - as a UK-based organisation, the Royal Society of Chemistry is uniquely placed within this project to ensure that the benefits for UK researchers and businesses are communicated effectively to the research community.

Both EMTRAIN and Open PHACTS are important responses to the changing nature of the drug invention landscape. Until recently, drug invention was undertaken mainly by larger pharmaceutical companies; this proved successful for the UK, with at least 10 of the top-selling drugs worldwide (>$1bn annual sales at peak) having had UK-trained PhD organic chemists as named inventors.

However, there has been a sharp decline in the number of drugs discovered globally, with fewer than 1-in-10 phase 1 clinical candidates reaching the market and increasing research and development costs. Such conditions have led to huge cuts in research and development budgets, job losses and site closures within the UK. In the wake of such changes, new approaches to drug discovery are being pursued that take account of the wider participation of academia, contract research organisations and the growing biotechnology sector.[14] As a result, it is increasingly important for the UK to develop infrastructure to encourage such collaborative endeavours. One UK example is the Stevenage Bioscience Catalyst, which brings together small biotech and life science companies to foster a culture of open innovation.

To remain truly competitive on a global stage, the UK must ensure that it is able to participate in analogous ventures across Europe, particularly in areas of broad societal importance such as drug invention. UK involvement in initiatives such as EMTRAIN and OpenPHACTS positions the UK to take advantage of knowledge, training and skilled scientists across Europe, thereby helping to ensure that the UK remains competitive within Europe and globally.

[14] - Healthcare Innovation in the UK, the Royal Society of Chemistry

Example D) BIOCHEM – Eco-IP Partnership for Driving Innovation in the Sector of Bio-based Products (Chemistry Innovation Knowledge Transfer Network & partners)

BIOCHEM is a programme that supports companies, particularly SMEs, across Europe, that aim to enter the market in bio-based products in the chemical sector. The seventeen consortium partners from eight European nations include innovation agencies, venture and public funding bodies. The project has developed tools, methodologies and processes that aid market entry by providing market information and access to funding directories. These resources and others, provided in one central location, form a 'BIOCHEM toolbox'.

Many of the projects have led to SMEs finding success with respect to approaching investors and finding partners for development. One such company is Starbon Technologies Limited, a spin-out company from the Green Chemistry Centre at University of York. Starbons® are a class of mesoporous materials, derived from complex sugars. These materials show a unique range of properties that afford potential applications in areas as diverse as medical devices and catalysis for bio-refining.[15]

Starbon Technologies Limited entered a BIOCHEM Business Plan Competition[16] and as a result were invited to present their business plan as part of a webinar. The webinar provided them with the opportunity to engage with four venture capitalists from across Europe and following the webinar, two venture capitalists requested an introduction to Starbon Technologies Limited. The spin-out also took advantage of further opportunities to present *via* the BIOCHEM initiative that generated further interest from investors.

The benefits for the UK of this European programme are:

- **Alignment of research priorities** – bio-based products in the chemical sector is an area of research strength in the UK, with the Centre of Excellence in Green Chemistry at the University of York, the Centre for Sustainable Chemical Technologies at the University of Bath and the planned Centre of Excellence for Sustainable Chemistry at the University of Nottingham, in collaboration with GlaxoSmithKline. Participation in European programmes such as BIOCHEM can help ensure that the future returns on such research can be maximised.
- **Access to tailored support for SMEs** – SMEs encounter many difficulties with respect to start-up funding and access to markets. Programmes like BIOCHEM provide a 'one-stop shop' that can provide SMEs with a wide range of assistance that is tailored to a specific market sector.
- **Exposure for UK SMEs to international finance** – As the programme is run at a European level across a number of partners, a wider group of potential investors in UK SMEs can be identified and approached for venture capital.

[15] - http://www.york.ac.uk/chemistry/research/green/industry/starbontechnologies/
[16] - BIOCHEM Case Study – Business Plan Competition Success Case

Example E) ACSEPT - Actinide Recycling by Separation and Transmutation (National Nuclear Laboratory and partners)

The ACSEPT project was part of the 7th EURATOM Framework Programme and ran between 2008 and 2012. The project focussed on developing aqueous and pyrochemical processes for advanced actinide separations, moving research and development towards pilot scale demonstrations. Actinide recycling by separation and transmutation is viewed as one of the most promising strategies for reducing the inventory of radioactive waste as part of a more sustainable future nuclear fuel cycle.

ACSEPT was the largest single project in the EURATOM 7th Framework Programme. It had a budget of €24 million, €8 million of which was from EU funding, with over 20 partners drawn from numerous universities and research institutes across Europe; this included all of the major European national nuclear laboratories as well as CRIEPI (Central Research Institute of Electric Power Industry in Japan) and ANSTO (the Australian Nuclear Science and Technology Organisation). The UK's National Nuclear Laboratory (NNL) was one of the partners involved in the project.

The benefits for the UK of this European programme are:

- **Developing people** – A total of 25 NNL staff were involved, resulting in a significant level of learning and development, with networks between researchers (both internally & externally) developed or enhanced. The project allowed the UK to maintain a skill base in fuel reprocessing science and engineering R&D against the backdrop of a difficult funding environment in the UK.
- **Increasing the UK's capability** – ACSEPT has driven the development and commissioning of NNL's glovebox capability for fuel cycle chemistry within its PuMA (plutonium and minor actinides) Laboratory. The gloveboxes have since been used for projects supporting Sellafield Ltd, NDA, DECC and the European Space Agency. Without ACSEPT, NNL would not have been in a position to support these customers.
- **Increased international reputation for the UK** - UK was seen as a leading partner in the project, and has established close collaborations with EU universities and research institutes. This has led to new opportunities for NNL and UK universities in other European level projects (SACSESS, ASGARD, TALISMAN). Eleven papers have been submitted to scientific journals and publications with a further ten planned. Eleven presentations have been made at international conferences.
- **Innovation** - NNL have led development of a new, innovative GANEX (Group Actinide Extraction) process that has now been hot tested with Spent Fuel at ITU, Karlsruhe. This process is being developed further through DECC funded research and development.
- **Underpinning future UK energy policy** – ACSEPT has enabled the UK to demonstrate the technical feasibility of innovative options for future closed fuel cycles that can be objectively evaluated against likely future scenarios in order to scientifically underpin UK nuclear energy strategy and policy decision making by Government.

Example F) F^3 Factory - Flexible, Fast, Future production methods

The F^3 Factory aims to enhance Europe's competitive position through the development of innovative manufacturing techniques for low to medium scale production leading to flexible, faster, future manufacturing.

The project started in 2009 and comprised a 4-year, €30 million demonstrator project involving 25 partners spread across nine EU member states. The project successfully combined the flexibility of batch manufacturing with efficiencies of large-scale continuous manufacturing to create a new paradigm in sustainable chemical production. As such, the F^3 Factory sets an example for the sort of active collaboration that can hugely benefit the UK within Horizon 2020 public-private partnerships and European Innovation Partnerships.

The benefits for the UK of this European programme are:

- **Access to new facilities** – as part of the project, the INVITE (INnovation VIsion TEchnologies) facility was designed and built specifically to help shorten innovation times for industrial members by providing equipment for use in demonstrator projects.
- **Information on best practice** – one of the work programmes within this project focussed on the development of an F^3 Factory handbook of standards, guidelines and protocols to enable other businesses in the chemicals sector across Europe to adopt more efficient processes.
- **Efficiency gains in production** – one of the nine case studies from this project focuses on the development of a flexible continuous process for the production of pharmaceutical materials at AstraZeneca in the UK. Involving partners across Europe new technologies have been developed and installed that have led to improved yields using the new process.[17]

[17] - http://www.f3factory.com/scripts/pages/en/about_f3/industrial_case_studies/cs2/index.php

Example G) KYROBIO – Discovery, Development & Demonstration of Biocatalysts for use in the Industrial Synthesis of Chiral Chemicals (CTech-Innovation, Chemistry Innovation Knowledge Transfer Network & partners)

The aim of KYROBIO is to broaden the range of single enantiomer chiral chemicals that are produced by industry in Europe using biotechnological routes. The project started in 2012 and is a 4-year project involving 17 partners across seven EU member states. Chiral chemicals are an important class of chemicals as they can have increased reactivity in relation to applications such as pharmaceuticals. Traditionally chiral chemicals have been prepared using chemical catalysts; however, the use of industrial biotechnology to produce chiral chemicals shows great potential for generating these in a more efficient manner. The project brings together partners from seven countries across academia and industry (including SMEs) to work collaboratively towards this goal.

The benefits for the UK of this European programme are:

- **Supply chains** – new supply chain relationships will be established that can include UK businesses.
- **Development of new products** - a new enzyme formulation has been devised as part of the first year of the project that will be commercialised by one of the SME partners. At least one new product is expected to be commercialised in the UK by the end of the project
- **Knowledge and technology awareness** – the Chemistry Innovation Knowledge Transfer Network (CIKTN) is the partner who is leading the work package on training, dissemination and community engagement. As a UK-based organisation, the CIKTN is ideally positioned to raise awareness of the programme and its potential benefits for other companies in this sector within the UK.