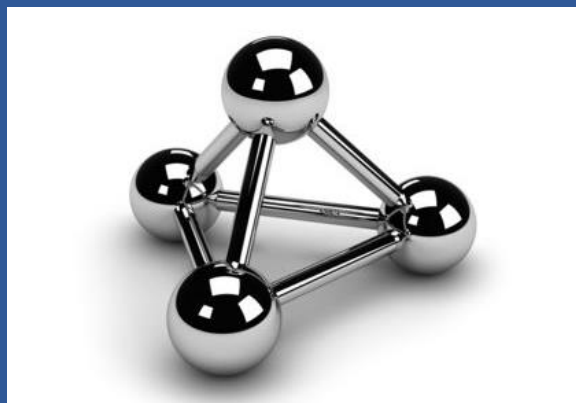


Independent Evaluation of the Knowledge Centre for Materials Chemistry (KCMC)



Final Report

March 2016

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Executive Summary

Established in 2009 with public funding support, the Knowledge Centre of Materials Chemistry (KCMC) is now hosted by the Knowledge Transfer Network (KTN) and represents an expanding partnership between industry and the knowledge base. It currently comprises four university partners with the University of Bristol on board since 2015, the Science and Technology Facilities Council (STFC)/Hartree Centre at Daresbury, Innovate UK and an Industry Steering Group – the Materials Chemistry Special Interest Group (MC-SIG).

The aim of this independent evaluation has been to review the achievements, benefits and impacts of KCMC activities - capturing and assessing economic benefits and value added for businesses, key partners and stakeholders and the UK economy to date, and exploring business views on the future contribution of KCMC.

This evaluation has taken place at a critical time in the lifetime of the science and innovation infrastructure debate in the UK. The UK Government recognises that research and innovation, and the skills to exploit them, are the essential components that will allow the UK economy to prosper and grow. At the same time, it is recognised that organisations, relationships and flows of funding and knowledge by which innovation can be translated into jobs and wealth, i.e. the innovation ecosystem, is a complex one that requires multiple interventions. Within the last year, numerous proposals, reports and consultations have been produced and considered in relation to research and innovation funding and its distribution, business and university collaborations and commercialisation of research. The UK innovation ecosystem is therefore still evolving and innovation brokers may be needed more than ever for the relationships between industry, academia/knowledge and government to work efficiently and effectively.

This evaluation has shown that KCMC is doing exactly that – it operates as a virtual centre of world-class capabilities and expertise in applied material chemistry, acting as a highly credible innovation broker bringing together industry and the academia that enables transactions between businesses and research centres to take place 'just in time', hence minimizing time and resources (i.e. transaction costs) that businesses and/or researchers would otherwise incur in their search of their ideal partner/collaborator in testing and/or taking forward new concepts and ideas.

The evaluation has also shown that KCMC adds significant economic, translational and commercial value in the innovation ecosystem. Key cumulative metrics at the end of the financial year in March 2015 are as follows:

- KCMC income: £19.4 million;
- Companies engaged: 472 (39% of which are small and medium-sized enterprises); and,
- GVA Benefit for the UK economy: £234 million.

KCMC is highly rated by businesses, academic/research partners and external stakeholders, and in the seven years since its establishment, it has expanded, is well connected and has raised its reach, impact and profile beyond its original sectoral and geographical focus – and this expansion has impacted positively upon the quality of its offer.

Another dimension of the added value of KCMC is that it 'brokers' a challenging area of work - materials often only represent a small fraction of the total value of the finished product. This of course could represent a fraction that makes the difference for a product carrying unique performance claims, or the element that gives the product the right feel or function – and hence making or breaking a successful commercial venture. The value of these materials within the overall value of the end product may not always be obvious, thus often undervaluing the contribution of materials chemistry to product innovation and increasing the challenge of value creation and value capture for companies. This challenge is also

highlighted in the strategy set out for the chemical industry and chemistry-using industries by the Chemistry Growth Partnership (CGP) and the Chemistry Growth Strategy Group (CSGG)¹. The strategy sets out the vision for the UK chemical industry to further reinforce the position as the country's leading manufacturing exporter and enable the chemistry-using industries to increase their Gross Value Added contribution to the UK economy by 50%, from £195 billion to £300 billion by 2030, while also recognising the requirement for both accelerated chemistry innovation and the rebuilding of UK chemistry supply chains as key enablers for this ambitious goal to be achieved.

More specific findings of the evaluation are summarised below.

Key Evaluation Findings

- KCMC has engaged with around 500 companies to date (approximately 75-80 companies per year).
- 4 in 10 of these companies are SMEs.
- 4 in 10 companies supported by KCMC are in the Chemicals and Materials sector, as it would be expected, and 2 in 10 are in the Engineering sector. KCMC also works with companies in the Energy & Environment, Life Sciences, Food & Drink and FMCG sector – these companies represent a smaller sample of companies in the KCMC portfolio but they are relatively large in terms of both their employment and turnover.
- At the end of its sixth full year (2015), KCMC had delivered projects to the value of £19.4m (150% above the original government investment). Industry contribution has also increased over time – representing 37% of total income at the end of 2015.
- North West remains an important location for KCMC engagements (it is also an important location for the Chemicals industry in the UK) – but 6 in 10 businesses engaged are located (HQs) outside the North West.
- KCMC is regarded by both business and research partners as an impartial and knowledgeable gateway and broker that enables effective, efficient, de-risked and accelerated connections to be made between industry needs and scientific skills and offer – adding value and complementing other knowledge transfer vehicles including KT teams within Universities and Catapults.
- For businesses, the best aspects of KCMC include:
 - ✓ Seamless, responsive industry relationship/network.
 - ✓ Well managed, access to unique expertise, equipment and testing facilities - a single point of contact to four leading research institutions, ensuring a 'best fit' to company requirements and a fast-track option for projects via dedicated scientists in partner institutions.
 - ✓ Partnering non-competing industries.
 - ✓ Structured networking of high quality.
 - ✓ Very good connections and networks.
 - ✓ Awareness of funding opportunities and access to national networks, grants and support for collaborative R&D.
 - ✓ Quick and responsive support.
- The original academic/research partners continue to support the Centre and new ones have been brought in – seeing it as the right vehicle not only to translate science and research for application in the commercial world and help in its implementation but also keeping them aware of industry

¹ STRATEGY FOR DELIVERING CHEMISTRY-FUELLED GROWTH OF THE UK ECONOMY, by the Chemistry Growth Strategy Group, July 2013.

technology needs and opportunities. The provision of knowledge transfer resource through an independent organisation provides an approach that complements their own central function resources, and delivers industry connectivity, in particular with SMEs, and practical understanding of how materials chemistry can drive industry innovation and commercial success. Engagement with KCMC also supports generation and leverage of research income and raises the profile of research in the business community.

- Quantifiable economic benefits take time to deliver clear gains and estimates of economic impacts presented in this report will need to be reviewed as more detailed information becomes available. At this stage, the evaluation has shown that engagement with KCMC propagates economic benefits for the UK economy through various routes. These include:
 - ✓ Direct impacts on key business performance metrics e.g. sales, markets, costs and turnover, and indirect impact through this to the wider economy and supply chain.
 - ✓ Direct impact on R&D expenditure by encouraging R&D that would have been unlikely otherwise (too expensive, risky or not thought to be possible) or would take longer to conduct.
 - ✓ Leveraging further R&D support as work has been proven as a result of KCMC input.
 - ✓ Offering a cost-effective approach to exploitation of research and science to date, as both industry partners and the knowledge base capitalise on own assets for scaling-up and exploitation of new concepts, rather than investing direct KCMC resources in large scale prototyping and pilot scale facilities (that can be also offered by others in the economy e.g. Catapults).
 - ✓ Securing additional research income and leveraging research funding for the knowledge base.
 - ✓ In the absence of a broker facility such as KCMC, more transactions (and hence costs) would be needed to take place between the knowledge base and industry to lead to a successful R&D collaboration.
 - ✓ Operational impacts through the direct employment of KCMC staff and support for the employment of researchers and the subsequent spending of their salaries within the economy (induced economic impact).
 - ✓ On average commercial/economic impacts tend to be 2/3 - 5 years away from businesses' first engagement; this implies that it may be relatively early to capture all the economic impacts for businesses as a result of their engagement with KCMC. On the basis of a series of assumptions drawn from discussions with businesses, it is estimated that in total, £234 million additional GVA for the UK economy can be attributed to enhanced business performance of businesses engaged with KCMC (to date). It is also estimated that, approximately, 70% of this, i.e. £164 million, is net attribution to engagement with KCMC.

Considerations for the Way Forward

The evaluation has shown that the KCMC model has been a successful model to date. However, in an increasingly competitive market of innovation brokerage services and constrained public sector funding, innovation brokers like KCMC will need to demonstrate their value to a wide range of sponsors including the private sector and continuously explore various business models.

Going forward, a number of strategic opportunities exist for KCMC. These are described below and some will emerge from the KCMC commitment to continuous improvement while others require a step change.

Continuous improvement

- Sustain and develop a relevant pipeline of innovation seekers and problem solvers - with project scientists and the SME focus at the heart of the offer.
- Ensure that liaisons exist at both strategic and delivery levels within partner organisations i.e. with CEOs, managers and researchers.
- Raise own profile and profile of industrial and academic partners through showcasing of their successes.
- Ensure that the overall KCMC specific offer and services is crystal clear and consistent in all messaging and communications.

Step Change

- Build breadth and depth of capability by further expansion of the KCMC to deliver the vision for accelerated new materials innovation across the UK.
- Further explore the need for industry-responsive resources and new funding models.
- Seek to develop more strategic relationships as part of the KCMC partnership with the Catapults.
- Develop connections with local and sub-regional economic development agents in key priority areas.

At an operational level, KCMC needs to consider adding selected outcome measures to its current metrics (that currently only capture internal and the immediate reach of KCMC's activities) in order to include longer-term economic and societal benefits; additional innovation-related achievements; capacity building of knowledge base institutions and businesses; and, sectoral and regional benefits. It is recognised that reviewing, demonstrating and showcasing the economic value of KCMC to internal and external stakeholders on a regular basis will require additional resources but it will also enhance the credibility of KCMC and raise its profile. For example, in addition to metrics already collected, outcome measures to be put in place could include:

- Intellectual property (IP) data – including new IP registered and value of IP.
- Technology transfer data – including number and value of licensing agreements and/or value of sale of IP from academia to industry.
- Environmental impacts arising from the introduction of new materials/products as a result of projects that KCMC has been involved with.
- Economic impacts – such as employment, turnover and profits resulting from projects that KCMC has been involved with.
- Skills Development – in particular, given the role KCMC is playing in supporting such programmes as the Knowledge Transfer Partnerships (KTPs) programme.

To be able to report back on these outcomes, KCMC will need to collect and collate in the future a wide range of project/post-project monitoring data in order to fully capture the technical and commercial effects of KCMC supported projects.

1. Introduction

- 1.1. In November 2015 WECD was commissioned by the Knowledge Centre of Materials Chemistry (KCMC) to undertake an independent evaluation of its achievements, benefits and impacts for key partners and businesses engaged, and ultimately the UK economy. This report presents the findings of this review.

The Brief

- 1.2. The key objectives of this evaluation were set as follows:

- A review of KCMC achievements to date based on the metrics agreed for KCMC in the Materials Chemistry Special Interest Group (MC-SIG). These include: business engagements, in particular engagements with SMEs, and collaborative research income.
- A review of perceptions of the Centre's achievements to date by key partners and businesses supported.
- Capturing and assessing economic benefits and value added for businesses, key partners and stakeholders and the UK economy to date.
- Exploring business views in the future contribution of KCMC.
- Providing estimates of the future contribution of KCMC over longer timescales as the impacts of current activities are realised.
- Drawing out conclusions to inform future direction.

- 1.3. To respond to these objectives, the review has involved:

- Thorough desk-based review of administrative data provided by KCMC (management and financial information) and relevant reporting e.g. past annual reports and business plans.
- Quantitative and qualitative assessment of direct and indirect/ripple economic and other impacts and leverage arising from the work of KCMC (to date but also in the future) – compliant with Government Guidance (such as HM Treasury's Magenta and Green Books² and the Additonality Guide³) and informed by the discussions with businesses and partners and other relevant research.
- Engagement with businesses (management and research teams), academics and key stakeholders to gauge views on the contribution of KCMC to date and in the future. The review included in-depth consultations with eleven companies, five academic partners and several other stakeholders. A full list of consultees is shown in **Appendix A**. A semi-structured questionnaire was used (See **Appendix B**).
- Consultations and regular communication with the KCMC team.
- Production of case studies/selected examples demonstrating KCMC's capabilities and achievements by highlighting the role, added value and contribution/attribution of KCMC to business performance drawing upon interviews with both businesses and researchers. It is worth noting that during our discussions, consultees provided financial-related information that has informed the production of estimates of economic impacts. Given, however, the confidential nature of this information, no such data has been included in the production of case studies included in this report.

² <https://www.gov.uk/government/publications/the-magenta-book> and <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>

³ Additionality Guide, HCA, Fourth Edition 2014.

The Context

- 1.4. Established in 2009, KCMC has now been in operation for nearly seven years as a virtual centre of world-class capabilities and expertise in applied material chemistry bringing together industry and academia. Its ultimate aim is to enable companies to enhance their competitive position through application of cutting edge materials chemistry research while giving the opportunity to world-class UK research institutions to directly contribute to this objective. As clearly stated in its mission, KCMC's role in this process is *'to accelerate product and process innovation through collaborative R&D in materials chemistry'*.
- 1.5. Following an initial investment by the Northwest Development Agency (NWD) and founded with academic partners including the Universities of Bolton, Liverpool, Manchester and STFC, KCMC is now hosted by the Knowledge Transfer Network (KTN)⁴ and represents an expanding partnership between industry and the knowledge base currently comprising four university partners with the University of Bristol on board since 2015⁵, the Science and Technology Facilities Council (STFC)/Hartree Centre at Daresbury, Innovate UK and an Industry Steering Group, MC-SIG⁶).



- 1.6. Since 2009, KCMC has also gone through two contract renewals, the first with additional support from Innovate UK (2013) and the second, most recently, with additional support from the KTN (2015) – with £8 million core Government grant that has levered £24 million collaborative research income to date (at the end of calendar year 2015, consisting of £15 million competitively won grants and £9 million industry contribution).
- 1.7. Since the early days of the establishment of KCMC, significant changes have occurred within the innovation infrastructure, funding and operational environment within which KCMC and its partners operate, streamlining and refocusing publicly-funded business support to actively improve and accelerate the absorptive capacity of businesses and engage them in research while also putting in place strategies and targets for Universities and research centres to demonstrate relevance of their activities (including fundamental science and research) to businesses, economy and society and demonstrate impact. All these have happened within an increasingly competitive funding environment that places its emphasis on demonstrable returns on investment and seeks to rely less on grant funding over time and more on alternative financial instruments.

⁴ www.ktn-uk.co.uk

⁵ Cardiff University/Cardiff Catalysis Institute also joined for a year (2014-15).

⁶ Established by Innovate UK (the then Technology Strategy Board) in 2013 with funding for three years to support the alignment of KCMC with industry needs in the UK innovation landscape. The ultimate goal is to enhance UK capability to develop and commercialise novel materials to meet future requirements across multiple industry sectors.

- 1.8. At the same time, it appears that Henry Chesbrough's (a leading academic in this field), innovation brokers may be needed more than ever⁷ for a number of reasons that are discussed below:
- 'Open innovation' where firms and other stakeholders collaborate to develop new ideas is an area of increasing policy interest. This is because innovation entails significant problem solving, with solutions frequently sitting outside the existing capabilities of businesses⁸ - underpinning what Henry Chesbrough calls a business model of 'outside-in and inside out'⁹. However, as stated by Chesbrough, the open innovation model assumes that useful knowledge is widely distributed (and we would add, easily accessible) – but this is not always the case.
 - Within an era of information abundance, lack of, or imperfect, information remains a significant market failure – which in fact, it appears to have been accentuated, potentially inhibiting both, the development but also adoption of new ideas, products and processes.
 - The R&D market landscape has changed: R&D now grows in a variety of settings but private sector funding for early stage research and testing is a relatively scarce commodity. Research and innovation has traditionally been prevalent in the private sector, and in particular within large corporations. The last few decades, however, have seen a shift away from this practice as large organisations are 'rationalising' their operations, thus resulting in reduced overall innovation funding.
 - The impact of innovation and technology is, as ever, mediated by the capacity of people and organisations – their knowledge, skills and outlook – to identify, perceive and interpret what is possible with new science and/or technology. The market potential of science, however, could be of significant size. For example, significant market opportunities exist for enablers of technological and scientific advancements such as materials chemistry operating within a sector with massive growth potential - the chemicals sector, that is at the very foundation of the UK's manufacturing industries and is behind a wide variety of products, ranging from lightweight polymers, through to medicines, clean drinking water and even the food we eat¹⁰. It is already a multi-billion pound industry that has significant exports and employs people in high-value and highly skilled jobs. For the future, the vision set by the Chemistry Growth Strategy Group (CGSG)¹¹ is that, by 2030, the UK chemical industry will have further reinforced its position as the country's leading manufacturing exporter and enabled the chemistry-using industries to increase their Gross Value Added contribution to the UK economy by 50%, from £195 billion to £300 billion.
 - Furthermore, as material chemistry focuses on understanding the relationship between the atomic structure of a material and its overall behaviour, it is central to the design, manufacture, characterisation and understanding of materials that drive development of new products and processes across a wide range of sectors, and can equip the UK industry with accelerated global comparative and competitive advantage in a wide range of sectors including energy, health care and biomedical, electronics, transport and food & drink – that is as long as *innovation seekers* in this area (materials chemistry) and *innovation generators* can find, understand and trust each other.
 - Because of the structure of the chemistry-using industry in the UK, which is highly fragmented, and where new materials innovation is increasingly sourced from SMEs and Universities, there

⁷ Chesbrough, H (2006) *Innovation Intermediaries, Enabling Open Innovation*, HBSP, Boston, Mass.

⁸ Innovation Report 2014, March 2014, Department for Business, Innovation and Skills.

⁹ Open Innovation: A new paradigm for understanding Industrial Innovation by Henry Chesbrough, 2005.

¹⁰ STRATEGY FOR DELIVERING CHEMISTRY-FUELLED GROWTH OF THE UK ECONOMY, by the Chemistry Growth Strategy Group (CGSG), July 2013.

¹¹ The group was formed by senior industrialists was formed to identify priorities and recommendations that will accelerate national economic growth.

is a particularly pivotal role for knowledge brokers in this niche space, acting between Universities, SME's and wider industry.

- 1.9. Within such an environment, innovation brokers such as KCMC (but also science parks, business incubators, technology transfer teams and various others innovation agents), would try to overcome the barriers created by the nature of the innovations, the unrecognised value of innovations and the power of monopolies. They would identify opportunities for innovation that the current system undervalues. They would try to reduce the risks and increase the rewards of the innovation and importantly they broker relationships that mobilise an innovation. Nevertheless, and despite the apparent value of an innovation broker, in an increasingly competitive market of innovation brokerage services and constrained public sector funding, innovation brokers would also need to demonstrate their value to a wide range of sponsors including the private sector and also continuously explore various business models.
- 1.10. The added complexity for KCMC is that it 'brokers' a challenging area of work - materials often only represent a small fraction of the total value of the finished product. This of course could represent a fraction that makes the difference for a product carrying unique performance claims, or the element that gives the product the right feel or function – and hence making or breaking a successful commercial venture. However, attributing the value of these materials in the overall value of the end product may not always be a straightforward process.
- 1.11. The review is therefore timely to capture and demonstrate the value of KCMC and assist it in positioning itself in the UK innovation infrastructure. Viewing the value of KCMC in economic (development) impacts' terms alone such as turnover and Gross Value Added (GVA), would, however, miss other important outcomes including capacity building and awareness for both academic and industrial partners in applied materials chemistry and other areas and promoting and strengthening the research capacity of the UK. Therefore, in addition to estimating the economic contribution of KCMC to key business and economic performance indicators, the review is presenting selected case studies that demonstrate the role played by KCMC in enabling a stronger/accelerated flow of ideas to the market and proactively helping in the formulation and fast track delivery of collaborative R&D projects.

Report Structure

- 1.12. The remainder of the report is structured as follows:
 - **Section 2** presents an overview of KCMC, its activities and achievements to date.
 - **Section 3** provides an assessment of the economic impacts of the KCMC on businesses and ultimately the UK economy.
 - **Sector 4** summarises the results of consultations undertaken with businesses and KCMC stakeholders and presents a series of case studies on the role and impacts of KCMC.
 - **Section 5** presents our summary and conclusions.

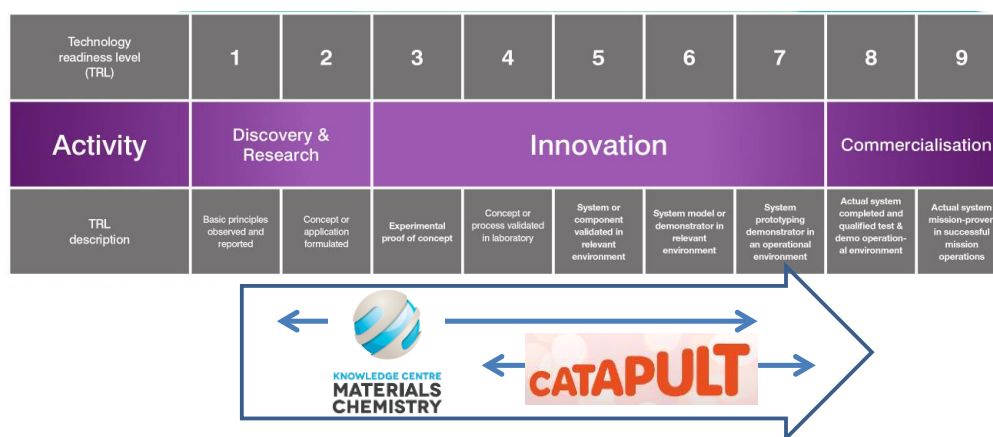
2. Overview of KCMC

- 2.1. This section provides an overview of the KCMC and its achievements against metrics agreed for KCMC in the Materials Chemistry Special Interest Group. These include: business engagements, in particular engagements with SMEs, and collaborative research income.

KCMC Areas of Interest and Key Activities

- 2.2. As noted in the introductory section, KCMC is a virtual centre that brings together industry and academia/knowledge base to drive innovation performance across a wide range of UK sectors and drive innovation-to-market timescales capitalising on the UK's world-class capabilities and expertise in applied material chemistry. More specifically, KCMC's mission is to accelerate product and process innovation for UK businesses through mainly collaborative R&D in materials chemistry, ensuring a connected innovation journey from TRL 1-7 (as shown in Figure 2.1).

Figure 2.1: KCMC in the TRL Chain



- 2.3. KCMC offers companies single-point access to its research partners, rapid project start-up via dedicated scientists, and ready access to support grant proposals. Figure 2.2 depicts how KCMC connects, facilitates and delivers in the innovation landscape.

Figure 2.2: KCMC Core Activities



Source: WECD based on discussions with the KCMC team.

- 2.4. KCMC catalyses innovation in advanced materials across applications in energy, health, home and personal care, transport, construction and ICT. The capabilities and expertise of the KCMC team cut across a number of applications and technologies, with major areas of expertise and interest in the following areas:

Energy and Sustainability

- Low carbon economy, fuel cells – solid oxide type and gas separation membranes, biofuels,

photovoltaics, piezoelectric, gas separation and storage, low energy materials of construction process route selection, design methodology;

- Materials challenges in the nuclear industry, including cleanup and waste reprocessing;
- Enhanced oil recovery: supercritical CO₂ compatible polymers & colloids for 'down the well' application; and,
- Sustainable materials and processing; renewable feedstock chemistry; CO₂ as a feedstock and incorporation into polymers; lead free ferroelectrics; microwave processing.

Electronics and Photonics

- Organic and inorganic semiconductors;
- Dielectrics (organic and high k inorganic);
- Nanoparticulate metals and semi-conductors;
- Devices, sensors and actuators; and,
- Spintronics.

Biologically Relevant Materials

- For medical devices;
- Regenerative medicine;
- Controlled / stimulated delivery of drugs, DNA, peptides; and,
- Anti-microbiological agents and biocides.

Formulated Products

- Multi-component products, direct write fluids, soft solids, discovering new solid forms, fire retardant agents and materials;
- Mesoscale modelling and design methodologies for property prediction and control;
- Construction and control of thin films on solid/flexible substrates and in free standing films and foams;
- Nano-crystal dispersion morphologies – control of colloidal stability, potential applications in dyes, pharmaceuticals; and,
- Control of morphology (crystalline, semi-crystalline and amorphous) in multi-component formulations, liquids, thin films and solids.

Multifunctional Materials

- Microporous materials, membranes, gas storage media, novel catalyst/ materials combinations; and,
- Smart packages, nanoparticles, tailored biomaterials, smart / functional textiles for controlled delivery of actives and/or enhanced functionality, high performance computing for material design and prediction of functionality.

New Composite Materials

- Three KCMC academic partners^[1] the Universities of Bristol, Bolton and Manchester – are playing^[2] a crucial role in delivering to industry new composite materials technologies. The University of Bristol is highly active in materials chemistry research, facilitated by several relevant EPSRC Centres for Doctoral Training (CDTs)^[3],^[4] which provide flagship national research, training and collaboration opportunities in Chemical Synthesis, Advanced Composites, Functional Nanomaterials, Catalysis, Diamond Science and Technology, and Theory and Modelling.

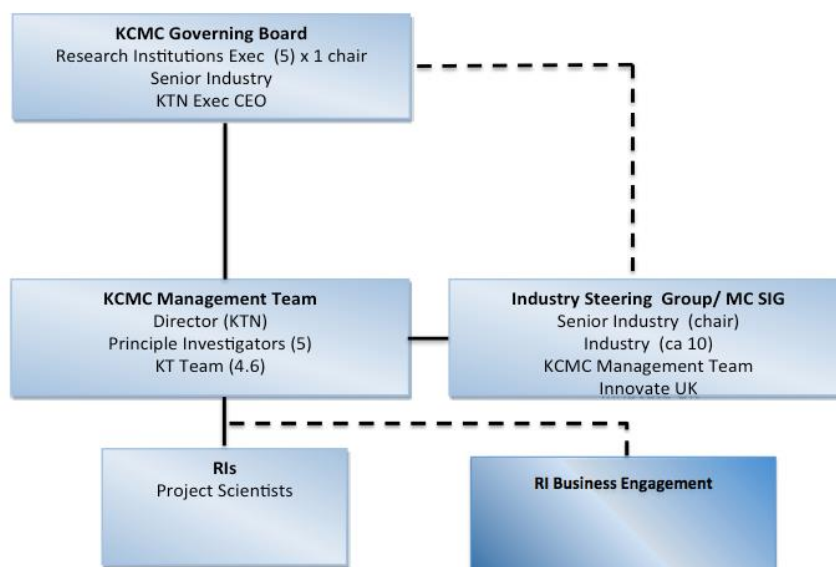
- 2.5. A review of the engagements that KCMC has been involved with to date indicates broad industry application illustrated by examples including:
- Catalyst specification and catalyst performance
 - Milling of materials
 - Medical textiles
 - Bio-transformations for chemical feedstocks
 - Lubricants
 - High neutron flux resistant materials and prediction
 - Photonic materials
 - Printed electronics
 - Graphene
 - Bio-materials
 - Data intensive computing
 - Thin film work with ALD (atomic layer deposition)
 - Sensor Technology
 - Piezoelectric materials
 - Advanced modelling for materials design
 - Energy materials

KCMC Business Model and Core Organisation

- 2.6. To deliver these, KCMC builds on the leadership skills of academics and industrialists, and brings them together in a coherent organisation with clear management accountability. This comprises an Industry Steering Group – the MC-SIG (see paragraph 1.5), chaired by a senior industry representative, an industry experienced, independently managed knowledge transfer team and flexible industry aligned research resources within the partner research institutions. As shown in Figure 2.3, the KCMC Governing Board oversees the work of KCMC. The latter comprises an executive leadership drawn from the five partner research institutes and industry representation (currently 2 companies). The core structure of KCMC requires dedicated knowledge transfer resources in the central KT team and science leadership from the partner research institutions, supported by industry focussed flexible project scientist resource.
- 2.7. The five knowledge base partners and Innovate UK support KCMC financially while the objectives of MC-SIG are to steer the work of KCMC based on:
- Identification of priority areas for materials chemistry collaborative research which support UK manufacturing industry growth strategies.
 - Work with other Knowledge Transfer Networks to maximise breadth of connection with industry needs.
 - Accelerating development and expansion of KCMC.
 - Continuous engagement and collaboration with knowledge intensive SMEs.
- 2.8. This approach enables timely and flexible connection of expert capabilities in the knowledge base with companies from a wide range of industry sectors, and has helped to address the needs of diverse companies drawing together the research interests of SMEs through to major multinational corporations.
- 2.9. New partners for KCMC are identified by the KCMC Management team and recommended for approval by the Governing Board on the basis of the following criteria:
- **Research Leadership:** Lead academics/research Institution with high level, well funded research, and well connected with industry;

- **Research interests:** The materials chemistry research interests of the lead are different and complementary to the research interests of the current KCMC research institutions;
- **Relationships:** Good academic relationships already in place and could be built upon to integrate the new research partner into the KCMC; and,
- **Institution strategy:** there must be the flexibility within the Research Institution to adopt the key elements of the KCMC business model i.e. Principal Investigators (PIs), Knowledge Transfer (KT) team, project scientists.

Figure 2.3: KCMC Governance and Management



Source: KCMC

2.10. In addition:

- KCMC is working closely with the Innovation theme of the Chemistry Growth Partnership – to coordinate activities and capitalise on potential growth areas such as composites and materials for energy generation and storage.
- KCMC is continuously exploring ways of collaborating with the Catapults. For example, areas where KCMC, KTN and Catapult industry experts from multiple sectors have worked together to accelerate innovation in 2014-15 have included:
 - Long-fibre reinforced composites
 - Solar fuels^[SEP]
 - Sensor technologies^[SEP]
 - Smart materials^[SEP]
 - Graphene commercialisation
- KCMC has provided major support through the Graphene SIG for relevant Innovate UK competitions and events.

2.11. Ultimately, the key goals for KCMC are:

- To create significant new opportunities for its research institution (RI) partners through new research revenue, high profile industry driven research collaborations and enhanced profile for the partners in the chemistry-using-industry.
- To achieve organic growth targets and two new strategic partners within 3 years.
- To deliver long-term value to the RI partners through:
 - In-depth understanding of RI capabilities;
 - Developing long term relationships with businesses;
 - Increasingly strategic and impactful project pipeline;
 - Interdisciplinary perspective on chemical science driven innovation; and,
 - Foresight on cross sector challenges where chemistry has a critical role.
- To strengthen the business model to make KCMC the preferred key UK partner for both privately and publicly funded materials chemistry collaborative research, and deliver public good support for risk limited innovation.
- To raise awareness of the impact of chemistry in solving global societal and business challenges and expand the vision of world leading knowledge transfer in materials chemistry.

KCMC Delivery Against Agreed Metrics

- 2.12. Metrics agreed for KCMC with the Materials Chemistry Special Interest Group include business engagements, in particular engagements with SMEs, and collaborative research income. Progress and achievements to date are summarised below.

KCMC Business Engagement

- 2.13. Review of the information held by KCMC shows that:

- 472 companies have been engaged with/through KCMC to date; and,
- There have been approximately 800 different types of engagements with these 472 companies. 87% of all companies have engaged once with KCMC and only a small proportion has engaged more than five times.

Figure 2.4: KCMC Engagements to date

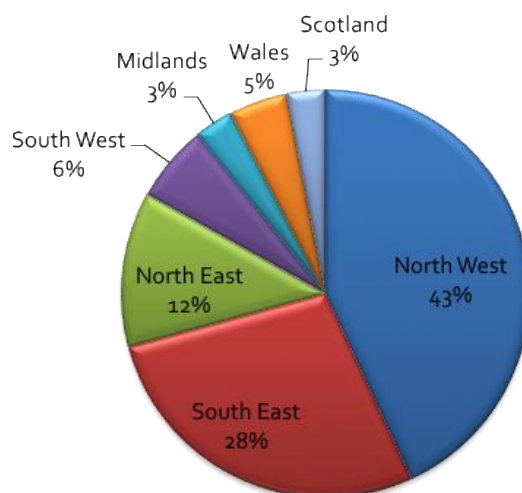
	Number of Companies	Number of Engagements (see note)
	410	1
	4	2
	35	3
	1	4
	18	5
	4	10
Total	472	≈800

Source: KCMC Database. **Note:** Each engagement represents a basket of activities (rather than one single activity e.g. discussion or meeting) and it may contain more than one type of activities/repeat activities with the same company leading to a project.

- 2.14. Examples of companies involved with KCMC include large corporates such as Astra Zeneca, Johnson Matthey, Solvay, Unilever but also small companies and start-ups such as ACAL Energy ([www. www.acalenergy.co.uk](http://www.acalenergy.co.uk)), Alphatek (www.alphatek.co.uk), Datalase (www.datalase.com), Chain Biotech (www.chainbiotech.com, at the Incubator, Imperial College London) and Ceres Power (www.cerespower.com, in Horsham, Sussex).

- 2.15. In fact, SMEs currently represent 39% of the total number of companies engaged with KCMC – mainly located in the North West, but with a relatively good spread across the country as shown by Figure 2.5.

Figure 2.5: Regional Engagement of KCMC with SMEs

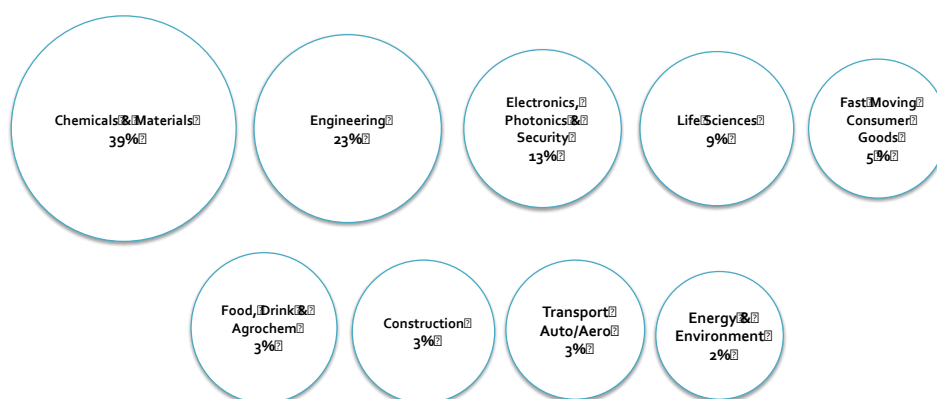


Source: WECD based on KCMC database

- 2.16. Sector analysis of companies engaged with (where information has been available) indicates that:

- **In terms of reach**, 4 in 10 companies engaged with KCMC are from within the Chemicals and Materials sector; 2 are in Engineering; 1 in Electronics, Photonics and Security and another 1 in Life Sciences (see Figure 2.6).
- **In terms of market presence (and potential economic impact and influence)**, however:
 - Measured in employment numbers of companies engaged, Life Sciences, Food & Drink and Engineering represent the key sectors engaged with KCMC (as shown in Figure 2.7).
 - Measured in turnover terms of companies engaged, Energy & Environment, Chemicals and Fast Moving Consumer Goods (FMCG) are the three most important sectors engaged with KCMC (as shown in Figure 2.7).

Figure 2.6: KCMC Engaged Companies by Sector (Broad)



Source: WECD based on KCMC and FAME Database¹²

¹² 405 companies in FAME database list (of 472 in KCMC).

Figure 2.7: KCMC Engaged Companies by their number of employees globally

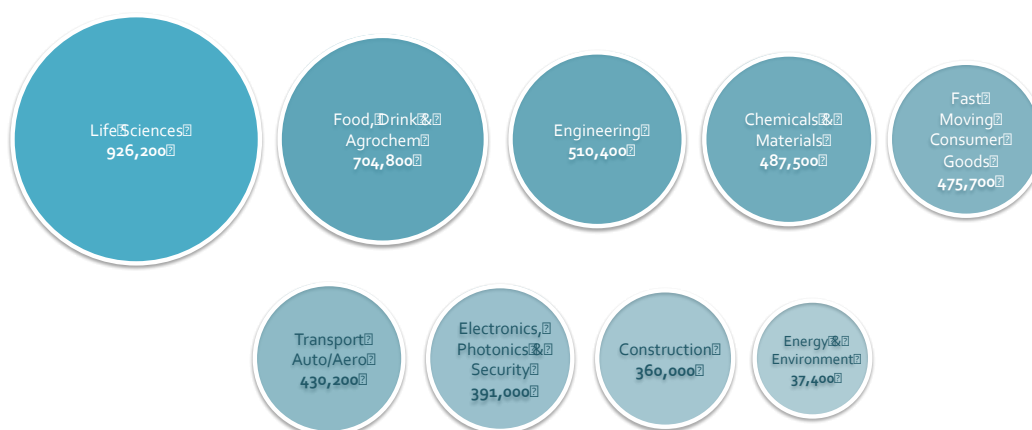
Source: WECD based on data from FAME Database¹³

Figure 2.8: KCMC Engaged Companies by their turnover



Source: WECD based on data from FAME Database

Collaborative R&D Income

- 2.17. As mentioned in paragraph 1.6, since 2009, KCMC has gone through two contract renewals, the first with additional support from Innovate UK (2013) and the second, most recently, with additional support from the KTN (2015) – with £8 million core Government grant that has levered £24 million collaborative research income to date by the end of calendar year 2015 (consisting of £15 million competitively won grants and £9 million industry contribution).
- 2.18. Figures 2.9 and 2.10 present KCMC annual income by contract year between 2010 and 2015. At the end of its sixth full contract year (April 1st 2015), KCMC had delivered projects to the value of **£19.4m (450% above the original government investment)**. It is worth noting that the **industry contribution** has increased on an annual basis over time and, overall, it **stands at 37% of total income** (compared with approximately 30% in the case of Catapults).

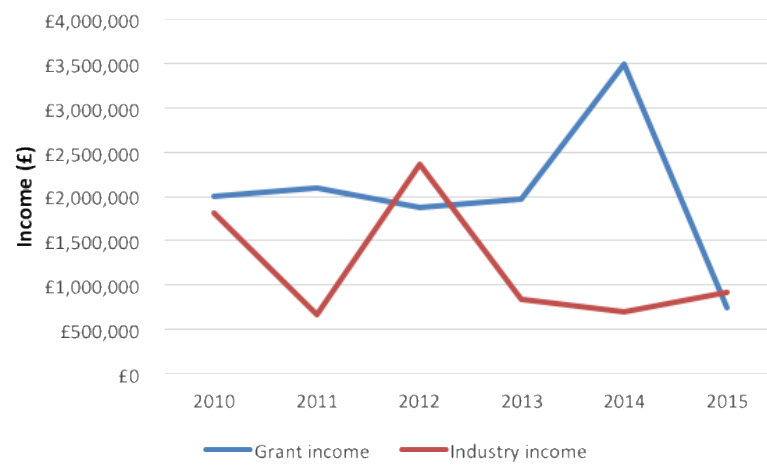
Figure 2.9: KCMC Income 2010-2015

Income	2010	2011	2012	2013	2014	2015
Grant income*	£1,999,109	£2,086,000	£1,868,891	£1,965,000	£3,486,504	£729,998
Industry income	£1,802,700	£657,000	£2,356,300	£826,000	£691,714	£905,981
Total	£3,801,809	£2,743,000	£4,225,191	£2,791,000	£4,178,218	£1,635,981

* Knowledge Transfer Grant Activity.

¹³ Some sort of financial or employment data for 255 out of 405 companies between 2007-2015.

Figure 2.10: KCMC Income by Source

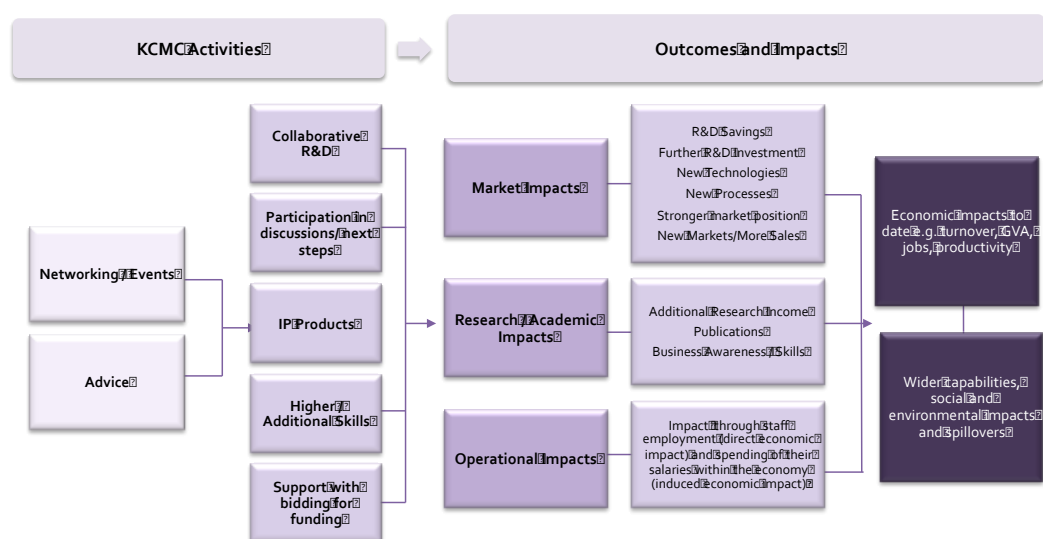


Source: KCMC

3. Capturing Economic Impacts

- 3.1. This section presents estimates of the current and future contribution of KCMC as the impacts of current activities are realised. The analysis presented here draws upon review of available background information and consultations undertaken based on contact details provided by KCMC. It needs to be recognised that this represents only a starting point and draws upon a range of assumptions that can be modified in the future, as more detailed information would become available.
- 3.2. KCMC and the companies engaged with KCMC currently collect very little information in relation to inputs and benefits associated with the impact of engagement on key business performance indicators e.g. Gross Value Added (GVA), jobs, productivity and/or market value that may arise as a result of the engagement with KCMC. Therefore, as well as a review of background data to the KCMC, the review has included in-depth consultations with eleven companies and five academic partners in order to explore qualitative and quantitative aspects of their engagement with KCMC including financial and wider benefits.
- 3.3. It is recognised that the companies interviewed represent only a very small sample of the work of KCMC. Nevertheless, information collected through the interviews with companies and the knowledge base provide useful context to better understand 'pathways to impact' i.e. from KCMC engagement to organisational and business impact (as shown in Figure 3.1 and described in the case study overleaf) and hence establish not only some early estimates of economic impacts arising from engagement with KCMC but also the added value that could be attributed to the involvement of KCMC.

**Figure 3.1: KCMC Engagement Logic Chain
Pathways to Organisational and Economic Impacts**



Source: WECD

- 3.4. Feedback from the consultations has, for example, shown that engagement with KCMC has led to:
- Savings in R&D costs (specialist skills and test equipment) represent the most common impact, directly leading to improved/higher turnover (and potentially contributing to higher profits and improved productivity).
 - Encouraging R&D that would have been unlikely otherwise (too expensive, risky or not thought to be possible) or would take longer to conduct.

- Leveraging further R&D support (significance and funding) as work has been proven as a result of KCMC input.
- Achieving competitive and comparative advantage i.e. first in the respective market, leading to increased sales and direct turnover improvements/access to new markets.
- Securing additional funding – for both businesses and the knowledge base.
- Trialling/developing new technologies and processes (that could also result to developing new products).
- Gaining access and/or entering new markets with ultimately positive impacts on sales and turnover.

3.5. The case study below provides an example of the value added gained by companies engaging with KCMC.



Nanoco (www.nanocotechnologies.com) is a world leading research, development and large-scale manufacturer of quantum dots and semiconductor nanoparticles. These can be used in displays such as TVs and phones, LED lighting, solar energy and bio-imaging. Nanoco's quantum dots do not contain heavy-metals which differentiates them from other quantum dot technologies. Nanoco's core technology revolves around the commercial scale production of high quality, cadmium and heavy-metal free quantum dots, called **CFQD** quantum dots, in a consistent and cost effective manner.

Challenge

As an R&D intensive company, Nanoco faces complex challenges with scaling up its business with high costs of development and often several competing technologies to choose from at each stage of development. Nanoco was interested in assessing the viability of one particular production technique.



Approach

Through KCMC, Nanoco was able to develop a project for proof of principle for a new production technique. Having done the initial work, Nanoco had enough confidence to do further testing leading to a prototype award from TSB and a grant for further feasibility testing.

Benefits

The key benefits of KCMC have been assistance in the development of a new-patented technique, development of a formal partnership with Liverpool University and access to specialist expertise.

KCMC Support

Nanoco has been involved with KCMC since 2009 and KCMC has provided the contacts and knowledge of expertise at Liverpool University as well as access to test facilities at below market rates. KCMC continues to provide valuable on-going networking opportunities and awareness of grant funding opportunities.



- 3.6. Estimates of various types of economic impacts and assumptions made to monetise these are presented below.

Market and Economic Impacts

- 3.7. Assumptions underpinning calculations of market economic impacts are based on feedback received during the consultations with businesses as follows:

- 65% of companies engaged with KCMC have already experienced positive impact on their turnover as a result of their engagement with KCMC (through either R&D costs gains or new markets). Furthermore, it is estimated that:
 - For 48% of these companies, impact has materialised within 2/3 years of engagement with KCMC (first engagement assumed in 2007/08); and,
 - For 52% of companies impact has materialised 4/5 years after their first engagement with KCMC.
 - Feedback indicates that commercial impact tends to be 2 - 5 years away from first engagement.
- It is also assumed that economic impact for the UK economy is generated through changes in the turnover of the businesses engaged (rather than jobs, profit or productivity, given that no consistent information could be established for any of these, at this stage at least). Of those businesses that have experienced a positive impact on their turnover to date following engagement with KCMC, it is assumed that:
 - One in 10 businesses have experienced high growth in their turnover – this is defined as £1 million increase in turnover.
 - Nine in 10 have on average experienced £300,000 increase in their turnover.
- 5% of businesses engaged to date expect to see positive returns in the near future i.e. by 2020.
- 30% have seen no impact to date and do not expect to do so in the future.

- 3.8. Additional metrics have been used to estimate Gross and Net GVA (cumulative) as follows:

- Approximate Gross Value Added (aGVA)¹⁴ in chemicals related industries¹⁵ at 28%-30% of turnover (ONS Data).
- Ready reckoners have been used for leakage, displacement and substitution effects as per Additionality Guidance (Fourth Edition, 2014):
 - Leakage¹⁶ has been calculated at 10% (given that projects are very specific and benefits will go to companies engaged in the UK).
 - Displacement¹⁷ effects have been calculated at 25% (there are expected to be some displacement effects, although only to a limited extent given the specific/innovative/unique type of projects undertaken i.e. activities undertaken are not reducing other similar activities).

¹⁴ aGVA= Income (main component of which is turnover) – Expenditure.

¹⁵ Standard Industrial Classification (SIC) Division 20 Manufacture of chemicals and chemical products (Revised 2007).

¹⁶ The proportion of outputs that benefit those outside of the intervention's target area or group.

¹⁷ The proportion of intervention outputs/outcomes accounted for by reduced outputs/outcomes elsewhere in the target area.

- It has been assumed that substitution¹⁸ stands at 0%, as there is no evidence to suggest that companies that get involved with KCMC substitute an existing activity or input for a similar one through KCMC to just take advantage of public funding.
- Multiplier effects could draw upon two different sources:
 - A multiplier effect of 1.5 based on ready reckoners provided by the Additionality Guidance; this multiplier indicates average local supply linkages and induced or income effects.
 - A GVA multiplier of 2.175 for the chemicals and chemicals-related industries (average/composite multiplier across 6 sub-sectors) – using ONS data.
- Given that, at this stage, there is no detailed information about the supply chain of businesses engaged with KCMC and the spillover of project benefits to it, the former multiplier has been used. Estimates can be adjusted in the future to reflect the latter, if additional information becomes available.
- For cumulative impacts, it has been assumed that impact is estimated to last over 5 years following materialisation.
- Net additional impacts i.e. turnover and GVA, have been estimated by using the standard methodology:

Net additional Impacts (income/GVA) = [Gross additional employment / businesses/income/GVA x (1 – Substitution) x (1 – Leakage) x (1 – Displacement) x Multiplier Effects]

Cumulative impacts have been estimated taking into account actual impacts to date and estimates of the persistence in the future.

Net Present Value (NPV) for GVA estimates at 3.5% discount rate (as per HM Treasury Green Book discount rate).

- 3.9. Figure 3.2 presents the end-estimates of these calculations i.e. gross and net GVA generated to 2020 by the companies engaged with KCMC to date (i.e. given impact persistence for 5 years).

Figure 3.2: Estimates of Gross GVA and KCMC Contribution to 2020

	Impact/GVA (based on businesses that have seen impact to date)	Future Additional GVA (based on businesses engaged to date ¹⁹)	Total
Gross GVA (NPV)	£205,000,000	£29,000,000	£234,000,000
Net GVA (NPV)	£145,000,000	£19,100,000	£164,100,000

- 3.10. It is worth noting that a more sophisticated model could be developed in the future to account for growth scenarios in industries/sectors that are highly related to materials and materials chemistry. For example, existing research indicates that there is a high growth potential in a number of areas within which companies engaged with KCMC operate:
- The specialty chemicals market has emerged as one of the most crucial chemicals segment across the globe. The global demand for specialty chemicals is expected to grow at a compound annual growth rate (CAGR) of 5.42% from 2015 to 2020.

¹⁸ Arising where a firm substitutes one activity for a similar one (such as recruiting a jobless person while another employee loses a job) to take advantage of public sector assistance. It can be thought of as 'within firm' displacement.

¹⁹ That gave stated that impact will materialise in the future, without taking into account businesses that could be supported/engaged in the future.

- The North American market for thermoplastic compounds reached 87.33 billion pounds in 2014. This market is expected to grow from 88.78 billion pounds in 2015 to 100.2 billion pounds by 2020, registering CAGR of 2.4% over the next five years.
- Global composites market is forecast to total US\$70bn by 2014. Due to the global shortage of the traditional materials, there has been an increasing need for alternative materials that are cost effective as well as environmentally friendly. The coming years represent a huge potential for composites materials that help lower carbon emissions and achieve cost savings. The market for composites end market in terms of value is expected to reach around \$90 billion by 2020, growing at a significant CAGR 7% to 9% from 2015 to 2020. The Asia-Pacific region dominated the composites market in terms of volume in 2014 and it is expected to grow at a higher CAGR, from 2015 to 2020.
- The Personal Care industry includes a wide array of products such as oral care, cosmetics, skin care, and hair care products and has been one of the most attractive markets in consumer products globally. Analysts forecast the Global Personal Care Ingredients market will grow at a CAGR of 4.54% over the period to 2018. The following companies are recognised as key players operating in the Global Personal Care Ingredients Market: Ashland Inc., BASF SE, Croda International plc, Dow Corning Corp., Solvay-Rhodia, AkzoNobel NV, Aston Chemicals Ltd., Biosil Technologies Inc., Clariant International Ltd., Eastman Chemical Co., Evonik Industries AG, Guangzhou Tinci Materials Technology Ltd., Huber Corp., Lonza Group Ltd., Momentive Performance Materials Holdings LLC, Royal DSM NV, Stepan Co., The Dow Chemical Co., Wacker Chemie AG. **[KCMC is already working with a number of these organisations]**.
- The battery and fuel cell industries have largely weathered the global recession and are poised to begin unprecedented expansion based on increased demand, opportunities to commercialize new technologies, and new applications and markets. The global advanced battery and fuel cell material value reached nearly \$19 billion in 2013. This market is expected to grow to \$27.9 billion in 2019 with a CAGR of 7.3% for the five-year period, 2014 to 2019.

Source: BCC Research

Research/Academic Impacts

- 3.11. As discussed in the next section, consultations with the KCMC partners in the knowledge base have identified a wide range of benefits that are attributed to the engagement with KCMC including additional reputational, business partnership/impact and financial benefits e.g. additional research income. However, this report is not intended to cover these impacts in depth.
- 3.12. In order to estimate direct economic impacts arising from this engagement in the future, it will be important to record both: additional research (and consultancy) income generated as a result of the KCMC introductions and an attribution indicator. In addition to the direct impact of additional research funding and consultancy income an indirect multiplier has been applied to reflect the wider impact on the economy of the additional activities that this income will support. The multiplier is based on the findings of the report *The Economic Impact of Higher Education Institutions*²⁰, according to which HEIs have an economic multiplier of 2.35.

Operational Impacts

- 3.13. The KCMC team and the team of researchers engaged in the work arising from collaborations with the industry also make a contribution to the UK economy through operational impacts i.e. their

²⁰ <http://www.universitiesuk.ac.uk/highereducation/Pages/ImpactOfUniversities.aspx>

employment (direct economic impact) and spending of their salaries within the economy (induced economic impact).

- 3.14. It is estimated that approximately 30 FTEs are fully involved in materials chemistry activities as part of the KCMC core team and through collaborative R&D projects on an annual basis; **their contribution to the UK economy is an estimated £2.9 million per annum** as shown in Figure 3.3.

Figure 3.3: Estimates of Operational Impacts

Variables	Estimates
FTEs (KCMC team and researchers involved in KCMC related projects)	30
aGVA per employee in scientific research and development (SIC 72) – 2014 ONS	£53,446
Direct contribution (aGVA)	£1.6 million per annum
Direct + Indirect and Induced contribution (GVA), based on 1.8 multiplier of scientific research	£2.9 million per annum

4. KCMC in the Innovation Landscape

- 4.1. This section summarises the high level results of the consultations with companies that have been engaged with KCMC and academic/research partners.

Companies

- 4.2. Companies were asked about their length of involvement with KCMC since its inception. The responses showed a complete range of timespans from those who had been involved from the start of KCMC to those who had only recently become involved.

- 4.3. Companies were also asked about the reasons of their engagement with KCMC. Their main responses are summarised below:

- The excellent knowledge of KCMC of networks and making connections, including:
 - Referrals made to the right/best place (hence minimizing transaction costs); and,
 - Understanding of UK Government-related issues: policy and funding.

As stated by one company: *'KCMC provides a relatively easy way of networking with hi-tech companies plus keeping in touch with local companies. It has also brought to our attention opportunities for grant funding.'*

- Where companies have their own in-house R&D capabilities, KCMC provides access to: specialist skills and equipment – **just in time** (i.e. in large corporates it would take time to get authorisation for accessing these), **affordable and de-risked** (which enables better management of risk and uncertainty in speculative products and matters in testing new concepts and ideas).
 - Where companies do not have their own resources for R&D, KCMC is excellent in identifying researchers/academics who have specific specialist expertise needed by the industry and are also willing to work with companies.
 - KCMC is also seen as having first class skills in not only understanding existing products and the need for replacement technologies, where relevant, but also highlighting potential commercial opportunities from emerging technologies. As stated by one company: *'We went into KCMC thinking it was a talking shop but it has had lots of practical value.'*
 - Companies highly commended the support received by KCMC in relation to IP/patents.
- 4.4. Companies were asked about their intensity of involvement with KCMC. Most highlighted numerous informal discussions, networking events and introductions to new contacts. However, the number and type of KCMC projects was a key focus of the discussion, these being the most intensive form of involvement. The average number of projects per company consulted was 3.5 with a range of 1 to 10 – most companies being in the 1-5 project category. Those more recent to KCMC had fewer projects.
- 4.5. When asked to rate the **extent to which initial expectations of KCMC had been met**²¹, the **overall rating from companies was 85%**. This is a high rating and would have been higher except that some companies said that the most significant benefits were yet to come. Most companies gave KCMC 4 or 5.
- 4.6. Companies were asked about the resource requirements they had to provide into the KCMC supported projects. Virtually all companies cited staff time as the main input, varying from ad hoc

²¹ On a scale of 1 to 5 where 5 was expectations fully met.

time to dedicated project resource. Many companies were also able to quantify the staff resource input, with it being costed in the region of £80k-£120k over the life of engagement with KCMC and the total number of projects undertaken (the average number of projects undertaken per company is 3.5 as cited in paragraph 4.4 above). Other inputs from companies have included providing data and materials for projects, manufacturing scale ups, IP and cash contributions. On the other hand, several companies highlighted that KCMC involvement had led onto access to larger grants such as those from Innovate UK. KCMC also gave several companies cost effective access to skills and resources, which would be otherwise difficult to access.

4.7. Companies were asked to rate the added value of the overall benefits arising from their engagement with KCMC (on a scale 1 to 5, where 5 equates to transformational and 1 to no difference made). On the basis of the scoring provided, on average, **84% of overall benefits would not have materialised without their engagement with KCMC and 65% of the financial benefits would not have materialised without the KCMC engagement.**

4.8. The nature of the specific benefits was as follows:

- Six companies particularly highlighted the value of new relationships and collaborations resulting from KCMC. As stated by one company: *'The main benefit of KCMC has been its connections and these have led onto new work.'*
- Six companies cited new products or technologies coming out of KCMC involvement. New market knowledge was also an important output.
- Four companies cited new patents.
- Several mentioned Knowledge Transfer Partnerships as key mechanisms in their interaction with KCMC.
- Qualitative benefits also included propelling the company's R&D function to main Board attention; influencing capital spending; building capabilities for the future and finding new knowledge and contacts for the long term.

4.9. Lastly, companies were asked to describe the best aspects of KCMC, what may have worked less well and where improvements could be made. The best aspects of KCMC could be summarised as follows:

- Seamless, responsive industry relationship/network
- Well managed, access to unique expertise, equipment and testing facilities
- Partnering non-competing industries
- Structured networking of high quality
- Very good connections and networks
- Awareness of funding opportunities
- Quick and responsive

4.10. As stated by companies:

'Without KCMC, how do you get to the point of finding out who to partner with? Brokering relationships has been key. Leveraging also important – learning from the expertise of others so you don't make the same mistakes.'

'We have tried partnering with other companies but it is hard to get it to work. It needs someone else in the middle who is impartial – and that is KCMC.'

'KCMC has propelled R&D division to a really strong position within the company.'

4.11. Companies also suggested some areas for improvement in the future, referring to both strategic and operational issues. These, for example, include:

- Conducting shorter meetings/events i.e. lasting no longer than 2 hours with shorter presentations;
- Recognise that industry works at a faster pace than academia;
- Regularly review companies' willingness for more involvement, in particular new ones, and provide opportunities for active engagement;
- Perhaps have company account managers to improve industry focus;
- Consider more technology-specific brokering and visits for KCMC staff in order to better understand specific industry challenges;
- Explore better connections with the Catapult network;
- Develop higher level networks within corporate organisations in related industries but also the financial services and the wider policy/funding environment;
- Improve visibility of KCMC and access through Innovate UK; and,
- Present the case and ultimately secure additional resources and funding for KCMC.

Key Partners and Stakeholders

4.12. Key partners were asked about the reasons of their engagement with KCMC. Their main responses are summarised below:

- From fundamental to near market science, KCMC has proved a valuable partner in finding the right audience in the private sector, performing three key roles:
 - a) Gateway to a larger network of businesses, in particular SMEs and the supply chain of OEMs; it fulfills a role that neither dedicated Business Development/Knowledge Transfer teams in Universities nor Catapults can fulfill. As stated by academic partners:
'This has been the best network we have been involved in.'
'The biggest benefit has been new contacts - this is where KCMC has added real value.'
 - b) Positioning science and research in the right business/industrial environment.
 - c) Translating science to commerce.
- Excellent knowledge of networks and connections, including:
 - Within the industry at operational/deliver level i.e. making things happen.
 - Impartial role: fully understanding the expertise of each University – no competition among current partners.
 - Understanding of UK Government-related issues: policy and funding.
- Ultimately supporting:
 - Raising the profile of research in the business community.
 - Generation of additional research income.
 - Assisting researchers and departments to demonstrate impact on business-related matters and establish collaborations/partnerships with the industry, in particular with SMEs. As stated by academic partners:

'Without KCMC we would have much more limited engagement with SMEs as this does not provide enough financial return'.

'KCMC has been very proactive at engaging with companies and the quality of engagement has been outstanding'.

- 4.13. When asked to rate the **extent to which initial expectations of KCMC had been met**²², the **overall rating from all partners was 100%**. Key stakeholders were also asked to rate the added value of the overall benefits arising from their engagement with KCMC (on a scale 1 to 5, where 5 equates to transformational and 1 to no difference made). Two of the respondents scored the value of the overall benefits 5, another 2 gave a score of 4 to 5 and one scored the added value as 4.

Case Studies

- 4.14. The following case studies aim to provide a better insight of KCMC's role in UK the innovation landscape.

Croda (www.croda.com) is a speciality chemicals company founded in

CRODA

1925. Its ingredients and technologies are found in many well-known industries and consumer products – the company

create, make and sell speciality chemicals that deliver real benefits to a

range of diverse products including health and beauty, home care, engine lubricants, plastics and many more. The company has a strong focus on innovation and product development. The

business is split into three core market sectors: **Personal Care, Life Sciences**, made up of: Crop Care and Health Care and **Performance Technologies**, made up of: Coatings and Polymers, Geo Technologies, Home Care, Lubricants and Polymer Additives. We also have an Industrial Chemicals business area. In all areas of our business our focus is on developing and delivering innovative ingredients sustainably



Challenge As an innovative company, Croda needs to keep up to date with the latest developments in markets materials and technologies. This can be time consuming and costly.

KCMC Support

Croda has been involved with KCMC since 2011 and the KCMC support has been about introductions, engagement with other companies, new connections and new market knowledge. The partnership has therefore been less about specific projects and more about enhanced market knowledge, introductions to new contacts in universities and companies including Croda clients, but beyond the normal customer contacts in those companies.

Benefits

The key benefits of KCMC include enabling Croda to get up to date on graphene, encapsulation, self-healing composites, lubricants and accessing valuable market knowledge on advanced ceramics. Croda staff knowledge, skills, connectivity and market knowledge have all been improved. A lot is now happening that would not have happened without KCMC and the support given by KCMC has enabled Croda to progress much more quickly than otherwise.

²² On a scale of 1 to 5 where 5 was expectations fully met.



NSG (www.nsg.com) is a world-leading manufacturer of glass, glazing systems and glass based products for **Construction** (glass for installation in new buildings and refurbishment), **Automotive** (supplying Original Equipment and Aftermarket replacement glass) and **Technical Glass** uses such as optoelectronics and glass fibre

composites. NSG's involvement with the UK market has been principally led by the acquisition of Pilkington in 2006. The company has manufacturing operations in 28 countries and sales in 130 countries worldwide.



Challenge

NSG is constantly innovating to develop new value-added products as ordinary float glass is getting commoditised. The company has a technology incubator to help connect with companies that have or are developing new materials and processes that can lead to new markets with value added glass products. Many new products involve glass coatings. Glass making is energy intensive so another challenge is to reduce energy costs.

KCMC Support

NSG's engagement with KCMC has been wide ranging with 50% of collaborations coming from KCMC networking and several specific projects emerging. KCMC support has been about networking introductions, new connections, new collaborations and innovations. The support given by KCMC has also enabled direct communication with UK government via Innovate UK. It has also led NSG R&D into thinking of newer materials and connections that has come about with the open innovation type discussions of NSG's needs with the KCMC team on a regular basis.

Benefits

Involvement with KCMC has led to discussions about exciting new materials development in start-up companies and university research projects such as two new glass coatings - a conductive coating and an anti-microbial coating. It has also given non-competing companies access to NSG technology which may lead to licensing opportunities. These developing links have helped raise the profile and contribution of the UK based R&D team's work programme within the global NSG senior management population. One example was the direct interest and involvement of the UK Glass Manufacturing Director in discussions with the KCMC university network in tackling fundamental challenges in glass manufacturing. Whilst some aspects would have been achieved without KCMC, the support has reduced the time otherwise required by 2-3 years.

Timeline

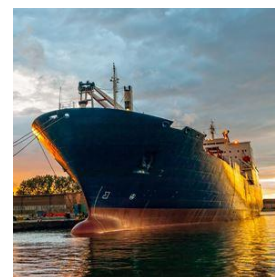
NSG has been involved with KCMC since 2009.

Infineum (www.infineum.com) is a world leading fuel and lubricant additives company. Its products reduce wear and extend the life of components. A joint venture between ExxonMobil and Shell, the company formulates, manufactures and markets its products to customers around the world. Key drivers of the business are environmental including fuel reduction, emissions reduction and the incorporation of biofuels.



Challenge

Infineum is constantly innovating to produce new and better products. An important part of that process is modelling. For example, using modelling to predict friction effects of different molecules can reduce development time. Infineum does not have that capability in-house. The company has also found that a lot of its challenges are similar to those in non-competing industries such as stability, formulation and direct properties. Household products, agrochemicals and personal care have similar challenges. But without the necessary contacts in other industries it is difficult to develop new partnerships to explore these issues.



Approach

Through KCMC, Infineum was able to be part of a collaborative project to access the modelling expertise of STFC Daresbury. Working alongside other non-competing companies the project used computational fluid dynamics to predict the low temperature waxing of fuel crystals.

Benefits

The key benefits of KCMC have been a reduction in new product development time, greater innovation and reduced development costs. It has enabled the company to hit the ground running and not wait for a PhD that might take a year to get going.

KCMC Support

KCMC brokered new relationships quickly and effectively and facilitated access to expertise that Infineum did not have in-house.

Timeline

Infineum has been involved with KCMC since 2012.

5. Summary and Conclusions

- 5.1. When launched in 2009 KCMC represented a response to an identified industry need for improved innovation in the chemistry-using industries (mainly based in the North West), capitalising on the fact that chemical technologies and innovation impact upon a high proportion of UK manufacturing and process industries, and the potential of leading edge materials chemistry to offer significant opportunities for competitive edge for UK companies in international markets.
- 5.2. This evaluation has shown that in the seven years since its establishment, KCMC has expanded, is well connected and has raised its reach, impact and profile beyond its original sectoral and geographical focus – and this expansion has not impacted negatively upon the quality of its offer; KCMC is highly rated by both businesses and academic/research partners.
- 5.3. More specifically, the key messages arising from the evaluation can be summarised against the specific evaluation objectives as follows:

KCMC achievements to date based on the metrics agreed for KCMC in MC-SIG i.e. business engagements, in particular engagements with SMEs, and collaborative research income.

- KCMC has engaged with around 500 companies to date (approximately 75-80 companies per year).
- 4 in 10 of these companies are SMEs.
- 4 in 10 companies supported by KCMC are from within the Chemicals and Materials sector, as it would be expected, and 2 in 10 are in the Engineering sector. KCMC also works with companies in the Energy & Environment, Life Sciences, Food & Drink and FMCG sector – these companies represent a smaller sample of companies in the KCMC portfolio but they are relatively large in terms of both their employment and turnover.
- North West remains an important location for KCMC engagements (it is also an important location for the Chemicals industry in the UK) – but 6 in 10 businesses engaged are located (HQs) outside the North West.
- At the end of its sixth full year (financial year 2015), KCMC had delivered projects to the value of £19.4 million ^[17] (150% above the original government investment). Industry contribution has also increased over time – representing 37% of total income at the end of 2015.

Perceptions of the Centre's achievements to date by key partners and businesses supported including exploring business views in the future contribution of KCMC.

- KCMC is regarded by both business and research partners as an impartial and knowledgeable gateway and broker that enables effective, efficient, de-risked and accelerated connections to be made between industry needs and scientific skills and offer – adding value and complementing other knowledge transfer vehicles including KT teams within Universities and Catapults.
- The original academic partners continue to support the Centre and new ones have been brought in – seeing it as the right vehicle not only to translate science and research for application in the commercial world and help in its implementation but also keeping them aware of industry technology needs and opportunities. The provision of knowledge transfer resource through an independent organisation provides an approach that complements their own central function resources, and delivers industry connectivity and practical understanding of how materials chemistry can drive industry innovation and commercial success.
- Businesses working with KCMC regard it as achieving growth and competitive advantage

directly for them – a personal, knowledgeable and trusted advisor that provides them with direct access to specialist skills and assets at an affordable fee. In particular, smaller companies and niche research teams that are more likely to have limited/constrained access to R&D assets particularly highly value KCMC.

- In the future, businesses would mainly like to see:
 - More resources for KCMC enabling more industry focus, perhaps a company account manager approach and more visits in order to better understand specific industry challenges;
 - Better connection to the Catapult network;
 - Recognition that industry works at a faster pace than academia;
 - Improved visibility and access through Innovate UK; and,
 - Development of higher level networks within corporate organisations in related industries but also the financial services and policy/funding environment

Assessing economic benefits and value added for businesses, key partners and stakeholders and the UK economy to date and providing estimates of the future contribution of KCMC over longer timescales as the impacts of current activities are realised.

The evaluation has shown that engagement with KCMC propagates economic benefits for the UK economy through various routes. For example:

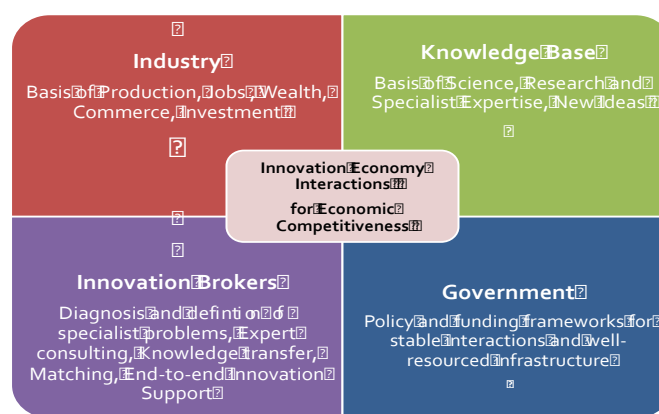
- Direct impacts on key business performance metrics e.g. sales, markets, costs and turnover, and indirect impact through this to the wider economy and supply chain.
- Direct impact on R&D expenditure by encouraging R&D that would have been unlikely otherwise (too expensive, risky or not thought to be possible) or would take longer to conduct.
- Leveraging further R&D support (significance and funding) as work has been proven as a result of KCMC input.
- Offering a cost-effective approach to exploitation of research and science to date, as both industry partners and the knowledge base capitalise on own assets for scaling-up and exploitation of new concepts, rather than investing direct KCMC resources in large scale prototyping and pilot scale facilities (that can be also offered by others in the economy e.g. Catapults).
- Securing additional research income and leveraging research funding for the knowledge base.
- In the absence of a broker facility such as KCMC, more transactions (and hence costs) would be needed to take place between the knowledge base and industry to lead to a successful R&D collaboration.
- Operational impacts through the direct employment of KCMC staff and support for the employment of researchers and the subsequent spending of their salaries within the economy (induced economic impact).
- On average commercial/economic impacts tend to be 2/3 - 5 years away from businesses' first engagement; this implies that it may be relatively early to capture all the economic impacts for businesses as a result of their engagement with KCMC. On the basis of a series of assumptions drawn from discussions with businesses, it is estimated that in total, **£234 million additional GVA for the UK economy can be attributed to enhanced business performance of businesses engaged with KCMC (to date)**. It is also estimated that, **approximately, 70% of this, i.e. £164 million, is net attribution to engagement with KCMC.**

- It needs to be recognised that the extent of net impacts on the UK economy depend on the size of the supply chain of businesses engaged, and the use, absorption and spillovers associated with new materials, products, processes as well as business/market decisions resulting from projects KCMC is engaged with. The above calculations assume a relatively modest multiplier of these activities given the lack of detailed information at this stage; however, these relationships can be considerable and taking them into account would substantially increase the difference made for the economy by KCMC-brokered projects.

Conclusions

- 5.4. This evaluation has taken place at a critical time in the lifetime of the science and innovation infrastructure debate in the UK. The UK Government recognises that research and innovation, and the skills to exploit them, are the essential components that will allow the UK economy to prosper and grow. The Innovation and Research Strategy for Growth, the Government response to Professor Wilson's Review of Business-University engagement²³ and the Annual Innovation Reports have all emphasised the importance of knowledge generation and knowledge transfer for the UK and improvement of the UK performance globally – economically and in terms of well being.
- 5.5. At the same time, it is recognised that organisations, relationships and flows of money and knowledge by which innovation can be translated into jobs and wealth, i.e. the innovation ecosystem, is a complex one²⁴. Furthermore, as discussed in the earlier sections, innovation brokers may be needed more than ever²⁵. The success of the Triple Helix model – i.e. capitalising on knowledge to pursue innovation and economic competitive advantage, has evolved to involve various others functions in order to enable the innovation/knowledge-base economy work efficiently – including innovation brokers in a fourth strand (as shown in Figure 5.1)²⁶.

Figure 5.1: Innovation Brokers – the Fourth Helix



Source: WECD

- 5.6. Extensive literature exists in relation to how innovation brokers link with other partners in the innovation economy i.e. their business models and what type of services they offer. The evaluation has shown that the KCMC model has been a successful model to date. However, the increased significance of brokering roles in the innovation-driven economy also means that various brokers and models have emerged (and will be emerging in the future) to deliver this function, thus making

²³ Following up the Wilson review of business- university collaboration, Next steps for universities, business and Government, JUNE 2012.

²⁴ Bridging the valley of death, Science and Technology Committee, Eight Report.

²⁵ Chesbrough, H (2006) Innovation Intermediaries, Enabling Open Innovation, HBSP, Boston, Mass.

²⁶ THE ROLE OF INNOVATION BROKERS IN A KNOWLEDGE ECONOMY THE FOURTH STRAND TO TRIPLE HELIX, by COECON, submitted to Triple Helix XI International Conference London, July 2013 (Collaborative Economics 520 S. El Camino Real, Suite 710 San Mateo, CA 94022).

the market more competitive.

- 5.7. Nevertheless, going forward, a number of opportunities exist for KCMC, capitalising on its success and demand for its services by both, industrial and knowledge base partners as well as the Government's commitment to put the UK at the forefront of research. These are presented below and some represent generic opportunities for continuous improvement and growth while others require a step change.

Objective	Continuous improvement	Step change
Inform and influence sector, regional and national innovation strategies.	Maintain and develop the linkage of KCMC with industry sector/innovation strategies.	Develop connections with local and sub-regional economic development agents in key priority areas.
	Identify societal issues and linkages that materials chemistry/new technologies would make a difference and inform both industry and knowledge base.	
Continue matching world-class scientific expertise and businesses.	Sustain and develop the relevant pipeline of innovation seekers and problem solvers - with project scientists and the SME focus at the heart of the offer.	Build critical mass by further expansion of the KCMC to deliver the vision for accelerated new materials innovation across the UK.
	Explore/better understand developmental and capacity building needs of both, industry and knowledge base – ensure that liaisons exist at both strategic and delivery levels within partner organisations.	
Further strengthen experience sharing, collaborations and networks – implement open innovation (safeguarding trust and confidentiality).	Raise own profile and profile of industrial and academic partners through showcasing of their successes.	
Engage and influence the full end-to-end innovation support line.	Make referrals/connections to other business services including legal and capital sources.	Seek to develop more strategic relationships as part of the KCMC partnership with the Catapults.
Continue providing diagnosis and definition of specialist problems in materials chemistry and expert consulting (IP, funding).	Clarify/disseminate the overall and specific offer and services.	Further explore the need for dedicated account managers and new funding models.
		Review current metrics (that currently only capture reach of KCMC's activities) to include economic and societal benefits; additional innovation outputs; capacity building of knowledge base institutions and businesses; and sectoral and regional benefits.

- 5.8. Reviewing, demonstrating and showcasing the economic value of KCMC to internal and external stakeholders on a regular basis will require additional resources but it will also enhance the credibility of KCMC and raise its profile. Outcome measures to be put in place could include:
- Intellectual property (IP) data – including new IP registered and value of IP.
 - Technology transfer data – including number and value of licensing agreements and/or value of sale of IP from academia to industry.
 - Environmental impacts arising from the introduction of new materials/products as a result of

projects that KCMC has been involved with.

- Economic impacts – such as employment, turnover and profits resulting from projects that KCMC has been involved with.
- Skills Development – in particular given the role KCMC is playing in supporting such programmes as the Knowledge Transfer Partnerships (KTPs) programme.

- 5.9. To be able to report back on these outcomes, KCMC will need to collect and collate a wide range of project monitoring data - monitoring data will need to provide a range of information on the technical progress of projects alongside longitudinal data relating to the activity of the businesses that are involved in collaborations e.g. R&D activity and further investment, new products developed, estimated value of new markets. Most importantly, consideration should be given to post-project monitoring i.e. monitoring of projects following the completion of the project (perhaps on an annual basis), to more completely capture the technical and commercial effects of KCMC supported projects.

APPENDIX A – LIST OF CONSULTEES

Businesses	Contact
ACALenergy	Andy Creeth
CeresPower	Bruce Girvan
WilliamBlythe	Chris Rainford
Croda	Damien Kelly
ScottBaderCompanyLimited	Dean Bugg
NSG	Dr. Su Varma
Photek	Gareth Jones
Victrex	John Grasmeder
NanocoTechnologiesLtd.	Lelsey Smith
Infineum	Peter Dowding
JohnsonMatthey	Stephen Poulston
KnowledgeBasePartnersandKeyStakeholders	Contact
UniversityofLiverpool	ProfessorMattRosseinsky
UniversityofManchester	ProfessorMikeTurner
Bristol	DrDuncanWass
UniversityofBolton	ProfessorBaljinderKandola
InnovateUK	ChrisWarkup
CPI	Dr.GrahamHillier
NationalCompositesCentre	ProfessorPeterChivers
STFC	Dr.PaulSherwood

APPENDIX B – CONSULTATION SCRIPT

Background and Context

WECD has been commissioned to undertake an evaluation of the Knowledge Centre for Materials Chemistry (KCMC). Commissioned by the KCMC Board, the evaluation aims to assess the actual and potential economic impacts of the KCMC over its life and into the future. We are keen to capture the impacts resulting from your involvement with the KCMC. Any views expressed will not be directly attributed to your company so you should feel free to offer frank and honest views. In some cases we may wish to follow up with case studies, in which case we will contact you to get your agreement on content and publishing.

A – Categorisation Data

A.1 – Company Name

A.2 - Contact name

A.3 – Contact Position

A.4 - Brief overview of company involvement with KCMC

- Date of first involvement (if known) or short, medium/long term involvement
- Number of interactions/projects (including any on-going)
- Motivation for initial and on-going involvement

A.5 – Taking into account your initial expectations of being involved in KCMC, to what extent were these expectations met? Please use a scale where 5 means *fully met* and 1 means *not met at all*

5 4 3 2 1

B – Project Inputs

B.1 – Please provide details of any inputs your company has made to KCMC projects:

- Financial investment (£amount and source including public and private)
- Staff time and grade
- Equipment
- Premises

C – Project Outputs, Outcomes and Impacts

C.1 – What have been the benefits of KCMC interaction to your company?

- New products/techniques
- New patents
- New markets (sector or geography)
- Improved competitive position
- Enhancement of company strategy
- Increased sales turnover
- Increased profit
- New or closer partnerships/collaborations
- Improvement in staff skills
- Enrichment of staff

→ Other?

C.2 – Taking all factors above together, how would you rate the KCMC in terms of benefits to your company? Please use a scale where 5 means *transformational* and 1 means *no difference*

5 4 3 2 1

C.3 – Taking the financial benefits specifically, please attribute them to KCMC? Please use a scale where 5 means *fully due to KCMC* and 1 means *not due to KCMC at all*

5 4 3 2 1

C.4 - What other support is or has been available to your company (aside from KCMC)?

D – Additionality

D.1 – In the absence of KCMC, to what extent do you think you would have achieved the benefits above anyway?

E – Lessons Learned

E.1 – What are the best aspects of KCMC?

E.2 – What has worked less well (if anything)?

E.3 – What potential improvements could be made?

E.4 – Any other comments to make on KCMC?

Thanks and Close