

# Lord Stern's review of the Research Excellence Framework - response form

The call for evidence is available at:

[www.gov.uk/government/consultations/research-excellence-framework-review-call-for-evidence](http://www.gov.uk/government/consultations/research-excellence-framework-review-call-for-evidence)

The closing date for responses is **Thursday 24 March 2016**.

Please return completed forms to:

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If you want information, including personal data, that you provide to be treated as confidential, please explain to us below why you regard the information you have provided as confidential. If we receive a request for disclosure of the information, we shall take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the department.

I want my response to be treated as confidential

Comments:

**We have combined some of the questions in this response which we felt had overlapping themes**

## Questions

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Please check the box that best describes you as a respondent to this consultation

	<b>Respondent type</b>
<input type="checkbox"/>	Alternative higher education provider (with designated courses)
<input type="checkbox"/>	Alternative higher education provider (no designated courses)
<input type="checkbox"/>	Awarding organisation
<input type="checkbox"/>	Business/Employer
<input type="checkbox"/>	Central government
<input type="checkbox"/>	Charity or social enterprise
<input type="checkbox"/>	Further Education College
<input type="checkbox"/>	Higher Education Institution
<input type="checkbox"/>	Individual (Please describe any particular relevant interest; teaching staff, student, etc.)
<input type="checkbox"/>	Legal representative
<input type="checkbox"/>	Local Government
<input checked="" type="checkbox"/>	Professional Body
<input type="checkbox"/>	Representative Body
<input type="checkbox"/>	Research Council
<input type="checkbox"/>	Trade union or staff association
<input type="checkbox"/>	Other (please describe)

If you selected 'Individual,' please describe any particular relevant interest; teaching staff, student, etc

Comments: [Click here to enter text.](#)

If you selected 'Other,' please give details

Comments: [Click here to enter text.](#)

### About us

*With over 54,000 members and a knowledge business that spans the globe, the Royal Society of Chemistry is the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world.*

*A not-for-profit organisation with a heritage that spans 175 years, we invest in educating future generations of scientists, we raise and maintain standards and work with industry and academia to promote collaboration and innovation. We advise governments on policy and we promote the talent, information and ideas that lead to great advances in science.*

### **Executive Summary**

The Royal Society of Chemistry welcomes the opportunity to respond to the above consultation, and would be pleased to continue working with the Government as plans develop and further details are available. This response has been prepared in consultation and discussion with members of the chemical sciences community, including members of the Heads of Chemistry UK group (HCUK)<sup>1</sup>. In this response we have focused on the Research Excellence Framework 2014 assessment undertaken by Main Panel B: UOA 8 (Chemistry) which most closely aligns with our membership as a professional body.

### **Impact of potential changes to the Research Excellence Framework**

- The costs of the REF to institutions and HEFCE should be reduced where possible, but a balance will need to be struck to maintain the quality and effectiveness of this exercise.
- There are well-established metrics for assessing some types of outputs; some of these could complement peer review but not replace it, so their introduction is unlikely to reduce the total burden of the REF.
- Introduction of a metrics-based element in the assessment of outputs could make the REF a more inclusive process by allowing a greater number of research-active staff and more outputs to be included.
- The disadvantages of metrics-based assessment of outputs, such as the difficulty of applying them consistently across fields and sub-fields should be carefully considered if they are to be introduced.
- Impact case studies were a welcome addition to REF 2014. The broad definition of impact should be retained but should be widened to capture skills development and breakthrough academic impacts.
- Research Environment may be an area where more opportunities exist to use an element of metrics-based assessment to provide greater transparency.
- Aggregating the Units of Assessment would likely diminish the positive influences of the REF without decreasing the administrative burden on institutions.

## **REF impact on strategic planning and decision making**

- Information captured in the REF can be useful in demonstrating the value of research to society and has been used by the Royal Society of Chemistry to demonstrate the impact of chemistry research. There is no particular need for additional information to be captured as part of the REF exercise.

## **REF influence on constructive behaviours**

- The balance of weighting between Outputs and Impacts should be maintained to ensure that fundamental research is not disadvantaged.
- The measures introduced to support interdisciplinary research in REF2014 should be retained but there is a need to communicate the associated assessment criteria more clearly.
- Guidance on assessment criteria for outputs, particularly for those other than journal articles, could encourage more diverse research and therefore submissions.
- While a process exists in principle to handle impact case studies with confidential information, there is currently little incentive for industrial partners to participate.

## **REF influence on academic behaviour**

- The assessment of research output by an expert panel with double blind assessment, while time intensive, remains a rigorous method of assessment and is therefore driving excellence.
- The impact of research is, in some cases, now being considered earlier in the research process as institutions and individuals seek to identify potential case studies.
- QR funding allocated in the REF should continue to serve as baseline funding for institutions to invest in infrastructure and fund curiosity-driven or early-stage research.
- There is evidence that in some institutions the REF is generating institutional pressure to publish in high impact journals.
- The REF encourages staff movement between institutions within the 'transfer window'. This incentivises departments to hire early career researchers, but can also be disruptive.
- Within chemistry, some use of metrics-based assessment could allow assessment of all research active staff, which could prevent or mitigate perceived "gaming" of the REF system.

## Section 1

**The primary purpose of the REF is to inform the allocation of quality-related research funding (QR).**

1. What changes to existing processes could more efficiently or more accurately assess the outputs, impacts and contexts of research in order to allocate QR? Should the definition of impact be broadened or refined? Is there scope for more or different use of metrics in any areas?
2. If REF is mainly a tool to allocate QR at institutional level, what is the benefit of organising an exercise over as many Units of Assessment as in REF 2014, or in having returns linking outputs to particular investigators? Would there be advantages in reporting on some dimensions of the REF (e.g. impact and/or environment) at a more aggregate or institutional level?
4. What data should REF collect to be of greater support to Government and research funders in driving research excellence and productivity?
9. Are there additional issues you would like to bring to the attention of the Review?

**The costs of the REF should be reduced where possible, but a balance will need to be struck to maintain the quality and effectiveness of this exercise.** REF2014 was estimated to have cost the Higher Education community £232m and HEFCE and other funding bodies £14m<sup>ii</sup>. Any efficiencies should ensure the positive qualities and benefits of the REF are retained and further load is not placed on research staff and HEIs.

Peer review underpins the REF and, while this is a labour intensive process, it is still well regarded within the wider academic community. Analysis produced in the *Metric Tide* report<sup>iii</sup> concluded that a wholly metrics-based approach would not provide a like for like replacement for peer review. The introduction of any metrics-based assessment would need to be in addition to the current requirements so it is difficult to see how this will reduce the cost or net administrative burden of the REF.

Any changes to the REF should be considered in light of impact on the continuity and clarity of the process. Major changes to the assessment process will have administrative and therefore financial implications for the institutions involved. Ensuring universities are clear on all aspects of the assessment criteria of the REF from an early stage will allow them to monitor and record successes in the run up to the next research assessment.

We would welcome the opportunity to work with HEFCE to develop any changes to the assessment process and report some initial points to consider in relation to output, impact, research environment and UOAs.

### Outputs

**There are well established metrics for assessing some forms of outputs; some of these could complement but not replace peer review, so their introduction is unlikely to reduce the total burden of the REF.** Journal papers were overwhelmingly the largest category of output submitted to Main Panel B: UOA 8 (Chemistry), accounting for 99.8% of submissions. A detailed correlation analysis of REF2014 scores<sup>iv</sup> completed alongside the *Metric Tide* report looked at how well different metrics

agreed with the outcomes of the REF peer review process. The analysis found that while the outputs in main panels A and B were more likely to have a statistically significant relationship with a range of metric indicators than those from other panels they still did not correlate with a sufficiently high degree of precision and sensitivity which are defined as “precision, which is the proportion of predictions of REF 4\* outcomes that were indeed assessed as REF 4\* (correct predictions); and sensitivity, which is the proportion of REF 4\* outputs identified by the metric prediction”.

Our members’ responses showed that there was a variety of perspectives on the increased use of metrics for the assessment of outputs. Where there was support for the introduction of a metrics-based element in the REF it was predominantly for assessment based on citation data rather the journal impact factor.

Potential benefits of introducing a metrics-based element in addition to peer review in the REF assessment are:

- **Well understood metrics are available to analyse the majority of outputs submitted to Main panel B, including Main Panel B: UOA 8 (Chemistry).** Some of our members believe that greater use of assessment based on citation metrics would simplify the REF. A high number of outputs submitted to UOA 8 had a Digital Object Identifier (DOI) which can easily enable metrics-based analysis. Journal articles represented the vast majority of outputs submitted to main panel B and 99.8% of those submitted for chemistry<sup>v</sup>.
- **Potential to assess a greater number of outputs per academic.** Metrics-based assessment is perceived to be less labour-intensive and so more outputs could be submitted per person. Some of our members felt that the submission of only 4 outputs per academic did not adequately reflect the breadth and quality of the research output of a researcher in the field of chemistry.
- **Metrics-based assessment could allow all research contract staff to be included in the REF process.** A number of our members commented that one challenge presented by the REF process is the amount of time spent by institutions selecting research staff and outputs for submission. Not being selected for submission was seen as being damaging to those researchers who were not included. The possibility of selecting academics was also seen by some of our members as a means to “game” the system.

These need to be balanced against drawbacks or limitations of the use of metrics for analysis of outputs:

- **Analysis by citation data has been shown not to correlate with expert peer review:** The metric which was considered to be most applicable to the chemistry outputs by the community was citation data. Analysis of chemistry outputs in the *Metric Tide* correlation analysis report showed that while the sensitivity was reasonable with 82.5% of REF 4\* outputs identified, the precision was much poorer with only 52.1% of the results agreeing with the REF2014 results. Field weighting of citation count to account for trends within chemistry only marginally increased the precision to 55.5% but decreased the sensitivity to 67.5%.
- **Metrics-based assessment is perceived to be easier to “game”.** We have heard concerns that increased use of metrics in the REF assessment would

increase attempts to “game” the REF, for example by trying to artificially inflate citation counts.

- **Metrics-based assessment may not be as applicable to other REF Panels.** Our members recognised that increased metrics-based analysis might not be suitable for disciplines where a significant number of submitted outputs do not have a DOI. This means that metrics might not be suitable for inclusion in assessments by all panels. The possibility of having different assessment processes for different panels would increase the complexity of the REF and could make comparisons between different disciplines less reliable.
- **Any metrics-based assessment would need to account for differences in sub-fields within a discipline.** Basing assessments on citation data may be difficult to apply across the board due to the different citation patterns found even within a UOA. For example, the citation pattern within physical chemistry is markedly lower than, for example, biochemistry but this does not reflect the relative quality of research in the two areas.
- **Metrics-based assessment could distort the research topics studied by overly favouring highly cited “hot” topics.** Some respondents believed that an increased use of bibliometrics would unconstructively influence research direction by pushing researchers to hot topics which they believed would be highly cited and accepted by journals with high impact factors.

## Impact

**The definition of impact for REF2014 was overall sufficiently broad to capture much of the wide range of contributions that chemistry research makes to all aspects of the wider society beyond academia.** Case studies were a welcome addition to REF2014 and demonstrated the impact of chemistry in a range of areas including economic, environmental, wider societal and policy impacts.

Changes to reporting impact which could be considered include:

- **More detailed guidance on how to prepare case studies will ensure a level playing field for assessment.** Main Panel B: UOA 8 (Chemistry) noted in their overview report the “need in a number of cases for HEIs to be given more guidance about how to write a successful template and case study”. Impact should be assessed based on the contribution of the research rather than the ability of the institution to prepare compelling text.
- **Guidance on how certain types of data are to be reported would improve the comparability of the case studies.** It would enable more effective identification of any subsequent analysis, for example by funding bodies and Government. The templates should however not be so prescriptive that they restrict the breadth of impacts which can be submitted by restricting the measures which can be reported.
- **The definition of impact should be expanded to include the contribution of research to creating a highly skilled workforce.** The Main Panel B: UOA 8 (Chemistry) report commented on the broader range of impacts relating to skills which are not captured by the current criteria, referring to “the training of research students who use their skills to benefit the economy and

society in a wide range of different professions". The training of PhD and post-doctoral researchers with outstanding analytical and problem-solving skills as well as the ability to design and deliver complex scientific research projects is key for a high-growth knowledge-based economy. Acknowledging and therefore incentivising this impact would support the Government and research funding agencies in driving research, innovation and ultimately productivity.

- **Impact statements should recognise milestone academic achievements.** Some respondents also thought that research which has had a major academic impact, such as creating a new field of research within or beyond a specific discipline, should also be eligible for inclusion as an impact statement.

## Research Environment

**Research Environment may be an area where more opportunities exist to use increased metrics-based assessment to provide greater transparency.** Some members of our community expressed concern that the criteria by which Research Environment were evaluated were unclear. These members commented that the inclusion of an increased weighting towards metrics-based assessment in this area would be transparent and provide an objective evaluation of these submissions.

**Not all components of this area should be metricised as this would decrease the value of the Environment template in encouraging departments to think strategically.** Some of our members commented on the positive impact of the Environment template on their departments' strategic development. Additionally, aspects of the 'people' component, such as measures to support diversity could not be adequately assessed by metrics alone.

**The timeframe covered by Research Environment should be considered; major investment within a UOA impacts longer than a single REF period.** The impact major strategic investment within a UOA, such as building new chemistry facilities, often continues to improve the research environment far beyond the REF period in which those investments were made and should be considered in subsequent assessments.

## Units of Assessment

**Aggregating the Units of Assessment would likely diminish the positive influences of the REF without decreasing the administrative burden on institutions.** The REF sphere of influence on chemistry research is wide, with impact on collaborative research, interdisciplinary research, career choices and in driving strategic thinking at a department level. If elements of the REF were to be reported at an aggregate level there is a risk of losing the benefits of the assessment process within chemistry. It would also make comparisons of departments in different institutions difficult, which some of our members view as an important component of the REF. Institutions would still have to undergo the administrative process of selecting research staff and preparing their REF submissions so it is not clear how aggregation would significantly reduce their net administrative burden.

## Section 2

**While the primary purpose of REF is QR resource allocation, data collected through the REF and results of REF assessments can also inform disciplinary, institutional and UK-wide decision making.**

3. What use is made of the information gathered through REF in decision making and strategic planning in your organisation? What information could be more useful? Does REF information duplicate or take priority over other management information?

**Information captured in the REF can be a valuable source of information to demonstrate the value of research.** Economic evidence captured in the impact case-studies has been used by the EPSRC<sup>vi</sup> as well as by the Royal Society of Chemistry<sup>vii</sup> to demonstrate the value of UK research to a wider audience, including members of the public and policy makers.

**The work required to prepare REF submissions, as well as the final results, are used by some departments to renew their strategies.** The process of preparing for the REF is used by some institutions to make strategic decisions such as regarding recruitment of teaching and research staff, as well as associated career paths. The results of the REF assessment were reported to be used in some institutions to refresh strategies and determine investment between departments. The results were also used for bench-marking against other institutions which can be used as a factor to drive improved performance within departments.

**There was no strong call for additional information to be captured as part of the REF assessment from members of the chemistry community.** Our members generally commented that the range of information captured in REF2014 was sufficient.

## Section 3

### **The incentive effects of the REF shape academic behaviour, such as through the introduction of the impact criteria.**

5. How might the REF be further refined or used by Government to incentivise constructive and creative behaviours such as promoting interdisciplinary research, collaboration between universities, and/or collaboration between universities and other public or private sector bodies?

**The balance of weighting between Outputs and Impacts should be maintained to ensure that fundamental research is not disadvantaged.** The Dowling Review of Business-University Research Collaborations<sup>viii</sup> recommended that the rating given to Impact should be maintained or increased to stimulate collaboration with industry. Some of our members commented that the requirement to demonstrate impact is already discouraging some researchers from pursuing curiosity driven “blue skies” research which is vital in maintaining UK core capability in research excellence and enabling transformational research. Such research will underpin and drive innovation on timescales extending beyond any one REF period and is another reason to consider including milestone research breakthroughs as eligible for inclusion in impact case studies.

**The measures introduced to support interdisciplinary research in REF2014 were welcome and should be retained.** Main Panel B: UOA 8 (Chemistry) noted in their report that submissions in this area were “clearly strengthened by a large component of collaborative work” and that “the submissions demonstrated the strong and continuing growth of interdisciplinary science”.

**Greater engagement with the chemistry community to clarify the REF assessment criteria could incentivise further interdisciplinary research.** Some of our members however commented that there remains a perception within some parts of the chemistry community that interdisciplinary research may not be understood and therefore not properly assessed by the Chemistry sub-panel. It was reported anecdotally that this has led to reluctance by some in the chemistry community to engage in such research. The process used for assessing such papers is clearly outlined in the Panel B report but more could be done to engage the community and dispel some of the myths relating to aspects of the assessment.

**Guidance on assessment criteria for outputs, particularly those other than journal papers, could encourage more diverse research and therefore submissions.** Only 3 patents were submitted as outputs to Main Panel B: UOA 8 (Chemistry) in REF2014. Comments from the chemistry community indicated that some institutions are reluctant to submit patents as outputs due to concern that they will not be as well received as journal articles. For example, one member commented that a staff member on a research contract for their institution was not submitted to the REF2014 as their submitted outputs would have been patents. This may indicate that the REF process is unintentionally driving behaviours whereby some institutions do not value industrial research partnerships generating patents as highly as research generating “top” journal papers, and therefore may discourage such collaborations.

**While a process exists in principle to handle impact case studies with confidential information<sup>ix</sup> there is currently little incentive for industrial partners to participate.**

The introduction of impact case studies clearly promotes collaboration between universities and other public and private sector bodies. Some of our respondents noted that industrial partners had in some instances been unwilling to contribute fully to case studies, for example to verify the impact of certain research in writing. Industrially applicable research findings are often not in the public domain for well-known reasons. For example some companies may not have the finances to protect their intellectual property once in the public domain or choose to retain IP as trade secrets rather than patenting. It can also be challenging to tease out individual contributions to the kind of long-term day-to-day industry-academia collaborations and relationships which are also significant in chemistry and lead to sustained high-value outputs.

## Section 4

**Previous studies have focused on the costs of REF with respect to the time and resources needed for the submission and assessment processes. The Review is also interested in views and any associated evidence that the REF influences, positively or negatively, the research and career choices of individuals, or the development of academic disciplines. It is also interested in views on how it might encourage institutions to 'game-play' and thereby limit the aggregate value of the exercise.**

6. In your view how does the REF process influence, positively or negatively, the choices of individual researchers and / or higher education institutions? What are the reasons for this and what are the effects? How do such effects of the REF compare with effects of other drivers in the system (e.g. success for individuals in international career markets, or for universities in global rankings)? What suggestions would you have to restrict gaming the system?
7. In your view how does the REF process influence the development of academic disciplines or impact upon other areas of scholarly activity relative to other factors? What changes would create or sustain positive influences in the future?

**The assessment of research output by an expert panel with double blind assessment, while time intensive, remains a rigorous method of assessment, and is therefore, driving excellence.** The REF is already driving research excellence; the percentage of 4\* outputs in chemistry increased by 7 percent in REF2014 compared to RAE2008 which Main Panel B: UOA 8 (Chemistry) attributed to "the general strengthening and investment in the discipline over recent years". The inclusion of international members within the panel further enhances the robustness of the process and could be increased to increase confidence in results.

**The impact of research is, in some cases, now being considered earlier in the research process as institutions and individuals seek to identify potential case studies.** Impact case studies identify and give examples of the benefits of research to society. Specific examples of how impact is being considered when making decisions are in the preparation of grant applications and increased efforts to engage with industrial collaborators. Increased focus on impact was welcomed by some of our members but others felt there was too much pressure from institutions to engage with industrial collaborators at the expense of more fundamental research.

**Any changes to the REF should be carefully considered and care should be taken that the assessment process does not undermine curiosity-driven research.** There was some concern in the community that the REF directs some people towards topical research areas which they believe will be highly cited and accepted in journals with high impact factors. This leaves less scope for pursuing fundamental or 'blue skies' research which is vital to the long term development of the field and contributes to breakthroughs and impact in ways which often cannot be initially anticipated.

**QR funding allocated in the REF should continue to serve as baseline funding for institutions to invest in infrastructure and fund curiosity-driven or early stage research.** It was felt that the balance between the contribution to REF scores from outputs and impacts should be maintained. The Chemistry panel noted that "many notable and high quality impacts arose from fundamental or 'blue skies' underpinning

research; and in many strong cases it was clear that there had not been a linear path from research to impact, despite the dependency of the impact on the underpinning research". Too much emphasis on impact could lead to increased short term planning and constrain fundamental curiosity-driven research which delivers transformational, 'disruptive' impacts in the long term.

**There is evidence that in some institutions the REF is generating institutional pressure to publish in high impact journals which can have mixed effects.** There remains a perception that papers submitted to journals with high impact factors will be judged more favourably in the REF and we collected evidence of internal institutional pressure to publish in such journals. This behaviour was seen as both negative and positive within the community. Some saw the push to publish the highest possible quality papers as desirable, with researchers focussing on publishing fewer, but higher quality, papers and so raising the standard of outputs. Others saw this behaviour as damaging as it could discourage academics from publishing papers which they considered would not be judged as 4\* or 3\*. Those at an earlier stage in their career such as PhD students and post-doctoral researchers often move within groups to progress during their career. They need to have their work published to build their CV for their next appointment. If fewer papers are published by their research group, because of departmental or institutional pressures on group leaders, this could make it more difficult for early stage researchers to find their next academic position in an increasingly competitive international environment.

**The REF encourages staff movement within the 'transfer window' between institutions and thereby incentivises departments to hire early career researchers.** Newly-hired early career researchers bring publications from their previous position which can be submitted as part of the new institution's REF submission. Therefore there is an incentive to provide opportunities for promising earlier career researchers. Staff movement can however be disruptive to individual departments and constitutes some of the 'gaming' that is disliked within the REF system.

**Within chemistry, some use of metrics-based assessment could allow assessment of all research-active staff which could prevent or mitigate "gaming" of the REF system.** We heard evidence that for some institutions the final ranking of departments is as important an outcome of the REF as allocation of funding. There was some support for greater inclusivity within the REF process to address the issue of institutions selectively submitting staff to submit to the REF. This selectivity was viewed by some of our members as an attempt to "game" the system in order to increase departmental rankings. Due to the very high percentage of outputs submitted to Main Panel B: UOA 8 (Chemistry) with DOIs the use of metrics for assessment could allow some degree of assessment of all research-active staff in a way that would be impossible by hand. This should not replace the peer-review system, but could provide wider insight into the true research outputs for an institution. Any introduction of metrics-based element in the REF assessment would need to be carefully considered to ensure they did not drive any unwanted or unintended behaviours within the research community.

Thank you for taking the time to let us have your views. We do not intend to acknowledge receipt of individual responses unless you tick the box below.

Please acknowledge this reply

**IND/16/1a**

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<sup>i</sup> *HCUK is an independent, self-governing body that represents the interests of departments engaged in chemical research, education and scholarship in 70 universities and similar institutions throughout the United Kingdom and Ireland.*

<sup>ii</sup> *REF Accountability Review: Costs, benefits and burden*, Technopolis (2015)

[http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/REF,Accountability,Review,Costs,benefits,and,burden/2015\\_refreviewcosts.pdf](http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/REF,Accountability,Review,Costs,benefits,and,burden/2015_refreviewcosts.pdf)

<sup>iii</sup> *The Metric Tide: Report of the Independent Review of the Role of Metrics in Research Assessment and Management*, Wilsdon et al (2015)

[http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/The,Metric,Tide/2015\\_metric\\_tide.pdf](http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/The,Metric,Tide/2015_metric_tide.pdf)

<sup>iv</sup> Correlation analysis of REF2014 score and metrics, Supplementary Report II to the Independent Review of the Role of Metrics in Research Assessment and Management

[http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/The,Metric,Tide/2015\\_metrictideS2.pdf](http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/The,Metric,Tide/2015_metrictideS2.pdf)

<sup>v</sup> Research Excellence Framework 2014, Overview report by Main Panel B and Sub-panels 7 to 15

<http://www.ref.ac.uk/media/ref/content/expanel/member/Main%20Panel%20B%20overview%20report.pdf>

<sup>vi</sup> Engineering and Physical Sciences Research Council, Driving research impact, Insights from the Research Excellence Framework 2014

<https://www.epsrc.ac.uk/newsevents/pubs/investing-in-excellence-delivering-impacts-for-the-uk-summary-report/>

<sup>vii</sup> *Inspirational chemistry for a modern economy*

<http://www.rsc.org/globalassets/04-campaigning-outreach/campaigning/campaign-for-government-science-support/inspirational-chemistry-for-a-modern-economy.pdf>

<sup>viii</sup> The Dowling Review of Business-University Research Collaborations

<http://www.raeng.org.uk/publications/reports/the-dowling-review-of-business-university-research>

<sup>ix</sup> <http://www.ref.ac.uk/about/guidance/datamanagement/confidentialimpactcasestudies/>