Governance for REsponsible innovATion

GUIDELINES FOR RESPONSIBLE RESEARCH AND INNOVATION

Introduction

Responsible Research and Innovation (RRI) has an important part to play in our future. These guidelines explain what RRI is, and the way that it will help ensure that research supports innovation in a way that delivers a future that is inclusive, healthy and sustainable.

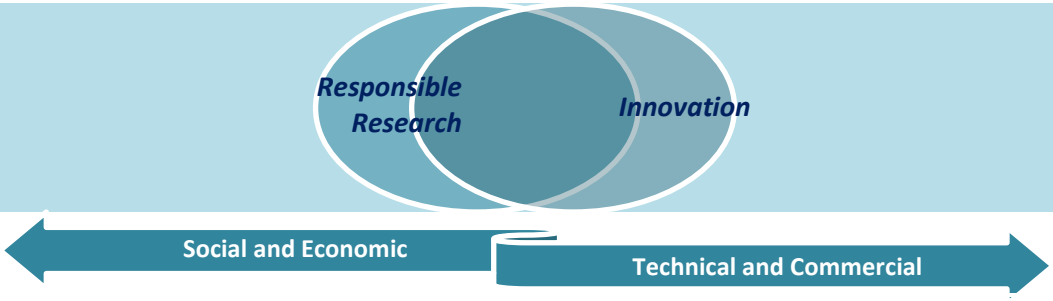
The guidelines derive from the GREAT Project that ended in 2016.[1] They offer practical pointers for the actions and activities of a range of interest groups and complement the framework for practitioners and strategic decision-makers, culminating in the publication of a 'Responsibility Navigator' that was developed in the parallel Res-AGorA project.[2] The guidelines should be read by all who undertake research or use its outcomes in their economic, social or political activities – at community, regional, national or international levels.

What is Responsible Research and Innovation (RRI)?

Responsible Research and Innovation (RRI) is a key action within the 'Science with and for Society' objective of the European Commission's Horizon 2020 Programme.[3] It is not a trend or a fashion. It represents a way of thinking that balances commercial and other goals with those concerned with wider wellbeing. A key part of RRI is concerned with people's engagement and participation in the research process. As noted by the European Commission, this will bring a 'better alignment' that will ensure research and innovation carries that crucial ingredient of responsibility.[4]

> ***Research and development are part of the economic foundation that supports our quality of life and the [European] social model.***[5]
>
> EUROPEAN COMMISSION (2010)

Sometimes the two facets of 'responsible research' and 'innovation' can be in tension. 'Responsible research' may focus on social and economic concerns; 'innovation' on technical and commercial goals.[6] RRI brings these together.



GREAT PROJECT

RRI does not aim to restrict commercial activity. It aims to 'add value' by making sure that ethical considerations that underpin community and societal norms are taken account of. An important reference point is that provided by the International Standard ISO 26000 in its 'Guidance on Social Responsibility' noted as giving attention to the need for transparency and engaging with stakeholders.[7] This means that RRI has real relevance to us as individuals, family or community members; as employers, employees, innovators and workers; as commissioners and procurers; and as customers and service users.

> ***Responsible research and innovation (RRI) aims at shaping the way we innovate and create new things and new ideas, taking into account the way norms are considered and assessed.***[8]
>
> PELLÉ AND REBER (2013)

A central question is 'how can we make RRI a part of our thinking?' By answering this question we can begin to think about how our individual, collective or corporate activities help ensure that innovations that may otherwise focus on 'raw' commercial objectives are balanced by wider considerations. The guidelines help to provide the answer by offering a selection of cameos that signal some kinds of issues that RRI seeks to address. A set of matrices are also offered that point to how different 'dimensions' of RRI relate to the five interest groups.

A Clear Definition

RRI gives emphasis to social as well commercial issues. Our approach ensures, in addition, a place for environmental concerns. The ethical 'steer' of RRI helps to ensure that the potential for harm is minimised.[9]

> ***Responsible research and innovation (RRI) is a way of thinking and doing that guides research and development in ethically appropriate ways. It ensures that social as well as commercial benefits are harnessed; and that any harm to the social and physical environment is obviated or minimised.***[10]
>
> GREAT PROJECT

Overall, RRI can be seen as better gearing 'research and innovation to fulfil societal needs' and able to 'guarantee systematic and consistent expression … of EU values as codified in the European treaties on human rights.'[11] Put more succinctly, the European Commission has stated that RRI can 'connect research and innovation with the futures in which they play a part'.[12] The GREAT approach to RRI above makes this clear.

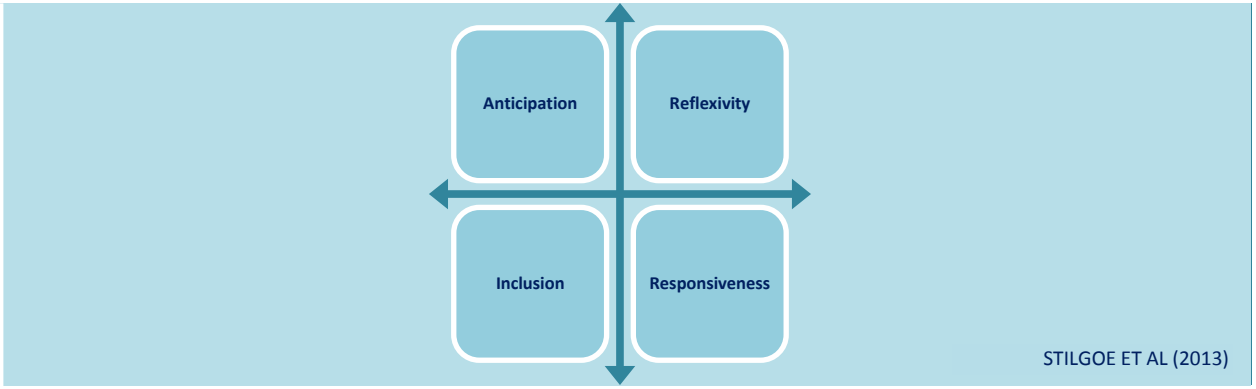
RRI links to broader European strategies and to social justice. It addresses, in part, what Commission President Jean-Claude Juncker referred to as the 'inappropriateness' in a social market economy that 'ship-owners and speculators become even richer, while pensioners can no longer support themselves.'[13]

> ***An innovation cannot be reduced to its economic benefit in terms of profit but has to take account of the social benefits in a broader sense.***[14]***.***
>
> GIANNI AND GOUJON (2013)

Four dimensions have been pointed to as central to and able to help anchor the broader concept of RRI. These dimensions underpin necessary actions that enable the operationalisation of RRI in practice.[15]

- **Anticipation** – taking a forward view that takes account of opportunities, risks, environmental concerns, etc.
- **Inclusion** – enabling the hearing of 'new voices' that may challenge what can be narrow 'we know what's good for you' top-down approaches.
- **Reflexivity** – putting research into context through the regular posing of questions regarding norms and values.
- **Responsiveness** – making changes as experience is gained and knowledge is built, including taking action to address any unintended consequences.

DIMENSIONS OF RRI



The adoption and integration of these dimensions within governance, research and innovation practices (as part of RRI) help to embed the necessary ethical approach. To these can be added the dimension of 'transparency' or openness out of which comes shared learning.

Each dimension is considered in these guidelines for different interest groups in relation to the seven key elements of RRI. These include the original six 'thematic elements' set out by the European Commission (listed below) and a seventh that is concerned with protecting the **Environment**.[16] This addition followed the consultation work undertaken during the project where the absence of the environment in the original list of thematic elements was considered in need of remedy.

- **Engagement** of all societal actors and their joint participation in the RRI process
- **Gender Equality** which highlights the need to integrate the gender dimension in the research and innovation context
- **Science Education** as a means to make change happen through raising awareness and embedding RRI into educational curricula
- **Open Access** as a means to boost innovation and increase the use of scientific results
- **Ethics** aimed at increasing societal relevance and acceptability of research and innovation outcomes
- **Governance** aimed at developing a framework that integrates the aforementioned five elements

All seven elements link with European goals as focused on 'justice and fundamental rights based on mutual trust.'[17] They also fit with the direction of the European Commission where the desired 'new industrial revolution' is required to be ethically founded - with green energy, clean transport and smart communications systems taking their place in helping deliver 'sustainable growth, create high-value jobs and solve societal challenges'.[18]

Who are these Guidelines for?

RRI is of concern to all people who specify, procure, undertake or use the outcomes of research in their economic, social or political activities – at community, regional, national or international levels. It is relevant, therefore, to a wide range of individuals and organisations. Five **interest groups** are noted below.[19]

The first four of the interest groups comprise those who individually or collectively specify, procure conduct or have a pecuniary or other specific interest in the outcomes of research and innovation. They include research funders, whether or not they are commercial organisations, and who in some cases will be engaged in the provision of goods and services. The fifth interest group comprises the wider range of people who have an interest in the outcomes of research and innovation (as consumers and citizens) for themselves and for future generations.

a) **Researchers and Research Institutions**. They must be accountable for what they do, how they do it; and, normally, for how the outcomes of their work are presented and/or shared.

b) **Organisations or Agencies that Undertake Research** or that design, manufacture, procure or purvey products and services that derive from research. These include commercial organisations and their investors that are, in large part, driven by profit; their ability to re-invest in research and innovation; and in ensuring the commitment, motivation and wellbeing of their employees. However, any approach that sees profit maximisation as the *only* goal is challenged by RRI.

c) **Professional Bodies and Associations** that are concerned with the skills, knowledge and conduct of researchers and innovators. Such bodies are, in some sense, guardians for themselves and others regarding quality standards in research and innovation and the related ethical reference points.

d) **Government and Regulatory Bodies**, policy-makers and strategists that set the frameworks for research, innovation and related activities. Such bodies carry the responsibility for ensuring that the legislative frameworks and relevant standards and guidance are conducive to RRI.

e) **Individuals, Communities** and the organisations that represent their interests comprise the wider interest group. They arguably have the most to gain from RRI but also stand to lose the most if the activities of some commercial organisations lack an ethical dimension.

How were the Guidelines Developed?

The guidelines draw on the work of the GREAT project and its detailed exploration of key ethical and related issues for 'responsibility' and 'innovation'. They have also benefited from shared knowledge derived from other European Commission funded projects, notably CONSIDER, PROGRESS, Res-AGorA, RESPONSIBILITY and RRI-TOOLS; and from consultations with professionals and a wider range of people.[20] Through this work a common language was agreed - for which some key terms are included in the Appendix.[21]

Of note is that the GREAT Project included an exploration of the way RRI was being addressed in nearly 200 European Commission funded projects. The work comprised personal interviews with a number of lead figures; and subsequent workshops with individuals representing the different interest groups. Further detail of the methodology is available in the RRI Observatory (developed in the RESPONSIBILITY project) that can be accessed at http://observatory-rri.info .

How can the Guidelines be used?

The guidelines can be used to support individuals and organisations to review or change the way they commission, undertake or use research to support innovation. By this means they can help to promote the ability of researchers and others to consider their personal, collective or corporate ethical standpoints; understand the way that these relate to the communities and cultures within which they operate; and ensure that reflexivity is built into the research process. For corporate bodies the guidelines can help to ensure that research is undertaken within a framework of good governance.

A set of **specific areas for action** is provided at the end of these guidelines that can support the process of review or change in line with RRI objectives.

What are the Key Elements of RRI?

There are seven key elements of RRI presented and discussed in these guidelines including the added element that embraces environmental concerns [22] and. The implications of the key elements for research and innovation are indicated in sets of matrices that relate to the four dimensions indicated above as helping to anchor the broader concept of RRI.[23] To simplify matters, two of the four dimensions (reflexiveness and responsiveness) are brought together in the matrices.[24] Cameos that relate to RRI practice are also offered.

The starting points for discussion of these 'key elements' necessarily relate to ethics and governance.

1. Doing the Right Thing (Ethics)

DRONES FOR HEALTH – NOT JUST WAR

Drone technologies are usually considered for surveillance or for warfare. But there are beneficial applications, too e.g. medicine deliveries for routine or emergency needs. The innovation around drone reliability, payload, fuel use and precision navigation may, therefore, bring clear positive benefits in general health maintenance or responding to disease outbreaks. The RRI perspective requires such social and wellbeing benefits to be set against the ethical concerns related to drones for military use.

Ethics are a cornerstone of RRI. They help ensure an approach to research that reduces the potential for poor practice. Ethics underpin the 'responsibility' in research and innovation – for individuals, collectives and corporate bodies. To ensure its ethical credentials are sound, responsible research gathers information that is up to date and well-grounded in relation to strategic policy, technological, social and cultural developments. Crucially (as indicated in the fourth key element - 'Choosing Together') it takes account of the needs and choices of the different interest groups. This requires engagement with consumers or others wherever appropriate.

Additionally, RRI always considers their potential social and environmental impact. It is necessary, therefore, that the outcomes of research, together with information on its funding and the underpinning methodology, are reported honestly - so that informed and balanced decisions can be made about the merits of pursuing a particular course of activity.

> ***Ethics is … more than a simple frame, [it represents] a guiding principle in the sense that it does not only preserve certain kinds of universal values like freedom or equality but has also to enhance the general wellbeing of the community.*** [25]
>
> GIANNI AND GOUJON (2013)

The ethical parameters with which RRI is concerned can be summarised as 'doing the right thing' supported by good and reflexive governance (the second key element). The parameters aim to ensure that 'responsibility' is demonstrated through

a. ***research always facilitating 'doing good' and contributing to social justice*** [26]***;***
b. ***research always being undertaken by people who have necessary skills and knowledge;*** [see 3];
c. ***research outcomes always being honestly reported;***
d. ***research always taking account of ethnic and cultural diversity for individuals and interest groups*** [see 4]***;***
e. ***research always seeking to minimise any adverse impact on the wellbeing and privacy of individuals;***
f. ***research always taking account of the potential environmental impact of the products and services with which it is concerned;*** [see 7] and

where appropriate

- ***g. the structures and the frameworks within which research is undertaken always seeking to redress (a) gender imbalances and (b) the exclusion of people due to disability or lack of digital literacy;*** [see 5]
- ***h. the research process engaging with and involving individuals and different interest groups;*** [see 4] and

where possible

- ***i. the outcomes of (and lessons leant through) research being made openly available.*** [see 6]

> ***80% of people say that the EU should actively promote worldwide respect for European ethical principles for conducting scientific research*** [27]
>
> EUROPEAN COMMISSION (2013)

What this means for the different interest groups is set out below.

Key Element 1 – Doing the Right Thing (Ethics)

	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Helps ensure greater foresight within research and research processes – including the identification of risks.	Sensitises research to the views of and potential impact on individuals and communities. Improves knowledge of market and their social and cultural context. Can enhance effectiveness and appropriateness of innovation. Facilitates changes in approach during the research and innovation process.	Ensures that research outcomes are shared; also that wheels are not re-invented (and resources wasted).
Commercial Bodies and Investors	Impacts on understanding of market opportunities; can lead to more innovation and higher economic returns on investment.		
Professional Bodies	Improves the ability to build expertise and ensure effective (re)training and learning for members.	Brings professionals closer to the people and communities they serve.	Fosters greater collaboration and cross-disciplinary working; can support changes in professional roles.
Government and Regulatory Bodies	Supports improved effectiveness of strategic planning and policy-making. Increases scope for innovation in ethically appropriate ways. Demonstrates recognition of the merits of an RRI approach.		Enhances the democratic process; improves readiness when reviewing strategies and policies, also legislation and regulatory frameworks (including standards) that support research and innovation. Demonstrates recognition of agendas concerned with consumer needs and rights.
Individuals and Communities	Helps public confidence and the building of trust in research and researchers.	Provides context within which research (undertaken by individuals or corporate bodies) can be more readily challenged.	Builds wider knowledge that can foster greater engagement and involvement in research and innovation.

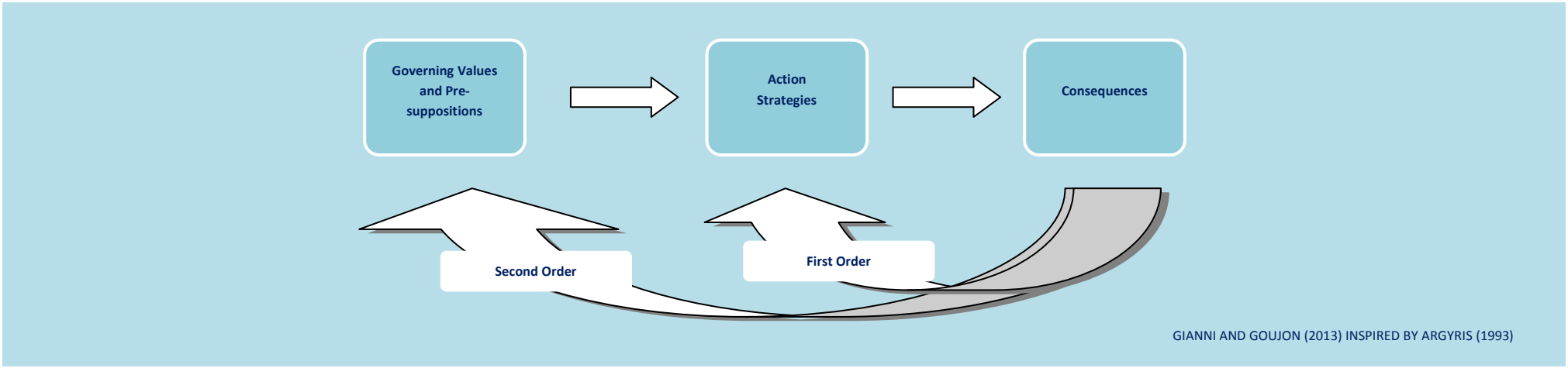
2. Good and Reflexive Governance

The very notion of 'responsibility' means that RRI is centrally concerned with the way that the role of research is defined and with governance of the research process. Good governance, in turn, carries a clear ethical component that helps to ensure not only that there are clear and both socially and commercially helpful outcomes from research, but also that those who undertake research have a foundation that helps to legitimise it. That foundation means that within the governance frameworks there is the capacity for and processes that demands openness about, for example, people's personal interests or connections that could influence their judgement about the way in which research is undertaken, and outcomes are used.

> ***81% of people say that researchers should be obliged to openly declare possible conflicts of interest.***[28]
>
> EUROPEAN COMMISSION (2013)

From the point of view of RRI there are three models of governance.[29] These directly relate to the nature and extent of engagement and involvement of different interest groups in the research process – including the users of technologies or services (see key element 4). What is termed the 'Standard' model does not include such engagement and involvement. 'Consultation' and 'Co-construction' models, by contrast, include both 'limited' and 'full' engagement and involvement. The 'Co-construction' model carries with it the essence and spirit of RRI - with participants, though not owning or standing to gain pecuniary benefits from the research or related innovation, having a direct, active and ongoing involvement. This level of involvement permits 'self-critical and self-conscious reflection'.[30] Such reflexivity can be first order (essentially reactive and dealing with immediate issues that arise) or second order (where fundamental re-thinking can take place including a re-consideration of underpinning norms and values).

REFLEXIVITY



GIANNI AND GOUJON (2013) INSPIRED BY ARGYRIS (1993)

Good and reflexive governance requires a high level of social awareness that can follow from RRI adoption. This awareness includes a willingness to adjust according to context but in ways that will contribute to the overall stability and wellbeing of our communities and nations.

The RRI approach helps remedy the shortcomings of forms of governance that have been narrowly framed in relation to 'formal risk assessment'; or have failed to 'identify in advance many of the most profound impacts … [of] innovation'.[31] Significant, in addition, is the call made for new and future-oriented scientific governance where there is care (in the sense of being careful to anticipate potential outcomes), responsiveness and a predisposition to share. These relate closely to the four dimensions of responsible innovation set out earlier.[32]

> ***Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present.***[33]
>
> STILGOE ET AL (2013)

What this means for the different interest groups is set out below.

ALCOPOPS AND BRAND MARKETING

The innovation of flavoured alcoholic drinks known as 'alcopops', led to intensive marketing that targeted young people. The marketing reached many who were aged below 16. The popularity of alcopops grew rapidly with one company cynically promoting a PR campaign and a parallel 'responsible marketing code' aimed at reducing under-age drinking. The RRI perspective looks for controls that protect against harm that might arise from innovations. A reflexive approach can help with this and ensure that both innovations and governance frameworks are guided by clear ethical principles.

Key Element 2 – Good and Reflexive Governance

	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Enables opportunities to be identified or problems overcome during the research process. Supports management decisions.	Helps ensure cultural awareness. Can enhance effectiveness and appropriateness of research and innovation.	Ensures that research outcomes are shared; sets new benchmarks for good practice that may challenge the *status quo* and help bring about changes in research practice.
Commercial Bodies and Investors	Ensures that research process is geared to delivery in terms of knowledge and commercial outcomes. Supports management decisions.	Enables research outcomes to take 'on board' changes in context (including technological innovations and market change).	Helps create context where commercial bodies can collaborate; supports product and service interoperability.
Professional Bodies	Enables clear RRI perspective to be embedded in training, learning and continuing professional development (CPD) activities.	Helps create context where professional bodies can collaborate.	
Government and Regulatory Bodies	Gives confidence that research and innovation activities are supporting governmental commercial, social and environmental goals (and meet related regulatory requirements).		
Individuals and Communities	Gives confidence that research and innovation activities are contributing to the ethical tenets of beneficence and justice; and, therefore, to community health and wellbeing.		

3. Creative Learning (Science Education)

An important aspect of RRI is about science education – by which we can ensure that a precondition is in place for a knowledgeable, skilled and competent workforce. This can help ensure that key goals around research and innovation are attained. Relating to this are the objectives set out by the European Commission for a European Research Area that gives support to the 'Innovation Union'. Research and innovation, supported by education and skills development, have a major part to play in this by helping to 'tackle major societal challenges, raise competitiveness and generate new jobs'.[34]

> ***Current technical developments have the advantage of significantly affecting the way we live. They will have positive and negative consequences and implications that should be addressed as early as possible.***[35]
>
> STAHL (2010)

There is a parallel imperative for our communities as a whole to become more 'science literate'. This imperative applies in a general sense where there must be higher levels of awareness of some of the threats as well as opportunities that science brings. The threats include those that impact on our privacy. These might arise because of inadequate safeguards around the collection, storage or usage of personal data. The opportunities arise through having a more capable and agile workforce involved in research and innovation - creating job opportunities and conferring commercial advantage to European companies.

The imperative for greater science literacy also applies to people's more specific understandings about the role of research. It extends to the way in which they, collectively or as individuals, can contribute to the research and innovation processes (see 4); and can be aware of the types and fields of research where innovation carries particular importance.

This 'new literacy' should include some knowledge of European Commission initiatives and investments concerned with, for example, information networks, energy and transport technologies and sustainable construction; together with a broad understanding of the role played by standards and regulatory frameworks.[36]

SMART METERS – BUT HOW SMART?

Smart meters are an innovation that will bring environmental benefits through the more efficient use of energy in our communities and homes. But the gathering of information on our consumption (and consumption patterns) offers the potential for both our presence or absence and our lifestyles to be monitored. The information gathered can support 'activity monitoring' and may have specific relevance in supporting some vulnerable people at home. But it also has implications for personal privacy. The RRI perspective is one that would point towards potential social and well-being benefits but requires, at the same time, the incorporation of robust safeguards (as with other digitally enabled systems) to protect privacy.

> ***We need to get more innovation out of our research. Cooperation between the worlds of science and the world of business must be enhanced, obstacles removed and incentives put in place.***[37]
>
> EUROPEAN COMMISSION (2010)

What this means for the different interest groups is set out below.

Key Element 3 – Creative Learning (Science Education)

	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Helps increase the competence of those engaged in research and their ability to deliver in relation to knowledge and commercial outcomes. Gives greater credibility to the work of researchers (and their organisations); ensures that there are continuing opportunities for building knowledge and skills development. Can enhance effectiveness and appropriateness of innovation.		Ensures that the benefits of education and learning are widely shared. Helps ensure that the work of researchers, individually or collectively, is accessible and carries the potential for recognition.
Commercial Bodies and Investors	Helps ensure necessary skills among management and other staff relating to research, and their ability to present outcomes in a way that facilitates decision-making. Can enhance effectiveness and appropriateness of innovation.		Enables appropriate decisions to be made regarding sharing research related approaches or outcomes.
Professional Bodies	Encourages more people to engage in research and to achieve standards in their practice that carry professional recognition.		Ensures that researchers and innovators are more accountable to their peers and the range of different interest groups.
Government and Regulatory Bodies	Helps ensure that long-term needs relating to the size and nature of the research-related workforce are achieved.		Supports innovation and the establishing of new good practice benchmarks for both research and innovation.
Individuals and Communities	Provides opportunities for individuals to develop their skills and creativity; helps increase employability and the retention of key staff within the workforce.		Gives wider access to research outcomes and to knowledge about related innovations.

4. Choosing Together (Engagement and Involvement)

'Choosing together' promotes inclusiveness. It accords with the Charter of Fundamental Rights of the European Union.[38] It resonates, furthermore, with some of the earliest debates and discussions about facets of RRI, as is captured in the definition offered by von Schomberg.[39] This affirms that RRI is a 'transparent, interactive process by which social actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products - in order to allow a proper embedding of scientific and technological advances in our society'.

> ***RRI means that societal actors work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of European society.***[40]
>
> EUROPEAN COMMISSION (2012)

Choosing together (as part of the process of engagement and involvement) takes an important place within the RRI. When properly conducted it enables research and innovation activities to be informed and to reflect a better understanding not just of the 'market' for particular products and services, but also of the broader societal, cultural and environmental contexts. Such understanding is essential wherever there is an actual or potential adverse societal or environmental impact

> ***Participation has come to be seen as a way of broadening the set of normative elements that are required to make technology-related decisions … in stark contrast with the limited ability of expert committees that usually stand for the values of other society members.***[41]
>
> PELLÉ AND REBER (2013)

SOCIAL NETWORKS AND ISOLATION

On-line social networks can help combat isolation and facilitate access to family and friends, jobs, training and education opportunities, services and information. But people need to have basic digital skills. These may be lacking, notably for older people who may not have not been active in digitally rich environments and can be challenged because e.g. of limited dexterity or poor eyesight. The adoption of 'Design for All' approaches for technologies can help *all* people through e.g. simple, accessible and usable interfaces and controls. The RRI perspective sees benefits from digital innovation but seeks, through design and service approaches, to address the needs of those who may be excluded.

To gain or build on that better understanding, a high level of engagement between organisations that undertake or promote research and innovation and 'wider society' is sometimes necessary. The extent of the necessary engagement can vary from that which draws on informed secondary information to that which involves people directly in the research and innovation processes. Incentives for participation can sometimes be necessary. 'Strong disincentives' have, furthermore, been suggested as potentially necessary in order to guard against research approaches that do not include participation, if RRI practices are to be widely adopted.[42]

The nature of engagement should be carefully considered and not undertaken merely for its own sake. Further, the methodology for engagement that is employed must recognise the potential for biases that arise because of people's particular perspectives, life experiences or cultural backgrounds. Within that engagement, furthermore, may 'lurk … the spectres of public resistance against technoscience' – where potential legitimate concerns about the uses of research and or damaging outcomes need to be addressed.[43] Effective engagement, in fact, requires reflexivity on the part of those engaged (as well as among researchers themselves) so that any 'baggage' that relates to cultures, strongly held beliefs or personal experiences can be set to one side.

> ***A stronger emphasis on RRI in the evaluation of research and research proposals can be an incentive for researchers to take societal needs into account.***[44]
>
> EUROPEAN COMMISSION (2013)

The objective within RRI is for the level of engagement to be commensurate with the ethical imperatives that seek to ensure informed decision-making and the minimising of harm to society or the environment. In the process of participation, however, it will, in some contexts, be 'almost impossible to fully involve non-experts due to the level of knowledge required to understand and debate specific issues.'[45] This is why it is crucial for organisations to embrace RRI approaches so that they can, as part of their normal research and innovation work, ensure that there is a defensible balance (in ethical terms) between their commercial objectives and environmental and social needs.

> ***Responsible innovation is a distributed phenomenon. It is a collective achievement of funding institution and consortia.***[46]
>
> PELLÉ AND REBER (2013)

What this means for the different interest groups is set out below.

Key Element 4 – Choosing Together (Engagement and Involvement)			
	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Increases awareness of merits and likely impact of research outcomes on a wide range of interest groups. Affords insights into the views and opinions of potential consumers or service users.	Enables adjustments to be made in response to views, opinions and new information gathered during the research process.	Enables sharing as well as gains in knowledge that informs the research process. Promotes interaction and mutual respect between researchers and the broader populace.
Commercial Bodies and Investors	Embeds engagement as a norm in the research and innovation processes. Helps ensure topicality and representativeness of information and knowledge derived through the research process.	Helps improve basis for good governance. Can enable demonstration of awareness of key issues.	
Professional Bodies	Reduces the potential for reliance on 'old ways' of doing things; helps in forward planning for the benefit of members.	Militates against narrow ways of thinking; can help foster inter-disciplinary and multi faceted approaches in research and innovation.	
Government and Regulatory Bodies	Reflects understanding of the importance of the shared future in which all have a stake.	Prompts reviews and helps ensure currency of strategies and policies; also legislation and regulatory frameworks that relate to research and innovation.	Promotes a higher level of accountability for those engaged in research and innovation that can be inclusive of different interest groups.
Individuals and Communities	Encourages on-going involvement in the research and innovation process.	Helps individual and collective learning regarding the role and processes of research and innovation; contributes to knowledge and skills development.	

5. Unlocking the Full Potential (Gender Equality)

Within RRI, unlocking the full potential relates specifically to the issue of gender. It responds to the disadvantage that affects research and innovation when there is a significant gender imbalance. However, such imbalance is not necessarily a bad thing. A surfeit of men or women in research within particular commercial environments may reflect gender differences in the markets being addressed. Similarly, there can be gender imbalances in parts of education and training. However, gender imbalances are particularly evident in technical subjects (predominantly male) from which a high proportion of scientific researchers are drawn. The process of redressing gender imbalances therefore presents a challenge for RRI.

> ***Inequalities between women and men violate fundamental rights. They also impose a heavy toll on the economy and result in underutilisation of talent. Economic and business benefits can be gained from enhancing gender equality.***[47]
>
> EUROPEAN COMMISSION (2011a)

The imperative within RRI for greater gender equality resonates with European policy. The European Parliament has affirmed the need to 'strengthen the promotion of gender equality in all Community policies and the resulting national policies, and the fight against discrimination based on sex'.[48] Gender equality is promoted within European Commissions research programmes.

> ***Men are more likely than women to have studied science and technology by a margin of 62% to 51%.***[49]
>
> ***The prevailing gender imbalance in science and research is still a major obstacle to the European objective of increasing competitiveness and maximising innovation potential.***[50]
>
> EUROPEAN COMMISSION (2014 & 2011a)

The context is one where the European Commission is concerned to lay 'the foundation for the new industrial revolution'. The pursuit of this is seen as one of the means by which the recent decline in European industry can be redressed.[51] The six 'priority action lines' concerned are advanced manufacturing technologies; key enabling technologies; bio-based products; sustainable industrial and construction policy and raw materials; clean vehicles and vessels; and smart grids. RRI is immensely important for the new industrial revolution because the science and technology focus carries a clear risk that gender imbalances will remain or be re-enforced. The effectiveness of research and innovation initiatives would be potentially compromised as a consequence of such imbalances.

What this means for the different interest groups is set out below.

Key Element 5 – Unlocking the full Potential (Gender Equality)

	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Ensures sensitivity to issues relating to gender that require consideration within the research and innovation process.	Encourages the formulation of research methodologies that are gender neutral or take account of gender specific issues.	
Commercial Bodies and Investors	Enhances the ability to address imbalances in research investment and prioritisation; also in the research and wider workforce. Enables knowledge, skills and competencies to be drawn upon regardless of gender. Can enhance effectiveness and appropriateness of innovation for both products and services.	Helps foster recognition of the role that both women and men can play in all aspects of research and innovation.	
Professional Bodies	Enhances the ability to give effective representation to and support the overcoming of gender imbalances.	Helps encourage openness to scrutiny of the bodies themselves and their members.	
Government and Regulatory Bodies	Helps ensure appropriate frameworks are in place to support people in the workforce including women returners (e.g. after having children) or older people (who are mostly women).	Enables reaffirmation of credentials that relate to activities that promote gender equality.	
Individuals and Communities	Encourages people, regardless of gender, to engage in the research and innovation process.	Helps to build the status of women in communities and contexts where gender equality is not properly recognised.	

6. Sharing Results (Open Access)

RRI makes a very important contribution to good research practice within which transparency, open access and the sharing of results plays a key part. Such good practice can be recognised, like RRI, as represented by ways of working, based on a set of principles, accordance with which helps to fulfil aims and objectives associated with appropriate political, economic and social goals; and contributing to the health, wellbeing and inclusion.[52] The sharing of knowledge enables others to adopt or adapt their approaches in light of such good practice and can help to encourage innovation.

> ***Open access [is] a key tool to bring people together and ideas in a way that catalyses science and innovation … it is essential to optimise the circulation and transfer of scientific knowledge among key stakeholders in European research[53].***
>
> EUROPEAN COMMISSION (2012c)

The contribution of RRI to good research practice around transparency links with both honesty and integrity. It chimes, therefore, with associated calls for researchers to adhere to the highest professional standards.[54] This means that the outcomes of research and the methodologies that led up to those outcomes should, wherever possible, be shared.

RESPONSIBLE STEERING OF PROJECTS

As demonstrated through multiple European Commission funded projects, there is no simple recipe for ensuring that they are steered appropriately. This reflects the fact that within and throughout the course of projects there are always tensions, conflicts and dilemmas that need to be addressed. The adoption of an RRI approach at the outset clearly assists – with first and second order reflexivity being one of the keys to effective progress. Such reflexivity contributes to a learning process (for all), supports openness and, therefore, offers one of the means to ensure that research and innovation is informed by an understanding of the importance of context and already established norms.

Through this openness, general knowledge can be increased and decisions around research and innovation can be improved. Indeed, the European Commission has argued for 'fuller and wider access to scientific publications and data' to help ensure that previous research knowledge is built upon and, therefore, contributes to the acceleration of innovation. Collaboration and the greater involvement of citizens and society are also called upon to improve transparency of the scientific process.[55]

In parallel there has been a longstanding commitment to openness and transparency in the world of standards and standardisation with the European Commission seeking to ensure that information (around standards) is made accessible and subject to e.g. on-line consultation; involving a wide range of stakeholders.[56]

> ***The European standardisation system must … become as inclusive as possible with all partners committed to … the core values of openness, transparency and scientific solidarity[57]***
>
> **EUR**OPEAN COMMISSION (2011b)

Of course there are frequently issues of commercial confidentiality that may make the sharing of knowledge difficult. But this does not detract from either the need for maximising open access or from the key points about the benefits of knowledge sharing.

What this means for the different interest groups is set out below.

Key Element 6 – Sharing Results (Open Access)			
	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Enhancing the extent to which research is timely and take account of 'state of the art' technologies, management or service frameworks. Can enhance effectiveness and appropriateness of innovation.	Promoting research and innovation approaches that accommodate new information. Facilitating adjustments in relation to identified risks and opportunities, unintended outcomes, etc.	Helping encourage sharing so that the overall quality of research is enhanced, and a firmer foundation is laid for the innovations that follow.
Commercial Bodies and Investors	Increasing economic returns by virtue of the extent to which innovations of and within products and services can be demonstrated.	Requiring the making balanced decisions on the timing of information sharing in relation to research or innovations that may be commercially confidential or sensitive.	
Professional Bodies	Potentially enhancing credentials by virtue of the underpinnings provided by higher quality research and innovations based on such research.	Potentially increased membership arising from higher levels of awareness of the importance of their role in quality research and innovation.	
Government and Regulatory Bodies	Benefiting from a higher economic return on investment (where public money is involved) on account of an improvement to the quality of research and ensuing innovations.	Costs saved because of a reduction in the extent to which research and innovation 'reinvents the wheel'.	
Individuals and Communities	Recognising the role and relevance of research. Increased motivation for individuals to engage with the research process or to become researchers and innovators.	Facilitating wider consumption of research related information; building knowledge among individuals and communities.	

7. Taking Care of our Planet (Environmental Stewardship)

Environmental stewardship is not a 'thematic' element included by the European Commission for RRI.[58] Its presence in these guidelines is justified given the emphasis given to sustainability within the six key elements and more broadly within European and international policy.[59] The ISO (International Organization for Standardization) standard 26000 (2010) provides guidance on 'how businesses and organizations can operate in a socially responsible way' with clauses that specifically address energy use and environmental impact.[60] The Responsible Industry project called for RRI approaches to be alert to 'mitigate environmental impacts' and adopt an 'environmentally friendly' profile. ISO 26000 was one of their reference points, noting that corporate social policy was 'a concept whereby companies integrate social and environmental concerns in their business operations'.[61]

> ***Responsible research and innovation means taking collective care for the future, through stewardship of innovation in the present[62].***
>
> STILGOE ET AL (2012)

The inclusion of environmental stewardship remedies, therefore, what can be regarded as an omission from the original European Commission 'framework' for RRI. It resonates closely with Europe's 'forward looking climate change policy' - where RRI is seen as supporting linked aims to minimise waste and high energy use through the development of efficient and sustainable products.[63]

The European Commission approach to combating adverse climate change (an aspect of environmental stewardship) includes 'reducing emissions by 80% by mid-century' – this requiring 'substantial further innovation' supported by 'increased research and development and a skilled workforce that includes researchers.[64] The policy instruments adopted with environmental matters in mind have been considered 'tangible' and meaningful' but with an accompanying call for a stronger regulatory approach.[65]

> ***The Union's environment policy has stimulated innovation and investment in environmental goods and services, generating jobs and export opportunities.***[66]
>
> EUROPEAN COMMISSION (2014)[67]

Work to date around the area of environmental stewardship is regarded as having strengthened the knowledge base and the 'evidence which underpins policy'. Interestingly from the point of view of ethics (see 1) is the fact that European policies have embedded the 'precautionary principle' that aims to ensure protection against harm for both the environment and 'consumers'.[68]

What this means for the different interest groups is set out below.

HEALTH IN THE AIR

'Telehealth' initiatives on aircraft use mobile and satellite communications to access health support. They provide telephony or video links to advice (including guidance on treatment) from medical professionals for the patient or others. This approach to 'remote' health care helps responses to accidents or illness and can obviate the need for 'medical diversion'. RRI recognises the environmental benefits of such interventions as well as those to people's health and wellbeing.

Key Element 7 – Taking Care of our Planet (Environmental Stewardship)

	Anticipation	Reflexivity and Responsiveness	Transparency or Openness
Researchers and Research Institutions	Encouraging inclusion of environmental considerations throughout the research and innovation processes.	Ensuring that research outcomes and products can consistently be considered in relation to their environmental impact.	
Commercial Bodies and Investors	Supporting and stimulating awareness of environmental factors for products and services, their development and day to day management.	Enabling changes to be made when new materials become available or new business and service models are identified.	Enabling the sharing of knowledge that can point to the environmental benefits of new innovations or 'ways of doing things'.
Professional Bodies	Pointing to the merits of building greater environmental awareness among professionals.	Demonstrating recognition of the importance of environmental issues within research and innovation.	
Government and Regulatory Bodies	Enabling the building in of environmental considerations to strategies and policies; also related legislation and regulatory frameworks that impact on research and innovation.	Facilitating adjustments to policy in light of new knowledge.	Enabling the demonstration of commitment to ensuring that research and innovation play their part in supporting the meeting of environmental targets.
Individuals and Communities	Ensuring wider awareness and increased knowledge of environmental issues and how these impact on research and innovation.	Increasing willingness to act individually and collectively in environmentally positive ways (e.g. recycling, use of public transport). Facilitating wider consciousness of such matters in a way that will influence research and innovation.	Contributing to increased knowledge and awareness of the environmental issue in research and innovation.

Specific Areas for Action

These guidelines show that RRI has meaning for all interest groups. With this in mind some specific areas for action are suggested for both organisations and individuals who have a particular concern for or are involved in research and innovation; and for those who have a more general interest that arises from a shared concern for the future.

We all, it is considered, should endeavour to be reflexive about our work and life experiences so that we are able to effectively contribute to the research and innovation process – whether as researchers or participants. A number of preconditions for this are embodied in the key elements of RRI as noted in these guidelines. Examples are the need to ensure that there is an ethical 'steer' for research and that there is much more openness (or transparency) with regard to research and its outcomes. The ethical steer can be supported by ethical impact analyses.[69]

Aside from ensuring that we are all more reflexive, some specific areas for action are suggested as follows.

Researchers and Research Institutions should examine the nature of their accountability and ensure that ethical and other key elements of RRI help to steer the way they both think and work. This could be reflected in mission statements and strategic documents as well as being re-enforced in product or service branding, staff job descriptions and training. By this means, a clear and appropriate basis for innovation can be better established. Related to this is the need to emphasise the importance of and the need to *be* honest and open in the reporting of research outcomes - including providing concise information about anticipated social, economic and environmental impacts. Relating to this the European Commission has called for[70]

- RRI to be mainstreamed within funding frameworks (in a context where there is increased emphasis on cross-disciplinary work); and
- Research activity to be more closely linked with standards and standardisation – with the latter giving greater attention to issues of 'societal interest'.

Organisations or Agencies that undertake Research that underpin their innovation and wider commercial activities should (as with researchers and research institutions) examine the nature of their accountability with a view to, wherever possible, maintaining an approach that fosters collaboration and the sharing of knowledge; and always is conscious of (and protects against) the potential adverse effects of their commercial activities. Research and related specifications should reflect this.

Professional Bodies and Associations should consider incorporation of RRI as an essential component of good research practice and seek to ensure that all its key elements are addressed in e.g. membership requirements, training and development, codes of conduct and good practice guides. Linked with this, the European Commission has proposed that RRI be incorporated within the curricula for the training of researchers.[71]

Government and Regulatory Bodies should, as part of the normal processes that underpin the creation or review of legislative frameworks, standards and guidance, ensure that the key elements of RRI are given appropriate priority. Within standards frameworks there should be sufficient flexibility to ensure that research and innovation is not stifled.[72] The process of standardisation should, furthermore, become more reflexive and open to wider participation.[73]

Individuals, Communities and the organisations that represent their interests should, in holding others to account in relation to research and innovation, reference RRI and require that all key elements within RRI are addressed. Linked with this, the European Commission has proposed that public procurement activity should take more account of societal issues such as those that are integral to RRI.[74]

Appendix A: Glossary

This glossary, aside for 'responsible research and innovation' itself, offers just 10 definitions. Eight of these derive from the work of the Go4 (group of four) projects viz. GREAT, PROGRESS, RESPONSIBILITY and RES-AGORA. A wider range of definitions can be found in the RRI Observatory to be accessed at http://observatory-rri.info .

Responsible Research and Innovation: A way of thinking and doing that guides research and development in ethically appropriate ways.

Accountability: The state of being answerable in actions, outcomes or reporting, to another party or parties.

Culture: The nature of (and manifestation of) behaviours and beliefs that derive from particular societal norms.

Good Practice: Practice that is informed; shared with others and operates according to principles associated with appropriate political, economic and social goals.

Governance: The function of determining an organisation's direction, objectives, policy and practice frameworks in order to ensure effective service provision.

Inclusion: The process by which the views, opinions and/or inputs of a range of individuals or organisations are harnessed in relation to a particular activity.

Innovation: Novelty in processes or outcomes that results (in economic or social contexts) from thought, activity and/or the manner of use (or provision) of products and materials (and/or services)

Open Access: The process that permits access to (and facilitates sharing of) information and knowledge that might otherwise be restricted.

Reflexivity: The process by which experience and knowledge continually influences attitudes, behaviours and actions and *vice versa*. This may be 'first order' relating to particular knowledge for a time or event; or 'second order' relating to new knowledge and understanding.

Responsibility: Role that carries an element of accountability (and potentially within a governance framework) which is acknowledged individually or collectively in relation to a particular activity or outcome.

Sustainability: The means by which particular activities are able to be maintained over a defined period of time - often linked (in an environmental sense) to the sustainable use of resources.

Sources and References

[1] Details of the GREAT Project can be found at www.great-project.eu .
[2] See www.res-agora.eu or www.responsibility-navigator.eu .
[3] See https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation .
[4] European Commission (2012a) 'A Stronger European Industry for Growth and Economic Recovery' COM(2012) 582.
[5] European Commission (2010) 'European 2020 Flagship Initiative: Innovation Union' SEC(2010) 1161.
[6] Gianni R and Goujon P (2013) 'Analytical Grid: Current Theory and Practice (in RRI)' GREAT Project.
[7] Buck B, Espinach L and Söderberg S (2014) 'GRI G4 Guidelines and ISO 26000: 2010' Global Reporting Initiative, Amsterdam. ISO 26000: 2010 can be accessed via the International Organization for Standardization at www.iso.org .
[8] Pellé S and Reber B (2013) 'The Theoretical Landscape' GREAT Project.
[9] This perspective is endorsed by Stilgoe J, Owen R and Macnaghten P (2013) 'Developing a Framework for Responsible Innovation', Research Policy 42 pp 1568-1580. They affirm that 'responsible research and innovation means taking collective care for the future, through stewardship of innovation in the present.
[10] This definition captures more succinctly the intent within other definitions.

[11] European Commission (2013) 'Options for Strengthening Responsible Research and Innovation' Directorate-General for Research and Innovation Science in Society.
[12] Ditto.
[13] Juncker J-C (2014) 'A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change' Opening Statement in the European Parliament, Strasbourg 15 July.
[14] Gianni and Goujon (2013) referenced above.
[15] Stilgoe et al (2013) referenced above.
[16] European Commission (2012b) 'Responsible Research and Development: Europe's Ability to Respond to Societal Challenges'.
[17] Juncker (2014) referenced above.
[18] European Commission (2012a) referenced above.
[19] The term 'interest groups' is used in these guidelines rather than 'stakeholders' in view of the generally wider definition of the latter.
[20] Details of the projects are to be found at CONSIDER (www.consider-project.eu); GREAT (www.great-project.eu); PROGRESS (www.progressproject.eu); RES-AGORA (www.res-agora.eu); RESPONSIBILITY (www.responsibility-rri.eu) and RRI TOOLS (www.rri-tools.eu).
[21] These guidelines help us emerge from what was described in the GREAT Project as a 'minefield of conflicting goals and objectives between research and innovation agents, on the one hand, and the agencies that either fund or regulate them, on the other.' See EA (European Academy of Technology and Innovation Assessment) project summary at www.ea-aw.de .
[22] These 'key elements' derive from the 'keys' set out by the European Commission (2012b) referenced above. A seventh 'environmental stewardship' has been added as a direct outcome of the consultation process.
[23] Stilgoe et al (2013) referenced above.
[24] Some of the content of the matrices has been informed by the work (within the Responsible-Industry project) of Porcari A, Borsella E and Mantovani E (2015) 'Responsible Industry: A Framework for Implementing Responsible Research and Innovation in ICT for an Ageing Society', Italian Association for Industrial Research, Rome.
[25] Gianni and Goujon (2013) referenced above.
[26] It can be noted that the ethical principles of beneficence, non-maleficence and social justice (also autonomy) were put forward in the context of biomedicine by Beauchamp TL and Childress JF (2012) 'Principles of Biomedical Ethics' Oxford University Press.
[27] European Commission (2014) 'Public Perceptions of Science Research and Innovation' Special Eurobarometer 401 Report.
[28] European Commission (2013) referenced above.
[29] Grimpe B and Jirotka M (2014) 'Case Study Report' GREAT Project.
[30] Ditto.
[31] Stilgoe et al (2013) referenced above.
[32] Ditto.
[33] Ditto.
[34] European Commission (2010) referenced above.
[35] Stahl B (2010) 'IT for a Better Future. How to Integrate Ethics, Politics and Innovation' in von Schomberg R (Ed) 'Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technology Fields' European Commission.
[36] European Commission (2014) 'For a European Industrial Renaissance' COM(2014) 14.
[37] European Commission (2010) referenced above.
[38] European Commission (2012a) referenced above.
[39] von Schomberg R (2013) 'A Vision of Responsible Innovation' in Owen R, Heintz M and Bessant J (Eds) 'Responsible Innovation'. John Wiley, London.
[40] European Commission (2012a) referenced above.
[41] Pellé and Reber (2013) referenced above.
[42] Porcari et al (2015) referenced above.
[43] Felt U and Fochler M (2010) 'Machineries for Making Publics: Inscribing and Describing Publics in Public Engagement', Minerva 48/3 pp 219-238.
[44] European Commission (2013) referenced above.
[45] Gianni and Goujon (2013) referenced above.
[46] Pellé and Reber (2013) referenced above.

[47] European Commission (2011a) 'Strategy for Equality between Women and Men 2010-2015', Luxembourg.
[48] Regulation EC 1922/2006 of the European Parliament and the Council of 20th December 2006.
[49] European Commission (2014) referenced above.
[50] European Commission (2011) referenced above.
[51] European Commission (2012a) referenced above.
[52] Good practice relates to 'ways of working based on a set of principles, accordance with which helps to fulfil aims and objectives associated with appropriate, political, economic and social goals'. See Sakkas et al (2008) 'ICT for ALL: Towards an e-Inclusive Society', ASM, Poland.
[53] European Commission (2012c) 'Towards Better Access to Scientific Information: Boosting Benefits of Public Investments in Research' COM(2012) 401.
[54] An example can be found in the European RESPECT code of practice for socio-economic research. See www.respectproject.org/main/index.php .
[55] European Commission (2015) 'Guidelines on open Access to Scientific Publications and Research data in Horizon 2020'.
[56] European Commission (2011b) 'A Strategic Vision for European Standards: Moving Forward to Enhance and Accelerate the Sustainable Growth of the European Economy by 2020' COM(2011) 311. Also see Regulation (EU) 1025 / 2012 on European Standardisation.
[57] Ditto.
[58] European Commission (2012b) referenced above.
[59] Environmental issues were also identified as important within workshops held within the GREAT project.
[60] Buck et al (2014) referenced above.
[61] Porcari et al (2015) referenced above.
[62] Stilgoe et al (2013) referenced above.
[63] European Commission (2014) 'A Framework for Climate and Energy in the Period from 2020 to 2030' COM(2014) 15.
[64] European Commission (2011c) 'A Roadmap for Moving to a Competitive Low Carbon Economy in 2050' COM(2011) 112.
[65] Schmitt S and Schulze K (2011) 'Choosing Environmental Policy Instruments: An Assessment of the Environmental Dimension of EU Energy Policy' in Tosun J and Solorio I (Eds) 'Energy and Environment in Europe: Assessing a Complex Relationship' European Integration Online Papers (IoP) Special Mini-Issue 1,15 Article 9.
[66] European Commission (2011c) Ditto.
[67] European Commission (2014) 'Living Well, within the Limits of our Planet', Luxembourg.
[68] Ditto.
[69] As pointed to by Porcari et al (2015) referenced above.
[70] European Commission (2013) referenced above.
[71] Ditto.
[72] European Commission (2011b) referenced above.
[73] Ditto.
[74] European Commission (2013) referenced above.

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