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The Innovation Union: a perfect means to confused ends?

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ABSTRACT

In this commentary we argue that innovation is a means, not an end in itself. Innovation is only desirable to the extent that it improves human health and well-being and contributes to environmental, social, and economic sustainability. If innovation is merely focussed on bringing more products to markets and delivering economic growth in the short term, as is currently the trend in the European Union and many OECD countries, it is unclear how it differs from the dominant pre-crisis approach which, notwithstanding its positive effects on living standards, led to unsustainable resource use, crippling biodiversity loss, and increasing greenhouse gas emissions. As the future European research, development and innovation policies are being defined, we should not miss an historic opportunity to concentrate on improving human health, well-being and quality of life, and to embark on a more ecologically, socially and economically sustainable path. Given the scale and irreversibility of our damaging effects on the environment and on the well-being of current and future generations, we call for these aspects to be urgently represented in European innovation discourses, policies, and actions. Re-balancing market focussed innovation and socially meaningful and responsible innovation (i.e. innovation with a human purpose) can be achieved by building on a broader concept of innovation which not only includes technological innovation, but also non-technological, social, institutional, organisational and behavioural innovation. We then discuss the importance of curiosity-driven research and of environment and health research as drivers of socially meaningful innovation in all its forms.

1. Introduction

In the wake of the recent financial crisis, Herculean efforts are being made to restore national economies and global financial markets. Getting the European economy moving again is now of prime concern to European Union leaders. Cost cutting measures in both the private and the public sectors have fuelled unemployment in many member states, but the hope

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is that new jobs will be created in the private sector to rapidly absorb workers who have been made redundant. Great emphasis has been placed on innovation as the cure for our current ills, perhaps nowhere more so than in the European Union. Notably, innovation is at the core of the EU 2020 Strategy (EC, 2010a) where it is presented as a key element to achieving smart, sustainable and inclusive growth – where "*smart growth*" is used to mean "*developing an economy based on knowledge and innovation*" (EC, 2010a, p. 3). One of the seven flagship initiatives deployed to deliver the objectives of the 2020 Strategy is the "Innovation Union". This aims "*to improve framework conditions and access to finance for research and innovation so as to ensure that innovative ideas can be turned into products and services that create growth and jobs*" (EC, 2010a, p. 3).

On the 4th February, 2011, the European Council gave strong backing to the Commission's Innovation Union blueprint, stressing that "*Investment in education, research, technology and innovation is a key driver of growth, and innovative ideas that can be turned into new marketable products and services help create growth and quality jobs*" (European Council, 2011, II.16). The priority of the European Commission is the stimulation of the European economy through the creation of new technologies and products that can be sold on the world markets. None of the official documents emanating from the European institutions contains a precise definition of innovation – including the 2011 Green Paper "From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation Funding" (EC, 2011a,b), which was under public consultation in the spring of 2011.[4] Moreover these documents barely consider the behavioural, social or sustainability aspects of innovation.

Innovation, defined here as new ways of doing and new ways of thinking, can legitimately be expected to contribute positively to employment, well-being, quality of life and society; and Europe should be truly committed to do more and play a bigger role in this respect, in the context of an increasingly competitive and resource-constrained world. Alarmingly however, the current European discourse on innovation is based on an implicit definition of innovation as solely a means of bringing products or services to the market. In a video interview, the European Commissioner for Research Mrs. Máire Geoghegan-Quinn explains that: "*Innovation means that we bring the wonderful scientific research that we have all the way along a chain until we get it into products and we sell [them] on the market; we develop products, we create products that the markets are there for and that people will want to buy*".[5]

This raises many questions. In this paper we focus on the following:

- If innovation is generally considered as a means towards some end, then should not the end be clearly identified?
- Has careful consideration been given to the consequences of rushing to generate more unrestrained economic activity through a concept of innovation focused on marketable products?
- What role is there for environment and health research in the future 'Innovation Union'?[6]

2. Innovation for what?

In the dominant discourse on the Innovation Union, innovation is deemed to be "*the only answer*" (EC, 2010b, p. 6) to tackle today's societal challenges, *inter alia*, "*returning to growth and higher levels of employment, combating climate change and moving towards a low-carbon society*" (EC, 2011a, p. 3), and "*resource scarcity, health and ageing*" (EC, 2010b, p. 2). Interestingly in this rhetoric, economic policy aims such as growth, productivity and competitiveness are given the same priority as aims relating to human well-being, quality of life and social and environmental sustainability. The underlying – and often unspoken – hypothesis seems to be that innovation leads to more products and services in the market place, which leads to more consumption, hence to growth and more jobs, which in turn lead to increased well-being, improvements in the quality of life and better health. Also implicit within this approach is that environmental, social and economic sustainability will emerge as part of the package, but with few details of how this monumental challenge will be met. None of the links in this chain of reasoning are necessarily true – or unproblematic. The history of the industrial and technological age is full of examples where the way humans have put technological innovations to use has been the cause of societal problems (notably health and environmental threats related to nuclear technologies, industrial chemicals, fossil fuels, mining, intensive agriculture, capture fisheries, aquaculture).

If the Innovation Union is successful, then as it is currently conceived, we will see a return to at least pre-crisis volumes of business, the growth of economies, the generation of jobs, and prosperity for all. The pre-crisis approach rode on the wave of manufacturing and consumption of products, global commerce and travel, ignoring or denying the underlying impacts of unsustainable resource use, crippling biodiversity loss and greenhouse gas emissions (IPCC, 2007; UNEP, 2007, 2010; CBD, 2010; EEA, 2010c). How will the new strategy differ from the old? Will such market-oriented innovation improve rather than aggravate the circumstances in which the ageing population of Europe is living, more than 75% of whom are now residents of urban environments, and who are experiencing high levels of cardiovascular diseases, cancers and epidemics of obesity and psychiatric disorders? Which "invisible hand" will lead us to environmentally sustainable use of resources and disposal of waste, or greater human well-being in Europe and across the globe?

Innovation is obviously not the only priority of the European Union. The European Union Treaty defines many other high level political, economic, social or environmental aims that need to be balanced as they may be conflicting.

[4] Consultation at: http://ec.europa.eu/research/csfri/index_en.cfm.

[5] "What is innovation?" video clip, available from the website of the 'Lisbon Council for Economic Competitiveness and Social Renewal' think tank, http://www.lisboncouncil.net/initiatives/innovation.html, accessed 28 April 2011.

[6] The same question obviously holds for many other research fields such as e.g. social organisation research or cultural research. These fields would deserve discussion too, but are beyond the intended scope of this paper.

These include aims such as promoting peace, European values and the well-being of the peoples of Europe; freedom, security, justice; balanced economic growth and price stability; full employment; social progress; sustainable development; a high level of protection and improvement of the quality of the environment; scientific progress and technological advances; cohesion; combating social exclusion and discriminations and respect for cultural diversity.[7] Such diverse objectives require trade-offs to be made on a daily basis. For instance, when the European Central Bank develops a policy based on a strong Euro to ensure price stability for Europeans, it limits the world exports of European-based innovation.

Putting products in the marketplace, growing the economy, achieving cutting-edge competitiveness, (technological) innovation and even job creation are not goals or ends *per se*, rather they are a means towards – and at the service of – our higher aspirations of enhanced well-being and sustainability.[8] Perhaps innovation should be more explicitly re-targeted – both in terms of the discourse as well as in actions – not just to deliver smart, sustainable and inclusive (economic) growth, but more directly to deliver better health and well-being, an improved quality of life and ultimately social, ecological and economic sustainability.

Hints of such a vision can be found in some of the EU's strategic documents mentioned above. For example non-technological, social and eco-innovation are mentioned in the Green Paper (EC, 2011a,b). An interpretation is fleetingly given in the Innovation Union flagship as "*a broad concept of innovation, both research-driven innovation and innovation in business models, design, branding and services that add value for users (...).*" (EC, 2010b, p. 7) One can also find references to innovation as a means to tackle societal challenges. The EU Council concluded on February 4th 2011 that "*innovation contributes to tackling the most critical societal challenges we are facing*" (European Council, 2011, II.16). And the Green Paper stresses that the Innovation Union should be "*putting a stronger focus on tackling societal challenges*" (EC, 2011a, p. 8). Yet still the overwhelming impression is that, notwithstanding these passing references, there is a headlong rush towards implementing the same approach as before in the hope of returning to a pre-crisis "business as usual" situation without regard to whether this is indeed a desirable, sufficient or even feasible option given the current state of the global environment.

"*Perfection of means and confusion of goals seem, in my opinion, to characterise our age*", said Albert Einstein in 1941 (Calaprice, 1996). Seven decades later, the European Union would have much to gain by avoiding being blinded by the immense power and 'perfection' of today's technological means while remaining confused about its goals. It is sometimes difficult to reconcile some aspects of current EU strategy with the goals clearly stated in Article 3 (1) of the Treaty on the European Union namely: "the Union's aim is to promote peace, its values and the well-being of its peoples" (EU, 2010).

[7] See the Treaty on European Union, in particular the Preamble and Articles 2 and 3.

[8] In the Aristotelian sense one could say that the former are intermediate aims (Nicomachean ethics, Book I).

3. Considering the consequences of innovation

A number of implicit assumptions underlie today's dominant discourse on innovation. In this section we discuss three of these assumptions:

- Innovation is always 'good' and necessarily generates jobs, economic growth and personal prosperity, which in turn improves health, well-being and quality of life.
- All the problems that we face can be solved through innovation.
- Curiosity-driven research is largely irrelevant to innovation.

These assumptions turn out to be at best problematic and hinder the debate about the consequences of innovation.

3.1. *Innovation is always good*

With regard to the first assumption, innovation is a means, not an end in itself hence the importance of grounding our innovation strategies on clearly identified higher ends. Innovative ideas may certainly result in new products, technologies and processes that improve the quality of peoples' lives. Antibiotics, potable tap water and electricity are all technological innovations that have vastly improved our health and well-being. Cars, mobile phones, televisions, computers, and similar products are regarded by many as being beneficial to our lives, though others, after due consideration, also note some negative consequences. Indeed, almost any innovative product or process is likely to have both positive and negative effects. This is true also for those innovations that appear at first sight as unambiguously 'good'. Antibiotics for instance, because of the way we have indiscriminately used them in humans and animals, have negative effects such as prevalence of antibiotic-resistant bacteria. In some cases, innovation can have unintended, unexpected negative consequences (especially in the long term), perverse effects, or hidden costs (usually externalised). And some innovations may turn out to be plain bad "good ideas". Examples include some pesticides, asbestos, halocarbons, and, in some circumstances, biofuels.[9] So to judge whether an innovation is 'good' entails consideration of its consequences over time (which may change) and reflection regarding its potential and real effects in terms of quality of life, well-being and sustainability. In other words, the suitability of an innovation is to be gauged against our higher societal aims. Indisputably, all the examples above and many other innovations, including those with negative effects on well-being or the environment, have generated new businesses and economic growth. Yet macroeconomic benefits are currently defined essentially in terms of growth in GDP, and do not necessarily lead to improvements in health and well-being or take into account the costs of environmental remediation or loss of natural capital. GDP can for instance increase as a result of increased health problems generating increased use of pharmaceuticals, or following the sale of more anti-personnel

[9] See Harremoës et al. (2001) for some interesting examples.

mines, or decontamination activities to deal with unintended side effects of an innovative product or process (Stiglitz et al., 2009; Jackson, 2009). Put another way, businesses often view the long term adverse impacts of their products on the environment and human health and well-being as "externalities". The lesson still to be learnt is that, as far as the planet as a whole is concerned, there are no externalities.

Society would benefit if these types of effects were taken into account transparently when making decisions about technology deployment. Considering the full range of consequences may turn out to be a difficult exercise, as in many instances, when an innovative process or product is introduced, its potential negative effects are unknown.[10] This was the case for instance for chlorofluorocarbons (CFCs) which turned out to be ozone depleting substances. And, as the positive and negative effects of technologies are not all known *ex ante*, the governance of innovation should be a dynamic process building on plural and conditional assessments (Stirling, 2010). Practical analytical and decision-support tools are being developed and implemented to address such situations, notably multi-criteria approaches.[11] Where a combination of high stakes, uncertainty and ignorance prevail, a rational governance approach exists in the form of the precautionary principle which "*provides justification for public policy actions in situations of scientific complexity, uncertainty and ignorance, where there may be a need to act in order to avoid, or reduce, potentially serious or irreversible threats to health or the environment, using an appropriate level of scientific evidence, and taking into account the likely pros and cons of action and inaction*" (Gee, 2006, see also Harremoës et al., 2001).[12] Article 191 of the Treaty on European Union builds on this principle: "*European Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.*" In a world where key actors of innovation are private companies, consideration of how to implement precautionary approaches in business strategies is urgently needed.

As for the idea that any innovation necessarily creates jobs, there is again room for scepticism. Economic history since the industrial revolution has been largely a history of decoupling growth from human labour by increasing automation of industrial processes and more recently, of services. Many of the new products and services contemplated in the current innovation proposals will indeed require an input of highly skilled labour for their realisation, but they will not necessarily lead to higher numbers of jobs for their production and distribution: some will, some won't and some will destroy jobs. Innovation (be it technological, organisational or social) may contribute to partly offsetting the jobs lost due to productivity gains from technological innovation. For instance, innovative renewable energy technologies are deemed to create more jobs than traditional energy production systems based on e.g. nuclear or fossil fuels (e.g. UNEP, 2008, 2011; EmployRES, 2009). Yet innovation does not *necessarily* imply more jobs.

3.2. *All our problems can be solved by Innovation*

The assumption that the societal and environmental problems we face can all be solved by technological innovation is also misguided. Experience shows that solving one problem often generates another. For example, the idea of growing crops to produce biofuels was thought by many to be a sustainable solution to our energy problems, until it became obvious that this might interfere with food production and drive food scarcity, higher food prices and biodiversity loss (e.g. Tilman et al., 2009). Moreover, reliance on 'technofixes' has the dangerous effect of giving us a false sense of security and engenders a complacent wait-and-see attitude whereby we do not need to worry about some of the more pressing challenges of our time because we will always find a solution in the future. This unwarranted trust in the *deus ex machina* suddenly solving an inextricable problem is often used to endorse a 'business as usual' attitude. Yet it is only credible if we imagine that the trend that technology will fix is reversible. Unfortunately many global environmental threats are likely to be irreversible. Issues such as climate change, the loss of biodiversity, or the modification of the genetic material of living organisms (by genetic engineering or by radioactive contamination) are irreversible. Once the climate has shifted to a different state, technology is unlikely to allow us to go back to the previous situation (at least not without huge risks and crippling costs). Once a species or genetic material is lost, it is lost forever, and if some simple ecosystems can be restored, more complex ecosystems (such as coral reefs or tropical rainforests) are beyond our ability to restore on timescales that are meaningful to humans. The 'technofix' argument also builds on a misplaced belief that we can control complex systems: from the human body – with the idea that we will be able to cure any disease or avoid the process of ageing – to the planet – with the idea that we will be able to control the atmosphere, the oceans or the whole biosphere through our management interventions (McGlade, 1994). Notwithstanding our technologies and our protective regulatory and monitoring systems, we are for instance still unable to prevent the accumulation of anthropogenic chemicals in our bodies during our lifetimes, despite them now being linked increasingly to altered incidences of various diseases.[13] Nor have we been able to eradicate starvation for millions on a planet where food abounds. So much for controllability.

The emerging link between innovation and resource efficiency is another promising area as far as addressing environmental problems through innovation is concerned. Yet it is not devoid of potential concerns. Just as is the case with the "Innovation Union", "Resource Efficient Europe" is one of the seven flagship initiatives composing the EU 2020 Strategy (EC, 2010a; 2011b). Hence resource efficiency is one

[10] And so are some unintended positive effects for that matter.

[11] See in particular the Multicriteria Mapping approach: http://www.multicriteriamapping.org/.

[12] This definition of the precautionary principle is the one used by the European Environment Agency.

[13] An example is Bisphenol A (BPA) and its link to potential greater risk for metabolic diseases such as cardiovascular diseases or type 2 diabetes (Lang et al., 2008; vom Saal and Myers, 2008).

area singled out for special attention in terms of innovation in the EU's current Framework 7 programme (and its successor, the "Horizon 2020 Framework Programme for Research and Innovation"). The rationale is that increasing the efficiency with which we use resources will certainly be beneficial for the environment and indirectly for human health and well-being, e.g. through reducing land use, energy consumption or adverse pollution impacts. But again this will not automatically occur as this assumption holds only if other things (in particular consumption) remain equal. Evidence suggests that there is a rebound effect, i.e. when we increase efficiency, we may actually use more of a resource in total as a result of the money saved. For instance if more efficient refrigerators are produced and sold to customers, old refrigerators may often be consigned to the garage as a store for chilled beer, resulting in overall increases in material and energy use. Similarly the consumer may decide to buy a bigger refrigerator or to spend the savings to drive more or fly... resulting in increased use of other natural resources. If resource efficiency strategies are not framed in appropriate policies (e.g. pricing policies), they will fail to deliver the desired environmental and human health benefits.[14] One solution to this problem is to combine assessments of 'resource efficiency' with assessments of 'resource effectiveness'. In other words, how successful have we been in producing the desired effect of reducing the use of natural resources? Ultimately, it is effectiveness that matters, not efficiency. For instance, we are already extremely efficient in extracting a whole range of natural resources, yet we are not always very effective in using them. Effectiveness is always measured in relation to a goal, so here again we see the importance of clarifying our goals.

3.3. *Curiosity driven research is largely irrelevant to innovation*

The third assumption we question relates to how innovation comes about. It is based on a belief that fundamental curiosity-driven research, applied research and technological development or innovation are conducted relatively independently of one another, and that therefore we should put the bulk of our resources and efforts into applied research to produce innovative technologies. Clearly not all research will lead to innovation, but all technological innovation is, in one way or another, underpinned by research, even if there may be significant time lags between when the research is conducted and the insights it provides to generate innovative technological application. It took two decades between the prediction of the existence of the positron by Paul Dirac in 1931 and its discovery by Carl D. Anderson a year later and the invention of positron emission tomography for medical imaging in the early 1950s, and another couple of decades before its clinical use. Similarly, as recalled by Lord Martin Rees, "*the pioneers of lasers had no idea that they would be used in eye surgery or in DVDs*" (Rees, 2009). We cannot predict in advance which research will lead to innovation. This provides an additional instrumental justification for fundamental 'blue sky' research, beyond the legitimate human quest for explaining the universe, independently of action (van den Hove, 2007). Ultimately, different types of research beyond issue-driven research and engineering may contribute to innovation – including curiosity-driven, non-technological, social sciences and humanities research. The latter two are of particular importance when it comes to organisational and social innovation, but are also relevant to strategic orientation and deployment of technological innovation (von Schomberg, in press; Diedrich et al., 2011). And all in all, there is often a dose of serendipity in the way innovation comes about!

There may be little value in classifying research by types, but if it must be done then the assertion of Sir George Porter, former President of the Royal Society, that there are only two kinds of research, applied and not-yet applied, is perhaps valuable (New Scientist, 1987). The risk of a narrow focus on innovation is to deplete the brimming reservoir of research that has yet to be applied and to mismanage the interaction between research and innovation.

Too narrow a focus on innovation for economic growth achieved through the production of marketable products may, as we have seen, give rise to unintended health, societal and environment side-effects. The indiscriminate production of goods also locks us onto a dominant, fixed and unrealistic path of material growth based on unsustainable use of finite resources and overburdening the sink capacity of our biosphere. This narrow focus results not only in technological lock-ins but also, more insidiously perhaps, in ideological lock-ins.

Increasing human health, well-being and quality of life and overall sustainability does not wholly depend on economic growth. There is ample evidence that the link between economic growth and high incomes on the one hand and health, well-being and quality of life on the other is questionable (e.g. Easterlin, 2001; Kahneman et al., 2006; Dolan et al., 2008). Hence there is a need to use a broader concept of innovation, which goes beyond technological marketable product development to include non-technological innovation, eco-innovation, health innovation, social innovation and behavioural innovation, including changes in attitudes towards production, consumption and waste and re-balancing our relationship with nature.[15] What is proposed here is a shift of emphasis from market-focussed innovation to socially meaningful innovation, building on a broader concept of sustainability. In the next section we look at the place and role for environment and health research in this perspective.

4. Environment and health research as drivers of socially meaningful innovation

The current financial and economic crises are woven into broader environmental and societal crises, manifest in particular as threats from climate change, failure of the fossil

[14] See e.g. the European Commission project: "Addressing the Rebound Effect" for a review of the significance of rebound effects and measures to address it in policy (http://rebound.eu-smr.eu).

[15] See the RESOLVE project for an example of collaborative research aiming at understanding the links between lifestyle, societal values and environment (http://resolve.sustainablelifestyles.ac.uk/).

fuel energy supply,[16] dwindling biodiversity and damaged ecosystems (McGlade, 2009; EEA, 2010a; Gee and van den Hove, 2010). A resolution of the financial and economic crises which does not simultaneously address the other, deeper, and irreversible problems that we face is unlikely to last a very long time. Any potentially useful approach requires innovative and socially meaningful ways of transforming the socio-ecological system in which we live. The short-sighted focus on innovation that only proposes more of the same will not trigger the transformations that are needed (Nobel Laureate Symposium, 2011; van den Hove et al., 2011). On the contrary, because of the inherent irreversibility of the environmental crises such an approach entails a high risk of serious backfire in the near future. Mitigation and adaptive capacities are necessary, but what is essential is the development of 'transformative capacity', defined by T. Elmqvist as "*the ability to fundamentally alter the nature of the system over the long term, when current ecological, social, or economic conditions become untenable or are undesirable*" (Elmqvist, 2010).

In such a framing, environmental research, in the broader sense, including a fuller grasp of the connections between the environment, human health and well-being, is vital. Without it we cannot sufficiently understand the socio-ecological system and the major crises in which we find ourselves. The knowledge we gain helps us to reflect on the possible evolution of the system and to imagine potential solutions to the problems we face. For instance, intense environmental research is required to deal with the legacy of our nuclear choices, be it nuclear contamination from accidents such as Chernobyl or Fukushima, the decommissioning of nuclear plants or piles of high level radioactive wastes from civil and military applications.

Environmental research is also innovative in many other senses. First, it is innovative in the ways in which we reach an understanding of the issues, that is, in the methodologies that it develops for that purpose. Because of the complexity of socio-ecological systems, the development of new holistic and interdisciplinary methodologies to address complexity and its inherent suite of uncertainties and indeterminacies is at the core of environmental research (Funtowicz and Ravetz, 1993; Stirling, 2010). Interestingly, these have prompted developments in other areas of research and technological development. For example, many of the early ideas and developments underpinning how local area computer networks could function were based on knowledge and analyses of ecosystems (Hogg et al., 1989; McGlade, 1999; Huberman, 2001). Environmental research is also innovative at the epistemological level. First because the knowledge it produces builds on the recognition of an irreducible plurality of pertinent analytical perspectives for a given situation of enquiry (epistemology of complexity) (O'Connor, 1999). And second because it integrates uncertainty and ignorance in its explanations and predictions of the world, hence departing from the inaccessible dream of certainty and foreknowledge. These innovative methodologies and epistemologies lead to social and behavioural innovations because they can inspire us by transforming the ways in which we live in the socio-ecological system.

Beyond these innovations in processes, environmental research is also the driver of technological innovations. One notable way in which this happens is through biomimicry whereby we learn to emulate natural forms, processes and ecosystems to develop new technologies and materials (Beynus, 1997, 2002).[17] Environmental research also leads to the discovery of organisms which have industrial or pharmaceutical applications. This is the case for instance of deep-sea research, which led to the discovery of extremophilic micro-organisms – i.e. organisms adapted to survive in ecological niches such as at high temperatures, extremes of pH, high salt concentrations and high pressure. Enzymes from these microorganisms have uses in food, chemical and pharmaceutical industries and in environmental biotechnology (Niehaus et al., 1999). Sponges are another category of organisms which are the source of a multitude of applications in the industrial, pharmaceutical and engineering worlds (Hogg et al., 2010).

Moreover, environmental research is directly upstream of many technological innovations aimed at addressing the issues it has identified and studied. For instance, climate change research has led to identification and better understanding of the challenges related to global warming and the options to mitigate or adapt to it. Once the need for renewable environment-friendly energy sources was established, technological innovation led to devices for capturing wind, wave, geothermal and solar energy. Innovation has also occurred in energy saving measures and the development of more energy-efficient products. Social innovation has accompanied technological innovation, for example, increased reliance on walking and cycling as ways of moving around, especially in cities. Innovation in communication promotes these alternative forms of transport, encouraging people to be physically active. This might also be thought of as social innovation in the sense that these new behaviours (or re-adoption of old behaviours) are an innovative public health intervention that leads to improved health and well-being, and arguably, quality of life. It also generates financial innovation as it provides a different way to reduce the burden on health services. Another example is the need to develop cheap sensors and associated communication technologies to ensure broad monitoring of the state and trend of the environment.

5. Conclusion: innovation with a purpose

In this commentary, we have stressed that innovation is not an end in itself but a means, hence the need to think deeply about what we want to achieve. If our aims are improved human health, wellbeing, quality of life and sustainability, then our discourses, policies and actions should re-target innovation to deliver these aims. Too narrow a focus on innovation, merely to bring more products to the market will inevitably continue to produce unintended negative consequences for society and the environment. Moreover, if made at the expense of funding curiosity-driven research, such a strategy will drain our potential for future innovation. In many OECD countries and in the European Union in particular, the

[16] On peak oil in particular see e.g. de Almeida and Silva (2011).

[17] See e.g. http://www.biomimicryinstitute.org.

current dominant vision of innovation maintains us in both technological and ideological lock-ins. Yet today's economic, societal and environmental crises will not be solved by more of the same. Given the scale and irreversibility of our damaging effects on the environment and on the well-being of current and future generations, there is no time for complacency. A shift from a market-only orientation to innovation towards more socially meaningful and socially and environmentally sustainable forms of innovation – innovation with a purpose – is urgently required as well as the adoption of a broader concept of innovation which not only includes technological innovation, but also non-technological, social, institutional and behavioural innovation.

A combination of innovative ways of thinking and doing and of innovative products and services can deliver the transformative capacity that will put us on a more ecologically, socially and economically sustainable path (e.g. Jackson, 2009). In this context, we argue that environment and health research are key drivers of all forms of innovation, because they focus on socio-ecological systems, because they stimulate the invention of technological, behavioural and institutional solutions and because ultimately environmental sustainability is a pre-condition for the sustainability of all other forms of innovation.

In practice, this means engaging in 'responsible innovation' whereby potential negative health, societal and environmental impacts of all new products, services and processes are considered in a transparent way from the early stages on, and whereby uncertainty, ignorance and the possibility of surprises are acknowledged (Stirling, 2010). It also entails innovating to minimise negative impacts of current products, services and processes, and involves applying the precautionary principle where stakes are high and potential damages irreversible. Responsible innovation also means recognising and accounting for the ethical dilemmas that may accompany innovation. It entails humility and a reflexive capacity that allows for the recognition of mistakes and the possibility to change courses accordingly.

The Europe 2020 Strategy stresses the need to "*re-focus R&D and innovation policy on the challenges facing our society*" (EC, 2010a, p. 10). This requires a transparent and democratic process where our aims and priorities are defined and regularly revisited in a dialogue with all actors (public authorities, innovators, producers, consumers, citizens, civil society). Such a process must also identify and implement appropriate ways to achieve these aims, via innovation and other means. Where innovation is indeed the appropriate means, the innovation cycle must be rethought to ensure accountability and transparency (STEPS, 2010). The time is ripe for radical innovation in the very way we conceive our innovation systems!

This commentary has focused on the situation in the European Union, yet many of the trends portrayed here and the proposed critique are not specific to Europe and apply to the situation in most OECD countries. As analysed in the STEPS '*New Manifesto on Innovation, Sustainability, Development*', there is also an international dimension to the questions discussed here, in particular in light of the interlinked global challenges of poverty reduction, social justice and environmental sustainability (STEPS, 2010).[18]

Through its past Framework Programs for Research and Technological Development, the EU has balanced longer term research and shorter term innovation with sensitivity for improved human health, well-being, quality of life, and environmental, social and economic sustainability. Today, the EU is in the midst of defining the future Common Strategic Framework for EU research and innovation funding. At this crucial time, it should be remembered that the European Union's research, development and innovation policy, if strategically designed and implemented, is an immensely powerful tool to contribute to shaping what René Passet calls "*an economy with a human purpose*" (une économie à finalité humaine) (Passet, 2001). The EU should not miss this historical opportunity to be responsible and innovative in its research and innovation policy and to inspire the rest of the world on this critical path.

[18] See also EEA (2010a,b) for a discussion of linkages between environmental and societal challenges.

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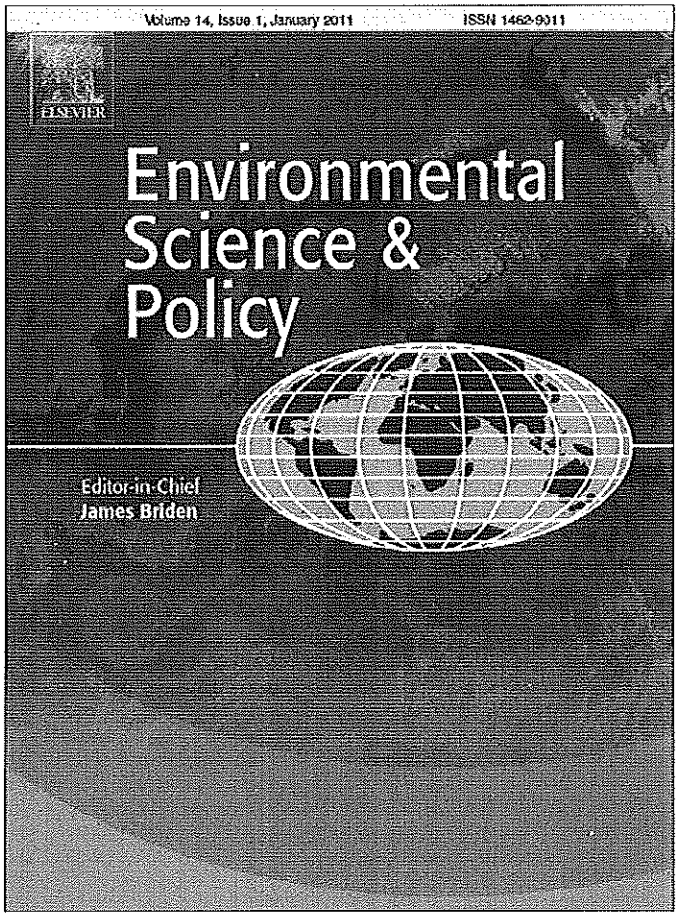

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