SSIC Secretariat Working Paper 1/2014

A Broad Understanding of Innovation and Its Importance for Innovation Policy

Rationale, Measurement, Implementation

Wolfgang Polt, Martin Berger, Helmut Gassler, Helene Schiffbänker, Sybille Reidl

Study by JOANNEUM RESEARCH on behalf of the Swiss Science and Innovation Council SSIC

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The Swiss Science and Innovation Council (SSIC) examines innovation policy from the multiple perspectives of innovation, support funding and society/value systems. As such, the SSIC is dealing with the question of how innovation could be conceived and supported in a broader sense. To get an informed overview of the pertinence of this question, the SSIC commissioned POLICIES, the Institute for Economic and Innovation Research of JOANNEUM RESEARCH, to elaborate the current state of discussion on the broad understanding of innovation and its importance for innovation policy.

The present publication examines the changes that have occurred with regard to the notion of innovation and innovation policy in recent decades. In particular, it traces the new demands on the notion of innovation and on innovation policy based on major observable trends in social development, and indeed changes to the innovation process itself.

Major global development trends, such as demographic changes, climate change, or structural economic change and increasing globalisation, raise the question of the extent to which a broadening of the notion of innovation also implies an extension of research, technology and innovation policy. Given that these global challenges overlap with several policy fields, and that innovation policy is expected to make a significant contribution to solving these global challenges, it appears essential for the target systems of the various policy areas and their instruments to be correlated in a coherent manner. In that sense, the definition of innovation policy itself must be broadened if it is to be capable of producing workable contributions to solving global problems. This can be seen in particular in the "new mission-oriented policies" that have become important pillars of innovation policy in a series of countries (Germany, Austria, Korea, Sweden), as well as at EU-level in the shape of Horizon 2020.

In recent decades there has been a gradual broadening of the concept of innovation, and subsequently of innovation policy. Key elements of this broader notion include:

- a concept spanning the whole chain of knowledge production from innovation and fundamental research to market launch;
- a "systemic understanding" of innovation, in which innovation is seen as the result of the cooperation and interaction of a multitude of various actors;
- a notion of innovation policy that is not restricted to promoting innovation as an end in itself, or for purely economic motives, but that considers innovation as an important tool in overcoming major social challenges;
- a broad understanding of innovation policy, which extends beyond traditional research and technology policy, embracing education policy in addressing major social challenges, as well as other relevant sectorial policies;
- a greater attention paid to public sector and social innovation.

Innovation research and innovation policies of developed, "knowledge-based" societies are becoming increasingly inclusive. In terms of direction and scope, it is possible to identify common patterns as well as country-specific aspects to this development, particularly with regard to the inclusion of "social innovation" in innovation policy. Other aspects (inclusion of service innovation, focus on major societal challenges), however, are already widespread.

The extended concept of innovation nevertheless presents some challenges, both in terms of its empirical operationalisation as well as its political implementation: the increasing number of indicator systems and measures in use today to portray innovation

and its various dimensions aptly reflects this difficulty. These diverse systems also make it difficult to formulate goals and benchmarks for "evidence-based" policy and demands the capacity for informed political discussions about these indicator systems.

The demands on innovation policy associated with the adoption of a broad notion of innovation are also significant: governance structures face a host of new challenges if a coherent relationship is to be established between diverse spheres of policy. This is especially evident for mission-oriented innovation policy, for example: the respective policy goals (CO_2 reduction, energy security etc.) can only be achieved if strategies can be harmonised and implemented in a coordinated manner. This requires a "whole-of-government" approach to policy setting, which is called for in corresponding OECD and EU policy concepts, but which in most countries is only put into practice to a very limited extent. The prerequisites for such an approach are clear allocation of competences, functioning coordination bodies, a common appreciation of the problem and a good basis of "evidence" upon which to formulate policy.

The broadening of the perception of innovation therefore reflects the increasing complexity of the innovation process and of the related task of shaping policy. An innovation policy that fails to recognise and adopt these changes in the innovation process will not fulfil its potential.

F

Le Conseil suisse de la science et de l'innovation (CSSI) mène une réflexion de fond sur la question de la politique de l'innovation sous l'angle de la conception de l'innovation, des modalités de son encouragement et des valeurs et besoins sociaux qui lui sont associés. En particulier, le CSSI souhaite étudier comment l'innovation peut être mieux conçue et encouragée au sens large. Pour se faire une idée globale de la pertinence de cette thématique au niveau international, le CSSI a mandaté POLICIES, l'Institut de Recherche sur l'Economie et l'Innovation de JOANNEUM RESEARCH, afin de dresser l'état des lieux de la discussion actuelle sur l'importance d'une conception large de l'innovation pour la politique de l'innovation.

La présente publication étudie l'évolution du concept d'innovation et de la politique d'innovation au cours des dernières décennies. Il s'agit notamment de mettre en lumière comment les différents concepts et politiques d'innovation concrétisent de nouvelles attentes issues, d'une part, des grandes tendances que l'on peut observer au niveau de la société, et, d'autre part, de la transformation des processus d'innovation eux-mêmes.

Les grandes tendances à l'échelle mondiale, comme l'évolution démographique, le changement climatique, les mutations structurelles de l'économie et la mondialisation croissante posent la question de savoir dans quelle mesure une compréhension élargie du concept d'innovation doit aussi s'accompagner d'une redéfinition de la politique en matière de recherche, technologie et innovation. Si l'on considère le fait que ces défis globaux relèvent de manière transversale de plusieurs domaines de l'action publique, et que, dans le même temps, la politique de l'innovation est appelée à contribuer à la résolution de ces défis globaux, il apparaît indispensable de redéfinir de manière cohérente les objectifs fondamentaux des différents domaines politiques et de revoir leurs modalités de mise en œuvre. En ce sens, la politique de l'innovation doit «s'élargir» de façon à être à même de contribuer à la résolution des problèmes globaux. A titre d'exemple, pensons à la redéfinition des objectifs de la politique orientée vers de nouvelles missions dans plusieurs pays (Allemagne, Autriche, Corée du Sud, Suède), de même qu'au niveau de l'Union européenne avec le programme Horizon 2020.

Au cours des dernières années, le concept d'innovation n'a cessé de s'étendre, la politique d'innovation suivant la même tendance. Les éléments centraux de la notion d'innovation sont:

- un concept qui recouvre l'ensemble de la chaîne de production du savoir, de la recherche fondamentale à la mise sur le marché;
- une compréhension «systémique» de l'innovation, vue comme la résultante de la coopération et de l'interaction d'une multitude d'acteurs divers;
- une compréhension de la politique d'innovation qui ne se limite pas à l'encouragement de l'innovation comme une fin en soi ou comme un objectif de portée purement économique, mais qui intègre l'innovation comme un levier permettant de relever des défis sociétaux majeurs;
- une conception élargie de la politique d'innovation dépassant la politique scientifique et technologique traditionnelle et incluant en tous les cas la politique de formation mais aussi, en ce qui concerne le domaine des grands défis sociétaux, les politiques sectorielles respectives;
- une attention accrue portée aux innovations dans le secteur public ainsi qu'aux innovations sociales.

Aussi bien la recherche sur l'innovation que la politique d'innovation des sociétés développées, fondées sur le savoir, ne cessent de s'élargir et de gagner en importance. L'orientation et la portée de cette extension conduisent à la fois à des modèles communs et à des particularismes nationaux. Ainsi, la prise en compte de l'«innovation sociale» en tant que volet de la politique de l'innovation n'est pas la même partout. D'autres extensions (inclusion des innovations dans les services, ajustement aux problèmes sociétaux) sont en revanche déjà largement répandues.

La conception large de l'innovation pose toutefois certains problèmes, aussi bien en ce qui concerne son application empirique que sa mise en œuvre politique: le nombre élevé de systèmes d'indicateurs et de métriques actuellement utilisés pour représenter l'innovation et ses dimensions diverses est l'expression manifeste de cette difficulté. Cette diversité complique également la formulation d'objectifs et de critères de référence pour une politique «basée sur des preuves» (evidence-based policy) et requiert une aptitude et de vastes connaissances pour traiter de ces systèmes d'indicateurs dans le débat politique. Les exigences posées à la politique d'innovation qui découlent de la prise en compte d'une conception élargie de l'innovation sont elles aussi considérables: de nouveaux défis se posent aux structures de gouvernance dès lors que des domaines politiques distincts doivent être mis en relation d'une manière cohérente. C'est particulièrement visible dans une politique d'innovation orientée vers des missions spécifiques. Chaque objectif politique (réduction de CO_2, sécurité énergétique, etc.) n'est atteignable que dans la mesure où les stratégies sectorielles sont harmonisées et coordonnées. Cela exige une approche globale de l'action gouvernementale, qui est certes réclamée dans les conceptions politiques respectives de l'OCDE et de l'UE mais qui n'est mise en œuvre que de manière très limitée dans la plupart des pays. Les conditions d'une telle approche sont des répartitions de compétences claires, des organes de coordination efficaces, une compréhension commune des problèmes et une solide base de données probantes pour la formulation de la politique.

L'élargissement du concept d'innovation ainsi que de la politique correspondante reflète donc la complexité croissante aussi bien des activités d'innovation que de l'action politique qui y est liée. Une politique d'innovation qui ne tient pas compte de ces évolutions dans le domaine de l'innovation reste en-deçà de ses potentialités.

D

Der Schweizerische Wissenschafts- und Innovationsrat (SWIR) setzt sich grundlegend mit dem Thema «Innovationspolitik» im Spannungsdreieck von Innovation, Förderung und Gesellschaft/Wertesystem auseinander. Dabei geht der SWIR der Frage nach, wie Innovationen breiter aufgefasst und gefördert werden können. Um sich über die Relevanz dieser Thematik im internationalen Kontext einen fundierten Überblick zu verschaffen, beauftragte der SWIR POLICIES, das Institut für Wirtschafts- und Innovationsforschung der JOANNEUM RESEARCH, den aktuellen Diskussionsstand zum breiten Innovationsverständnis und seiner Bedeutung für die Innovationspolitik aufzuarbeiten.

In der vorliegenden Publikation wird den Veränderungen, die der Innovationsbegriff und die Innovationspolitik in den letzten Jahrzehnten erfahren haben, nachgegangen. Dabei werden die neuen Anforderungen an Innovationsbegriff wie -politik zum einen aus den beobachtbaren großen gesellschaftlichen Entwicklungstrends, zum anderen aus den Veränderungen des Innovationsprozesses selbst abgeleitet.

Große globale Entwicklungstrends wie demographische Veränderungen, der Klimawandel oder der wirtschaftliche Strukturwandel und die zunehmende Globalisierung der Wirtschaft werfen die Frage auf, inwieweit eine solche breitere Fassung des Innovationsbegriffs auch eine notwendige Ausweitung für die Forschungs-, Technologie- und Innovationspolitik darstellt. Dadurch, dass diese globalen Herausforderungen Querschnittsmaterien darstellen, die eine Mehrzahl von Politikbereichen ansprechen und gleichzeitig von der Innovationspolitik ein wesentlicher Beitrag zur Lösung dieser globalen Herausforderungen erwartet wird, ergibt sich naturgemäß die Notwendigkeit, die Zielsysteme der unterschiedlichen Politikbereiche sowie ihre unterschiedlichen Instrumente in kohärenter Weise aufeinander zu beziehen. In diesem Sinn muss auch die Innovationspolitik «breiter» werden, um tatsächlich taugliche Beiträge zur Lösung der globalen Probleme bereitstellen zu können. Dies zeigt sich insbesondere in der «neuen missionsorientierten Politik», die in einer Reihe von Ländern (Deutschland, Österreich, Korea, Schweden) aber auch auf der Ebene der Europäischen Union mit dem Programm «Horizon 2020» zentraler Pfeiler der Innovationspolitik geworden ist.

In den letzten Jahrzehnten ist es zu einer zunehmenden Ausweitung des Innovationsbegriffs und in Folge auch der Innovationspolitik gekommen. Kernelemente dieses Innovationsbegriffs sind:

- ein die ganze Kette der Wissensproduktion umspannendes Konzept von Innovation, von der Grundlagenforschung bis zur Markteinführung;
- ein «systemisches Verständnis» von Innovation, das Innovation als das Resultat von Kooperation und Interaktion einer Vielzahl unterschiedlicher Akteure begreift;
- ein Verständnis von Innovationspolitik, das sich nicht auf die Förderung von Innovation als Selbstzweck oder mit ausschließlich ökonomischer Zielsetzung beschränkt, sondern Innovationen als wesentlichen Hebel zur Bewältigung großer gesellschaftlicher Herausforderungen sieht;
- ein breites Verständnis von Innovationspolitik, das über traditionelle Forschungs- und Technologiepolitik hinausreicht und jedenfalls Bildungspolitik, im Bereich großer gesellschaftlicher Herausforderungen aber auch jeweilige «Bereichspolitiken» mit einschließt;
- zunehmende Beachtung in der aktuellen Innovationspolitik von Bereichen der Innovation im öffentlichen Sektor und der sozialen Innovationen.

Sowohl die Innovationsforschung als auch die Innovationspolitik von entwickelten «wissensbasierten» Gesellschaften sind zunehmend «breiter» geworden. In Richtung und Umfang dieser Ausweitung lassen sich sowohl gemeinsame Muster als auch Länderspezifika festmachen, insbesondere im Ausmaß der Einbeziehung von «sozialer Innovation» als Teil der Innovationspolitik. Andere Ausweitungen (Einschluss von Dienstleistungsinnovationen, Ausrichtung an gesellschaftlichen Problemen) sind dagegen bereits sehr verbreitet.

Der erweiterte Innovationsbegriff ist allerdings herausfordernd, sowohl was seine empirische Operationalisierung als auch seine politische Umsetzung angeht: Die zunehmende Zahl von Indikatorensystemen und Metriken, die heute verwendet werden, um Innovation und ihre verschiedenen Dimensionen abzubilden, ist beredter Ausdruck dieser Schwierigkeit. Diese Vielfalt macht auch die Formulierung von Zielen und Benchmarks für «evidenz-basierte» Politik schwierig und verlangt kenntnisreiche politische Diskussionen dieser Indikatorensysteme.

Die mit der Adaption eines breiten Innovationsbegriffs verbundenen Anforderungen an die Innovationspolitik sind ebenfalls beträchtlich: Zum einen stellen sich ganz neue Herausforderungen an die Governance-Strukturen, wenn unterschiedliche Politikbereiche miteinander in kohärente Beziehung gebracht werden sollen. Dies ist etwa bei missionsorientierter Innovationspolitik augenfällig: Die jeweiligen Politikziele (CO_2-Reduktion, Energiesicherheit etc.) sind nur dann erreichbar, wenn es gelingt, Bereichsstrategien aufeinander abzustimmen und koordiniert umzusetzen. Dies verlangt nach einem «whole-of-government»-Politikansatz, der zwar in entsprechenden Politikkonzeptionen der OECD und der EU eingefordert, in der Praxis der meisten Länder allerdings nur sehr eingeschränkt umgesetzt wird. Voraussetzungen für einen solchen Ansatz sind klare Kompetenzzuteilungen, funktionierende Koordinationsgremien, eine gemeinsame Problemeinsicht und eine gute Evidenzbasis für die Politikformulierung.

Die Erweiterung sowohl des Innovationsbegriffs als auch des Zugangs der Innovationspolitik sind somit notwendige Entsprechungen der zunehmenden Komplexität sowohl des Innovationsgeschehens als auch der damit verbundenen politischen Gestaltungsaufgabe. Eine Innovationspolitik, die diese Veränderungen im Innovationsgeschehen nicht aufnimmt, bleibt hinter ihren Möglichkeiten.

1 Introduction and Background

As an advisory body to the Swiss Federal Council, the Swiss Science and Innovation Council (SSIC) is currently analysing the issue of "innovation policy" in the context of the interrelation between innovation, funding and society/value systems. The SSIC is interested in the issue of how innovations in the broader sense can be better supported by the federal government. In order to obtain an informed overview of the subject in an international context, the SSIC commissioned POLICIES, the Institute for Economic and Innovation Research of JOANNEUM RESEARCH, to elaborate the current state of discussion on the broad understanding of innovation and its importance for innovation policy[1]. A similar broad notion of innovation is for instance used as a basis for the European Union's new research framework programme Horizon 2020, the latest OECD Innovation Strategy (see OECD 2010b) and – at the national research and innovation strategy level – the German "High Tech Strategy 2020" and the Austrian research strategy from 2011.

Major global development trends (Chapter 2) raise the issue of whether research, technology and innovation policy will not be forced to develop a broader notion of innovation. The fact that these global challenges represent cross-sectional issues which concern a number of spheres of policy and that there is an expectation that innovation policy will make a crucial contribution to solving these global challenges, naturally results in a need to relate the target systems of the various spheres of policy and their different instruments to each other in a coherent manner. Therefore, so the hypothesis, innovation policy must become "broader" in order to be able to make appropriate contributions to solving the global problems.

The study also approaches the concept of "innovation" from the angle of theory of science and innovation policy (Chapter 3). Here it will be shown how, over time, the notion of innovation has changed. The original narrower concept is increasingly being expanded, allowing an improved depiction of innovation activities which are becoming more and more complex. This relates in particular to the inclusion of various forms of non-technological innovation, e.g. organisational improvements in firms, entering new markets and the development of new services.

This concept, which had already gone beyond the original narrow formulation focused on research and development, has been extended once again to include the concept of "social innovation", which also took entrepreneurial innovation in the non-profit area into account as well as genuine innovation in social relations. Proponents of a broader concept and understanding of innovation argue that it is necessary in order to deal with the increasingly complex innovation process and the expansion in the areas in which the concept can be applied.

The options for and limits to the empirical recording of various notions of innovation are then discussed against the background of the ongoing extension in the concept (Chapter 4). A progressively broader notion of innovation not only leads to increasingly greater difficulties in terms of empirical and statistical recording of what can be considered to be innovation, it also results in greater complexity in innovation policy if it is to live up to this more inclusive understanding. This problem is addressed in Chapter 5: here we will first discuss how a broader notion of innovation is being considered in international and national strategy papers.

1 We would like to thank Mr Marco Vencato and Mr Jörg Musiolik from the SSIC office for the intensive discussions on the subject. Special thanks go to Mrs Elsa Hamerla from the POLICIES Secretariat for her administrative support.

Further, the application of a broader notion of innovation is also described in four different dimensions of the concept, without claiming to cover the potential scope of the topic completely. The first case relates to its expansion to cover service innovations, which is discussed using examples from the creative industries. Secondly, the dimension of innovations in the public sector is shown using e-government as an example. The third case outlines a specific type of so-called "mission-oriented innovation policy", i.e. an innovation policy which directly addresses a specific social problem. Lastly, "gender mainstreaming" is outlined as one of the many examples of "social innovation" which focuses directly on the creation of new forms of social relations. The intention is to use these four prominent examples to illustrate current attempts to implement various dimensions of a broad notion of innovation.

It is evident that many such attempts at implementation are already in progress and that, in many countries, not only the *notion* of innovation but also innovation *policy* has become broader in their approaches. As a result, it has become more challenging both to measure and to implement policy.

2 Trends in Globalisation

This chapter examines (i) the extent to which socio-economic trends in globalisation are relevant to Switzerland and also significant for innovation policy, and (ii) the extent to which a broader notion of innovation is required in order to deal with the challenges these trends pose.

Globalisation, if we consider it to be the internationalisation of economic and scientific activities on a global scale, is a challenge in itself both for the stakeholders in an innovation system and for research and innovation policy. Yet increasingly the grand societal challenges can only be overcome with internationally coordinated action.[2] Innovations play a central role in overcoming these challenges (OECD 2010: 165). International cooperation is required for some of these challenges since no country is capable of successfully overcoming these problems on its own. What would be required of individual countries is unattractive from a cost/benefit perspective on account of the opportunistic behaviour of other countries, and an uncoordinated approach is considerably more expensive and offers less chance of success (ibid.).

Three selected "globalisation trends" will be examined below with an outline of their significance for Switzerland and a look at their implications for research and innovation policy. These trends are demographic change and international migration (2.1), climate change and the associated challenge of moving towards renewable sources of energy (2.2) and structural change, which can be seen in the tertiarisation and globalisation of the economy, amongst other things (2.3).

2.1 Demographic change and migration

Over the last 25 years, life expectancy at birth has increased by six years in Switzerland and currently stands at 82 years of age (2008). This means that within the OECD only people from Japan have a statistically higher life expectancy (Figure 1). Life expectancy will have risen by at least four years to 86.6 years by 2045–2050, according to UN estimates, and will thereby remain among the highest in the world (3rd place) (United Nations 2009: 74).

The combination of a higher life expectancy and falling or stagnating birth rates[3] means that the old-age support ratio (number of people of working age [20–64] per person of pension age [65+]) falls and the reciprocal old-age dependency ratio rises, even when international migration is taken into account. For instance the pension of a retiree in Switzerland will have to be generated by two workers in the future instead of by four (Figure 2). The Federal Statistical Office's mean scenario for the period 2010–2060 also provides similar results, despite using a different methodology (Bundesamt für Statistik 2010b). Differing alternative scenarios do, of course, also provide significant differences in results, particularly as migration trends are especially difficult to predict.

2 "Grand challenges are not to be defined, assessed or solved by any single scientific or technological discipline or within one specific sectoral policy framework. Societies are facing complex, interlinked, global and local challenges. For challenges like healthy aging and climate change it is evident that we need new policies, new governance models, new innovation solutions and strategies, and new investment models. But the necessary holistic or generic approach also includes the need for highly specialised knowledge and highly specific technological and organizational solutions. Grand challenges involve many different stakeholders, are multidimensional, transdisciplinary, systemic and they require new ways of thinking which go beyond traditional frameworks and disciplines. And they lead to a need to re-think research and innovation policy" (Leijten et al. 2012: 11).

3 The number of live births per 1000 people has hovered around 10 since 2000, while in the 1990s it was around 12. In comparison, the birth rate is just under 13 in the OECD, 11 in the EU-27 and almost 20 globally (World Bank 2012).

An expanded and purposefully designed immigration and migration policy represents one of the alternatives to "over-ageing" in society. Switzerland is already a country of immigration, with 26 % of the population born abroad (2010). This is the third-highest figure within the OECD (see Figure 3). 24 % of these immigrants arrived in Switzerland in the last five years, with a total of 57 % of all immigrants coming from other high-income OECD countries – a high number compared with neighbouring countries (the figure for France, Germany and Austria is around 30 %, for Italy 20 %, ibid.: 49).

A split between migrants can be observed: On the one hand many of the immigrants are well educated, with the proportion of highly educated individuals (ISCED 5 and 6), for instance, amongst those of working age (15–64) at 30 % in the case of immigrants, 28 % among the native-born population and 27 % in the case of the "second generation", i.e. the children of immigrants who were born in the country (2008; Eurostat 2012). However, the proportion of individuals with low levels of education (ISCED 0–2) is considerably higher among immigrants, at 31 %, than it is among the native-born population (15 %) and the "second generation" (21 %) (ibid.).

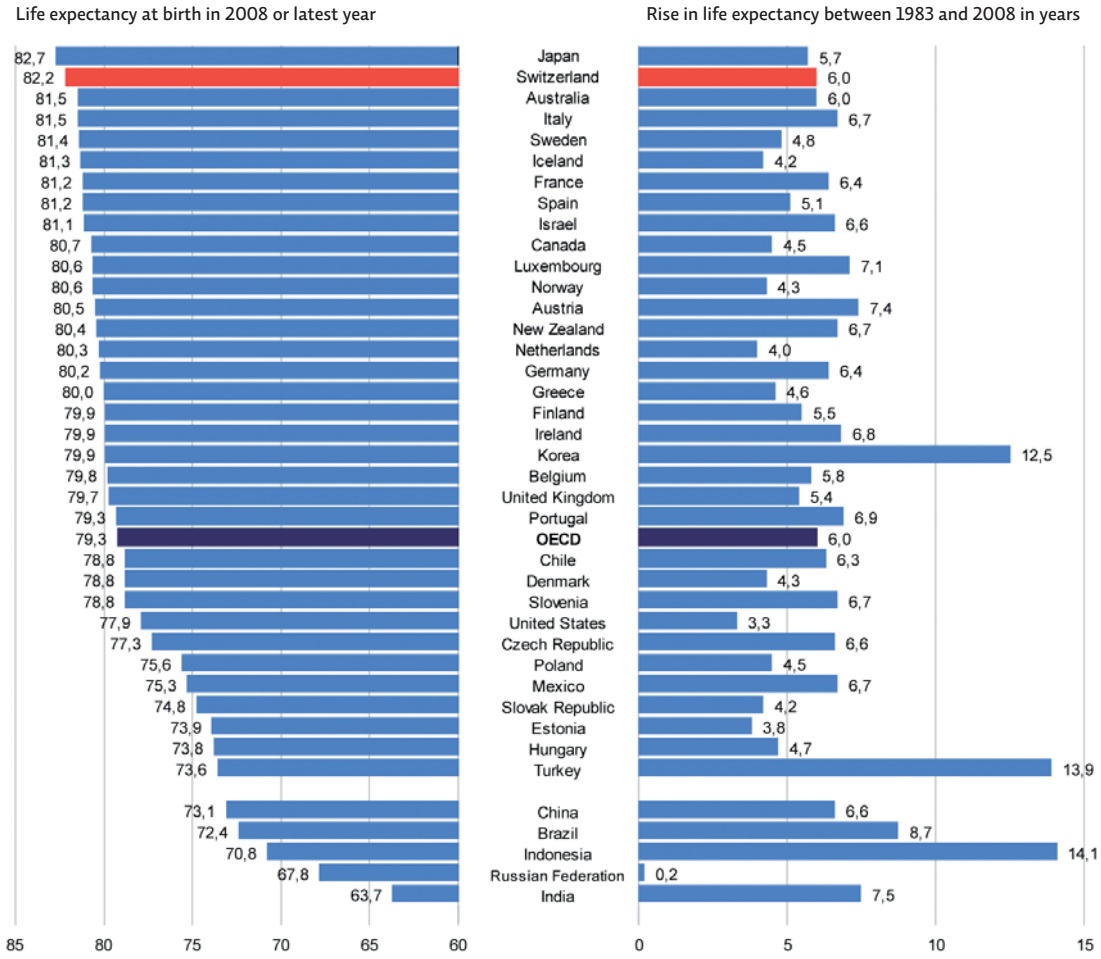

Figure 1: **Life expectancy at birth and its rise since 1983**

Source: OECD 2011

This situation is most pronounced among those aged 25–34, with 44 % of immigrants in this age bracket highly educated (ISCED 5 und 6), whereas the figure for the native-born population is 40 % and for the "second generation" 31 % (2008, OECD 2012a: 83). On the other hand those with low levels of education (ISCED 0–2) represent 19 % of immigrants, which is considerably above the proportion for the native-born population (2.5 %) or the "second generation" (8 %) (OECD 2012a).

At 7.4 %, the unemployment rate among immigrants (aged between 15 and 64 for the years 2009–2010) is one of the lowest in an OECD comparison, although this makes it around 4 percentage points higher than the proportion of those born in the country (ibid.: 99). The unemployment rate for the "second generation" (aged between 15 and 34; 2008), at 6.2 %, is still at least 3 percentage points higher than it is for children of native-born par-

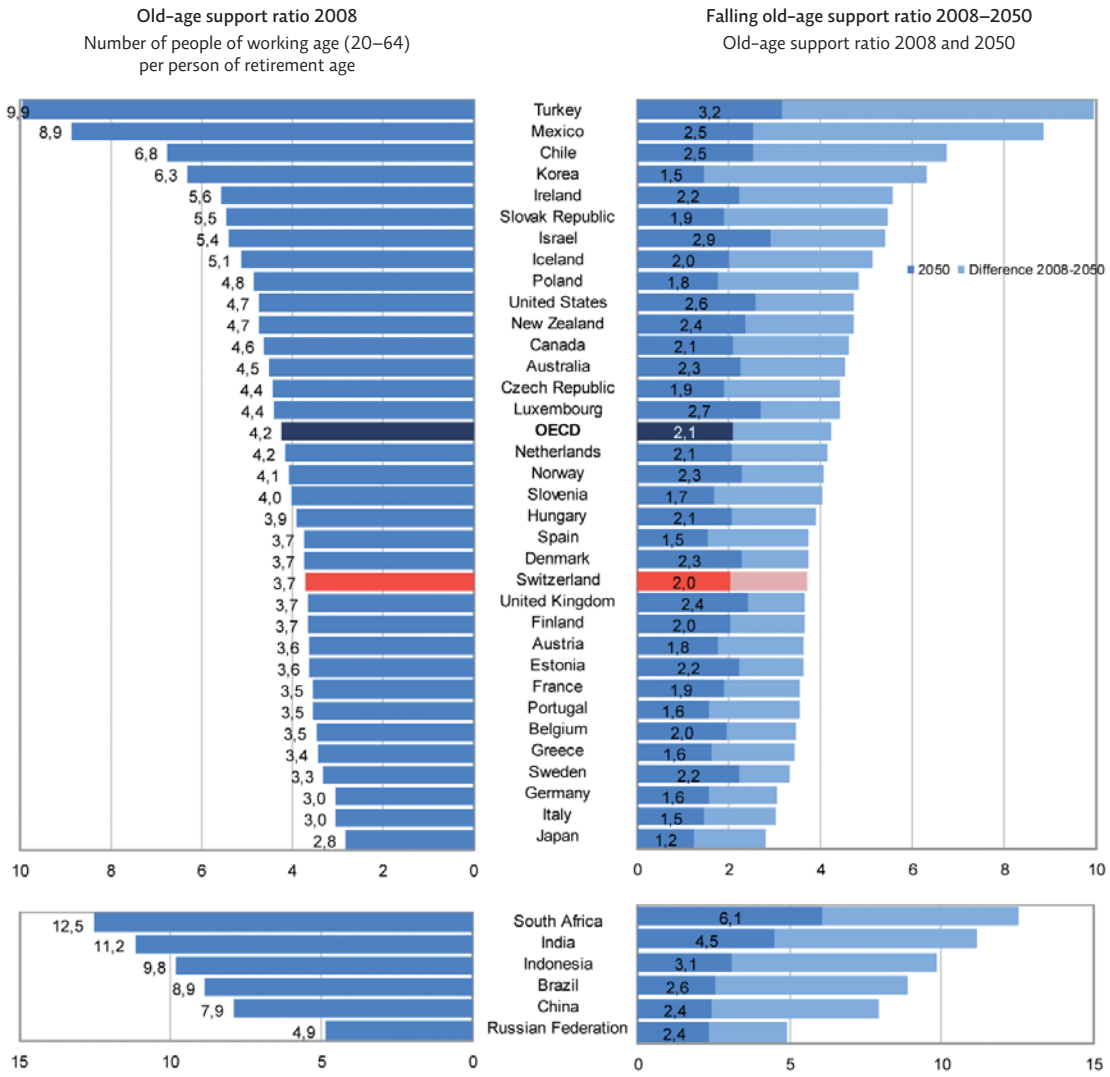

Figure 2: **Old-age support ratio 2008 and its change 2008–2050**

Source: OECD 2011 based on OECD 2011b and United Nations 2009 (average variant)

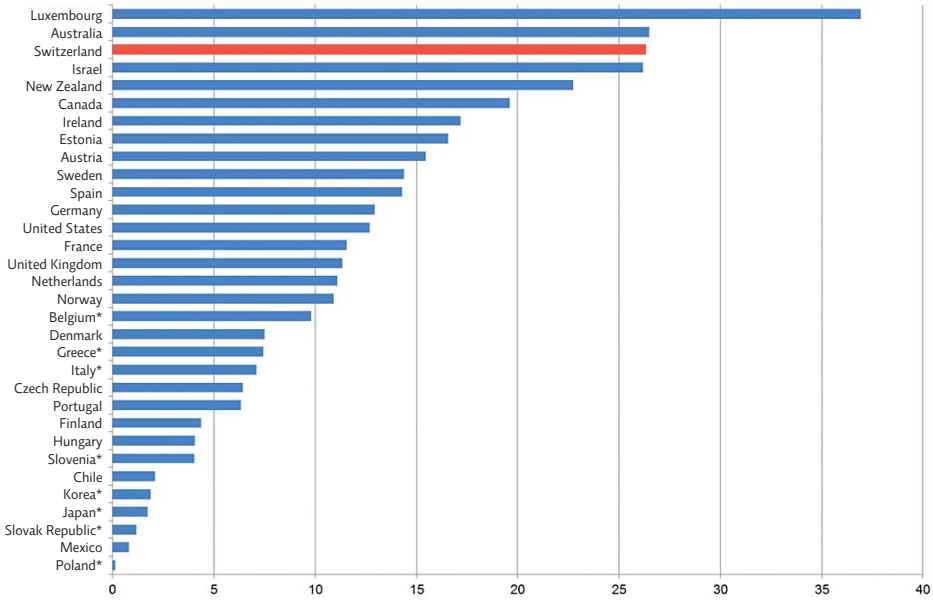

Figure 3: **Proportion of the population born abroad (2009)**

* substituted information on the proportion of the population of foreign nationality based on a lack of data; this is normally a few percentage points lower than when the place of birth is taken into account.
Source: OECD: International Migration Database, 23 Nov. 2012

ents (ibid.: 103). Highly qualified immigrants work in jobs commensurate with their education levels at the same rate as do native-born workers. The over-qualification rate for highly qualified individuals aged 15–64 is 18 % for immigrants and 20.5 % for native-born employees (2009–2010; ibid.: 121). This also applies to second-generation individuals (ibid.: 123). However, immigrants from lower-income countries are much more frequently over-qualified for their employment activity than immigrants from high-income OECD countries (ibid.: 132).

The Federal Statistical Office predicts only a slight rise in the future share of foreign workers among the working population. Thus the 23 % share (full-time equivalents; 2005) is expected to stagnate (low growth) or rise to 26 % (average growth) or increase to 28 % (high growth scenario) by 2060 (Federal Statistical Office 2010: 79 et seq.).

Relevance for research and innovation policy

The population dynamics are relevant for innovation policy on multiple levels, indirectly as well as to some extent directly.

— Innovations play an essential part in increasing productivity and in economic growth (e. g. Hall 2011; OECD 2010a, 2010b). This is necessary in order to maintain the same or improved standard of living for an increased number of pensioners in spite of a decline in the number of workers (even with an increase in the pension age) and to finance a health system that is being used more extensively. *This makes an even more pronounced innovation policy a necessity for ageing societies.*

- The proportion of older employees will increase with greater life expectancy and an expected rise in the pensionable age. *This will require innovations in the areas of workplace design, organisation and processes.* There is also a need for assurances that a knowledge-based society that is characterised by a larger number of older employees loses none of its innovative potential. Special measures are required in this regard for the purposes of retaining or making optimum use of the capabilities of older employees (e.g. life-long learning) (see Jones & Hayden 2009a).
- The growing number of older people means an increased *demand for (innovative) products* (e.g. age-appropriate technologies) *and services* (e.g. housing types, trips) geared towards the "silver economy" (Jones & Hayden 2009b), along with a general need for society to adapt to the needs of older people, such as the use of online e-Government services to replace visits to physical offices, new types of support and care services. This also includes dealing with the increasing number of pensioners who fall ill or require care, which presents new challenges for healthcare systems (Karakasidou & Cunningham 2010a; Köhler & Goldmann 2008). Overcoming these challenges *often requires a linkage between technological and social innovations*[4] (e.g. telecare, robotherapy, and so-called ambient assisted living more generally; Klein 2008).
- Even with the expected increase in retirement ages, pensioners still represent a growing group of individuals who are no longer engaged in occupational activities, but who are available for and open to voluntary and social activities and therefore also to social innovations (e.g. "reading mentors", "hired grandparents", "soup kitchens"). *Integration of these groups in society through genuine social innovation is required here.*
- International migration is a (growing) factor in a globalised world – including and especially with regard to highly qualified individuals (see OECD 2008). One of the tasks in innovation policy must be to encourage this "brain circulation" and offer an attractive location for highly mobile and qualified workers as well as to minimise or offset any potential disadvantages. Diversity (in relation to cultural background, age and gender) also has a beneficial influence on innovative capacities (see e.g. Ottaviano & Peri 2006; Niebuhr 2010; Audretsch et al. 2009; Florida 2002a; Focus Consultancy 2008). *In this way, "managed migration" and "managed diversity" also become central tasks for innovation policy.* Additionally, it is imperative that workers' jobs and responsibilities match their qualifications – particularly in the case of immigrants.

In any case, it does seem that socio-demographic change suggests a broadening of the concept of innovation, particularly towards "social" innovations, though this change may either provide impetus for further innovations or pose factors that could inhibit innovative capabilities.

4 There are numerous definitions of social innovations (see Chapter 5.3.4). A working group of the European Commission writes: "Social innovations are innovations that are social in both their ends and their means. Specifically, we define social innovations as new ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. They are innovations that are not only good for society but also enhance society's capacity to act" (BEPA 2011: 9).

2.2 Climate change and energy policy

It is predicted that climate change will lead over the course of this century to higher temperatures all year round in Switzerland. While summer will see less rainfall, with longer periods of dry and hot weather more likely, increased precipitation during the winter is to be expected, which will more frequently appear in the form of rain rather than snow. This is associated with floods and an increase in maximum snow levels, along with diverse effects on the balance of nature, biodiversity, quality of life for humans and significant economic sub-sectors (e.g. tourism) (OcCC 2008; CH2011 2011; North et al. 2007; OcCC & ProClim 2007).

Politicians aim to achieve lower temperature increases through a reduction in greenhouse gas emissions. To this end, Switzerland made a commitment through its CO_2 Act (new version as of 2013) to *"reduce CO_2 emissions overall by 10 % by 2010 compared with 1990 from the use of fossil energy resources …"*[5], with the average figure between 2008 and 2012 used as a basis. The intention is for greenhouse gases to be reduced by 20 % overall by 2020. An essential component of this effort is the Energy Strategy 2050, which has a target of reducing average energy consumption by 35 % per person and year by 2035 (compared with the year 2000 as a base), stabilising power consumption as of 2020 and achieving annual production of water power of 37 000 GWh and other renewable energies of almost 12,000 GWh by 2035 (Swiss Federal Office of Energy 2012). The "EnergieSchweiz" programme and the planned technology fund to reduce greenhouse gases are additional important instruments (see Federal Office for the Environment 2010, 2012a; North et al. 2007).

On the other hand, there are plans to implement measures to adapt to those effects of climate change that will occur in spite of the countermeasures already taken. The first part of a corresponding strategy has been passed by the Federal Council (Federal Office for the Environment 2012a), which enumerates the major challenges and formulates key objectives for changes in the areas of water management, natural hazards, agriculture and the forestry industry, energy, tourism, biodiversity management, health and spatial development.

Figure 4 shows that for a highly industrialised country, Switzerland has low CO_2 emissions in international comparison. Only a few countries in the OECD such as Sweden and France had a lower value in 2010 (both measured in relation to the primary energy supply as well as to the population). This is in particular due to the high proportion of water and nuclear power in power generation. CO_2 emissions were reduced by 1.7 % between 1990 and 2010 (OECD: 6.7%; in relation to overall primary energy supply) or even 7.5 % (OECD: 3.7%; *per capita*) (International Energy Agency 2012). The expansion in renewable energies is demonstrated by the fact that their share in the primary energy supply increased[6] from 15.0 % in 1990 (OECD: 5.9 %) to 18.8 % in 2010 (OECD: 7.6 %) (OECD 2012: Green Growth Indicators). By contrast, traffic's role as a source of CO_2 is growing dramatically both in Switzerland as well as across the OECD as a whole (18.2 % increase between 1990 and 2010, International Energy Agency 2012: II.359).

5 641.71, Federal Act on the Reduction of CO_2 Emissions (CO_2 Act) from 8 October 1999 (version dated 1 May 2012).

6 This also increased by 7.8 % in the same period (International Energy Agency 2012).

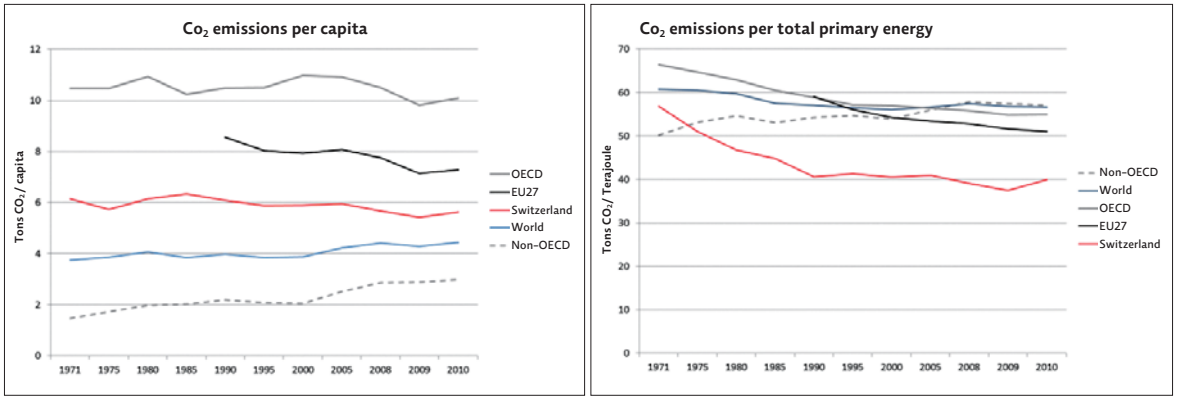

Figure 4: **CO_2 emissions in Switzerland in international comparison (1970–2010)**

Source: International Energy Agency 2012: II.46 et seq.

Relevance for research and innovation policy

When it comes to climate protection and measures for adapting to climate change, Switzerland primarily turns to technological innovations in the area of energy production and conservation, which could also generate competitive advantages economically in future (Federal Office for the Environment 2012a; OcCC 2008: 44 et seq.). However, a "change in society towards saving energy" (OcCC 2008: 40) is also required – which is something that certainly reaches into the domain of "social innovations".

From the point of view of innovation policy there are aspects of climate change and energy supply which can ultimately be consolidated under the umbrella of "eco-innovations". The following is the European Eco-Innovation Observatory's[7] (EIO) definition of the term:

> *"Eco-innovation is innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle. The understanding of eco-innovation has broadened from a traditional understanding of innovating to reduce environmental impacts towards innovating to minimise the use of natural resources in the design, production, use, re-use and recycling of products and materials. Technological innovation alone is not sufficient to enable the transition of Europe into a sustainable economy; the magnitude of the challenge also calls for systemic innovations in the way services are delivered and organisations are run. Public acceptance and social changes are key in this process* [our emphasis]" (O'Brien et. al. 2011: vii).

According to this understanding, "eco-innovations" go distinctly beyond any narrow technical concept. The EIO actually attempts to record system innovations[8] which produce breakthroughs in production and consumer patterns and has coined the term "material flow innovation", which is intended to supplement the traditional concepts of innovation in products, processes, organisation and marketing as well as social innovation (ibid: 2).

7 An initiative promoted by the European Commission, DG Environment; details at www.eco-innovation.eu.

8 "... this type of innovation does not only refer to technological systems, but also to radical and disruptive technologies that alter the market conditions [...] as well as all types of system changes such as industrial, societal, or behavioural changes" (Bleischwitz et al. 2009: 16).

What is required is an eco-innovation policy that builds on this, which the EIO illustrates as follows:

> *"Eco-innovation policy aims to support development and diffusion of innovations resulting in a long-term economic and environmental sustainability. In doing so, it has a mission to counteract both market and system-level failures, which prohibit eco-innovations from being developed and diffused. Policy researchers argue* 'eco-innovation is a prime candidate for "new mission" policies, to deal with (interrelated) societal challenges of climate change, resource efficiency and energy/resource scarcity' *(Kemp 2011). In order to deliver on these ambitious sustainability goals, eco-innovation policy needs to be based on two pillars responding to the eco-innovation challenge.*
> *On the one hand, the policy needs to establish a wide framework favourable for eco-innovation and set an overall direction of change* [our emphasis]. *This includes, notably, setting clear and binding environmental targets and limits of both resource use and emissions, as well as bringing about a level playing field for eco-innovators by recognising both economic and environmental benefits of their activities. Recognising environmental cost of the use of non-renewable resources is one of the key actions in this context. The first pillar is a domain of environmental and wider macro-economic policies based on scientific evidence on the planetary boundaries and wider societal trends. The second pillar of eco-innovation policy focuses directly on eco-innovation activity by both supporting material efficiency improvements of companies as well as by supporting development and implementation of more radical and systemic eco-innovations. This is a domain of science, innovation and entrepreneurship policies, which focus on providing the support for eco-innovations with a high potential to contribute to a wider shift towards the overall targets"* (O'Brien & Miedzinski 2012: 48).

The OECD (2011c: 29) highlights the significance of non-technological innovations in the study "Better Policies to Support Eco-innovation". Because the sense of urgency associated with many environmental issues promotes an emphasis on the (more rapid) spread of existing technologies instead of new (technological) developments (ibid.: 43), a diffusion-oriented innovation policy (within the scope of a policy mix bringing together various departmental policies) is of crucial importance (ibid.: 44). Regulations can play an essential role in this.

In this respect a case study on innovation in waste disposal management and recycling shows that political measures initially (in the 1980s and 1990s) led to an increase in technological innovations. The rate of innovation did fall as the industry matured, but recycling quotas have nevertheless continued to increase and the amount of waste has declined. This leads the authors to conclude that *"for mature sectors, responses to environmental policy shocks may be reflected in behavioural and organisational innovations, rather than in terms of technological inventions [our emphasis]"* (OECD 2011d: 17), which is made clear by the example of the significance of non-technological innovations.

In summary the following conclusions can be drawn for innovation policy from the mega-trend of climate change:

- Innovations, and especially their (rapid) spread, are crucial in slowing down climate change (and meet the 2 °C target) and in successfully adapting to climate change in particular or for more resource-efficient and environmentally friendly economic activity in general.

- The diffusion and acceptance of existing alternatives are also important in addition to new technological products and processes. Social innovations, such as behavioural or organisational innovations, and systemic innovations[9] are of major importance in this respect and require a broadened concept of innovation.
- The fact that many climate-related innovations involve network infrastructures (e.g. transport networks, energy networks) with the corresponding network externalities means that systemic innovations are required. In some circumstances the existence of old and inefficient infrastructure technology acts as a brake on innovations, even though there may already be more efficient alternatives. This means that without accompanying measures any new technology may be slow, or in extreme cases completely unable, to win out against the prevailing technology or network infrastructure.
- Many activities in this area can be handled via the market, but they still require an appropriate social context or political framework and infrastructure initiatives before they can be successfully implemented (e.g. car sharing, e-mobility, thermal rehabilitation of buildings). Since the objectives of sustainability are interdisciplinary and cover a wide variety of issues, they also affect a large number of policy fields and their interaction.
- As a grand challenge, then, climate change is an essential justification for social innovations. Operational or market-based innovation processes are in many cases not adequate. On the contrary, a commitment is required from civil society, the public sector, social enterprises, non-governmental organisations and others in order to meet this challenge.

In addition to existing challenges associated with traditional RTI policy (for instance in R&D for new battery systems, CCS, etc.), there is a need to combine technological innovations with changes in individual and institutional behaviours that is a direct result of society's attempts to manage climate change and pursue environmentally oriented innovation.

2.3 Structural change

Structural shifts which are significant for innovation policy are also evident in long-term trends that characterise the industrial sector. Attention should be drawn especially to the process of tertiarisation as well as that of globalisation.

Tertiarisation

The trend towards tertiarisation is being reassessed both as part of the economic and financial crisis as well as within the scope of the debate around globalisation: While a manufacturing base was for a long time considered to be a characteristic of an "obsolete" economic structure, off-shoring or cutting jobs in manufacturing is increasingly viewed critically, which also highlights the need for a renaissance in industrial policy (European Commission 2012). The crucial reasons for this include the significance of manufacturing as an essential player in a functioning (national or regional) innovation system, along with the role of manufacturing in contributing to growth and to solving global challenges at the same time ("green growth") through developing clean technologies (see Reiner 2012).

9 For example, this may be defined as: "A set of interconnected innovations, where each is dependent on the other, with innovation both in the parts of the system and in the ways that they interact" (Davies et al.: 4).

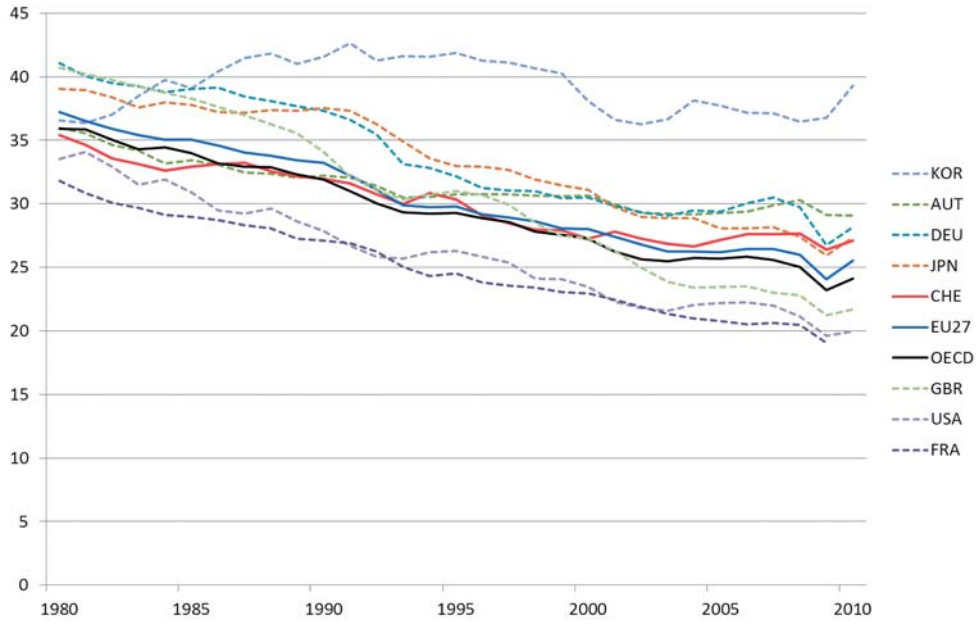

Figure 5: **Proportion of value added for manufacturing* (as % of gross domestic product)**

*Manufacturing: mining, manufacture of goods, construction, energy and water supply (ISIC 10–45, vers. 3)
Source: World Bank 2012

The fear (or "myth") of deindustrialisation has been consistently voiced for decades in Switzerland too, and these concerns are more loudly expressed particularly when the Swiss franc is strong (Schwarz 2012; see also Lack & Schwarz 2012). Furthermore, this fear is articulated across party lines (see NZZ 2012a, 2012b).

The proportion of value added for manufacturing has actually decreased markedly in the last 30 years in many industrialised countries, including Switzerland (see Figure 5). Here the proportion for manufacturing (and that for the manufacture of goods) fell from 35 % (1980) to 27 % (2010) (World Bank 2012). However, the average annual "growth" (i.e. contraction) rate is considerably lower in Switzerland, at -0.9 %, than for the OECD or the EU-27 (-1.3 % each). The United Kingdom (-2.1 %), France (-1.8 %) and the USA (-1.7 %) exhibit an above-average tertiarisation process in particular. Based on productivity increases, the proportion of employees in manufacturing in Switzerland, as is the case in other countries, fell more markedly in this period than the proportion of value added, i.e. from 38 % to 21 % (ibid.).

Globalisation of R&D

The Swiss economy is traditionally a highly industrialised one. This relates both to exports as well as direct investments (locations abroad) (Arvanitis et al. 2011). However, the international data available on the globalisation of individual corporate functions and of R&D in particular are unsatisfactory. For instance, there is little corresponding information in the relevant OECD databases for Switzerland (as well as for many other countries). Having said that, the available data does show heavy globalisation for R&D. R&D expenditure by Swiss multinationals in foreign subsidiaries in 2008, for example, was consid-

erably higher than that at home, amounting to just under 132 % of domestic R&D (OECD 2012b)[10]. In comparison, in Germany the proportion is 25 % (2007), in the USA 15 % (2008) and in Japan 3 % (2007) (ibid.).

Information on international patent linkage also provides evidence of the high level of globalisation in R&D: 65 % of the patent applications with the WIPO (PCT) from Swiss firms were developed by inventors abroad in 2009. The figures for Sweden (32 %), Germany (18 %), the USA (15 %) and Japan (3 %) are also well below the figure for Switzerland (ibid.)[11].

On the other hand, Switzerland is also of interest to foreign firms as a research location; 29 % of all patent applications for domestically developed inventions were filed with the WIPO (PCT) by foreign firms in 2009. In Sweden this figure is 21 %, in Germany 18 %, the USA 12 % and Japan 3 % (ibid.).

National figures from the Federal Statistical Office show that more than half (57 %; 2008) of internal R&D expenditure was made abroad (Federal Statistical Office 2012). However, this overall picture is heavily influenced by the chemical and pharmaceutical industries, which accounted for 70 % of overall R&D investments abroad in 2008 (Berger et al. 2010: 117).

A specific corporate survey on globalisation carried out by the KOF Swiss Economic Institute in 2010 (Arvanitis et al. 2011) shows that R&D tends to be less globalised among Swiss firms as compared with other corporate functions. Of those firms that were surveyed and which are active abroad, 82 % have globalised distribution, 68 % globalised manufacturing and 47 % globalised procurement, but the figure for R&D is 30 %. In addition to work done by subsidiaries, contractual collaboration with foreign partners also contributes to this figure (Table 1).

Table 1:
Institutional form of presence abroad according to sectors*

Institutional form	Manufacturing	Services	Total
Distribution	**86**	**70**	**82**
Own sales and distribution organisation	62	49	58
Joint venture	22	21	22
Contractual collaboration	49	35	45
Production	**68**	**67**	**68**
Own production facilities	43	34	41
Joint venture	15	12	14
Contractual collaboration	18	30	21
Made-to-order production	23	20	21
Procurement	**49**	**43**	**47**
Own production for primary products	27	14	23
Joint venture	9	8	9
Contractual collaboration	24	29	25
R&D	**34**	**17**	**30**
Own R&D institution/department	21	8	18
Joint venture	4	2	4
Contractual collaboration	16	10	14
Specific performance agreements	**25**	**33**	**27**
Licensing, franchising	17	11	15
Management, service agreements	12	27	16

* multiple answers possible; as a percentage of firms active abroad
Source: Arvanitis et al. 2011: 34

10 Globalisation – Activity of Multinationals – Outward Activity of Multinationals – Share in National Total (Manufacturing).

11 Science Technology, Patents – Patent Statistics – International Co-operation in Patents – Domestic Ownership of Inventions Made Abroad.

Reasons for R&D abroad	Sector				Total
	Low-tech manufacturing	High-tech manufacturing	Knowledge-based services	Other services	
A. Individual motives					
1. Proximity to leading universities	37	36	22	20	34
2. Proximity to innovative firms (networks)	33	30	33	40	31
3. Knowledge transfer to Switzerland	26	32	17	0	28
4. Local production and sales support	44	32	33	20	34
5. Access to highly qualified (R&D) staff	22	38	28	0	33
6. Lower costs of R&D activities	19	37	33	0	32
7. More funding of R&D (taxes, subsidies)	19	22	11	0	20
8. Less restrictive regulations	7	8	0	0	6
Total A	*207*	*233*	*178*	*80*	*217*
B. Motive groupings					
Knowledge	32	33	24	20	31
Market	44	32	33	20	34
Resources	22	38	28	0	33
Location	15	22	15	0	19
Total B	*113*	*125*	*100*	*40*	*116*

Table 2: **Motives behind R&D investments abroad***

* overall and according to sectors (% share of firms which attach [very] high importance to a motive or motive grouping: values 4 and 5 on a 5-point scale). Knowledge: average of motives 1 to 3; Market: motive 4; Resources: motive 5; Location: average of motives 6 to 8
Source: Berger et al. 2010: 127

The results of this survey also show that R&D abroad is to a considerable extent focused on high-tech firms as well as on larger firms with 250 employees or more. Firms in the knowledge-based service area also now perform a significant level of R&D abroad. From an organisational perspective, R&D in a company's own subsidiaries predominates, as opposed to joint ventures or contractual collaborations. The geographical focus for R&D abroad is on Western Europe (85 % of all firms with R&D abroad reported activities there) and – in a distant second place – North America (31 %). This is followed by China (15 %) and Central/Eastern Europe (13 %) along with other countries in Asia (10[12] or 9 %[13]).

The motives for performing R&D abroad are shown in Table 2. The first six individual motives are roughly of equal significance, with only direct and indirect research and technology sponsorship and more favourable regulatory frameworks abroad playing significantly less of a role. If the individual motives are consolidated into motive groupings, it becomes apparent that the knowledge, market and resource motives are of nearly equal importance. Since the latter can in part be allocated to "knowledge sourcing", the knowledge motive is an important driver for R&D abroad. In contrast, the cost-based location motive is of less importance. This pattern differs considerably from the conditions that prevailed 20 years ago. At that time, R&D investments were predominantly determined by the mar-

12 India along with Thailand, Malaysia, Indonesia and the Philippines.

13 Hong Kong, Singapore, Taiwan and South Korea.

ket motive. The shift that has occurred in the meantime towards knowledge as a motive points to increased globalisation in the innovation process. However, this trend must be understood within a context in which 77 % of firms are still pursuing an R&D strategy that is purely domestically oriented (Berger et al. 2010: 117 et seq.; Arvanitis et al. 2011).

Relevance for research and innovation policy

The trends that have just been described also have direct relevance to innovation policy in a more traditional and narrower understanding of the concept:

— Manufacturing's proportion of value added and of employment, which is trending downwards, has significant implications for research and innovation policy, as there are considerable differences in innovation behaviour between sectors. In the manufacturing sector, for instance, there is a larger proportion of firms with R&D (43 % compared with 16 % in the services sector), with innovations (62 % *vs.* 43 %) or patents (15 % *vs.* 1.5 %) (KOF/ SECO 2010). However, the innovation methods also differ considerably among industries (see OECD 2009: Chapter 2). *Ensuring that there is an adequate industrial basis for maintaining a high level of R&D or a high level of cooperation between science and industry may in and of itself be the objective of any innovation policy.*

— With increasing deindustrialisation the issue arises as to the extent to which R&D and innovation activities can be maintained with no geographical proximity to production and to what degree the national innovation system as a whole suffers from a reduction of industrial research, which is of essential importance for innovation-related interaction well beyond its sector. There are concerns that extensive off-shoring processes and associated contractions in the country's manufacturing base will lead to a reduction in innovation potential (Pisano & Shi 2009; Tassey 2010). In actual fact, it can be seen in the case of the United Kingdom, for example, that the process of deindustrialisation was accompanied by a decline in corporate R&D expenditure (measured as a proportion of GDP) (see Figure 6).

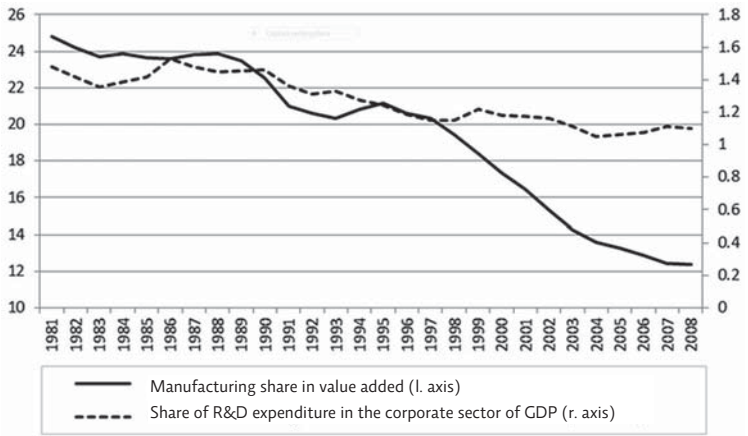

Figure 6: **Example of the United Kingdom: De-industrialisation and decline in corporate R&D**

Source: OECD, AMECO. Calculated by JOANNEUM RESEARCH

A close linkage between innovations in different sectors is also evident. For instance, services firms are often in part outsourced research departments of biotechnology or pharmaceutical firms. A trend towards increased linkages between service innovations and technological product and process innovations can be envisaged. On the one hand, technical innovations are the basis for service (as well as social) innovations (e.g. internet, mobile telecommunications), and on the other, technical innovators are only increasingly able to sell their products successfully with additional or integrated services and service innovations (see Borowiecki et al. 2011; Ruhland et al. 2010). This means that any reduction in the manufacturing base also affects research and innovation taking place in the services area.

Since R&D is increasingly globalised, effective (transnational) knowledge management is required in order to transfer knowledge generated abroad to a particular firm or to Switzerland more generally and to use it there. Establishing absorption capacity is important for this (e.g. language and cultural skills to make better use of the growing research market of China; see Berger & Nones 2008).

Furthermore an increase in or maintenance of the attractiveness of the domestic innovation/R&D location must be ensured. Most prominent among the evident motives for choosing locations are the quality of research institutions and the available workforce as well as the presence of other innovative firms in upstream and downstream areas (clusters). *An active research and innovation policy can play a role in making the location more attractive.*

Activities in the area of public and social innovations only play an indirect role within these trends by improving general conditions (e.g. reducing bureaucracy and cutting transaction costs; employee participation and the culture surrounding wage disputes) and enhancing the quality of life at the location (social innovations as an aid in promoting social integration and avoiding social conflicts). The trend towards increased globalisation in R&D activities does first and foremost affect "traditional" innovation policy, but in terms of ensuring the quality of the location or requiring international innovation management, which also has to cope with cultural diversity, *this trend also has important cultural dimensions which transcend the narrow perception of innovation and should be integral part of any modern innovation policy.*

3 Understanding of Innovation

This chapter will empirically trace the development of the notion of innovation as well as review the theoretical literature on innovation, including perspectives on the notion's feasibility and applicability. The following questions will frame this discussion: (i) how has the understanding of the notion of innovation changed and spread over time? The broadening of the concept of innovation to include non-technological, organisational and social innovations is of particular interest here; (ii) what corresponding developments have been witnessed in the connected areas of research, technology and innovation policies?

3.1 What are innovations? – The theoretical notion of innovation and its empirical analysis

Invention – Innovation – Diffusion

Invention refers to the discovery of new solutions to problems or new ideas, whilst **innovation** is used in reference to the first implementation of this, and **diffusion** refers specifically to its dissemination (Schätzl 2003: 115). This differentiation amongst terms is often attributed to Schumpeter (1911; 1961).

Research on innovation tends to focus on a concrete product or concrete (technical) process, and it is argued that whereas inventions are more universal, innovations originate predominantly in firms: *"While inventions may be carried out anywhere, for example in universities, innovations occur mostly in firms, though they may also occur in other types of organizations, such as public hospitals. To be able to turn an invention into an innovation, a firm normally needs to combine several different types of knowledge, capabilities, skills, and resources"* (Fagerberg 2005: 5). One frequently notes a time lag between invention and innovation, even if "innovations" tend to be the results of continuous processes (ibid.).

Incremental innovations[14], i.e. small-scale improvements to existing technological capabilities, are frequently contrasted with **radical innovations,** or those in which the "sets of characteristics" differ markedly from those of the original products to which they now have only a distant relationship (Grupp 1997: 138). This contrast, however, is oversimplified and ignores **(standard) innovations,** which *"are characterised by a new technical [our emphasis] characteristic (or the loss of a characteristic)"* (ibid.: 137).

Understanding of the innovation process has changed over time, particularly towards greater complexity and an extension of the concept of innovation: following the World War II, the **linear model of innovation** established itself as the standard model for understanding innovation. It is best exemplified in the influential "Bush Report" (Bush 1945). As implied by the name, this model postulates a chain of innovations that operate along the vector from basic research ▸ applied research ▸ development ▸ (production and) diffusion. This model was incredibly influential and drove the statistical increase in R&D expenditures – reason enough, according to Godin (2009: 15 et seq.), for this model's continued relevance to current innovation policies. The linear model's place in theoretical innovation research was challenged in the 1970s in particular by the **interactive model of innovation** (Kline 1985; Abernathy & Utterback 1978). This postulated a "chain-linked process" that

14 Innovations through improvement, in which performance is significantly improved without any alteration to the dominant construction (Grupp 1997: 135 et seq.).

was comprised of numerous feedback loops and instances of interaction between "segments" inside and outside of the company, all along a chain of innovation. This concept has not been incorporated (or could not be incorporated) into official statistics, however, due to its complexity (Godin 2009).

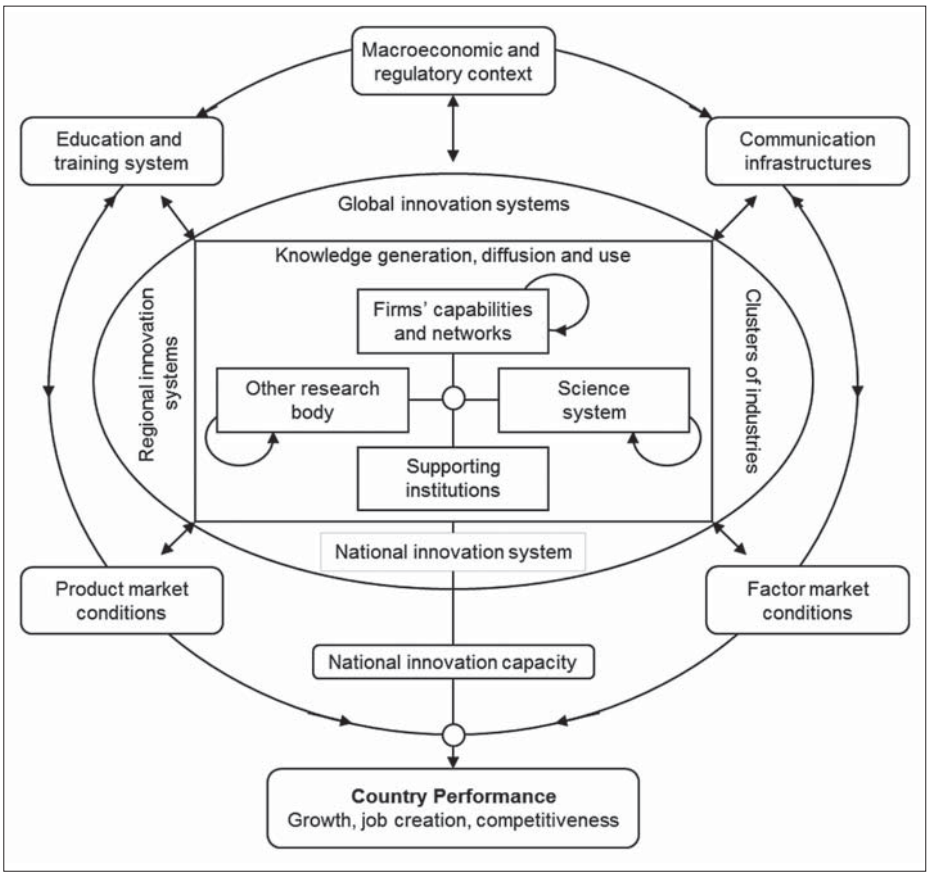

Figure 7:
Stakeholders and links in an innovation system

Source: OECD 1999: 23

However, there was a growing recognition of the significance of interactions (including inter-organisational ones) for innovation, which eventually led to concepts of **innovation systems** (understood at first at a national level) (Freeman 1987; Lundvall 1992; Nelson 1993; see Figure 7). Concepts of national innovation systems, regional innovation systems (Cooke et al. 1997; Braczyk et al. 1998) and sectoral innovation systems (Breschi & Malerba 1997; Malerba 2002) which were developed somewhat later seek to describe all of the relevant organisations and interactions between these and fundamental institutions involved (understood as formal and informal codes of conduct), thereby accounting for the relevant political, economic, historical, cultural and sociological determinants of innovation (Edquist 1997). In addition to new products and processes, organisational and institutional changes are also essentially understood as innovations (ibid.).

Lundvall's considerations regarding the significance of cooperation between producers and users form an important precursor for the development of the concept of an innovation system (1985). **Innovation cooperation** generally plays a considerable role in this concept. It has been argued that the closely intertwined developments related to increasing globalisation, growing competition, the shortening of product life cycles and expanded connections between research and innovation have strengthened the drive towards innovation and necessitate concomitant cooperation across organisations. These allow stakeholders to pool resources, minimise costs and risks related to R&D and innovation projects, as well as shorten the time-to-market of innovations and the time space in which investment costs can be recouped.

The significance of the user (especially lead users) to the innovation process has been highlighted on the business side by the concept of **user innovation** (von Hippel 1988; von Hippel 2005). Coming from the perspective of management, Chesbrough (2003) later formulated the more expanded concept of **open innovation,** emphasising that innovation processes located in firms are increasingly open and therefore combine knowledge internal to the company and from sources outside. Put more simply: *"… open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively"* (Chesbrough 2006: 1).

The notion of innovation and its measurement

Theoretical and empirical research on innovation has developed predominantly through interaction and in tandem with developments in innovation policies, which have come to constitute a distinct policy field (see Mytelka & Smith 2002). The OECD and the European Commission have made a substantial contribution to consolidating the concept's various meanings and means of assessment thanks to the publication of what is referred to as the "Oslo Manual" (first edition 1992) and their introduction of a Europe-wide survey of innovation (Community Innovation Survey – CIS, first undertaken in 1992) (ibid.).

It should be noted that both the first edition (1992) and the second edition (1996) of the OECD's Oslo Manual focused very much on the *"Technological Product and Process (TPP) definition of innovation"* (OECD 2005: 10) and the manufacturing sector. Only in the third edition (2005) increased attention was paid to the services industry and the definition of innovation expanded to include organisational and marketing innovations.

Questions regarding strategic developments and other developments in management, organisation, marketing and design were included in the third version of the innovation survey (survey year 2001), but these were only defined as organisational or marketing *innovations* after the publication of the third edition of the Oslo Manual. The choice of terminology already indicates that these non-technological "developments" were not at first considered to be "innovations" in the true sense. Changes in terminology are evidence of the evolution and broadening of the concept of innovation. Concrete implementation of the concepts of innovation in the surveys by the national governments differs: the ZEW in Germany, for example, introduced the term *"innovations"* to describe organisational and marketing *innovations* already in its fifth CIS (2007)[15], whereas Austrian reports stuck with the notion of "developments" until the sixth CIS (2009), in which organisational and marketing *innovations* were the subject of enquiry for the first time (Statistik Austria 2008; Statistik Austria 2010).

15 www.zew.de/de/publikationen/innovationserhebungen/euroinno.php3.

Nonetheless, the notion of innovation and empirical descriptions of innovation continue to be strongly influenced by their technical and industrial roots and remain market-focused. Adolf (2012), for example, offers the following critique of its approach:

> *"From the point of view of cultural studies and the social sciences, the notion of innovation […] must first be expanded beyond the limitations that frequently characterise its use. First, discussions of innovation are generally framed in terms of an economic or business context, as if the history of innovation begins only with the founding of the first firm. Innovation, though, is not only an economic or business phenomenon – even if the headstrong entrepreneur has played an important role up to today. Closely related to this is the second point, which is that innovation is often tied to new products or production processes, which is derived from Schumpeter. But technology has a social origin and a cultural context, which means we must dig a little deeper here. Third, innovation's appearance is frequently narrated after the fact as the result of a brilliant individual, in spite of it being anchored in organisations, networks and other communities. It would be insufficient to base an explanation of innovation on just this; moreover, this would ignore the erratic moment that marks the arrival of something that is actually new"* (Adolf 2012: 28).

Many would point here to an analytically useful distinction between "social innovations" (new developments in social structures, social behaviour or the culture of a society) and "technological-economic innovations (process or product innovations)", though these are of limited practical use as developments in society, technology and the economy are closely intertwined with one another (ibid.). Rammert (2010) offers a similar argument: *"Seen from the perspective of social sciences and the arts and humanities, technological innovation and economic innovation are just two forms, if exceptionally important ones, of social innovation"* (ibid.: 22) and draws a general line between economic, political, social and cultural innovations.

Rigby et al. (2008) differentiate between **defining the demand for innovation** (needs of innovation; outlining) and what **innovation actually delivers** (responding). Stakeholders may belong to several different groups, the various combinations of which produce different specific types of innovation (Figure 8). These may be divided generally as follows (ibid.: 6):

1. **Commercial/business innovations:** these have been the main focus of innovation research up until now. Service innovations are an exception, though they have been generally ignored in traditional innovation research and innovation policies until recently. Service innovations arise not only in the service industry, but also in firms in other economic sub-sectors. It remains important, however, to preserve the distinctions between the basic characteristics of these innovations in contrast to "classic" TPP innovations and R&D. Service innovations often feature (IT-related) technological and non-technological aspects that are not formally connected to R&D activities. Users/clients also have a (even) greater role in cooperative work leading to innovation. The OECD describes the distinguishing characters as such: *"First, service production encompasses a high degree of interaction between the user and the service provider. Second, the nature of the R&D and innovation process is difficult to capture, whereby it is in some sense invisible and therefore underestimated. Evidence of the process of service R&D and innovation is often embedded within firms as R&D is often partly simultaneous to*

production and not sequential. Third, what is referred to as the service-dominant logic, which merges goods and services into value propositions and views the outcome as service and value, no matter if it is based on what is traditionally called services or goods. Finally, service-specific forms of R&D and innovation often coincide with new patterns of product distribution, client interaction, renewal of service delivery organization, tapping of the potential of new technological options, mostly ICT-based and completely new revenue streams and business models" (OECD 2012c: 11).

2. **Social innovations** (social innovation; citizen/NGO driven; Rigby et al. 2008): *"Social innovations can be distinguished on a 'material' basis from technological innovations since the former have an immaterial and intangible structure. There is no technical object that is created; newness is effected instead on the level of social practices. A social innovation is the creation by certain stakeholders or constellations of stakeholders of an intentional, targeted new configuration of social practices in well-defined spheres of activity or social contexts with the goal of solving problems or meeting needs in a better manner than those offered by currently existing means"* (Howaldt & Schwarz 2010: 89).

   The importance of social innovations is often accounted for with reference to the large global challenges (climate change, migration, demographic shifts, poverty) that must be met with constrained government budgets. Because of externalities and information asymmetries, there are market failures in addressing these challenges. It is the role of the state or public administrations to respond to these challenges, but given widely recognised deficits (e.g. inefficiencies and the slowness of large bureaucracies to change, poor allocations resulting from price distortions related to subventions) and especially the (increasing) constraints imposed on budgets, the state is as well limited in its abilities (see BEPA 2011: 24 et seq.). Hence, social innovations are needed to include members of civil society in the innovation process more thoroughly.

   As a social innovation is a new idea that simultaneously fulfils social needs and establishes social relations, social innovations offer *"… new responses to pressing social demands, which affect the process of social interactions. It is aimed at improving human well-being"* (Stiglitz, quoted in BEPA 2011: 33).

   Because the innovation process and innovation result are equally relevant, the European Commission has provided the following "working definition" in one of its publications: *"Social Innovation relates to the development of new forms of organisation and interactions to respond to social issues (the process dimension). It aims at addressing (the outcome dimension):*
   - *Social demands that are traditionally not addressed by the market or existing institutions and are directed towards vulnerable groups in society. Approach 1*
   - *Societal challenges in which the boundary between "social" and "economic" blurs, and which are directed towards society as a whole. Approach 2*
   - *The need to reform society in the direction of a more participative arena where empowerment and learning are sources and outcomes of well-being. Approach 3"* (BEPA 2011: 43).

   Examples provided include micro credit (e.g. of the Grameen Bank) (Approach 1), Open Universities (Approach 2) and projects that are part of *"farewell to the male breadwinner model – EQUAL strategies to dismantle traditional gender roles and stereotypes"* (Approach 3) (ibid.).

Caulier-Grice et al. (2012a: 18) define social innovations within the framework of the currently active "tepsie" project[16] as *"new solutions (products, services, models, markets, processes etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society's capacity to act"*. Seven typologies of social innovations are identified within this definition (Table 3).

So far, notions of "social innovation" generally tend to be characterised by *"inconsistent theoretical concepts, definitions and categories"* (Hochgerner et al. 2011: 13). For instance, some broad definitions include social innovations in the business world, political reforms and new lifestyles (e.g. Zapf 1994) that would be better described as organisational innovations or which are examples of social change at large rather than social innovation. Hochgerner et al. (2011: 36) describe current academic debates that pose the questions of how to define social innovation so as to distinguish it from social change or social reforms, to what extent normative claims are made for social innovations (often they are implicitly assumed to be inherently "good") and how their novelty and effect can be captured and measured empirically. An additional question, one that is extremely relevant for innovation policy, is to what extent "social entrepreneurs" can be a target group of innovation policy.

According to Kesselring und Leitner (2008: 32), the special form of social innovation in business environments is found *"in the intended creation of new forms of social organisation that are attached to highly valued objectives and/or particular challenges and problems and which may have an internal or external orientation"*. Areas in which social innovations are most likely to be found include labour and company organisations, employer and employee relations, communications structures, knowledge management, further education, employee participation, security and health measures, human resources development and accompanying organisational services for technical innovation processes. The only condition is that social innovations must be successfully and sustainably embedded institutionally. This often serves as a model for other firms.

Table 3:
Typologies of social innovation

Source: Caulier-Grice et al. 2012a: 25

Types of social innovation	Examples
i) New products	Assistive technologies developed for people with disabilities (voice synthesizers)
ii) New services	Mobile banking (MPesa in Kenya)
iii) New processes	Peer-to-peer collaboration and crowdsourcing
iv) New markets	Fair Trade or time banking
v) New platforms	New legal or regulatory frameworks or platforms for care
vi) New organisational forms	Community interest companies
vii) New business models	Social franchising, or just in time models applied to social challenges

16 See www.tepsie.eu.

3. Rigby et al. (2008) propose an additional means for analytically capturing innovation: **society-driven innovations** (also citizen- and government-driven). These are characterised in the following way: *"(i) The objective is something other than just the narrow economic goals of competitiveness and economic growth. Rather it is to meet some sort of social or cultural need; (ii) This 'societal need' is defined by society (usually through the government acting as 'the voice of the people'); (iii) Government policy is deliberately oriented to this objective – and this is the primary goal of the research or innovation programme (not just a hoped-for spin-off)"* (ibid.: 15).

4. The conceptual contrast with social innovations is first and foremost the role of the stakeholder. If social innovations, depending on the definition, are pursued especially within civil society or outside of the realm of profit-oriented businesses, then the state will define and implement society-driven innovations. These categories are critical for this study because they include two fields that are important for the current discussion regarding the concept of innovation and innovation policy, namely a) innovation in the public sector and b) mission-oriented innovation policy.

		Responding to social and cultural objectives			
		Citizens	**Government**	**Firms**	**Universities**
Outlining social and cultural objectives	**Citizens**	Social Innovations [Internal Innovation] [Aspects of Collective Demand = Club Goods]	Regulation; Public Goods; Public Safety, Defence; Laws and Prohibitions, e. g. Stem Cell Research (Collectively Demanded)	Private Goods (Individually Demanded not Societally Driven); Eco- or Social Goods (Collectively Demanded)	Educational and Knowledge Services
	Government	Merit Goods Health; Education.	Reform of Government: Improvement of Processes, including Innovation Processes [Internal Innovation]	Market Order, Regulation, Public Goods Production	Knowledge for Policy
	Firms	New Technologies, Rules, Forms of Consumption	Market Order	Business to Business Innovation [Internal Innovation] [Aspects of Collective Demand = Club Goods]	Knowledge for Strategy
	Universities		New Scientific Technology – Instrumentalities	New Scientific Technology – Instrumentalities	Knowledge Production [Internal Innovation]

Figure 8:
Stakeholders in the innovation system and their role

Source: Rigby et al. 2008: 10

Innovation in the public sector[17]**:** The OECD contends: *"The public sector is coming under increasing pressure from a number of directions – rising costs, increasing demands from citizens and businesses, demographic changes, the environment, and globalization pressures that increase the difficulty of maintaining high levels of welfare services. The need for action has only become more visible following the financial crisis and subsequent worsening of government budget deficits. The sum message from all of this is that the public sector must do more for less. Public sector innovation is an important factor in helping to maintain the quality of public services in the wake of cost cuts"* (OECD 2011e: 2).

Accounting for the significance of innovation for the public sector, there are initiatives at the OECD that aim to extend innovation surveys to that sector (see also OECD Observatory of Public Sector Innovation[18]). This effort will preserve the definitions of innovation as laid out in the Oslo Manual, since they appear to be equally applicable to the public sector (ibid.: 8), though recommended adjustments to account for aspects specific to this sector were implemented in the initial pilot projects (Bloch 2011).

In its new form, **mission-oriented innovation policy** has made a renaissance in innovation policy. The intent of this policy approach is to address social problems directly via innovation policy, which has most recently included focusing on large global challenges such as climate change, demographic shifts, etc. This policy will be discussed in more detail in a later chapter (see Chapter 3.2).

Summary: The development of the notion of innovation as a "shell model"

Figure 9 demonstrates that the focus of the concept of innovation was placed for a long time on technological innovations in products and processes (TPP) in the manufacturing sector. The expansion to include non-technological innovations and to the service industry came in later phases. The latest developments account for social innovations and innovation activities of all sorts in the public sector and society more broadly.

One challenge inherent to the notion of innovation described above is its ubiquity and, potentially,

- a **loss of the concept's meaning:** is each adjustment made to a workflow or every type of social change (e.g. the rise in the number of women in work in the last several decades, the use of car sharing schemes, changes in consumer behaviour) an example of innovation? If so, what is still regarded as not being innovation? If the term is used too broadly, saying something is "innovative" no longer implies that there is some "aspect of quality" inherent in that designation. Under some circumstances then, any and every type of "novelty" or "difference" would need to be labelled an innovation. *In this way, it becomes harder to locate innovation.*
- **Problems with measuring innovations:** the assortment of instruments used to assess technological innovation is now relatively well-established (see Chapter 4), but discussion is still needed when it comes to the value of these measurements (problems of self-assessment of respondents, problems in determining the scope of innovations and its effects, etc.). As Chapter 4 makes clear, this is all the more true for definitions of innovation that are more broadly applied (e.g. social innovations), the empirical assessment of which has proven to be quite difficult. How relevant can this "hardly measur-

17 "The link between innovation in public sector organisations and social innovation is particularly important. Social fields such as health or education or protecting the environment are often core themes taken forward by public sector organisations; they are also areas where social innovation can make and is making a prominent contribution" (European Commission 2012: 17).

18 www.oecd.org/governance/oecdobservatoryofpublicsectorinnovation.htm.

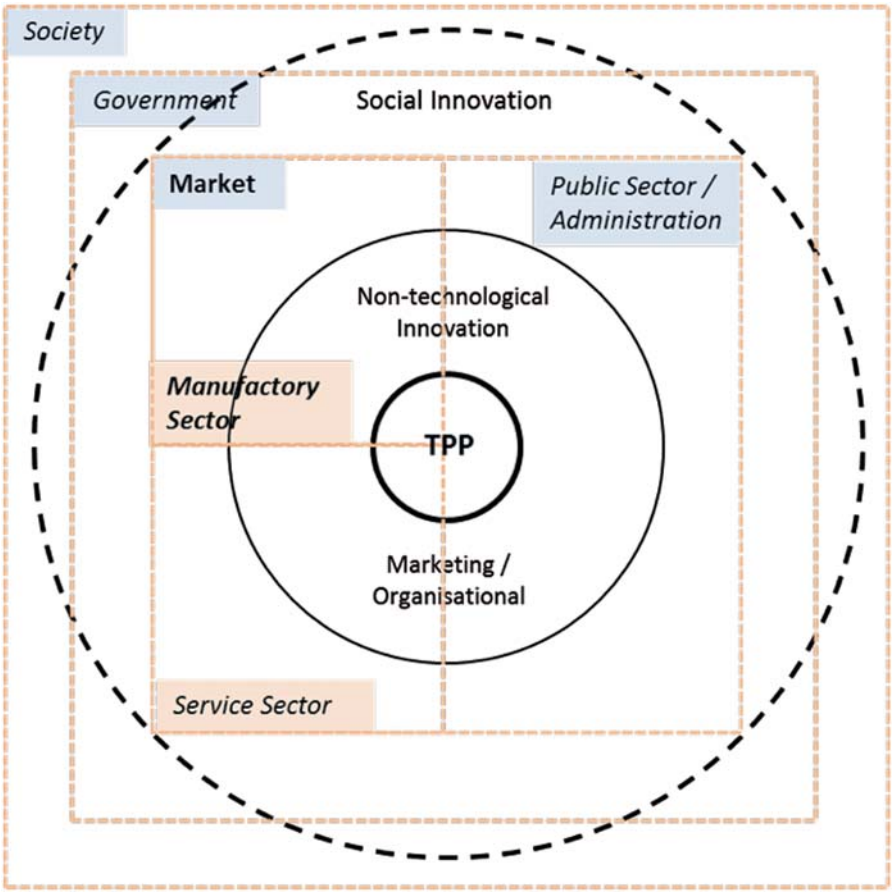

Figure 9:
Shell model of innovation definitions and their applications

Source: JOANNEUM RESEARCH

able" concept of innovation be for analyses of the performance of innovation systems and, consequently, for "evidence-based policy"? As a matter of fact, there are a large number of approaches currently being used to rank innovative activity. They range from rankings that are grounded (to varying degrees) in traditional PPT frameworks which compare for example "technology readiness levels", to other systems that incorporate indicators drawn from the business world and the education system, such as the "Innovation Union Scoreboard" (IUS) mentioned above. There are additional conceptualisations that have been used to compare countries with one another, including the "Creativity Index" developed by Richard Florida (see Florida 2002). *The sheer quantity and diversity of these various assessment models mean that any comparison of innovation performance will be arbitrary to some extent.*

— **Problems of political implementation**: how can "innovation policy" be distinguished from other areas of policy if the notion of innovation is defined so broadly? Already now, many policy areas impinge upon innovation policy and vice versa – as described in the concept of the policy mix (see Chapter 3.2.2). If societal and social innovations come under the purview of innovation policy, there will be practically no area of political life that does not in some way influence innovative capabilities. *This implementation of policies relevant for innovation could well result in considerable governance problems.*

3.2 Development of research, technology and innovation policies

3.2.1 Phases of RTI policies

While technology-specific orientation of governmental "research and technology policy" and innovation policy has remained the reference model up until today in many developed, industrialised countries, according to Gassler, Polt & Rammer (2008), substantial changes have been introduced over the course of the past few decades in the way priorities are set, including the rationales and processes involved, and there have been shifts to other methods of prioritisation. These are not cases of a new set of priorities replacing the old ones, but a process in which newly developed content-based priorities, institutional arrangements and nexuses of rationales are added as supplements to existing structures and approaches. There are four trends that have become especially evident:

- the "classic" mission orientation that marked the 1940s and 1950s, which also overlapped with political and military aims;
- the expansion of technology related government funding to "key civil enabling technologies" beginning in the 1960s in order to support also international technological and economic competitive venues;
- the addition of "generic" and "systematic" approaches to "thematic funding" beginning in the 1980s, in which the focus was not only on individual sectors or technologies, but on the entire system as a whole and its internal connections (such as cooperation between industry and the research sector);
- the trend over the past few years towards a "new mission orientation" in which the focus is expanded beyond technological issues to include societal-wide problems (sustainability, health, security, demographic shifts, etc.).

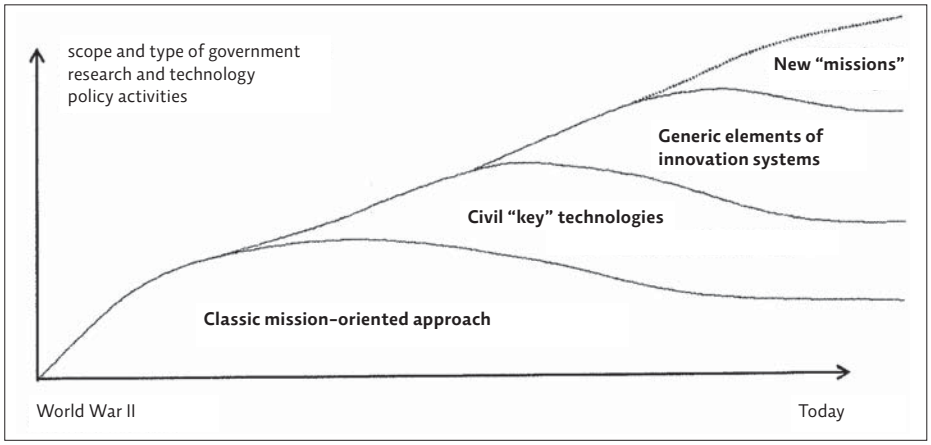

Figure 10:
Trends in priority setting in research and technology policy: Schematic presentation

Source: Gassler, Polt & Rammer 2008

Traditional mission orientation

Research and technology policy as specific policy areas arose after World War II because of the need to fund the development of specific technologies. The thematic focus was on "large-scale technologies" (e.g. nuclear energy, aerospace and weapons technology), the development of which required major technical infrastructures, long project timelines and significant financial outlays. At first, only national governments had a need for these types of technologies, meaning that their applicability in the private sector played no role in the financing of their development. The "dual use" concept and the transfer of technology to civilian fields of application arose only later. The role of (basic) scientific research was strongly emphasised ("science push") and funding was generally restricted to small groups (academic institutions, large firms). Small groups of experts (from government agencies, the military and to a degree from the research community) were responsible for defining the objectives and identifying the technologies to be developed. Individual ministries and government departments administered the actual funding programmes. Centralised government bodies assumed responsibility for monitoring and regulating the projects and programmes.

Mission-oriented policy ultimately aimed to create technologies that would not otherwise have come to fruition, either on the basis of private initiative (i.e. as part of industrial research agendas) or through the "normal" advance of science. From the point of view of industrial research, the potential commercial use of these technologies was far outweighed by the enormous costs attached to them, the long timelines involved in their development and the high degree of technological uncertainty involved. In this respect, mission-oriented policy drew its legitimacy from the fact that its work was genuinely at the government or public level and involved the production of public goods.

Industrial policy and "key civil enabling technologies"

A new phase was entered in the 1960s, during which the concept of mission orientation was expanded to technological fields that were no longer solely tasked exclusively with the production of public goods, but which offered substantial commercial applicability. The expansion to include civilian areas of application was driven primarily by three factors. First, the success of mission-oriented research agendas in the area of "large-scale technologies" encouraged the application of the model to other technological fields. Second, institutional structures had been created that had grown rapidly and assumed political influence. These agencies/ministries actively sought out further areas in which to become active. Third, many other countries identified a "need to catch up technologically", especially Germany and Japan. This policy focused on "catching up" was strongly influenced by industrial policy and its objectives went beyond pure research or technology policy.

Funding the development of key enabling technologies remains a fundamental pillar of research and technology policy in all OECD member countries. This approach is characterised by the focus on a number of technologies the list of which is strikingly similar across all of the relevant countries. Though emphasised to varying degrees, information technology (microelectronics, later including software), production technologies (robotics, factory automation), biotechnology, environmental technologies, material technologies, "alternative" energy technologies (wind power, solar energy), medical technologies and nanotechnologies all belong to the list. The objectives, instruments and budget for

funding are typically defined through the use of multi-year programmes. Responsibility for programme administration is frequently assumed by independent institutions (agencies) that have been created especially for this purpose and which increasingly act as institutional stakeholders in their own rights and with their own interests when it comes to research and technology policy. Funding is made available to a broad target group composed of actors from the research sector as well as industry so as to support the diffusion and wide application of the new technologies. The focus is on short and medium-term projects with a small number of participants. Instruments such as technology forecasts, technology assessments and Delphi studies have been widely implemented in the identification of technological fields that deserve financial support. Because industrial policy also played a role in determining programme objectives, certain other instruments are also utilised to some degree, such as the formation of national consortia, funding for "national champions" or subsidised support offered to new large-scale companies (Airbus is a "paradigmatic example").

The fundamental difference in comparison to the classic mission orientation is to be found in procedural matters (methods used to identify funding priorities) and institutional aspects (programming, decentralisation) and in programmes' increasing diffusion orientation. These government interventions are justified on the one hand through reference to industrial policy arguments and on the other through an emphasis on the significant impact of crossover technology on productivity and competitiveness.

Systemic approaches and cluster policy

These developments have met with an increasing amount of criticism that funding for technological priorities is too one-sided and plagued by significant risk of failure (keywords: monostructure, path dependency, efficiency and information problems, structural policy and competition policy). This subsequently resulted in growing attention to generic objectives and "functional" priorities (which focus, for example, on formations, cooperation or internationalisation). The innovation system approach and the cluster approach have been particularly influential in this regard. In these approaches, emphasis is placed on the significance of vertical cooperation between technology producers and users, though horizontal cooperation is emphasised as well. Also, other dimensions gain in importance, such as: bringing research and industry together in open, flexible forms of cooperation, the role of the state as regulator and the party that provides framework conditions favourable to innovation (which includes policies related to tax, financial markets, employment law and product-specific regulations), the importance of small and medium-sized enterprises (SMEs) and newly created technology-oriented organisations and businesses that function not only as partners but also as competitors for large-scale firms and, finally, the function of decentralised governmental organisations as supporters of innovation processes.

In addition, the cluster approach places an emphasis on the significance of the spatial agglomeration of competence areas, vertical cooperation between suppliers, producers and customers with particular demands, the cumulative build-up of sector-specific resources and infrastructures and the diffusion of technologies, innovation-driving regulations and government support.

Research and innovation policy increasingly turned to these two approaches in the 1990s either by thematic adding to the research funding, or replaced it in some countries. Such functional priority setting – e.g. funding for cooperative efforts, support for founding new high-tech firms, regional network building – is pursued in one of two ways. In the first, additional instruments are integrated into already existing technology programmes (e.g. support for networks for new companies and regional networks in the biotechnology programmes in Germany), resulting in a new programme that combines certain generic instruments with a thematic focus (e.g. the competence centres programmes in Austria and Sweden[19]). In the second, these instruments are introduced as a form of crossover measure alongside thematic research support. These new instruments offered the opportunity to address a larger number of stakeholders (research institutions, SMEs) and to integrate them into programmes, thereby more firmly anchoring this policy field across a broader base.

In many countries, specialised programme administrators are charged with the responsibility of implementing these increasingly complex programmes, which leads to a functional differentiation between government stakeholders in research and technology policy and a growing diversity of organisations focused on programme implementation. The incorporation of systemic and cluster approaches has significantly increased the number of stakeholders involved in research and innovation policy and has made decision-making processes as well as coordination between individual institutions distinctly more complex.

New mission orientation

A more prominent orientation towards thematic fields has been witnessed again over the course of the last ten years in research and innovation policy. However, in contrast to previous approaches, topics are increasingly determined by the problems that society faces (sustainability of modern industrialised societies, mobility, demographic shifts and the ageing population, security as well as health and well-being). Appropriate topics are found in the areas of overlap between societal objectives and possibilities for scientific-technological problem solving. The urgency with which new technologies ought to be developed is determined to a far greater degree by the perspective of future users rather than solely by what is currently scientifically or technologically possible. In this approach, technological development projects are determined to be worthy of funding primarily on the basis of their contribution to problem solving and not only by the degree of innovation. The selection and decision-making processes incorporate a number of groups of stakeholders that go well beyond the traditional spectrum of technology policy actors. These include in particular potential users of the technology and stakeholders from other policy areas (environmental policy, health policy, social policy, regulatory law, the setting of norms and standards, etc.). The central objective of this process is the quick and broad diffusion of results in the most consistent and coherent way to other policy areas (e.g. environmental policy, social policy, etc.). The significance of incremental innovation is emphasised to the same extent as is the necessity of systemic innovation (improvements and behavioural changes that must be undertaken by a large number of stakeholders). A diverse assortment of instruments must be deployed in implementing this "new mission orientation", with broadly conceived cooperative projects emphasised in particular.

19 These programmes were also not specified thematically *ex ante.*

These changes have not been without effect when it comes to institutional arrangements related to policy. Over the past several years, we have witnessed a convergence in the OECD countries between the theoretical frame of reference for research and innovation policy and the overarching policy objectives up to and including the general setting of priorities. This means that in practically all highly developed industrialised countries, alongside the classic type of mission orientation there can be found functional priority setting, more narrowly defined thematic focuses motivated by industry policy as well as priority setting, all targeted towards addressing new social needs (as understood under the "new" mission orientation). The latter now occupy a role at a strategic level in formulating objectives as well as at the operational level in relevant technology policy programmes (see Chapter 5).

3.2.2 Changes in the governance and policy mix in the wake of an extended notion of innovation

The separation between the strategic-political level (ministries) and the operational level (implementation of instruments, funding programmes) that has become evident recently is of great relevance to the process of setting priorities. The former is increasingly supported by advisory boards that also have assumed to some degree (or at least *de facto*) functions related to decision-making. The latter has been and continues to be increasingly outsourced from administrative organisations (i.e. the relevant subject-specific ministries for research and technology, or in some countries, groups of relevant ministries) to external agencies. Though this process is evident in most countries, the degree of centralisation (or decentralisation) varies to a considerable degree. Naturally this trend had substantial effects on processes related to setting policy priorities. A variety of stakeholder groups engage in these processes the shape of which ranges from "top-down" (centralised, hierarchical policy decisions) to "bottom-up" (decisions involving the lowest level of research stakeholders themselves). South Korea provides an ideal example of a top-down approach to technological priority setting. A comprehensive Delphi-oriented foresight process undertaken in the recent past identified ten "growth industries" (e.g. digital television, intelligent robots, new generation semiconductors) and 80 corresponding key enabling technologies. This type of hierarchical and centralised orientation towards planning does not exist (any more) in European countries. The thematic setting of priorities here is formulated on a more generalised, strategic level (most frequently from advisory boards by means of suggestions that are binding or non-binding to a varying degree), which are then made operational by agencies which increasingly take "bottom-up" processes into account in their work. Strict and precise connections amongst the various levels of the hierarchy do not necessarily exist.

One problem inherent to this type of priority setting is of course finding the appropriate method for choosing thematic topics. There is currently quite some scepticism (at least in Anglo-Saxon and European countries) regarding the capabilities of governments to identify thematic objectives and priorities on a too fine-grained level and in a manner too close to the markets. In most countries, more trust is placed in the market itself or in decision-makers belonging to organisations that participate directly in the market, just as these tend to be preferred in contrast to technocratic planning processes when it

comes to deciding on concrete technological priorities. These types of strategic decisions regarding priorities are meant to serve more as signals in a more general way and to promote additional impetus for R&D investment, but without in any way interfering with or determining the investment plans and decisions of private market forces. It should additionally be noted that most often the thematically organised programmes tend to address technology areas in a broad manner and are not sub-detailing technologies extensively. Furthermore, it has to be noted that funding addressing specific topics, in many countries is losing importance as compared to non-thematically targeted funding. One example in case is tax incentives for R&D, which have grown substantially in recent years in some countries. In addition, governments in many countries have become well aware of their limited steering capacities and have therefore strategically aimed at increasing private contributions to the sum total of research funding available.

Also, it is generally true that priorities across most countries tend to be quite similar at a generic level (i.e. at the level of keywords focused on purported key enabling technologies). There is a push in *de facto* all OECD countries' strategy documents for a focus on technologies such as ICT, biotechnology, medical engineering and life sciences generally, new materials and, especially more recently, nanotechnologies. Individual countries have ultimately moved towards setting priorities with respect to particular technological topics, in which similar "catalogues" of priorities tend to appear, but in which there are few distinctive specific technological specialisations (Gassler et al. 2008). The scepticism towards thematic priority setting when it comes to technology is one of the reasons for the resurrection of mission-oriented priority setting with an eye on broad societal challenges. These have remained a legitimate and genuine area for government priorities.

Policy mix for a broad innovation approach

The broadening of the definition of innovation and the linking of research and innovation policies to other policy targets are necessarily accompanied by an expansion of the types of instruments involved. If RTI policy is also meant to provide impetus to non-technological innovation and if the objectives identified in other policy areas are ever more connected to RTI policy (as intended, for example, in "new mission orientation"), then one area that needs to be addressed is the means by which a reasonable (or even "optimum") mix of policy instruments can meet the given objectives. The discussion on the so-called "policy mix" is perhaps the best frame of addressing this question of how to define in a coherent and consistent manner the bundle of measures.

The fundamental idea underlying the policy mix concept is that it is not only policy instruments genuine to a specific area that have an effect on R&D and innovation. Measures that more properly belong to areas, that seem to have no or little relationship to the policy under question (e.g. regional policy or trade policy) can also have considerable effect on innovation. One could therefore say that a portfolio of policy instruments exists in which various instruments interact with one another and impact an area. It would be insufficient to focus on isolated policy instruments individually.

Nauwelaers et al. (2009: 3 et seq.), with reference to the EU Policy Mix Project[20], have defined a **policy mix as the combination of policy instruments which interact with each other and exert an influence on a policy area.** In the case of this actual project, the matter under discussion was R&D investment, but the concept is equally applicable to

20 See http://ec.europa.eu/research/policymix/index.cfm.

innovation. **Policy instruments** include all programmes, organisations, rules and regulations in which the public sector is actively involved and which have intended or unintended effects on the respective policy field. The notion of **interaction** describes how an instrument's effect is influenced or modified by the "co-existence" of other instruments in the mix. **Influence is** a "direct" effect through the instruments of the relevant policy area (R&D in this case) and an "indirect" effect through instruments belonging to other policy areas. Figure 11 depicts the framework in which policy measures and areas exert influence on one another.

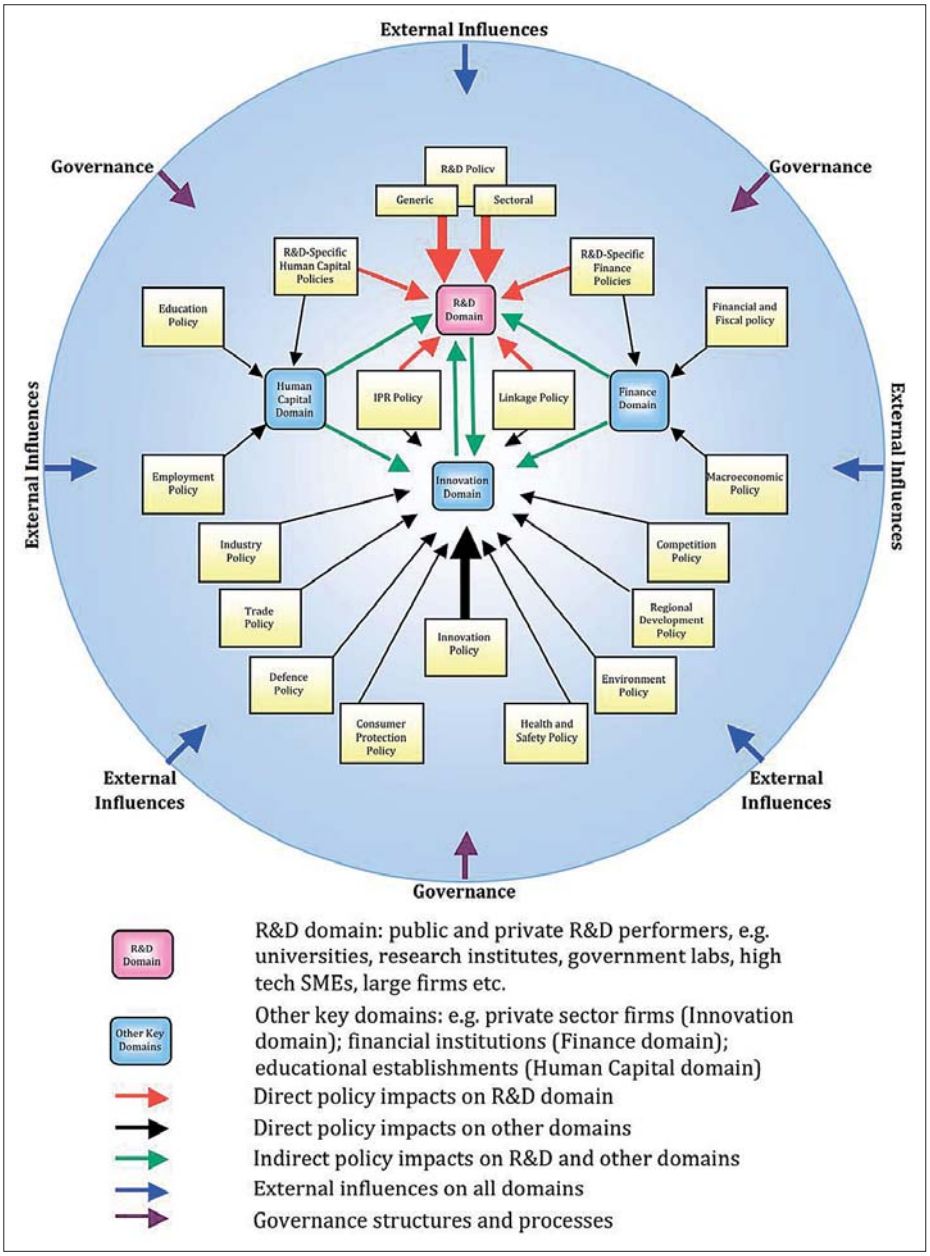

Figure 11:
Policy mix scope – using R&D policy as an example

Source: Nauwelaers et al. 2006: 8

Within the framework of the cited project, five critical core aspects (or questions) were identified for the design of a coherent, coordinated and effective policy mix. These are:

a) a focus on the specific challenges presented by the national innovation system (how can this be accomplished?);
b) appropriate coordination of the relevant policy areas and stakeholders (how can this be secured?);
c) taking stakeholders into account in an appropriate manner during the design and implementation of the policy mix (what are the advantages and disadvantages of a broad discussion/consideration of stakeholder interests?);
d) the design of a policy mix that is coherent (which objectives, which priorities should be pursued, how can positive interactions be supported and negative ones avoided?), and
e) implementation and evaluation (how can policy mixes be evaluated, what are the requirements involved in an efficient implementation?) (Nauwelaers 2009: 11 and Polt & Weber 2014).

3.3 Current challenges for research and innovation policy

In summary, the following important extension of the notion of innovation and innovation policy can be identified currently (see also Acheson et al. 2011):

— the formulation of a **mission-oriented innovation policy** addressing global challenges (see Chapter 3.2 and Polt & Weber 2014);
— the use of **public procurement** as an instrument of innovation policy (see Edler & Georghiou 2007; OECD 2011 et seq.);
— an improved consideration of **service innovations**, which may often arise as a special form of social innovation (e.g. Howaldt & Schwarz 2010; Rammert 2010). In this respect, **creative industries** particularly become a focus of innovation policy (Acheson et al. 2011). A more prominent consideration of services is evident, for example, in the revision of the European Community Innovation Survey (see above); it still poses additional challenges, however, to innovation policy (see OECD 2012c);
— innovations for or in the **public sector** as a significant non-market area (e.g. Bloch 2011; León et al. 2012; OECD 2011e); an area which is equally difficult to record in innovation surveys;
— the consideration of **social innovations in general** (e.g. BEPA 2010; Howaldt & Schwarz 2010), which may be relevant to market and non-market spheres.

These are the fundamental directions in which the broadening of the notion of innovation and therefore correspondingly of innovation policy have travelled.

4 Indicators of Innovation

This chapter discusses the extent to which the shifts in the notion of innovation have been reflected in the statistical recording of innovations and whether the current set of available indicators is or can be an adequate reflection of a broad understanding of innovation. This is discussed alongside the following questions: (i) What indicators are usually used to measure innovations and how are they ascertained? What indicators of innovation are captured in Switzerland and which are available in national and international data sources? Is the situation concerning data availability satisfactory in Switzerland? (ii) Are the commonly used indicators "meaningful" in terms of a broadly conceived notion of innovation and where are the limits in quantifying the concept? What additions to the existing system of indicators seem sensible? (iii) To what extent are broadly conceived statistical concepts used in comparator countries?

The basic principles for the innovation measurements in use today are the so-called "Frascati" (R&D) and the "Oslo" (innovation) Manuals of the OECD (OECD 2002; OECD 2005). These are implemented on the one hand in the national R&D surveys, and on the other in the innovation surveys (in Europe: Community Innovation Survey).

The **R&D surveys** capture data on the R&D input in the government (GOVERD), higher education (HERD), private non-profit institution (PNPRD) and business enterprise (BERD) sectors, in particular R&D expenditure and R&D staff. When analysing the expenditure, a distinction is made between internal and external expenditure, financing and implementing sector and type of expenditure (staff, investments). Headcount and full-time equivalents as well as employment and education level are captured for R&D staff. Furthermore, input into the areas of basic research, applied research and experimental development are split up and also subdivided according to sector and product group (BERD), field of science (HERD) and socio-economic objective categories (GOVERD) (OECD 2002). For this the definition of R&D and its boundaries along with R&D activities in the services area and the social and natural sciences are also addressed in the Frascati Manual (ibid.: Ch. 2).

In Switzerland the R&D survey is carried out every four years by the Federal Statistical Office based on the Frascati Manual (Federal Statistical Office 2010a). These data are available in international databases at the OECD and Eurostat, with the four-year cycle resulting in gaps in the data for relatively long periods compared with the other countries. In addition, any industry-specific split for R&D expenditure in the business enterprise sector is either not available in detail (Eurostat) or not in very much detail (OECD, Federal Statistical Office) – this is a problem that also applies to quite a few other countries.

Up to now the **Innovation Survey** has only examined selected industries in the business enterprise sector. The data gathered relate to innovation output (new products, processes, organisational and marketing innovations), innovation input (innovation activities subdivided into [internal and external] R&D, the acquisition of machinery and equipment, the acquisition of external knowledge [licences, patents], further education and marketing measures for innovations as well as design and other activities). Questions are also posed about the innovation process (innovation developers, important sources of information, innovation cooperation initiatives, constraints) and the target setting for innovation and funding (OECD 2005; CIS-Core Questionnaire 2010[21]).

21 www.statistik.at/web_de/static/subdokumente/b_cis_eurostat_core_questionnaire_cis_2010.pdf.

The innovation survey has been carried out by the KOF/ETH Zurich in Switzerland on a three-year cycle since 1990. It is organised as a panel survey and basically takes into account the issues set out in the CIS-Core Questionnaire, even though there are differences in the wording of the questions and their scope[22]. For instance, a product in the KOF questionnaire is also defined as "goods" or a "service", but there is no differentiation between the two and there is no question related to "organisational" or "marketing innovations" *per se*. However, there are detailed questions (at least there were in 2008) on ICT use, flexibility of working times, changes to the organisation of the firm as a whole, to workplace design and cooperation.

The data is not published in international databases (Eurostat), but it can be viewed as a publication and selected tables in German, French and Italian on the homepage of the State Secretariat for Economic Affairs[23] (SECO).

Both the R&D statistics and the innovation survey in Switzerland do formally deal with the service segments and service innovations, but these areas are more difficult to analyse and have been rather poorly treated historically, with the statistics being subdivided in a less sophisticated manner (e.g. sub-division by industry; see OECD database) than for trade and commerce.

The Innovation Union Scoreboard (PRO INNO Europe 2012) is also compiled at the European level, where 25 individual indicators are published together with a Summary Innovation Index for the Member States (Table 4). This takes into account aspects of a broader concept of innovation, e.g. human capital, which is captured as a prerequisite for innovation activities of any kind, patent applications (including those pertaining to major societal challenges) and trademark and design applications (which are more relevant for services) are also captured, along with organisational and marketing innovations (from the CIS) and knowledge-intensive service exports. Data is also published for Switzerland (ibid.: 56) and regularly depicts the country as one of the innovation leaders.

Another synthetic indicator made up of individual sub-indicators is the **"Innovation Indicator"** of various German research institutions (BDI & Deutsche Telekom Stiftung 2012). It takes into account many of the "traditional" indicators, but also includes additional aspects such as the qualification and education of the population or employees (29), internationality (percentage of foreign students [1] or percentage of international co-publications [36]), e-readiness (10), and the percentage of "post-materialists" (13) (see Table 5). Since 1995, Switzerland has consistently been first in the rankings in this indicator.

The current report expressly discusses the use of additional indicators to measure diversity in relation to gender, ancestry and age. However, the report does state that *"in relation to innovation systems with regard to their focus in the Innovation Indicator, […] capturing an innovative culture of openness and diversity of this type [is] again significantly more difficult than at the individual firm level"* (ibid.: 94). It also claims that potential other indicators (Table 6) relate primarily to the gender aspect. With respect to this indicator it needs to be taken into consideration that equality can be better than a high indicator value.

22 See http://www.kof.ethz.ch/static_media/filer_public/2012/09/16/fb_inno_2008_de_2.pdf.

23 http://www.seco.admin.ch/themen/00374/00459/04076/04077/index.html?lang=de.

Table 4:
Indicators from the Innovation Union Scoreboard

Source: PRO INNO Europe 2012: 10 et seq.

ENABLERS	
a) Human resources	
1.1.1	New doctorate graduates (ISCED 6) per 1000 population aged 25–34
1.1.2	Percentage population aged 30–34 having completed tertiary education
1.1.3	Percentage youth aged 20–24 having attained at least upper secondary level education
b) Open, excellent and attractive research systems	
1.2.1	International scientific co-publications per million population
1.2.2	Scientific publications among the top 10 % most cited publications worldwide as % of total scientific publications of the country
1.2.3	Non-EU doctorate students as a % of all doctorate students
c) Finance and support	
1.3.1	R&D expenditure in the public sector as % of GDP
1.3.2	Venture capital (early stage, expansion and replacement) as % of GDP
FIRM ACTIVITIES	
a) Firm investments	
2.1.1	R&D expenditure in the business sector as % of GDP
2.1.2	Non-R&D innovation expenditures as % of turnover
b) Linkages & entrepreneurship	
2.2.1	SMEs innovating in-house as % of SMEs
2.2.2	Innovative SMEs collaborating with others as % of SMEs
2.2.3	Public-private co-publications per million population
c) Intellectual assets	
2.3.1	PCT patents applications per billion GDP (in PPS€)
2.3.2	PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change; mitigation; health)
2.3.3	Community trademarks per billion GDP (in PPS€)
2.3.4	Community designs per billion GDP (in PPS€)
OUTPUTS	
a) Innovators	
3.1.1	SMEs introducing product or process innovations as % of SMEs
3.1.2	SMEs introducing marketing or organisational innovations as % of SMEs
3.1.3	High-growth innovative firms (not yet available)
b) Economic effects	
3.2.1	Employment in knowledge-intensive activities (manufacturing and services) as % of total employment
3.2.2	Medium and high-tech product exports as % total product exports
3.2.3	Knowledge-intensive services exports as % total service exports
3.2.4	Sales of new-to-market and new-to-firm innovations as % of turnover
3.2.5	License and patent revenues from abroad as % of GDP

Table 5:
Individual indicators of the German Innovation Indicator

Source: BDI and Deutsche Telekom Stiftung 2012: 91

1. Foreign students as a percentage of all students
2. Employees with at least secondary school education level II, with no university degree as a percentage of all employees
3. Doctoral graduates (ISCED 6) in the STEM subjects as a percentage of the population
4. University graduates in relation to the highly-qualified employees aged 55+
5. Employees with tertiary education as a percentage of all employees
6. Annual education tasks (tertiary level incl. R&D) per student
7. Quality of the education system (scale of 1 to 7 based on expert assessments)
8. Quality of mathematical/natural science education (scale of 1 to 7 based on expert assessments)
9. PISA Index: science, reading skills, mathematics (on open scale with mean value 500 and standard deviation 100)
10. E-readiness indicator (scale of 1 to 10)
11. Assessment of likelihood of success (according to own statements)
12. Number of personal computers per 100 citizens
13. Post-materialists (Inglehart) as percentage of the population
14. Government demand for advanced technological products (scale of 1 to 7 based on expert assessments)
15. Demand from firms for technological products (scale of 1 to 7 based on expert assessments)
16. Venture capital used for the initial stage in relation to gross domestic product
17. Extent of the marketing (scale of 1 to 7 based on expert assessments)
18. International co-patents as a percentage of all applications for transnational patents
19. Value added in high-tech as a percentage of overall value added
20. Employees in knowledge-intensive services as a percentage of all employees
21. Intensity of domestic competition (scale of 1 to 7 based on expert assessments)
22. Gross domestic product (GDP) per capita of the population
23. Patent applications of transnational patents per citizen
24. Patent applications to the USPTO per citizen
25. Value added per working hour (in constant PPP$)
26. Balance of trade with high-tech measured against the population
27. Percentage of the R&D expenditure of universities financed by firms
28. Internal R&D expenditure of firms as a percentage of GDP
29. Funding effects of R&D tax incentives: Percentage of R&D expenditure of firms that was financed by an R&D tax incentive
30. Government-financed R&D expenditure of firms as a percentage of GDP
31. Number of researchers in full-time equivalents per 1,000 citizens
32. Number of technical scientific articles in relation to the population
33. Quality of scientific research institutions (scale of 1 to 7 based on expert assessments)
34. Number of quotes per technical scientific publication in relation to global average (measured against the average of the relevant discipline)
35. Number of patents from public research per citizen
36. International co-publications as a percentage of all technical scientific articles
37. R&D expenditure in government research institutions and universities as a percentage of GDP
38. Share of any country in the 10 % most frequently quoted technical scientific publications

Another indicator which attempts to identify a broader potential for innovation and creativity[24] is Florida's **Technology – Talent – Tolerance (TTT) Index** (2002). It is based on Florida's highly popular theory that creativity has become the driving force in economic growth. The Index is composed of a total of seven individual indicators grouped in three partial indicators:

a) Technology Index
- Regional economic growth in technology sectors (High Tech Index)
- Patents *per capita* of the population (Innovation Index)

b) Talent Index
- Employees in creative professions as a percentage of all employees (Creative Class)
- Individuals who have completed academic education as a percentage of the population (Human Capital Index)

c) Tolerance Index
- Artists as a percentage of employees (Bohemian Index)
- Homosexuals as a percentage of the population (Gay Index)
- Percentage of the population born abroad (Melting Pot Index)
  (quoted according to Landsberg 2010: 14).

These indicators are adjusted according to the national or regional data situation to be workable.

Plans to expand the kinds of innovation-related statistics are primarily pursued in two directions: to improve the recording of innovations in the public sector, and to adequately depict social innovations: *"the current measurement framework applies to business innovation, but innovation is also important for the public sector. Consideration is being given to extending the methodology to include public sector innovation and social innovation, so as to correspond to the reality of innovation today"* (OECD 2010a: 20).

Public sector

Based on the existing pilot surveys on innovations in the public sector (see Bloch 2011; OECD 2011g) the OECD has put some fundamental preliminary considerations for measuring public sector innovation forward for discussion (OECD 2011c). According to these, "production" in the public sector is overwhelmingly characterised by services, and they differ from private commercial services to the extent that they often have the characteristics of a "public good". One problem is the fact that, unlike in the private sector, there is no standard measurement of output (such as turnover or value added). Furthermore it states that the public sector is extremely heterogeneous (ministries, schools, research institutions, police, administration, healthcare institutions, etc.) and its target setting goes beyond the direct output of the organisation, for instance supporting (enabling) other actors, e.g. in innovation activities. Furthermore the decision-making processes and organisational forms differ significantly from those in private services: many organisations in the public sector do not have full autonomy in decision-making, meaning that external stakeholders (politicians, other public stakeholders) exercise greater influence than

24 Florida uses these concepts almost interchangeably: "Creativity is no longer the monopoly of advertisers and artists, but is instead part of every activity which uses knowledge innovatively to produce any goods whatsoever. Expressed more elegantly, this means: 'What was innovative a decade ago is now quite simply creative' (Kunzmann 2009)" (Landsberg 2010: 7).

Table 6:
Potential indicators for measuring diversity

Source: BDI and Deutsche Telekom Stiftung 2012: 95

Gender dimension
— Percentage of the employees who are women with at least secondary education at level II, not including employees with university degrees
— Percentage of the employees who are women with tertiary education
— Percentage of researchers who are women (in full-time equivalents)
— Quote rate of publications by women in relation to the quote rate of publications by men, measured as a deviation from uniform distribution
— Number of scientific publications by women per one million citizens
— Percentage of top 10 % publications by women in relation to the percentage of top 10 % publications by men, measured as a deviation from uniform distribution
— Percentage of women with entrepreneurial activities in the initial phase measured against employees in relation to the percentage of men as a deviation from uniform distribution
— Percentage of women with established business activities in the initial phase measured against employees in relation to the corresponding percentage of men as a deviation from uniform distribution
— Percentage of women working as entrepreneurs at the formation phase measured against employees in relation to the percentage of men as a deviation from uniform distribution
— Employment rate of women in relation to the employment rate of men as a deviation from uniform distribution
— Employment rate of women with at least ISCED2 in relation to employment rate of men with at least ISCED2 as a deviation from uniform distribution
— Percentage of women in parliament measured as a deviation from uniform distribution (50 %)
— Percentage of transnational patents with at least one woman in the team of inventors, measured as a deviation from uniform distribution (50 %)
Demographics dimension
— Number of university graduates in relation to the number of highly-qualified employees aged 55 or older
— Employees aged 55 or older as a percentage of all employees
Internationality dimension
— Foreign students as a percentage of all students
— Number of migrants per one million citizens
— International co-patents as a percentage of all transnational patents
— International co-publications as a percentage of all technical scientific publications
— Foreign employees as a percentage of all employees

would be the case with private firms. The report also considers that the structures for incentives and readiness to take risk are considerably different in the public sector (both on an individual as well as an organisational level), and that this is important in understanding and surveying innovation activities in the public sector (ibid.: 5 et seq.).

It has become clear from preliminary studies that by and large the typologies of product, process, organisational and marketing innovations from the Oslo Manual are also suitable for the public sector. However, product and process innovations would have to be less technically defined if they are to take public services into account more effectively. Thus, even if the public sector has no "market", "marketing" (in the sense of promotion) is still an important innovation activity. But adjustments would have to be made to the wording in relation to the degree of innovation as a result (market innovations *vs.* business innovations). The report considers the extent to which innovations have been initiated top down (by politicians, hierarchy) or from the organisation itself to be an additional dimension. Broader and more qualitative impact categories would have to be queried in the absence of a uniform output measurement of quantity (turnover with new products). Measurement of innovation expenditure is also considered to be unsatisfactory, since many respondents to the pilot studies were unable to provide any information on this point. On the other hand questions on staff costs for innovations were less of a problem.

The CIS questions on the impact of innovation, cooperation partners and sources of knowledge make sense, but they would have to be adapted to the specific features of the sector. In addition it states that political drivers of innovation must be accounted for (budget increases and reductions, new laws and regulations, innovations and changes in other organisations, new political priorities, etc.). "Innovative public procurement" has been the subject of existing surveys on account of its growing significance in relation to innovation policy (see Chapter 3.2). Finally it states that questions on the status of innovations in the organisation's strategy, the role of management and the structure of the innovation process must be taken into account for the purposes of improved understanding of the innovation process in public sector organisations. It considers that this also applies to the circumstances which can promote or hinder the innovation process (ibid.).

Example questionnaires are available for the MEPIN Project (Measuring Public Innovation in the Nordic Countries; Bugge et al. 2011: 74), the EU Innobarometer 2010 (Innovation in Public Administration) and the NESTA Public Sector Innovation Index (see OECD 2011g: Annex 2–4).

Social innovations

Compared with the instruments for monitoring innovations in the business area (at the European level of the CIS and the Innovation Union Scoreboard), the problems in measuring social innovations become clear, according to Wobbe (2012: 322): on the one hand because a basic definition is lacking and on the other because of the complex nature of social innovations. Wobbe sees a further fundamental problem in reliably and uniformly measuring the output (or the outcome, i.e. the direct result) of social innovations in terms of social value[25] and social returns (Social Innovation eXchange and Young Foundation for the Bureau of European Policy Advisors 2010: 102). Otherwise the innovation input may be counted multiple times, which he sees as a problem in the sphere of social innovations, as well (ibid.).

Caulier-Grice et al. (2012b) also point out that there are methods available for capturing the social value and social impact at the individual project and organisational levels, but not at the national or regional levels. They claim that, with social innovations, the outcome and process have greater significance than the input and output measures accordingly (ibid.: 26 et seq.).

As such there are currently no generally accepted indicators for measuring social innovations (European Commission 2012: 17). For this reason, a scoreboard for social innovation should be developed (similar to the Innovation Union Scoreboard). It should include three categories: 1) extent of, 2) drivers of and 3) other conditions of social innovations. The scoreboard prototype takes the following categories into account (Table 7).

It is clear from this look at the trends of innovation indicator development that the statistics are increasingly enhanced with a view to reflecting a broader notion of innovation. This is especially true in cases involving attempts to incorporate non-technological innovation. Although it seems that the metrics could still be improved, it has generally been recognised that an expansion of the concept is necessary.

The more comprehensive indicator systems include examples of the development status of the science and education system in addition to technology-related indicators and – on occasion – attempts to depict the scope and thematic direction of how the grand social challenges are being addressed (e.g. number of patents in renewable energies). However, on the whole, we cannot yet say that the innovation statistics are currently reflecting the broader innovative-theoretical concepts nor that these have been developed well enough.

Because the indicators are still somewhat elusive and have not yet been made sufficiently operational qualitative expert assessments in the form of a rapid assessment tool have been proposed as a solution (or interim solution): *"Social innovation lacks well established data sources. One useful approach that can be conducted in the interim is to develop and utilise a rapid assessment tool that can assess the factors in place to support social innovation at regional/city level"* (ibid.: 21). The EU also appointed an expert commission in the autumn of 2012 with the aim of measuring the impact of social innovations[26].

25 See also Mulgan 2010.

26 http://socialinnovation.se/en/eu-appoints-experts-to-measure-results-of-social-innovation/.

Table 7:
Prototype Scoreboard on Social Innovation

Source: European Commission 2012: 19

Category	Indicator
Extent of social innovation	**Core indicator 1** **Policy awareness and policy take-up of social innovation** (with a particular focus on Europe 2020 targets) SI1a) Europe 2020 employment target (as per a proposed measure put to the European Parliament and Council) SI1b) Europe 2020 innovation target SI1c) Europe 2020 climate change target SI1d) Europe 2020 education target SI1e) Europe 2020 social exclusion target
	Core indicator 2 **User-driven innovation** SI2a) Importance of citizens as clients or users for the development of innovations in the public sector SI2b) Introduction of customer-driven innovations in social enterprises
	Core indicator 3 **Procurement** SI3) Procurement of potentially innovative solutions **Supplementary indicator(s)** TEPSIE is examining economic indicators (potentially covering economic value and employment)
Drivers of social innovation	**Core indicator 4** **Hubs and incubators (information that can potentially be drawn from use of rapid assessment tool in major regions and cities)** SI4) Extent of specialist hubs and incubators to encourage entrepreneurship and disseminate good practice **Supplementary indicator(s) (information that can potentially be drawn from use of rapid assessment tool in major regions and cities)** Specialist forms of finance for social innovation Links are made between innovative projects and mainstream agencies
Wider context	**Core indicator 5** **Higher quality relationships to meet social needs** SI5a) Ability to ask a relative, friend or neighbour for help SI5b) Participation in informal voluntary activity

5 A Broader Innovation Policy in Other Countries

The following section takes a look at strategy papers of international bodies such as the EU and the OECD that discuss a broader notion of innovation on the one hand, and on the other, it looks at selected countries to see whether (and if so, how) a more inclusive definition of innovation is used as a basis for research and innovation policy. It also covers the effects that the notion of innovation has on the direction and implementation of policy measures.

This assessment is done against the background of the following questions: (i) To what extent is a broader notion of innovation accounted for in political strategy documents, particularly within the scope of the grand challenges and the new mission orientation? (ii) To what extent do funding programmes already exist or are being planned which allow for a corresponding broadening of the concept of innovation? What are the most important distinguishing features between these "traditional" measures and innovation policy? And finally (iii) have experimental approaches to funding been implemented? If there are already documented reports/evaluations on these: what are the experiences from such an approach to funding?

5.1 Perceptions of innovation in current supranational strategy documents

5.1.1 OECD Innovation Strategy

With the "OECD Innovation Strategy" (2010b) the OECD has put forward a guiding document which also assumes a broader concept of innovation according to its own understanding. The core elements of this notion of innovation are as follows:

- a concept of innovation which encompasses the entire chain from basic research to market launch;
- a "systemic understanding" of innovation which sees innovation as the outcome of cooperation and interaction between a large number of different stakeholders;
- an understanding of innovation policy which is neither limited to funding innovation as an end in itself nor has purely economic objectives, but rather sees innovation as a crucial tool in overcoming major societal challenges;
- a broad understanding of innovation policy which goes beyond traditional research and technology policy, and in all cases includes education policy in the area of major societal challenges as well as relevant "sectorial policies". However, the OECD Innovation Strategy does not discuss how this linkage to the relevant sectorial policies might look (a central issue for the "new mission-oriented innovation policy");
- for the purposes of a broader understanding the OECD also argues in favour of an expansion in the statistical recording of innovations (see Chapter 4 of this report).

However, the OECD's approach is still largely rooted in the PPT paradigm, despite this more inclusive version of the definition of innovation: for instance the linkage of innovation policy to other spheres of policy, which is at the heart of the new mission-oriented innovation policy, is only addressed in a very cursory manner.

Even the areas which have been at the centre of the efforts to improve in the statistics recorded for innovations, i.e. innovation in the public sector and social innovation, either are not mentioned in the OECD Innovation Strategy or only appear at the margins without being discussed in detail.

> *"The last few years have seen a burst of interest in steering research and innovation to address social challenges. This interest reflects the rise of 'social innovation', the use of innovation to address social problems. Many of today's social challenges, such as those associated with ageing populations and environmental sustainability, as well as long-standing problems such as poverty, education and migration, have resisted conventional government or market solutions"* (OECD 2010b: 182 et seq.).

To this extent the OECD Innovation Strategy remains "narrower" and more grounded in the PPT framework than the innovation strategies in other countries, and especially the EU.

5.1.2 European Union – Horizon 2020

The European research and technology policy is currently in a process of transformation as part of the new direction for the next programme period from 2014 to 2020 (Horizon 2020). "Horizon 2020" is an attempt to consolidate European research, technology and innovation policy into a single programme. It is aimed at supporting all phases of the innovation chain, including in particular activities close to the market and also comprising innovative financing instruments and non-technological and social innovations. The programme also has an explicit objective of meeting the need for research associated with the extensive range of EU strategies, by paying particular attention to the best possible use and distribution of the knowledge generated by the funded activities, all the way down to marketing this knowledge. Horizon 2020 focuses on the following three priorities (pillars) (see Figure 12):

- generating excellent scientific performance for the purpose of strengthening the world-class level of the EU's excellent science;
- promoting industrial leadership – including small and medium-sized enterprises (SMEs) – in terms of innovation processes, and
- overcoming societal challenges as a direct response to the challenges stated in the Strategy Europe 2020 by supporting activities which cover the entire spectrum from research to bringing it to the market.

Generally, the **innovation union** of the European Union provides for comprehensive access to innovation policy as one of the seven leading initiatives in the **Europe 2020 Strategy** adopted in October 2010: on the one hand it states that the area of innovation policy must be extended beyond the traditional focus of funding R&D and a **comprehensive innovation concept** must be applied which also includes innovations of business models, design, branding and services. According to the strategy, innovations in the public sector and social innovations are also important in addition to traditional innovations in the industrial sector, with incorporation of the stakeholders at the same time in the broadest manner possible (European Commission 2011d: 10 et seq.).

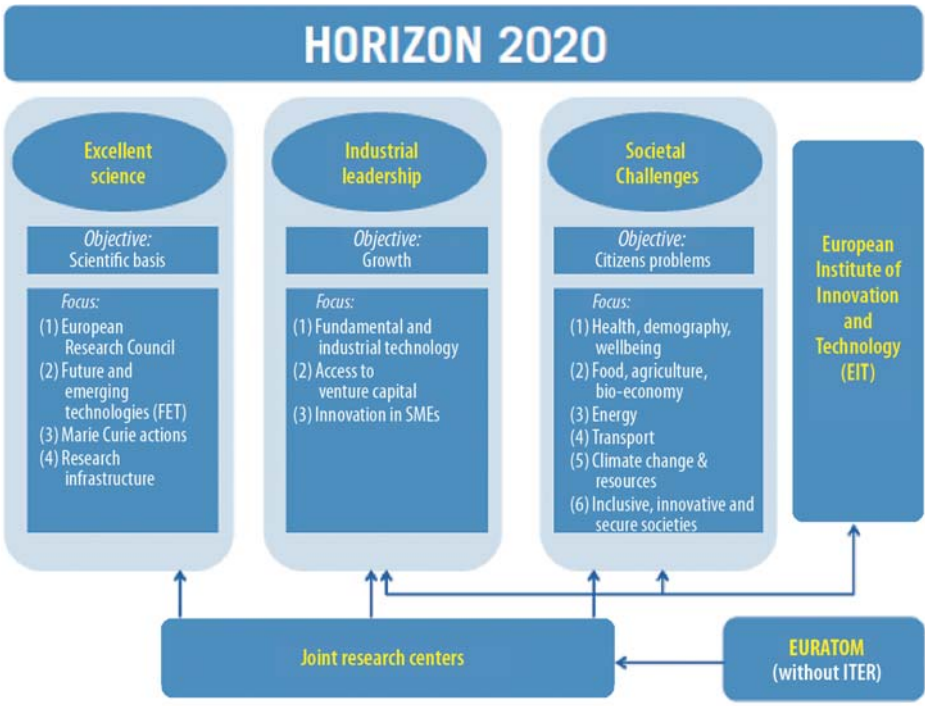

Figure 12:
The pillars of Horizon 2020

Source: adapted from Naczinsky (2012)

On the other hand it states that a "focus is required on innovations with which the major societal challenges determined in [the strategy] Europe 2020 can be overcome" (European Commission 2010b: 8). The strategy identified the following major societal challenges:

- health, demographic change and well being
- food security, sustainable agriculture, marine and maritime research and bio-economics
- secure, clean and efficient energy
- intelligent, environmentally friendly and integrated transport
- climate protection, resource efficiency and raw materials
- integrated, innovative and secure societies.

Furthermore, major significance is given to **social innovation** in the European Union's RTI policy:

> *"Social innovation is an important new area which should be fostered. This involves tapping into the resourcefulness of welfare organisations, associations and social entrepreneurs in order to seek out new ways of solving social problems for which the market or the public sector have no satisfactory answers. This resourcefulness can also be tapped into in order to bring about the changes in behaviour needed in order to be able to address major societal challenges such as climate change. Aside from satisfying social needs and solving societal problems, social innovations can encourage people and create new societal relations or forms of cooperation. They are therefore innovative in and of themselves and at the same time good for the innovative capacities of society"* (European Commission 2011b: 25 et seq.).

Social innovations were first mentioned by the European Commission in the mid-1990s: *"Innovation is not just an economic mechanism or a technical process. It is above all a social phenomenon. Through it, individuals and societies express their creativity, needs and desires. By its purpose, its effects or its methods, innovation is thus intimately involved in the social conditions in which it is produced"* (European Commission 1995: 11), but this aspect of the concept of innovation was not given a significant status in the practice of innovation policy until these strategy documents.

Social innovations were also supported in the past by the European Social Fund (ESF), and social innovation will be the focus of the ESF's next generation of programmes and Member States can have greater support for social innovations provided by the ESF (European Commission 2011b: 25 et seq.).

The European Commission also published three initiatives aimed at promoting social entrepreneurship and social innovations across Europe[27]:

— *"Initiative for social entrepreneurship"* (COM(2011) 682): The focal point is an action plan to fund the formation and development of social enterprises which provides for eleven measures in the areas of a) improving access to funds for social enterprises; b) increasing visibility of social enterprises; c) improving the legal conditions used by European social enterprises.
— *"Proposal for the establishment of a new category of the European Fund for social entrepreneurship"* (COM(2011) 862): The "European Social Entrepreneurship Fund" (EuSEF) seal of approval aims to make it easier for investors to identify funds which are focused on investments in European social enterprises.
— *"Proposal for a Regulation about a European Union Programme for Social Change and Innovation"* (COM(2011) 609): The funding programme is to provide almost € 960 million in total for the period 2014 to 2020. The proposal builds on three existing sub-programmes PROGRESS, EURES and the Progress Microfinance Facility for employment and social inclusion.
  The Progress programme has a special budget available in the period 2014–2020 for social innovation and social experimentation. Social experimentation refers to an initial small-scale testing of innovative political measures. Of the € 574 million proposed for Progress in the period 2014–2020, € 97 million will be made available for pilot schemes[28].

Furthermore a platform was established at www.socialinnovationeurope.eu which is intended to be used as an exchange and link for the relevant stakeholders in the sphere of social innovations.

27 See www.beobachtungsstelle-gesellschaftspolitik.de/soziale-innovation.html.

28 http://ec.europa.eu/social/main.jsp?langId=de&catId=89&newsId=1093.

5.2 Important national strategy documents

This section examines how the extension of the notion of innovation has been reflected in individual countries' RTI-policy strategy papers. The selection criteria for the choice of countries were cultural and geographical proximity as well as the existence of respective activities and policies by the relevant country. We will look at (i) what understanding of innovation underlies the relevant strategy and which significance (ii) mission-oriented innovation policy, (iii) service innovations and (iv) social innovations have in the relevant strategy. The following countries were selected for the international comparison:

- **Austria,** since it is also a relatively small open national economy like Switzerland, which does however make use of a very broad spectrum of innovation funding, and was able to achieve a successful transformation to an R&D-based innovation system in the last two decades. Austria's current research, technology and innovation policy strategy was published on 8 March 2011 and was the result of several years of discussion and analysis[29] (Bundeskanzleramt 2011).
- **Germany,** since it has a comparable economic structure and has market significance across Europe. The crucial strategy document in Germany is High-Tech Strategy 2020 (HTS2020; BMBF 2010), which was adopted in 2010 and as such became the successor to the original High-Tech Strategy from 2006. The strategy plan is understood as *"encompassing the content of innovation-policy themes across the ministries"* (ibid.: 4), and takes into account funding aspects and framework conditions.
- **Sweden** as a smaller European national economy which is extremely strong in terms of research and as such resembles Switzerland and is also faced with similar challenges, but which also differs from it as a result of pursuing a more interventionist economic policy. Crucial documents in Sweden are the four-year Research and Innovation Act (currently for the period 2013–2016; Government Offices of Sweden 2012) and the Swedish Innovation Strategy (currently from October 2012; Government Offices of Sweden 2012b).
- **South Korea** as an industrialised country outside of Europe whose innovation policy is characterised by a heavy top-down approach and a large number of sectoral and sub-strategies, laws and planning documents, and which has become one of the most research-intensive countries over recent decades, undergoing significant paradigm shifts in its innovation policy in the process.

29 The starting points were the Austrian research dialogue (2007–2008), the evaluation of the Austrian research funding system ("System Evaluation") in 2008–2009 and the proposals and recommendations of the Austrian Council for Research and Technology Development ("Strategy 2020") in summer 2009.

5.2.1 Understanding of innovation

The starting point for the **Austrian RTI strategy** (Bundeskanzleramt 2011) is the successful development of the Austrian research and innovation system in recent decades, which has led to Austria being ranked at the forefront of the "Innovation Followers" within the EU and has allowed its innovation system to evolve from a "catching-up" stage (particularly concerning "embodied technology change") to being a research-based innovation system. On the other hand, new short-term (consequences of the global financial and economic crisis) and long-term challenges ("Grand Challenges" such as global scarcity of energy and natural resources, climate change, demographic change) set the framework in which the strategy plan must function and for which accordingly adaptation strategies and development options must be formulated for science, research and technology alike.

The strategy plan for research, technology and innovation puts forward two prioritised objectives: The intention is for Austria to become one of the most innovative countries in the EU by 2020 and to make use of the potentials offered by science, research, technology and innovation in order to overcome the major social and economic challenges of the future. The approach of national innovation systems serves as a conceptual-theoretical basis (see Lundvall 1992) when using an inclusive concept of innovation, which in addition to technological and organisational innovations also explicitly includes the services sector and at the same time recognises the significance of continuous "policy learning" (public sector innovation)[30].

Within this vision and the conceptual background, the strategic framework defines five interrelated pillars in which – building on specific structures, development trends and challenges – the strategy is to be implemented and operationalised using appropriate measures:

- **Education system:** A quantitatively and qualitatively well-equipped education system is an essential prerequisite for innovative thought and action. Access to and the permeability of the system should be fundamentally improved. The envisioned measures aim for a broad structural reform of the education system at all levels (from early intervention at nursery-school age to quality improvements in university teaching). At the same time, improved integration procedures can do a better job of unlocking the human capital of Austria's population. Systematically increasing the mobility of students and graduates should ensure further internationalisation, which is an important indicator of the world-wide interconnection of the Austrian research and innovation system. At universities, the improved situation (such as transparent, performance-related awarding of professional positions, further development of the collective agreement and implementing a tenure track system, improving funding for doctoral candidates and post-docs, etc.) should ensure that academic careers become more attractive. Questions surrounding gender balance also need to be pushed forward.
- **Basic research:** In a knowledge society, basic research is a fertile ground for the innovation system. In research and innovation policy basic research is consequently considered to be a key area of the government's responsibility. Accordingly, the institutional elements of basic research in Austria must be strengthened. In addition to improvements in infrastructure, essential packages of measures include the reform of

30 Since around the mid-1990s, Austrian RTI policy has been conceptually based on the innovation system paradigm (see BMWF 1994, 1996).

university financing, further development of performance agreements, and the continued expansion of third-party financing via competitively evaluated projects. At the same time, the role of the universities as partners in the transfer of knowledge to firms should be further expanded and strengthened, e.g. by establishing Knowledge Transfer Centres.

- **Innovation and corporate research:** The innovation output of Austrian firms and their employees is a crucial factor in achieving strategic targets. A complex package of measures is developed therefore in the RTI strategy for the purposes of improving innovation performance, ranging from the targeted expansion of direct funding and demand-based innovation measures (such as in the area of public procurement or in setting standards), to actively promoting the foundation of innovative firms and further intensifying the links between science and industry.
- **Governance of the research and innovation system:** The framework conditions for the Austrian innovation systems must face up to the new challenges. Political governance cannot be restricted purely to research, technology and innovation policy in its narrower sense. In the face of the new challenges, it can only be effective if there is mutual coordination and cooperation with other spheres of policy, in particular education policy, competition policy, environmental policy and a general policy of international openness and mobility. Thus the reorientation of the framework conditions and governance structures aims for more efficient distribution of expertise, creating adequate mechanisms for defining focal points, a transparent structuring of the funding system and coherence in the distribution of responsibilities in a multi-level political system, from regional coordination to internationalisation. To achieve this, the measures include establishing a high-level Task Force for Research, Technology and Innovation (consisting of eight working groups) whose high-level responsibilities include the support, realisation and coordination of the implementation of the new RTI strategy.
- **Funding system:** The precise formulation and further development of the funding system plays a central role in the Austrian federal government's RTI strategy. In Austria, this has led in recent years to a differentiated and broadly-based funding system that covers everything from indirect (tax) funding and open-topic bottom-up funding-upon-application to top-down programmes for defined topics. This funding system must now be adjusted to fit the new strategic objective: establishing Austria as an Innovation Leader, with the emphasis on maximum efficiency in the use of funds, increasingly applying the principle of fund allocation through a competitive process. Specific measures include, for example, raising the research bonus from 8% to 10% (while eliminating the research tax reliefs at the same time), cleaning up the many different strategic programmes by concentrating resource allocation on a select few broadly-defined focal points with strategic relevance, and more extensive streamlining and harmonisation of instruments. The objective is to achieve a distribution of public and private financing by 2020 in which one-third is public and the other two-thirds are private.

The government explicitly phrases its perception of innovation broadly: *"We must adopt a broad approach to innovation that not only includes technological, research-driven and non-technological innovations in manufacturing and in the service sector but also ecological and social innovations and innovations in the public sector"* (ibid.: 24).

The **German High-Tech Strategy 2020** (BMBF 2010) states that Germany is faced with one of the greatest economic and financial challenges it has seen in decades, and that the *"global race for knowledge"* and the *"international competition for talents, technologies and market leadership"* will intensify even further. At the same time it notes that the solution to global challenges of climate change, demographic changes, the spread of common diseases and the need to ensure global food resources requires contributions to be made by research, developing technologies and innovation activities. It states that Germany must *"not cease its efforts"* in this regard and must shape leading markets which are fit for the future.

The underlying understanding of innovation is not explicitly formulated in the HTS 2020, but the strategy plan does describe new technologies, services and social changes as drivers of innovation just as much as global challenges. It goes on to define five "areas of need" based on this: climate/energy, health/food, mobility, security and communication. The funding of key enabling technologies and improving the circumstances in which innovation takes place are cross-sectional issues which extend across all five areas of need (ibid.: 5). Key enabling technologies include bio and nanotechnologies, micro- and nano-electronics, optical technologies, micro-system, materials and production engineering, service research, aerospace technology and information and communication technology. The innovation-friendly framework conditions include the formation and promotion of small and medium-sized enterprises (SMEs), innovation financing/venture capital, standardisation, innovation-based procurement and qualified expert staff (ibid.: 11). The report also emphasises the need for more effective interlocking between science and industry to achieve a faster transfer of knowledge and technology and transfer new ideas to new products more quickly. The instruments mentioned to achieve this include patent policy, the "campus model" as a location for research cooperation initiatives between science and industry along with continuation of the Leading-Edge Cluster Competition and the Innovation Alliance. There are also plans to introduce new discussion platforms for citizens' dialogues on these themes for the future. Lastly, a continuation of the "foresight" processes is also required. As a whole the HTS approach to policy setting over the years has noticeably shifted towards a so-called "new mission-oriented innovation policy", with a greater emphasis on topical priorities related to problems in society.

The main argument in the **Swedish Innovation Strategy** (Government Offices of Sweden 2012b) is that a broad concept of innovation is required when drafting and implementing innovation policy and that the grand societal challenges must be the starting point for this policy (see OECD 2013: 232). As such the strategy plan is explicitly in line with the international context of the OECD Innovation Strategy and the Europe 2020 Strategy (Government Offices of Sweden 2012b: 10). Innovation is not merely understood as new products or technological solutions and instead has a much broader concept:

> *"It* [an innovation] *may also be new ways of planning and developing urban or rural areas and built environments. It can be combinations of goods, systems and services for the global telecommunications market or smart transport solutions. Innovation can also take the form of new ways of designing or organising healthcare services for the elderly, new ways of submitting tax returns, new methods of involving customers or users in developing services or goods and new ways of taking advantage of and distributing art and artistic achievements. Innovation can also be new ways of using old, naturally occurring conditions, e. g., cooling energy-intensive data servers through localisation in cold climates or new ways of using land, ecosystem services, raw materials from nature and biologically/ecologically based technologies and methods"* (ibid.: 9).

Policy measures have been stated in three areas for the purposes of creating a "strong climate of innovation".

- Reasonable, functioning and stable **framework conditions** with, for example, stable state finances, free competition, regulations, intellectual property rights, tax law structures, labour and financial markets are all important, as is the education and research system.
- Innovations in the **public sector and demand-based innovation policy:** these include on the one hand the innovative capability of the government/public sector, and on the other the latter's contribution to the demand for innovations by setting standards, through public demand, etc.
- **Direct measures** to fund innovation processes by providing funding for innovation activities, start-ups, consultancy offerings and knowledge and innovation infrastructures (e.g. start-up centres, clusters, networks) (ibid.: 19).

Korea's research, technology and innovation policy is characterised by a large number of strategies, laws and planning documents. In Korea we can also observe a broader understanding of innovation. The starting point is "Vision 2025: Development of Science and Technology" as published in 2000 (Government of the Republic of Korea 2000), which aims to achieve scientific and technological competitiveness by 2025 which is comparable with the G7 countries in selected areas. In summary the OECD states: *"It proposed the following fundamental shifts in science and technology policy: i) from a government-led and development-oriented innovation system to a private industry-led and diffusion-oriented innovation system; ii) from a closed R&D system to a globally networked R&D system; iii) from a supply-dominated investment enhancement strategy to an efficient utilisation and investment-distribution strategy; iv) from a short-term technology-development strategy to a long-term market-creating innovation strategy; and v) towards establishing a science- and technology-led national innovation system"* (OECD 2009b: 184). A "Science and Technology Framework Law" (2001), "Basic Plans of Science and Technology" for five years at a time (currently 2008–2012), an "Implementation Plan for the National Innovation System" (2004) and an "R&D Total Roadmap" (2006) with a planning horizon of 5–15 years were created building on this strategy. The "577 Initiative" was added in 2008, which among other things provides for R&D intensity of 5 % in 2012 and for South Korea to be one of the seven "major S&T powers in the world" (ibid.: 184 et seq.).

Overall an increasing adaptation of a broad notion of innovation can be found in the strategy documents studied. In the European countries this adaptation has even been fundamental in nature, and is also being applied to innovation policy. This will now be illustrated using a few important dimensions for the concept.

5.2.2 Mission-oriented innovation policy

Mission-oriented innovation policy plays an increasing role in all of the countries studied. In some of them it is even described as a central starting point for current innovation policy.

Austria's RTI strategy (Bundeskanzleramt 2011) tends to keep their publications open as far as topics are concerned (i.e. they don't address specific fields of technology or selected "high-tech industries"), yet it certainly addresses the discussion around a "new mission orientation". Certain topical priorities become clear due to the focus on the "societal challenges" (Grand Challenges; specifically, they mention: climate change, dealing with scarce resources, increasing resource and energy efficiency[31] and ensuring quality of life in the midst of demographic change). However, "traditional" generic technologies are also stated, as can also be found in the RTI-policy strategies of many other countries (such as IT, materials engineering, nanotechnologies, etc.). It should also be noted that the RTI strategy does not rule out top-down induced or defined programmes and instruments, but says there must be balance here in relation to open-topic bottom-up approaches: *"Top-down policy prioritisation must, however, always be supported by evidence. We must find an adequate balance between top-down and bottom-up approaches to research funding"* (ibid.: 35).

As already mentioned the **German** HTS2020 makes reference to globalisation in the form of a *"global race for knowledge"* surrounding talents, technologies and market leadership, and global challenges such as climate change, demographic change, global food levels and the finite nature of raw materials and energy sources (BMBF 2010: 3). The HTS2020 explicitly pursues a *"mission-oriented approach"* (ibid.: 6). In this context, future projects are defined which *"take the most important challenges into consideration as examples in the individual areas of need"* (ibid.). The aim is for the projects to pursue concrete scientific, technological and social goals, and develop them over ten to fifteen years. Examples include "Intelligent restructuring of energy supply", "Living an independent life well into old age" and "One million electric cars in Germany by 2020". The HTS 2020 names a series of action items for each area of need, including research and framework programmes (e.g. the 6th energy research programme, the research for sustainable development framework programme).

In **Sweden** the former Research and Innovation Act from 2008 lists climate change, energy crisis, water shortages, poverty, demographic change, international conflicts and risks of a pandemic as a starting point, although it does not provide any specific innovation policy measures (Cunningham & Karakasidou 2010). The current Act also speaks of "pressing social needs" and "social challenges", and makes reference e.g. to energy and health research, without explicitly mentioning an innovation policy. The only exception is the reference to "specific innovation areas" which should be defined and supported specially by VINNOVA and for which the social challenges should act as a starting point (Government Offices of Sweden 2012a).

31 Increasing resource efficiency is also set out as a strategic objective for Austria in the Resource Efficiency action plan. Resource efficiency is also one of the important arenas within the framework of Europe 2020 (Flagship Initiative "Resource efficient Europe").

VINNOVA is the Swedish Government Agency for Innovation Systems which was founded in 2001 and has eleven strategic areas of action. One of these is called "challenge-driven innovation" (Vinnova 2013; Vinnova 2011). It supports four broad societal challenges on the assumption that Sweden is in a good starting position to allow it to occupy a leading position in innovation. These areas are sustainable and attractive towns and cities, health, well-being and medical care, competitive manufacturing and the information society 3.0. There are a total of € 28 million available for these activities for the period 2011–2013 (Melin et al. 2011).

The current innovation strategy names societal challenges as one of its essential motivations (Government Offices of Sweden 2012b: 5). It refers to the need for (im)migration as an important factor in maintaining Swedish innovation capabilities against the background of demographic change (ibid.: 26). The significance of variety and diversity in an open and inclusive society is also highlighted with reference to gender, age and ethnic background (ibid.).

Except in the area of (circular) migration (see above), globalisation in particular is seen as an opportunity for growth and a driver of innovation (for the purposes of maintaining competitiveness) (ibid.: 35 et seq.). At the same time, the major dependency on the global economy and multinational firms is seen as a weakness which makes it necessary to create attractive framework conditions for strengthening Sweden as a location (ibid.: 37).

In **South Korea** the strategy plans have been implemented using specific R&D programmes that are targeted at industries ("flagship-industries") or areas of technology (e.g. "next-generation growth engines", "critical technologies" or "candidate technologies" of the 577 Initiative). The 577 Initiative details 50 critical and 40 potential technologies which should be pursued. They expressly include "global issues-related technologies" such as environmental technologies and technologies for water management and protection as well as for adaptation to climate change. Other areas of technology can also be allocated to the grand challenges such as various fields in biotechnology/medicine or energy research (OECD 2009b: 204 et seq.).

> *"The NSTC has reviewed 2012 R&D budget draft and selected five major investment areas to respond to social challenges and industrial demand as follows: big public R&D such as space and aviation industry, particle accelerator, construction and maritime industry; green resources such as new and renewable energy, essential industry such as machine and equipment and materials; advanced fusion industry such as system semiconductor, LED system and ICT industry; and life welfare technology. All of the major areas have specific policy measures and will be implemented by relevant departments and research performers amongst industry, GRIs and universities"* (Ko and Choe 2011: 18).

It can be seen from applicable budget comparisons of the OECD that South Korea gives less significance to societal challenges in the strategy plan than the European countries but that it does plan huge investments in "green growth (industries)". However, here too, the emphasis on the industrial-policy reasoning is stronger than that of the societal challenges.

5.2.3 Service innovations

Service innovations can indeed be found already in the "traditional" notion of innovation as argued in Chapter 2, although they have been traditionally underrepresented in innovation-policy practice. At least in this regard, the greater emphasis on services in the innovation policy strategies in recent years can be seen as an extension of innovation policy.

In **Austria** there has been intense debate about the significance of innovations in the services sector for several years. The RTI strategy explicitly highlights the fact that the innovation capabilities of the services sector represent an essential component in any modern innovation system. The question arose as to the extent to which the technology and innovation policy support system meets this level of importance and whether there is "accessibility" in principle for service providers to various instruments and programmes.

Access to the funding mechanisms of certain open-topic programmes has been possible in principle in the past (e.g. the general programmes of the Austrian Research Promotion Agency [FFG]) and this has also been utilised, but the question still arises as to whether "traditional" R&D or innovation support is actually adequate for the sizeable remainder of services segments. In order to visibly emphasise the importance of an innovative services sector, the so-called "Services Initiative" was launched. It aims to make it easier for service providers to access the RTI funding system largely based on existing instruments. The Services Initiative (DLI) is an initiative from the Austrian Federal Ministry of Economy, Family and Youth (BMWFJ) which is processed via the Austrian Research Promotion Agency (FFG) and is aimed at funding services projects with additional budgets. The services initiative is being implemented within the framework of ongoing Austrian Research Promotion Agency (FFG) funding programmes in accordance with existing guidelines and processing standards (FFG 2013). Within the framework of the service initiative there were funding commitments amounting to around € 5.7 million in 2011 (FFG, 2012). The service initiative accounts both for service innovations *sui generis* (those within the services sector itself) as well as service innovations which are developed by industrial enterprises (e.g. in combination with a technological innovation).

Austrian RTI policy has also increasingly turned towards the "creative industries" area in recent years, with recognition that this sector is exhibiting dynamic development and also serves as an important "service sector" for other sectors (in the sense of providing "creative ideas"). This recognition is reflected, for example, in the regular publication of the "Creative industries report Austria" and in the launch of applicable policy instruments which exclusively address the creative industries. Accordingly the RTI strategy also explicitly names this sector as an important tool for improving innovation capabilities in the economy as a whole.

Service innovations are viewed as a cross-sectional theme in the **German HTS2020.** The report particularly highlights the fact that *"a combination of technology and service innovations are often [required] in order to guarantee success"* (BMBF 2010: 9).

In addition to the five areas of need the HTS2020 also takes into account the accompanying key enabling technologies: the service economy is understood as a key enabling technology (in addition to nanotechnologies, biological and ICT technology).

The BMBF support programme for service research "Innovations with services" was also set up in 2006 by the Federal Ministry of Education and Research (funding period approx. 6 years with funds of approx. € 70 million). The guiding theme of the support programme is *"to make a contribution to the German position achieving the same excellence in the services area that distinguishes Germany in the area of industrial production. This applies both to service research and to the service sector"* (BMBF 2009a: 8). The goal is to improve the market position, create attractive employment opportunities as well as enable a new orientation in service research using economic, social and technological developments. The action areas are divided into innovation management, innovations in growth areas and people in firms that provide a service.

The research programme is supplemented with an "Action Plan for Service Providers 2020" (BMBF 2009c), which aims to integrate service research into other R&D activities at an early stage in order to achieve more rapid commercialisation (ibid.: 16). While the HTS2020 sees itself as a comprehensive and coordinating document in innovation policy, the action plan is intended to fulfil a similar function in terms of funding research through cross-departmental funding guidelines, specific requirements for service innovations and supplementary projects for developing innovative services in combination with the development of new technologies.

The **Swedish innovation strategy** (see Government Offices of Sweden 2012c) does not address services as a separate point, but reference is made to the significance of innovation capabilities in service areas such as ICT, transportation/logistics and the cultural and creative industries (ibid.: 35 et seq.). A separate "Strategy for more service innovation" was also drafted ahead of the Innovation Strategy 2010 with four priorities: appropriate and effective framework conditions, knowledge and capabilities, digital infrastructure and internationalisation (see Government Offices of Sweden 2012c: 41). Kuusisto (2008: 24) points out that national innovation policy mainly relies on public sector innovation, while regional innovation policy is more heavily concerned with commercial service innovations (see also Eklund et al. 2007).

In **South Korea** the 577 Initiative includes the additional area of "knowledge-based service technologies". Furthermore "digital content/software solution" is also stated within the framework of "next-generation growth engines" (2006) – this would for instance also include online gaming software (OECD 2009b). A roadmap for the services area (2008) provides *inter alia* for funding innovations through greater government R&D expenditure in the services area and outsourcing support (ibid.: 213). However, the OECD Report states that the concept of "service sciences" required for service innovations is still underdeveloped (ibid.: 214). A "service innovation action programme" was also adopted in South Korea in 2010. The "Service Progress" plan was also proclaimed in 2009 with the aim of reducing regulation and obstacles to trade and thereby stimulating service innovations (Kovács 2011: 51). The "Content" industry as a part of the creative industries represents a particular focal area for Korea in the services sector. Korea has set itself the ambitious target of becoming one of the five leading global content providers in the coming years and with the KOCCA (Korean Creative Content Agency) set up an agency in 2009 just to implement this ambitious target.

5.2.4 Public sector innovation and social innovations

The areas of innovation in the public sector and of social innovations are somewhat outside of the traditional concept of innovation since they are to a very large extent not aimed at creating marketable products and production processes. However, both are attracting attention in current innovation policy as is demonstrated below.

"New public management" concepts have been discussed in **Austria** since the 1990s. It has been recognised that the organisation and processes for administrative action need to be rethought, and concepts and experiences from the management of private-economic units may offer opportunities for improvement and increased efficiency – at least with some adaptation. One tangible result is the statutory implementation of so-called "performance budgeting" which is now used for the budget creation process.

A concrete area of innovation in which Austria has implemented a large number of activities in recent years and has taken up a pioneering role within Europe at least in some sub-areas is the area of e-government[32]. The target of the Austrian e-government strategy (as a part of Austria's ICT strategy) is to improve quality and efficiency in administration, increase transparency for citizens and give citizens and firms easier access to official procedural steps by implementing modern information and communication technologies. The new information and communication technologies (in particular the internet) have contributed in recent years to the noticeable improvement in the quality of communication between administrative bodies and citizens (and firms). The public authorities in Austria are transitioning towards offering all procedural steps (transactions) online, from application to completion, applying the one-stop shop principle.

Austria made its first steps towards e-government in 1998 with the formation of the "E-Austria" task force[33]. These activities then led in 2001 to the establishment of the "ICT Board" with the task of creating the legal and technical conditions and coordinating the planning and development of e-government solutions between the federation, states and municipal communities. A separate e-government Act which came into force on 1 March 2004 provides the current legal basis for e-government (it has been amended as needed since that time). The Digital Austria platform was introduced in the Federal Chancellery in 2005 as a tool for comprehensive coordination in the e-government strategy which coordinates the corresponding activities of all administrative bodies (municipal authorities, regional governments and the federal government).

Although the RTI strategy also explicitly mentions social innovations in addition to innovations in the public sector (see 5.2.1), no specific strategy documents or programmes are reported currently in this regard.

The **German HTS2020** makes no reference either to "innovations in the public sector" or to "social innovation". However, they are included implicitly, e. g. innovation-based procurement by the public sector and innovations to improve quality of life for older people. We are not aware of any further strategy documents which explicitly address social innovations; the annual reports of the Research and Innovation expert committee do not mention them either. However, a separate chapter of the current 2013 report does address innovative public procurement.

32 The European Commission has used benchmarking for years related to the implementation of e-government in 25 EU countries, as well as Iceland, Norway and Switzerland. In these benchmarks Austria has been selected as an "e-government European champion" several times already.

33 Federal Chancellery, Digital Austria platform (2011): Network of authorities – the Austrian e-government ABC, Vienna.

Innovations in the public sector are one of the six pillars of **Swedish innovation strategy** (Government Offices of Sweden 2012b: 23) and as such take up considerable space. The stated objective is as follows: *"Innovative and collaborative public service organisations that are legally secure and effective, and have a high degree of quality, service and availability"*. Demographic change and the resulting lack of manpower is in particular stated as the justification: *"In order to adapt to these changes [i. e. ageing in society], innovations are needed to deliver public services with increased quality and efficiency"* (ibid.: 7). The strategy plan states three sub-goals, that:

— *"Public sector organisations work systematically with innovation in order to increase efficiency and quality":* The stated areas of innovation include e-government, a stronger user orientation, increased efficiency, access to public data (open data), innovative procurement and deregulation (ibid.: 43 et seq.).
— *"Public sector organisations contribute to developing innovative ways of meeting societal challenges":* It is stated that the public sector is responsible for coordinating the solutions for complex societal challenges, as these cannot be provided by individual stakeholders. As a result it has to initiate cooperation with relevant stakeholders, develop further methods and expertise for innovation promotion, define targets and areas where eco-innovations are of particular significance and support international cooperation in this regard (ibid.: 44 et seq.).
— *"Efficient public sector support for innovation with a focus on customer benefit"*. The stated goal is improved coordination of innovation funding, a greater focus on its benefits and impact as well as its measurement over different periods. In general, it is stated that initiatives should work towards a longer-term perspective that reinforces expertise in the public sector and either creates or improves effective structures for the cooperation of private and public stakeholders (ibid.: 45 et seq.).

One of the eleven strategic areas for VINNOVA is accordingly "Innovation Capacity in the public sector"[34]. The Swedish government has also created a *"National Council for Innovation and Quality in the Public Sector"* with its report expected in mid-2013 (OECD 2013: 265).

Finally, innovation policy should also be a "learning" and therefore an innovative activity which is improved and adapted on a continuous basis. This would call for ongoing monitoring, evaluations and analyses of the measures implemented nationally and internationally (Government Offices of Sweden 2012b: 51 et seq.)

Social innovations are treated much more concisely in the innovation strategy than public sector innovation. The "Innovative businesses and organisations" pillar also includes the following sub-goal: *"Using the potential of social innovation and social entrepreneurship to contribute to meeting societal challenges"* (Government Offices of Sweden 2012b: 40). Social innovations can be found in all areas of society (firms, public sector, civil society). The strategy plan does not state any clear objectives, but it does express the need to establish a knowledge base and asks to what extent social innovations can make a contribution to solving social challenges and what the needs are in individual countries and problem areas. As a whole, this area considers not only Sweden, but rather looks at social innovation from a developmental-political dimension (40 et seq.).

34 www.vinnova.se/en/Our-activities/.

In **South Korea** an initiative was launched in 2006 for the public sector to create a strategic innovation-oriented procurement programme with innovative SMEs as the target group. The efforts related to innovation-oriented public procurement are reflected in the NTPA (New Technology Purchasing Assurance) scheme. In this scheme, the public sector and government firms undertake to reserve a proportion of their procurement volumes for (innovative) products and services (e.g. software) for innovative SMEs (Ko & Choe 2011: 16).

On the whole, the assessment that innovation in the public sector (and in particular the area of e-government) has found its way into innovation policy strategies does appear to be justified. The same cannot be said for social innovation. Here the topic still appears to be too cumbersome and too elusive from an operational viewpoint. In this sense the extension has not yet been understood within the framework of the current innovation policy strategy documents, although this is already gaining ground at EU level.

5.3 Case studies from selected areas of a broader research and innovation policy

The dimensions stated above which currently represent the most significant extensions to the concept of innovation are themselves very broad and allow various deductions to be made regarding innovation policy. For this reason, we have selected several individual cases which have already attracted political attention and will give them a more detailed inspection in the following chapter. These are the *"creative industries"* as an example of innovation in the services sector, *e-government* as an example of innovation in the public sector, *green-growth* strategies as an example of mission-oriented innovation policy and *gender mainstreaming* as an example of social innovation in association with innovation policy.

5.3.1 Service innovation: Creative industries case example

The political focus in recent years has increasingly been on service innovations. This is due to the search for new sources of growth and the significance of services for national economies while productivity increases have merely remained moderate. Service innovations are not only significant for the services sector, they are also increasingly an important factor in the success of manufacturing firms, which in many cases offer their products in combination with innovative services (OECD 2012b).

Many countries have implemented specific measures for this reason, and the following approaches can be distinguished:

- service innovations explicitly accounted for in generic RTI policy measures, such as tax incentives for R&D (e.g. in the Netherlands);
- adaptation of demand-oriented instruments such as public procurement (Finland, United Kingdom) or regulation (Sweden, Denmark, Germany, United Kingdom) for improved funding of service innovations;

- service innovations explicitly accounted for in mission-oriented R&D and innovation support such as the ageing society (South Korea) or sustainable urban planning (Sweden);
- integration of service innovations in funding programmes for cooperation initiatives between science and industry (OECD 2012b).

Specific innovation funding measures in the creative industries are presented below as examples. The creative industries were selected because this service area has been characterised by a notable vitality in recent years and the economic and innovation policy in many countries explicitly addresses this area with specific measures or instruments.

Table 8:
Major new policy options for fostering service innovation policy in selected OECD countries

Source: OECD 2012c: 168

Policy option	Instrument	Examples
Launch a specific instrument to foster service innovation	Service innovation research programmes	**Austria,** Finland (Serve), **Germany** (innovation with services) and Japan (service science solutions research programme) have dedicated research and innovation programmes covering issues such as engaging users/ employees in development, new business models and the "servitisation" of industry.
	Service cluster	Denmark introduced the Service Cluster Denmark which supports R&D–based co–creation for services by businesses and researchers.
	Innovation voucher	France introduced the green service innovation voucher for SMEs in the construction sector. Ireland has an SME voucher that supports new business models, customer interfaces or a new service delivery.
	Service lab	The United Kingdom introduced the public services innovation lab to test innovative solutions and bring them to scale across the country's public services.
Adjusting the scope of horizontal policy instruments	Procurement of innovative services	**Sweden** introduced an innovative procurement programme to spur procurement of innovation in the public sector.
	R&D tax credit	The Netherlands extended the R&D tax credit to include development of service–based software.
Adjusting the governance structure for innovation	Fountain collaboration, i.e. user–defined scope within cross–sector collaborations	**Sweden** has embedded service innovation in its new challenge–driven innovation approach which emphasises co–creation with customers/users and cross–sector collaboration focused, for example, on sustainable cities and future health and care.

Austria

Technology and innovation policies have paid growing attention to Austrian creative industries over the course of the past several years. As part of so-called knowledge-based services (with a close cross-over connection to artistic and cultural production), this greater emphasis on a more comprehensive understanding of innovation is evident in the increasing attention paid to this sector, an understanding that relaxes or even transcends the earlier limitations focused on technological and industrial innovations. In addition to the creative industries' considerable contribution to employment, the sector is also regarded as an important component of the entire economy's performance when it comes to growth and innovation.

Based on this, in 2008 the Federal Ministry of Economy, Family and Youth (BMWFJ), along with creativ wirtschaft austria (cwa) and the Austria Wirtschaftsservice GmbH (aws), founded the "evolve" initiative as a type of "umbrella brand" to offer more funding to the creative industries in a more comprehensive manner. The goal of evolve is to integrate the variety of activities undertaken at a federal level in order to provide a more finely tuned portfolio of funding and support mechanisms. Evolve is not solely concerned with financial support, but includes activities encompassing awareness, service, referrals and coaching. The creation of this type of infrastructure to support innovation should address deficits in the current system and put the creative industries in the spotlight.

The involvement of two separate stakeholders on the federal level in the development and implementation of the programme marks another of evolve's defining characteristics. The aws manages the evolve funding scheme under the name "impulse". This programme represents a development and expansion of aws's earlier impulse programme called "creativwirtschaft", which was operational between 2004 and 2008. Service provision and networking opportunities connected to evolve on the other hand are provided primarily by the cwa.

The activities of evolve and its sponsors can be described as belonging to one of three pillars: a) funding, b) services and c) public awareness. The last two types are considered "measures to improve effectiveness". The purely financial instruments are integrated into a broad portfolio of measures aimed at improving effectiveness. This way, evolve is able to pursue a systematic approach to funding and thereby addresses creative entrepreneurs' needs and potential throughout all industries and sectors in Austria. The measures and instruments are developed and used in line with the structural aspects peculiar to the creative industries (an above-average rate of one-person companies, higher percentage of highly qualified workers, public image and self-image of corporate conduct, heterogeneity amongst creative industries, greater difficulties in accessing external funding, etc.).

The cornerstone of the "umbrella brand" evolve is the impulse funding programme, which is operated by the Austria Wirtschaftsservice GmbH (aws). The programme's objectives may be subdivided into primary and secondary targets as follows:

Primary targets

- establishing the creative industries as a driver of innovation and a significant factor in the creation of value;
- improving the business performance capabilities of companies active in the creative industries;
- increasing the potential for innovation and the competitiveness of SMEs in all industries via the integration of creative services in entrepreneurial activities;

- optimal support services for potential business creators and firms in the creative industries;
- increasing the number of Austrian companies active in the creative industries, especially by means of start-ups;
- improving business know-how in the creative industries;
- stimulating investment – material and immaterial;
- establishing Austria as an internationally renowned location for creative businesses.

Secondary targets
- stimulating cooperation amongst firms active in the creative industries and with more "traditional" businesses;
- increasing the significance accorded to creative work in industry.

The programme offers three different lines of support, each of which provides specific support instruments as suited to the respective maturity and focus of the project (see Table 9).

	Impulse XS	**Impulse XL**	**Impulse LEAD**
Programme start date	2009	2008 (2nd call with new guidelines)	first call 2010
Project phases	experimental development activities – only measures for determining technical and economic feasibility	experimental development activities – all measures related to development and, as appropriate, first use and/or market transition	experimental development activities – all measures related to development and, as appropriate, first use and/or market transition
Applicants	smallest companies – all industries (existing/starting up)/natural persons	SMEs – all industries (existing/starting up)	service partnerships involving cooperation with SMEs
Project content	innovative entrepreneurial projects in the creative industries context	innovative entrepreneurial projects in the creative industries context	forward-thinking projects that can serve as models, aimed at networking, professionalising and publicising the creative industries
Funding amount	70 % of project costs up to a max. of € 45,000	50 % of project costs up to a max. of € 200,000	80 % of project costs up to a max. of € 300,000
Project span	1 year	3 years	1 to 3 years

Table 9:
Overview of funding lines offered by the "impulse" programme

Source: aws

Around 150 to 160 projects applied to the XS funding line each year on average, with just under 30 projects receiving funding. The total amount of funding provided amounts to between €1.7 and €1.8 million annually. There were 70–100 applications each year for the XL programme, of which around 20 projects won funding support totalling around €2.7 million annually. There were just under 60 applications for the LEAD programme, with around 5–10 projects receiving funding amounting to a total of just under €2 million.

In addition to the funding schemes (XS, XL, LEAD), there are also a series of supplemental measures and activities that among other things seek to increase awareness (impulse awareness) of what the Austrian creative industries have achieved. Others aim to transmit specialist know-how by providing relevant training and professional development programmes and to generally improve business and entrepreneurial competencies in the creative industries (impulse training).

Germany

In 2007 the German federal government launched its "Kultur- & Kreativwirtschaft" ("Cultural and creative industries") initiative. Amongst other aims, the initiative seeks to strengthen the competitiveness of the cultural and creative industries and improve employment opportunities in small cultural institutions. Specific objectives include assessing programmes related to technology policy for their applicability to the cultural and creative industries and, when appropriate, adapting them to this purpose, easing access to outside capital and further developing the framework for digital copyright[35]. An additional objective is to harness the innovative potential in the cultural and creative industries for an "economic regeneration". The significance of the cultural and creative industries for innovation in other economic sectors is highlighted:

> *"The cultural and creative industries make profound contributions to the creation and formation of innovation. This benefits not only this sector itself, but other industries and economic sectors too. Aspects that drive innovation include new technologies, services and societal changes as well as global challenges that are in serious need of solutions. Whether outside idea generators, service providers or cooperative partners, creatives can and should be incorporated more intensely in small and medium-sized enterprise innovation processes"* (BMWi/BKM 2012: 3).

It is explicitly acknowledged in this respect that *"innovations as they relate to the cultural and creative industries [...] are most often not primarily of a technological nature"* (BMWi/VIB1 2012: 5).

Support for the cultural and creative industries primarily takes the form of development loans (ERP start-up loans, KfW business loans, micro credits), which are not specifically designed for the creative industries, and project funding and prizes that are awarded on the federal, provincial and local level as well as by foundations and trusts, etc.[36].

The use of **micro loans** may be considered a **new funding approach.** The "Mikrokreditfonds Deutschland" (Microcredit Fund Germany) was founded in 2010. Entrepreneurs can secure a micro loan by approaching an accredited microfinance institution (the fund's partner organisations, e.g. business incubators or business consultancies). These institutions advise entrepreneurs and assess the concept's potential. If the provision of micro loans is approved, the German GLS-Bank disburses the loan amounts, which are drawn from the Microcredit Fund.

35 www.kultur-kreativ-wirtschaft.de/KuK/Navigation/Initiative/ziele.html.

36 www.kultur-kreativ-wirtschaft.de/KuK/Navigation/finanzierung-foerderung.html.

The consultation and assessment processes differ from traditional banking procedures in order to account for the particularities of starting new businesses in the cultural and creative industries. These pose two additional difficulties from the perspective of the banks. First, their products and services cannot easily be assessed using the banks' typical automated assessment mechanisms because they are unable to produce any trustworthy prognoses regarding the potential success of the endeavour. Second, when it comes to those active in the creative and cultural industries, the (potential) borrower's creditworthiness (income) tends to be below average, which is a "classic" indicator of a poor likelihood that the borrower will repay the loan. Microfinance institutions, on the other hand, apply qualitative and holistic criteria[37]. A borrower's first micro loan can be for an amount up to € 10,000 and the term of the loan is usually up to three years[38].

Another noteworthy innovation in funding projects and firms in the cultural and creative industries is crowdfunding or crowd investing, even though this has (so far) not involved the use of government-backed financing. Examples of crowdfunding platforms, in which social, artistic or technological projects are supported by a large number of sponsors giving small amounts, include the internet-based Kickstarter (from the US, but funding projects in Europe too) and Germany's startnext. Crowdinvesting platforms are one special form of this concept in which investors and entrepreneurs are brought together. Investors generally become involved through a form of silent participation involving smaller amounts (starting from € 250–1000). Two prominent examples from Germany are the pioneers Seedmatch and Innovestment, both of which have been actively supporting start-ups online since the second half of 2011.

Sweden

The Swedish government released its "Action Plan for Cultural and Creative Industries" in 2009[39], in which it made 73 million Swedish kronor available. The action plan aims to create better conditions for the creative industries. This includes funding for coaching and design activities, incubators, networks and entrepreneurs individually, among other measures[40]. This support for the cultural and creative industries is offered principally through VINNOVA and Tillväxtverket (the Swedish economic promotion agency).

In addition, the Council for Cultural and Creative Industries was founded in 2010, which is intended to provide advice through its members to various relevant ministries regarding economic and business activities[41]. The council released its "Three recommendations for growth and innovation in the cultural and creative industries" in 2012[42].

The current version of the Swedish Agency for Cultural Policy's report "Cultural Policy Analysis 2013" (in Swedish, with an English summary)[43] expressly examines the possibilities crowdfunding offers the creative industries and notes that *"there has also been an increased level of interest from public actors, who contribute public funds to crowdfunding platforms in order to rejuvenate and democratise culture"*.

37 www.kultur-kreativ-wirtschaft.de/KuK/Navigation/Finanzierung-Foerderung/mikrokredite,did=336430.html.

38 www.mein-mikrokredit.de/mein-mikrokredit.html.

39 www.government.se/content/1/c6/13/62/05/b0159c17.pdf (Swedish).

40 www.government.se/content/1/c6/13/62/05/b0159c17.pdf.

41 www.government.se/sb/d/3009/a/171720.

42 www.regeringen.se/content/1/c6/15/61/31/4a94689a.pdf.

43 www.kulturanalys.se/wp-content/uploads/2013/02/Kulturanalys_2013.pdf.

Eight "regional hubs"[44] for the "experience industry" in Sweden began receiving funding in 2003. This concept expands the traditional understanding of the creative industries to include tourism and gastronomy. With funding from VINNOVA and the national economic promotion agency (Nutek at that time), these hubs developed a "triple helix approach" to promote cooperation amongst various stakeholders in two industries (e.g. design/advertising, film, fashion, computer games) – with one acting as the primary area – in which they hoped to form "national nodes of competence"[45].

Korea

Korean economic policy explicitly addresses the creative industries, with special emphasis placed on the content industry. The most important institutional element of this support for the creative industries was the 2009 founding of KOCCA (Korean Creative Content Agency) in accordance with article 31 of the "Framework Act on Cultural Industry Promotion". KOCCA took shape as a conglomeration of a variety of content-oriented agencies, particularly the Korea Broadcasting Institute, Korea Culture and Content Agency, Korea Game Industry Agency, Cultural Contents Center and the Digital Contents Business Group of the Korea IT Industry Promotion Agency. KOCCA's stated strategic objective is *"… to establish a comprehensive support system to nurture the content industry, and aim to develop Korea as one of the world's top 5 contents powerhouses"* (KOCCA 2012). This objective's importance is premised on the assumption that the content industry will be one of the 21st century's key modern industries and a driver of future economic growth in its own right in Korea.

The Korean content industry is already highly developed, with more than 120,000 firms employing around 500,000 workers and generating sales of around US$ 57 billion (2009) and export earnings of around US$ 2.5 billion. "Games", "animation" and "cartoons" are the key focus areas of the Korean content industry[46]. KOCCA is engaged in additional areas too, including music, characters and broadcasting.

KOCCA operates outside of Korea as well, with regional offices in Japan, China, Europe (UK) and the US. These "overseas offices" are meant to survey and document the cultural and content industries in their respective locations and to act as contact points for Korean creative companies that are export-oriented and to provide easier access for these to export markets and to potential cooperative partners.

The focus of KOCCA's support mechanisms are diverse and include everything from support measures with human capital, direct funding specifically with the aim of increasing export potential (especially with respect to the strategic markets in the US and China), the organisation of conferences, participation in trade fairs and exhibitions, the development of technology (e.g. 3D), content development (e.g. digitisation of cultural content) and commercialisation of this through to the provision of infrastructures (e.g. High Tech Content Creation Systems).

The preceding examples make it clear that the creative industries already represent an important aspect of innovation policy in a number of countries. The same is true for e-government, which will be discussed in the next section.

44 Karlshamn, Hultsfred, Trollhättan, Piteå Hällefors (since 2003) and Stockholm, Gothenburg and Malmö (since 2005).

45 http://ec.europa.eu/culture/documents/eu_omc_wg_cci_final_report_june_2010.pdf.

46 Korea has traditionally been strong in the computer games industry, and computer games are extremely popular amongst Koreans, as is demonstrated in the area of e-sports, amongst others. Given this highly developed home market, there are very positive prospects when it comes to exports for the Korean computer games industry.

5.3.2 Public sector innovation: The example of e–government

There has been much discussion since the 1980s in a number of developed countries regarding the modernisation of public administration under the banner of "New Public Management". Key points in these conversations have been the redefinition of the remit of public and/or governmental authorities, the "outsourcing" of activities that do not legally need to be performed by a public authority as well as the reorganisation of these activities according to market principles, changes in accounting procedures (moving away from public finance), the modernisation of the organisation, improved customer orientation, etc. All of these reforms require appropriate organisational changes that, in their very nature, may be seen as examples of organisational innovation and which are frequently connected with forms of technological innovation (especially with respect to ICT). One area that has been the focus of dynamic attention in the past few years – driven by technological innovation on the one hand and by the concept of New Public Management on the other – is "e-government". The following section will examine the concrete ways in which it has been implemented in a number of countries.

Austria

The promotion of e-government structures has led to substantial changes in public administration's relationship to its "clients" (citizens and firms) and in internal administrative processes (e.g. electronic files), all accompanied by continual innovation. The establishment of e-government in Austria has targeted all three principle tiers of activity:

- information: Provision of information, on an agency's website, for example. Introduction – e-government Basics;
- communication: Possibilities for exchange and the interactive retrieval of information;
- transaction: Actual provision of services, for instance with signed application forms and electronic notification of decisions.

The Austrian e-government strategy is arranged according to a series of general principles that are meant to guarantee the acceptance of e-government by businesses and society. These principles include remaining relevant to citizens, convenience through efficiency, trust and security, transparency, accessibility, ease of use, data privacy, cooperation, sustainability, interoperability and technology neutrality.

The readiness for and openness towards innovation was also evident in the establishment of the e-government Innovation Centre (EGIZ), a cooperative effort between the federal chancellery and the Graz University of Technology. EGIZ's task is to assist and support the federal chancellery in the ongoing development of e-government and with federal ICT strategy more generally as well as in the implementation of research and innovation plans related to e-government (e.g. IT security, participation in international cooperative projects)[47]. There is an additional cooperative effort with the Danube University Krems (Centre for e-government) with an emphasis on further education and e-Democracy.

47 The connection to "public innovation" is also explicitly referenced in official documentation: "e–government [...] is also a synonym for a modern and innovative state ..." (BKA 2011).

The Digital Austria platform unveiled its model for Austrian e-government in 2009 with its "virtual government building" for the year 2020, which was built on the following elements and principles (BKA 2011): simple, appropriate and better contact with administrative offices; uniform user interfaces for applications; secure electronic means for people and firms to prove their identity; convergence of e-government, e-Health, e-Justice, e-Commerce, e-Learning, e-Environment as well as EU and international developments; an IT solution to meet performance requirements; transparency and trust through stronger data privacy; diversity of users of e-government; participation and interactive information systems.

A variety of e-government applications that are used in Austria are distinguished according to their relevance for the specific target groups (i) citizens, (ii) firms and (iii) internal administrative processes (inter-agency interaction).

Over the course of ongoing development, the number of applications has risen continually; their complexity has markedly increased, as has their "depth". One of the earliest applications (introduced back in 1997) was primarily concerned with making a great deal of information available via the governmental agency information system www.help.gv.at and the legal information system RIS (www.ris.bka.gv.at). Help.gv.at has continued to be expanded and further developed in keeping with its role as a "one stop shop" and in concert with technological innovations related to IT (e.g. the integration of an app specifically designed for use with mobile devices). In addition to information, users can find official forms (originally to download and print out, but now available to be filled out and submitted online). With the introduction of MyHelp in 2009 – and the use of a specially designed citizen's card – a new degree of personalisation can be offered, which ensures that services are provided in a more accurate manner. Both of these functions have now been integrated into a new dynamic system. The introduction of an electronic signature (electronic authentication), the equivalent of an analogue signature on a paper form, was a prerequisite for the transformation of online information systems into a fully electronic tool for taking care of administrative functions. A model example of the move towards digital administrative tools is the introduction of electronic tax returns (e.g. employee tax assessment). Over time, a number of administrative functions at the local level can be taken care of online. The equivalent of help.gv.at for firms is the business service portal www.usp.gv.at, which offers, in addition to a wealth of information relevant to businesses, the option of completing a variety of procedures online. E-government applications naturally increase efficiency when it comes to administrative functions within agencies or that involve more than one agency or office. A perfect example of this is the electronic file (ELAK). This allows for seamless communication between agencies, authorities and a variety of administrative offices, shortening the time needed to react and to process paperwork by up to 15 per cent (BKA 2011). ELAK was first implemented comprehensively in 2001 by the Austrian foreign ministry and the federal chancellery. Since that time, ELAK has been gradually implemented throughout the federal government and on the provincial level.

Germany

E-government has been considered a key concern in Germany too since 2000. The federal administration began its BundOnline initiative in 2005 to make several hundred services available online. An IT planning council has been the central organ for cooperation at the federal level in information technology since 2010 (which was only possible after a change was made to the country's constitution). This body agreed in autumn 2010 as part of the National e-government Strategy[48] to optimise and harmonise electronic administrative services in a comprehensive manner (federal, state and local levels).

Significant infrastructure-related projects include the electronic identity mechanisms in the new personal identification card and the De-Mail project, which was meant to provide both the legal (2011) and technical structures for an electronic messaging service that would allow documents to be sent securely and in an authenticated manner.

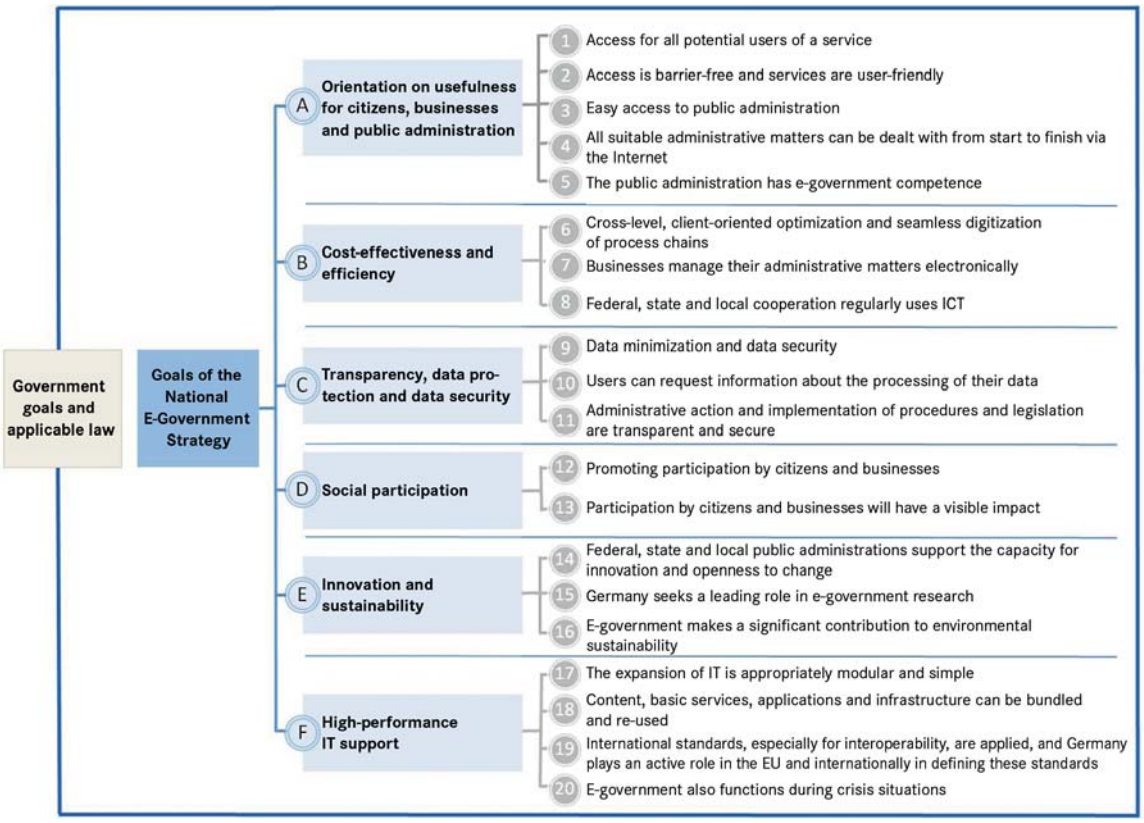

Figure 13: **Target system of Germany's e-government strategy**

Source: Nationale E-Government Strategie 2010

48 www.it-planungsrat.de/SharedDocs/Downloads/DE/Pressemitteilung/NEGS.pdf?__blob=publicationFile.

It was to this end that the Federal Ministry of the Interior started the "e-government-Initiative" to support government agencies in developing and implementing applications that would be able to make use of the new personal identity cards and De-Mail. These agencies had until summer 2012 to express interest regarding support services (informational events, workshops, centralised collection of information and experiential data drawn from other projects, individualised consultations on project management and the changeover to new processes and technical integration). From these expressions of interest, examples and model plans were chosen that other agencies could study and adapt for their own use[49].

A draft law was formulated by the cabinet in autumn 2012 to provide a legal basis for the provision of administrative services via e-government in a way that is independent of time of day or user location. This bill has been introduced to parliament and is expected to be passed in 2013[50].

Making administrative data available (keyword: open government data) is one aspect of e-government. This is meant to enable private companies to develop products or services on the basis of this data, thereby contributing to economic growth (e.g. through the use of geodata for smartphone applications). At the same time, it ought to promote transparency in the work of the government and the authorities. The pilot project Govdata.de has brought data together online since February 2013[51].

Sweden

The Swedish government formulated its "Action Plan for e-government" in 2008 to cover the period between that year and 2010, with the aim for Sweden to be a world leader in e-government by 2010 and offer *"the world's simplest government administration"*, which *"would be as simple as possible for the greatest number of people possible"*. "E-delegations" were founded in 2009 to drive and coordinate development in e-government. In turn, these produced a "Strategy on the work of the Public Agencies in the field of e-government" for the time period 2009–2014 in which a unified eID system would be introduced, an internet forum would be implemented to promote participation by citizens and businesses and e-Services would be jointly developed by government bodies and private stakeholders, amongst other objectives (EC 2012). The "Digital Agenda" published in 2011 (Government Offices of Sweden 2011) conceives of these improvements in public administration as an explicit form of support for innovation and participation (ibid.: 22). The E-delegations formed a Programme Council and opened an office in autumn 2012 to assist in coordinating the services they had initiated[52]. The legal basis for this expansion of e-government was provided in 2010 (EC 2012).

In 2010 VINNOVA, along with other Scandinavian countries, announced a call for proposals for projects related to "Citizen-Centric e-government Services". Five projects were funded. There are additional (planned) activities to do with e-government, but there is as yet no information available in English about these.

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49 www.bmi.bund.de/DE/Themen/IT-Netzpolitik/E-Government/E-Government-Initiative/e-government-initiative_node.html.

50 www.bmi.bund.de/DE/Themen/IT-Netzpolitik/E-Government/E-Government-Gesetz/e-government-gesetz_node.html.

51 www.bmi.bund.de/DE/Nachrichten/Dossiers/OpenData/opendata_node.html.

52 These include: Mina meddelanden (My messages), Min ärendeöversikt (Overview of my transactions), Mina fullmakter (My powers of attorney), E-arkiv och e-diarium (eArchive and eRegister) and Effektiv informationsförsörjning (Ekonomiskt bistånd) (Effective information systems [Financial assistance]). www.edelegationen.se/Documents/Remisser,%20bet%C3%A4nkanden%20mm/Summary%20of%20SOU%202012_68.pdf.

Korea

Korea's strategy regarding administrative processes, communication and interaction with citizens and economic stakeholders is explicitly concerned with using information and communications technologies to make these as efficient and user-friendly as possible. As with many other aspects of technology, the Korean government is ambitious: *"Korea has one of the most comprehensive, mature and high performance e-government programs in Asia, if not in the world. [...] Its vision is to be 'the world's best digital government for the people'."*

Korean e-government policies are essentially grounded in a broadly conceived ICT policy that has the comprehensive "digitisation" of the economy and society as its goal. The various phases of this policy – beginning with the use of computers in public administration in the late 1970s until around the mid-1980s – are illustrated in Figure 14. This is all accompanied by significant investment in network infrastructures (broadband backbone, networking of all government offices, schools, etc.), which has resulted in Korea being amongst the world leaders at a very early stage, e.g. in the spread of broadband access.

It was in the 1990s that Korea took its first strategic moves in the direction of e-government (in a narrower sense). The "Framework on Informatization Promotion Act" was enacted in 1995, which provided the legal basis for the e-government initiatives to come. The first internet-based public services (such as the land registry) went online in the late 1990s. In addition, the government appointed Chief Information Officers (CIOs), who were responsible for driving the continued implementation of internet-based services in their re-

Phase	Period	Event	Achievement
First Introduction	1978~1987	Computerization of Administrative system	• 1st and 2nd phase Administrative System Computerization Projects(1978~1986)
	1987~1996	Construction of National Backbone Network	• 1st and 2nd phase National Backbone Construction Projects(1987~1996)
Foundation Building	1996~2000	Informatization Promotion	• Foundation-building for High-speed Information and Communications(1995~2005) - Construction optical transmission network in 144 zones nation-wide • Unit or function-based informatization - Procurement, passport, patent, customs, etc
Project Initiation	2001~2002	11 Initiatives for e-Government	• 11 initiative tasks for electronic civil application, e-Procurement, etc • Partial and limited connection between unit tasks
Growth	2003~2007	31 Roadmap Projects for e-Government	• Implemented 31 e-Government roadmap projects under participation of multiple ministries(2003~2007) • Amendment of e-Government Act(Jan. 2007)
Maturity	2008~	Expansion of Integration and Connection	• e-Government promotion based on utilization and integration • Expansion of target organizations to administrative institutions, public offices, and some private-sector organizations • Unification of frameworks for national informatization and e-Government implementation

Figure 14: **Long-term development of Korea's e-government policy**

Source: NIA 2011

spective areas. An integrated e-government implementation plan was introduced in 1999 and became law in 2001 with the "Promotion of Digitalization of Administrative Work for E-Government Realization Act". The SCEG (Special Committee for e-government) took up its work that same year. The SCEG is charged with guaranteeing and encouraging cooperation and coordination between the separate government agencies in the implementation of e-government initiatives. In 2003 the "Participatory Government's Vision and Direction of e-government" and the "e-government Roadmap" were released with the aim of introducing the "World's Best Open e-government". In addition to more "traditional" elements of e-government ("digitisation" of internal processes, making information available, digital interactions between citizens/firms and government offices), current efforts in this field are distinguished by elements more particular to e-Democracy (direct participation of citizens in democratic decision-making).

5.3.3 Mission-oriented innovation policy: The example of green growth

Over the course of the past decade, research and innovation policy has increasingly focused on the issue of societal problems (Grand Challenges) (see Chapter 3.2.1). One example of this type of mission is "green growth", an environmentally friendly, sustainable economic growth that has been promoted by the OECD in the publication of its global green growth strategy, amongst other avenues (see OECD 2011h). These efforts reference a broad conceptualisation of innovation, one that explicitly includes new business models, work patterns, urban planning and transport concepts (ibid.: 51 et seq.). Based on the "systemic" character of these issues, many countries explicitly place a high value not only on pure technology-oriented research and development (and the public funding of this), but also on the development of model solutions and pilot projects. These efforts are sometimes bundled together in the form of "model regions" to act as "lighthouses" to guide other efforts to apply models of sustainable growth and development. The following section will examine related support mechanisms, including new funding instruments, in a select group of countries.

Austria

Elements of a mission-oriented technology policy have existed in Austria for some years now, and the discussion surrounding a "new mission-orientation" could already be discerned in the 1990s in the conceptual considerations being made at that time about the direction Austria's technology policy should take. These efforts were recognised internationally, and Austria was considered to number amongst those countries in which there was *"very strong evidence of a vivid, in some cases longstanding public and/or high-level debate on climate change/a resource efficient economy in connection with innovation"* (Karakasidou & Cunningham 2010b). As may be expected, an explicit cross-agency, thematic orientation according to "missions" as they relate to "grand challenges" was evident in the government's RTI strategy dated March 2011. At the same time, the agencies involved considered issues related to the development of "green growth" strategies, recognising that the relevant market segments offer Austrian manufacturing great potential

for growth. However, no coherent overall concept of this type of "green growth" strategy currently exists. The following can therefore only illustrate individual elements of mission-oriented activities related to "green growth" by briefly describing pertinent thematic programmes.

IV2S / IV2Splus / Future Mobility

The strategic programmes "Intelligent Transport Systems and Services" (IV2S) (2002 to 2006), its successor "IV2Splus" (2007 to 2012) and now "Mobilität der Zukunft" ("Future Mobility") are systemic programmes with a focus on the strategic funding of research and development in mobility and transport technologies. The Federal Ministry for Transport, Innovation and Technology (BMVIT) is responsible for the programme, whilst the Austrian Research Promotion Agency (FFG) handles the actual administration. The programme's objective is to use the funding offered for research and development to drive the development of additional transport and environmental policies. As such, the programme's goals are three-fold:

- society-wide objectives for issues related to transport and the environment;
- improvement of business competitiveness via RTI;
- networking and cooperation (both on the national level between science and industry in particular as well as on the European/international levels).

The programme draws on Austrian manufacturing's existing strengths and connects the mechanisms used to support RTI activities with the larger social remits attached to the challenges (the mission) involving transport and the environment.

IV2S was organised into three different programme tracks: (i) railway technology, (ii) car industry suppliers and (iii) telematics/logistics. The programme offers support in the form of grants for R&D projects that do not need to be repaid and which are awarded in accordance with RTD guidelines. The breadth of funded projects stretches from basic research to model projects and validation projects, whereby particular focus was placed on partnership projects (especially those involving science and industry). Each of the three tracks involved a number of calls for proposals for the purposes of operational implementation. Winning projects were chosen in close coordination with the respective "communities". The successor programme "Future Mobility" builds on the subject-specific competencies developed in the previous programmes and the knowledge generated in the pertinent RTI communities. The programme is comprised of four complementary subject areas that each address their own challenges and lay out their own objectives. The focus when it comes to "personal mobility" and "commodities mobility" is on "value enhancement" (i.e. applicable uses in society or the possibility of use) attached to the technologies and innovations applied or derived from the mobility systems' organisational and social contexts (systematic innovation fields). In contrast, "transport infrastructure" and "vehicle technologies" are concerned with specific technologies and stakeholders (technology fields).

These programme clusters may be viewed as examples of the successful linking of goals articulated in industry, technology and environmental policies, in which the strengths and competencies of Austrian manufacturing (railways as well the car industry) and the Austrian research landscape (as represented by relevant institutions, especially technical institutes) are addressed and in which societal objectives are given equal emphasis (need for mobility, reduction of transport's environmental impact). Given its

concurrent focus on further improving the competitiveness of Austrian "transport clusters", the programme certainly fulfils the criteria for "green growth". A 2012 evaluation of the earlier programmes, IV2S/IV2Splus, found that IV2S in particular had significant effects which were both economic (sales revenue, patents, user licenses, cost and resource savings via improved efficiency) and scientific (publications, conference papers) (Oberholzner et al. 2012).

Climate and Energy Fund (KliEN)

The Climate and Energy Fund (KliEN), founded in 2007 and a significant instrument in implementing Austria's climate strategy, is another example of the way societal objectives and RTI policies can be systematically linked. The Fund is owned by the Republic of Austria, which is represented by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and Federal Ministry for Transport, Innovation and Technology (BMVIT). There are three components to the Climate Fund's funding strategy:

- research and development in the areas of sustainable energy technologies and climate research;
- acceleration of projects in the area of local and regional public transport, environmentally friendly freight traffic and mobility management projects;
- a drive for projects to support market penetration of climate-related and sustainable energy technologies.

A total of €730 million were made available between 2007 and 2012, though disbursements of these funds were organised in the respective agencies (the Austrian Research Promotion Agency [FFG] and Austria Wirtschaftsservice GmbH, aws, are specifically responsible for RTI-related measures). The individual funding programmes are divided into three funding tracks: research (climate change research and energy research), transport (electromobility, innovative mobility solutions, multimodal sustainable logistics) and market penetration (education for energy and mobility technologies, building as a power plant, energy autarchy, expansion of renewable energy, increasing energy efficiency). Funding goes to support everything from basic research (e.g. climate change research) to technology development (e.g. in the energy and transport fields) and supporting educational initiatives and model projects and regions as well as individual investments as applicable (e.g. thermal renovation, solar installations). The connections amongst the support mechanisms for RTI, education and investments as well as the focus on urban and regional policies demonstrate KLiEN's systematic and interdisciplinary character, and provide a response to the complexity of networked systems that make up the fields of transport and energy.

Germany

In addition to the significant role of green growth in high-tech strategy, as mentioned in Chapter 5.2.2, funding support is influenced especially by the Federal Ministry of Education and Research's (BMBF) framework programme for research and sustainable development (FONA; BMBF 2009) and the Environmental Technologies Master Plan (BMBF & BMU 2008). The Master Plan aims to create a situation in which environmental and innovation policies are imbricated with one another to such a degree that German environmental technologies will be targeted towards the leading markets (markets with high growth potential) (ibid.: 5). As such, the scheme identifies targeted fields addressed at specific leading markets: target field "water technology" for the "sustainable water management" leading market; the target field "technologies for raw materials productivity" for the "natural resources and material efficiency" leading market and the "circular flow economy, waste and recycling" leading market; the target field "climate protection technology" for the "energy efficiency", "energy production" and "sustainable mobility" leading markets (the latter two only to a degree). The "energy efficiency" and "energy production" leading markets are also addressed by the energy research programme (more below) (ibid.: 12).

Research for sustainable development (FONA)

The "Research for sustainable development" programme supports research in climate, energy and resources by providing institutional funding to non-university research institutes and through the provision of defined project support mechanisms. Project funding is targeted at efforts from basic research to application in the following five areas of action: global responsibility – international networking; earth systems and geo-technologies; climate and energy; sustainable business and resources; social change. These areas are supplemented by cross-over topics including land management, economics and sustainability as well as research infrastructures. Objectives include helping the country to fulfil its climate change-related goals, developing concepts for adapting to climate change and contributing to social change by fostering understanding of sustainable development and developing related measures. Firms, universities and non-university research institutions are invited to submit proposals (BMWT 2013).

Energy research programme

The sixth energy research programme, initiated by the Federal Ministry for the Environment (BMU), the Federal Ministry for Economic Affairs and Energy (BMWi), the BMBF and the Federal Ministry of Food and Agriculture (BMELV), sets the guidelines and focal points for the funding period 2011–2014. Three and a half billion euros have been made available for this[53]. The overarching objective is to improve energy efficiency and to expand the use of renewable energy sources so as to contribute towards meeting the energy and climate targets to which the federal government has committed itself. The individual ministries involved have outlined their own particular aims as well. The BMWi is concerned with energy conservation and energy efficiency; the BMU with R&D related to wind energy, photovoltaics, geothermal energy, thermal solar energy, solar thermal power plants, hydro-power and ocean energy. The BMELV is concerned with research and development related to technologies to harness bioenergy, and the BMBF is interested in basic research related to photovoltaics, bioenergy, wind energy and energy efficiency. Firms, universities and non-university research institutions located in Germany are invited to submit proposals (BMWT 2013).

53 www.fona.de/de/15191.

BMU Environmental innovation programme (UIP)

The BMU supports the first use of large-scale technical processes and combinations of processes that work to reduce or eliminate environmental pollution as much as possible. Areas that may receive funding include: energy conservation, energy efficiency and the use of renewable energies, environmentally friendly energy supply and distribution as well as resource efficiency and minimising material use and waste. The goal is to achieve optimal economic performance whilst minimising environmental pollution as far as possible and using the least amount of resources and energy possible. Domestic and foreign firms, local authorities and similar bodies are invited to submit applications for funding. SMEs are given priority in terms of funding (BMWT 2013).

Funding is provided by means of a) a loan issued by the KfW using funds from the environmental innovation programme with a subsidy on the interest of up to 70 % of eligible expenditures, or b) an investment subsidy of up to 30 % of the amount of eligible expenditures[54].

The traditional means of funding support in Germany, which includes the support of "green growth" programmes, is project funding, whether in the form of individual projects or cooperative projects. Support is additionally provided, as in UIP, by means of loans or subsidies. A **new funding approach** was created in 2012 as part of FONA to provide support for "sustainable land management". "Transdisciplinary innovation groups" are not only meant to assist with R&D activities, but also to better support the implementation of the resulting concepts. The objective is to produce an applicable solution and to create a detailed concept on how it may be implemented (innovation management). An innovation group must be located in an organisation from the research sector or applied sciences sector (administration/business) and must work in an explicitly interdisciplinary manner (BMBF 2012).

Sweden

The current Swedish innovation strategy (Government Offices of Sweden 2012b) explicitly follows a mission-oriented approach (see Chapter 5.2.2), though the role of "green growth" in innovation policy is only mentioned in a limited way and not defined as a primary objective. Support for innovation overwhelmingly takes the form of (cooperative) project funding. The most important research and innovation programmes were "Environment-driven markets" (2009–2010; € 4.9 million), "SWECIA – MISTRA Swedish research programme on Climate, Impacts and Adaptation" (2008–2015; € 11 million), "Solar energy for hydrogen production" (from 1994; € 10 million), "Green Nano" (2008–2010; € 4 million) and the new "Challenge-Driven Innovation" (2011–2013; € 28 million) (Melin et al. 2011; Erawatch). The "Nordic Top-level Research Initiative" provided an additional € 48 million of funding over five years. This cooperation amongst Nordic countries represents a contribution to dealing with climate change and is comprised of six component programmes, such as CCS[55] or energy efficiency by means of nanotechnologies (Karakasidou & Cunningham 2010b), which establish an explicit link to green growth to a certain degree. In addition, VINNOVA has created the "Innovations for a Sustainable Future" programme, amongst others, under its strategic umbrella area of "Transportation and Environment".

54 www.umweltinnovationsprogramm.de/.

55 CO_2 capture and storage.

There was a call in 2009 for proposals related to "Environmental Innovations'[56]. According to the study's authors, none of these instruments involved the use of innovative funding formats.

They summarised Nordic Innovation (2012: 48) as follows: *"The role of green growth and welfare in Swedish innovation policies is rather fragmented, but that is likely to change in the coming National Innovation Strategy."*

South Korea

During the economic and financial crisis in 2008, South Korea decided to invest a large portion of its stimulus package in "green growth": *"No nation was as bullish on the idea as South Korea. Asia's fourth-largest economy poured 80 percent of its $ 38 billion stimulus program into what it calls 'green growth'. Later, it committed 2 percent of its annual GDP over five years to the same national cause"* (Feldman 2011). This was how South Korea became a pioneer in "green growth". This was also connected to its national "green growth strategy", which was also enacted in 2008. It makes use of a variety of instruments, such as direct R&D funding, regulations and monetary stimulus mechanisms. Investments totalling around €107 trillion won (around €73 billion) are planned for the period 2009–2013 to support new "green" technologies and corresponding infrastructure (OECD 2012: 83). The objective is to reach the position of "World's 7th Green Power" by 2020 and position 5 by 2050. The strategy's concrete goals are a) energy independence and a reduction in climate change, b) the creation of new motors for economic growth and c) an improvement in quality of life and in international reputation.

The development of green technologies is an explicit aim. A five-year plan (2010–2015) was enacted in order to guide the implementation of the strategy (Park 2010; Zelenovskaya 2012). In accordance with this, 20 % of all public R&D expenditure is to go to "green R&D" projects starting in 2012 (Jones & Yoo 2011: 20).

The "National Science and Technology Council" and a "Green Growth Committee" coordinate this R&D policy. R&D funding is provided in both a top-down and bottom-up manner, and all funding is awarded as part of a competitive process. Budget allocations are made based on priorities, whereby the development of "green technology" ranks as one of the highest (OECD 2012: 83). Funding takes the form of tax incentives, government loans and guarantees for firms, projects or technologies that have been awarded a "green certificate" by the government (Jones & Yoo 2011: 23).

Additional measures have been used to assist in implementing innovations, such as the 2012 introduction of the bonus-malus systems to promote sales of low-emission cars (2010 Strategy for Green Car Development) and tax incentives for hybrid/electric cars (OECD 2012: 80).

In addition, the Global Green Growth Institute (GGGI) was founded in 2010 in South Korea. A recognised international organisation since 2012, some 18 nations now take active part in it. The institute is explicitly dedicated to promoting research on "green growth" and to advising political decision-makers[57]. As before, however, the focus in Korea is predominantly technological in nature. A study by Nordic Innovation (2012: 56) noted: *"Korea will likely continue to play a leading role on technology innovation, particularly green growth and to some extent welfare. But the approach still lacks emphasis on 'soft' innovation …"*

56 www.vinnova.se/en/Our-activities/Transportation-and-Environment/.

57 http://gggi.org/about-gggi/who-we-are/.

"Green growth" strategies or aspects thereof, form an important component of innovation policy in developed industrialised countries, even if the level of systematisation and coherence amongst policies varies. A pronounced emphasis on industry policy is evident in each case, but this adds to the perception in relevant markets that these efforts offer promising potential for growth. As can be seen with reference to a number of pertinent examples, strategies are not sufficiently broad in conception if they are primarily focused on R&D. As is generally the case in the "new mission-orientation", the use of a wide array of instruments (regulations, innovative public procurement processes, measures that promote diffusion, etc.) are necessary if policies are to be formulated that are able to address the largest challenges facing our societies.

5.3.4 Social innovation: The example of gender mainstreaming

One "social innovation" that has been a key aspect of innovation policy in many countries in the past several years is increasing the number of women in R&D and more consideration of gender in science and research more generally.

Gender mainstreaming began appearing as a concerted strategy in the mid-1990s as a means to integrate a gender perspective into all areas of politics. The intent was to expand efforts made by stakeholders for equality and the promotion of women beyond the traditional policy focusing on equality. Specific know-how and concrete instruments are necessary in the top-down approach to gender mainstreaming, both of which help to translate political goals around equality into concrete practice. Frequently used measures include calls for proposals specifically targeted at women, the dissemination of examples of best practice, gender training, guidelines, monitoring the percentage of women in organisations and the promotion of women as entrepreneurs, innovators, managers and members on supervisory boards.

The implementation of gender mainstreaming in R&D generally takes place on three various levels of intervention:

- access to promote women: measures that only address women in order to empower them as an underrepresented group, such as mentoring programmes, special training and professional development activities for women;
- approaches that seek to alter structures: systematic analyses of practices and processes to identify possible gender bias, such as the recruitment and promotion of female employees;
- integration of gender as a component of research: the relevance of gender and the different types of contexts in which research can be used are introduced into a variety of research areas with the aim of effecting a qualitative improvement in research outcomes. One example is the different needs posed by male and female users when it comes to transport planning.

Austria

Over the past several years, Austria has made a significant effort to firmly anchor gender as a category to be considered in R&D activities. From a very low starting point, Austria can now boast of one of the strongest increases in the number of female researchers in international comparisons (European Commission She Figures 2012).

The differences in the increase in the number of women working in the higher education sector and in the business enterprise sector are the result of very different traditions when it comes to implementing equality measures. Whereas efforts to promote women and gender equality in universities date back to the mid-1970s (Wroblewski et al. 2007: 114), women involved in research in industry have only been the object of promotion efforts since 2004 as part of the fFORTE programme. The move to implement equality-promoting measures followed the 2003 appearance of the first European benchmark report on the topic (European Commission 2003: She Figures), in which it became obvious that the proportion of female researchers in Austria was one of the lowest amongst the EU-27.

The measures implemented as part of fFORTE address a number of barriers that appear at a variety of career stages (socialisation, school, first job, career development) and are quite heterogeneous in terms of the way they work and their duration. They address women on an individual level (grants/prizes, measures to promote empowerment) and on a more structural level (gender criteria in funding decisions, quotas in the composition of university bodies, improvements in hiring processes and decisions regarding promotion, working groups, etc.). They are furthermore aimed at a variety of target groups (school pupils, university students, researchers, the scientific community, firms, HR professionals, policy makers, etc.).

A broader gender mainstreaming was achieved once applicants to the central Austrian funding agencies (Austrian Research Promotion Agency FFG, Austrian Science Fund FWF) were required to give consideration to the topic in their proposals. This allows for gender awareness to spread more widely throughout the research community beyond experts working on gender, as do specific calls for proposals that are formulated with the intention of integrating gender into a variety of fields of research in the natural sciences and technology (FEMtech-FTI-Programm, ZIT-Calls). The Laura Bassi Centres of Expertise (LBC), currently a pilot programme, gather new experiences on changing male-dominated research and leadership cultures. An applicant's management capabilities and ability to work in a team are key in successful funding applications, as is the future potential of the research to be undertaken. This is in contrast to the typical retrospective focus on existing publications. Those involved in these initiatives intend for these innovative approaches to be adopted by other programmes to contribute to an even broader mainstreaming.

Employees		Higher education sector		Business enterprise sector	
		Total	Growth	Total	Growth
Total	1998	5955.4		11,716	
	2009	11,262.1	89 %	21,599	84 %
Men	1998	4611.3		10,754.2	
	2009	7420.6	61 %	18,356.1	71 %
Women	1998	1344.1		961.8	
	2009	3831.5	185 %	3242.9	237 %

Table 10:
Employees active in research 1998 to 2009 according to gender

Source: R&D Survey by Statistik Austria, own calculations

Germany[58]

The German parliament passed an anti-discrimination law in 2006; the federal government as well as state governments have pledged their support for gender mainstreaming. Higher education policy is the responsibility of state governments, and all German states consider higher education institutions to be responsible for ensuring equal opportunity. There has been an increase in the proportion of women at universities in Germany. Women represented 23 % of engineering graduates and 41 % of graduates in the natural sciences in 2010. But only 9 % and 13 % respectively of professors in these fields were women (GWK 2012).

The Federal Ministry of Education and Research (BMBF) funds a variety of programmes to promote equal opportunity in German research institutions and has furthermore established the advisory body "Equal Opportunity in Education and Research". This is charged with supporting equal opportunity throughout all areas in which the BMBF works, to assess what is needed in education and research and to support strategic measures and projects. One example of an initiative supported by the BMBF is the Centre of Excellence Women and Science (CEWS), founded in 2000. This is a national platform for sociological research on equality in science, policy advising, knowledge transfer and the monitoring and evaluation of measures to promote equal opportunity in the sciences. CEWS works together with the Women in Science steering group in the Joint Science Conference (GWK), which coordinates the support for scientific research among the federal government and state governments.

The BMBF also supports the FiF project (Women in EU Research). This project supports female researchers in accessing EU research programmes by providing information on research institutions, universities and firms active in R&D that are eager to support women in their career development. The German Council of Science and Humanities started its "Campaign for Equal Opportunity" in 2006 in order to increase the number of women in leadership positions in research and academia. As part of this campaign, all relevant research institutions must define goals for their organisation as related to equal opportunity.

Each state ministry for science and research has an advisory body on equal opportunity that has its own budget for research programmes on gender and equal opportunity. In addition, the proportion of women is a factor in the target and performance agreements concluded between the states and their universities and in deciding how basic funding is to be distributed. Several research institutions have established mentoring and career development programmes for female researchers (e.g. the Helmholtz Gesellschaft, the Technische Universität Darmstadt, WWTH Aachen). Additionally, a variety of initiatives have been implemented to create and support interest in the STEM subjects amongst girls and young women ("MINT-Pakt", Girls Day, etc.). There are no analyses of the programmes' effectiveness as of yet.

Germany has not introduced any quota for women in science and research as of yet, but in 2008 the majority of the members of the German Research Foundation (DFG) approved the introduction and implementation of research-oriented standards for equal opportunity for the period 2008–2013. The DFG supports the activities of its members by providing advice and coordinating services. Support for female researchers has not yet been generally introduced into the guidelines regulating the provision of research funding. The "excellence initiative" is one exception; gender is one of the criteria used in the assessment of applications.

58 This discussion is primarily based on information from the following sources: European Commission (2008): Benchmarking policy measures for gender equality in science. Brussels; and from: Deloitte (2012): The Researchers Profile 2012. Country Profile Germany.

Sweden

A long-established tradition of embracing equal opportunity in Sweden at the statutory level has led to a high degree of awareness about equal opportunity more generally, which has in turn provided the essential framework for implementing gender mainstreaming in R&D specifically. Sweden currently occupies fourth place in an international ranking of equal opportunity (see World Economic Forum 2012: The Global Gender Gap Report). This awareness about gender is reflected in the high rates of labour participation among women. Efforts aimed at equal opportunity have allowed many conceptions about gender roles to be overturned (the man as the family's primary provider, or "bread winner", the woman as a secondary earner and primary caregiver for children who is responsible for housework). Gender mainstreaming was successful in Sweden in the early 1990s, much earlier than it did in the rest of Europe.

Equal opportunity policies, long a feature of the Swedish innovation system, have been and are primarily aimed at university research activities, but rarely feature in the private business enterprise sector. In the past year and a half, Swedish innovation policy has made efforts to target funding in a way that will better exploit female researchers' potential within Sweden's innovation system. The goal of the policy is to improve the innovation performance of the Swedish economy as well as the research companies' cost-benefit analyses and financial performance by increasing awareness of gender (Vinnova et al. 2011: 14). This policy is based on the recognition that human capital is the key resource that influences Swedish performance when it comes to innovation, such that the maximum exploitation of its potential is absolutely necessary if Sweden is to maintain its position as an innovation leader in global competition. As such, increasing the number of women working in research is treated as an integral part of the broader conversation around the continued developments in conceptualising innovation, in which several questions occupy prominent roles, including what innovation is, how it is supported and what gender biases may be present in those support mechanisms. There are three means through which attempts to include more women in the innovation system are made (Lindberg 2012: 63): (i) targeted inclusion within the framework of existing funding schemes, (ii) the expansion of innovation funding to areas that tend to be dominated by women and (iii) ridding conceptualisations of innovation of gender stereotyping. In the latter it is important to mitigate normative ways of thinking about the ways in which women and men act in society and to expand upon the existing male norm around which innovation is conceived – as the basis for a technological product. This way innovation becomes more generalised and can be more widely understood, as an *"idea that has been taken into use and then created value by diffusion"* (Vinnova et al. 2011: 46).

The first step in the concrete implementation of this strategy, "Gender & Innovation", was the call for proposals issued in 2004 by the Swedish innovation agency VINNOVA[59] that sought projects in which researchers focused on the innovation system and gender experts worked together and effected a knowledge transfer between innovation and gender research. The twelve funded projects demonstrate ways to increase gender awareness in innovative organisations and firms and develop methods to this end. An implementation call for proposals was issued in 2008 (=TIGER-Call), in which ten concrete projects were implemented as part of the innovation system with the involvement of gender researchers and innovation experts. This applied gender-research funding programme

59 As a public funding agency, VINNOVA is charged with a public responsibility "to increase young researchers' possibilities for better working conditions, promote gender equality in appraisal of funding and within the organisation, and gender mainstreaming within research" (see deloitte–datasheet: 5).

aimed to change processes within the innovation system and increase gender awareness amongst the variety of stakeholders involved in that system. The experiential data gathered was published[60] and thereby made available to the community and those responsible for programmes, which also allows for the transfer of practical knowledge related to this new subject area. VINNOVA makes this relevant collected practical experience available to stakeholders actively involved in practice as well as to parties responsible for the programmes. This material includes examples of how relevant stakeholders can be made more conscious of the subject and how new innovations can be fostered.

Korea[61]

South Korea has one of the lowest birth rates in the world, a result of birth control policies dating from the 1970s, which also means it has one of the world's most rapidly ageing populations. It is against this background that policies have begun to focus on the low levels of employment of women (around 50 %). There has been a concerted national political effort beginning in the mid-1990s to implement gender mainstreaming measures to promote equal opportunity in the labour market[62]. This focus was particularly aimed at the underrepresentation of women in R&D – not least because the competitiveness of Korean R&D-based industries has clearly risen in concert with the increased proportion of women actively working in R&D over the past ten years.

This is why the "1st Basic Plan" was implemented from 2004 to 2008 to fund and support women active in R&D activities. One nation-wide and four regional "Institutes for Supporting Women in Science and Technology" (IS-WIST) were created to research developments in equal opportunity policies and women in the natural sciences and engineering, as well as to provide support to these female researchers. The WISE programme (Women Into Science and Engineering) was begun in 2001 and is a mentoring programme that aims to increase the number of women in the natural sciences and technology. The WIE (Women in Engineering) project implemented gender-sensitive curricula in technical schools in an effort to support women in engineering fields. Female school pupils were able to gain experience in technical labs as part of WATCH21 (Women's Academy for Technology Change in the 21st Century). Another project was the establishment of a nursery in the Daedeok Research Complex that could accommodate 550 children. The Recruitment Target System (RTS) has been in operation in all publicly funded research institutions since 2003 to increase the number of new female employees by 30 % by 2013. A total of 200 positions were created just for women at the country's universities across all subject areas. A group of 25 public research institutions joined together in 2007 to create a "Promotion Target System", which aimed to ensure that 30 % of all funding went to female scientists. A research budget for female scientists in the amount of US$ 2.5 million was created in 2000 to encourage women to engage in natural science and technological research and choose careers in these fields. The budget was increased to US$ 15.7 million by 2010. Gender criteria began to be incorporated into research funding decisions starting in 2003. Projects were awarded additional points for having female project managers up until 2009. Since 2009 preference has been given to projects that involve women returning to careers in science.

60 Andersson et al. (2012): Promoting Innovation – Policies, Practices and Procedures – Anthropology to develop genderaware innovative organisations, Stockholm.

61 This discussion is primarily based on information from the following sources: Kong–Ju–Bock 2010.

62 South Korea ranked number 108 out of 135 countries in the 2012 Gender Gap Report – it was ranked number 115 in 2009. The report identified no real change in the level of inequality between women and men in South Korea (World Economic Forum 2012: The Global Gender Gap Report).

Thanks to the activities grouped under the "1st Basic Plan", the percentage of female doctoral students increased from 16 % to 21 %. The number of female early career researchers in R&D increased from 18 % in 2003 to 27 % in 2009, and the number of women involved in R&D projects increased from 12 % to 16 %.

The "2nd Basic Plan" (2009–2013) focuses even more strongly on encouraging girls to study the natural sciences and technological fields. The second focus is on providing more strategic support for female scientists and engineers. Finally, the plan places the creation of balance between family life and a research career at the centre of its efforts.

The social innovation of "gender mainstreaming" provides an illustrative example of how a variety of innovation concepts can be utilised simultaneously even when they have varying degrees of influence or acceptance (and this is true even though gender mainstreaming itself has already enjoyed a notable broadening of its influence). Whilst some countries focus on a quantitative expansion of the number of women active in R&D activities, others pursue the additional objectives of effecting qualitative changes in the way research is performed and changing research and working culture more broadly.

6 Conluding Remarks

This study has considered whether and in what ways the notion of innovation has undergone changes in recent decades, and to what degree these changes – especially expansions towards a "broader" understanding of innovation – are of significance for innovation policy.

6.1 The expansionary trend in the notion of innovation

The most important results and conclusions can be summarised as follows:

- Recent decades have in fact witnessed an increasing expansion of the notion of innovation and subsequently also in innovation policy. Innovation research and innovation policy of developed, "knowledge-based" societies have in fact become increasingly "broader".
- In terms of the direction and scope of this expansion, both general patterns and country-specific characteristics are evident – especially the extent to which "social innovation" is included as part of innovation policy. Other extensions like the inclusion of service innovation or orientation towards social problems are already very prevalent.
- Extensions of the *notion of innovation* include in particular:
  - the inclusion of non-technological, organisational, and institutional innovations. Such a scope was already inherent in Schumpeter's notion of innovation, yet latest versions of the OECD's Oslo Manual, and the empirical innovation surveys based on it, have very recently taken it up;
  - the increased focus on the interplay of social changes and innovations: On the one hand, social trends, such as ageing societies, migration, and the increasing tertiarisation and globalisation of economic structures, change the frameworks within which innovation takes place. On the other hand, it is precisely these social changes that innovation must address – in the framework of a mission-oriented innovation policy that also includes new technological developments as well as "social innovations" that can take place alongside or even without technological innovation.
- The extensions of both the notion of innovation and approaches to innovation policy are therefore necessary corollaries of the increasing complexity of both innovation activity as well as the associated policy decisions. An innovation policy that does not incorporate these changes in innovation activity is punching below its weight.
- However, a broader notion of innovation is challenging, both in terms of its empirical operationalisation and its political implementation:
  - The increasing number of indicator systems and metrics used today to measure innovation and its various dimensions is an expression of this difficulty. This variety also makes it difficult to formulate targets and benchmarks for "evidence-based" policy and requires the capability of very knowledgeable discussions and interpretations, of these indicators in political discourse.
  - The demands on innovation policy associated with the adoption of a broad concept of innovation are also considerable. For one, completely new challenges emerge for governance structures whenever different policy fields are supposed to be brought into a coherent relationship with one another. This is obvious, for example, in mission-oriented innovation policy: The respective policy objectives (CO_2 reduction, energy security, etc.) are then only achievable when it is possible to align sectoral

strategies and implement them in a coordinated way. This requires a "whole-of-government" approach to policy setting that, although called for in the policy designs of the OECD and EU, are only implemented in a very limited way in most countries. The prerequisites for such an approach would be clear allocation of competences, functioning coordination bodies, a common understanding of the problem, and solid basis of evidence for formulating policy.

6.2 Global trends and their relevance for innovation policies

In detail, the following conclusions for innovation policy can be drawn from the global trends we outlined here:

Socio-demographic change and innovation policy

The major trends in *population dynamics* have several aspects that are – at least indirectly and sometimes even directly – relevant for innovation policy on multiple levels:

- Innovations play an essential part in increasing productivity and in economic growth. This is necessary in order to maintain the same or improved standard of living for a growing number of pensioners in spite of a decline in the number of workers (even with an increase in the retirement age) and to finance a health-care system that is being used more extensively. *This makes an even more intensive and sustainable innovation policy a necessity for ageing societies.*
- The share of older employees will increase with greater life expectancy and an expected rise in the pensionable age. *This will require innovations in the areas of workplace design, organisation and processes.* There is also a need for measures that secure that a knowledge-based society which is characterised by a larger number of older employees does not lose its innovative potential. Special measures are required in this regard for the purposes of retaining or making optimum use of the capabilities of older employees (e.g. life-long learning).
- The growing number of older people means an increased *demand for (innovative) products* (e.g. age-appropriate technologies) *and services* (housing types, travels) geared towards the "silver economy", along with a general necessity for society to adapt to the needs of older people, such as the use of online e-government services to replace visits to physical offices, new types of support and care services. This also includes dealing with the increasing number of pensioners who fall ill or require care, which presents new challenges for healthcare systems. Overcoming these challenges *often requires a linkage between technological and social innovations*[63].

  Even with the expected increase in retirement ages, pensioners still represent a growing group of individuals who are no longer engaged in occupational activities, but who are available for and open to voluntary and social activities and therefore also to so-

63 There are numerous definitions of social innovations (see Chapter 5.3.4). A working group of the European Commission writes: "Social innovations are innovations that are social in both their ends and their means. Specifically, we define social innovations as new ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. They are innovations that are not only good for society but also enhance society's capacity to act" (BEPA 2011: 9).

cial innovations (e.g. "reading mentors", "hired grandparents", "soup kitchens"). *Integration of these groups in society through genuine social innovation is required here.*

— International migration is a (growing) factor in a globalised world – including highly skilled and qualified individuals. One of the tasks in innovation policy must be to encourage this "brain circulation" and offer an attractive location for highly mobile and qualified workers as well as to minimise or offset any potential disadvantages. Diversity (in relation to cultural background, age and gender) also has been shown to have a beneficial influence on innovative capacities. *In this way, "managed migration" and "managed diversity" also become central tasks for innovation policy.* It is also imperative that workers' jobs and responsibilities match their qualifications – particularly in the case of immigrants.

In any case, it does seem that socio-demographic change encourages a broadening of the concept of innovation, particularly towards "social" innovations, though this change may either provide impetus for further innovations or pose factors that could inhibit innovative capabilities.

Climate change and innovation policy

Conclusions can also be drawn for innovation policy from the mega-trend of *climate change:*

— Innovations, and especially their (rapid) spread, are crucial in slowing down climate change (2°C target) and in successfully adapting to climate change in particular or for more resource-efficient and environmentally friendly economic activity in general.
— The diffusion and acceptance of existing alternative ways of consumption and use are also important in addition to new technological products and processes. Social innovations, such as behavioural or organisational innovations, and systemic innovations[64] are of major importance in this respect and require a broader approach to innovation.
— The fact that many climate-related areas involve network infrastructures (e.g. transport and energy networks) with the corresponding network externalities implies that systemic innovations are also required. In some circumstances the existence of old and inefficient infrastructure technology acts as a brake on innovations, even though there may already be more efficient alternatives in principle available. This means that without accompanying measures any new technology may be slow to diffuse, or in extreme cases completely unable to win out against the prevailing technology or network infrastructure.
— Many activities in this area can be handled via the market, but they still require an appropriate social context or political framework and infrastructures before they can be successfully implemented (e.g. car sharing, e-mobility, thermal rehabilitation of buildings). Since the objectives of sustainability are interdisciplinary and cover a wide variety of issues, they also affect a large number of policy fields and their interaction.
— The "grand challenge" of climate change is also an important justification for social innovations. Operational and market-based innovation processes are often not adequate in themselves. On the contrary, a commitment is required from civil society, the public sector, social enterprises, non-governmental organisations and others in order to meet this challenge.

64 For example, this may be defined as: "A set of interconnected innovations, where each is dependent on the other, with innovation both in the parts of the system and in the ways that they interact" (Davies et al.: 4).

Thus, in tackling climate change, RTI policy has to go beyond its traditional confines (for instance in R&D for new battery systems, CCS, etc.) and combine technological innovations with changes in individual and institutional behaviours.

Structural change in the economy and innovation policy

The long-term trends concerning *structural change in the economy* have a direct relevance for innovation policy in a "narrower" sense as well:

- Manufacturing's proportion of value added and of employment, which is trending downwards, is significant for research and innovation policy, as there are substantial sector-specific differences in innovation behaviour between manufacturing and services. On the one hand, innovation patterns differ considerably among industries; on the other hand, closer linkage between innovations in different industries is also evident: e.g. service innovations and technological product and process innovations are expected. Also, technical innovations are the basis for service (as well as social) innovations (e.g. internet, mobile telecommunications), and innovators are only able to sell their products successfully with additional or integrated services and service innovations. This implies that any reduction or change in the manufacturing base also affects research and innovation taking place in the services area. *Ensuring that there is an adequate industrial basis for maintaining a high level of R&D or a high level of cooperation between science and industry may in and of itself be an objective of innovation policy.*
- With heavy deindustrialisation the issue arises as to the extent to which R&D and innovation activities can be maintained with no geographical proximity to production. There are fears that extensive off-shoring processes and associated contractions in the country's manufacturing base will lead to a long-term reduction in innovation potential.
- Since R&D is becoming increasingly globalised, effective (transnational) knowledge management is required in order to transfer knowledge generated abroad to a particular firm or to Switzerland and to apply it there. Establishing sufficient absorption capacity is important in this (e.g. language and cultural skills to make better use of the growing research capacity of China).
- Furthermore, an improvement or maintenance of the attractiveness of the domestic innovation/R&D location must be ensured. Most prominent among the evident motives for choosing locations are the quality of research institutions and the available workforce as well as the presence of other innovative firms in upstream and downstream areas (clusters). *An active research and innovation policy can play a role in making the location more attractive.*

Activities in the area of public and social innovations play an indirect but important role within these trends by improving general conditions (e.g. reducing bureaucracy and cutting transaction costs; employee participation and the culture surrounding wage disputes) and improving the quality of life at the location (social innovations as an aid in promoting social integration and avoiding social conflicts). While the trend towards increased globalisation in R&D activities does first and foremost affect "traditional" innovation policy, in ensuring the quality of the location or requiring international innovation management, and to cope with cultural diversity *this trend also has important cultural dimensions which transcend the narrow concept of innovation and should be integral part of any modern innovation policy.*

6.3 Fields of action for a broader innovation policy

More and more, the international guiding documents of the OECD and the EU are adopting a "broader understanding of innovation", the core elements of which are as follows:

- a concept of innovation which encompasses the entire chain from basic research to market launch;
- a "systemic understanding" of innovation which sees innovation as the outcome of cooperation and interaction between a larger number of different stakeholders;
- an understanding of innovation policy which is neither limited to funding innovation as an end in itself nor has purely economic objectives, but rather sees innovation as a crucial tool in addressing major societal challenges;
- a broad understanding of innovation policy which goes beyond traditional research and technology policy, and in all cases includes education policy as well as other relevant "policy areas";
- innovation in the public sector and social innovations are also receiving more and more attention in current innovation policy.

In our analysis of important sub-domains we are able to identify various specific concretisations of a broader innovation policy:

Innovation in the public sector

"New public management" concepts have been put forward to initiate innovation in the public sector since the 1990s. It has been recognised that the organisation and processes for administrative action need to be rethought, and concepts and experiences from the management of private-economic units may offer opportunities for improvement and increased efficiency – at least with some adaptation.

- *Efficiency and quality:* The stated areas of innovation include e-government, a stronger user orientation, and increased efficiency, access to public data (open data), innovative procurement and deregulation.
- The public sector is responsible for coordinating policies to tackle complex societal challenges, as these cannot be provided by individual stakeholders. As a result, it has to initiate cooperation with relevant stakeholders, develop further methods and expertise for innovation promotion, define targets and areas where e.g. eco-innovations are of particular significance and support international cooperation in those areas.
- The objective is improved coordination of innovation funding, a greater focus on its benefits and impact as well as its measurement over different periods. In general, work is required towards a longer-term perspective with the initiatives, expertise must be reinforced in the public sector and effective structures must either be created or improved for the cooperation of private and public stakeholders.
- One area of public sector innovation that has been developing dynamically in the past few years – driven by technological innovation on the one hand and by the concept of New Public Management on the other – is "e-government". The promotion of e-government has led to substantial changes in public administration's relationship to its "clients" (citizens and firms) and in the internal administrative processes (e.g. electronic files), and is accompanied by continual innovation.

An innovative public sector is an important factor both for the general productivity of an innovation system and as a potentially important recipient of innovations from the private sector via innovative public procurement.

Service innovations and innovation policy

In recent years, *service innovations* have increasingly come into the focus of innovation policy. This is due on the one hand to the search for new sources of growth and the increasing significance and share of services in the economy while productivity increases in the sector have remained moderate. Service innovations are not only significant for the services sector, they are also an increasingly important factor in the success of manufacturing firms which in many cases offer their products in combination with innovative services. This is particularly evident in the "creative industries" which have already become the explicit object of innovation policy in some countries.

For this reason, many countries have implemented specific measures, with the following approaches being discernable:

- service innovations explicitly accounted for in generic RTI policy measures, such as tax incentives for R&D (e.g. in the Netherlands);
- adaptation of demand-oriented instruments such as public procurement (Finland, United Kingdom) or regulation (Sweden, Denmark, Germany, United Kingdom) for improved funding of service innovations;
- service innovations explicitly accounted for in mission-oriented R&D and innovation support such as the ageing society (South Korea) or sustainable urban planning (Sweden);
- integration of service innovations in funding programmes for cooperation initiatives between science and industry.

Societal challenges and innovation policy

Research and innovation policy recently has increasingly focused on the issue of *societal problems (grand challenges)* and pursued a mission-oriented innovation strategy. One example of this type of mission is "green growth": i.e. environmentally friendly, sustainable economic growth. This mission specifically references a broad conceptualisation of innovation, one that explicitly includes new business models, work patterns, urban planning and transport concepts. Due to the "systemic" character of these issues, many countries place a high value not only on pure technology-oriented research and development (and the public funding of this), but also on the development of model solutions, pilot projects and experiments. These efforts are sometimes bundled together in the form of "model regions" to act as "lighthouses" to guide other efforts to apply models of sustainable growth and development.

"Green growth" strategies or aspects thereof, form an important component of current innovation policy in most developed industrialised countries, even if the level of systematisation and coherence amongst policies varies between countries. A pronounced emphasis on industrial policy is evident in each case, as these efforts offer promising potential for growth in new industries. As can be seen with reference to a number of pertinent examples, strategies are "not sufficiently broad in conception" if they are primarily fo-

cused on R&D. As is generally the case in the "new mission-orientation", the use of a wide array of instruments (regulations, innovative public procurement processes, measures that promote diffusion) are necessary if policies are to be formulated that are able to address the largest challenges facing our societies.

Social innovation in innovation policy

One *"social innovation"* that has been a key target of innovation policy in many countries in the past several years was increasing the number of women in R&D and more consideration of gender in science and research (gender mainstreaming) more generally.

Gender mainstreaming began appearing as a concerted strategy in the mid-1990s as a means to integrate a gender perspective into all areas of politics. The intent was to expand previous efforts made to achieve greater equality and the promotion of women beyond the traditional political focus on equality. Specific gender know-how and concrete instruments/tools are necessary in the top-down approach to gender mainstreaming, both of which help to translate political goals concerning equality into everyday practice. Measures in this vein include specific calls for proposals, provision of examples of best practice, measures for gender trainings, development of guidelines, monitoring the percentage of women in organisations and promotional measures for women as entrepreneurs, innovators, managers and board members.

The implementation of gender mainstreaming in R&D generally takes place on three various levels of intervention:

- approach to promote women: measures that address only women in order to empower them as an underrepresented group, such as mentoring programmes, special trainings and professional development activities for women;
- approaches that seek to alter structures: systematic analyses of practices and processes to identify possible gender bias, such as the recruitment and promotion of female employees;
- integration of gender as a component of research: the relevance of gender and the different types of contexts in which research can be used are introduced into a variety of research areas with the aim of effecting a qualitative improvement in research outcomes. One example is the different needs posed by male and female users when it comes to transport planning.

The social innovation of "gender mainstreaming" provides an illustrative example of how a variety of innovation concepts can be utilised simultaneously even when they have varying degrees of influence or acceptance (and this is true even though gender mainstreaming itself has already enjoyed a notable broadening of its influence). Whilst some countries focus on a quantitative expansion of the number of women active in R&D activities, others in addition pursue objectives of effecting qualitative changes in the way research is performed and changing research and working culture more broadly.

6.4 Putting a broad notion of innovation to practice

It is clear from the development of innovation indicators that this broader notion of innovation is also increasingly being reflected in the statistics. This is especially true with respect to the incorporation of non-technological innovations. Although metrics currently developed are far from being perfect, the basic idea that a broadening of the concept of innovation is needed has been widely accepted.

More comprehensive indicator systems include indicators reflecting of the development of the science and education system in addition to technology-related indicators. Occasionally, attempts on a case-by-case basis to depict the scope and thematic direction of how the grand challenges are being addressed. *However, on the whole, we cannot yet say that the innovation statistics are currently reflecting the broader innovative-theoretical concepts that have been developed well enough.*

One problem inherent to this extension of the notion of innovation is its ubiquity and consequently

- a **loss of the concept's meaning:** If the term is used too broadly, saying something is "innovative" no longer implies that there is some "aspect of quality" inherent in the designation. Under some circumstances then, any and every type of "novelty" or "difference" would need to be labelled an innovation. *This makes it harder to identify innovation.*
- **Problems with measuring** innovations: the portfolio of instruments used to assess technological innovation is now relatively well-established (see Chapter 4), but discussion is still needed when it comes to the robustness and validity of these measurements (keywords pre-define the findings, problems in determining the scope of innovations and its effects, etc.). This is all the more true for definitions of innovation that are even broader (e.g. social innovations), the empirical assessment of which has proven to be rather difficult. Partly as a reflection of these difficulties there are a large number of approaches currently being used to rank innovative activity. They range from rankings that are grounded (to varying degrees) in traditional PPT frameworks which compare "technology readiness levels" for example, to other systems that incorporate indicators drawn from the business world and the education system, such as the "Innovation Union Scoreboard" (IUS). There are additional conceptualisations that have been used to compare countries with one another, e.g. the "Creativity Index" created by Richard Florida. *The sheer quantity and diversity of these various assessment models means that any comparison of innovation performance will be arbitrary to some extent.*
- **Problems with the political implementation:** how can "innovation policy" be distinguished from other areas of politics and policy if the concept of innovation is defined so broadly? As described in the concept of the policy mix many different policy areas are already impacting innovations. If societal and social innovations come under the purview of innovation policy, there will be no area of political life that does not in some way influence innovative capabilities. *This will most likely lead to noticeable governance problems.*

Overall, an assessment of the trends of the conceptualisation of innovation shows that:

(i) the notion of innovation in research, statistics, and policy is indeed becoming increasingly broad;

(ii) this broader notion is conceptionally more adequate than earlier, more narrow definitions for understanding the increasing complexity of innovation activity;

(iii) however, it will become increasingly difficult to gain a clear and less ambiguous picture of innovation activity;

(iv) policy concepts built upon this extended understanding of innovation are also becoming more complex, associated with high demands on policy administration systems in terms of governance capacities, coordination capabilities, and evidence-based policy formulation.

(v) In this context, we must view the broad perception of innovation as appropriate in terms of content, yet difficult in terms of practical operationalisation (in innovation research) and implementation (in innovation policy). In fact, it will actually require substantial innovations in political and administrative systems itself to apply this broader notion in the best possible manner.

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List of Figures and Tables

Abbreviations

AMECO	Annual Macro-economic Database
aws	Austria Wirtschaftsservice GmbH (Austria)
BEPA	Bureau of European Policy Advisers (European Commission)
BERD	Business Expenditure on Research and Development
BKA	Federal Chancellery (Austria)
BMBF	Federal Ministry for Education and Research
BMELV	Federal Ministry of Food and Agriculture (Germany)
BMU	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Germany)
BMWF	Federal Ministry of Science and Research (Austria)
BMWFJ	Federal Ministry of Economy, Family and Youth (Austria)
BMWi	Federal Ministry for Economic Affairs and Energy (Germany)
BMWT	Federal Ministry for Economic Affairs and Technology (Germany)
CCS	Carbon, Capture and Storage
CIS	Community Innovation Survey
cwa	creativ wirtschaft austria
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
DG	Directorate-General of the EU
EIO	Eco-Innovation Observatory
ELAK	Austrian Electronic File system
ERP	European Recovery Program
ESF	European Social Fund
ETH	Swiss Federal Institute of Technology in Zurich
FFG	Austrian Research Promotion Agency
FONA	Research for sustainable development
FSO	Federal Statistical Office (Switzerland)
FWF	The Austrian Science Fund
GDP	Gross Domestic Product
GLS	GLS Gemeinschaftsbank (German bank)
GOVERD	Government Intramural Expenditure on Research and Development
GRIs	Government Research Institutes
GWK	Joint Science Conference
HERD	Higher Education Expenditure on Research and Development
HTS 2020	German High-Tech Strategy
ICT	Information and Communication Technology
ISCED	International Standard Classification of Education (Unesco)
IUS	Innovation Union Scoreboard (European Commission)
JR	JOANNEUM RESEARCH Forschungsgesellschaft (research institute)
KfW	Kreditanstalt für Wiederaufbau (German Government-owned Development Bank)
KfW	German Government Loan for Business
KliEN	Climate and Energy Fund (Austria)
KOCCA	Korean Creative Content Agency
KOF	Swiss Economic Institute at the ETH Zurich
KRW	South Korean won
NESTA	Public Sector Innovation Index
NSTC	National Science and Technology Council (USA)
OcCC	Organe consultatif sur les changements climatiques (Consultative body on questions related to climate change, Switzerland)
OECD	Organisation for Economic Co-operation and Development
PCT	International Patent System
PISA	Programme for International Student Assessment
PNPRD	Private Non-profit Expenditure on R&D
PPS	Purchase Power Standard
R&D	Research and Development
RTD	Commercial-technical Research and Technology Development
RTI	Research, Technology and Innovation
RWTH	RWTH Aachen University
SCEG	Special Committee for e-Government (Korea)
SECO	State Secretariat for Economic Affairs (Switzerland)
SEK	Swedish Krona
SME	Small and Medium-sized Enterprise
SSIC	Swiss Science and Innovation Council
TEPSIE	Research collaboration between six European institutions
TPP	Technological Product and Process
TTT	Technology – Talent – Tolerance, Florida's index
UIP	Environmental Innovation Programme
USPTO	United States Patent and Trademark Office
VINNOVA	Swedish Government Agency for Innovation Systems founded in 2001
WIPO	World Intellectual Property Organization
ZEW	Centre for European Economic Research (Germany)
ZIT	Technology Agency of the City of Vienna (Austria)

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