



TRANSITION TO BIO-ECONOMY, SMART SPECIALIZATION AND QUADRUPLE HELIX

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Summary

In the transition to a sustainable bio-economy in Europe several strategies and documents can be related to the transformation. *Smart specialization* is one way in which the European Union aims to develop smart, sustainable and inclusive growth, while the member states and regions are required to develop smart specialization strategies. These strategies are used to highlight and identify regional strengths and assets, thus developing strategies to strengthen the competitiveness of the European regions. In connection with the smart specialization strategies bio-economy has been emphasized as an important part of the transformation into a sustainable European economy. The aim is to create a competitive, innovative European market and to generate green and sustainable growth through the development of so called RIS3 – *Regional Innovation Strategies for Smart Specialization*.

However, there is no coherent definition of the concept *bio-economy*. As a whole, the term refers to a larger societal context, including many dimensions such as the economy, the environment and social aspects. There are also differences in how the concept is used in various contexts. In the United States and the OECD, the concept is mainly used to describe the conversion of raw materials into products used in biotechnology and the life sciences. The definition used in the EU rather focuses on how biomass can be used as a resource in the transition into a more sustainable society. This will be managed through using renewable resources in combination with higher demands on sustainability, biodiversity and environmental protection in sectors such as agriculture, fisheries and food production. The aim is to transform the current economy into an economy based on renewable resources through innovation and new technological solutions.

Another part of the transition into a more sustainable society can be based on a widening of earlier regional innovation systems (RIS), such as triple helix based on partnership and collaboration between academia, government and industry into a quadruple helix system. *Quadruple helix* represents a widening of previous regional innovation systems to include

civil society as a fourth helix. However, the significance of what civil society can be varies both in policy contexts and in academia. One important aspect is where the public, to a greater extent than earlier, is seen as important in innovation processes and knowledge production. In research democratic aspects are also highlighted by the inclusion of earlier marginalized groups in innovation processes, mainly women and immigrant groups. Further research on social innovation emphasizes the role of civil society where, for example, employees, users, citizens, NGOs and local communities are key players with considerable knowledge of specific matters, which might challenge traditional and slow organization and power structures. Social innovations are also geared towards social and societal challenges, such as for example the transition into a sustainable society. In relation to the fourth helix and bio-economy, civil society carries experiences and knowledge about everyday practices, lifestyles and consumption patterns that are highly relevant in the transformation into a more sustainable society.

About the project:

The project "Transition into bio-economy, smart specialization and quadruple helix" is an ongoing project. It is financed by the University of Karlstad by the Centre for Research on Region Building (CRS), Region Värmland and Vinnova through the initiative "Paper Province 2.0".

The project aims to deepen the importance and the knowledge of the meaning of civil society such as users, NGOs, labour unions, and so on. The inclusion of civil society, a fourth helix, can thereby be seen as a widening of earlier regional innovation systems, such as the triple helix, traditionally founded on cooperation between academia, authorities, firms and business, into a quadruple helix system.

Participating researchers: **Ida Grundel** (PhD in Human Geography) e-mail: ida.grundel@kau.se and **Margareta Dahlström** (Professor of Human Geography) e-mail: margareta.dahlstrom@kau.se

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Why bio-economy?

The term bio-economy has become more and more commonly used at both national and regional levels across Europe. In many ways, its appearance in policy and academic circles are linked to economic policies produced at different levels ranging from international organizations such as the OECD, and the EU to national and regional authorities promoting the transition into a bio-based economy, a transition where new innovations, technological development and knowledge production are seen as essential to accelerating the transformation from a fossil based economic system into a new economy based on renewable resources¹. In this transformation the EU strategy *Europe 2020* plays an important role giving guidelines and a vision for the European market in the coming years. The vision mainly aims to tackle structural weaknesses and to deliver the following results: *smart growth* by investments in research, knowledge production and innovation; *sustainable growth* by creating a more resources efficient economy; *inclusive growth* focusing on job creation and poverty reduction to create territorial cohesion within the EU. These goals are primarily being fulfilled by investments in research, innovation and entrepreneurship. To a large extent this also connects to the European Union's work with Smart Specialisation Strategies, where the European member states and regions are responsible for developing their own strategies for smart specialization.² These strategies aim to identify the strengths and assets of each region, which are expected to help strengthen the competitiveness of each region, but also of the EU.³ Further, the European Union has developed the Innovation Union Strategy to create an innovation-friendly environment in member states.⁴ In relation to smart specialization and the European innovation policy, bio-economy is seen as a fundamental condition in the transformation into a sustainable economy, which in turn is seen as promoting green and sustainable growth in the EU. The goal is to create a more innovative economy based on the use of renewable resources in industry but also to place greater demands on sustainable agriculture, fisheries and food security, while protecting biodiversity and the environment.⁵

The relation between smart specialization and bio-economy involves several aspects and perspectives related to innovation policy and the European market, something that also raises issues about the possibilities of transforming the economy into a more sustainable market. In research there are both critical perspectives of the bio-economy, especially indicating the links to biotechnology and genetic modification of cells, crops and other raw materials,⁶ whereas others see the transformation into bio-economy as inevitable because of the limited access to non-renewable resources.⁷ Innovation policy as such has also been criticized because of the undemocratic processes in the exclusion of civil society, women and other groups in society. This policy brief therefore aims to highlight the relationship between bio-economy and civil society (a fourth helix) in innovation processes as being a necessity for a transition into a sustainable society.

What is bio-economy?

There are several possible definitions of the term bio-economy, including related concepts such as a bio-based economy and a knowledge-based bio-economy. As a whole, the term bio-economy refers to the wider society, including economic, social as well as environmental aspects. Several countries around the world have developed strategies and visions for a bio-based society leading to increased research on issues linked to bio-economy. The transformation into a bio based economy is primarily related to the OECD and the strategic document, *The Bioeconomy to 2030: Designing a Policy Agenda*, from 2009. This document emphasizes how research in the life sciences can contribute to new solutions for health and resource related challenges, where the private sector and governmental agencies are seen as fundamental actors promoting new innovations. In the document above, it is mainly biotechnology, life sciences and related technologies that are seen as key drivers of the bio-economy. However there is a difference between the definitions made by the EU, the OECD and the U.S. The OECD and USA withhold the process of transforming raw material into products in biotechnology or life sciences, while the EU focuses on using biomass as a resource regardless if it comes from waste or other renewable materials or energy sources⁸ The differences can be related to dissimilarities between the use of *biotechnology* in the OECD and the USA, and *bio-resources* in the EU.⁹ Biotechnology can in turn be defined as a science based on the use of living organisms and systems in the production of products and services in trade and industry. It is also possible to define a green, red and blue biotechnology. The green biotechnology is based on agriculture to develop genetically modified organisms. The blue refers to marine and aquatic techniques, whereas the red relates to the healthcare and medical sector. There is also a white or an industrial biotechnology based on production of enzymes and microorganisms to produce pharmaceutical products, chemicals, food, paper, pulp and textiles¹⁰.

Thus, there are differences in the definitions of bio-economy, both in academic literature, policy literature and in various parts of the world. The differences can be difficult to distinguish and a



Photo: Jan Alexandersson

more general definition should relate to aspects of sustainability in a world of finite resources. To a great extent this latter perspective is mainly ignored in environmental organizations, but also in more critical research. Based on this approach bio-economy can be linked to a broader definition of green economy

related to the United Nations Environment Programme (UNEP).¹¹ A possible starting point is to conclude that our natural resources are limited, thus making it necessary to change our production systems to more environmentally friendly alternatives. However, there is also a critique of the bio-economy as such because of different ideological ideas about sustainability and conservation. Several scholars see the bio-economy as a set of ideas relating to theories of ecological modernization whereas technological development and innovation are seen as the solutions to environmental problems of today and in the future. Further, new innovations and technological solutions are believed to create new markets¹² and a question asked is how growth and sustainability are compatible, as they involve the pursuit of profit maximization and market management. Some researchers see the relation between the bio-economy and the market as a risk leading to economic aspects superseding social and democratic features in importance. However, it can also be seen as a way of forcing firms and industries into producing environment-friendly and sustainable products leading to a more sustainable society.¹³

It is, in other words, important to emphasize the sustainability aspects through which the bio-economy can be seen as a way of transforming production systems and the society as a whole into becoming more sustainable. In the bio-economy this can be done through the transition to renewable energy systems, reduced dependence on fossil fuels, and a wiser use of natural resources. There are also social impacts pointed out as important gains from the bio-economy, such as the creation of new jobs in new sectors, a positive development in rural regions and the enhancement of the competitiveness of certain places.

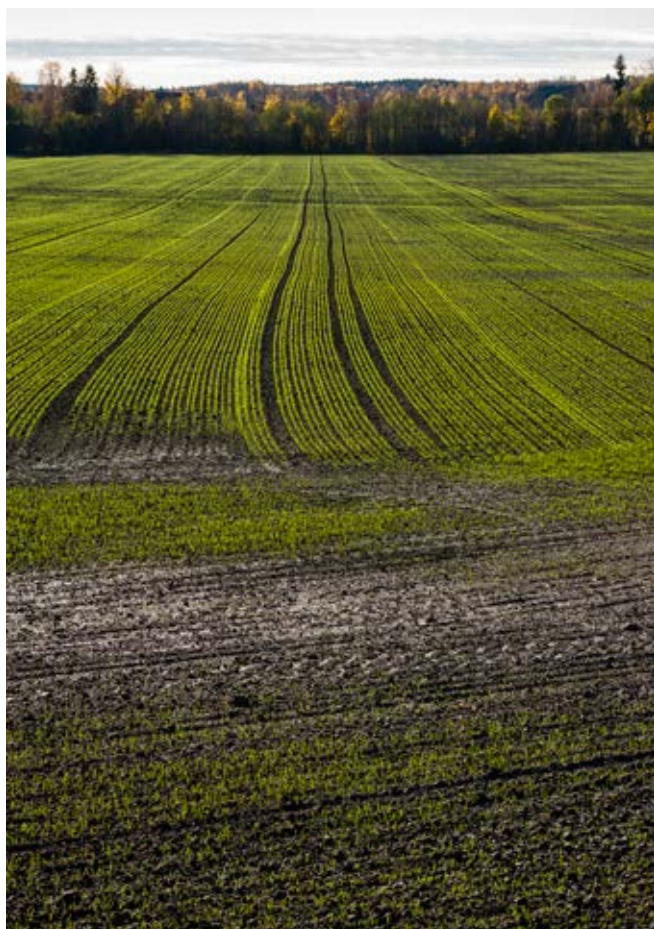


Photo: Jan Andersson

The European Union and the bio-economy

In the strategy *Innovating for Sustainable Growth: A Bioeconomy for Europe* (2012), the European Commission has singled out the bio-economy as one of the main and basic conditions required to shift into a sustainable economy. The strategy emphasizes the importance of strengthening the knowledge base of the bio-economy and to promote innovation in order to increase resource productivity adapted to future climate change. From a European perspective this involves both the transition away from fossil fuels and resources, but also to strengthen the competitiveness of the European Union. Industries and firms are seen as gaining from more resource efficient, bio-based bioenergy. Further, the bio-economy is believed to create new jobs in rural and coastal areas and to improve the economic and environmental conditions of production and manufacturing.

The EU defines the bio-economy as:

...the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy
(The European Commission, 2012:3).

The relation to *Europe 2020* and the strategy for smart growth also distinguish the European definition of a European bio-economy by stressing the importance of innovation, resource efficiency and competitiveness.

A Nordic context

In a Swedish context there is currently no national strategy for the development of the bio-economy. The only relevant document is primarily the strategy developed by FORMAS together with the Swedish Energy Agency and VINNOVA, commissioned by the Swedish government. The aim was to create a research and innovation platform to highlight knowledge gaps and main themes for research on the transformation into a sustainable bio-economy:

The transition to a biobased economy represents a shift from an economy that is largely based on fossil raw material into a resource efficient economy base on renewable materials produced through a sustainable use of ecosystem services from land and water
(FORMAS, VINNOVA and the Swedish Energy Agency, 2012:9).

It is thus possible to conclude that a Swedish definition of the bio-economy refers to the transition of the economy through the use of renewable resources, smarter use of raw materials, ecosystem services, a change of consumption patterns and new value chains, recycling and the care of environment and biodiversity¹⁴:

A sustainable production of biomass for enabling increased use across a wide range of sectors. The aim is to reduce the effects of climate change and the use of fossil raw materials.

An increased added value of biomass, while reducing energy consumption where energy is received from the end products. The aim is to optimise the value of ecosystem services and its contribution to the economy (FORMAS, VINNOVA and the Swedish Energy Agency, 2012:9).

Furthermore, the Nordic Council of Ministers has taken several initiatives to strengthen the bio-economy in the Nordic countries. NordBio is one example that started in 2014 stretching over a time period of three years. The definition made by the Nordic Council of Ministers was taken in 2014:

The bioeconomy refers to economic activities based on optimal utilization of maritime and terrestrial biological resources – emphasizing also: that the bioeconomy is an approach for sustainable socioeconomic development; an approach that builds on a circular thinking; and an approach that aims to enable a transition from a fossil-based to a bio-based society (Nordic Council of Ministers, 2014).

The bio-economy and the forest industry

In the forest bio-economy a large part of new innovations has been geared towards renewable fuel or other materials based on wood as a substitute for plastic, concrete and steel.¹⁵ Biofuel and thus bio-refineries have been singled out as priorities. The development of bio-refineries, particularly aims to create new alternatives to the use and dependency of fossil fuel. When it comes to categorize bio-based fuel it is possible to divide it into three categories. The first category comes from food-production such as wheat, sugar and cooking oil, while the second category consists of non-food such as straw and timber. The third generation of biofuel consists primarily of algae, but is still in a process of further development. Today, it is still the first generation of biofuels that are produced at a larger scale, whereas new alternatives could be based on waste and other refuse to produce fuel, for example, and/or other products and thereby reduce waste in general.¹⁶



Photo: Jan Alexandersson

According to the Finnish Forest Association, the sector of forest bio-economy is often omitted in the international sphere. Primarily, it is food, fiber and fuel that are discussed but the forest sector could be included as both an energy and production source. However, a large part of the discussion of a forest bio-economy points to new challenges. Using the term sustainable bio-economy puts pressure on a sustainable forest management, especially when developing new products. Technological development and new innovations demand new ways of thinking in, for example, bio-refineries, where ways of measuring quality of timber could change. Other matters relate to increased pressure on forestry due to increased demands through the introduction of new products and services. This must also be put in relation to conservation and biodiversity:

The sustainable economic use of forests provides one solution to the global environmental challenges that the planet faces. Global deforestation is a crucial cause of the extinction of species and plays a considerable role in the warming of the climate (Finnish Forest Association, 2015).

The new demands could be met by the introduction of good examples in sustainable forestry. One way is to use environmental certification as a tool to ensure sustainable forestry by claiming certification on wooden raw material.¹⁷ Further the importance of creating “green value chains” is fundamental to the development of the bio-economy in the forest sector. It is also important to make use of already existing knowledge and values among users and other groups affecting societal change and development.¹⁸

Changed innovation policies

Innovations are seen as fundamental to both national and regional development policies. To a great extent this can be linked to EU policies, where the European Commission has highlighted innovation as a tool for economic growth and to strengthen the competitiveness of the European Union.¹⁹ The bio-economy is also a significant part of *Europe 2020* through innovation policies and new technological solutions.

Innovations

In its simplest form, an innovation is seen as a new invention brought into use in society. However, innovations must be seen in a broader perspective and do not only constitute goods and products, but can also include services, ideas and practices:

The broader interpretation of the term innovation refers to an innovation as an idea, practice or material artifact (Rogers and Shoemaker, 1971:19).

Further, the environments and institutional and cultural contexts leading to new innovations have come to be seen as a part of innovation processes. Because of this change of view on innovations, innovation policies are directed towards the creation of innovation systems, which are therefore seen as drivers of development and economic growth. A critique of earlier innovation systems has been launched against a linear view of innovations where research and science were seen as creating new high-technological solutions. This linear view was used as a way of meeting market demands and to commercialize new products, thus favoring a producer perspective. Innovations have thus been seen as knowledge inherited by talented individuals and/or research groups.²⁰

However, the view on innovation processes has widened and it is possible to see how the development of innovation policy has changed over time. At first innovation policy mainly focused on innovation and technological development, invented by specific talented groups and researchers, who represented a linear traditional view on innovation. In the second generation of innovation policy, the view on innovation was seen as a process made possible by collaboration between different actors in an innovation system. The third generation innovation policy is related to the second generation. Both of them point to the importance of innovation systems, but the third generation includes other sectors, such as innovations in service and healthcare and also other kinds of innovations than earlier, such as organizational and user-driven innovations.²¹ User-driven innovation mainly occurs in healthcare, where new tools, instruments and services are developed along with patient-based user needs, but it has also played an important part in the development of new software and gaming technologies in video games. The video game industry is further based on open source, which is a way of distributing

knowledge between users, producers and other actors which thereby can serve and gain from new innovations.²²

The third generation innovation policy can also be seen as a way of including new sectors, earlier excluded in innovation processes, such as the service sector, tourism industry and other kinds of creative industries dominated by women.²³ Traditionally, innovation policy has been directed towards technological development in heavy industry dominated by men.²⁴ An important part in the development of innovation systems must therefore be to include different actors in the innovation process. It is important to stress that innovations do not only occur in more traditional business sectors in industry. The report *Måste innovationer vara av metall – Do innovations have to be made of metal* (2007), highlights other examples of innovations in new sectors such as Grythyttan where food and meals have been used to develop a new municipal development strategy. Other examples are: a reorganization of eldercare in Gothenburg, new ways of handling stress and thereby reducing sick leave and a new concert hall in Vara, Sweden.

Innovation policy

Innovation policy is often used as a tool by local and regional authorities to create and stimulate innovation in firms and businesses where cooperation and collaboration through regional innovation systems (RIS) have become important.²⁵ A regional innovation system is a kind of network believed to enhance innovation through collaboration between different actors in society. The most common form is triple helix where universities and research institutions collaborate with firms, businesses and authorities in a specific place.²⁶ RIS can thereby be seen as an institutional infrastructure supporting innovation and knowledge development in firms and businesses in a specific region.²⁷ As an effect of the European Commission's imposition on European regions to develop so called RIS3 – *Regional Innovation Systems for Smart Specialization*, regional innovation systems have developed further. Regions in Europe must now develop smart specialization strategies to be able to gain funding from the European structural funds.²⁸

Innovation policy and triple helix have been criticized for being a context producing and reproducing gender roles. This occurs in different ways, but especially through generating certain knowledge that sustain the notion that specific actors are important in innovation processes, especially men. This must be put in relation to more general views on men and women in which entrepreneurship and innovation are normally seen as masculine features.²⁹ These imaginaries of gender and gender roles are reproduced in innovation policy and works both to include and exclude through norms and values of who is and who is not invited to partake in innovation processes.³⁰ In this way, innovation policy can convey conceptions, norms and values also about gender, class and ethnicity. One way of abandoning more narrow ideas can be a widening of earlier innovation systems such as triple helix to include a fourth helix, where academy, businesses, authorities and the civil society is seen as main actors.³¹



Photo: iStockphoto

What is quadruple helix?

Quadruple helix is a way of widening the earlier triple helix system to include a fourth helix. However, the definition of a fourth helix varies in research and in policy literature. Carayannis and Campbell see the fourth helix in two ways. It is built on culture and media as well as civil society. The first part includes aspects such as culture and innovation culture, values and lifestyles, multiculturalism and creativity, media, arts and art schools. Further, a wider recognition and integration of civil society and the public must be made in innovation and knowledge production.³²

In research, mainly democratic aspects are discussed in relation to quadruple helix, whereas groups earlier excluded from innovation processes are given opportunities to participate and influence regional development. Low Hock Heng and others point to the possibility for NGOs and other associations to give a voice to and represent the civil society.³³ NGOs also represent individuals with other interests than purely economic ones, such as environmental and social aspects. At the same time, the definitions of a fourth helix vary. Another possible definition is to see civil society as an arena outside the family, the state and the market where people are gathered for a common interest. Civil society is hereby represented by social movements, non-governmental organizations, community associations and cultural associations that can be separated from academy, authorities and businesses in a triple helix system.³⁴ Yawson argues that the fourth helix should be represented by the civil society,³⁵ while others see the public as users, and that it is mainly user-driven innovation and/or entrepreneurship³⁶ that are singled out as vital to growth and economic development. However, this latter definition makes it difficult to differentiate between a triple helix and a quadruple helix system when the fourth helix is seen as entrepreneurs. However, user-driven innovation must be regarded as more democratic than other innovation systems because of the inclusion of the users in the actual innovation process. From a critical perspective user-driven innovation can be seen as a way for firms and businesses to adapt to market demands without having to take the risks of developing new products.

Social innovations

In relation to EU's smart specialization strategy, social innovations are seen as important to regional development. Social innovations can be defined as both social in relation to their purpose, but also due to the fact that they serve to meet social and societal needs and challenges. Social innovations should be seen as a way for excluded and marginalized groups to participate in innovation processes, where they can play an important role as the fourth helix. Furthermore, social innovations challenge more traditional, organizational and hierarchical structures that are normally seen as slow and difficult to change. They therefore serve to create new relationships with employees and workers, users and citizens, NGOs and local societies through specific knowledge.³⁷ Including civil society in regional innovation systems becomes more important along with discussing the role of public organizations and authorities. Carayannis and Rakhmatullin point to certain aspects that authorities must provide in a quadruple helix system: serve as providers of meeting places and create opportunities to participate in innovation processes for different actors; create regional and local quadruple helix systems with

the help of innovation policies; support the development of a quadruple helix system to enhance democracy and public participation; become users of the products and services developed by user-driven innovation in, for example, healthcare and finally, assure and control quality.³⁸

Eco innovation

Another kind of innovation that must be put in relation to the bio-economy and the fourth helix is eco-innovation. One possible definition of eco-innovation is an innovation that reduces environmental impact in relation to production and consumption patterns:

An innovation that improves environmental performance, in line with the idea that the reduction in environmental impacts (whether intentional or not) is the main distinguishing feature of eco-innovation
(Carrillo-Hermosilla, Del Rio & Könnölä, 2010:1075).

This definition means that an innovation does not have to be developed to reduce environmental impact, but that the final product, or service, serves to reduce environmental impact. However, this definition stands in contrast to other definitions of eco-innovations in which the original purpose of the innovation is to reduce climate and environment change.

Eco-innovations can be seen as a possible way to include both economic and environmental goals in regional development, while also seeing the environmental goals as beneficial to society as a whole. This argument is also important in relation to the inclusion of a fourth helix in a bio-economy to create larger societal gains in a longer perspective. But it is also possible, as argued by Carayannis and Campbell, to include a fifth helix, which refers to a quintuple helix system with five helices.³⁹ However the fifth helix does not involve a fifth actor, but the protection of local and regional environments and surroundings in the innovation process. In that way the fifth helix can be seen as a frame for different social sectors to work in favor of the sustainable development or/and social ecology necessary for a transition to sustainable development.

Is the fourth helix a key to transition?

There are several arguments for why a fourth helix should be included in a regional innovation policy. A further discussion of the fourth helix indicates the importance of the inclusion of previously excluded groups in innovation and policy processes. A common critique has been that national and regional innovation policies support heavy industry and companies normally dominated by men, thus excluding women and other marginalized groups. However, a large part of other sectors, such as the service sector, employs women, but are just as important for the transition into a knowledge-based economy and thereby also a knowledge based bio-economy.⁴⁰

In a triple helix model, different actors normally participate for different reasons.⁴¹ Firms and businesses are mainly interested in maximizing growth and cutting costs. Public authorities both represent society and create economic development and growth by supporting industry and business, whereas academia mainly participate by creating new knowledge and new ideas.⁴² More common everyday practices are not given any significant role in innovation processes, thus creating a lack of knowledge in relation to civil society. Civil society should be seen as a group that, through their experiences and everyday practices in different cultural contexts, represents knowledge about lifestyles and consumption patterns that are important in the transition to a bio-economy. In earlier innovation systems, such as the triple helix system, NGOs have not been regarded as important, while they are seen as external carriers of knowledge in eco-innovation. Historically, environmental organizations have played an important role in producing new knowledge about environmental problems.⁴³

Including civil society in innovation processes can contribute to changing attitudes towards environmental issues, lifestyles and consumption patterns. It can also bring about institutional changes in public authority, industry and business practices.⁴⁴ There are several connections to be made between eco-innovation and bio-economy, which make the relation between civil organizations and firms important as a starting point for the future. Through engagement and expertise in specific issues, civil society can create a balance between the common good and more market driven orientations. It can also pave the way for new innovations and technological development in new sectors. Another important aspect is the need of a common frame for working with questions concerning sustainable development, innovation and technological development,⁴⁵ which is based on a more democratic society where more actors than before are included in innovation policy and innovation processes.

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Endnotes

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Centre for Research on Region Building

The Centre for Research on Region Building, CRS, at Karlstad University is an interdisciplinary environment for research on societal change processes in a regional perspective.

The researchers and doctoral students linked to the centre represent at least eight disciplines: political science, human geography, history, sociology, social work, environmental studies, biology, and risk and environmental studies.

The research projects involve understanding and comparing change processes in time and space and how these can be controlled in the age of regionalisation and globalisation.

How, for instance, do new forms of organisation and governance in the regional arena develop and what are the impacts on democracy? How are living environments and opportunities for work and livelihood on the global market affected? And how can actors on the regional level together with actors on other levels contribute to the adaptation to a more sustainable development?

The interdisciplinary perspective, combined with the ambition to develop the knowledge required to advance social structuring and planning, also means that the methodological development of inter- and transdisciplinary research is a crucial part of our activities, which comprise research, doctoral studies and research dissemination.

One of the foundational principles of the Centre is the importance of research collaboration between researchers of various academic backgrounds and at different stages in their careers. Active groups of researchers, normally including senior researchers and doctoral students, are thematically organised.

Research is also pursued in cooperation with other researchers and environments at Karlstad University as well as with other higher education institutions in Sweden and abroad.

Centre for Research on Region Building was inaugurated on 1 April 2015. It has its roots in the former Forum on Region Building, the Graduate School in Region Building, and the research conducted at Cerut, Centre for Research on Regional Development.