European Commission

Business Innovation Observatory

Trend report

Disruptive innovations and policy responses: self-production, insects as food, flying sensors, graphene & others

December 2015

Internal Market, Industry, Entrepreneurship and SMEs

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Disruptive innovations and
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Executive summary

This report gives a quick glance on the most interesting findings of the 5th semester of the Business Innovation Observatory project.

A summary of five innovation trends:

Collaborative economy refers to concepts in which consumers fulfil each other's needs instead of requesting it to large organizations. In particular we look at Crowdsolving and the Maker Economy.

The silver economy concerns the increasing business opportunities associated with the specific needs of the growing population of elderly persons over 50 and the related growth in public and consumer expenditure. Two case studies of the 5th semester focus on the opportunities offered by active ageing and independent living.

Sustainable, safe and nutritious food covers the latest developments in the food industry analysed in three case studies: New nutrient sources; food processing technologies; and new products with added-value.

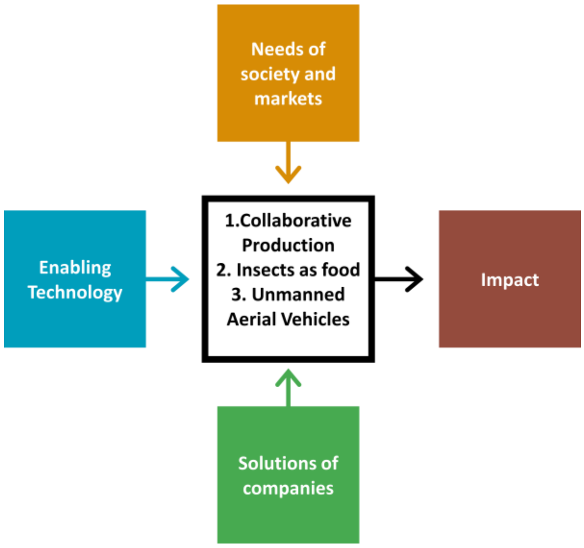
This semester also includes an assessment of the business opportunities related to two **advanced materials**. Graphene is the strongest material ever discovered and a very strong conductor of electricity, while aerogels are among the lightest solid materials known today.

Space-enabled applications encompass the latest developments in Satellite-Enabled Positioning Applications and innovations enabled by the next generation of the global navigation satellite systems; they also present the Unmanned Aerial Vehicle (UAVs) systems for civilian applications, also known as drones.

Highlight of three disruptive innovations:

These three innovations have been selected because they are likely to disrupt and transform markets, sectors, value chains, and innovation systems.

Figure 1: Factors for disruptive innovations to impact their environment



Collaborative production and the 'produce-it-yourself' movement disrupt the traditional view on the role of companies as producers and individuals as consumers. In turn, this economic perspective is driven by individuals and communities rather than by corporations. Internet-based technologies connect people in order to optimise the use of their resources. It empowers individuals to fund, design, prototype, produce, manufacture, distribute, market and sell their own goods.

According to a recent UN projection our planet will have to feed about 10 billion people by 2050. Currently, animal proteins account for about 40% of global protein consumption. As a result of an increasing world population, more efficient and sustainable sources of proteins are needed. Using **insects and algae as food** and feed represents an interesting approach in this context.

Unmanned Aerial Vehicles (UAVs) have a huge potential for innovative civil applications. Technologically, it is based on developments in navigation (GPS), aviation materials, robotics and ICT. As 'flying sensors' the spectrum of possible civilian uses of UAVs includes monitoring and surveillance of environmental, agricultural and fishery operations; security tasks, such as search and rescue support, disaster response, border control, etc. Civil UAVs present a huge potential for applications in wide variety of sectors to the benefit of European society, creating jobs and addressing societal challenges.

Focus on three policy challenges:

Facilitating the creation of **co-working spaces and virtual collaborative platforms** is crucial for the maker movement. Co-working spaces, Fab Labs and makerspaces allow people with common interests to come together, increasing access to manufacturing infrastructure which was previously confined to manufacturing companies. Digital platforms also enable individuals to more easily connect and share ideas and resources fuelling the maker movement. These networks in turn influence others to become makers themselves. But to fully take of more infrastructure, both physical and virtual, is needed.

The policy challenge of **promoting new protein sources** lies on both the supply and the demand side. This new protein sources industry is today being held back by a restrictive and unclear EU regulatory environment. The lack of clear position at the EU level on the classification of insects and algae as Novel Foods results in a legislative ambiguity across Member States. Most particularly, the use of insect proteins in feed is being hindered by the lack of precision in defining the scope of the regulations. On the other hand marketing and persuading customers and consumers to shift to these new sources of protein remains a challenge.

Boosting the civil UAV market could lead to job creation and new innovative applications in various sectors. The EU established the main principles that should govern UAVs development in Europe as from 2016 onwards within the Riga Declaration. Moreover, in recent years, some 10 Member States have issued partial regulation allowing limited civil UAVs operations. But more can be done do help this sector to grow.

A comprehensive set of recommendations has been formulated to address these challenges.

1. Five trends in Business Innovation

Five trends in business innovation have been identified and analysed by the Business Innovation Observatory in the case studies of the fifth semester:

- Collaborative Economy
- Silver Economy
- Sustainable, Safe and Nutritious Food
- Advanced Materials
- Space Enabled Applications

1.1. Collaborative Economy

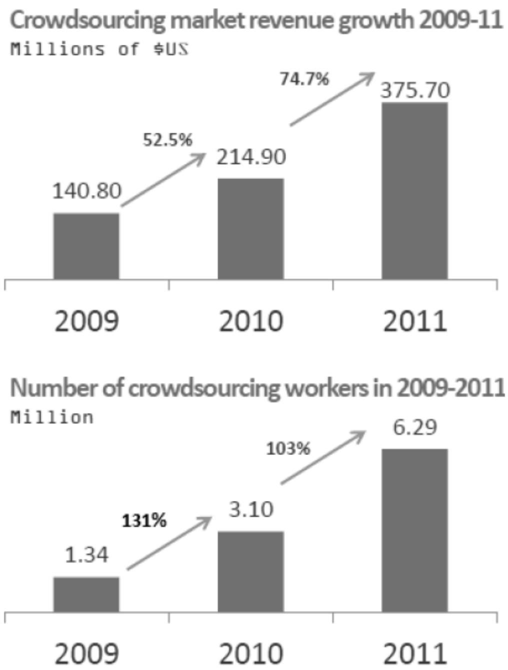
The rise of collaborative or sharing economy is quite a simple concept according to which consumers are able to fulfil their needs from each other instead of requesting it from large organizations. This includes goods, such as baby toys and wedding dresses, to services such as web design work or ridesharing. This report explores **crowdsolving** and **collaborative production** and the maker economy.

Crowdsolving is defined as the "job" that becomes a problem and requires a solution. Crowdsolving enables individuals and organisations using new technologies to submit, discuss, refine and rank ideas in relation to a specific question or problem.

Crowdsolving is most commonly manifested in the form of a crowd contest, where a sponsor (generally a company) identifies a specific challenge or problem, offers a cash prize, and broadcasts an invitation to submit solutions. The best solutions are then selected either with the help of the crowd or by the sponsor. The winning solution finally awards the cash prize and the solution is adopted by the sponsoring organisation.

There are also other existing forms of crowdsolving solutions including the use of "gamification" (the use of game thinking and game design in non-game context) and social networks, testified by a start-up called "Instagram for doctors" where doctors can share photos of patient conditions for other doctors to comment and propose possible diagnoses.

Figure 2: Main market indicators for the crowdsourcing (period 2009-2011)



Source: Massolution[1]

Collaborative production involves the collaboration of groups or networks of individuals to design, produce or distribute goods, and is related to the idea that the community decides what to produce.

Collaborative production has two main characteristics: it is a peer-to-peer system where individuals collaborate among different networks, and it is an open platform that can be improved, modified or integrated with a large amount of shared information.

Collaborative production platforms allow for extremely localised and personalised products/services that would have otherwise been very costly for traditional companies.

Collaborative production can take many different forms such as co-ideating, co-funding, co-building, co-distributing, co-marketing and co-selling efforts. It can take place as company-to-company, company-to-customers, or simply among individuals.

Table 1: Some examples of the Collaborative Economy

Company	Business innovation and success signal
CloudMe (SW)	CloudMe offers secure file storage, file synchronization and client software to individuals and companies. Premium features include additional server space. 1.3 million users from more than 220 countries, aiming for 20-30 million users in the coming years. In 2012, 2013 and 2014 they won the Bully Award by White Bull in Barcelona, awarded to the top 30 tech start-ups in Europe.
Trampolinn (FR)	Trampolinn is a home-swapping community where the members receive each other for free exchanging nights. Three nights are given free at sign up. Trampolinn has been running since the summer of 2014 and has today 30,000 users from 150 countries and 3,800 cities.
SkipsoLabs (UK & CH)	SkipsoLabs is a crowdsourcing website that helps companies, governments, universities and not-for-profits find ideas, talents and solutions to their most critical challenges. Active user base globally covering countries such as the US, Mexico, Italy, UK, Spain, Switzerland, China, Australia, India and Uganda. Its clients include XPRIZE, Microsoft, Intesa Sanpaolo, Cleantech Open, NYSERDA, Electrolux, and EXPO.
Phonebloks (NL)	Phonebloks is an independent organisation helping the consumer electronics manufacturing industry steer development and production that produces less electronic waste than their products do today by promoting modularity, open innovation, open source and the circular economy. Phonebloks manages a community of 25,000 members.

Table 2: Main drivers and obstacles for the Collaborative Economy

	Drivers
Crowdsolving	• Companies have direct access to a large range of talents in multiple disciplines • Time and cost optimisation • Rise of tools for development, design and collaboration
Collaborative production	• Consumer wants to be both consumer and producer • Fast design-productions cycles • Falling cost of technology • Rise of physical and virtual places for collaboration

	Obstacles
Crowdsolving	• Issues in guaranteeing company data confidentiality • Intellectual property transmission
Collaborative production	• Difficulty to scale to industrial production • Design a viable business model • Lack of appropriate laws, especially regarding quality and safety standards.

This report also looked at the issue of **Freemium model.** It is a pricing strategy used by businesses, typically in relation to digital offerings. The product is given away for free to the users being given the option to pay for additional, or premium, features or versions.

The freemium business model is widely used for products for which there is easy access through social media and smartphones, from where it is possible to easily download additional services. The objective is to enlarge the subscriber base as much as possible by encouraging the free users to become subscribers. However, as a fundamental requirement, a freemium model has to be appealing enough to attract free users, without removing the incentive for users to pay for the premium version.

The two essential parts of a successful freemium model are:

1. That marginal costs are significantly lower than in traditional goods; and,
2. The service is based on a word-of-mouth marketing strategy through which users recommend it to their friends and family

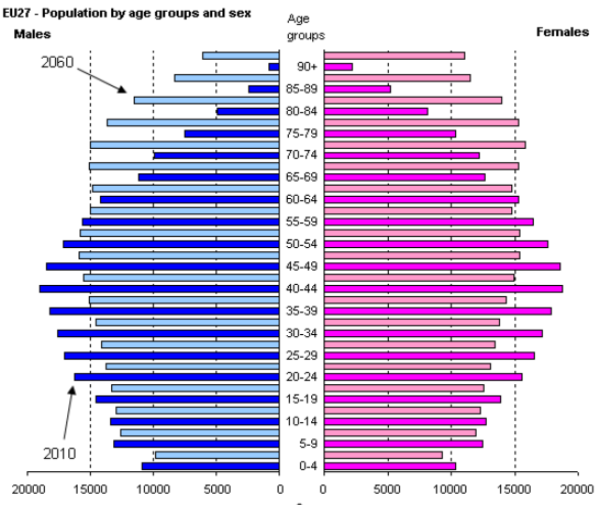
1.2. Silver Economy

The silver economy defines a set of services and technologies that may be applied to cope with Europe's growing proportion of elderly people due to the fact that people live longer and the birth rate is lower. Therefore, elderly people will account for a larger part of the European society. This is likely to increase the burden on social and health systems of the EU Member States.

The silver economy can be defined as: "existing and emerging economic opportunities associated with the growing public and consumer expenditure related to population ageing and the specific needs of the population over 50.[2]

This demographic situation potentially can create a huge market composed of elderly consumers. These persons have very specific needs and requirements in terms of services and tools. The main priority is to support those that require assistance due to old age and to support those that can and are willing to remain active.

Figure 3: Age structure of the EU-27 population in 2010 and 2060



Source: European Parliamentary Research Service (based on Eurostat data)[3]

This trend encompasses the case studies for "independent living". The idea behind it is to give seniors innovative tools helping them deal with everyday life independently; and helping the elderly stay active and continue to contribute to the society and the economy.

Table 3: Some examples for the Silver Economy

Company	Business innovation and success signals
Imaginary (IT)	Imaginary specialises in advanced interactive technologies supporting training, learning and eHealth. Holds a portfolio of more than 20 EU-financed projects providing game-based solutions in many areas, including eHealth for elderly people.
Duka PC (DK)	Duka PC developed an easy-to-use computer adapted to the needs of elderly people. Successful expansion of its operations to several countries in Northern Europe, with a growing number of private and public sector customers.
Gociety (NL)	Gociety offers GoLivePhone®, an easy-to-use smartphone developed for seniors and other services related to it, like a web app connecting the carer and the phone user. More than EUR 250,000 gathered following a crowdfunding campaign in the Netherlands.

Giraff of Sweden produces an electronic device ("avatar") for telecare services by helping carers conduct a virtual visit at elderly persons' home. This service combines IT and communication systems to allow independent living of elderly people and allow the provision of preventive health services by monitoring the person's health status.

The EU has launched a number of measures to stimulate silver economy and to help European companies and SMEs participate in it. They include the Active and Assisted Living Joint Programme[4], the eHealth Action Plan[5], the European Innovation Partnership on Active and Healthy Ageing[6]. In addition, in the first two years of Horizon 2020 (Work Programme for 2014/15), the EU will invest some EUR 1,200 million for better health, in particular to keep older people active and independent for longer and to contribute to the sustainability of health and care systems.

Figure 4: Old-age dependency ratios

Source: The Economist, based on European Commission data[7]

The drivers and obstacles for silver economy which emerge specifically from the case studies developed under the trend are briefly presented in Table 4 and point to the importance of regulations and standards.

Table 4: Main drivers and obstacles for the Silver Economy

	Drivers
Active Aging	• The interest of elderly persons in "cool" products • The economic crisis enables social innovation
Independent Living	• Strong social protection in Europe • Necessity to care for a growing proportion of elderly people with fewer resources encourages public-private cooperation
	Obstacles
Active Aging	• Regulatory complexity • Purchasing power inequality
Independent Living	• Cultural differences in Europe in the approach to elderly care • Low sense of urgency to support silver economy

1.3. Sustainable, Safe and Nutritious Food

The trend "Sustainable, Safe and Nutritious Food" covers the latest developments in the food industry through three case studies:

1. New nutrient sources
2. Food processing technologies
3. New products with added-value

Each of them focuses on innovations occurring at different steps of the food value chain.

The case study focusing on **new nutrient sources** explores the production and commercialisation of new sources of nutrients, which represent a currently unexploited resource of nutrition.

New sources of food are needed to face the challenges that are putting food security and food production under great stress.

The crushing weight of the world's population, projected to soar to a staggering 9.6 billion by 2050, will inevitably result in an increased demand for food, namely animal proteins. Animal proteins account for about 40 per cent of global protein consumption, but their production is highly inefficient, with about 2 to 15kg of plant material being required for a single kilo of animal products.

One possible solution is to find alternative food to animal proteins for human consumption and animal feed production such as, insects, algae and in-vitro meat. The latter is still in experimental phase and therefore not mature enough for commercialisation. For this reason, the BIO Innovation Report only takes into consideration insects and algae production.

The consumption of insects is already well known in countries across Asia, Latin America and Africa, where they are integral part of the diet of at least 2 billion people. However, Western culture is still far away from the recognition of this food on the consumers' tables.

Insects need to be processed in order to be edible. Once collected, this food needs to be treated (frozen, dried, sun-dried or boiled). Algae are simple plant organisms, capturing sunlight and converting carbon dioxide into sugars and oxygen during the photosynthesis process.

Benefits coming from the use of these organisms are associated with many health issues, such as lowering blood pressure and preventing strokes. Also protein contents are very important together with minerals, amino acids and vitamins contained in these products.

Innovative businesses related to this topic are emerging across Europe, exploring the power of these new sources of nutrients in order to convert it into sustainable practical solutions for food and feed applications.

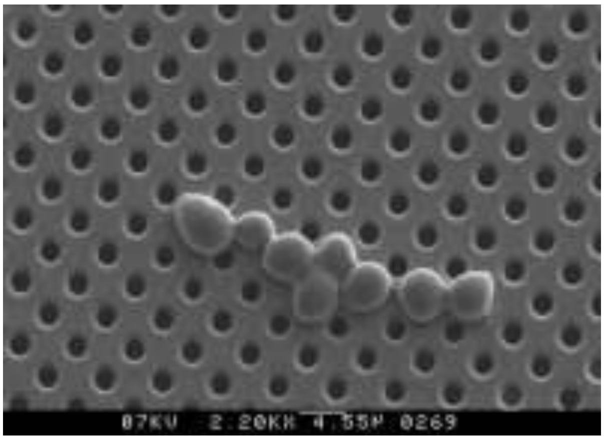
Table 5: Some examples for Sustainable, Safe and Nutritious Food

Company	Business innovation and success signals
Protix Biosystem (NL)	Protix produces high-value insect-based products for pet food and animal feed. Founding partner of the "International Producers of Insects for Feed and Food" association. Official member of NeVeDi, the Dutch Feed Industry Association.
Aquamarijn (NL)	Aquamarijn develops innovative micro and nano technologies for a variety of applications and industries. In 2004, Small Times finalist 'Innovator of the year'. Extensive press coverage in trade magazines and publications.
Biozoon (GE)	Biozoon developed a 3D printer capable of printing dozens of different meals from a gelatin base, targeted at people who have difficulties chewing. Leader of the PERFORMANCE project funded by the European Commission. Already 5 brands on the market: texturePro ®, cocktailPro ®, partyPro ®, seneoPro ® and myBiosportiv ®. Distributed in 18 countries around the world.
Solanic (NL)	Solanic developed a process to recover potato proteins from potato processing waste water. In 2014, awarded the FSSC 22000 Certificate of Approval for food safety. Solid financial results since its inception. Extensive participation in exhibitions and fairs.

The case study on **food processing technologies** entails a series of steps (unit operations) that turn raw ingredients into products fit for human consumption. The efficiency and sustainability of these steps can be improved by two broad sets of innovative technologies: non-thermal pasteurisation and nano/micro technologies (high-pressure processing, microwave volumetric heating and pulsed electric field). The advantage of these technologies is that they do not involve significant heating; they extend the shelf life of foods without altering their nutritional benefits and taste.

One of the case study companies is Aquamarijn (Table 5): a nano and micro engineering company, founded with the aim of developing innovative and performant membranes for a variety of applications, including microfiltration and emulsification. Aquamarijn engineered a novel microfiltration membrane, the microsieve®, characterised by many well defined pores of controllable size and location. It does not suffer from fouling and therefore results in a longer filtration cycle with lower power consumption, without requiring the use of cleaning chemicals.

The microsieve's well-defined pores allow accurate separation of particles at the micrometric scale



Source: Aquamarijn[8]

Finally, the last case study regards **new products with added-value**. The added value feature is represented by a business' addition to the raw materials purchased. It is given by the difference between the initial cost and the amount received upon selling. Traditionally, in the food industry, value is added in several ways along the value chain.
It leverages two main approaches: valorisation and effective nutrition.

- Raw materials that enter the food processing chain are traded as by-products and are therefore scarcely valorised. This clearly represents an opportunity for further valorisation actions of by-products.
- Effective nutrition is a possible means to bring to market foods which have a higher added-value both from a social, economic and nutritional perspective.

Table 6: Main drivers and obstacles for Sustainable, Safe and Nutritious Food

Drivers	
New nutrient sources	• Health and environmental awareness initiatives
Food processing technologies	• Consumer demand for fresh and healthy food – the "cleanse craze" • The EU salt Reduction Framework
New products with high added-value	• Food labelling requirements and demand for "clean-label" products • Consumer trends (vegetarian/vegan diets, healthy ageing)
Obstacles	
New nutrient sources	• Customer aversion – the "yuck factor" • Lack of harmonisation around the 'Novel Foods Regulation' • Animal proteins restriction in feed • Inflated substrate costs and limited variety • Production and scaling up costs
Food processing technologies	• Fragmentation of the EU food market hampers innovation • Lack of harmonisation around the "Novel Foods Regulation" • Lack of understanding of commercial applications
New products with high added-value	• Strictness and unsuitability of health claims procedures for food industry • Excessive focus of EU subsidies on technical aspects • Rigidity of EU healthcare systems and reimbursements

1.4. Advanced Materials

Technological advancements in the production and quality of basic materials are a well-known driver of disruptive innovation and growth. These advanced materials offer new innovative possibilities for growth through the support of new existing industrial and commercial products and processes.

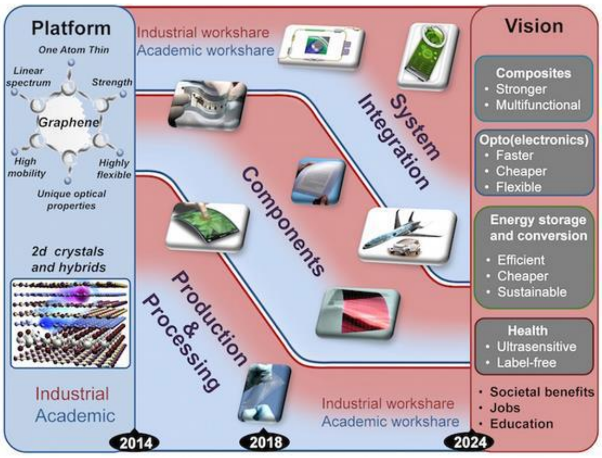
The first of the two case studies presents the potential for innovative growth arising from the recently discovered material called **graphene** (case study 55).

Research has shown that graphene is a **very strong conductor of electricity**. The electronic mobility of graphene is very high, albeit this is dictated by the quality of the graphene and the substrate. Additionally, as a result of its molecular structure and the bonding arrangements between the carbon atoms, graphene is the **strongest material ever discovered.**

Graphene has a huge **variety of potential market applications.** Its electronic conductivity properties makes it ideal as a component in electrical circuitry and it could be used in various ways from creating ultra-fast electronic transistors to help increase and improve the efficiency of batteries. Its optical properties give it the potential to have applications in photovoltaic cells, while the material's mechanical properties have garnered interest of the aviation industry given its potential to both strengthen and reduce the weight of aircraft wings. The technology even has the potential to revolutionise aspects of the health sector such as in tissue engineering and drug delivery.

The graphene market is still in its nascent stage and **heavily R&D oriented**. Research efforts in the field recently benefitted from a EUR 1 billion investment by the ERC under the Future and Emerging Technologies (FET) Graphene Flagship project, the largest-ever research initiative funded in the history of the EU.

Figure 2: European roadmap for graphene science and technology



Source: Graphene Flagship Roadmap[9]

Given that the technology readiness level of graphene is still relatively low and as a whole the market is in its early stages according to the technology roadmap (Figure 2), the majority of the companies involved in the emerging graphene market have a strong degree of research focus attributed to them and cater to the academic field at this time, with an objective of catering towards industrial clients as the market develops.

Table 7: Some examples for Advanced Materials

Company	Business innovation and success signals
Directa Plus (IT)	Engaged in the development and marketing of innovative manufacturing processes for the production of a new generation of nanomaterials. Identified in 2013 as a top 10 Cleantech SME in Italy by the Cleantech Group; Shortlisted for "Innovation friend of the Environment 2013" for the use of graphene in rubber. Recently opened its Graphene Factory: Europe's largest pristine graphene nanoplatelets production unit. Expobici Innovation Award 2014 for the first carbon-fiber rim reinforced with G+. Selected amongst the top 5 best eco-innovation projects by European Commission's GEnIuS project (Graphene Eco Innovative Sorbent). To date the company has been granted 35 patents, with 11 still pending.
Cambridge Nanosystems (UK)	The company has developed a means of synthesising pristine graphene through a novel and proprietary production method based on microwave plasma. Coverage in the British and International media. Opened a factory in the UK to produce their pure grapheme. Hosted the 3rd Nano-Carbon Enhanced. Materials Consortium on 9 June 2015. Won the 2015 Business Innovation Award.
Graphensic (SE)	Graphensic supplies epitaxial graphene on silicon carbide. Associate member of the Graphene Flagship Initiative. Multiple mentions in the national press. Multiple publications in peer reviewed journals and mainstream media.
Svenska Aerogels (SE)	The company has developed a new production process, which is estimated to reduce the cost of producing aerogels by 90%. Multiple mentions in the press. Collaborations with several large multinational companies. Classified as a "Climate Solver" by the WWF for its potential to influence the overall insulation market and contribute to global energy savings and reduction of CO2 emissions.
Separex (FR)	Separex is a French company originally spun out of academia employing thirty expert employees with unique experience in research and implementation of industrial supercritical fluid applications. Member of the AERSUS project geared towards developing aerogel applications for the space industry. Clients include important market players such as Nike. Numerous mentions in the mainstream media.
Green Earth Aerogel Technologies (ES)	GEAT is a start-up company that directly produces aerogels using agricultural waste materials from rice as raw materials. Finalist in 3 major international business plan competitions.

The second case study focuses on **Aerogels** (case study 56), which are one of the lightest solid materials known today, and are created through the combination of a polymer with a solvent to form a gel.

Aerogels can be derived from different origins. They can be made from metal oxides and can be exploited for their conductivity, as catalysts for chemical reactions, matrices for explosives, or as precursors for other materials like carbon nanotube catalysts

Aerogels made from aluminium are often found in catalysis when combined with a metal. They can have potential applications in the photovoltaics and play a role as chemical sensors. Finally, there are Metal Aerogels, which can be exploited for their high conductivity and surface area.

Despite this variety of different potential market applications, to date, the use of aerogels has been limited. This is because of the cost and time in production as well as due to the fact that they are generally uneconomical for businesses.

Figure 3: Crayons supported on an aerogel over a flame

Source: NASA Jet Propulsion Lab[10]

Aerogels are seeing greater importance in exotic sectors such as the space industry, where the minimisation of weight is critical, in which aerogels have been used in insulation and other original applications. Today, market forces are driving demand for new insulating solutions for houses and buildings, which aerogels can help meet.

Table 8: Main drivers and obstacles for Advanced Materials

	Drivers
Aerogels	• Increasing demand for greater energy efficiency and environmental-friendliness. • The cost of producing aerogels will drop as the market develops. • Increased use of novel construction and architectural techniques.
Graphene	• Need for better energy storage drives investment into graphene. • Graphene is riding high on the hype wave and benefitting from investment as a result.
	Obstacles
Aerogels	• Risk-aversion of the construction sector. • VC market less inclined to invest into cleantech.
Graphene	• The technology still needs the spark to allow for mass production. • Entry to the value chain is too spread out and not focussed enough.

1.5. Space Enabled Applications

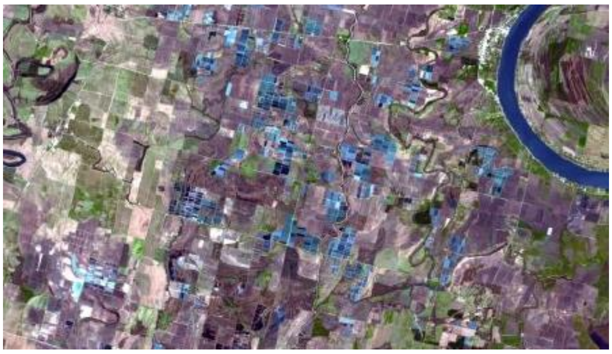
This trend encompasses the latest developments in "Satellite Enabled Positioning Applications" and the "Unmanned Aerial Vehicle (UAVs) system for civilian applications".

The case study on **Satellite Enabled Positioning Applications** (case study 57) focuses on technological innovations and applications enabled by next generation global navigation satellite systems.

The rise of the systems based on satellite transmissions using positioning information provided by GNSS systems have led to a changing landscape of location-based services and applications which rely on our capability to determine an exact position. For instance in the transport sector, intelligent positioning systems through satellite-based navigation have improved safety, traffic management, fuel efficiency and travel time optimisation, consequently reducing emissions.

Another example would be in the field of civil engineering, where satellite positioning machine guidance can be used for large construction works and satellite navigation can be used to control vehicles transporting heavy loads therefore increasing the efficiency of construction sites.

Remote Sensing, image from Deimos-1 Satellite



Source: Deimos-Space[11]

Furthermore, the combination of GNSS systems and geographic information systems has led to major cost reductions in the discovery of natural resources, oil and gas, and the management of utilities such as water, electricity, sewerage, etc. This combination of systems can be also used to increase effectiveness and precision in the agricultural industry through improved monitoring of soil and control of fertilizing and pesticide procedures. GNSS systems are therefore vital to European industries and public services; they have been key enablers of innovation in sectors such as transportation, tourism, telecommunications, agriculture, and computer networks among many others.

Table 9: Some examples for Space Enabled Applications

Company	Business innovation and success signals
Geko Navsat (ES)	Develops sensorial navigation applications using satellite positioning information. Participated in research projects under the FP7. Has won several SME and technology competitions at national and European levels.
Geosat (DE)	Uses patented technology to use satellite data to identify oil and gas wells. Disruptive patented technology. Supported by the European Space Agency Business Incubator Centre.
Deimos Engenharia (PT)	Integrated innovative products and services covering all aspects of an aerospace mission. Successfully launched its satellite in 2015; Media coverage. Participates in ARTES programme funded by the European Space Agency.
Aerialtronics (NL)	The company develops UAVs for commercial applications exploiting commercial opportunities. Participation in projects under H2020. Wide base of large commercial customers.
UAV Factory (LV)	Specialised in fixed wing UAVs for long range and long endurance missions. Beneficiary of ERDF funding for research and development. Media coverage in Unmanned systems technology magazine.
Defendec (ES)	Defendec develops new technologies for border protection and surveillance of border lines based on geo-location. Participation in the FP7 project TALOS. Media coverage. Prestigious institutional clients.

The case study 58 on **Unmanned Aerial Vehicle** (UAVs) **system for civilian applications** focuses on the potential applications that have been made possible by technological innovation of UAV systems, in particular for the purpose of remote sensing, measuring, and data collection from a three dimensional perspective limiting the costs and dangers of manned aviation. Given that early developments of the technology were motivated by military applications, UAV systems have mainly been used in the past for specific tasks of surveillance, reconnaissance, and mapping of hostile areas targeted by military operations. Knowledge generated by these military origins enabled designers, developers and suppliers of flying unmanned platforms to adapt the technologies in use (hardware and software) for civilian purposes and to propose a number of UAVs systems related products and services at lower costs.

Aerialtronics Altura Rotorcopter for site inspection

Source: Aerialtronics[12]

Products and services in demand include e.g. photogrammetry (digital surface modelling), imagery and recognition, flight operations for inspection (in particular for industries with physical networks – railways, pipelines, electrical networks). Other common uses of UAVs are in agriculture and forestry for precision farming, or monitoring species and vegetation. Another example of use is for traffic monitoring and surveillance, which allows to overview the time estimation, lane occupation and incidence response.

Table 10: Main drivers and obstacles for Space Enabled Applications

Drivers	
Satellite-enabled positioning applications	• Large existing support for R&D in a research intensive industry • Appropriate business models and client awareness taking into account the nature of research-intensive and innovative products
UAVs systems for civilian applications	• Understanding UAVs as tools to deploy aerial data networks. • Global visibility and informal collaboration • Commercially oriented investments
Obstacles	
Satellite-enabled positioning applications	• Early stage of adoption due to limited understanding of the technology • Limited support of a client-centric vision for an industry oriented towards research.
UAVs systems for civilian applications	• Security and safety given that UAVs are machines operating in the air, and as such, if a system fails the damages on the ground may be important

2. Disruptive innovations

This section will cover three disruptive innovations: ‘Produce-it-yourself’, insects and algae as food, and civil UAVs (drones).

These innovations have been selected because they are likely to disrupt and transform markets, sectors, value chains, and innovation systems. The stories of these three disruptive innovations take a prospective view, anticipating breakthroughs in their wider uptake in the near future. Concrete existing examples in terms of the new products/services, companies, sectors, and business opportunities are discussed, as well as the transformative socio-economic impacts and related policy challenges.

1.6. Collaborative production: Produce it yourself

Collaborative production and the ‘produce it yourself’ movement disrupt the traditional view on the role of companies as producers and individuals as consumers. Together with collaborative consumption, collaborative learning and collaborative finance, collaborative production is one of the four main areas of co-activity of the collaborative economy, often used interchangeably with the sharing, or peer-to-peer economy.

The collaborative economy involves using internet-based technologies to connect people in order to optimise the use of resources such as goods and skills. In turn, collaborative production entails the collaboration in networks of individuals to design, produce or distribute goods. It manifests itself in co-ideating, co-funding, co-building, co-distributing, co-marketing and co-selling efforts. Collaborative production can take place company-to-company, company-to-customers, or simply among individuals. In turn, the ‘Produce it yourself’ economy perspective involves efforts which are initiated and driven by individuals and communities rather than by corporations. It “puts power in the hands of the people to fund, design, prototype, produce, manufacture, distribute, market and sell their own goods.[13]

One of the common challenges faced by collaborative production startups is in scaling up manufacturing to a sufficiently large scale, as well as the tension between democratised manufacturing, taxation and existing regulations that favour traditional import and export approaches to manufactured products. There are also quality and safety issues to consider when individuals are empowered to make a wide range of goods. Uncertainty and risks relating to flexible work contracts is another factor to consider, alongside the challenge to develop a viable business model.

Table 11: The disruption of Collaborative production

Disruption	Collaborative production entails the collaboration of groups or networks of individuals to design, produce or distribute goods, and is related to the idea that it is the community that decides what to produce. Mixing the concepts of „customisation“ and the distributive movement of „Produce it yourself“ is giving birth to a disruptive approach of self-producing spreading even to the B2B business model.
Challenges	Reaching sufficient scale of production Taxation. Financing and developing a viable business model. Regulations which favour traditional import/export approaches. Radical changes in the production process – marketing jumps at the beginning of production chain (instead of at the end).
Market opportunity	The number of manufacturing firms with zero employees has grown by almost 40% over the past three years in the UK. The overall market for 3D printing products and various maker services reached EUR 1.95 billion in 2012, and is expected to hit EUR 5.34 billion by 2017.
Policy challenges	Existing tax and regulations favour traditional import and export approaches to manufactured products. Ensuring quality and safety standards for home produced goods. Implications of flexible work contracts.
Relevant case studies	Collaborative production and the maker economy (Case study 51), as well as Crowdsolving (Case study 50) within the trend of the Collaborative Economy.

The make-it-yourself economy is creating the possibilities to create new streams of income, both for individual artisan sellers as well as for local family-based makers. Etsy, the internet-based global handicraft marketplace, has more than one million artisan sellers who sell handmade products on the site, with the site itself generating close to EUR 900,000 in revenues in 2012.

Hackster, another example, is a hardware creation community of over 20,000 people on 45 platforms where hardware hackers and makers share their projects. Another example is OpenDesk which designs furniture for digital fabrication, linking a global network of makers to a range of designers. The furniture can be downloaded as a digital file and made locally and on demand.

The UK government in turn estimates that the population of manufacturing firms with zero employees (i.e. consisting of just the owners) has increased by almost 40 per cent over the past three years[14].

'Makers' contribute approximately EUR 26 billion to the world economy annually[15]. The overall market for 3D printing products and various maker services reached EUR 1.95 billion in 2012, and is expected to hit EUR 5.34 billion by 2017[16].

The policy challenges involve: several regulations concerning tax and import/export trade regulations, ensuring quality and safety standards of homemade products. Perhaps most challenging are the high risks and insecure job characteristics for the individual makers (in terms of unemployment and health insurance, pension).

Collaborative production makes the crowd an important resource for innovation, entrepreneurship and growth. This innovation trend disrupts existing markets for resources, products and services. The organisational and institutional disruption concerns a mixed, blended conception of the role of people and civil society as consumer, innovator, employee and entrepreneur.

1.7. Insects and algae as food

Table 12: The disruption of insects and algae as food

Disruption	New nutrient sources have a very positive social and economic impact, but eating habits are quite rigid. Insects and algae as food disrupt our menu and food and feed market. The solution of insects and algae was not expected at such as investors, customers, retailers, and regulators were not prepared.
Challenges	Need for new sources of protein. Food and feed security are predicted to be put under great stress, due to population growth and the increase in animal protein demand. Customer aversion, unclear regulatory environment, and hesitant attitude of investors and retailers.
Market opportunity	Alternative proteins are estimated to make up 33 per cent of global protein consumption by 2054. The edible insect industry alone could become a EUR 320 million business in the US and Europe within the next decade.
Policy challenges	Actively promoting insects and algae production and commercialisation. Addressing customer aversion and hesitant attitude of investors and retailers. Adapting animal feed regulations to new protein sources.
Relevant case studies	New nutrient sources (case 52)

According to a United Nations report in 2013 the world's population is projected to soar to a staggering 9.6 billion by 2050. The crushing weight of this increasing population will inevitably result in an increased demand for food, and therefore of animal proteins[17]. Animal proteins account for about 40 per cent of global protein consumption. Additional sources of proteins are needed, because the production of animal proteins is highly inefficient, with about 2 to 15 kg of plant material being required for 1 kg of animal products. Furthermore, cattle breeding and meat consumption are associated with a high environmental footprint and greenhouse gas release, thus making these practices unsustainable[18].

Figure 5: The consumption of insects, known as entomophagy, is becoming a real possibility in Europe

Source: Bug Corp[19]

Using insects and algae as a new proteins source represents a new approach to this challenge. It has potential positive social and economic impact, but eating habits in his respect are still quite rigid. A report by New Nutrition Business claims that the edible insect industry alone could become a EUR 320 million business in the US and Europe within the next 10 to 15 years. Also high-value microalgal products have a very good potential for expansion. For instance, the current global market size of natural astaxanthin from Haematococcus for the human market is estimated to grow from EUR 180 to EUR 630 million by 2017.

The main policy challenge lies in preparing all stakeholders (regulators, consumers, investors, producers, farmers, retailers, etc.) and supporting the development of these new markets.

Non-ruminant processed animal proteins (PAPs) have been allowed in aquaculture feed. However, the slaughtering requirements exclude insect proteins from benefitting from this policy relaxation. In order to enable European SMEs to fully take advantage of the large market potential offered by the aquaculture sector, the scope of the concerned legislations should be broadened, updated and made relevant to alternative protein sources.

In Europe, the use of insects such as mealworms, crickets and maggots is currently limited to pet food. However, it is expected to be extended to feedstock for aquaculture, cattle and poultry in the near future, especially given that their properties have been shown to be comparable to fishmeal.

Currently non-ruminant PAPs are not allowed in pig and poultry feed, since the legislation prohibits intra-species recycling of proteins (for instance, pork proteins cannot be fed to pigs), and there are no reliable diagnostic tests that can ensure that feed complies with this ban. Again, even though these restrictions are not theoretically applicable to insects, the use of insect proteins in feed is being hindered by the lack of precision in defining the scope of the regulations. It is thus worthwhile to support the revision of the regulations through investments in the development of accurate and reliable tests to detect the presence of non-ruminant proteins in animal feed.

1.8. Civil UAVs – Flying sensors

Unmanned Aerial Vehicles (UAVs), also known as Remotely Piloted Aircraft Systems (RPAS), or Drones as they are more commonly known by the general public, have a huge potential for innovative civil applications.

The development of drones started in the 1950's and was developed mostly for defence and military uses in recent years. This development was related to political changes (end of the Cold War and emergence of low intensity conflicts) as well as technological developments concerning navigation (GPS), aviation materials, robotics and ICT.

Since then UAVs have entered the market for civil and private use, which is rapidly expanding. In particular, these devices can offer various advantages. First, they are remotely piloted and might have advanced features e.g. sense-and-avoid technology to prevent mid-air collisions or transponders. They can improve the safety of operations in dangerous environments such as natural disasters, fires or industrial incidents of toxic, chemical or nuclear origin. Secondly the use of Remotely Piloted Aircraft Systems (RPAS) presents a clear economic advantage reducing the cost of aerial operations and allowing economies of scale compared to the use of satellite systems. RPAS are well suited to perform prolonged surveillance missions due to their endurance and range which can be quite substantial for the more complex systems. Thirdly, they present also environmental benefits – less fuel consumption, fewer $CO2$ emissions, and reduced noise.

Spectrum of possible civilian uses of UAV includes monitoring and surveillance of environmental, agricultural and fishery operations; security tasks, such as search and rescue support, disaster response, border control, and many other activities on behalf of public bodies and law enforcement agencies.

Figure 6: Illustration of a drone

Source: UAV Factory[20]

Table 13: The disruption of UAVs – Flying sensors

Disruption	A broad range of cross-sectorial applications of UAVs is surprising markets with unexpected solutions. The uptake of this multi-purpose innovation will induce further distributed product-, process-, organisational and market innovations.
Challenges	Technical challenges to build aerial electronic networks for data gathering and processing. Further product development, commercialisation and market development. Safeguard the European competitive advantage. Cross-sector, and Science-Industry collaboration.
Market opportunity	Cross-industry applications of drones (e.g. precision agriculture, transport, 3D mapping, surveillance, catastrophe management, traffic monitoring and other services).
Policy challenges	Support the creation of jobs and growth in the European UAVs industry; Continuous improvement and homogenisation of the regulatory framework which provides further incentives for future development; Clearly define the safety and security regulations that would protect both society (civilians on the ground) and the economic benefits the industry can provide; Increase awareness among investors and promote market development with public procurement.
Relevant case studies	UAVs systems for civilian applications (Case 58).

Example of possible commercial applications include precision agriculture and fisheries, power/gas line monitoring, infrastructure inspection, communications and broadcast services, wireless communication relay, natural resources monitoring, journalism, cinema, aerial photography, digital mapping, land and wildlife management, air quality management/control, etc.

The market potential for UAVs use has been estimated worldwide to double from EUR 5.7 billion to EUR 10.3 billion per year by 2020. In 2014, the distribution of this market was estimated to be 89 per cent military and 11 per cent civilian, although this distribution is shifting in favour of civilian applications and these are likely to grow up to 16 per cent of the market of UAVs within a 10 year horizon.

Market potential in aerospace payload and transportation will therefore stem from the development of wide range UAVs, increased payload capacity, and improved sensors and navigation systems. Commercial applications already include 3D mapping, commercial pipeline observation, border patrol, package delivery, photography, and agriculture.

Concerning only the market for data collection and real-time monitoring, UAVs offer major advantages in terms of speed, detail, and accuracy compared to the use of satellite gathered imagery. Cost effective acquisition of data and observation enabled by the take-up of the UAVs market is already applied in a number of areas including agricultural monitoring, disaster management, power line surveying, law enforcement, weather monitoring, aerial mapping, environmental monitoring, oil and gas exploration, or freight transport.

The advantages of UAVs compared to other airborne platforms (satellite, airplanes, helicopters) include: flexibility (ex: size, range, mission duration); mobility (3D movement, random patterns, they can be flown in hostile/dangerous environments/weathers); they are configurable/customizable in terms of sensors required for specific missions; they do not depend upon human factors (autonomy, size, construction, weight); economical in terms of production, operation and maintenance of (commercial) platforms reduced; safe and cost-effective.

2. Policy challenges and recommendations

This section covers three policy challenges related to the trends covered in the 5th semester:

- How to facilitate the creation of co-working spaces and virtual collaborative platforms?
- How to promote new proteins sources?
- How to boost the civil UAVs market?

2.1. Facilitating the creation of co-working spaces and virtual collaborative platforms

Background

The rise of co-working spaces, Fab Labs, makerspaces and hackerspaces allows people with common interests to come together, increasing access to manufacturing infrastructure which was previously confined to manufacturing companies. These types of spaces are becoming particularly popular in Europe – there are about three times more Fab Labs in the EU than in the US.

Figure 7: The makerspace GR Makers in Grand Rapids, founder Casey DuBois

Source: Matthew Gryczan (2014); Photo by Jon Brouwer

Maker spaces are community centres or co-working spaces, typically independently owned, that provide access to certain tools and light equipment for fabrication, such as 3D printers and open-source hardware board toolkits and technology. Some are more sophisticated or specialised and offer advanced tools and materials for plastics, textiles or for metal- and woodworking. The spaces often also provide mentors, courses and a community of interest around the "makers movement" or DIY (do-it-yourself) fabrication and prototyping[21].

In the website of the global FabFoundation 579 entries to Fablabs around the globe are listed[22]. From this total 270 (or 47%) are located in the EU. Fablabs were originally designed as prototyping platforms for local entrepreneurship, but they have also expanded to universities and other training and research institutes. Fablabs have to subscribe to the fablab charter and have to offer public access to their facilities[23]. FabFoundation also provides links to machines and to projects of this international maker community. In the EU the coverage of this kind of access differs a lot between Member States. Some examples of countries with the number of member labs (on November 2015) include: Austria 5, Belgium 13, Bulgaria 1; France 58; Germany 30; Italy 59; Netherlands 28; Poland 5; Spain 22; UK 23.

Figure 8: Collaboration space in Barcelona, Spain

Source: Victor Mulas (2014) Worldbank. Photo: Victor Mulas

Living labs are yet another type of collaborative space. Living labs are environments where the user-centric design methodology is applied to test prototypes developed by entrepreneurs, companies, universities or the public in general. The basic principle of the living lab is to form collaborative environments among different actors and to help develop products through interactive user-centric design. Living labs have flexible approaches and have been employed for academic purposes in universities and/or city governments to form local communities of innovation, by companies to develop products, etc.

The European Network of Living Labs (ENoLL) is the international federation of benchmarked Living Labs in Europe and worldwide. Founded in November 2006 under the auspices of the Finnish European Presidency, the network has been growing in 'waves'. To this date, 8 waves have been launched, resulting in 370 accepted Living Labs.

Other types of collaborative places include: Industry innovation labs, Urban Labs, and Innovation Hubs. There are also mixed or hybrid forms of such collaboration spaces.

Besides such physical places to produce together, internet-based platforms are also essential to understand and to promote this trend of collaborative production. The Internet and social media are enabling individuals to more easily connect and share ideas and resources, e.g. in terms of goods, skills or investments. These internet platforms are fuelling the maker movement. Makers are forming their own communities, and these networks are in turn influencing others to become makers themselves.

The policy instruments to promote ICT platforms are numerous. Good practice policy models include policies which increase consumers trust in online markets, at national or EU level. Good practice is also to improve the digital business environment by promoting standards for doing business in a digital environment.

The Digital Single Market strategy will further help to develop ICT platforms. This strategy involves tearing down regulatory walls and moving from 28 national markets to a single one. The strategy is made up of three policy areas:

- Better online access to digital goods and services;
- An environment where digital networks and services can prosper;
- Digital as a driver for growth.

This sector has also been growing in the US. As an example (Case study 51) TechShop[24], a private chain of maker workspaces in the US offers access to state-of-the-art prototyping tools at an affordable EUR 90 a month. TechShop does things differently – it is a more corporate model. TechShop has experienced a 798 per cent revenue growth in the last three years. Moreover, in 2012, DARPA — the research arm of the Department of Defense in the US — announced a USD 10 million grant (around EUR 9 million) to promote the maker movement among high-school students. DARPA also gave USD 3.5 million to TechShop to establish new makerspaces that could help the agency with its "innovation agenda."

The maker movement is also a rapidly expanding trend in China. Growing number of both participating companies and visitors of the Maker Carnivals across the country is a visible sign of this process.

Conclusions and policy recommendations

The policy challenge to promote collaboration is not only evident in the case studies on the Collaborative Economy. Also in many other case studies peer-to-peer and cross-industry collaboration is mentioned as an important driver for innovation and scaling up. Which specific infrastructures, institutions and regulations are especially relevant for the collaborative production?

In terms of infrastructure, support to set-up maker spaces on the local and city level is important. These community centres or co-working spaces, are typically independently owned, and provide access to certain tools and light equipment for fabrication, such as 3D printers and open-source hardware board toolkits and technology. Also the virtual infrastructure, ICT platforms as marketplaces to consolidate demand for the services of local makers and connect entrepreneurs to the crowdfunding platforms, is necessary.

On the national level issue related to tax and trade policy should be solved. So far the existing policies in this areas do not promote the 'make-it-yourself' movement. Updating and clarifying tax rules impacting activities along the production and distribution chain would help to develop the potential of the movement.

Ensuring quality and safety standards for home produced goods, is another remaining policy challenge. Last, but not least, policy implications related to the work contracts should be tackled.

Regulation should further encourage democratised manufacturing also in terms of enhancing interoperability of systems and open standards. Policy makers can also support the development of an appropriate mix of government, community and industry standards to assure the quality of products and services emerging from collaborative production.

More support for expanding the users' base, would also be important.

Finally, issues related to data protection which may be specific to the development of collaborative platforms should be reviewed and the existing data protection provision amended if necessary.

2.2. Promoting new protein sources

Background

The uptake of new protein sources entails numerous social benefits across several interconnected areas, from job creation, economic diversification, to food security and improved public health. Most importantly, it could have a considerable positive impact on greenhouse gas emissions and environmental protection. In this context insects and algae show potential as alternatives to animal proteins for both human consumption and feed applications.

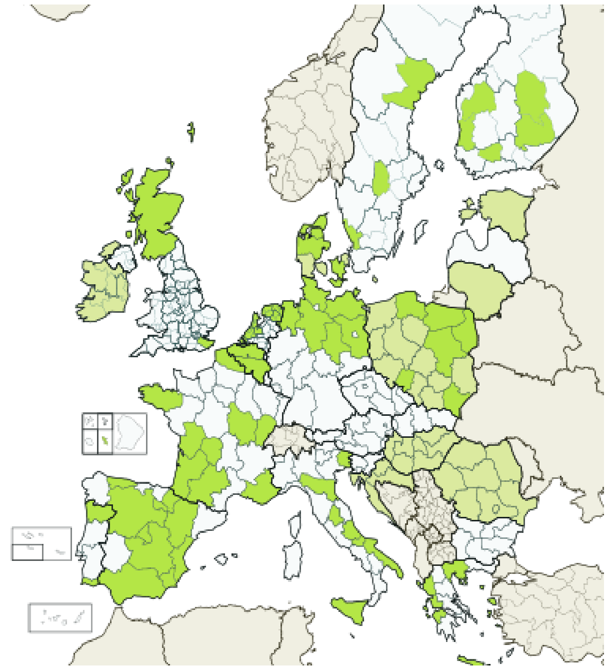
The main driver in ensuring the integration of alternative protein sources in Western diets is the enhancement of health and environmental awareness. Many initiatives have been launched recently to sensitise customers and other stakeholders to the environmental burden of animal rearing and to raise their interest in alternative proteins. Furthermore, research consortia have been established to provide better scientific evidence to support such initiatives.

EU PROteINSECT project brings together the expertise of 12 partners from 7 countries across Europe, China and Africa, ranging from feed industry multinationals, research centres and universities, to farmers and policy experts. The consortium aims to support and facilitate the adoption of fly larvae proteins in animal feed both from a technological and regulatory perspective. The project was launched in 2013 for a period of three years.

Rising awareness and interest is also being expressed at the community level by educational institutions. For instance, the products of Eat Grub, (a company showcased in case study 52 on new nutrient sources) are being sold to local schools as teaching material for lessons on nutrition and sustainability.

Living labs in the field of food are an interesting policy instrument to promote experimentation and awareness raising demonstration at the same time. Such initiatives are often part of regional innovation strategies. In 80 EU regions the Smart Specialisation Strategy involves food as one of its priorities (See Figure 3).

Figure 9: Regions in Europe which have a Smart Specialisation Strategy with food as their main or secondary innovation priority



Source: Smart Specialisation Platform, IPTS[25]

The Restaurant of the Future is such a living lab[26], and part of the regional innovation strategy of Food Valley (Gelderland in the Netherlands). It is a real-life environment where scientists can observe restaurant patrons in conditioned situations over a prolonged period of time. This research may include behaviour, food choice, design and layout, the influence of lighting, presentation, traffic flow, taste, packing, preparation and countless other aspects involving out-of-home eating and drinking. The Restaurant of the Future comprises two parts. The company restaurant is open to the general public, on the condition that all visitors are registered. During registration, the visitor agrees to be observed closely by cameras. The second part is a sensory consumer research lab which can be used by companies to assess their products under various circumstances, such as smell, colour and taste.

Another example, coming from Belgium, is the Smart Gastronomy Lab supported by the University of Liège and by a grant from the Creative Wallonia programme. This living lab is a restaurant and a research lab focused on making 3-D printed foods more palatable to people. It also creates foods with enhanced nutritional profiles that people actually want to eat. In the Smart Gastronomy Lab insects and algae are infused into traditional recipes to boost their protein profile, and "senior-adapted food" for elderly people is being developed[27].

Conclusions and policy recommendations

The policy challenge of promoting new protein sources has an innovation demand- and supply-side.

On the innovation supply-side the new protein sources industry is being held back by the current restrictive and unclear regulatory EU framework. The lack of a clear position at the EU level on the classification of insects and algae as Novel Foods results in a legislative ambiguity across Member States. Most particularly, the use of insect proteins in feed is being hindered by the lack of precision in defining the scope of the regulations. For example, the slaughtering requirements exclude insect proteins from being used in aquaculture feed.

Due to the unclear stance of the Commission on novel nutrient sources as feed and food, finding investors who are willing to take the risk to invest in an emerging and relatively unregulated sector is a challenge. Business Angels and Venture Capitalists are concerned that the precarious regulatory environment may never allow the alternative nutrient industry to fully take off and achieve the expected revenues, thus negatively affecting their return on the investments in the long run.

In 2013, the Commission presented a proposal for a Regulation. Under the draft, novel food would be subject to a simpler, clearer and more efficient authorisation procedure fully centralised at EU level, which should enable safe and innovative food to be placed on the EU market faster without compromising a high level of public health.

On the innovation demand-side marketing is a challenge: how to persuade customers and consumers to shift to these new sources of proteins. The so-called “yuck factor” remains a major obstacle to the uptake of new sources of proteins. This holds true especially for insects. Raising awareness and bringing about a change of mentality is a long and challenging process. On the other hand, other ‘super foods’

(foods with supposed health benefits) have also become popular in quite a short time. This contradiction highlights the difficulty to predict consumer's behaviour, mainly due to the cultural dimension.

Awareness raising initiatives and instruments such as Living Labs can fulfil an important role in testing, experimenting and demonstrating aspects concerning new protein sources, and ultimately persuade customers and consumers to shift to these new sources.

Moreover, businesses involved in the production and processing of insects intended for use as animal feed components face a major regulatory bottleneck related to the ban of processed animal proteins (PAPs) in feed[1]. Since slaughtering does not apply to insects, insect-derived proteins are naturally non-compliant with the existing regulation, meaning that insect-derived proteins are currently not allowed as a constituent of animal feed within the EU. Therefore to further unlock the large potential of novel nutrient sources, the animal feed regulation should be adapted to new protein sources.

Expert associations such as the International Platform of Insects for Food and Feed (IPIFF) and the European Algae Biomass Association (EABA) should play an important role in this process.

2.3. Boosting Civil UAVs market

Background

Civilian applications of UAVs lead to creation of jobs, developing innovative applications in various sectors or conducting dangerous important tasks.

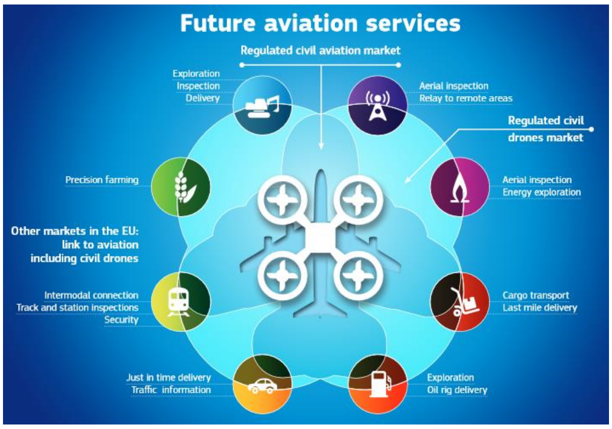
The overall aviation regulatory framework is established at the European level and covers the market of air services and aeronautical products. The EU, through the European Aviation Safety Agency (EASA) is competent for RPAS heavier than 150 kg. Lighter RPAS fall under Member States' competence. Moreover, in recent years, around ten Member States have issued partial regulation allowing limited RPAS operations.[2]

In order to address the currently fragmented regulatory framework, and also considering the huge potential that the RPAS market might represent for European industry and the aviation sector, in 2014 the European Commission adopted a Communication presenting its strategy on the future regulation of RPAS in the EU[28]. It proposed a combination of new and existing regulatory action at the European level, dealing with all relevant issues, including the insertion of safety, security, privacy and data protection requirements and the removal of legal uncertainties that hinder the development of the European market for UAVs.

In 2014, the EU Council of ministers expressed their agreement with the objective of gradual and progressive integration of civil drones into normal airspace, stressing the need to focus on safety in the first place.[29]

With the 2015 Riga declaration[30], the EU established the main principles that should govern UAV development to allow businesses to provide drone services everywhere in Europe as from 2016 onwards.

Figure 10: Future aviation services infographic



Source: DG Mobility and Transport, European Commission[32]

A general EU regulatory framework for data protection and privacy is also in place and should contribute to allay the possible concerns of the general public concerning the possible use of the data gathered through the RPAS systems. Notably, it should prevent that excessive concerns for public data protection and privacy may create a more restrictive approach towards the use of these devices. (See more on the regulatory issues in case study no 58).

On the innovation side the SESAR Joint Undertaking plays an important role[3]. Among selected projects EUR 4 million are granted for the first EU RPAS demonstration flights projects under SESAR. SESAR has helped to demonstrated in practice the feasibility of flying UAVs alongside civil air traffic. Italian air traffic controllers have recently completed a live

[1] This prohibition was promulgated by the European Commission through regulation (EC) 999/2001, following the *Bovine Spongiform Encephalopathy* (BSE) outbreak in the 1990s, and also extends to insects. The regulation was subsequently amended in 2013 by regulation EC 56/2013, allowing non-ruminant animal proteins to be included in aquaculture feed, thus theoretically lifting the ban on insect-based meal. However, a restrictive element persists in the form of tight requirements on the slaughtering of animals for PAPs production.

[2] For instance in Italy, the Civil aviation body (ENAC) regulation of 16.12.2013, Regolamento mezzi aerei a pilotaggio remoto. http://www.enac.gov.it/repository/ContentManagement/information/N122671512/Regolamento_APR_ed.1.pdf

[3] SESAR (*Single European Sky ATM Research*) is the technological pillar of the Single European Sky. It aims to improve Air Traffic Management (ATM) performance by modernising and harmonising ATM systems through the definition, development, validation and deployment of innovative technological and operational solutions.

demonstration with a RPAS in non-segregated airspace, showing how these types of aircraft can be managed safely and effectively by adapting existing procedures and technologies[31].

Figure 11: Drone picture

Source: SESAR[32]

Non-EU countries are also working towards the adoption of RPAS specific rules for civil UAVs to allow them to operate in an integrated way with the rest of air traffic. For example, the US Congress has mandated the Federal Aviation Administration to integrate RPAS into the US Airspace by 2015. The aim is to allow the market for UAVs to flourish in the USA. It is estimated that more than 34,000 manufacturing jobs and 70,000 jobs in total will be created in US in the first three years of RPAS integration in the national US airspace, with an economic impact of more than USD 13.6 billion. The same study forecasts that agriculture and public safety will represent the most promising civil markets in US[33]. In order to allay growing concerns over safety, the American administration announced recently the creation of a national registry of UAVs, and mandated a specialists' task force to study ways of implementing this approach[34].

Conclusions and policy recommendations

The existing UAV regulation is still fragmented. Moreover, the introduction of UAVs technologies for civilian use faces some barriers in terms of the risks involved in the widespread introduction of these systems; the security of an integrated aerospace between manned and unmanned aircrafts as well as public opinion concerns about the preservation of privacy.

Therefore it is necessary to continue the efforts to establish a solid European policy framework concerning UAVs to support this developing market that should guarantee both UAVs smooth integration into civil airspace ("non-segregated" as commercial aviation) and ensure high levels of safety, security and privacy for citizens.

Regulation for security and safety of UAVs operations is based on the perceived risks of operating these aircrafts along other vehicles or above populated areas. In fact, effective regulations should be deployed to ensure that vehicle integrates safety functionalities such as risk mitigation procedures in case of emergency. Therefore mechanisms and incentives should be devised for the rapid diffusion of safety technologies and the accompanying rules that would enable safe UAVs missions over crowds.

The uptake and integration of RPAS-related technologies should be encouraged, notably as regards piloting automation, detect and avoid sensors and secure data-link.

Appropriate rules should be proposed about how, where and when to operate UAVs which should lead both to an integrated and secure integrated air-space. Rules for smaller UAVs (i.e. below 150 kg) should be coherent and sufficiently flexible in terms of certification to avoid creating unnecessary barriers to a nascent industry.

These systems should be perceived in a wider sense as UAVs which are part of a network for data collection. Therefore issues related to regulation of RPAS should already seek to integrate this systemic approach and their possible impact in the product and services that could be derived from the deployment of this UAVs-based data systems.

Funding should be stepped up from public authorities for supporting demonstration programmes. Notably, the adoption and integration of RPAS related technologies should be encouraged (piloting automation, detect and avoid sensors and secure data-link).

Public Procurement should be adapted for the purchase of integrated UAVs solutions. Today, the market for UAVs services and missions for surveillance and mapping is highly institutional; advancement in innovation and technologies related to the development of these vehicles is usually sponsored through institutional purchases and support. However, when the innovation is not ready; the most important challenge for an SME is to gain access to supporting sources such as early stage public procurement. Therefore, the use of "Public-Procurement for Innovation" instruments could be envisaged to favour RPAS uptake by national, regional and local authorities.

The industry should also be more atrracttive for the risk capital, which is currently not the case because of the novelty of the technology.

Finally, the companies developing UAV technologies and systems have greatly benefitted from networks of informal collaboration with other companies in the industry and higher education institutions. Therefore, support should be considered for networking and internationalisation initiatives for the sector.

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