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BIOECONOMY $8 000.000.000.000 BIOTECHNOLOGIES

Prospects for the raw materials economy of Ukraine and its transition to a high-margin biotechnological processing industry

- Bioeconomy in the G7 countries
- Bioeconomy - win - win strategy for Ukraine
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- Cynefin method as a tool for risk management in bioeconomy
- Innovative landscape bioplastics
- Engineering Biology (SynBio)
- Wheat starch and wheat gluten: market, production, application
- Bioethanol production: dry or wet milling?
- Export opportunities of products of deep processing of grain

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CONTENT:

Olga Kulakova
CEO

When it comes to controversial scientific issues, scientists need to consider their approach to public engagement.

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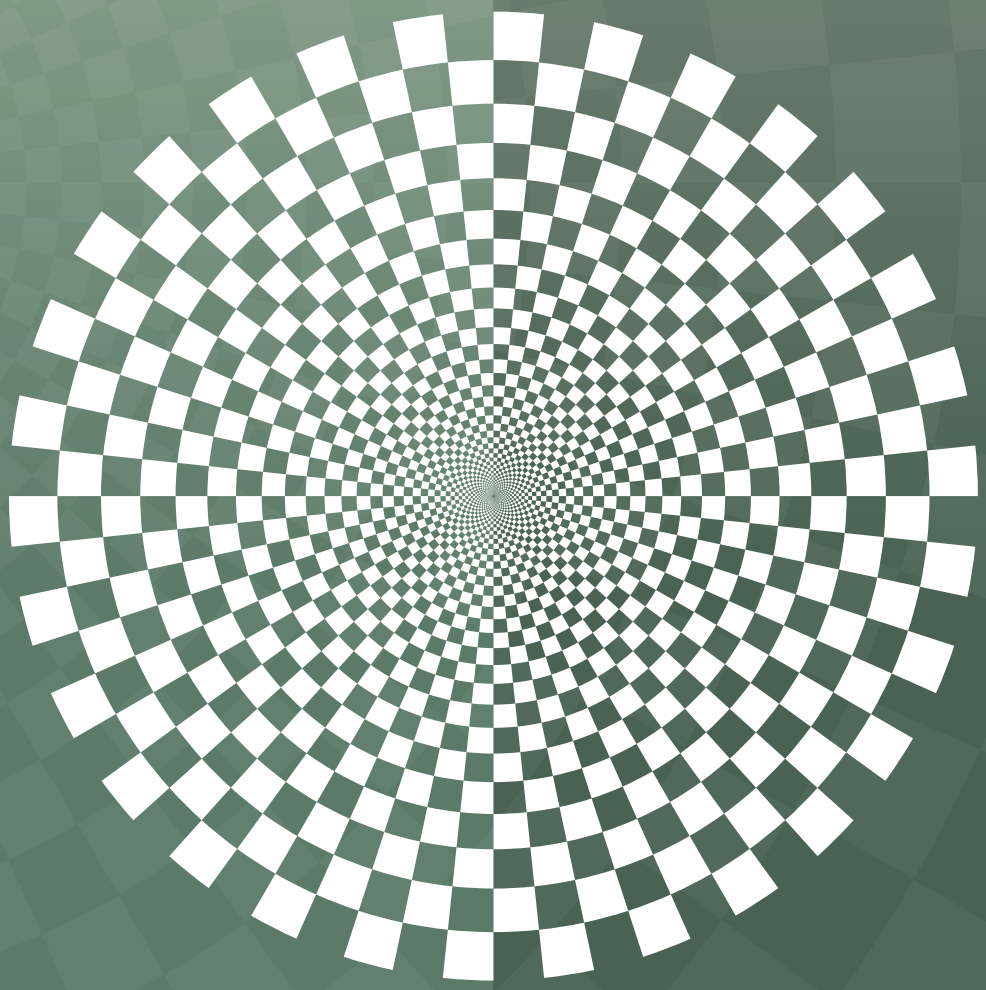

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BIOECONOMICS IN THE G7 COUNTRIES

Terms and Definitions

Bioeconomy, an economy based on "bio" process - it is an economic activity, including the research, production and consumption, using as a primary resource base of biomaterials and biotechnology formation of transformations in products and value-added services.

Circular economy or closed-loop economy based on resource renewal, it is an alternative to traditional linear economy. The circular economy aims to change the classic linear production model by focusing on goods and services that minimize waste and pollution. The principles of a circular economy are based on resource renewal, recyclability, and the transition from fossil fuels to renewable energy sources.

Sustainable Bioeconomy - a renewable segment of circular economy, which aims to maintain the value of the land, products, materials and resources.

What is the difference between a circular economy and a bioeconomy? Circular economy is “What?”: The result to be achieved, while bioeconomy is “How?”: What bio-processes must be used to achieve the result.

Which economic sectors are included in the bioeconomy?

Over the past decade, more than 50 countries around the world have had publications related to bioeconomy. Today there are already policy initiatives at the supranational level, for example, the Scandinavian countries have created the Nordic Bioeconomy, and in Central and Eastern Europe there is the Bio - East initiative. These pinpoint initiatives very clearly reflect the existing division of concepts between East and West: Eastern countries serve only as sources of raw materials for large Western companies and have limited access to research.

The development of bioeconomic strategies for CEE [Central and Eastern Europe] countries could help overcome imbalances and make better use of existing potential.

The national classifications of sectors included in the bioeconomy vary. For example, the Netherlands does not include forestry and food in the bio-oriented economy. The US excludes energy, food, feed, livestock and pharmaceuticals from the bio-economy.

Thus, there is no generally accepted classification of sectors included in the bioeconomy, but it is very important for a country to determine which sectors are included, what is the contribution of the bio-based economy to GDP, what added value it creates.

According to the European Bioeconomic Strategy, updated in 2018, the bioeconomy includes the sectors:

- terrestrial and marine ecosystems, including the services they provide
- all primary production sectors using or producing biological resources [agriculture, forestry, fisheries and aquaculture]
- all economic and industrial sectors using biological resources and processes for the production of food, feed, bio-products, energy and services (biomedicine).

Sectoral contributions to the EU bioeconomy in 2015,%

Sector	Worker 18 million	turnover € 2.3 trillion	ext. Art. € 620 million
Agriculture	51.0	16.8	28.0
Forestry	3.0	2.2	3.8
Fishing	1.2	0.5	1.1
Food industry	25.1	51.0	37.6
Bio-textiles	5.6	4.6	4.6
Woodworking	7.8	7.7	7.6
Paper industry	3.6	8.3	7.3
Chemistry and pharmaceuticals	2.5	7.8	9.1
Liquid biofuels	0.1	0.5	0.4
Bio-electricity	0.1	0.5	0.5

Source: EuroStat DataBase

Based on EU definitions, the European Commission has divided the bioeconomy sectors into 3 groups:

- Core bioeconomy: agriculture, forestry, fisheries, food processing, bio-energy and bio-fuels.
- Partial bioeconomy: chemicals, plastics industry, construction, pharmaceuticals, textile industry, waste management and bio-technology.
- Indirect Sectors- sectors that have an indirect impact on the bioeconomy: technology, machinery, retail trade, water supply services, and other services.

The history of the emergence of the term "bioeconomy"

The term "bioeconomy" was first used by Juan Enríquez and Rodrigo Martinez ,representing the Harvard Business School working group in 1997 at the AAAS Genomics Workshop . The term became popular in the mid-2000s when it was adopted by the European Union and the Organization for Economic Cooperation and Development as a political agenda and framework for promoting the use of biotechnology.

Since then, the EU [2012, 2018] and OECD [2016] have developed specific bioeconomy strategies. A growing number of countries around the world are integrating their bioeconomy strategies into policy frameworks.

The term is now widely used by regional development agencies, national and international organizations, and various biotechnology companies.

Current issues of bioeconomy

Human activities have violated 4 of the 9 planetary boundaries: climate change, biodiversity loss, land system change, and changing nitrogen and phosphorus cycles. We are witnessing the sixth mass extinction and biodiversity loss. Today, 75% of terrestrial ecosystems, 40% of marine ecosystems and 50% of freshwater watercourses have undergone major changes.

The total annual ecological loss of reactive nitrogen in Europe is estimated at € 70 ÷ 320 billion, which affects the quality of water and air, as well as affects ecosystems and human health. The ocean covers 70% of the Earth's surface and provides half of the oxygen we breathe, absorbs a quarter of CO2 emissions, and stores the greatest biodiversity on the planet.

Bioeconomy uses innovation in science and the bio-industry to achieve environmentally and socially sustainable growth and employment based on a wealth of biological resources. The usefulness and potential benefits of the bioeconomy have been recognized and acknowledged by all members of the G7, and more than 30 countries around the world.

In recent years, the EU has provided great political impetus and called for increased international cooperation to promote the development of the global bioeconomy. In bioeconomy, Germany, the United States and Japan have set ambitious targets with specific national strategies. France, Britain, Italy and Canada provide significant support to the biosphere-based economy.

Many countries are working to stimulate their bioeconomy, seeing it as a sector with great potential for sustainable growth. The strategies for the development and support of the national bioeconomy cover various areas, incl. agriculture, medicine, food industry, energy, industrial chemistry.

Review of Bioeconomic Policies for G7 Countries

Considering climate change, the depletion of fossil and mineral resources, global food situation and the significant progress in the field of natural sciences, members of the G7 have made significant efforts to take its rightful place in the economy based on the biosphere.

Germany, France, USA and Japan have set ambitious targets with specific national bioeconomy strategies. UK, Italy and Canada are also providing support. Within the G7, the EU has become the driving force behind bioeconomic policies. In addition to approving strategies and an action plan, the Horizon 2020 EU-28 program is planning significant funding for the bioeconomy. Many other EU members are also implementing country-specific bioeconomy strategies such as the Netherlands, Belgium, Denmark, Sweden, Spain and Finland. In the upcoming debate on the structural fund, 18 out of 28 EU countries have already indicated bioeconomy as a priority.

Differences between strategies

There are large differences in the political objectives and measures of individual countries, which are characterized by the prevailing industrial and economic profile of countries and the amount of resources available to them, especially their natural resource potential. Their underlying motives range from the desire to ensure access to resources to comprehensive renewal of the innovation system and the ecological transformation of the economy. Approaches also differ.

The United States and Canada have vast areas of forest, coastline, and arable land. Traditionally, they practice bioeconomy on a large scale, in terms of agricultural and forestry production. However, it was recognized that new technologies can further add value to the agricultural and forestry sectors while promoting rural development. Canada and the United States have developed utilization strategies focused on their natural assets. Key areas are the production of green chemicals or bioenergy such as wood pellets, bioethanol, and more recently also next generation biofuels. The United States and Canada have complemented agricultural strategies with an agricultural research strategy focused primarily on industrial biotechnology. When it comes to innovation policy, the term bio-economics is usually synonymous with biotechnology. North American countries are encouraging the use of biotechnology in agriculture, industry and medicine in the hope of gaining a technological advantage. In this interpretation, bioeconomy also includes healthcare, pharmaceuticals and innovative services [bioinformatics].

In countries with few natural resources and strong industrial structures like Germany, Japan, France and Italy, the bioeconomy is viewed more in terms of innovation potential. Unlike North America, the EU does not classify biotech innovation as part of the bioeconomy. The EU's focus is, firstly, on the replacement of fossil fuels and the associated reduction in greenhouse gas emissions, and, secondly, on achieving technological advantage through new methods of processing biomass to produce new products.

In resource-limited countries, access to and use of “alternative biomass” such as CO2 , waste or other residues plays a significant role. In order to ensure access to raw materials, Germany, Japan and the UK are also trying to establish international technological and resource partnerships with developing countries that have abundant biomass reserves.

Great Britain in particular has a highly developed service sector and excellent biological research. The country views the

bioeconomy primarily as an opportunity to capitalize on the strengths for the development of knowledge-intensive, high-performance industries. Second, it is pursuing a re-industrialization strategy, which is to develop vast productive capacities, for example, by converting decommissioned industrial facilities into biofuels.

Countries such as Germany, France, Japan and the United States have published nationwide, coordinated overarching bioeconomy strategies that include multiple departments (environment, agriculture, economics, research, etc.).

Other countries, such as Italy or Canada, rely mainly on sectoral or regional initiatives and are limited to developing framework conditions at the national level.

Political approach

Some G7 countries are “top-down”. Bioeconomy development is driven by the political sector, which develops concepts, strategies and action plans for the development of a bio-oriented economy. This category includes the EU, Japan, Germany and the United States.

Germany has a research and policy strategy approved by the Cabinet of Ministers.

Japan has developed a National Biomass Promotion Plan with quantitative targets for the use of renewable resources, and has adopted a biomass industrialization strategy.

With its technology-driven Bioeconomy Plan, the United States has identified a comprehensive package of interventions to foster biotechnology innovation. This is complemented by its agricultural policy, outlined in the “Farming Bill”, which includes measures for innovation in AgroSciences, bioeconomic infrastructure development and biomass production. In addition, the United States is the only country with a dedicated public procurement program for bio-products to stimulate market demand. Similar initiatives are currently being discussed in the EU.

In Italy, France and Canada, it is more of an industry driving the bioeconomy from the “bottom up”. The initiatives are initiated and funded primarily by the private sector. The political sector is limited to funding scientific research and related development. Where appropriate, framework conditions are established through funding of crop area for clusters, legal and regulatory interventions, or demand-side incentives [environmental procurement, bioenergy feedstock tariffs]. Thus, the role of the political sector is less active than in the USA, Japan or Germany, but it should not be underestimated.

For example, the vibrant biochemical and plastics processing industry in Italy is partly due to the ban on the use of single-use plastic bags. In addition to numerous cluster initiatives, France is making interesting strides in consumer standards. For example, certificates have been introduced for sustainable investment funds generating venture capital for the green economy. The construction industry uses a special label for bio-based buildings.

The UK is uniquely positioned in terms of political approaches. To a large extent, the industrial sector is the driving force behind the UK bioeconomy, although, for example, the government's bioenergy strategy is not backed up by further support measures. However, parliament is playing a very active role as there have already been two in-depth studies of the potential of the bioeconomy that have not yet been conducted in any other G7 country.

Review of Bioeconomic Policies for G7 Countries

Country G7	Strategy name	Responsible person	Key areas of funding
The EU	Driving innovation for sustainable growth	Government departments for science, research and innovation	Research & Innovation (Horizon 2020), public-private partnership
Germany	Bioeconomy Research Bioeconomy Strategy and Policies	Ministry of Scientific Research, Ministry of Agriculture	R&D food security, sustainable agriculture, healthy eating, industrial processes, bioenergy
France	Bioeconomy-related policies	Ministry of Ecology, Ministry of Scientific Research	Bioenergy, green chemistry, clusters, circular economy
Italy	There is no defined policy	---	Member of EU programs
Great Britain	Bioeconomy-related policies	Parliament, Department of Energy & Climate, Environmental Protection, Transport, Business	Bioenergy, agricultural sciences and technologies
USA	Bioeconomy concept, farm bill	White House, USDA	Biomedicine [Life Sciences], Agriculture [several fields]
Canada	Outrunning growth	Ministry of Agriculture	R&D on renewable resources and bio-based materials, bioenergy
Japan	Utilization of biomass	Cabinet of Ministers, National Council for Biomass Policies	Research and innovation, circular economy, regional development

Source : Bioökonomierat " Bioeconomy Policy & Strategies in G7 "

Regional stakeholders

Regional stakeholders play a significant role in advancing the bioeconomy in the G7. in Canada, British Columbia, Alberta and Ontario have developed their own concepts of bioeconomy. In Italy, regional green clusters have been established in Sardinia, Piedmont and Lombardy.

France supports regional “poles of competitiveness” with an environmental focus related to biological chemistry. In Germany, 2 federal districts have developed their own bioeconomy strategies - North Rhine-Westphalia [key areas: medical biotechnology, diagnostics and regenerative medicine] and Baden-Württemberg [key performances: biogas, lignocellulose value chains, algae optimization and bioeconomic modeling].

Global stakeholders

The OECD and the EU with a bioeconomic strategy are the only supranational stakeholders. So far, neither the United Nations (UNEP , UNCTAD or FAO), the World Bank [WBG], the Intergovernmental Panel on Climate Change [IPCC], or any other such organization has addressed the topic of bioeconomy. However, elements of bioeconomy play an important role in the WBG- initiated green growth knowledge platform.

The EU has been promoting the bioeconomy for about 10 years and is considered a pioneer internationally. Along with the numerous research projects that are anchored in the respective framework programs, the main goal is to create new value chains between industries that were not previously considered as economic partners.

Due to competition, individual EU countries have to be content with promoting less competitive areas, while the EU, as the main stakeholder, can finance projects close to market. This has been happening for several years under the umbrella of innovation financing, within which individual countries can also develop their own financing measures. An example is BIC's public-private partnership . The directly stated goal is to create "flagships" in the form of industrial plants and bioreactors. The total funding for the BIC initiative is € 1 billion from Horizon 2020 and € 2.8 billion from private funds.

BIOECONOMY OF THE EUROPEAN UNION

Driving innovation for sustainable growth

Bioeconomy of the EU

The European Commission defines bioeconomy as the production of renewable biological resources and the conversion of these resources and waste streams into value-added products such as food, feed, bioproducts and bioenergy.

Bioeconomy EU28 provides € 2.3 trillion. annual turnover [4% of GDP], generates € 620 million in value added, employs 18 million people [8% of the EU]. By 2030, the bioeconomy is expected to generate net economic benefits of € 1.8 trillion for the EU. + 1 million new green jobs through the development of new biodegradable products

Agriculture and forestry cover 85% of the EU area and generates € 437 billion per year. Food systems use 70% of all fresh water and 30% of energy. The agriculture and food sector [food, beverages and tobacco] accounts for 65.6% of value added, 67.8% of turnover and 76.1% of workers in the bioeconomy.

Although the agricultural sector employs 51% of all workers in the EU bioeconomy, it generates only 28.0% of value added, which indicates its low productivity. Conversely, the food sector generates 37.6% of value added while employing half the number of people. Green chemistry and pharmaceuticals employ 2.5% of people, and the generated value added is 9.1%.

Current position of the EU bioeconomy

The EU Commissioner for Research, Science and Innovation, Janez Potocnik, in 2005 for the first time presented a knowledge-based **bioeconomy concept:** “Transforming knowledge in the natural sciences into new, sustainable, environmentally efficient and competitive products”. According to the concept, bioeconomy encompasses industrial and economic activities that use renewable biological resources.

“The Cologne Paper”, published under the German Presidency of the Council of the EU in 2007, defines the **new economic concept** mainly as based on biological rather than fossil resources, with biomass as raw materials and bio-factories as production facilities. ... At the same time, bio products and processes within the Lead Market Initiative are recognized as key elements of future markets. Since then, the Directorate General for Enterprise and Industry has taken bio-based products into account when developing standards and regulations.

Finally, in 2012, the European Union presented **a bioeconomy strategy** together with an Action plan titled “Innovating for Sustainable Growth: A Bioeconomy for Europe“. The strategy document is divided into two sections: the" communication document" and the "working document". The EU Bioeconomy Strategy, formulated in 2012, updated in 2018.

In addition, the **European Innovation Partnership for Agriculture** EIP-AGRI [European Innovation Partnership for Agriculture] was established by the EU Commission in 2012 , which plays an important role in promoting the development of the bioeconomy. EIP-AGRI aims to promote the intensification of agriculture and forestry: Achieve more from less See [get more out of less] and to promote the proper quality and quantity of biomass for the production of food, feed, and new biomaterials.

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EU Bioeconomic Strategy

The European Commission defines bioeconomy as the production of renewable biological resources and the conversion of these resources and waste streams into value-added products such as food, feed, bioproducts and bioenergy.

Through the use of a wide range of sciences, promising and industrial technologies, as well as local and tacit knowledge, the sectors of the bioeconomy have a strong innovative potential. In 2012, the EU set a course for a resource efficient and sustainable bioeconomy. The goal is to create a more innovative and low-emission economy that combines the requirements of sustainable agriculture and fisheries, food security and the use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection.

To achieve these goals, the European Commission has developed a Bioeconomy Strategy and Bioeconomy Action Plan focusing on three key aspects:

- Investment in skills, research and innovation, development of new "bio" technologies and processes;
- Market development and competitiveness;
- Encouraging closer collaboration between policy makers and stakeholders.

The **Bioeconomy Strategy** document was prepared under the leadership of the Directorate General for Science, Research and Innovation. However, the Directorates for Agriculture and Rural Development, Maritime Affairs and Fisheries, as well as the Directorate for Business and Industry have contributed more to the development of bioeconomic policies in the EU.

The scientific and innovation component pays special attention to co-investment in the innovation market. The funds allocated for these purposes within the framework of the Horizon 2020 research program have doubled compared to the 7th framework program and reached € 4 billion. 1/4 of these funds are intended for public-private partnerships with the strengthening of EU industrial actions [The Biobased Industries Consortium] ... In addition, support was provided to engage in effective stakeholder dialogue for agricultural, forestry or marine research projects. A number of other Horizon 2020 programs also support bioeconomic innovations, for example in terms of resource efficiency - a public-private partnership in the chemical industry called Spire (spire) or in clean energy - the European Industrial Bioenergy Initiative EIBI [European Industrial Bioenergy Initiative].

To ensure policy coherence in the EU, a bioeconomy group was appointed as an expert committee in 2013 with the task of providing intersectoral and interdisciplinary policy advice over two years. The pan-European coordination of bioeconomy research funding should be further improved through ERA-Net activities and EU Member States' joint program initiatives. In addition, a bioeconomy observatory was established to develop policy and coordinate efforts in this area. Since 2016, the observatory has begun to register and scientifically support the development of bioeconomy in the EU through monitoring and modeling research.

The third component of the strategy is aimed at developing the market and increasing the competitiveness of the bioeconomy sector. Supporting activities are mainly related to standardization research and coordination of relevant implementation activities in the European Committee for Standardization (CEN). These implementation activities include the development of measurement methods and standards for various bio-based products, as well as labels for switching.

The bioeconomy strategy and innovation partnerships fall within the time frame of the Europe 2020 strategy. The Commission is working to ensure a coherent approach to the bioeconomy through a variety of programs and instruments, including the Common Agricultural Policy (CAP), the Common Fisheries Policy, Horizon 2020, the European Environmental Initiatives, the Blue Growth Initiative for the Marine Sector and the European Innovative Partnership for Sustainable Agriculture.

The bioeconomy strategy is being implemented primarily through research and innovation funding under the new Horizon 2020 framework.

The program Horizon Europe 2020

The program Horizon 2020 - the 8th Framework Programs for Research and Technological Development [the FP 8], the seven-year program [2014 ÷ 2020] EU funding to support and encourage research in Europe-sky research space. The largest framework program in the history of the EU, with a budget of € 80 billion at 2011 prices.

In June 2018, Juncker's Commissariat set a new level of ambition to deepen Europe's innovation potential: within the EU's long-term budget for 2021-2027. adopted a program of Horizon Europe 2020. Horizon Europe 2020 is based on the current program Horizon 2020 will promote academic excellence through the European Research Council of the ERC [by European Research Council], scholarships Marie Skłodowska - Curie and exchanges, benefit through scientific advice, technical support , JRC [Joint Research Center] targeted research , science and knowledge services.

The preliminary political decision on Horizon Europe 2000, reached by the European Parliament, Council and Commission, is now subject to formal approval by the European Parliament. The budgetary aspects of Horizon Europe 2020 are governed by the general agreement on the next long-term EU budget. Horizon Europe 2000 is expected to be operational from 1-Jan-2021.

Horizon 2000, like Horizon Europe 2000, is an open program in which organizations from almost any country can take part. All participants are divided into 3 groups:

- EU MS - EU member states
- AC - associate members (incl. Ukraine)
- Non-EU MS & AC - third countries

According to the rules of participation in the Horizon 2000 program, third-country organizations can participate in FP 8, but are not eligible for automatic financial support from the program budget. They can enter into consortia, but for their projects they must themselves seek funding for their projects.

With 7% of the world's population, the EU provides 20% of global investment in

R&D, produces a third of all high-quality scientific publications, and is a leader in pharmaceuticals, engineering, chemistry and fashion. EU funding has allowed teams from different countries to work together and make incredible discoveries, making Europe a world-class leader in research and innovation.

Linking Horizon 2000 to the EU Bioeconomy

As of 2019, the European Union has already invested € 4 billion in the bioeconomy sector under the Horizon 2000 program. This figure is planned to reach € 10 billion in the coming years.

Updated European Bioeconomy Strategy

The European Union's Bioeconomy Strategy was formulated in 2012 and updated in 2018. The new bioeconomy strategy seeks to improve and scale up the sustainable use of renewable resources to address regional and global challenges such as climate change and sustainable development. Its main goal is a neutral economy by 2050 and the preservation of Europe's natural environment. It paves the way for the renewal of European industries and sectors through biological innovation, food security and the value and protection of ecosystems and bioresources.

Action plan for strategy implementation

Achieving a sustainable and circular bioeconomy requires a concerted effort from government and industry. Building on three key EU goals in bioeconomy and to stimulate collective efforts, the European Commission has put forward an action plan for the development of a sustainable and circular bioeconomy that serves the European society, environment and economy, with 14 concrete measures:

1. Scaling up and strengthening biology-based sectors

- Establishment of a € 100 million circular thematic bioeconomy investment platform to move closer to the market and reduce the risk of private investment in viable solutions.
- Facilitate the development of new sustainable bio-processing plants throughout Europe.

2. Rapid expansion of the bioeconomy across Europe

- Development of a strategic program for the deployment of sustainable agricultural systems, forestry and bioproducts in the countries of Central and Eastern Europe with a large under-utilized potential of biomass and waste.
- Creation of the EU Bioeconomic Policy Support Fund under the Horizon 2020 program to develop national and regional bioeconomy programs.
- Launch of pilot activities for bio-economy development in rural, coastal and urban areas for waste management and agriculture.

3. Protecting the ecosystem and understanding the environmental constraints of bioeconomy

- Introduce a pan-European monitoring system to track the progress of the circular bioeconomy.
- Expand the knowledge base and understanding of the fields of bioeconomy by collecting data and making it available through the Bioeconomy Knowledge Center.
- Provide guidance and promote good practice in bioeconomy in a safe environmental framework.

Three key EU goals in the bioeconomy sector

In the “Working places, Growth, Justice and Democratic Change” program, President Juncker has identified 10 key EU priorities, of which the bioeconomy is at the center of three.

• New impetus for jobs, growth and investment

An innovative bioeconomy is an important source of new jobs, especially at the local and regional level, as well as in rural and coastal areas. It creates great opportunities for the growth of new markets in the areas of biodiversity, fuels, food and organic products.

• Flexible alliance of energy with forward-looking climate change policies

Europe must diversify its energy sources and support the breakthrough in low-carbon technologies through concerted research. Replacing fossil raw materials with biological resources is a component of a forward-looking climate change policy.

• Deepening of the domestic market with strengthening of the industrial base

An innovative bio-industry will help to increase the share of industry in GDP from 16% to 20% and create a closed resource-efficient economy. The food and non-alcoholic beverage industry is the largest manufacturing sector in the European Community.

Marine and food products are two aspects of the bioeconomy where Europe can and should lead the global agenda as part of a strategy to transform the EU into a strong global player.

Carlos Moedas , Commissioner for Research and Innovation, has identified three strategic priorities for the bioeconomy at European level:

• Bioeconomy can help address the serious food and energy challenges that require an open and innovative approach with close collaboration between all stakeholders;

- Bioeconomy is an open science as it promotes research across all disciplines;
- Bioeconomy is open to the whole world because it promotes research in the EU and beyond, as well as global cooperation to solve global problems.

As one of the few bioeconomic strategies globally, the EU document recognizes that the community must make an equitable contribution to addressing the most important global challenges, in particular climate change, resource stress and food security.

BIOECONOMY OF **GERMANY**

Comprehensive Bioeconomic Strategy

German National Bioeconomy Strategies

When it comes to bioeconomic policy, Germany is considered a world leader thanks to two documents: the National Research Strategy for bioeconomy «Forschungsstrategie BioÖkonomie 2030", published in 2010, and Strategy bioeconomic policy , published in 2013.

While both strategic documents aim to strengthen the domestic bioeconomy, they also provide a global perspective, for example on global food security and social standards.

Back in 2009, an independent expert committee, the German Bioeconomy Council , was created to advise the federal government on bioeconomic policy and facilitate stakeholder dialogue.

The National Bioeconomy Research Strategy was developed under the leadership of the Ministry of Education and Research. The National Research Strategy (NFS, 2010) received € 2.4 billion, which is primarily aimed at strengthening the innovative capacity of research organizations and enterprises. Various programs have been funded through the NFS, such as the Renewable Sources Program, BonaRes (land), GloBe (World Food Security), IPAS (Plant Breeding), DPPN (Plant Externals and Internals), ANIHWA (Animal Health), and basic research. in the field of biotechnology and bioenergy.

The support measures stimulate the creation of unusual alliances between the scientific community, SMEs and large industrial enterprises from various sectors to help create new bioeconomic value chains. For example, the lignocellulose plant of the bioeconomic cluster in Leuna is funded with € 40 million. The national research strategy covers the period up to 2016.

The Bioeconomic Policy Strategy is the result of a collaboration between the Ministry of Food and Agriculture (BMEL), the Ministry of Education and Research BMBF, the Ministry of Economic Affairs and Energy (BMWi), the Ministry of Economic Cooperation and Development (BMZ), the Ministry of Environment and Nuclear Safety (BMUB), the Ministry of the Interior (BMI) and the Ministry of Foreign Affairs (AA). Political strategy has no time horizon.

Rather, the research strategy focuses on innovation in five target areas:

1. global food security
2. sustainable agricultural production
3. healthy and safe food
4. use of renewable resources
5. increased use of sustainable bioenergy

Sustainable production of renewable resources and advances in biotechnology are considered key drivers of the development of the bioeconomy.

The policy strategy aims to ensure consultation and cooperation between various political and public stakeholders. Objectives: increase transparency, identify potential conflicts of interest and facilitate discussion of appropriate solutions at the regional, federal and international levels.

Action plans for national strategies

Along with these strategies directly related to the bioeconomy, the Action Plan for the Use of Renewable Resources for the Production of Materials and Energy (2009/2010), the Action Plan for Renewable Energy (2010) and the Forest Strategy 2020 (2011) also play a central role in the development of the bioeconomy. ...

An action plan for the use of renewable resources for the production of materials and energy and the Forestry Strategy are developed by the BMEL [Ministry of Food and Agriculture]. The Renewable Energy Action Plan has been developed by BMW [Ministry of Economy and Energy].

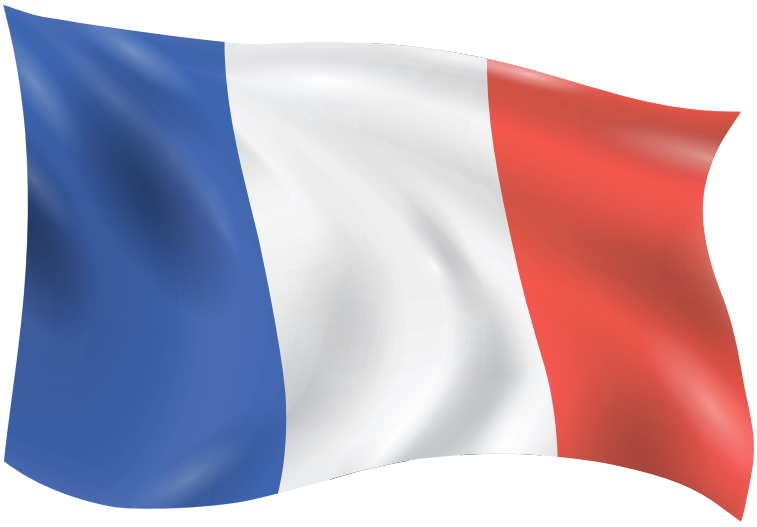
The development of demonstration and pilot plants is supported by various federal and regional ministries. Examples include a second-generation bioethanol plant in Straubing, a biogenic waste plant in Karlsruhe and an algae kerosene refinery in JuIich.

Strategy policies

Strategic policies cover a wide range of applications and interventions along the bioeconomy value chain, providing a comprehensive list of specific policy actions to advance the bioeconomy, taking into account potential conflicts of interest. The policies of the strategy describe R&D funding schemes for renewable resources, industrial biotechnology, and agricultural sciences, and measures to expand and accelerate technology transfer.

BIOECONOMY OF **FRANCE**

Resource wealth as a growth lever



Current position of the bioeconomy of France

In 2015, the turnover of the bioeconomy sector in the EU-28 amounted to € 2.259 billion, incl. in France € 333 billion [14.7% of the EU turnover], in the Netherlands € 114 billion [5%].

France's bioeconomy, with a turnover of € 50 billion, including agriculture and forestry, fisheries, food, beverages and tobacco, is one of the largest in Europe. Food, beverages and tobacco accounted for more than half of France's bioeconomy sector (in terms of turnover), with agriculture just over 20%. Other important sectors are biochemistry, pharmaceuticals and the plastics and rubber sector.

Until 2017, France's bioeconomy did not define a specific research and policy strategy, but was discussed in the context of a green economy [economie verte] and industrial ecology [ecologie indistrielle] , and in recent years in a circular economy [economie circulare].

In 2017, France adopted a national bioeconomy strategy, and in 2018 a corresponding action plan for 2018-2020. The strategy defines: Bioeconomy is a set of activities related to the production, use and processing of biological resources. Bio-products are defined as products derived in whole or in part from bio-resources.

Bioeconomy Strategy and Action Plan
French Bioeconomy Strategy

In order to support the development of the bioeconomy, France has developed a strategy, which on 18-Jan-2017 submitted to the Council of Ministers. It is the result of ministries of agriculture, environment and economy and scientific research, in addition to input from stakeholders including top-down economic agents, government agencies, researchers, civil society, etc. The French Bioeconomy Strategy lays the foundation for the sustainable development of the bioeconomy, taking into account the resources and needs of the national territory, while avoiding overexploitation.

Bioeconomy Action Plan

The Bioeconomy Action Plan translates the Bioeconomy Strategy into concrete actions, ensuring its rapid implementation across France in 2018, 2019 and 2020. The action plan intentionally focuses on the non-food components of the bioeconomy in 2018. It does not address the use of food-related biomass as it is not covered by specific policies.

Developers and implementers of the French bioeconomy

The bioeconomic policy of France was developed simultaneously by several ministries:

- Ministry of Economy and Finance
- Ministry of Higher Education, Research and Innovation
- Ministry of Territorial Cohesion
- Ministry of Ecological Transition
- Ministry of Agriculture and Food

The actual implementation of bioeconomy policies is carried out by:

- Agencies such as French environment and energy management agency and French agency of a biodiversity;
- Research organizations: National Institute for Agricultural Research with regional centers in France [INRA], National Center for Scientific Research with branches throughout France [CNRS], National Research Institute for Science and Technology for Environment and Agriculture [IRSTEA];
- State - owned industrial enterprises [EPIC]: Agricultural Research Center for International Development [CIRAD] and Commission on Alternative Energy and Atomic Energy [CEA];
- Higher education institutions linked by the French public university system, such as, but not limited to, the School of Agricultural and Biological Sciences [\ENSA], Schools of Chemistry [ESCPE], Polytechnic Institutes, National Institute of Applied Sciences [INSA];
- Competitive clusters combining small, medium and large enterprises, knowledge institutions, for example, Pole IAR - Pole de la Bioeconomie [308 members], AXELERA [345], Mer Bretagne Atlantique [332], Mediterranee [360], USIPA [8] *; currently 56 clusters are registered;
- The Carnot Institute, established in 2006 for research conducted by government laboratories in partnership with socio-economic players. The

Carnot Institute conducts a competitive selection of applications, assigns the Carnot mark [mark have 36] to research structures, tests the innovative competencies of industrial partners.

For specific actions under the Strategy and Action Plan for 2018-2020, these organizations are designated as “lead entities”.

Bioeconomy Action Plan

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The French bioeconomic strategy is consistent with another national strategy for bioresources extraction, mobilization and use, environmental goals and objectives: Plant Protein Plan, National Low Carbon Strategy, National Biomass Mobilization Strategy and Regional Biomass Schemes, Roadmap for a Circular Economy, National Strategy biodiversity conservation, multi-year energy program, “4 per 1000” program, National Forest and Timber Program, Convention on Biological Diversity, National Seas and Coastal Areas Strategy.

The action plan intentionally does not cover the previously discussed topics. In particular, the Action Plan does not address everything related to the circular economy, such as recycling bio-waste.

The bioeconomy will not develop without the involvement of local regions. The action plan focuses on a national framework and instruments that can help to develop the bioeconomy in the regions. The government can support regions to implement local policies for the bioeconomy and to ensure satisfactory linkages between national and regional strategies.

The Action Plan is the result of a wide-ranging consultation process involving government and stakeholders. Some of the actions at the request of the President of France are derived from sectoral plans drawn up by cross-sectoral bodies.

The action plan translates the overall bioeconomic strategy into operational actions under 5 headings:

- Expanding knowledge
- Promotion of bioeconomy and its products
- Coordination of supply terms with demand
- Sustainable production and processing of biological resources
- Removing barriers and financing

The plan lists specific actions, with a description and indication of the content, expected results and time frame for each action. Each action is detailed in a specification describing the framework, identifying targets to be achieved, a proposed implementation schedule and specific indicators to monitor progress and / or results.

French politicians

The French national bioeconomy policy stems from EU policy, in particular the European Bioeconomy Strategy [2012 , updated in 2018]. This policy aims to accelerate the deployment of a sustainable European bioeconomy and maximize its contribution to the implementation of the United Nations 2030 agenda and its sustainable development goals.

The main goal of the activities is to ensure sustainable satisfaction of society's needs for food and part of society's needs for materials and energy, while conserving natural resources and guaranteeing the provision of high-quality environmental services.

These actions should be:

- effective, sustainable, circular and productive in the long term;
- focused on raising awareness of the general public about the benefits of bioeconomy:
- based on local regions and contribute to the creation of local jobs and the development of economic value
- to recognize the leading role that bioeconomy plays in creating value in France.

The proposed measures are aimed at strengthening the attractiveness of France and making it a leader in the bioeconomy at the European and global levels.

The future of France's bioeconomy

In the future, the bioeconomy is expected to play a key role in the production of renewable sources, improving the sustainability of chemicals and industries, and the transition to a circular economy.

The bioeconomy sector is changing rapidly. New developments and new policies are changing both the turnover and the shares of individual sectors in the overall French bioeconomy market. For example, the chemical industry has set a goal to double the amount of plant materials used by 2020. With its competencies and resources, France should also seize the opportunity and become a leader in the supply of vegetable proteins to the domestic market and for export [30 Projects pour une agriculture competitive & respectueuse de i'Environnement , 2015]. France should strive for 100% recyclable plastics Year and 2025 to reduce the emissions of GHG gases avoid additional emission of CO 2 gas volumes 8 million tons / year, thanks to the plastics processing [roadmap for circular economy, 2018].

) * The Federation of Industries USIPA [Union des Syndicats des Industries des Produits Amylaces et de leurs derives] represents 8 private companies: 4 in starches [Roquette , Tereos , ADM and Cargill] and 4 in caramel ingredients [Metarom , Nigay , Pectnerand Sethness - Roquette].

BIOECONOMY OF **ITALY**

Chimica Verde cluster [green chemistry]

The current position of Italy's bioeconomy

In Italy, the Chimica Verde [green economy] concept has more political relevance than the bioeconomy concept. One of the most important tasks is the transition of the chemical industry to green or plant chemistry. Innovation efforts are less focused on agriculture or water resources than in other countries. However, due to competition for land and food, practically nothing has been done in practice. In addition, genetically modified organisms in agriculture and the food industry are controversial.

Although Italy has been developing a federal strategy for bioeconomic research for some time to this day, not a single document has yet been published. Italy has hosted and will continue to host important international events related to the bioeconomy, namely the 3rd EU Stakeholder Conference on Bioeconomy in 2014 and the World Expo 2015 on World Food Security. This could raise political awareness and stimulate the development of a bioeconomic strategy in Italy

In the scientific field, the state-funded universities of Bologna, Milan, Turin and Florence are very active in the bioeconomy sector. In 2012, the Ministry of Education, Universities and Research called for the creation of innovation clusters that will be funded by EU programs such as the Structural Fund or Horizon 2020. At the end of 2012, the Ministry approved the National Biotechnology Cluster, which focuses on green chemistry ... The cluster began operations in 2014 and is supported by eight regions. In 2013, the Ministry of Economic Development created the Sustainable Growth Fund (Fondo per la Crescita Sostenibile) to support SME , in particular with a total funding of around € 300 million for research projects aimed at key innovation areas of the EU Horizon 2020 program .

Italy took on a pioneering role in the development of the market and in 2011 prohibited businesses from supplying non - biodegradable plastic bags. This law has made a significant contribution to the promotion of green chemistry in Italy. The Italian industry, especially in the north, is creating a bioeconomy in the field of green chemistry. This is taking place through a bottom-up approach, without any significant national support, but with the help of EU research programs.

Examples of building large-scale biomaterials production are the succinic acid plant in Cassano Spinola or the biological 1,4-butanediol plant near Venice, and the conversion of the largest fossil-based chemical complex in Sardinia into a large-scale plant, bio-based, between ENI and Novamont . In this sector, there are a number of important processes of joint activities of the Italian industry with the French, Belgian, Dutch and, more recently, American industry.

Until May 2019, Italy focused not on developing its own bioeconomy, but on EU programs in the field of biotechnology. Its goal was to rapidly modernize key sectors of the industry. The challenge for Italian companies was to increase competitiveness through participation in international networks and programs and technology clusters.

Italy's updated bioeconomic strategy

Italy has updated its national bioeconomy strategy. It was officially presented by the Italian government on the morning of May 1-2019 in Rome, in the presence of Waldemar Kutta [European Commission] and Philippe Mengal [BBI JU Executive Director]. Now the Italian bioeconomy means integrating sustainable production of renewable biological resources and converting these resources and waste into value-added products such as food, feed, organic products and bioenergy

This strategy aims to provide a shared vision of the economic, social and environmental opportunities and challenges associated with creating an Italian bioeconomy based on longer, sustainable and locally oriented value chains. It also provides Italy with a significant opportunity to improve its competitiveness and role in promoting sustainable growth in Europe and the Mediterranean.

The Italian bioeconomy is worth € 328 billion with 2 million jobs, according to a new report released by Intesa Sanpaolo, a leading Italian banking group. The goal of the strategy is to increase these indicators by 15% by 2030. The bioeconomic strategy will be part of the National Smart Specialization Strategy, focusing on areas such as health, food and quality of life "+ sustainable industry, energy and the environment.

BIOECONOMY OF THE **WHITE HOUSE**

Development of new markets

Current position of the US bioeconomy

The US bioeconomy, encompassing healthcare, information systems, agriculture, food processing, national defense, chemistry, and other spheres, is rapidly developing, exerting an increasing influence on the viability of America. Biotechnology generates 2% of US GDP, or $ 388 billion. To remain the global leader in the bioeconomy, the US needs to develop an ecosystem that prioritizes innovative research in addition to developing strong infrastructure, workforce, and data access systems.

Recognizing the critical role of bioeconomy in the industries of the future, in Aug 2019, the Trump administration signed the R&D Priority Memorandum for 2021, which identified bioeconomy as a key area for federal agencies to focus R&D efforts on.

In September-2019 Office of the White House Science and Technology Policy OSTP [of The White House is of Office of Science and Technology the Policy] published a request for information from the public and stakeholders, which should make the federal government to promote and protect US bioeconomy.

On Oct 7, 2019, America's first bioeconomy summit was held at the White House. The summit marked a meeting of the country's bioeconomy experts, federal officials, and industry leaders to discuss the challenges, opportunities, and leadership of the United States in the bioeconomy. The summit ended with a series of breakout sessions that allowed over 100 participants to discuss specific topics in small groups.

Key -conclusions from breakout discussions

• Building a workforce for the bioeconomy of the future

Leadership in the bioeconomy depends on its greatest asset, the workforce. It is imperative to maintain the education and training pipeline for the next generation of scientists, engineers and innovators in the bioeconomy field. The importance of providing large research and academic institutions is recognized.

• Promotion and protection of critical bioeconomy infrastructure and data

At the heart of bioeconomy success is secure infrastructure and data to ensure that the new field will benefit Americans. Security must be combined with innovation and flexibility, with a specific approach to protecting genetic and biological infrastructure and data.

• Leverage the entire US innovation ecosystem

Cooperation and partnerships between sectors are an important topic of the summit. Participants acknowledged that the federal government alone cannot provide US leadership in the field of bioeconomy; potential opportunities for cooperation between the entire innovation ecosystem of the country with industry and academia are needed.

• Regularly identify opportunities and challenges

The field of bioeconomy requires a regulatory framework that stimulates innovation and allows big breakthroughs to surpass itself. Participants from the private sector and academia provided federal officials with a view of regulatory approaches that will support new technological scientific advances in this area.

Summit Conclusions and Next Steps

The White House continues to seek governmental and nongovernmental prospects for maintaining and strengthening the US leadership in the bioeconomy. The President's Executive Office is working with partners in their federal agencies to improve interagency cooperation and prioritize bioeconomy in R&D budgets to stimulate basic research in this area.

Whether it's about supporting ecosystem R&D, developing the American workforce, or reforming administrative barriers to new discoveries, the main goal is to keep America as the world's innovation capital. The US launched the National Artificial Intelligence Strategy, the National Quantum Initiative, 5G Infrastructure: the administration considers biotechnology to be just as important an industry, and the bioeconomy is already an integral part of the overall US economy.

In 2017, revenues from engineering biological systems reached almost $ 400 billion. In 2018, the private sector invested $ 3.7 billion in early stage biological engineering companies and manufacturing technologies. CAR - T is an amazing new biological treatment for cancer from the patient's own immune cells instead of surgery, chemotherapy and radiation.
For the military draft “Medusa” [by Project Medusa], which is a prototype of a bio-factory airstrips, which allows you to build airstrips where we want and when we want to, in a short time by eliminating the need to deliver concrete and asphalt for construction, increasing the mobility, efficiency and strength of the military.

BIOECONOMY OF **CANADA**

Resource wealth as a growth lever

The current position of Canada's bioeconomy

Canada has not yet developed a federal strategy or vision for bioeconomy. In 2006, Canada developed a renewable energy strategy in which wood plays a key role as a raw material [Bio - Pathway Project, 2009].

The Growing Forward Agricultural Strategy [2013 ÷ 2018] defines Canada's agricultural policy with a total investment of CAD 3 billion for innovation, competitiveness and marketing. The Canadian government has high hopes for the application of biotechnology to agriculture and forestry. Accordingly, the commercial cultivation of genetically modified crops was adopted at a relatively early stage.

Inspired by the preparatory efforts of the US Bioeconomy Project, in 2009 the National Biological Association BioteCanada developed a strategic Blueprint beyond Moose and Mountains, a competitive strategy motivated by the fact that the Canadian bioeconomy may lag behind the world [USA , France and even Brazil]. The plan was discussed at a round table with political and stakeholders [Public Policy Forum, 2009], but was not adopted.

The future of Canada's bioeconomy

Several targeted bioeconomic policy actions have been taken at the provincial level. In 2011, the British Columbia government created the Bioeconomy Council under the Department of Labor, Tourism and Innovation. The province is focusing primarily on harnessing vast forest and Agri-Resources for bioenergy, but also recognizes the need to develop private technology.

Alberta is one of the strongest agricultural provinces in Canada and also relies on the bio-economy. In addition to agriculture, the strategy also promotes the production of bio-based chemicals and materials, as well as bioenergy.

The responsibility for developing the Growing Forward agricultural strategy rests with the Ministry of Agriculture. The strategy provides funding for programs in the field of agricultural research and commercialization of innovations, but these programs are not specifically focused on environmental or bioeconomic applications. The strategy is being implemented in selected provinces on a co-financing basis.

Natural Resources Canada [Natural the Resources Canada] is responsible for developing policies in the field of bioenergy and forestry. The Forest Innovation Program (FIP) supports research, development and technology transfer in the Canadian forest sector. Bio-materials are directly mentioned.

In addition, the ministry also manages the Canadian Biomass Innovation Network CBIN [Canadian Biomass Innovation Network], consisting of researchers, policy makers, industry experts, an NGO. CBIN awards innovative projects in sustainable resource management, biomass conversion technologies, bio-processing and sustainability measurement techniques. These funds come from the top-down programs ecoETI [ecoENERGY Technology Initiative] and BEST [Bio - Based Energy Systems and Technologies].

The NextGen Biofuel Foundation is supporting the construction of second-generation bio-fuel demonstration plants.

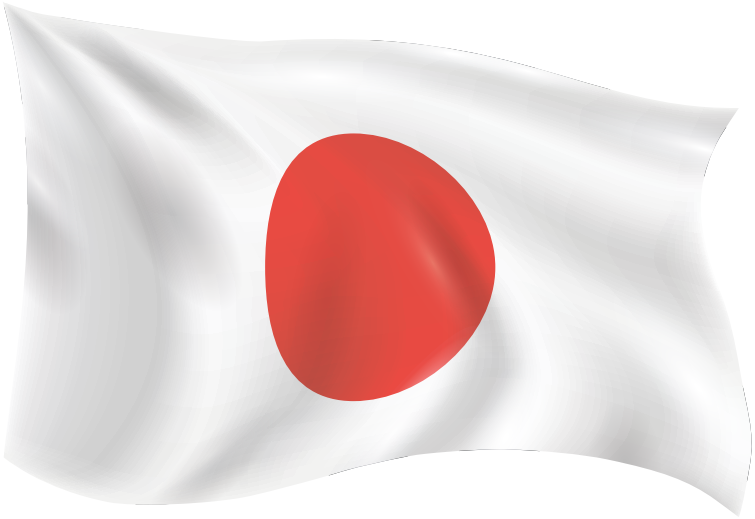
Policy strategies are backed up by traditional funding for research and technology, as well as commercialization projects. Private sector stakeholders are expected to finance these investments.

Several Canadian provinces are also planning to establish a collaborative bio-brigade cluster with a focus on sustainable chemistry, similar to industrial clusters in Lampton and Sarnia, where international industrial consortia are building industrial plants to produce biochemicals. To stimulate demand, the national green policy stipulates that environmental criteria must be taken into account in the procurement process.

R&D programs are limited to 5 ÷ 7 years. The country's federal R&D efforts are based on the optimal use of the country's natural resources. Bioenergy is a priority. Biomaterial research is playing an increasing role Currently, the Canadian federal government is limited to coordinating strategic objectives without defining its own overarching bioeconomy strategy. British Columbia's Provincial Strategy seeks to create a long-term “bioeconomic vision” that includes various goals such as protecting the climate, opening up new markets, creating jobs and stimulating renewable energy production.

BIOECONOMY OF **JAPAN**

Regional energy and circular economy



Current position of Japan's bioeconomy

The term “bioeconomy” is almost never used in Japan, but there are strategies and plans aimed exclusively at the production and industrial use of biomass that are consistent with the concept of a bioeconomic strategy. The Japanese Cabinet of Ministers has defined national strategies such as the National Biomass Promotion Plan, the Comprehensive Research and Technology Strategy, and the Biodiversity Conservation Strategy. The biomass industrialization strategy was defined by the National Council for Biomass Policy.

Japan's National Bioeconomy Strategies

With the aim of creating a sustainable economy through the efficient use of biological resources, the Biomass Nippon Strategy was developed in 2002 .

In 2009, the “**Basic Law on the Promotion of the Use of Biomass**” was adopted , which set out the principles for the use of biomass and defined government responsibilities, stakeholders and funding. Under this law, a National Council for Biomass Policy was appointed. The council consisted of representatives of seven (7) line ministries: the Cabinet of Ministers (national strategy), the Ministry of Economy, Trade and Industry, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of the Interior (regional development), the Ministry of Education and Science, the Ministry of Transport and infrastructure (infrastructure policy) and the Ministry of the Environment (policy to reduce greenhouse gas emissions). In order to ensure comprehensive and effective promotion of the use of biomass and coordination of actions between departments, a conference call on the use of biomass was established. The conference center is located in the Ministry of Agriculture, Forestry and Fisheries (MAFF).

In 2010, the National Biomass Promotion Plan was adopted , which sets quantitative targets for biomass use until 2020 and sets fundamental policies at the national and regional levels. It aims to provide a framework for increasing the use of available biomass and aims at efficient use of biomass throughout the value chain.

The **National Biomass Promotion Plan** (2010) defines three national targets:

1. Use of biomass 26 million tons / year (CO 2 equivalent) and the purpose of using certain types of resources;
2. Development of plans for prefectures and 600 districts;
3. ¥ 500 billion development of a new bioeconomy

In the short term, the main priorities are the development of technologies for using waste and residues (wastewater, paper and wood, food, agriculture and forestry) for energy production, and in the medium term, the development of industrial technologies (bioplastics, biofuels, logistics). In the long term, innovations in new biological resources (such as algae) and bioreactors are advancing.

The funding was aimed at ensuring stakeholder collaboration throughout the value chain through the primary, secondary and tertiary sectors. The action plan focuses on the technology vector (key technologies and sources of raw materials) and the training of consultants.

Following the Great East Earthquake and Tsunami of 2012, the Biomass Industrialization Strategy was developed, setting out guidelines for promoting the industrial use of biomass. The aim of the strategy is to achieve autonomous and decentralized energy production.

To achieve the goals, the biomass industrialization strategy identifies 7 areas of action:

1) basic research
2) Technology
3) supply of biomass
4) demand and market development
5) specific biomass strategies
6) a comprehensive support strategy and
7) strategy of globalization.

For each of the seven areas of activity, the Strategy includes measures. Basic research and technology are supported with specific ideas for content. For example, funding for basic research in the field of biotechnology and microalgae technology, funding for applied research in the field of biofuels and thermal utilization of biomass, including experimental installations and tests. The ALCA [Advanced Low Carbon Technology Research and Development Program] program of the Japanese Science and Technology Agency JST [Japanese S & T] is one of the funded innovation programs. In addition to solar research,

investments are also being made in "game - changing" biotechnology.

The main thrust of the industrialization strategy (2012) is the development of renewable energy systems (currently less than 10%) in rural areas and the development of industrial conversion technologies (eg. fermentation, combustion, fuel conversion) as well as new products. Another particular priority is the need to establish a biomass system, including logistics, along the entire value chain. Awareness campaigns are needed to make the public aware of these issues, and pilot projects are planned to encourage them to take action.

Along with increasing the share of renewables and reducing greenhouse gas emissions, a biomass strategy should help rebuild rural areas and encourage sustainable land use systems. The biomass strategy is consistent with the implementation of effective life cycle management. Interdisciplinary and international cooperation in bioeconomic research and industry contributes to cultural changes in Japanese society that the government deems necessary.

The Biomass Industrialization Strategy (2012) is focused on achieving these goals. Japanese politics implements various strategies through goals, action plans, and measurable indicators.

After the change of government, Abe's cabinet adopted the **Japan Revival Strategy** in 2013 , according to which scientific research and technology should lead Japan to new growth. Based on the strategy, in June 2013 the Cabinet of Ministers adopted a comprehensive science and technology strategy, which focuses on creating a clean energy system and revitalizing the regional economy.

The National Strategy and **Action Plan for Biodiversity Conservation 2012-2020** also contributes to the development of the bioeconomy. Living in harmony with nature is recognized as a new paradigm for the Japanese people. The Biodiversity Conservation Strategy emphasizes the importance of the traditionally managed agricultural and forestry areas of Satoyama for maintaining and restoring the vitality and efficiency of ecosystems. It should help revitalize rural areas that suffer from youth migration to urban areas. From a socio-economic point of view, the need to achieve a more equitable distribution and more intensive exchange of resources between rural and urban areas is recognized. The biodiversity conservation strategy envisages a 50% reduction in the use of pesticides and chemical fertilizers in agriculture through the introduction of natural plant protection methods and improved management.

Implementation of Bioeconomic Policies in Japan

In 2012, a single-entry tariff was established for renewable energy sources, incl. biomass. In 2012, the Law on the Promotion of Green Procurement was also adopted. Government subsidies are required for the procurement of environmentally friendly products. Japan has introduced a variety of labels to identify green and bio-based products for consumers: the Ecoleaf biodiversity label, GreenPla, and BiomassPla for bioplastics.

Quantitative targets, for example in the food sector (food processing law), are introduced to improve the supply of biomass and the circular economy. Recycling of food waste is mainly used for the production of animal feed, 38% of which is to come from domestic production by 2020 (baseline for food, agriculture and rural areas).

In addition, through pilot projects and direct payments, local recycling concepts and biomass management systems are being developed. There are also tax incentives for biofuel producers. To mitigate the effects of climate change, a CO 2 tax was introduced in 2012. The CO 2 tax rate was gradually increased until April 2016. In parallel, a standardized system for carbon certificates or credits was introduced. Private funding for green innovation should be encouraged by tax incentives for companies with high R&D spending and tax exemptions for losses from venture capital holdings.

As part of the support strategy, regional biomass industrialization networks are encouraged. The goal of these networks is to realize the concept of biomass, to create bio-based, environmentally friendly and resilient communities. Business clusters along the biomass production value chain should also contribute to this development. The globalization strategy focuses on developing business models and connections within Asia.

The RIKEN R&D Institute implements a comprehensive biomass research program covering the value chain from raw materials through chemical processes to biomaterials. The National Institute of Advanced Industry, Science and Technology is engaged in research on important topics in the field of green chemistry and renewable energy. It has its own research centers for bio-purification, including demonstration plants, bio-production, renewable energies and bio-based materials.

BIOECONOMY WIN - WIN STRATEGY FOR **UKRAINE**

Ukraine's course on bioeconomy

On the Ukrainian arena, company Insightex defines bioeconomy as follows:

Bioeconomy or economy based on bio processes - all types of economic activities, including research, production and consumption, using biological materials and biotechnology as a primary resource base to transform them into value-added goods and services for needs, not limited to agriculture, healthcare, food, chemical and energy industries, environmental protection.

At the present stage of development of society, a resource-efficient and viable bioeconomy is the locomotive of progress, primarily in agriculture and the food industry, which tend to grow further due to an increase in the world's population [2020 - 7 billion, 2050 - 9 billion people].

Biotechnological production refers to high-tech industries, most of which are concentrated in industrialized countries. Slightly less than half of the world's biotech products are produced by US companies. Major manufacturers are EU [Germany, France], UK, Japan and Canada. In recent years, many countries in Pacific Asia have seen growth, primarily China, Vietnam and Indonesia.

To achieve high rates of economic growth, Ukraine must embark on a bioeconomy course, the goal of which is to create a more innovative and low-emission economy, combining the needs of a viable Ukrainian agriculture, food security and the sustainable use of renewable resources. The need for the development of bioeconomy in Ukraine is due not only to economic factors, but also social, environmental and even political aspects.

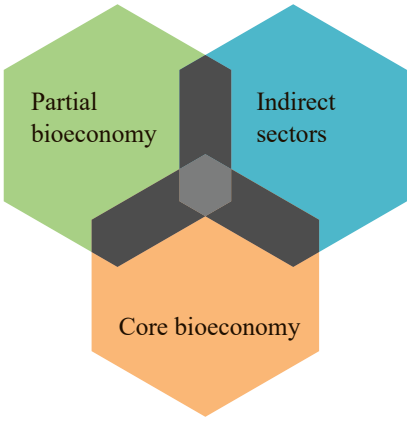
Talking about the formation of bioeconomy in Ukraine is quite problematic: the volume of biotechnological products in 2011, Ukraine was in 70th place, produced only about 0.2% of all biotechnological products in the world, while the world leader USA - 40%.

The transition from fossil fuels to renewable resources is an important element of the ecological transition envisioned by most industrialized countries. The bioeconomy will not develop without the involvement of local regions.

Structuring bioeconomy in Ukraine

To better understand what real steps Ukraine should take in the field of bioeconomy, it is necessary to structure it. However, there is no single approach to bioeconomy in the world; it covers many different sectors, which requires its own national methodology.

Based on the EU definition, the European Commission conducted a survey and classified the bioeconomy into 3 sectors: core, partial and indirect bioeconomy.



The core bioeconomy includes areas such as agriculture and forestry, fisheries, food processing, bioenergy and biofuels. The partial bioeconomy in the EU-28 includes chemicals, plastics, construction, pharmaceuticals, textiles, waste management and biotechnology. Engineering, technology, equipment manufacturing, trade, water supply and similar services have an indirect impact on the bioeconomy.

Such a classification allows the best way to calculate the economic contribution of the country's economy to the bioeconomy, but it is difficult to use it to determine

breakthrough technologies in certain areas. Therefore, Insightex proposes to structure the bioeconomy of Ukraine by sectoral basis:

Sectoral structure of the bioeconomy of Ukraine:

1. Agriculture
2. Forestry
3. Fishing
4. Food industry
5. Building
6. Industrial bioeconomy
7. Energy, transport, green chemistry
8. Engineering Biology [SynBio]
9. Aeronautics
10. Biodiversity and environmental protection
11. Pharmaceuticals and cosmetics

SECTORAL ANALYSIS OF BIOECONOMY OF UKRAINE

In September 2020, the Cabinet of Ministers of Ukraine approved the "Forecast of the economic and social development of Ukraine for 2021-2023" prepared by the Ministry of Economic Development, Trade and Agriculture. In 2020, Ukraine's GDP under the influence of the Coronavirus and the economic crisis will decrease by 4.8%, but starting from 2021 GDP will grow, the growth will accordingly be: 2021 - 4.6%, 2022 - 4.3%, 2023 - 4.7%. In 2021, Ukraine's GDP will reach UAH 4.3 trillion. or, taking into account the forecast rate of UAH 29.1 / $, it will amount to $ 147.8 billion.

The trade deficit is $ 10.4 billion. The biggest problem with this indicator is that no money is invested in Ukraine. The bioeconomy sector is capable of solving such problems, especially when it comes to real money and real investments in projects that can create value-added and create new jobs. As the practice of past years shows, the volume of such investments in Ukraine is kept below 20%, while for real growth it needs to be increased to at least 25% of GDP.

The "missing" 5% or $ 7.4 billion of investments in the Ukrainian economy can be provided by the bioeconomy. Company Insightex shows the main directions where capital investments can enter as early as 2021.

Agriculture

In Jan-Jul-2020, food products of groups 1-24 UKT ZED provided $ 11.7 billion out of $ 26.6 billion, or 44% of all proceeds from the export of goods from Ukraine. The export leader is still corn, whose share is 12.03% [18.96 million tons; $ 3.20 billion], followed by 11.95% sunflower oil [4.35 million tons; $ 3.18 billion] and wheat 5.06% [6.8 million tons; $ 1.35 billion] = these three agricultural business positions account for 29.04% of all export earnings. Of the top 10 export positions, only poultry meat belongs to non-crop production.

Most of these goods could be processed in Ukraine with high value-added, in particular, corn and wheat by the wet milling method, and the processed products - starches, feed and bioethanol are guaranteed to be sold as a raw product in foreign markets. Semi-drying corn oil could launch the paint and varnish industry in Ukraine, 90% of whose products are imported due to the lack of raw materials for its production in our country.

The total demand of Ukraine for investments in deep processing of grain, and this means in the bioeconomy of the country, is estimated at $ 15 billion, which is 2 times higher than the volume of investments required for sustainable growth of the Ukrainian economy. Such investments would create 85,000 high-paying jobs and, according to the American methodology of the state of Indiana, support 0.5 million jobs.

A sustainable bioeconomy must aim to achieve land degradation neutrality and rehabilitate degraded land. Realizing this potential requires investment, innovation, strategy development and systemic change.

Climate change has already led to high summer temperatures that have a negative impact on crop yields, especially in southern Ukraine. For these purposes, the government has already begun to form strategies for irrigating fields in the Kherson, Odessa, Nikolaev regions, and farmers are experimenting seeds of drought-resistant hybrids. Solving problems with high temperatures and water supply can increase yields in these regions. At the same time, you need to understand that the heat is consistently moving north and the experience of the southern regions will soon need to be applied in central Ukraine.

Forestry and woodworking

Forestry is a key player in the bioeconomy. The total area of forest areas in Ukraine is 10.4 million hectares, or 16% of the territory of the country. The forest fund includes forest areas, incl. protective afforestation, with an area of at least 0.1 ha, except for parks, gardens and squares in settlements. Ukraine occupies the 9th place in Europe in the area of forests and 6th place on the timber resources [rating - 2.1 billion m 3]. During the year in the forests of Ukraine, an average of 35 million m3 of timber grows. The state is the subject of ownership rights to forests, 73% of forest land is in the use of enterprises of the State Agency.

The most important eco-systemic service of forests is climate and landscape change mitigation. Ukraine is the only European country that has neither a national forest policy or strategy, nor a state forestry development program. The consequences of this are catastrophic - illegal deforestation in the Carpathians leads to excessive water flows from the mountains, which through floods and waterlogging cause enormous damage to the lower reaches. Violators do not shun deforestation in protected areas, which leads to the loss of biodiversity. The ban on deforestation in Ukraine failed to solve any problems.

Forest bioeconomy - wood products, wood waste, cellulose processing and bleaching plants, lignin and extracts, deep processing of forest biomass, smart packaging from wood and wood fibers instead of plastic, hygiene and care products, reproduction of forest genetic resources, management forest plantations (DNA markers for monitoring illegal logging), creation of biotechnological forms of trees with specified characteristics, biological forest protection, wooden housing construction, electricity and heat production from biomass.

Fisheries and aquaculture

Despite the protracted crisis of ocean fishing under the flag of Ukraine, fishing remains a source of valuable biological raw materials. The total resource of aquatic biological resources available for Ukrainian fishing in the Azov and Black Seas, in areas not occupied by Russia, is estimated at 120 thousand tons / year, of which 80% are the resources of the Azov Sea. In 2019, the fish catch in the Sea of Azov is 16.1 thousand tons + in the Black Sea 14.1 thousand tons = 30.2 thousand tons [for comparison, 1997: 30 thousand tons]. Ukraine received 22.4 thousand tons of aquatic biological resources in the CCALMR zone [Antarctica], Ukrainian fishery in the NAFO zone [v . Atlantic] is absent [1997: 346 thousand tons].

In addition to sea fishing, the fisheries of Ukraine include inland water bodies [rivers, ponds, lakes], aquaculture and STRA [fish farms combining elements of aquaculture and industrial fishing], in 2019, which accounted for 21.3 + 15.0 + 8.3 = 44.6 thousand tons of fish bioresources [1997: 42 thousand tons]. Ukraine has the largest potential for fish farming in Europe, but its volume is 0.1% of world production.

The total fish catch in 2019 amounted to 97.2 thousand tons, Ukrainian companies imported 394.0 thousand tons of fish and seafood worth $ 745.45 million, incl. fresh and frozen fish 307.8 thousand tons, $ 517.16 million.

Thus, the supply of fish biological resources in 2019 to Ukraine is estimated at 491.2 thousand tons, taking into account 46.2 thousand tons of export, fish consumption in Ukraine in 2019 amounted to 445.0 thousand tons or 10.6 kg / person / year [fish consumption per capita in world - 20.9 kg / person]. Fish consumption in Ukraine is strongly influenced by the dollar exchange rate and the income of the population.

If Ukraine restores ocean fishing, makes partial import substitution and increases the consumption of fish products to the world average, the country's GDP could increase by $ 1.5 billion.

Food industry

All actions of the food industry related to the development, production, logistics and distribution of food, beverages and tobacco products are referred to as actions of bioeconomy. Bioeconomic segment performance - transformation of organic food, management of food residues and waste, conversion of waste into valuable safe organic products, effective management of market risks while achieving the goals of a circular economy.

The food industry, as part of the overall bioeconomy strategy, plays the first (out of five) and main role - ensuring the food security of the country, which is crucial.

Higher levels of advances in bioeconomy at the expense of the food industry can be met by Industry 4.0 based on new technologies.

Energy, transport, green chemistry

Everything - energy, transport and chemistry - is only partially covered by bioeconomy. The segment performs the third (out of five) main function of bioeconomy - reducing dependence on non-renewable resources.

In the field of energy, the main application of the bioeconomy is the production of bio-electricity (Ukraine has a cascade of powerful hydroelectric power plants, with the support of the government it is developing a park of solar panels), as well as wood pellet boilers, biogas, and biosynthetic fuel.

The bioeconomy for transportation is liquid fuels, bioethanol and biodiesel. Currently used 5th attempt of Parliament to move transport fuel from a dead point, that is, to implement the mandatory addition of bioethanol to gasoline, but again, most likely, efforts will fail. It is quite logical, since there is no strategy and an integrated approach that can remove the main obstacles - to introduce a bio-fuel culture, regulate infrastructure, stimulate consumers to re-equip engines, certify manufacturers and logistics, and develop standards. For bioethanol export opportunities, there must be appropriate logistics and port exits.

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The promotion involves not only the government, but also private business. A technology for the production of paper materials has been developed in Ukraine as an alternative to plastic - Blue Ocean Solution became the first Ukrainian manufacturer of eco-products for the HoReCa segment .

Ltd " Konvi-Pak " has introduced a new technological process for the production of bags using environmentally friendly cellulose Glassine paper. Glassine is a smart paper made from natural materials. The solution is the optimal combination of grease and moisture resistance, like a film, the ability to hold its shape, like paper, and protective properties, like foil. Advantages - 100% environmental friendliness of the package, inexpensive cost and recyclability.

And although private achievements in the field of plastic substitution are not so impressive, Ukraine has already taken the first steps in this direction. It is clear that without government support, the replacement of plastic with biodegradable materials will not be resolved by private business not only in Ukraine, but also in any developed country, and therefore we expect the next step of the government.

Industrial bioeconomy

Industrial bioeconomy includes such activities as, but not limited to:

- Textiles: the goal is environmentally friendly products from textiles in the garment (apparel, 40%) and technical areas (60%). The environmental friendliness of textiles is determined by the choice of raw materials and methods of processing. Biodegradable Agri-textiles are popular - linen, hemp, cellulose polymers [three-dimensional textiles – FogHa-TiN, CloudFisher , Polar bear pavilion, moos wals. Cotton, although renewable, requires a lot of water to grow. Renewable precursor materials alginate, chitin, chitosan.
- Mechanical engineering: bioreactors, bio-processor technology, agricultural machinery, greenhouse technologies, lubricants
- Automotive: natural fiber housings, bioplastic interior, bio-fabric car seats, dandelion tires.

Building

Bioeconomy of construction: use of forest materials / wood /, natural fiber reinforcement, composite materials, biological insulating materials, bio-containing concrete additives + wallpaper, adhesives, skirting boards, etc., the production of which is based on starches. The construction boom is accelerating the development of the bioeconomy.

Pharmaceuticals and cosmetics

Biomedicine includes the development and production of biotechnological products for the diagnosis and treatment of human diseases. The most dynamically growing segments of bio-medicine in the world are cellular and gene technologies, bio-compatible materials and technologies for molecular genetic diagnostics.

The technology of molecular genetic diagnostics is based on the use of biomarkers, followed by a transition to integral medicine, i.e. prescribing a suitable medicine for a patient based on the characteristics of his body.

Tissue engineering - means and methods of cell therapy, including the regeneration of damaged tissues and organs. New materials for medical purposes that do not induce an immune response of the organism - biocompatibility - have recently been widely used. Products made using stem cells and composites from biodegradable materials for dentistry, oncology, traumatology and surgery, as well as biocompatible dressings and wound healing nanocomposite materials are entering the market. Polylactide PLA , derived from corn, is bioresorbable and is used as a matrix for tissue and suture regeneration.

Aeronautics

Aeronautics is the art of taking off. The use of unmanned aerial vehicles at a height of 5 ÷ 10 m above the fields makes it possible to survey the fields and track the harvest. Drones are used for spectral analysis of soils, for sowing work, for fertilizing, spraying plantings in order to protect against weeds and harmful insects.

The use of aircraft in agriculture has shown a number of advantages over ground equipment:

- Implementation of sowing operations with high accuracy of Trichogramma insertion (4 ha / hour);
- processing of large areas in a shorter time (500 ÷ 700 hectares per day) without damaging crops;
- low labor costs;
- economical use of materials (sowing, to protect crops, growth stimulants, desiccants) due to fine-droplet [up to 100 microns] and high density of spraying at an optimal height [1 ÷ 3 m];
- the possibility of carrying out work in hard-to-reach areas (mountainous terrain, high soil moisture);
- possibility of visual observation of the state of crops and prompt response to situations;
- elimination of the consequences of natural disasters.

The use of aeronautics in agriculture can increase the yield by 20-30%. Disadvantage: direct dependence on weather conditions, and the fate of the crop often depends on the speed of solving the problem in agriculture.

Biodiversity and environmental protection

This segment is responsible for the second and fourth (out of five) main goals of bioeconomy, respectively:

- management of natural resources, maintenance of biodiversity, improvement of water security, conservation and productivity of healthy ecosystems of the seas, oceans, forests and soils;
- adaptation and mitigation of climate change consequences, reduction of greenhouse gas emissions.

The segment also includes the need to improve the capabilities for monitoring and forecasting the state and development of natural resources.

Efficient treatment of urban wastewater containing high-value organic residues can generate $ 150 million in value added annually for a million-plus city, create 1,200 jobs and save 600,000 tons of carbon dioxide. In the 5 largest cities of Ukraine, representing 17.5% of the population of Ukraine, the effect may be 7.3 times higher and amount to $ 1.1 billion and create 9 thousand new jobs.

Currently, not all technologies are commercially viable, but the dynamics of the process over the past 20 years suggests that industrial waste disposal technologies will be mass-produced over the next 10 years.

Steps to promote bioeconomy in Ukraine

For the consistent promotion and sustainable development of bioeconomy in Ukraine, it is necessary to take only two steps: (1) Develop a Bioeconomy Strategy and Action Plan for the implementation of the strategy, and (2) implement this plan.

The bioeconomy strategy is the result of the work of ministries, stakeholders,

including top-down economic agents, government agencies, researchers, civil society, etc. The strategy lays the foundation for sustainable development of the bioeconomy, taking into account the resources and needs of Ukraine.

The Role of Research and Innovation in Bioeconomy

Maximizing the impact of research and innovation is a key driver of bioeconomy. To create market innovation in the bioeconomy, regulation and financing must be conducive to innovation. Research and innovation in bioeconomy should be on the government's agenda. Important research findings and innovations that can address the challenges and opportunities of the bioeconomy should receive government support.

Long-term development programs with financial frameworks can provide significant systemic impetus to research and innovation in the areas and sectors covered by the bioeconomy. The combined platform of the long-term development plan of Ukraine and regional governments, the optimal amount of funding for research and innovation should reach $ 1 billion.

Bioeconomy research and innovation is an important area of cooperation at the global level.

Problems holding back the development of the bioeconomy

The main problems hindering the development of bioeconomy in Ukraine are:

- Lack of comprehensive approaches to the development of bioeconomy;
- Imperfect legislative regulation and stimulation of bioeconomy development;
- Imperfection of mechanisms for commercialization of developments;
- Insecurity of intellectual property;
- Insufficient funding for biotech developments;
- Low innovation activity of enterprises;
- Lack of necessary infrastructure elements;
- Innovative inertia of local governments;
- Lack of specialists.

Challenges for the development of the bioeconomy

For the development of bioeconomy in Ukraine, it is necessary to solve the following tasks, not limited to:

- Integration of resources and organizational structures available in the country, their focus on priority areas of biotechnology development;
- Development of production and innovation infrastructure of bioeconomy, including the creation of systems of scientific and technological, information, personnel and marketing support;
- Creation of a regulatory, informational and financial environment conducive to the intensification of bioeconomy development;
- Creation of a single educational space for biotechnological focus;
- Improving the system of training, re-training and retention of personnel to ensure research activities and the needs of biotechnological enterprises;
- ensuring the competitiveness of the applied research and development sector, including the introduction of project financing for scientific organizations, updating the instrument and bench base of research centers, supporting small innovative businesses, stimulating the participation of organizations in international research and technological projects;
- involvement of local self-government bodies in the process of stimulation and development of local biotechnology;
- creating an environment for activating the demand of organizations for biotechnology products;
- introduction of biotechnology, both in the production and non-production spheres (industry, energy, agriculture, medical services for the population, etc.);
- Formation of a system of green environmental management; introduction of environmental imperatives that help minimize anthropogenic impact in the process of intensification of production and other activities;
- formation of territorial clusters of agrobiotechnology, combining the development and production of high-tech bioproducts, contributing to the effective interaction of participants in the bio-industry market;
- increasing the ecological culture of the population, the formation of positive consumer attitudes in relation to the products of the bio-industry.

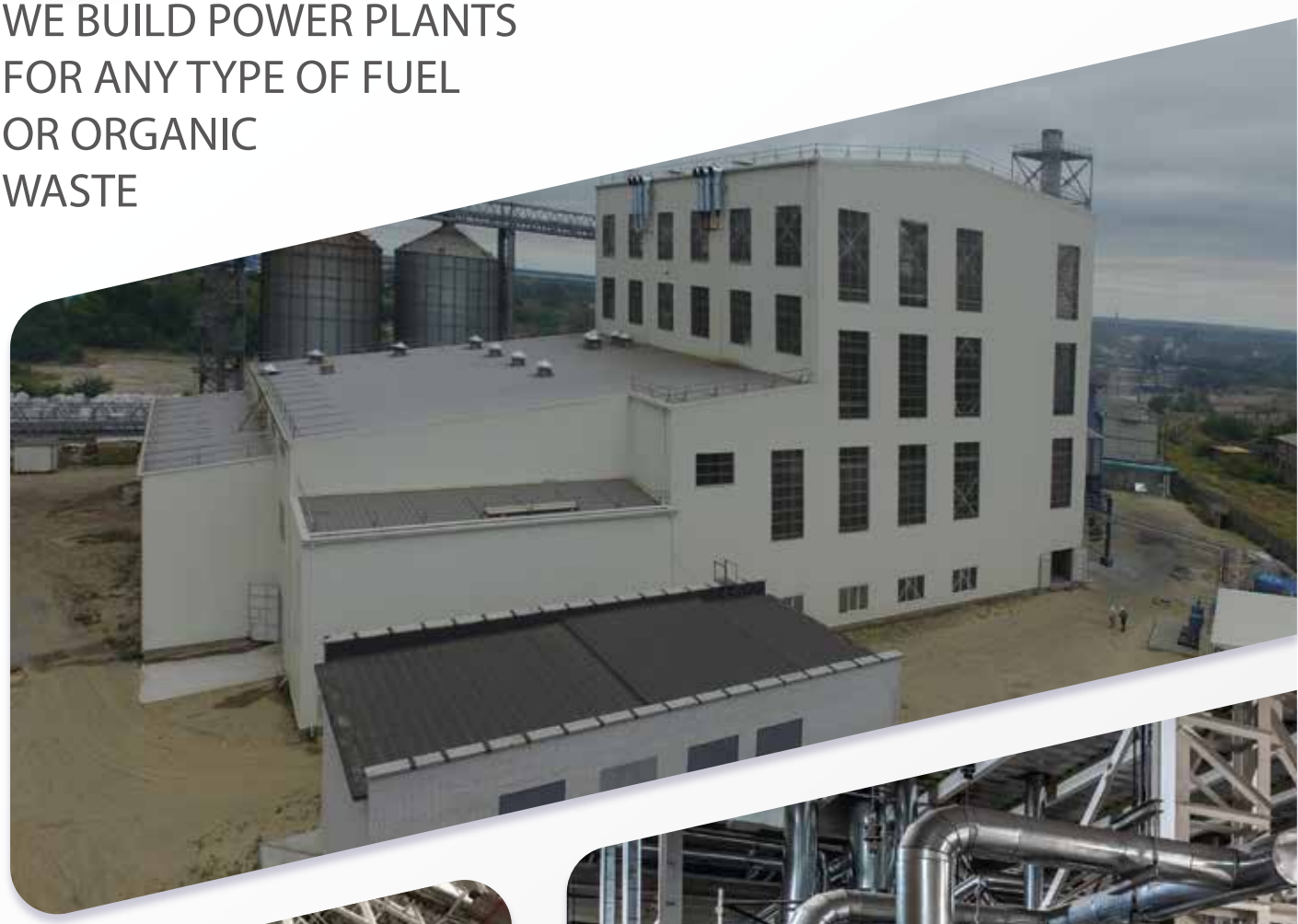
Conclusions

Bioeconomy is capable of doubling Ukraine's GDP.

Bioeconomy- win - win strategy for Ukraine [win - win = victory without losers].

KOTLOENERGOPROJECT

WE BUILD POWER PLANTS FOR ANY TYPE OF FUEL OR ORGANIC WASTE



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LAUNCHING ON THE PROJECT THE POWER OF THE BIGGEST IN UKRAINE THERMAL POWER PLANTS ON BIOMASS

The Ayax-Dnepr power plant was designed by "Kotloenergoproekt" as part of 2 steam boilers designed and manufactured by Kotloenergoproekt, 35 t / h each with steam parameters p = 40 kg / cm2 and T = 440 C, and an electric steam condensing turbine generator with a capacity of 16 MW.

The power plant uses sunflower husk and sunflower husk pellets as fuel.

Steam boilers installed at TPPs were designed and manufactured by "Kotloenergoproekt", Kharkov. The boilers are multi-fuel and are designed to operate on various types of biomass: sunflower husks, wood chips and litter from the waste of growing, transportation and processing of sunflower.

Nowadays, after the end of the regime adjustment, the following environmental performance indicators of the boilers have been achieved:

NOx---- до 100 ppm;

CO ----- 0 ppm».

The efficiency of the boilers was 90%, and the boiler load regulation range was 30-110%.

Ash deposits are removed from the heating surfaces during the automatic operation of the boiler using standard blowers and does not require stopping the boiler unit.

Cleaning flue gases from dust up to 20mg / m3; produced in two (one per boiler) electrostatic precipitators produced by LLC "Consortium Energomashekologiya", Zaporozhye.

In terms of the achieved technical and environmental indicators, the steam boilers E-35-40-440D of the "Kotloenergoproekt" company significantly exceed all foreign and domestic analogues.

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BUSINESS & STRATEGIES

ORGANIZING INNOVATIVE SOLUTIONS IN **ROCHE**

Roche , a globally renowned pharmaceutical and diagnostic group based in Switzerland, has enjoyed an innovative success that most other major companies will envy. With an impressive track record of scientific discovery, the company is recognized as a leader in the industry's most lucrative category, cancer drugs. Over the past 10 years, Roche shares have been among the best in the sector. CEO Severin Schwan believes that Roche's continued success will depend on its ability to complement its pharmaceutical and diagnostic portfolio with further innovative advances.

Focus on scientific innovation

Over the past 100 years, all of Roche's strongest growth has been driven by revolutionary innovation. It all started with the powerful tonic Digalen, one of the most important medical innovations of its time. Later, between the two world wars, Roche was the first company to synthesize vitamin C. The ability to manufacture artificially in industrial quantities rather than extract it from plants transformed Roche's business in the 1930s. Then, in the 1960s, Roche took a big step forward with the development of benzodiazepines such as Valium for the central nervous system. This was a breakthrough because other anesthetics had serious side effects: too much use could lead to death.

Roche has grown in a variety of areas over the past decade , but major advances are in new cancer treatments and biologics. The American company Genentech was looking for new antibodies when most people in science did not believe that compounds such as Herceptin and Avastin could treat serious diseases such as cancer. The emphasis on cutting-edge drugs that has characterized Roche's history remains the company's core strategy today. Whoever fails at innovation fails as a company.

While other companies are taking a broader approach, covering over-the-counter drugs, Roche has deliberately focused its activities on innovative pharmaceutical and diagnostic areas. The first step was to choose which playing field to play on, as it is difficult to achieve success in multiple directions. After that, another question arises: "How will you play?" Roche chose a differentiated approach: cutting edge science and real competitive advantage in one or two areas, doing everything else well, although not necessarily better than others.

The ability to lead the world as the largest biotech diagnostic company provides an important advantage for the implementation of a more personalized form of healthcare. A lot of what Roche uses are internal projects, partnerships or acquisitions, depending on the issue.

Communication between management and innovation team

Roche's innovation process is bottom-up; management does not believe in visionary leaders who try to shape the fate of their companies with their own wonderful ideas. For this, there are thousands of brilliant minds closely associated with science, while a leader must only have an understanding of the biology of disease and be an organizer.

However, if the leader is too detached from science, he will not be able to ask the right questions and will not feel the consequences of his management decisions. Clarity of thinking is key. If scientists who really understand what they are talking about, they can explain difficult scientific topics even to non-professionals. On the other hand, there are doubts about scientists who cannot explain the principles or why they are interesting.

The Roche CEO walks into laboratories, sometimes up to 30 minutes. talks to people who are world experts in their fields, as well as other people to pick up the signal. This takes time. This does not mean that if at the meeting you were told about an interesting technology, the next day you need to run and buy a company. Accumulation can literally last for years.

Much of what Roche uses are internal projects, partnerships or acquisitions, depending on the science issue. The work of the company is built on a team basis: the team visits patients, meets with doctors and gets acquainted with technologies.

Sometimes top team members are required to speak on topics outside their immediate area of expertise. Any member of the team has the privilege of asking any questions that might prompt a new perspective. Interest in what the company is doing must flow through the entire organization.

Roche R&D structure

In the early stages, research is about the concepts, understanding, and quality of people. The main thing is to give the team more freedom. Putting them in little boxes, imposing standard operating procedures and telling them what to do will get you nothing from the team.

Unlike most competitors, Roche's research is very independent. Subdivisions are located in Basel, San Francisco, Tokyo. There is no global head of the R&D department: the pharmaceutical research departments report to the first head, the diagnostic department reports to the head of the diagnostics department.

The problem with a global R&D leader is that such a person will inevitably be prejudiced, preferring one approach over the other. He will want to introduce central guidelines and decision-making committees. The Global R&D Leader is an unnecessary layer that can potentially destroy value by taking away freedom and suppressing diversity. Everyone in the world thinks differently and it takes a lot of discipline to allow other views to be valid.

Not too often, but it happens that people in different departments are working towards the same goal. Often, even a small difference in the molecule can significantly improve efficiency or safety, and therefore two teams are encouraged to participate in Roche . In some cases, one of the two can be a valuable reserve to help you get to market on time.

However, the perspective changes when they get to the late stages of development, and scale starts to matter. At this stage, more patients may be required for testing, and this can be costly when there are two teams. In this case, you need to make a choice - there is no point in duplicating. Therefore, in the later stages of pharmaceuticals, Roche represents a single global organization.

R&D teams usually contact the portfolio committee at a later stage to make the final decision on moving a product into mainstream research. There are subcommittees for technical expertise, but the leadership and final say rests with the Global Development Leader or Product Strategy Leader.

How Roche works for innovation

One of the principles of Roche is to decentralize and give people the freedom to create. But people must also have the courage to use their freedom to take risks. If no one is willing to take a position, the model doesn't work. It's important to have a culture that attracts people who are willing to take action, not delegate authority to the top and wait for approval. But one thing is certain: those who are far from science are most often mistaken.

Of course, sub-committees are needed to collect information, and those who are closer to his actions will always have a better position. The higher the delegation, the worse the solution.

At Roche, people have to take their own initiative. Nobody promotes them from above. There is succession planning, but the idea that employees have mentors to take care of their careers is an illusion. If an employee has a good idea, he should follow it, and not wait until asked.

Corporate culture is a buzzword, but the challenge is to make culture a reality, not just a marketing brochure. This is a very fragile concept.

In Roche people come because they see in a leading company in a area of science, but there are only those who share and understand the core values of Roche. People should really strive to change the lives of patients for the better, no matter what field they work in. They need courage to take risks and follow their convictions.

Openness to the outside world is also very important. 99% of innovation happens outside of Roche, so to be successful you need to treat the innovation that happens there with the same respect as if it were your own. Cooperation requires a culture in which people do not differentiate between the parties.

Roche does not use startups in its work. What distinguishes the company from startups is access to money, extensive knowledge and technology, which allows it to work with little or no profit. Even if they don't admit it, quite a few of those who join startups want to get its shares and become a millionaire. There is nothing wrong with that, but the disintegration of people in a large listed company and the transfer of some of the shares brings the worst of both worlds.

Disruptive innovation is about things that little people believe, so a variety of mindsets helps a lot. Where many scientists around the world claim that "this is nonsense", Roche understands that this could be a breakthrough. If everyone agrees with the result, then most likely you are late.

Diversity is difficult to achieve, but at Roche it is due to its decentralized approach and its conscious policy of evolving in different ways. For 5 years, Roche has set itself the goal of increasing the proportion of women in 400 leadership positions from 13% to 20%, and now it is 22%. Roche is now looking to increase the number of emerging market leaders by 30%; it recognizes not only the growing importance of these markets, but also their understanding in terms of functions. It is very important to be inclusive. Moving a brilliant general manager from Asia to Switzerland is one thing, but it still takes a lot of work to bridge the cultural divide.

It's okay to encourage diversity, but you also need to be able to create an environment where diversity is used. Otherwise, there is a danger that many diverse people will be simply dysfunctional.

International plans for innovation

Roche has a full value chain in China and obviously a lot of innovation is coming from emerging markets, but research there is still in its infancy compared to the US

and EU. Roche oversees the field of science where innovation comes from, but does not intend to build any hub elsewhere. It still remains a European and American focused company.

International clusters make it possible to attract the best people from all over the world, but it is impossible to make diversity work if there is no initial force at the center that creates the secret sauce. If you try to cook it yourself, you can skip one of the ingredients or be mistaken in the temperature.

Financing innovative projects

Good accountants always ask for three times as much money, which is a sign that they have a lot of ideas. But someone else has to distribute these resources from above. Too much interference is dangerous. If you focus on just one area, you might miss the next step in other directions. All Roche strategies follow science, but the problem is that we don't know where it will lead.

However, there are some special circumstances in which a decision must be made to shift money to a new area. Given the experience in a particular field and all the established connections, this is a natural playing field for the company to play. And here you have to ask yourself, will the company have a big impact by spending more in a new area and less on a traditional one? Or do you need to increase the budget as a whole?

The amounts Roche invests in really big and risky late-stage projects are just a small fraction of what is spent on late-stage projects. Roche recently decided to bring two projects of the Alzheimer's molecule to a late stage: on the one hand, this is that the company has begun to understand this terrible disease, but on the other hand, the risks are enormous. Roche management understands that if it fails, it can digest the Alzheimer's project, but it is extremely dangerous if all the late-stage projects were the same.

Large, late-stage projects are very different from early-stage clinical trials, which involve many small, very high-risk activities. The chances of success are slim from the start, but their goal is to find things that will one day become disruptive innovations and reduce their risks early on to the point where they don't become a big game if they get to the last stage.

Assessment of investments in innovation

Some companies have made statements about how they measure research productivity, suggesting that it be measured by the R&D deduction rate. Roche thinks this is absurd. This is a kind of bureaucracy taken to the extreme. It's a dispatcher running through the laboratory, forcing scientists to fill out spreadsheets that kill innovation. Scientific judgment cannot be expressed in numbers. You can look at these numbers in retrospect: if there are deviations from previous periods, you need to understand what went wrong. Are there the right people? Is the management correct? But it is impossible to do this in a perspective way.

In later stages of development, the study gets more data, less ambiguity, and easier to have metrics. Any project at Roche has scenario planning that displays execution phases, analysis of executions, what can go wrong [risk management] and how much you have to pay to mitigate risks.

Where money is wasted, there is no flexibility for innovation. The Roche CEO prefers 10% more innovation than 10% efficiency. In most cases, the growth of innovation inevitably ends with an increase in efficiency.

Roche's main strategy

The majority of shares in Roche are owned by the founding Hoffmann-Oeri family, which gives them an important advantage and allows them to think long-term. Most of all they care about passing the company on to the next generation in a better condition than it was accepted. They think in 30-year cycles, which works very well with cutting-edge scientific advances, making it possible to make decisions that can bring tangible benefits for at least 10-15 years. This allows directors to think more about what's wrong with the company rather than the short-term consequences. It is unlikely that the traditional investor community welcomes this.

Short-term success is equally important, it increases financial opportunities, allows you to do the right things in the long run. Without long-term thinking, Roche would hardly have taken over Genentech and could not have bought PCR. These deals opened up entirely new possibilities in molecular diagnostics.

Sometimes people say it is crazy to close a deal that requires a 15-year return period. That is why Roche has done it.

Source : This article is based on an interview with Severin Schwan , CEO of Roche , published at https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/organizing-for-breakthrough-innovation

MANAGEMENT PROJECT

RISK MANAGEMENT IN **BIOECONOMY**

CYNEFIN - TASK STRUCTURING TOOL AND DECISION-MAKING IN BIOECONOMY

Modern production is based mainly on mineral resources. Two goals - reducing GHG gases and moving from limited mineral resources to renewable resources - stimulate the search for alternative sources of energy and raw materials.

Cascading technologies and the use of by-products are the main strategies for increasing the efficiency of resource use, which in business can be a key economic benefit and also limit the impact on the environment.

Before conversion at the end of the life cycle, strategies are characterized by the consistent reuse of similar inputs, which leads to fluctuations in raw materials in terms of quantity and quality. This leads to more complex production networks, as it requires the involvement of companies from previously unrelated industries, as well as specialized training in biomass management in new value chains. In addition, innovative developments in new materials have a significant impact on manufacturing processes, sites, infrastructure and logistics. All this in the emerging bioeconomy leads to new types of risks and uncertainties.

This creates the need for careful and flexible planning. How an enterprise can quantify the desired resource efficiency remains open, since the efficiency and sustainability of homogeneous supply often contradict each other. In addition, social pressures increase on sustainability and this factor must also be taken into account in any assessment. Sound risk management is a prerequisite.

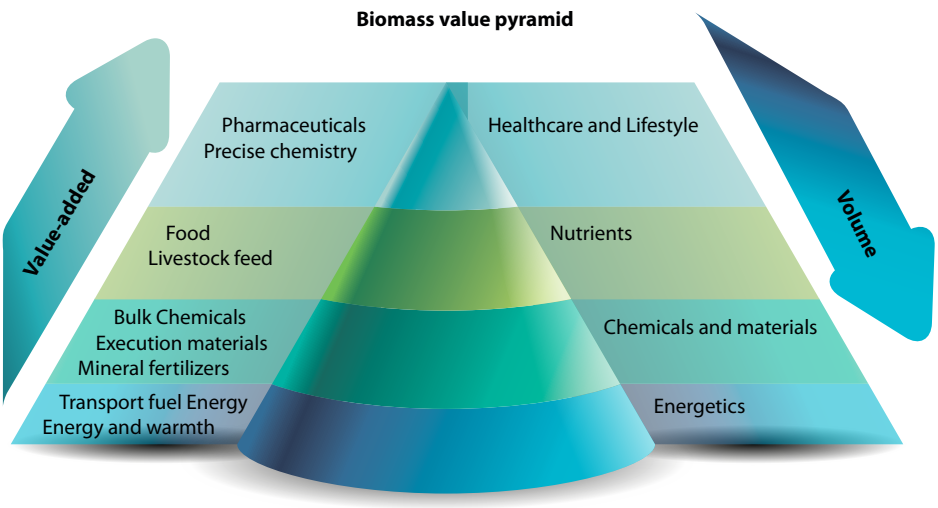
Although there are many analysis and decision methods, their relevance in the various contexts where they can be applied needs further study. The aim of the work is to outline an approach to structuring problems and solving problems when using renewable resources for industrial processing.

Risks and uncertainties in bioeconomy

The main tasks of production planning in the bioeconomy are cascading and management of offal.

Cascading uses products in an integrated manner and within the economic system through multiple use sequences. For example: *wood → solid wood billets → furniture making → furniture shredding at the end of its useful life → burning for energy.*

Wood offal- shavings - can be used to produce particle board and fiberboard, or for energy production.



The fig. 1 shows a pyramid of biomass value, which shows where biomass can have the highest value-added. Leftovers from the processes can be used at the bottom of the pyramid. Unconnected industries must learn to form cooperative networks and create new value chains, all the way up to a global scale.

The chemical industry did not use large amounts of bio-processing in the past, but now these enterprises must learn to use the residual biomass. Farmers need economical logistics that harness the value of residual biomass. The forestry sector must shift its focus from the wholesale supply of timber to specialized, high-quality products.

The new value chains linking biomass, energy and chemical production are complex for three main reasons:

(1) The quality (chemical composition) and quantity (harvesting level) of renewable resources vary considerably. Along with price fluctuations, this can greatly affect operational planning. Thus, the increase in the use of renewable raw materials in industrial production networks requires more sophisticated approaches to operational planning.

(2) New production-oriented value chains require completely new technologies and processes. Some of the new concepts are quite radical or even destructive because focus on production execution in a completely new way, rather than more efficient execution in old ways. They can have a significant impact on manufacturing, logistics and trade.

3) The growing industrial demand for bio-raw materials stimulates land acquisition and increases land prices in biomass production areas.

Transition of a bioeconomic strategy into reality is a problematic and complex process. To achieve social support, the strategy must be communicated to policy-makers, the public, academia and industry. The consensus process is necessary and must be initiated and coordinated by independent and widely recognized institutions.

Entrepreneurs must balance many operational variables, leading to decision-making problems such as planning location, capacity and supply, new networks and logistics, and production planning for rural energy. And these are just a few of them.

Cynefin framework model

The Cynefin model [Kenevin model] is a tool for understanding the type of environment in which a project or product exists, in order to determine the most effective work processes in the corresponding environment. The Cynefin term in Wales means “habitat” and includes cultural, social and environmental aspects.

An agent is everything that operates within the system. It can be a person, a group of people, an idea, rules.

A system is any network in which there is some consistency. The system may be vague, it may or may not have a goal.

Welshman David John Snowden, 1954, who developed Cynefin , distinguishes 4 types of environment:

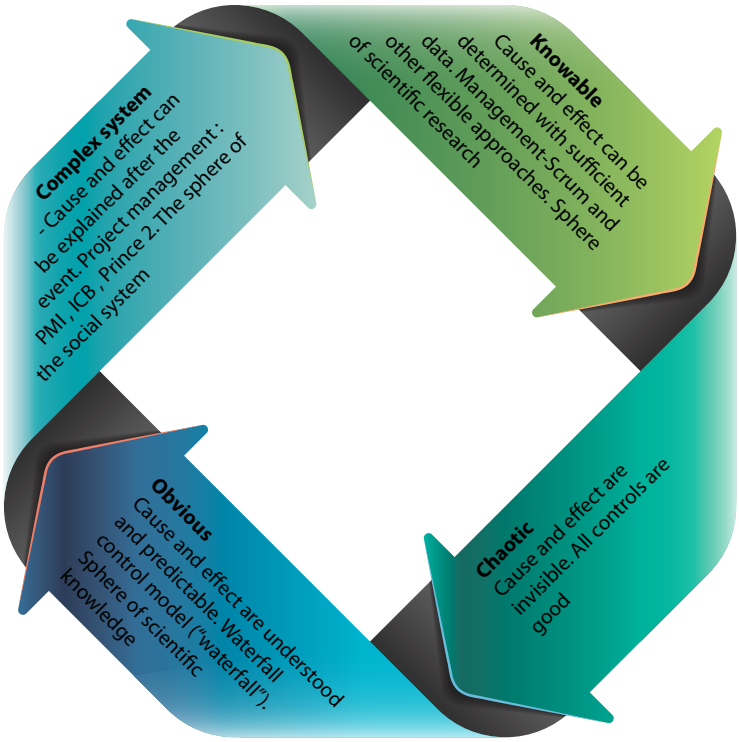
- Obvious - cause and effect are clear and predictable. Cascade management model (“waterfall”). Sphere of scientific knowledge.
- Complex ordered - cause and effect can be explained after the event. Project management: PMI, ICB, Prince2 . The sphere of the social system.
- Knowable - cause and effect can be determined using sufficient data. Management - Scrum and other flexible approaches. Sphere of scientific research
- Chaotic - cause and effect invisible. All controls are good.

The fifth environment, disorder, is used when it is unclear which of the four contexts is prevalent.

Cynefin's model helps managers sort causal relationships in order to make decisions. Depending on the system in which the project or product is located, actions will be determined and will be very different from each other.

CONSEQUENCE MANAGEMENT

Next, we 'll apply the Cynefin framework to renewable resources. Although



public risk management techniques were published in the scientific literature, they were not available to managers and industrial companies. The main attention is paid to the consequences of management decisions on various aspects in conditions of risks and uncertainties.

Obvious system

The causes and effects are clear and predictable. In such a system, there is the concept of best practices and direct directives, since in them it is really possible to find the best way to achieve results. Exhaustive communication between managers and other participants in the process is usually not required, since disagreements about the necessary actions are rare. There is some optimal process for making a product and moving away from it will make the process less efficient.

In an obvious system, the decision-making process usually consists of recognizing patterns and responding to them with well-rehearsed actions. This process is often referred to as a recognition-based decision-making process.

In a such system, decision making is based on scientific knowledge and usually consists of recognizing problems and responding to them with well-rehearsed actions. In the renewable resource industry, where the supply of raw materials in terms of quality varies over time, measures such as inventory management are applied. Renewable raw materials are harvested in a short period of time, while their quantity and quality must be available for industrial processes throughout the year. The chemical properties of raw materials can change during transportation, storage and post-harvest processing. This requires a restructuring of logistics and manufacturing processes throughout the supply chain, made up of industrial and non-industrial partners.

The so-called “liner risk problems” are quite simple in structure, and the probabilities of causing harm are well studied, risks and risk mitigation measures are controllable and do not require a complex approach. However, it should be remembered that often risks that appear to be linear may turn out to be more complex and uncertain than originally estimated.

Practice has shown that small deviations can represent general industrial and global risks. For example, biomass is susceptible to infection, and in the 19th century (Ireland) a logistical error caused potato blight and plant death, resulting in the Great Famine.

Knowable system

The connections between agents in the system are so intricate that they cannot be understood. With the same impacts on the system, the results can be completely different. You can even find enough facts to prove conflicting theories.

There are no best and no good practices in this system. To confirm or disprove assumptions, hypotheses are simply built, and experiments are performed. These experiments will not necessarily be successful but should add insight into what is happening.

For example, we cannot say for sure what the soil fertility depends on. What happens if trees are cut down? What if you plant the same plants every year? Experimental results will provide directions for work.

In a knowable system, cause and effect can be determined through scientific research. For example, replacing fossil raw materials with biomass requires the study of chemical, physical, biological properties, as well as modification of production processes. Skills enable you to analyze, react and find new technological adaptations. Thus, changes in the quality of raw materials for decision-making require different tools than changes in quantity and time.

In a knowable system, there is more analysis than recognition, and a person must learn from the available data about specific circumstances. To make decisions and predict the potential results from a given action, models and a lot of explicit knowledge of cause and effect are used.

Since bioeconomy deals with the sustainable and innovative use of renewable resources, it is desirable to test the positive effects. Quantifying the positive environmental effects with the consequences of cascading use remains elusive, both in theory and in practice.

At first glance, a product's environmental impact assessment seems straightforward as a suitable tool (eg life cycle assessment) is readily available. However, indicators of economic and environmental impact and resource efficiency are still lacking.

Most environmental decisions have a lot in common: there are many stakeholders and uncertainties, many conflicting criteria and consequences that extend into the future. Stakeholders and their value preferences can complicate seemingly simple solutions such as site planning for a community biogas plant. Once values and beliefs come into play, transparency of the subjective judgments and elements of knowledge that formulated the solution becomes necessary.

Complex ordered system

In a complex system, decision-making requires the collection and processing of data, their analysis, and not simple recognition. The solution will involve using models to predict potential outcomes with an appropriate level of uncertainty.

The connection between the cause and effect can be found only with certain knowledge. This is an area where experts are setting the tone. In a complex system, there is no concept of best practices, but good practices just appear; in a complex system, it is optimal to use project management PMI , ICB , Prince 2, etc.

Decision support is heavily based on learning from judgment [c asking two experts how to achieve the best result and you will get two very different answers] and developing broad strategies that need to be flexible enough to accommodate change as it evolves.

A system with many interacting causes and effects forms a complex area where overt and tacit knowledge may be vast but unlikely to be all-encompassing. Much of today's business has moved into a complex area as change has become an integral part of the business, and it introduces unpredictability and fluidity.

For example, the move to more renewable resources has led to changes in the choice of energy supplier. The changing

business environment creates incentives for management to apply new approaches to improve resource efficiency throughout the entire value chain, from supply chain design and operations to consumer purchasing.

A complex system is also an area of social systems where cause and effect can only be determined after the fact. Ambiguity arises when individual actors or stakeholders assess the inputs or outputs of the system differently. Decision making will be more focused on examining judgments and problems, on developing broad strategies that are flexible enough to accommodate changes as they evolve. For example, first-generation bio-fuels, after initially being recognized as a clean alternative to fossil fuels, have since come under fire for many ethical and sustainability concerns. As a consequence, second-generation bio-processing plants have been developed today, using biomass as feedstock.
When it comes to sustainability, decision making is inherently particularly difficult. At the heart of sustainable development is the need to find a balance of approach between efficiency, productivity, sustainability and social cohesion.

Chaotic system

Events occur in a chaotic system that go beyond ordinary experience; the relationship between cause and effect is not distinguishable and cannot be defined, since they are constantly shifting, there are high levels of uncertainty, misunderstandings and imperfect data that are characteristic of dynamic open systems.

Thus, there are no managed models, decisions cannot be made on the basis of analytics, since there is no concept of how to split data for analysis. Managers must take probing action and observe what is happening until they can understand the situation and gradually transfer the context to one of the other areas.

Natural disasters are one of the main sources of chaos. Earthquakes, floods and storms can have multiple impacts on various parts of the supply and energy supply chain, and pest infestations can have serious consequences. Emergencies are distinguished by causes and magnitude of impact, but they have a common characteristic of sudden occurrence and the need for coordinated and effective management of them.

Strategic planning in bioeconomy should take into account that the cultivation of raw materials can be subject to long-term changes, such as climate change or irregularly recurring events, such as natural disasters - severe wind damage, fungal and insect infestations with high overall economic impact. Extreme weather events, if they occur, also have an impact on planned production.

A crisis or emergency is a sequence of sudden alarming events that damage an enterprise. They tend to occur quickly and

generate a sense of fear and threat among the affected individuals. This can be caused by a technological failure, malfunctioning machines or the Internet.

Businesses can be economically affected by natural disasters in two ways: (1) direct losses from physical damage to industrial facilities or stocks, (2) indirect losses, i.e. losses not directly caused by extreme events; spatially or temporarily separated from it, but cause the termination of economic ties, for example, the cessation of production or investment.

Chaos is a state of crisis and innovation that always goes side by side. There are two possible ways out of the state of chaos: (1) introducing rigid restrictions and obtaining an ordered simple system, or (2) quick actions that will reduce the chaos and allow the system to go into a state of being understood.

Conclusions for risk management

Businesses in the bioeconomy sector face a number of risks and uncertainties. While the work is aimed at reducing uncertainties, the goal of adopting a risk-based approach to decision making is to ensure that uncertainty is recognized and rigorously taken into account in decision making.

Risk management is concerned with the formation and collection of knowledge about risks and decision-making in order to mitigate, control and manage them. Risk management is based on competence and sound judgment. Only in this way can managers find the necessary trade-offs between risk, reward and other important impact criteria.

The Cynefin framework, developed in 2002 by Snowden based on knowledge management concepts and organizational strategy, can help sort different types of situations, make causal decisions about them in order to idealize appropriate decision-making processes and respond accordingly.

In simple and knowable areas, explicit knowledge can be deployed using a database, knowledge base, and models. Here, making a decision is the act of choosing from a variety of alternatives. The decision-making process includes recognizing and determining the nature of the situation, identifying alternatives, choosing the best alternative and applying it in practice. Decision making under certainty assumes that the decision maker knows the alternatives with reasonable certainty.

Risk decision making models are used when a decision must be made under conditions in which the availability of an alternative, its potential benefits and costs are associated with estimates of probability. Thus, risk is the product of the probability or frequency of the effect and its magnitude.

In risk management, risk analysis combines three elements: hazard, vulnerability and risk exposure. Decisions are often based on past experience. However, the inherent uncertainty in such models is often grossly underestimated and poorly represented. The contexts in obvious and knowable spaces are necessarily repeated or usually occur in a certain sense, so that sufficient understanding and scientific theories allow predictive models.

The content of complex and chaotic areas is usually new, and the breadth of judgment is greater. Here, tools are needed to facilitate collaboration and judgment. Disagreements often arise due to different values or worldviews, leading to divergence or conflict of interest.
Appropriate participatory processes should be developed here, which would encourage different actors to contribute in areas in which they are competent, and thus could contribute to improving the quality of the end result. A state of uncertainty occurs when the decision-maker either does not know all the alternatives or does not know the consequences of the risks associated with each of them. Uncertainty characterizes the quality of our knowledge about risk and can affect both probabilistic and subsequent risk components. Managers should gather as much relevant information as possible and approach the situation in a logical and rational manner. In these conditions, intuition, judgment and experience significantly influence decision making.

Behavioral aspects of decision making must also be considered. They reflect subjective opinions such as tastes, political forces, intuition, escalating commitment (where the decision-maker stays with the decision, even if it is wrong), risk taking, and ethics.

Because bioeconomy claims to support sustainability, managers must consider a wide range of stakeholders when making decisions, each with unique preferences, perspectives and values. Issues of sustainability, fairness and social acceptance, which were previously discussed mainly in the area of public risk management, are becoming relevant for managers.

The two main tasks of risk management are (1) to generate and collect knowledge about the risk, and (2) to decide how to mitigate, control or otherwise manage it. Companies should consider the question of whether it is possible to change the risk management system in order to solve management problems?

The risk management model applies principles of good governance in identifying, assessing, managing and transferring risks. However, industrial risk management has a different perspective. For example, crisis management for a company includes the development of mitigation measures, insurance coverage, and emergency management. Assessing the value of industrial assets, as part of the overall vulnerability and risk assessment, is also an important input to planning and decision making and provides an indication of the acceptable levels of costs for risk mitigation activities. In addition, the assessment of industrial assets helps to identify vulnerabilities in the supply chain and thus shows where consistent planning of emergency management and reserves is fundamental.

Source : *Risk-management in the Bioeconomy. Author: Jutta Geldermann, Georg-August-Universität Göttingen, Germany. January 2017.web-site https://www.researchgate.net/publication/315664653*

INNOVATIONS

INNOVATIVE LANDSCAPE **BIOPLASTICS**

Clarivate™

Clarivate Analytics PLC [NYSE : CCC], the global leader and analytics to accelerate the pace of innovation, has released a report on the innovative landscape of bioplastics on 22-Apr-2020.

Bioplastic

Bioplastic is a plastic material obtained in whole or in part from biomass (plants) and has biodegradable properties.

The biodegradability of a plastic depends on its chemical structure. 100% bio-based plastic is not necessarily biodegradable. The biomass used to make bioplastics comes from sources such as corn, sugarcane or cellulose.

The renaissance of bioplastics

Bioplastics have been around for over 100 years. The first bioplastic was invented at the end of the 19th century by Alex Parkes: it was expensive and easily broken, and therefore did not receive widespread acceptance. Company Parkes went bankrupt after only 10 years after its discovery.

Since then, the bioplastics industry has evolved in the shadow of the plastics industry, which gained acceptance and mass production in the 1950s. The advent of plastics has shown new opportunities for manufacturers to create multiple products from versatile and cost-effective.

A dizzying array of products has become available to the average consumer, including plastic cups, combs, bottles, and more. The possibilities of plastic seemed endless. In the 1990s, plastic captured 80% of the grocery package market. Today, plastic has become a key material not only for consumer products, but also for a wide range of industries, including automotive, electronics, healthcare. Plastic is indispensable for its ability to maintain sterility, and remains popular for its durability, versatility, and cost effectiveness.

Yet despite its widespread popularity, there is widespread acceptance of the global problem of plastics and waste consumption. Reducing waste may not be the only solution to this big problem. To solve the problem, the current consumption pattern needs to be revised. This entails a radical departure from current product development fundamentals towards evaluating new materials such as bioplastics, planning the recycling and reuse of plastics in a circular economy.

Thus, bioplastic has re-emerged as a reliable alternative. For a wider introduction of bioplastics, we see a supportive policy on the part of many, primarily developed countries.

The current landscape of bioplastics

The world production of bioplastics in 2019 amounted to 2.11 million tons, which is only a small share compared to 359 million tons of plastics [0.6%]. Further growth is expected to be modest over the next 3 years, reaching 2.43 Mt in 2024, still less than 1% of annual plastics production.

Rigid and flexible packaging dominates global bioplastics production, accounting for more than half [53%] of the total bioplastics market in 2019. Although the market is still small and nascent, some exciting innovations in bioplastics have emerged:

- Bioplastic containers made of rice starch with a high degree of heat resistance and strength;
- Edible bioplastic food wrappers made from corn and shellfish;
- Lego sets manufactured as bioplastic s5 from sugar cane.

Is bioplastic good enough to be true?

Take a bioplastic package as an example. Just because it's made from bioplastic doesn't mean it's biodegradable. Depending on the material, it can be compostable, non-biodegradable [withstand the same degradation time as plastic], and biodegradable. Even if bioplastic is biodegradable, degradation may require specific conditions today that require industrial composting plants to process bioplastic waste.

But recycling companies and local authorities are currently not prepared to deal with bioplastic waste. Many recycling and composting companies today view bioplastics as a polluting material. The disposal of this waste is an area that should be addressed, ideally before the widespread adoption of bioplastics.

The carbon footprint of bioplastics production also needs to be considered. Plastics production consumes approx. 8% of world oil production. Bioplastics proponents argue that its production reduces our dependence on fossil fuels, thereby conserving natural resources and reducing associated emissions. But there are other environmental considerations when plants go for bioplastics.

Land use for biomass for bioplastics is currently 0.02% of 4.8 billion hectares of global agriculture and may not be of much concern, but the picture is likely to change if bioplastics production is increased in the future. If more tons of compostable bioplastics are composted, higher methane production can be observed at the end of their life compared to their plastic equivalent.

The economics of bioplastics manufacturing partly explains the relative lack of growth and development of bioplastics compared to its popular counterpart. For example, a bioplastic such as PLA [polylactic acid], which is usually made from corn starch, cassava or sugar cane, can be 20-50% more expensive than its equivalent. This is due to the complex process of converting plant material into building blocks for PLA.

Human attitude to waste is a factor influencing the sustainability of bioplastics. The fact that a product is made from bioplastic does not mean that it will not turn into garbage in its natural environment. If this happens, as is the case with petroleum-based plastics, some may be incapable of degradation, which will take hundreds of years, potentially posing a threat to wildlife and marine life that often mistakenly consume these products. Unless there are significant changes in people's attitudes towards plastics consumption and disposal (and these ratios still vary dramatically around the world), waste, be it bioplastic or plastic, will still end up in the seas and forests.

Bioplastics may not be the green savior that some have touted, but as the world searches for reliable alternatives to plastics, we expect new innovations and further growth in bioplastics. We look forward to a renewed collective effort to reduce and recycle plastics in a circular economy that is advancing regionally, nationally and globally.

Innovative trends in bioplastics

For a deeper dive into innovative trends in bioplastics, let's take a closer look at packaging solutions specific to the food, beverage and cosmetic industries, i.e. closest to the consumer and who are the largest contributors to waste streams today in terms of the use of single-use plastics.

The use of bioplastics for food, beverages and cosmetics accounts for slightly less than half of all patent activity in the field of bioplastic packaging [47%; data for 2017, since patent applications remain non-public for 18 months], although according to 2018 estimates, this percentage has decreased slightly [46%].

According to the report, bioplastics packaging is in its early stages of development today, with no dominant company or organization. 40% of all inventions are owned by companies that have declared one invention, less than 10% of companies own ≥10 inventions.

Biodegradable and compostable packaging is a key concern for consumers and regulators. A recent report by the third largest global market research company Ipsos [A Throwaway World : The Challenge of Plastic Packaging and

Wase], conducted in 28 countries, shows that:

- 80% of people in the world say , that manufacturers must recycle and reuse the packaging they produce.
- 71% of people in the world believe that single-use plastic should be banned as soon as possible.
- 63% are willing to change where they shop if they need less plastic packaging (this figure varies by country).
- 75% of global consumers say they feel better about brands that contribute to better environmental performance.
- 75% of consumers say they want to buy products with the least amount of packaging.

Innovation at FMCG

As a general trend, bioplastic innovations in food, beverage and cosmetics packaging [together with FMCG] are closely related. In addition, they are attentive to trends in all geographic regions and in any technical field.

Over the past 15 years, the number of patents has grown significantly, mainly due to China, Taiwan and South Korea. The overall growth has accelerated since 2012, but the effect of this overall recovery can be seen as the effect of monetary inflation, i.e. it was more of an interpretation of earlier patents in various technical fields, whereas inventive activity must be at the core to appreciate growth.

However, in terms of patented inventions, this market is not growing rapidly. According to DWPI [Derwent World Patents Index ™] for the period 2012 ÷ 2017. The number of first-time patents filed per year for bioplastic packaging for food, beverage and cosmetics increased 58%, while the total number of first-time patents filed increased by 70%.

This suggests that the focus on consumer impact and sales of food, beverages and cosmetics, and hence waste streams that enter the environment, are below the baseline, i.e. no real growth. This is a wake-up call for companies that sell products to retailers and consumers: their supply chains are in desperate need of more attention and investment.

It is unlikely that individual ideas can lead to significant changes in the industry. It is unlikely that one invention or patented idea will act like a silver bullet.

Innovation in bioplastic packaging focuses mainly on the mechanical properties of the material [448 inventions cite mechanical strength as motivation] and biodegradable properties [331 inventions cite biodegradability as motivation.].

The requirements for biodegradable meat packaging are very different from those for toothbrushes. There are also several vectors of innovation in every use

of packaging, for example:

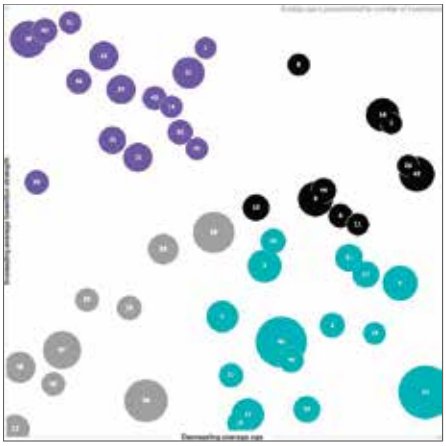
- how do you produce the material?
- is the process economical?
- focus on flexibility, material strength or tear resistance.
- its profile (biodegradable, compostable).

Of the three sectors, bio-packaging for food is experiencing the most growth. Almost 60% of biodegradable or compostable inventions in food packaging have been sold since 2015, compared to 40% for cosmetics packaging. If bio-packaging for consumer products in general does not outrun general innovation trends, then innovations focused on the use of bio-packaging in cosmetics are particularly poorly implemented: during the period 2012 ÷ 2017, 137 inventions were sold globally, from 9 to 29 per year [for comparison , 1510 innovations were sold for bio-packaging of food products during the specified period, 757 innovations in the beverage industry].

Market model for assessing innovation in bioplastics

Most patent analyzes show at some point in time the top list of top applications and applicant organizations that spend the most effort or investment in the technical field. To understand business dynamics, instead of ranking by list, the top 50 companies are looked at by number and rank in terms of average age of activity and power of ingenuity. This process creates a market model representing a 2x2 grid with X- axis conditions: strong and weak, and Y- axis: young and old portfolios.

The upper left quadrant [old, strong portfolios] are closely related to the performance of the market at the moment; organizations with a long history in this sector have created technical intellectual property rights with good top-down influence and impact, cross-technological applicability and law enforcement potential. This quadrant includes the following companies: coffee. K - Fee, illy , Lavazza , Starbucks , Nestle and Jacobs Douwe



Egberts - all of them either specialize in coffee or have a significant coffee business. DWPI shows that they are all focused on incorporating bioplastics into their business with one item - coffee capsules. This makes sense as coffee husks are a significant waste problem.

The upper right quadrant [strong, young portfolios] are potential offenders in the current market. These are, first of all, two well-known companies Footprint [USA, established in 2013], focused on sustainable packaging, and CHOCAL Aluminumverpackungen [Germany], specializing in aluminum foil packaging. It is noteworthy that the quadrant of potential "violators" includes the academic circles of China and Great Britain, specializing in production and materials science.

The analysis shows that the primary inventive peak is currently in the supply of materials and equipment [Toray, BASF], while the secondary peak is in the packaging industry. FMCG firms - retailers, food, beverage and cosmetics manufacturers - are the last in the volume allocation.

Analysis of the bioplastic packaging dataset shows that a very large number of subjects have only one invention. This speaks to the difficult nature of the innovation landscape.

40% of all inventions related to

Clarivate Analytics

Bio-packaging innovations sold

year	products	beverages	cosmetics
2012	185	90	26
2013	198	116	28
2014	255	137	29
2015	248	133	nine
2016	340	133	28
2017	284	148	17

Source: Clarivate Report "The Bioplastic innovation landscape"

bioplastic packaging of food, beverages and cosmetics belong to applicants with one invention, and only 1% of the landscape belongs to organizations with ≥10 inventions. This suggests that the sector is immature, with no one company having a dominant or even competitive advantage over another.

The longevity paradox

A unique aspect of the DWPI database is that each invention is summarized in context-sensitive fields, including those that focus on novelty and those based on superiority over previous inventions. In simple terms, pre-contextual information technologies provide a unique entry point for analytics: it tells you where the market is focusing its resources and where it is not. And this is done through the prism of problem solving, and not through a general technical classification.

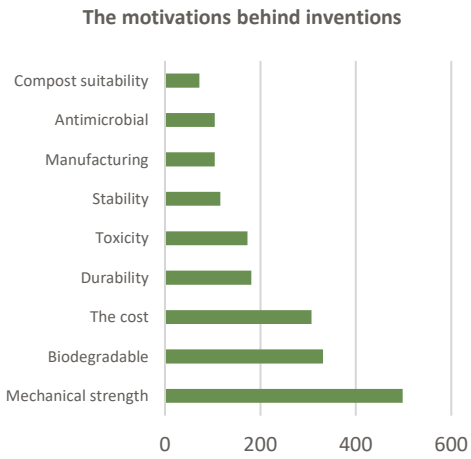
In bioplastics, the focus is on the mechanical properties of materials. This is to be expected. History has shown that biodegradable polymers such as PHA [polyhydroxyalkanoates] were initially classified as a very specific use, such as dissolving tissue seams, but then PHA moved to industrial use and were used in food waste streams such as municipal compost where household farms can dispose of skins, food debris and other organic matter.

To help collect and dispose of food waste, housewives needed compostable PHA bags, but they weren't very durable. They break very easily and the requirement for degradation easily conflicts with durability.

The solution to the longevity paradox - finding materials that don't survive in the natural environment but are durable enough to function as intended - is one of the main fronts of the innovation battle.

Competitive cost

The other front is cost - these materials must be economical, competitive with petroleum materials, and have a price that consumers are willing to pay or willing to be regulated by government.



The economics of bioplastics is complex. It's not just the cost of raw materials and production. Cost planning should include how long the materials will last, what protective benefits they provide to food, how they handle liquids, and whether additional logistics or costs are needed to maintain the FMCG supply chain.

Focusing on the problem-solution category provides a way to model the stages of technical development that have occurred before in the landscape and predict whether they will happen next. Fundamental research is related to the nature of the biodegradation of materials and the apparent cost factors.

The first wave of hard intellectual property rights involved grouting and stability assurance, mainly around oxidation and water stability. Currently, the focus of innovation in FMCG bioplastics is on the mechanical properties of materials. It is these solutions that make it possible to use them much more widely in consumer applications. Finally, more and more new technologies are associated with the specialization of bioplastic packaging as they are deployed for specific applications and uses. For example, are materials degraded by moist or short shelf life food such as meat or fish, how long the food can be stored in it, is it altered in terms of food safety, is it antiseptic or antibacterial, or how it copes with other microbiological factors.

Commercial aspects of bio-packaging

Since the very first moment of the invention of bioplastics in 1907 [still a valid US trademark], synthetic plastics have become a factor of life. While consumers have become increasingly aware of the downsides of traditional plastics in recent years, trademark data suggests that companies are still slowly transitioning to recyclable and biodegradable packaging or recyclable product.
Since 2018, we have seen some positive signs that biodegradable and recyclable products are becoming more important, but this trend still represents only a small fraction of the entire plastics sector.

Consumer sentiment is important for visibility, but the world of money has its own laws. Commercially, trademarks for biodegradable and recyclable plastics are still not attractive. They represent only 8% of the total plastics trademark filings filed with the USPTO [United States] and EUIPO [European Union].
Until the economics of bioplastics manufacturing improves and benefits from a cost advantage over traditional plastic or government incentives such as deposit schemes, subsidies or taxes on non-recyclable products are applied to bioplastics, their adoption will continue to be slow. pace.
However, the report shows that plastic has been and will be a part of our daily lives.
In terms of domain names, the expansion of the internet space in 2012 has resulted in a number of top-level “green” and “eco” names such as Bio [bio], Green [green], Organic [organic], Eco [eco], Solar [solar]. These top - level domain names (TDL) are designed to support companies, industries and individuals working to develop more sustainable activities and products, including bioplastics.

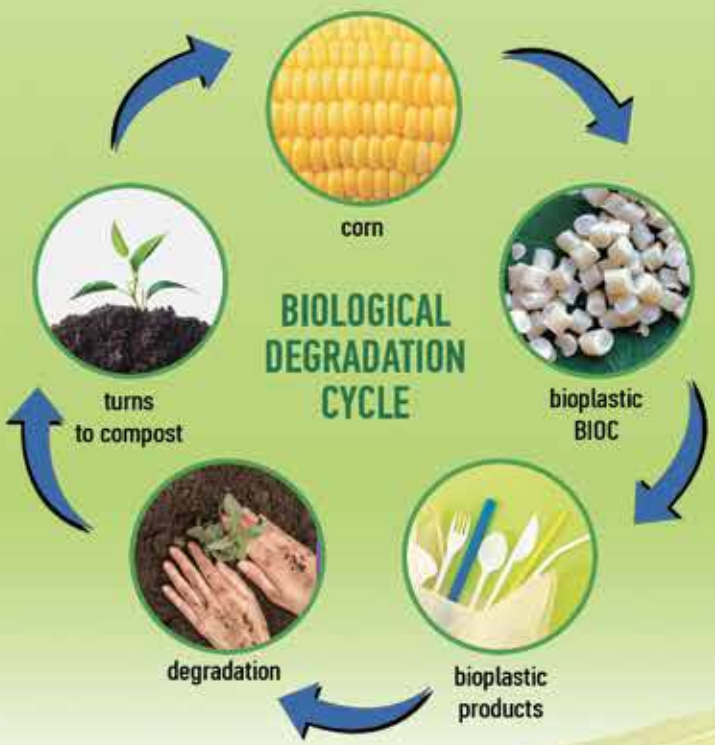
The website www.allthings.bio has a web -Page Catering is, devoted to articles, videos, and information about Innovations in the field of biodegradable packaging. The news bulletins feature products such as diapers, toys and tableware made from biodegradable plastic.

BIOC
www.bioc.com.ua

INNOVATIVE TECHNOLOGY OF BIOPOLYMER MANUFACTURING

The project of the industrial corn processing into 100% degradable biopolymer based on unique technology of triple nanopolymerization, that allows to produce bioplastics with high physical and mechanical characteristics and a controlled period of biological destruction

- **More than 50% corn starch content in the end-product**
- **Biopolymer production per year: up to 30 thousand tons**
- **The end-products will find a broad range of applications**
- **Complete processing chain from corn to bioplastics**
- **Possibility of easy replacement of plastic granules with BIOC bioplastic granules**
- **Variable period of biological degradation of bioplastics and end-products**



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