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Improvement of the bioeconomy development analysis instruments: European Union Projects and Germany experience

Scientific problem. The need for climate protection, the increasing purchasing power and demand for foodstuffs in emerging nations with growing populations, as well as rising crude oil prices have meant that agricultural raw materials are now more in the spotlight, both economically and with regard to sustainable production. New markets for biologically based products have also developed. At the same time, progress in biotechnology and gene technology gave opened up completely new possibilities in the food and feed sectors, which may provide clear answers to the social, economic, cultural and climactic changes we are currently facing. In the future, foodstuffs with a proven potential for disease prevention will, for example, be a key component of healthcare, and thus also represent a significant factor of the economy and growth.

Given the global challenges in food production and water and energy provision, these are extremely strong reasons why the political, scientific and business communities must engage immediately with the bio-economy.

Analysis of recent researches and publications. There are a lot of foreign publications devoted to the investigation of the bio-economy

and its sectors. It is important to pay attention to the works of Kean Birch, David Tyfield [1], Robert Carlson [2], Jonna Goven and Vincenzo Pavone [3]. These researchers investigate different issues of the modern bio-economy. As to Ukrainian publications, there are a lot of works devoted to the bioenergy (Geletukha G., Zheleznaya T., Kucheruk P., Olejnik E. [4], Andrejchuk I., Metoshop I., Aleksin O. [5]) and it is the lack of publications where other sectors of the bio-economy are investigated.

The objective of the article is identifying ways of analytical bioeconomy instruments relying on Germany Bioeconomy Council working results and other European projects. It gives the possibilities for improving of the scientific base of Ukrainian bioeconomy.

Statement of the main results of the study. Throughout Europe the entire bio-economy currently employs 22 million people and produces an annual turnover of 1.7 trillion Euro. It thus represents one of the largest economic sectors of the EU. An annual turnover of Germany is 300 billion Euro and around 2 million people employed.

The growth in biomass production is constrained by a limited availability of the geo-resources land and water, as well as the lack of plant varieties with a high efficiency in exploit-

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ing resources. In addition, it is expected that soils will continue to suffer increasing processes of degradation (including the effects of climate change). This means that existing land must be used as effectively as possible without neglecting the principle of sustainability.

To be in a position to best meet these challenges, science, agriculture, the food, chemical and energy industries, as well as politics on the one hand, and producers and consumers on the other, must in the future be as closely united as possible.

For overall coordination, Germany's science and technology needs a regionally anchored research structure, but one which also is active internationally, and in which non-university research institutions, universities, ministerial institutions and business collaborate closely. In the opinion of the Council, therefore, there is a fundamental need for structural change to make possible the interaction on a broad level of all areas pertaining to the bio-economy as if they were a single unit [6].

First recommendation: Understand that the bio-economy is a systemic field of research (establish overriding research structures).

The bio-economy encompasses a broad spectrum of topics which need to be considered as a whole, and require a close interlinking of all areas and actors. Intensive transfers between science, business, politics and society which break with conventional structures and the autonomy of individual academic disciplines, are absolutely crucial for the successful development of a knowledge-based bio-economy.

At present the research landscape in Germany, which is still mainly oriented towards individual academic disciplines, is insufficiently developed to achieve this. Therefore, either new agendas which transcend individual disciplines and institutions need to be developed, or existing efforts in this direction must be supported. A change in research structures in Germany towards national centers is also necessary along the lines of the cluster development that is already in motion.

The federal structure of the university system obstructs the formation of national centers of research and education. Better coordination between institutions funded by central govern-

ment and those by the Länder is, therefore, a permanent challenge.

The Council also believes that there should be a greater pooling of research funding, so as to ensure that the funds are used more efficiently. Bio-economic research funding ought to come 'in a single chunk', so as to determine the priorities and distribution of monies for research as closely as possible along the lines of agreed performance criteria or benchmarks. The setting up of an inter-ministerial working group would be an important first step towards achieving this.

Finally, there are several possible models for a suitable pooling of research areas relevant to the bio-economy, from a partial to a complete consolidation of all areas (as with the EU Commission, for example).

Second recommendation: Create reliable political parameters – eliminate legal uncertainties, for example in the areas of green gene technology.

The current debate on green gene technology highlights the fact that a social outlook open to research and innovation as well as reliable legal parameters are necessary to increase Germany's chances in international competition with regard to these technologies – particularly given the very high level of plant research in Germany. This does not only concern universities and research centres, but small, medium as well as large enterprises in the private sector, for whom investment decisions are substantially dependent on the corresponding legal regulations. Reliable legal regulations are essential to preserve the long-term survival of development processes in many areas of the bio-economy. Only a high level of social acceptance can create the right conditions for a bio-economic research landscape in Germany.

The Council therefore supports the establishment of legal certainty and reliable parameters from the research stage to licensing and marketing, including transparent consumer information, so as to enable the responsible development and application of new technologies. As in comparable areas of the life sciences or energy research, political decisions should be made on the basis of independent scientific evaluations and with a long-term perspective.

Green gene technology is only one example here. Others are tissue engineering, animal cloning, stem cell research, genome analysis, as well as the issue of humane animal husbandry and the establishment of sustainability criteria for the importing of biomass. On a more general level, an assessment should be made as to whether there ought not to be a study undertaken in Germany, along the lines of the European Commission's Lead Market Initiatives, to find out where there are institutional, legal and other obstacles impeding the advancement of the bio-economy, for bio-based products for example.

Such a study should also make suggestions for overcoming these obstacles. To improve the level of dialogue, another of the Council's suggestions is that the topic of the bio-economy should be given consideration at so-called round tables on green gene technology or other communication factors, to ensure harmony on issues of acceptance with closely-related topics.

Third recommendation: Increase research funding in times of crisis as well – offer incentives for more private investment.

The tax system for funding the bio-economy must become more innovation friendly, and be developed into a funding scheme open to all fields and in businesses of all sizes. In this respect, the Bio-economy Council welcomes the BMBF's eight-point plan of May 2009 for innovation and growth. The Council believes that the new coalition pact should adopt the basic measures necessary to increase innovation, and lower the tax and contributions burden.

Besides amendments to corporation tax and to the law on the modernization of the parameters for capital investment in venture capital, a tax-based research and development funding scheme should be adopted. Freeing innovative startups from social security contributions – as encouraged by the Expert Commission for Research and Innovation – can help to accelerate the growth of new firms. A reliable legal framework is necessary for the survival not only of small and medium businesses. Just as important as strategies for implementing the bio-economy in the current economic climate by means of investment incentives (funding instruments oriented to small and medium businesses, flexible funding criteria), are the current legislative processes. Only these can

create long-term planning security for investment decisions in the private sector.

Despite, and indeed because of the current difficult economic situation, public funding of the bio-economy as an important field of the future should be gradually expanded. The reasoning behind this anti-cyclical research funding is the positive effects that targeted measures will have on sales and employment. In the current economic crisis important sectors of the bio-economy have already shown that they can act as a buffer, and in the long term create jobs that are safe from economic crisis. Developing those bio-economic research institutions that receive central government funding should also be looked at.

Fourth recommendation: Ensure knowledge transfer at both a national and international level.

Many countries and regions of the world are actively working on the concept of the bio-economy. Globalization has particular significance for bio-economic markets, production and research. The global distribution of biological resources, research activity and markets for the varied products, but ones that are closely linked in the networks of value chains, is a prominent feature of the bio-economy. The international division of labor in research, production and market access is fundamentally important in the bio-economy.

The global challenges we face today and the consequent development of a knowledge-based bio-economy, as well as the integrative research that accompanies this, urgently require the intensive exchange of information on an international level. In the long term, Germany also needs to create targeted funding instruments for joint research in international partnerships examining the bio-economy. There must, therefore, be a strengthening of cooperation and cross-linking between existing bio-economy-related bodies, structures and initiatives in science, business, politics and society, while a plan for strategic partnerships at international level must be developed. Cooperation should not only be intensified with the BRIC countries, but with selected African as well as other Asian and South American nations which play a key role in production and processing or which are a market for German goods.

In view of the finite nature of global resources, or of those that are dwindling ever more rapidly, many large countries have oriented their international trade strategically. Because of its dependence on raw materials, Germany has also sought closer contacts and cooperation beyond the borders of the European Union. These partnerships are in Germany's interest and should be seen as investment in innovation. In this respect the high level of confidence in the German research landscape is manifest. It is the Council's recommendation that this confidence should be developed towards international strategic partnerships on a national level. European and global knowledge transfer must, therefore, be an integral part of international partnerships in which Germany is involved. Also of great importance are links with developing countries.

Here the aim should be, by means of efficient development, to support mechanisms for overcoming key challenges such as sustainable economic development, climate protection and an improvement in nutrition through bio-economic processes and products. The establishment of scientific centres by the German Foreign Office and the BMBF as part of the 'Foreign Science Policy Initiative' breaks new ground and must be developed further. In view of the high potential for innovation and the need for strategic partnerships it is recommended that certain scientific centres should be linked to centres dealing with bio-economic topics in specific continents or countries.

Fifth recommendation: Enable more excellence in student development.

The initiative to create internationally competitive parameters for public research institutions must be consistently developed. This is not just a case of setting up professorships and student research groups. Universities and research institutions must also be encouraged to work efficiently and in a more business-like fashion. Incentives for developing a lively and dynamic culture of innovation should be offered, which also focus more on potential economic applications. For this they should also make use of business and political know-how of business and politics. Businesses for their part ought to include scientists more on their advisory boards. In addition, innovation trans-

fer between science, business and politics should also be intensified at the labor level through regular exchange.

This approach implies more permeability between the areas concerned. To ensure the development of a first-rate cadre of students, educational structures must be set up that reflect the systemic character of the bio-economy. This includes the creation of interdisciplinary study programs. At the Weihenstephan Centre of Science at the TU in Munich, this has already been realized, at least to some extent. The reform should include simplifying collaboration across Land (regional) boundaries. The 'Doctoral Certificate Program in Agricultural Economics' is an example of a long-term, national institution for a structured educational program in agricultural and food economics in Germany. The cooperation of a number of faculties and research institutes means that a comprehensive range of courses can be offered, providing access to all relevant research areas in agricultural, forest and food economics, across Land and institutional boundaries, thus laying the foundation for the bio-economy.

To enable these sorts of developments, the natural sciences must be strengthened within schools by adapting the curriculum and pedagogical agendas, something that has long been recommended in a variety of initiatives from the political arena, science academies, public bodies and foundations.

Targeted funding of top students through cooperation with schools, universities and businesses is absolutely vital to ensure that the bio-economy continues to develop successfully in Germany.

First of all, to promote and monitor the development of the EU bioeconomy, the EC launched two projects. In November 2012 the Systems Analysis Tools Framework for the EU Bio-Based Economy Strategy project (SAT-BBE) was launched with the purpose to design an analysis tool useful to monitoring the evolution and impacts of the bioeconomy. Secondly, in February 2013, the Bioeconomy Information System Observatory project (BISO) started with the objective to set up a Bioeconomy Observatory. That observatory must bring together relevant data sets and information sources, and use various models and tools to provide a co-

herent basis for establishing baselines, monitoring, and scenario modelling for the bioeconomy.[7].

SAT-BBE and BISO are complementary projects. SAT-BBE develops a Systems Analysis Framework for the Bioeconomy to assess and address the short and long term challenges for an effective and sustainable EU strategy. Among other it develops a conceptual analysis tool for monitoring the evolution of the bioeconomy and could thus advise the BISO project on the types and sources of data and tools that need to be taken into account. Also, BISO assemble and implements the data and tools that lie beyond the conceptual framework to be designed in SAT-BBE into an information system. Similarly, SAT-BBE could benefit from the BISO project in the sense that the latter is providing a comprehensive insight in the availability of data and tools that could be helpful when developing the conceptual analysis framework of the bioeconomy.

More precisely, the purpose of SAT-BBE is to develop a system analysis tool for monitoring and assessing the evolution of the bioeconomy based on both quantitative and qualitative analytical models and tools. The toolbox enables to assess and address the impact of drives and various policies on the evolution of the bioeconomy and the implication on people, planet and profit indicators. The focus is thereby not only on economic aspects, but also on other effects, e.g. land use, food security, biodiversity and greenhouse gas emissions. A systems analysis tools framework has the purpose to understand the functional requirements of a bio-based economy and to measure the necessary extent for transformation of the economy as a whole to a bio-based foundation.

Systems analysis implies the capacity to understand relations between parts, and the nature of both the parts and their relationships.

Obviously, the EU Bioeconomy Strategy addresses the need to establish a Bioeconomy Observatory (BISO). This is an information system allowing the Commission and other stakeholders to assess the progress and impact of the bioeconomy. It must bring together relevant data sets and information sources, and would use assessment, modelling and forward-looking tools meant to provide a coherent basis for establishing baselines, monitoring, and scenario modelling for the bioeconomy as a whole.

The main objective of the BISO project is to monitor the bioeconomy in the past, by collecting, structuring and storing observed data in an information system. Reversely, the SAT-BBE is looking forward in the sense that it is investigating what type of data and models will be required to monitor and steer the evolution of the bioeconomy. More precisely, the aim of SAT-BBE is to design a systems analyses framework that enables stakeholders to conduct policy analysis, scenario studies and impact assessments in respect with the long term EU bioeconomy.

Aforementioned purposes show that both projects have complementary objectives to fulfil, and could benefit from each other (Table 1): SAT-BBE provides knowledge on the type of indicators, criteria that are useful to conduct ex-ante impact assessment studies; herewith it could advice on what information must be implemented in the BISO information system; BISO provides information on existing bioeconomy related indicators and tools, and centralizes them in an information system in order to make them accessible.

Table 1

Comparison between BISO project and SAT-BBE project

	Bioeconomy Observatory (BISO)	System Analysis Tool for bioeconomy (SAT-BBE)
Objective	Bring together and organize relevant data sets, indicators and quantitative and qualitative methods, to perform EU capacity mapping, technology watch, bioeconomy policy outlook and market monitoring in areas related to the bioeconomy	Identify how to describe (in terms of data and indicators), monitor and model the bioeconomy part of the economic system, by the development of an appropriate toolkit. The concepts of bioeconomy and non-bioeconomy sectors will be defined, major interactions and feedback effects between the bioeconomy and other parts of the system will be identified and analysed, and the likely impacts and trade-offs of the bioeconomy “drivers” will be studied.
Main Activity	System shaping, centralization, and sharing of existing data, indicators, and tools relevant to the Bioeconomy	Demonstrating how the existing data and quantitative models and their future extensions and improvements, as well as qualitative analyses (e.g. foresight analyses), can be used to describe the bioeconomy development, its interactions with the rest of the economy, and its impacts to environmental resources and their quality. Identify research gaps based on existing data and tools..

Duration	March 2013 - February 2016	October 2012 - March 2015
Consortium	JRC Headquarter Brussels (Belgium), IPTS Seville (Spain), IS-PRA (Italy)	LEI-WUR (NL), Utrecht University (NL), European Forest Institute (Finland), Wuppertal Institute (Germany), IIASA (Austria), IFPRI (USA), Institute for Environmental Studies-VU University Amsterdam (NL), Thünen Institute (Germany)
External Cooperation	EU Commission services EU Member States International organizations (Key) Third countries (non-EU) Industry associations and expert groups	European Commission services External expert groups

Source: [7].

In our opinion, we should pay special attention to scenarios of the future development of bio-economy - based on the use of fossil re-

sources and bio-oriented scenario – which were developed by scientists of project SAT-BBE.

Table 2

Plausible evolution of the bioeconomy sectors under the “Fossilised” and “BioProgressive” cases

Category	‘Fossilised’ case	‘BioProgressive’ case	Performance indicators
Agriculture			
Crops	Lower productivity growth with more reliance on area expansion than yield gains	Faster productivity growth with less crop area expansion and higher harvest intensity	Livestock production per unit feed
Livestock	Slower productivity growth with stagnant feeding conversion ratios	Faster productivity growth with rapidly improving feeding efficiencies	Livestock production per unit feed
Fisheries	Slower expansion of aquaculture growth with persistence of disease and little innovation in feed substitutes for fishmeal	Faster expansion of aquaculture growth with rapid decline in antibiotic use and steady innovations in feed alternatives	Fish production per unit feed
Forestry			
Pulp & paper industry	Stagnant levels of productivity and slow innovation in use of forestry by-products	Steady productivity growth with steady innovation in use of forest by-products for fuel and other uses	Value added generated per unit area of forest
Bioenergy	Slow innovations in bioenergy and continued reliance on first-generation biofuels with limited growth in advanced biofuels and limited use of co-products	Faster innovation in bioenergy with steady replacement of first-generation technologies with more advanced cellulosic technologies and broadening range of co-products	Share of energy in renewables, KJ per kg feedstock
Biochemicals	Stagnant development of biochemical products with limited innovations in conversion processes and development of useful co-products	Rapid development and innovation in range and utility of bio-products with improving efficiencies and proliferation in commercial co-products	Share of chemical sector output in advanced biochemicals

Source: [2].

As seen from table 2 “Fossilised” scenario assumes inward-looking, fragmented and non-cooperative tendencies of national governments and institutions that lead to low levels of technical innovation, openness to trade and exchange of ideas, migration, economic growth; reluctance to form cooperative, beneficial political or monetary unions. It reflects higher levels of population growth, localized concentrations of poverty, malnutrition and socially-depressed populations within countries and regions. It provides little progress towards a knowledge-based worldwide bioeconomy.

“BioProgressive” scenario is based on tendencies towards a more open exchange of

commerce, ideas and innovations that allows innovations to spread faster and for populations within a more globalized environment to benefit from the spill-overs related to faster technological progress and productivity and efficiency advances. The rates of technical innovation and productivity improvements are high, there is higher freedom of movement for human populations, more liberalized labor markets and competitive wages, higher economic growth, generally lower population growth accompanied by higher levels of education, overall higher levels of human well-being. It provides fast progress towards a knowledge-based global bioeconomy.

For each scenario the impacts on the performance indicators are measured by comparing the scenarios outcomes with these under a Business-as-Usual baseline scenario. A baseline normally takes the historical trends of economic and technical productivity and population growth – relying on the current UN medium variant population projections, and the projections of economic growth from OECD and the World Bank Global Economic Prospects - as starting points. Furthermore, the baseline assumes that current bioenergy related policies remain in place, and that the key technologies currently in use within the agrofood, forestry, biochemical and biotechnology sectors persist for the coming decades.

In order to fully exploit the benefits of the BioProgressive scenario, possible trade-offs must be managed and negative impacts need to be minimized. The most important drawbacks expected in the areas of economy, society and environment are related to the increasing demand for land and competition with food crops. These may result in socio-economic impacts, affecting employment, economic growth, food security, prices of agricultural commodities and food, environmental impacts such as climate change, impacts on biodiversity of terrestrial and aquatic ecosystems. Possible strategies or responses for addressing environmental drawbacks are, for example, increased use of organic wastes, forests and/or agricultural residues, but also the development of biorefineries that allow for a more complete use of the biomass for pro-

ducing biobased materials, energy, fuels and heat [7].

Incorporating strategies that control the trade-offs that may occur under a 'BioProgressive' or 'Fossilised' case should be key in providing a complete assessment and accounting of the potential pathways of the EU's bioeconomy.

Conclusions. It is got such conclusions. Today bioeconomy branches develop very fast and dynamically. The aim of them is ecological stability protection. The Bioeconomy Council presented such recommendations according bioeconomy development in Germany: to understand and take a fact that the bioeconomy is a systematic sphere of investigating; to create stable political conditions: eliminate legal gaps, for example in the sphere of "green" technologies; to stimulate financing investigations in crisis conditions and to offer incentives for private investments; support knowledge transfer on the national and international levels; to encourage studentship.

It is analyzed the results of work of the European projects at the bioeconomy development: Bio-Based Economy Strategy project (SAT-BBE) and the Bioeconomy Information System Observatory project (BISO) started with the objective to set up a Bioeconomy Observatory. Set of instruments proposed by such projects allow assessing and directing campaign influence and other issues on the bioeconomy development, attracting society, business, politics and scientists.

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