1. Bioprincipled City

Quality of Life in Greener Cities

The integration of biological principles into urban planning and city life has become a key element for the achievement of greener cities with high levels of self-sufficiency and quality of life. Locally coordinated production, provision, use and recycling systems ensure that mega cities function on the basis of closed material and energy cycles. Emissions, waste and losses are minimized. Renewable resources, cropping techniques and biotechnology play a major role in closing the loops. Value-chains are based on the cascading use of natural and renewable resources, e.g. water. Urban (vertical) farms are economically and ecologically efficient high-tech production centres. Spaces for recreation, production, services, work and living are integrated and decentralized in city districts. Mega cities innovate sustainable building designs and construction techniques by referring to biological principles and renewable resources. Green areas, and especially the green belts of big cities are recognized as important retreats and contribute to biodiversity, water regulation and filtration, air cleaning, halting soil erosion and desertification, mitigating temperature extremes (saving energy consumption) and human recreation.

Key Aspects

Urban planning based on biological principles

- closed material and energy cycles
- cascading use of natural resources, such as water
- living, working, leisure spaces and biotopes combined in urban centers
- green belts and spaces provide ecosystem-services

Architecture based on biological principles

- bio-inspired design solutions
- biobased building materials

Urban Production

- green industrial production co-exists with residential areas
- urban farms produce fresh food locally

Relevancy Score*: 74%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi

2. Artifical Photosynthesis

Independence from fossile fuels

Aided by the renewable production of carbohydrates, people are no longer dependent on the use of fossil fuels, thus protecting the environment and nature. This can contribute to the decarbonization of the atmosphere. Artificial photosynthesis is superior to the plant-based systems or the solar cells common in 2015 in terms of sustainability and efficiency. Understanding and applying the photosynthetic process in man-made systems facilitates further steps that produce biofuels or primary energy.

Key Aspects

Generation of renewable energy (Hydrogen)

- bacteria and algae enable efficient production
- replacement of fossil fuels

Development of biofuel cells and biobatteries

- energy supply on an industrial scale
- powering small devices, e.g. consumer electronics

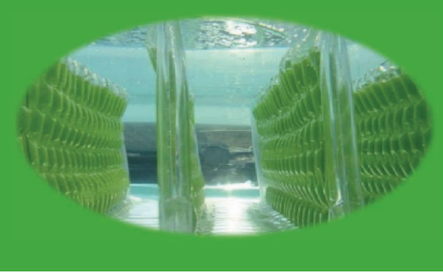
Production of hydrocarbon (Sugar, Starch)

- feedstock for the chemical industry
- basis for food production in the agro-industry

Relevancy Score*: 61%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi

3. New Foodsystems



Food security and healthy nutrition

Sustainable consumption is implemented in new food concepts. Low-emission agriculture which sustains biodiversity contributes to this. The food industry offers products that represent an attractive alternative to resource-intensive meat consumption based on new sources of protein in plants, algae, fungi or insects. Individually tailored foods ensure that people receive a varied and healthy diet within the scope of new supply concepts. Efficiency gains lead to losses being prevented or reintegrated into the material cycle along the entire value chain. Regional approaches are implemented where appropriate.

Key Aspects

Healthy and sustainable nutrition

- using alternative sources of protein
- implementing principles for sustainable consumption in new food concepts
- balanced and healthy diets
- personalized nutrition

Resource-efficient food value chains

- zero-waste
- sustainable agriculture with low emissions
- reduction of input per produced food unit
- regional approaches to food systems
- national and international food strategies consider the social role of food

Relevancy Score*: 79%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi

4. Global Governance

Dialogue and agreements for a sustainable bioeconomy

To take full advantage of the positive potential of the bioeconomy, a global policy framework has been adopted by most countries active in the bioeconomy. The framework defines the guiding principles of fair exchange, specifically respecting the sustainable development goals (ending hunger, ensuring eco-system performance, maintaining biodiversity). Mechanisms for monitoring and ensuring food security, protecting biodiversity and the eco-system performance are in place. This includes principles for knowledge sharing and intellectual property rights.

Key Aspects

Establishing worldwide policy mechanisms supporting sustainable bioeconomy and green growth

- mechanisms for monitoring ensuring food security and eco-system performance (incl. biodiversity)
- mechanisms for responsible trade in biobased products and services
- mechanism for responsible investments in agricultural and biobased industries
- mechanism for sharing knowledge and technologies relevant for the bioeconomy

Global agreement on principles and standards

- principles for intellectual property rights
- principles for managing biosafety and biotic risks
- sustainability criteria applicable to the production, trade and use of biomass
- international standards in biotechnology and synthetic biology
- principles for sustainable consumption of biobased products

Relevancy Score*: 70%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi

5. Sustainable Marine Production

Eco-friendly biomass from seafarms

To meet the needs of a growing population and an expanding bioeconomy, sustainable aquatic cultivation of marine organisms has gained importance. New methods not only complement fading yields of non-sustainable fishery. They bear new potential to grow and harvest algae, mussels, krill, plankton and other marine organisms in seafarms that are operated environmentally friendly (e.g. avoiding antibiotics, preference for plant-based protein). Algae for example serve as a source for food and food supplements (e.g. omega 3 fatty acids), feed as well as fine chemicals (e.g. oils). Algae and marine plants are exploited to produce hydrogen and biomass for the production of energy (biofuels). Marine production is carried out sustainably by applying bio-principles and bioeconomic modeling and simulation tools. The cultivation processes are associated with additional positive effects for the environment e.g. treating marine littering (e.g. plastics), filtering harmful substances out of the water or protecting the seashore.

Key Aspects

Seafarms as additional biomass producers

- environmentally-friendly aquatic cultivation of marine organisms
- complementing fading yields of non-sustainable fishery
- algae as a source for food, feed and fine chemicals

Sustainable production

- application of bioprinciples to ensure sustainablity
- application of monitoring, modeling and simulation tools
- provision of eco-systems services
- treating marine littering and filtering plastics

Relevancy Score*: 73%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi

6. Biorefineries 4.0

Biorefineries facilitate zero-waste and circular economy

Biorefineries of the fourth generation have gained large economic importance and form an own industrial sector. The basis of which are multi-purpose concepts converting lignocellulose-containing feedstocks (wood, straw etc.), algae, food and even plastic waste efficiently and flexibly into energy, fuels, bulk and fine chemicals. Biomass is an established source for active pharmaceutical ingredients which are produced in energy-efficient biocatalytic downstream processes. Overall, any carbon-containing waste can be transformed via gasification or enzymatic biotransformation. The production capacity of all biorefineries makes up 10 to 20 per cent of the chemical and petrochemical industry. The dimension and number of agricultural monocultures has been reduced. The dilemma “food vs. fuel” is solved. The new biorefineries fit elegantly into the landscape and do not produce “waste” anymore: a zero-waste circular economy is a reality.

Key Aspects

Developing Biorefineries of the fourth generation

- development of an own industrial sector
- flexible and multi-purpose concepts converting any carbon-containing waste
- energy-efficient biocatalytic downstream processes
- residues as feedstock for feed, food, fine chemicals and fuels
- biorefineries are “green” and do not produce any waste

Avoiding negative externalities

- saving land for food
- zero-waste circular economy

Relevancy Score*: 75%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi

7. Developing Consumer Markets

Establishing sustainable consumption patterns

Bioeconomy under the principle of sustainability is a part of everyday life. The foundations of Bioeconomy are integrated into primary education. Higher education transfers knowledge on the complex interplay within the Bioeconomy. Entrepreneurs, engineers and farmers have access to hands-on training in biobased technologies and economy. These efforts contribute to a new understanding of sustainability. Preserving nature by using it, is part of it. People are used to think in categories of renewability and re-usability and are trained in adapting their behavior to new knowledge. Useful and easy-to-understand labels or apps inform of a product's life-cycle cost. Consumers and entrepreneurs prefer sustainable, bio-based products and understand the costs and benefits involved. Consumption becomes more value and less quantity oriented. Participatory approaches are common in policy making at local, regional and national level. Citizens are involved in different sustainability projects and learn by doing. There are no taboos for creativity in research & development – but risks are made transparent and are not neglected. Marketing and product development rely strongly on consumer collaboration and feed-back.

Key Aspects

Education & training

- basic and advanced education on bioeconomy at school
- training in biobased technologies for entrepreneurs, engineers and farmers
- labels or apps informing about a product‘s life-cycle cost

Citizen and consumer involvement

- two-sided communication systems leading to a new understanding of sustainability
- participative approaches in policy making
- contribution to sustainability projects (learning by doing)
- consumer collaboration and feed-back in product development

Relevancy Score*: 67%

*Global Visions for the Bioeconomy – an International Delphi Study, Bioeconomy Council 2015, www.gbs2015.com/delphi