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ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

ENVIRONMENT [ENERGY] CLIMATE CHANGE [MONITORING AND ASSESSMENT

HOW SUSTAINABILITY IS ADDRESSED IN OFFICIAL BIOECONOMY STRATEGIES AT INTERNATIONAL, NATIONAL AND REGIONAL LEVELS

An overview



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ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

ENVIRONMENT CLIMATE CHANGE [ENERGY] MONITORING AND ASSESSMENT

HOW SUSTAINABILITY IS ADDRESSED IN OFFICIAL BIOECONOMY STRATEGIES AT INTERNATIONAL, NATIONAL AND REGIONAL LEVELS

An overview

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ACRONYMS

B5	5 percent biodiesel blend in diesel
B7	7 percent biodiesel blend in diesel
B10	10 percent biodiesel blend in diesel
BBE	Bio-based economy
BE	Bioeconomy
BSR	Baltic Sea Region
E2	2 percent ethanol blend in petrol
E5	5 percent ethanol blend in petrol
EU CAP	European Union Common Agricultural Policy
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
GFFA	Global Forum for Food and Agriculture
GHG	Greenhouse gas
IEA	International Energy Agency
ILUC	Indirect land use change
IT	Information technology
LCA	Life-cycle assessment
OECD	Organisation for Economic Co-operation and Development
PPP	Public-private partnership
SCAR	Standing Committee on Agricultural Research
SME	Small and medium enterprise
R&D	Research and development
R+D+I	Research, development and innovation
USDA	United States Department of Agriculture
WBSCD	World Business Council for Sustainable Development

EXECUTIVE SUMMARY

The crosscutting nature of bioeconomy offers a unique opportunity to address in a comprehensive manner inter-connected societal challenges such as food security, natural resource scarcity, fossil resource dependence and climate change, while achieving sustainable economic development.

Bioeconomy is a reality and it has generated increasing interest in many parts of the world. The sheer importance and multi-facetted character of bioeconomy – hence also of its potential impacts, make it imperative that it be developed in a sustainable way. It is therefore important and timely to develop guidelines to develop bioeconomy in a sustainable way. In that line, in January 2015, at the occasion of the Global Forum for Food and Agriculture (GFFA) meeting in Berlin, 62 Ministers of Agriculture recommended that FAO coordinate international work on bioeconomy. This translated in some support from the Government of Germany to FAO regarding a programme to develop sustainable bioeconomy guidelines. This overview is the first output of the first phase of this sustainable bioeconomy guidelines programme. The overview concerns twenty bioeconomy strategies, at international, national and sub-national levels. It analyses how these strategies have addressed sustainability issues. The report also provides a brief discussion on approaches used to develop bioeconomy strategies. Finally, it also discusses 10 action plans related to some of the bioeconomy strategies.

The main findings of this overview can be summarised as follows:

- It is yet another evidence of the strong interest in bioeconomy at different levels worldwide, as a possible contribution to addressing major global, national and regional development and environmental challenges;
- Ensuring that bioeconomy is developed in a sustainable way and will benefit all sections of the population is a necessity but will not be easy to achieve. There is no "one-size fits all" in terms of priorities, approaches, and how sustainability is addressed in BE development strategies and implementation plans;
- The current bioeconomy strategies are written as broad frameworks. They include environmental and socio-economic considerations. However, they show common weaknesses and gaps. These concern for instance the sound use of land, water and waste management along the whole value chain, possible competition between the different biomass-end use sectors, energy security, bio-innovations, enabling and converging technologies, mechanisms to benefit smallholders;
- Efforts towards the implementation of the bioeconomy strategies have been developed through action plans only in few cases. They also show some weaknesses and gaps. They concern for instance monitoring and evaluation, and financing aspect

(e.g. barriers to access green finance and capital markets, financial support to small-scale producers and enterprises). However, there are some interesting examples of decentralised bioeconomy programmes;

- There is already a lot of knowledge worldwide on successful ingredients and pitfalls regarding the sustainable production of biomass, and, to a lesser extent, its use. And significant Research and Development (R&D) is underway to develop needed innovations along the biomass value chain to complement existing knowledge;
- The analysis shows that many countries indicate that sustainability standards and guidelines should be developed and agreed on at international level. This is actually being addressed by the programme on sustainable bioeconomy guidelines being developed under FAO's coordination.

One can draw some useful lessons from these conclusions regarding the development of sustainable bioeconomy guidelines:

- It does not have to start from scratch and has to avoid reinventing wheels. One should build on the vast body of knowledge, policies, approaches and good practices related to the conventional sectors of biomass production and use (agriculture, forestry, fisheries) and more recently, modern bioenergy. On that basis, one can adapt existing ones to bioeconomy, and fill gaps where needed;
- It will have to combine general aspects and enough flexibility to allow for solutions to be tailored to local circumstances;
- It should be achieved through a joint effort by a multistakeholder international partnership, coordinated by an international body;
- It seems advisable that, at least part of the guidelines – such as principles and criteria – goes through a formal multistakeholder endorsement at international level, in order to improve their legitimacy;
- It should be supported by a significant communication effort towards the general public, to ensure societal acceptance of and active involvement in bioeconomy.

CHAPTER 1

INTRODUCTION

1.1. SOME DEFINITIONS

The International Advisory Committee on Bioeconomy, set up at the occasion of the First Global Bioeconomy Summit in Berlin in November 2015, defines bioeconomy as "knowledge-based production and utilization of biological resources, biological processes and principles to sustainably provide goods and services across all economic sectors"
Bioeconomy involves three elements:

- *Renewable biomass*: This concerns the use of renewable biomass and efficient bioprocesses to achieve a sustainable production;
- *Enabling and converging technologies* ('Nano-Bio-Info-Cogno'): Beyond biotechnology, a key development is the combination of digitalization and 'biologization'. Sustainable development is supported by applications such as precision agriculture, satellite forestry monitoring, DNA barcoding of fish species, etc. In the IT industry, biological knowledge is applied to computer and chip design, e.g. DNA storage;
- *Integration across applications*: Integration concerns primary production (i.e. all living natural resources), health (i.e. pharmaceuticals and medical devices), and industry (i.e. chemicals, plastics, enzymes, pulp and paper, bioenergy).

The terms bioeconomy (BE) and bio-based economy (BBE) are sometimes used interchangeably. However, it is worth to distinguish them:

- Bioeconomy strategies and policies include regular food and feed chains;
- Bio-based economy only takes into consideration the production of non-food goods, i.e. bio-based materials, chemicals and medicine/ pharma, pulp and paper, wood, textiles and bioenergy, with the exception of functional foods (nutraceuticals), tailored food products to meet specialized dietary requirements and nutraceuticals (IEA-Bioenergy Task 42, 2014).

Simply put, bioeconomy includes both bio-based economy and the production and use of food and feed.

The term Bio-based Industries can refer to the industrial production of all possible bio-based goods (using renewable resources, bio-based processes and/ or technologies).

In this report, we have considered strategies related to bioeconomy, bio-based economy and bio-industries given their rather broader and somewhat similar scope, and their innovative character. They are referred to as "BE strategies". On the other hand, and for the above-mentioned reasons this overview does not concern strategies or policies specific to biotechnology or bioenergy, nor those specific to sectors relevant to biomass

production and use (i.e. agriculture, forestry and fisheries). Private sector strategies were not considered either.

1.2. BACKGROUND

The crosscutting nature of bioeconomy offers a unique opportunity to address in a comprehensive manner inter-connected societal challenges such as food security, natural resource scarcity, fossil resource dependence and climate change, while achieving sustainable economic development.

Bioeconomy, if done right, offers countries, particularly those with scarce fossil resources yet ample land for agriculture and forestry, an opportunity to increase the value-generation potential of their agricultural production and to boost their economic development through the processing of agricultural products into renewable materials and energy, while ensuring food security and nutrition.

Bioeconomy is a reality and it has generated increasing interest in many parts of the world. Indeed, in recent years, several strategies and programmes have been developed at international, national and regional levels. Moreover, one can consider that bioeconomy plays an important role in many developing countries, given the importance of their agricultural sector and the use of biomass to produce energy, medicinal plants and as building material, in addition to food, feed and fibre. Moreover, different groups in various parts of the world are interested in bioeconomy, e.g. the International Advisory Committee on Bioeconomy (IACB) of the 2015 Global Bioeconomy Summit; the Global Green Growth Forum/3GF; the Ibero-American Network of Bioeconomy and Climate Change (REBICAMCLI) between Mexico, Honduras, Nicaragua, Colombia, Cuba and Spain; the EU Bioeconomy Panel, the EU-coordinated International Bioeconomy Forum (IBF); the Food, Fuel, Fibre and Forests/4Fs Dialogue; and the WBCSD Action 2020.

There are significant revenue potentials along the entire biomass value chain. Indeed, by some estimates, in 2013, bio-based economy in the EU generated about 3.2 million jobs and has an annual turnover of 600 billion EURO (excluding agriculture, forestry, fishery, food[1] and tobacco products). These figures increase to 18.3 million jobs when all sectors of bioeconomy are included (60 percent in biomass production and 25 percent in food and tobacco industries) and a turnover of 2.1 trillion EURO (22 percent on biomass production and 55 percent in food and tobacco industries, in contrast) (Ronzon et al., 2015, and Piotrowski et al., 2016). In the U.S., the bio-based economy (excluding food, feed, livestock, pharma and energy) represents about 4 million jobs and about 370 billion US-Dollars in 2013, including direct, indirect and induced effects (Golden et al., 2015). Moreover, the World Economic Forum (WEF) estimates that the revenue potential for new business opportunities in the biomass value chains could globally amount to about USD 295 billion by 2020,; that is three times the amount of 2010. These revenues generated at the different stages of new biomass value chains include the manufacturing of agricultural inputs, biomass production and trading, bio-refining inputs (e.g. biomass pre-treatment methods), the actual biomass conversion in the biorefineries and the sale of

1 Including food, beverages and feed products

end products (WEF, 2010). Finally, according to the OECD (2009), a "business as usual" estimate is that biotechnology could contribute up to approximately 2.7 percent of GDP in the OECD by 2030. Biotechnology could account for an even higher share of GDP in non-OECD countries, due to the greater importance to GDP of primary and industrial production compared to OECD countries.

The sheer importance and multi-facetted character of bioeconomy – hence also of its potential impacts – make it imperative that it is developed in a sustainable way. However, achieving sustainable bioeconomy development faces many challenges. These concern not only ensuring food security but also addressing climate change and managing natural resources in a sustainable way, managing competition between different uses of biomass, while guaranteeing that bioeconomy benefits everybody. Trade-offs and synergies are likely, not only for the biomass production and supply, but also for skilled labour, land use, new waste streams, market niches or national funds. Environmental and socio-economic sustainability issues, such as the greenhouse gas (GHG) balance, biodiversity, social well-being, governance or job creation are key elements of sustainable bioeconomy. As evidence of these challenges, a recent study on the prospects of bioeconomy in Europe shows that, whatever scenario they have considered, there is no "all wins" bioeconomy development option (Philippidis et al., 2016).

The increasing potential of and interest in bioeconomy must be oriented in the right direction in order to make sure bioeconomy works for people, food and nutrition security, sustainable economic growth, while preventing climate change and not harming the environment. This will require significant efforts in terms of knowledge, policies and institutions, both at national level and through international collaboration. It is therefore important and timely to develop guidelines to develop bioeconomy in a sustainable way. In that line, in January 2015, at the occasion of the Global Forum for Food and Agriculture (GFFA) meeting in Berlin, 62 Ministers of Agriculture recommended that FAO coordinate international work on bioeconomy. This translated soon after in some support from the Government of Germany to FAO regarding a programme to develop sustainable bioeconomy guidelines. A key ingredient to ensure good results of this programme concerns the creation of a multi-partner informal sustainable bioeconomy working group, as an advisory body throughout the development of the sustainable BE guidelines. This overview is one of the outputs of the first phase of this sustainable bioeconomy guidelines programme.

CHAPTER 2

STOCK TAKING/ GAP ANALYSIS REGARDING THE CONSIDERATION OF SUSTAINABILITY ISSUES IN MAJOR BIOECONOMY STRATEGIES

Twenty BE strategies at international, national and regional levels are included in this analysis. The results of the stocktaking/ gap analysis are summarised in Table 1.

From a methodological point of view:

- One major constraint was that detailed parameters (such as GHG emissions, land use, etc.) could not be used, as most strategies are written as broad frameworks and do not go into that level of detail. As a result, of the above, the selected bioeconomy documents were classified according to the following broad categories, reflecting the general nature of the strategy documents reviewed:
  - Environmental sustainability, including issues such as land; natural resources management and environment; biodiversity; soil; inputs; water; GHG; air and waste;
  - Socio-economic sustainability, comprising issues such as access to resources, rural and social development, employment/ income, health and safety, energy security and access, gender, social acceptance, productivity, economic development, R&D, competitiveness and investments and infrastructure;
  - Competition and synergies among biomass end-use sectors, e.g. in terms of biomass, uses of land, infrastructure and skilled labour;
  - Food security with its four dimensions: availability, access, utilization and stability;
  - Enabling factors, including sustainability issues in areas such as policies, regulations and markets, rule of law, institutional setups, monitoring and accountability, participation and transparency, human capacity development and cooperation.
- In Table 1, the various categories are ticked only if explicitly addressed under each initiative. Issues mentioned only briefly or indirectly addressed under other categories/ issues are not ticked.

TABLE 1.

Summary of gap analysis of sustainability issues in official BE strategies

✓= The issue is addressed

CATEGORIES	Environmental sustainability	Socio-economic sustainability	Competition/ synergies among biomass end-use sectors	Food security	Enabling Factors
INTERNATIONAL					
Baltic Sea Region - *2015-2018 Strategy and Action Plan Towards a BSR Bioeconomy* (2015)	✓	✓	✓		✓
EC - *Innovating for Sustainable Growth. A Bioeconomy for Europe* (2012)	✓	✓	✓	✓	✓
OECD - *The BE to 2030. Designing a Policy Agenda* (2009)	✓	✓		✓	✓
West Nordic Countries - *Future Opportunities for Bioeconomy in the West Nordic Countries* (2014)	✓	✓	✓	✓	✓
NATIONAL					
Argentina - *La Bioeconomía en la Argentina: Oportunidades y Desafíos* (2015)	✓	✓	✓	✓	✓
China - *Development Plan for the Bio-Industry* (2012)	✓	✓		✓	✓
Denmark - *Denmark as Growth Hub for a Sustainable Bioeconomy* (2014)	✓	✓		✓	✓
Finland - *The Finnish Bioeconomy Strategy* (2014)	✓	✓			✓
Germany - *National Policy Strategy on Bioeconomy* (2014)	✓	✓	✓	✓	✓
Japan - *The Biomass Industrialization Strategy* (2012)	✓	✓		✓	✓
Malaysia - *The Bioeconomy Transformation Programme* (2012)	✓	✓		✓	✓
The Netherlands - *Framework memorandum on the Bio-based Economy* (2012)	✓		✓	✓	✓
Russia - *BIO-2020* (2012)	✓	✓	✓		✓
South Africa - *The Bio-economy Strategy* (2013)	✓	✓		✓	✓
Spain - *Spanish Bioeconomy Strategy: Horizon 2030* (2016)	✓	✓			✓
USA - *National Bioeconomy Blueprint* (2012)	✓	✓		✓	✓
REGIONAL					
Baden-Württemberg (Germany) - *Bioeconomy. Baden-Württemberg Path Towards a Sustainable Future* (2013)	✓	✓	✓		✓
British Columbia (Canada) - *British Columbia Bio-economy* (2011)	✓	✓			✓
Flanders (Belgium) - *Bioeconomy in Flanders* (2014)	✓	✓	✓		✓
Scotland (UK) - *The Biorefinery Roadmap for Scotland* (2015)	✓	✓			✓

Note: The State of South Australia (Australia) has a regional strategy: "Building a Bioeconomy in South Australia" (2011-2015), however, the document is not available. There also exists the "Manitoba Bio products Strategy" (Canada). France and Norway will release national BE strategies in 2016 (Lang, 2016).

The following considerations can be drawn from Table 1:

- In some cases, there is a combination of national and regional strategies (i.e. in Argentina, Japan and Germany). There are also cases (e.g. Japan, Denmark and Germany), where national strategies are combined with industry-led initiatives (Bioökonomierat, 2015a);
- There are gaps in the way the different categories are addressed in each strategy. However, a gap concerning one particular aspect does not necessarily mean that efforts are not undertaken regarding this aspect. Indeed this aspect may well be addressed in other formal documents, such as sectoral strategies (forestry, agriculture, bioenergy). Moreover, the gap analysis for each strategy is further blurred by the fact that there are links between these categories. Some measures are aimed at one of them can indirectly also influence others. For example many innovations that bring socio-economic sustainability like employment and health, would very likely increase national food security. Another example is that competition in the use of biomass should account for environmental sustainability and availability of biomass among sectors.

Given the above, it seems more valid and interesting to look at the way each category is dealt with across the different BE strategies. This analysis is presented in turn.

CHAPTER 3

DISCUSSION ON MAIN CATEGORIES USED IN THE STOCK-TAKING/ GAP ANALYSIS

3.1. ENVIRONMENTAL SUSTAINABILITY

The analysis shows that all BE strategies address a relatively broad range of environmental sustainability issues in depth. However, very few use indicators or specific methodologies to measure it – even though life cycle analysis and footprint approaches are sometimes mentioned.

The majority of environmental aspects, such as GHG emissions, air pollution, natural resources management and waste, are broadly considered across the entire value chain at both stages, i.e. for biomass production and biomass use. At times, the different stages of the value chain are separated, as in the South African strategy, in which the management of waste and wastewater from industrial processes is a stand-alone core objective, along with agricultural and forestry biomass production and the medical sector.

Natural resources management is widely present in the strategies analysed, but in different ways according to the amount of natural resources assets. Broadly speaking:

- Countries well-endowed with biomass from natural resources (e.g. China, Finland, Malaysia and South Africa) promote the sustainability of the primary production and exploitation of biomass resources (Overbeek et al., 2016). Finland and The US emphasise utilisation strategies based on these resources in bioeconomy. Key utilisations include chemicals and bioenergy, and link to industrial biotechnology (Bioökonomierat, 2015 a and b);
- In countries that do not have a lot of natural biomass but have a strong industrial sector (e.g. Germany, UK and Japan), bioeconomy is more often viewed for its potential for innovation and industrial renaissance. Countries with scarce natural biomass resources also rely more heavily on biomass waste and residues. Some like Germany and Japan also wish to create partnerships with countries that have more natural biomass (Bioökonomierat, 2015a), like in the German-Thai agreement signed in January 2016. Moreover, the Dutch strategy claims that the EU Common Agriculture Policy (EU-CAP) shall enable an increase in the availability of sustainable biomass, and highlights the importance of import and transit relations with third countries, e.g. partnerships with Brazil and Malaysia for research.

None of the strategies addresses the issue of water utilization at different stages of the value chain. They normally address water issues for either the biomass production or biomass utilization stages, not accounting for competition/ synergies across the value chain. For example, the South African strategy addresses the bioremediation of domestic

and industrial wastewater. Similarly, waste management is mostly addressed for industries, as part of resource use efficiency.

Biodiversity conservation is highlighted both for resource-rich and resource-poor countries. However, concrete actions, e.g. taking an ecosystems approach, are usually not mentioned or are developed in depth.

Climate change mitigation and reduction of the use of fossil fuels are often mentioned, in particular in the EU Strategy. Resilience/ adaptation is at times cited (e.g. by the West Nordic Countries), but there are few references to synergies between mitigation of and adaptation to climate change.

Land use changes and competition for land resulting from bioeconomy development are seldom mentioned. The demand for land includes food/ feed, forestry, biomaterials and bioenergy production, as well as building and transport. In fact, the German strategy is the only one that includes competition among uses of land as a key issue.

Finally, the importance of secure tenure of land, water and other productive natural resources is not presented as an important factor, although it is mentioned in a few strategies:

- The German strategy addresses the issue to some extent, in three ways:
  - The Federal Government is committed to follow globally the VGGTs,[2] regarding the planning of land use and the structuring of investments involving transfers of property and usage rights to land, fisheries and forests, when companies invest in countries with weak governmental leadership and/ or sourcing products from such countries.
  - The Government also supports FAO in the implementation of these Voluntary Guidelines.
  - Securing the right to access to land and other productive resources, and their sustainable management, in developing countries.
- The West Nordic Countries document mentions the controversial issue of property rights in the cultivation of algae and the respect of the Sámi people rights. It also explains that there is a regulation permit to fish in rivers in the reindeer herding area.
- The British Columbia strategy announces that new forest tenure options will be deployed to improve the access to residual wood fibre.
- The Dutch strategy briefly states that land rights are an important social aspect in policy coherence.
- The Argentinian document mentions land tenure among issues to take into account in the policy development to orientate the distribution of economic benefits.

3.2. SOCIO-ECONOMIC SUSTAINABILITY

In terms of the socio-economic aspects of sustainability, emphasis is on job creation, economic growth and, in some cases, wealth creation.

In general, all BE strategies seek to promote economic growth through innovation and competitiveness, to internationalize companies and help market deployment for the new bio-based products as well as creation of demand for them. However, emerging

2 "Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security" of the UN Committee on World Food Security

countries see bioeconomy as a means to achieve economic development, while some highly industrialized countries see bioeconomy as a way to preserve the environment and capitalize their biomass and natural resources (Overbeek et al., 2016). In some strategies, e.g. Malaysia and Finland, they specify a willingness to become hubs for new products and innovation.

All strategies and initiatives promote R&D and education very strongly. Furthermore, Germany, South Africa and Russia, in particular, underline in their strategies the importance of having high skilled labour involved in the development of their national bioeconomies.

In Europe, and more strongly in Finland and the Nordic Countries, the strategies stimulate the market for functional food (nutraceuticals) for social health and well-being, while in Malaysia or South Africa wellness is considered a result of rural economic development.

Rural development is a key issue in the strategies of the United States, Finland, Russia and Argentina. Moreover, the increase of rural communities' income through the commercialization of products based on indigenous plants (mainly medicinal ones), is mentioned in the strategies of Malaysia, China and South Africa (in the latter case through its farmer-to-pharma concept, DST, 2013). Germany also includes traditional medicinal plants in its strategy. However, it acknowledges that many such plants are not native of Germany and therefore cannot be cultivated competitively in Germany. Hence, sustainability of production should occur in the country of origin.

3.3. COMPETITION/ SYNERGIES AMONG BIOMASS END-USE SECTORS

Competition among biomass end-use sectors is present in almost all international BE strategies. However, at national level, it is addressed more in terms of resource use efficiency and productivity, while in the regional strategies, the industrial synergies and biotechnological hubs are more promoted. The strategies aim at developing methodologies to mitigate the risk of competition often refer to the cascading use principle, and biorefineries as a way to operationalise this principle. Cascading use is a sequential use of biomass from the highest value to energy recovery from side-streams and at the very end of the life cycle (EU Commission, 2015), and is described in depth in the German, Flemish and EU documents. Whilst the idea of cascading use is usually accepted, controversies arise when it comes about which value should be used to decide on the sequence biomass should be used, i.e. GHG emissions, most efficient use of biomass, economic value-addition, local needs, etc.; and who should decide on the value that should prevail. In that line, the German strategy has a cautious approach. It considers cascading use under its strategic approach on "Optimising existing value-added chains and networks", and states: "Where possible and purposeful, cascading use and coupled use of biomass should be applied". Circular economy [3] and the creation of biotechnological hubs or clusters are other suggested ways to address competition between end-use sectors. Synergies among

3 Circularity implies design of the products and processes towards zero waste, use of renewable energy, reuse and return to the biosphere, and restoration to replace the end-of-life concept (EU Commission, 2015).

biomass end-use sectors are usually considered in terms of resource use efficiency, coupled production and industrial symbiosis.

Energy security is absent in all documents. This can be seen as a major gap given that energy is needed for whatever use of biomass and, and in particular at every stage of the cascading use. Moreover, energy security should also matter if reduction of use of fossil fuel is a key objective in bioeconomy development, because one should consider the possible competition between fossil fuel and renewable energy, and policies possibly underpinning this competition.

Apart from the competition for the biomass raw material, there are few examples of competition for other resources, including:

- Possible locations for bioeconomy plants. The German strategy states: "The question of which products are produced in Germany and on what scale is decided through competition among business locations, according to the principle of comparative costs" (BMEL, 2014).
- In their strategies, Germany, China and South Africa briefly mention a competition for skilled labour in the new bio industry and biotechnology.

The issue of waste is typically addressed only for the biomass use phase. The Netherlands, for instance, highlights the importance of the logistics to reduce waste. Some approaches like the most efficient paths of use and the circular economy imply zero waste per se. Therefore, the potential competition for waste biomass as feedstock is usually not accounted for. Most strategies do not make a differentiation between primary agricultural raw materials and more sustainable types of biomasses, i.e. waste/ residues.

3.4. FOOD SECURITY

On the one hand, countries where food security is not relevant address it at the global level. The US, Dutch and Spanish documents address international food security as part of the global picture of the bioeconomy. Germany, the EU and Denmark among others prioritise food production within the bioeconomy and the competition for biomass between food and industry/ energy: "synergy effects between food production and the provision of raw materials for energy and industry" (BMEL, 2014). Countries such as Russia and Finland, stress that they have unlimited natural resources and hence a big potential for bioeconomy, and food security is not addressed in their strategies.

On the other hand, food security is discussed where it is an issue of national concern. It is widely addressed in the South African strategy, the Chinese and Malaysian documents, and Japan endorses the food first principle as it considers only food waste as a type of biomass to be used for bio-industries. The Argentinian strategy expresses awareness and a willingness to ensure no competition with food and feed within their upcoming national strategy. The EU also addresses domestic food security through resource-efficient food supply chains.

None of the regional strategies addresses food security. This is probably because food security is not an issue in the countries where they are located (i.e. Germany, Canada, Belgium and the UK). In other cases, it can be also be due to the fact that global food

security is already endorsed in sectorial policies at a national level, like The UK Global Food Security Strategic Plan 2011-2016 (Global Food Security, 2013).

Food safety is present in most strategies. It can be considered in some cases under the food utilization dimension of food security.

3.5. ENABLING FACTORS

Governments put in place policy and regulatory instruments as well as programmes to create an enabling environment for the development of the bioeconomy and to foster its implementation. Generally, they include capacity development interventions for research and innovation, as well as the improvement of existing regulations for emerging products and technologies, mainly to create transparency. However, due to the general nature of the documents, these actions are not presented in detail in the BE strategies. For instance, they do not include mandates concerning amounts of biofuels or biomaterials. Moreover, they are not very specific regarding subsidies and more mechanisms could be developed to guarantee that bioeconomy benefits small producers – Malaysia being an exception. Policy targets are usually quite general; only a couple of strategies (e.g. USA and the Netherlands) mention measurable policy targets (IEA, 2014).

In general, bioeconomy strategies address the issue of enabling green finance for the development of new business models, innovative products, technologies and processes, as well as entrepreneurship and small and medium enterprises (SMEs), especially in the strategies of the US, Malaysia, Germany and the Netherlands. The creation of an enabling environment for venture capital (necessary source of money for start-ups with limited access to capital markets) is mentioned in the strategies of South Africa, where the Technology Innovation Agency stimulates investment through venture capital and foreign investment, and British Columbia (Canada), which also has a venture capital financing support for early stage companies. The Scottish roadmap also mentions available funding for capital to be spend on infrastructure and capacity development. However, the barriers and opportunities of green finance and capital markets are not addressed in the strategies as issues for the sustainable bioeconomy development. Concrete opportunities to access financing are in the vast majority of the cases directed only for research and piloting purposes, and concern less small-scale farmers and entrepreneurs' access to private financing and support – one exception is the Bioeconomy Community Development Programme of the Malaysian strategy's (see also section 6.2.2).

While there are references to sectorial policy mechanisms, like the Renewable Energy Directive (RED) in the EU document or biofuel mandates in several countries, concrete regulations specific to bioeconomy are not mentioned. There is no explicit reference to policy actions related to direct or indirect land use change. Sometimes this may be implicit within other policies, for example, the EU 2015 Indirect Land Use Change (ILUC) Directive (EC, 2015a) limits the mandate of the Renewable Energy Directive (RED) of the renewable energy targets for transport from first generation biofuels. The focus is often placed on the alignment of innovation with policy development, e.g. the "European Innovation Partnerships", and on the reform of regulations to reduce policy barriers and

to increase the speed of policy processes, e.g. in the US and EU documents. Interaction among policy actions at EU, Member State and regional level is another example at a transnational level.

The common governance elements in the strategies to boost the effectiveness of policy instruments and actions include respect of the rule of law, administrative capacity, strong and capable civil society, stakeholder participation, civil responsibility and informed dialogue with society and stakeholders, knowledge sharing, impact assessment institutions and management practices transparency, and grievance mechanisms.

All strategies support transparency, consumer awareness, and visibility in general terms. Several of them state the importance of having sustainability certification schemes, mainly at international level. However, there is not a clear link made so far between certification schemes and subsidies or other supports. They all share the view that international markets should take sustainability into consideration, and some of them (e.g. The Netherlands) recommend the use of an internationally agreed transparent monitoring and reporting system. In general, European countries express the need of an EU-level of sustainability tracking and accountability, rather than national, due to the global dimension of bioeconomy, as stated in the Flemish document.

Similarly, at national level, strategies present different transparency instruments that can be put in place, for instance public awareness and knowledge raising to empower civil society. For instance, the Scottish strategy describes what is needed for the stimulation of the market demand: first, awareness raising has to occur, and for the longer term, public procurement policies should be in place.

As regards institutional arrangements, there is a general aim to link national agencies with the private sector and research institutions (e.g. Germany) and to set arrangements between markets and regulations. Bio-based industries public-private partnerships (PPP) and the creation of technological clusters are other tools used for the enhancement of new markets, like in the current strategies of the EU and USA, as well as The Netherlands, which objective is to search for international partners. However, a few initiatives ensure participation by smallholders and rural communities and account for risks and rewards of bioeconomy to vulnerable communities (e.g. Japan and Malaysia). Enabling factors are closely linked to approaches used to develop bioeconomy strategies, and implementation mechanisms. Both are discussed in the following sections of this report.

CHAPTER 4

SOME CONSIDERATIONS ON APPROACHES USED IN DEVELOPING BE STRATEGIES

Different approaches have been used to develop BE strategies (IEA, 2014; Bioökonomierat, 2015a and b; Philip, 2016; Lang, 2016; and Overbeek et al., 2016):

- "Top-down" strategies have been mainly driven by government policies, which give funds and incentives for R&D to promote and shape the bioeconomy development and foster the use of biomass and biotechnology for different sectors. Finland, Germany, Japan, The Netherlands, the EU and the US fall in this category;
- On the other hand, "bottom-up" initiatives have been led by industry and regional cluster development, in which government policies frame the enabling conditions for market deployment and stimulate the demand. They provide incentives and financing for clusters and individual enterprises to implement their own plans in order to meet the overall strategic objectives. The Scottish initiative in the UK, the Flemish one in Belgium and the Baden-Württemberg initiative in Germany are industry-led documents that outline the actions needed and the support required to develop bioeconomy;
- A combination of the above can be found in countries which combine national and regional strategies (e.g. Denmark, Japan, UK and Germany);
- The Malaysia community-based bioeconomy and the Japan 'Biomass Town' programmes illustrate a local-level approach to bioeconomy (as explained in section 6.2.2). The Argentinian document also presents territorial planning policies as a way to ensure the sustainability of the bioeconomy development and to tackle the local barriers from the design phase (CONICET, 2015). The territorial approach has been adopted in Argentina due to the different types of biomass produced in each region (quantity and quality) and the specific features of the industry value chains that each region adopts to optimize their natural resources (CONICET, 2015). For instance, the Pampa Region, where soils have been severely degraded in the last 20 years, would implement bioeconomy in a different way than other regions. This would include the adoption of several good agricultural practices like no-till. Another reason to face the development of bioeconomy through a territorial approaches lies is the difficulty of biomass logistics. For example, the majority of ethanol and

by-products plants are located in hinterlands, far from the ports (Trigo et al., 2015).

Whilst inclusiveness is promoted in nearly all strategies, active civil society participation has been inadequate in the development of most strategies (IEA, 2014). As a result, the general public is insufficiently informed and has not yet" bought into" bioeconomy.

The Finnish document is a good example of stakeholder consultation, with stakeholders giving inputs during five workshops, three regional forums and sectoral consultations. The process to develop the Spanish strategy included the opinion of science experts, private sector and social organizations, as well as a public consultation. The European Commission carried out a public consultation in 2011 before publishing the strategy. The nature of the Dutch Framework Memorandum document is different, as it represents the government's view and commitment to the development of bioeconomy, and Table 1 shows how socio-economic aspects are not explicitly addressed in it. The Baltic Sea Region strategy established the "Baltic Sea Region (BSR) Bioeconomy Policy Dialogue Forum", twice a year, to assess the policy strategy, fund opportunities and adopt a detailed cooperation framework.

Mechanisms to measure the contribution of bioeconomy to sustainable development are lacking or inadequate in most strategies. In particular, with the exception of the EU through its Bioeconomy Observatory, no approach is proposed to manage conflicting goals, such as the competition between biomass end use sectors, or the effects of the intensification of biomass production to the environmental sustainability (Bioökonomierat, 2015b).

CHAPTER 5

OVERVIEW OF SOME BIOECONOMY ACTION PLANS AND APPROACHES

This chapter explores different action plans and implementation approaches of some of the BE strategies. Additionally, current successful examples of decentralised implementation programmes are presented.

5.1. ACTION PLANS IN EXISTING OFFICIAL BIOECONOMY STRATEGIES

In general, there is a limited number of official BE strategies that explicitly include action plans, particularly when documents are developed by more than one ministry. Those that include action plans are presented in Table 2, including three international, six national and one regional strategy.

The nature of the action plans varies greatly, and their level of detail is not dependant on the level of the strategy (international, national or regional) or the format in which the action plan is presented (as a separate document, as a list of wide strategic objectives with specific measures, or as a list of short actions and actors).

The results of the overview are summarised in Table 2.

From a methodological point of view:

- BE action plans have been classified in the table according to their format:
  - Stand-alone documents that accompany the main strategy: the EU (one general plan) and Spain (yearly action plans);
  - Strategies structured on strategic objectives, with actions to achieve them: Germany, US and Flanders;
  - Strategies including a list of actions and actors: Baltic Sea Region, Finland, Russia, Scotland and West Nordic Countries.
- Categories were selected according to the most common elements present in the listed action plans:
  - R+D+I (Research, Development and Innovation), concerning countries' lines of research and actions towards scaling-up innovation, including Increase knowledge (and the transfer of it), PPP (for business innovation) and human capacity development.
  - Stakeholder engagement, referring to platform forums and databases developed by countries to foster policy interaction among different sectors and stakeholders (e.g. a bioeconomy panel).
  - Markets and competitiveness, counting efforts towards both a demand- and supply- driven bioeconomy. This includes the review of related policies to reduce

the barriers to bioeconomy; identification of available local natural and financial resources; creation of industrial networks and symbiosis; consumer awareness and public procurement.

- In Table 2, the various categories are ticked only if explicitly addressed under each initiative. When issues are mentioned only briefly or are indirectly addressed under other categories, the issues are not ticked. Moreover, despite the close link between implementation and the impact of bioeconomy, impacts are not presented in this document because they are hardly addressed in action plans, if at all. It also does not analyse relationships between the bioeconomy action plans and strategies to other policies at a national, international and regional levels (especially complex in the case of the EU).

TABLE 2.

Common elements in the three models of BE implementation actions plans

CATEGORIES		Stand-alone documents		Strategic objectives and measures			List of actions and actors				
		EC	Spain	Flanders	Germany	US[4]	Baltic Sea Region	Finland	Russia	Scotland	W. Nordic Countries
R+D+I (Research, Development and Innovation)	Knowledge enhancement and transfer	✓	✓	✓	✓	✓	✓	✓	✓		
	PPP (for business innovation)	✓	✓	✓	✓	✓	✓			✓	✓
	Human capacity development	✓		✓	✓	✓			✓		
Stakeholder engagement		✓	✓	✓	✓	✓	✓	✓			✓
Markets and competitiveness	Policy alignment and coherence	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Identification of possible value chains and feedstocks	✓	✓	✓	✓		✓	✓	✓	✓	✓
	Setting up industrial networks	✓	✓	✓	✓	✓	✓		✓	✓	
	Labelling and consumer awareness	✓	✓	✓	✓		✓	✓		✓	
	Public procurement and mandates/ regulations	✓	✓	✓		✓	✓	✓		✓	

4 Here it refers to the US bioeconomy strategy. An "Integrated Bioeconomy Implementation Plan" is to be released in 2016 (US Government, 2016).

5.1.1. Discussion on the main categories used in Table 2

(i) R+D+I (Research, Development and Innovation)

– *Knowledge enhancement and transfer*

The EU action plan includes a great number of actions towards aligning the research activities with EU/ national and regional programmes and establishes the main areas of research in line with the EU Framework Programme for Research and Innovation Horizon 2020. The US includes a strategic objective dedicated only to support R&D investments, as a way to accelerate the progress to market. Examples of technology transfer in the US document include the creation of innovation and knowledge partnerships, streamlining the licensing of research to start-up companies and improving the transfer of government-owned technology to the private sector.

– *Public-Private-Partnerships for business innovation*

The US document includes an action to increase "pre-competitive collaborations", in which PPPs are incentivised and formed to support expertise improving their knowledge (e.g. with pool resources and share of information on successes and failures) (See also section 6.2.3). Education and apprenticeship are addressed in the German document as a cross-sectorial area of action. Related measures include formation of PPPs, cooperation models and the creation of an international network. The Programmes of the EU, Malaysia and The Netherlands also have strong PPP schemes. At regional level, Flanders has for instance PPP programmes for bio-based industries like SPIRE and 'BRIDGE'.

– *Human capacity development*

An action of the Russian document concerns the creation of educational programs in biotechnology and systems to train, retrain and keep human resources. The US includes the "Innovative New Funding Programs" that are used for enhancing entrepreneurship in universities to commercialise their research.

(ii) Stakeholder engagement

Policy interaction and the engagement of relevant stakeholders is needed for policy coherence, since bioeconomy is cross-sectorial and involves different policy areas. Therefore, strategies propose actions towards the development of processes to involve stakeholders, such as regulators, producers, and consumers.

The US Strategy states that federal agencies should increase stakeholder collaborations to identify barriers and needs for progress and investment, as well as areas to improve regulatory frameworks. Moreover, the Federal Activities Report on the Bioeconomy (US, 2016) lists all executive agencies within the federal government and interagency projects involved in bioeconomy development across the value chain. The only action that is carried out by each agency at each stage of the value chain concerns "Public private collaboration to overcome barriers and accelerate deployment".

Given that all European countries are called upon to formulate their strategies in accordance to the 2012 EU Bioeconomy Strategy, all action plans are very similar, despite of their different formats. They all include actions to increase policy interaction and stakeholder engagement, for example to establish a bioeconomy Council, a Panel,

and an Observatory, an inter-Ministerial Working Group, and expanding international cooperation (standards), among others. Other examples are the Baltic Sea Region plan, which includes a steering group to support forums and to prepare the annual "State of Bioeconomy in the BSR Reports". The Finnish document mentions an action for setting a process of stakeholder involvement in regulations development.

(iii) Markets and competitiveness

Table 2 shows several demand-side mechanisms that are generally perceived as essential parts of the implementation of bioeconomy. They include:

– *Policy alignment and coherence: Identification of legal, administrative and financial limitations*

Strategies commonly include the review and harmonization of policies to address the gaps. The Russian "Plan of the Programme Implementation" is focused on the creation of a legal basis for the expansion of new markets for bio-products and development of industrial biotechnology.

The EU Strategy is aligned with the Lead Markets Initiative on bio-based products (EC, 2007) the RED, the Strategic Energy Technology (SET) plan. It also supports the Blue Growth initiative and the initiative on «A Resource Efficient Europe». Moreover, during 2016, the EU Bioeconomy Strategy will be reviewed and adapted to the Circular Economy Action Plan (EC, 2015b).

The German strategy mentions the "review and adaptation of funding-support measures for bioenergy to include the repercussions on material use". Another example concerns actions to implement the EU Parliament regulation on timber and timber products (No 995/2010). The Dutch document refers to "The Green Deal approach"; which supports businesses and research by removing regulatory barriers and generating opportunities to access existing policy measures. The review of regulations is crucial for the deployment of bioeconomy, since the use and extraction of biomaterials from new sources, like new waste streams, can fall into regulations that constrain their use.

– *Identification of available feedstocks and opportunities to create multiple value streams*

The EU plan includes improving the understanding of current, potential and future availability and demand for biomass across sectors. Another example concerns an action point of the Finnish strategy to prepare roadmaps anticipating the global demand and sustainability challenges in trends.

The German document includes an action to conduct research to estimate how each value chain (food, material and energy) will benefit the overall economy. In addition, there are several actions regarding funding FAO projects towards balancing out the provision of food and biomass for energy and industry.

– *Setting up industrial networks, promote resource use efficiency and engage industry*

The EU promotes diversified and integrated biorefineries, demo plots, and the cascading use of biomass and waste with the required logistics and support the establishment of biorefineries networks across Europe as well as clusters in every Member State. Likewise,

Finland includes an action to create cooperation platforms among cross-sectorial activities to improve their competitiveness in the international market, with the allocation of Structural Funds.

– *Developing the demand for new products: labelling and consumer awareness*

Action plans include public awareness raising and increase in knowledge with the promotion of labelling and empowerment of the civil society and the creation of international standards.

The EU document contains several actions for the development of a bio-based products knowledge base for certification schemes and labels for green procurement. As well, the Finnish document emphasizes the importance of communications to influence consumer choices highlighting the sustainability of the products and the support of the replication of good practices.

In the German action plan, one of the strategic objectives is to establish and develop internationally recognised sustainability standards in agriculture and forestry. This is also common in most European plans.

– *Market-guarantee mechanisms: public procurement and mandates*

Some action plans refer to public procurement mechanisms, mandates and regulations to foster innovation and pull the demand for biotechnology:

- The strategic objective "From Lab to the Market" of the US document includes actions to drive innovation through federal procurement, i.e. advanced biofuels for military and commercial transportation (Biofuels Digest, 2016), and the purchase of bio-products by federal authorities to drive the creation and growth of new markets in rural areas (US Government, 2012b). In addition, a tax relief and other economic incentives for SMEs are presented as instruments to facilitate the transition of bio-inventions from research to market. Moreover, the USDA Biomass Crop Assistance Program (BCAP)[5] provides financial support to farmers to establish and maintain non-food crops for energy and bio-based products, as well as it helps with the cost of biomass residues collection and transportation to an USDA-approved conversion facility. This is an important pillar of the strategy to boost rural economy, and in May 2016, the programme expanded the types of feedstock eligible to include new bio-based products (USDA, 2016).
- In the EU, the Baltic Sea Region and Spanish documents refer to specific actions to identify good green procurement practices and procedures to implement them (e.g. "Baltic Green Public Procurement" project, and biogas buses in Sweden). The Scottish document also mentions an action to make a business case for the introduction of a public procurement policy towards the end of the bio-refining sector development roadmap. Finland has several actions, e.g. to develop criteria for sustainable public procurement.

Bioeconomy action plans generally do not include requirements, minimum amount obligations or rewarding schemes to promote the adoption of bioeconomy. One notable

5 www.fsa.usda.gov/bcap

exception concerns biofuels (Biofuels Digest, 2016). In this case, the strategies specify that policies should align with the mandates and targets (Biofuels Digest, 2016):

- The EU Directive 2015/1513 (amendment of the and Renewable Energy Fuel Quality Directives) sets a minimum of 10 percent renewable energy for transport (no more than 7 percent from first generation biofuels) by 2020, and a national minimum of advanced biofuels consumption (reference value: 0.5 percent). Germany has a 6.25 percent blending requirement. Finland has a specific action that accounts for risk financing to help the generation of new businesses.
- In the case of the US, volume requirements are set in the Renewable Fuel Standard for different categories of biofuels, and the government has committed to replace 36 billion gallons of fossil fuels for transport with biofuels by 2022 (16 billion from cellulosic ethanol and 5 billion from advanced processes) (WEF, 2010).
- Argentina has an E5 ethanol and a B10 mandate in place – in the latter case with an obligation also for thermoelectric plants running on biodiesel to comply.
- Malaysia has a B7 mandate in the eastern part of the country and a B5 mandate elsewhere.
- In South Africa, E2 and B5 mandates came into effect from October 2015.

5.1.2. Other considerations

Currently, countries are adopting only some elements of the full package (i.e. policy strategy + R&D programme + board/ panel/ council + bioeconomy implementing agencies + monitoring schemes). Monitoring of results and the development of demonstration projects are present only in the Scottish, Russian and Finnish documents. Malaysia does not have an action plan, and rather implements bioeconomy with "entry point projects and trigger projects" (MOSTI, 2012).

It is worth mentioning that the German Bioeconomy Strategy is the only one that includes a specific set of actions regarding land use competition, including measures such as the effective assortment of land for various uses and the reduction of claims made on agricultural areas by non-agricultural use (better definitions, creation of governance standards, etc.). It also promotes material use of biomass as a priority, to defuse competition for different land-uses.

(i) Standards and certification

Many countries indicate that sustainability standards and certification schemes should be developed and agreed upon an international level. This should actually be part of an internationally agreed sustainable bioeconomy framework. Such a framework requires international coordination and is part of the FAO-coordinated programme on sustainable bioeconomy guidelines.

(ii) Implementing bodies

Sometimes, the implementing bodies are specified for each action, like in the Scottish document; which allocates an agency to each action. In other cases, a specific action is coordinated by a specific Ministry and implemented by certain agencies, like for the

Finnish action plan or South Africa, where different Ministries implement the strategy under the general coordination of the Department of Science and Technology (DST, 2013).

Examples of actors that coordinate and oversee the action plans include a reference group of leading representatives from private sector, knowledge institutions, civil society and government (Baltic Sea Region), Bioeconomy Corp in Malaysia, and the Spanish Bioeconomy Strategy Monitoring Group (Spain).

(iii) Financing of the implementation

Strategies usually specify that financing will not be the responsibility of just one body, but different mechanisms will fund different actions (e.g. Spain by the R+D+I plan and with aid included in other plans). The Russian plan also lists the main investment directions, including infrastructure, creation of science-based biotechnology, facilities and technologies for new products in emerging markets.

The Malaysian bioeconomy agency disburses funding with soft loans to companies and cooperatives that are part of the national Community Development Programme (see section 6.2.2). Another example of funding for local action is the South African "Green Funding" allocated to projects involving reforestation of unused landfill sites, the scale up of traditional medicinal plant harvesting, research into a policy framework to promote sustainable innovation and capacity building projects.[6]

(iv) Measurable targets and monitoring and reporting mechanisms

The Netherlands presents a good example on this issue as it reports yearly the progress made in the country ("Monitoring Bio-based Economy in the Netherlands"). Some indicators are: "Knowledge position" (indicating the investments and funding into R&D of Bio-based Economy), "number of projects related to Bio-based Economy", "amount of biomass into Bio-based Economy", "market development in NL and worldwide", "value added from Bio-based Economy" (Hamer et al., 2016).

The US also has an extensive list of measurable targets available (USDA, 2011), i.e. 16 main indicators, including:

- Input indicators: For instance, amount of cropland in energy-dedicated crops, quantity of chemical and other inputs used in bio-based production.
- Investment indicators: For instance, government spending on bioeconomy R&D, private capital investment in plant and equipment.
- Output indicators: For instance, production levels of chemical-based products, emissions from bio-based production, direct value added from bio-based production, production levels of biofuels, and quantity of by-products from biofuel production.

Apart from the ones presented in the table, there are other sectorial action plans that build on the bioeconomy ones, and vice versa. However, such interrelations are not taken into account in the present report. As an example, in the German bioeconomy document, crosscutting strategies and action plans are listed, including "*Action Plans for*

6 South African Green Fund list of Projects: www.sagreenfund.org.za/wordpress/wp-content/uploads/2015/09/Green-Fund-Investment-Project-Portfolio-end-Aug-2015.pdf

the use of renewable raw materials as materials and as energy sources" (2009/2010), and the "*National Action Plan for Renewable Energies*" (2010). Another example is Austria, which has a stand-alone "*Action Plan for the use of renewable raw materials. Towards a resource-saving and bio-based economy Action Plan for conversion of biomass*" (2015) to expand existing policy initiatives. In addition, within the Chinese document there are also action plans for different aims, e.g. "*Biotech Drugs Development Action Plan*" (the full document is not available). Lastly, Japan, in its "*Basic Act for the Promotion of Biomass Utilization*", 2009 (another document), includes Biomass Utilization Promotion Plans, at national, prefectural and municipal levels.

5.2. EXAMPLES OF DECENTRALISED IMPLEMENTATION MECHANISMS

Independently of including lists of actions in their strategies, countries carry out BE programmes and pilot projects. Such schemes are the basis for the promotion of sustainable bioeconomy good practices, offering opportunities to channel their adoption and ensuring their continuity. Some examples for different implementation mechanisms at decentralised levels are presented hereafter.

5.2.1. Implementation through institutional arrangements and local public involvement

The Japanese "Biomass Town Concept" concerns the establishment of a comprehensive biomass utilization system (generation, conversion, distribution and use). The stakeholders who carry out the different steps are linked through institutional arrangements including cooperatives and regional clusters. Resources are distributed to increase efficiency, with the setup of recycling systems (MAFF, 2012). The aim is to revitalise rural areas by generating a system based on local conditions and "stable and appropriate to the community". It also increases public knowledge and empowerment of the civil society.

The plan is formulated through stakeholder consensus and includes a basic survey, an analysis of the biomass potential and a description of the target area, as well as the benefits to the community from the specific use of the biomass. The stakeholders who designed it operate the plan.

Not only is it a measurable target of the national bioeconomy strategy of Japan (goal 600: number of "biomass towns" where biomass is efficiently used in recycling systems), but also the Ministry in charge supported the formulation of Biomass Town Plans in other ASEAN countries from 2008 to 2012 (Thailand, Viet Nam, Malaysia and Indonesia) (MAFF, 2013).

5.2.2. Implementation through contract farming and support to communities

The Malaysian Bioeconomy Community Development Programme is a component of the country's Bioeconomy Transformation Programme. Its development includes both contract farming and the application of biotechnology. Certified companies (that have the 'BioNexus status') and cooperatives receive soft loans from Bioeconomy Corp (Malaysian Bioeconomy Development Corp, ex BiotechCorp, which is the bioeconomy implementing

agency) in order to fund the necessary farming purchases (e.g. seedlings, bio-fertilizer and land cleaning) for their contracted farmers.

Companies and cooperatives have guaranteed sustainable biomass supply and farmers get a guaranteed income, a locked demand and the opportunity to develop their bio-entrepreneurship skills. Other benefits are the maximisation of the potential of idle land and the increase of the value-added of the agro-based industry (MOSTI and Bioeconomy Corp, 2013).

5.2.3. Implementation through rural development and public-private partnerships

There is a general aim among the strategies to link agriculture to the industrial/ bio-industrial sector, in order to boost rural development and promote PPP for decentralised production and processing.

A very comprehensive example is the Russian Development Plan of Regional Biotechnology Programmes and Bio-clusters. Regional programmes are implemented for the development of (Osmakova, 2015):

- biotechnology, i.e. there is a biotechnology specialisation for each region: green chemistry, processing of vegetative raw materials, processing of agricultural products, in vitro diagnosis, etc;
- bio-products, i.e. there are regional programmes for different bio-products developed for other regions, e.g. bioethanol, bio-reagents for agriculture (Plant Tissue Culture), biopolymers, enzymes, amino acids, etc.
- Another example is Flanders, which has the "Innovation Hub for Sustainable Chemistry"[7] and the "Flemish cluster for industrial biotechnology" (CINBIOS).[8] Likewise, The Netherlands developed nine regional hubs up to 2015, each with a different focus: bioenergy, bio-based coatings, bio building blocks, bio-based aromatics or aquatic biomass, among others (Hamer et al., 2016). In addition, the ScanBalt BioRegion is a successful example a meta-cluster partnership in the Baltic Sea Region.
- In general, the creation of biotechnological hubs or clusters is present in many countries and strongly focused at creating different regional bioeconomies, aiming at the use and promotion of resources of different agro-ecological zones in their countries. Examples of this include Malaysia, various Nordic countries, Argentina and China. Within the pilot projects of the Bioeconomy Community Development Programme, Malaysia has also developed sectorial clusters in different regions, for example farms of honeybee, dairy, oyster aquaculture and herbs (MOSTI and Bioeconomy Corp, 2014).
- However, creating regional hubs can also have other purposes. In the case of Germany, a dedicated "bioeconomy cluster" has been established, with the purpose of promoting coupled production and the cascading use of biomass (e.g. in

7 www.fi-sch.be
8 www.bio.be

lignocellulosic biorefineries). Sometimes, countries without a holistic BE strategy also have bioeconomy regional hubs (e.g. France and Italy).

5.2.4. Implementation through Public Procurement for an increased market uptake of bio-based products

In March 2016, the EU Commission (Public Procurement Working Group for Bio-based Products) published a report outlining 15 recommendation for "an increased uptake of bio-based products in public procurement" showing benefits for regional, national and European bodies and bio-economy producers.[9] They include benchmarking and goal setting, sector analysis, review and update of legislation when possible, development of standards and labels, bio-based uptake indicators, promotional sector, products and materials campaigns (regional and national), technical support of procurers, and a permanent coordination initiative.

There is a specific recommendation to create a Bio-based Materials Directive (or a wider Materials Quality Directive), even if its success may be limited when it would be implemented within the constraints of the legal framework. It should include measures and targets (including for public procurement) to support the acceleration of bio-based material market uptake. Moreover, it states that "inspiration should also be drawn from the USDA Bio-Preferred legislation which mandates 'affirmative public procurement practices', as opposed to 'mandated targets' ".

9 http://ec.europa.eu/DocsRoom/documents/16281/attachments/1/translations/en/renditions/native and ec.europa.eu/DocsRoom/documents/16282/attachments/1/translations/en/renditions/native

CHAPTER 6

CONCLUDING REMARKS

The following conclusions can be drawn from this overview of the major BE strategies developed at international, national and regional levels:

- It is yet another evidence of the strong interest in bioeconomy at different levels worldwide, as a possible contribution to addressing major global, national and regional development and environmental challenges;
- Ensuring that bioeconomy is developed in a sustainable way and will benefit all sections of the population is a necessity but will not be easy to achieve. There is no "one-size fits all" in terms of priorities, approaches, and how sustainability is addressed in BE development strategies and implementation plans;
- The current BE strategies are written as broad frameworks. They include environmental and socio-economic considerations. However, they also show common weaknesses and gaps have been identified. These concern for instance the sound use of land, water and waste management along the whole value chain, possible competition between the different biomass-end use sectors, energy security, bio-innovations, enabling and converging technologies, and mechanisms to benefit smallholders;
- Efforts towards the implementation of the bioeconomy strategies have been developed through action plans only in a few cases. They also show some weaknesses and gaps. They concern for instance monitoring and evaluation, and financing aspect (e.g. barriers to access green finance and capital markets, financial support to small-scale producers and enterprises). However, there are some interesting examples of decentralised bioeconomy programmes;
- There is already a lot of knowledge worldwide on successful ingredients and pitfalls regarding the sustainable production of biomass, and, to a lesser extent, its use. And significant R&D is underway to develop needed innovations along the biomass value chain to complement existing knowledge;
- The analysis shows that many countries indicate that sustainability standards and guidelines should be developed and agreed on an international level. This is actually being addressed by the programme on sustainable bioeconomy guidelines being developed under FAO's coordination.

One can draw some useful lessons from these conclusions regarding the development of sustainable bioeconomy guidelines:

- It does not have to start from scratch and has to avoid reinventing wheels. One should build on the vast body of knowledge, policies, approaches and good practices related to the conventional sectors of biomass production and use (agriculture, forestry, fisheries) and more recently, modern bioenergy. On that basis, one can adapt existing ones to bioeconomy, and fill gaps where needed;
- It will have to combine general aspects and enough flexibility to allow for solutions to be tailored to local circumstances;
- It should be achieved through a joint effort by a multistakeholder international partnership, coordinated by an international body;
- It seems advisable that, at least part of the guidelines – such as principles and criteria – goes through a formal multistakeholder endorsement at international level, in order to improve their legitimacy;
- It should be supported by a significant communication effort towards the general public, to ensure societal acceptance of and active involvement in bioeconomy.

REFERENCES

Biofuels Digest, 2016. *Biofuels Mandates Around the World: 2016* www.biofuelsdigest.com/bdigest/2016/01/03/biofuels-mandates-around-the-world-2016/

Bioökonomierat, 2015a. *Bioeconomy Policy – Synopsis and Analysis of Strategies in the G7*. A report from the German Bioeconomy Council. http://biooekonomierat.de/en/publications/?tx_rsmpublications_pi1%5Bpublication%5D=88&tx_rsmpublications_pi1%5Baction%5D=show&tx_rsmpublications_pi1%5Bcontroller%5D=Publication&cHash=03a8cf54bb3351be152a24d96e523cb3

Bioökonomierat, 2015b. *Bioeconomy Policy (Part II) – Synopsis of National Strategies around the World.* A report from the German Bioecono my Council, November 2015. http://biooekonomierat.de/en/publications/?tx_rsmpublications_pi1%5Bpublication%5D=96&tx_rsmpublications_pi1%5Baction%5D=show&tx_rsmpublications_pi1%5Bcontroller%5D=Publication&cHash=07878beb63c751a3ae88953bb33e6d37

BIOPRO Baden-Württemberg GmbH and the Government of Baden-Württemberg, 2013. *Bioeconomy – Baden-Württemberg's path towards a sustainable future*. www.bio-pro.de/index.php/download_file/14193/9616/

BMEL (German Federal Minister of Food and Agriculture), 2014. *National Policy Strategy on Bioeconomy*. www.bmel.de/SharedDocs/Downloads/EN/Publications/NatPolicyStrategyBioeconomy.pdf?__blob=publicationFile

British Columbia Bio-Economy Committee, 2011. *British Columbia Bio-economy*. www.gov.bc.ca/jtst/down/bio_economy_report_final.pdf

China's State Council, 2012a. *12th Five-year Development Plan for National Strategic Emerging Industries (2011-2015).* www.gov.cn/zwgk/2012-07/20/content_2187770.htm

China's State Council, 2012b. *Development Plan for the Bio-Industry*. Guo Fa [2012] No. 65. www.lawinfochina.com/display.aspx?lib=law&id=15327&CGid

CONICET, 2015. *La Bioeconomía en la Argentina: Oportunidades y Desafíos. Temas de Discusión en el Marco de la Red de Estudios en Bioeconomía.* www.bioeconomia.mincyt.gob.ar/wp-content/uploads/2014/12/TEMAS-DE-DISCUSI%C3%93N-EN-EL-MARCO-DE-LA-RED-DE-ESTUDIOS-EN-BIOECONOM%C3%8DA-DEL-CONICET-ABRIL2015.pdf

DST, 2013. *The Bio-economy Strategy*. ISBN number: 978-1-919966-06-9. South African Department of Science and Technology. www.innovus.co.za/media/Bioeconomy_Strategy.pdf

EC, 2007. *Annex I to the communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - A lead market initiative for Europe* {COM(2007) 860 final SEC(2007) 1730} /* SEC/2007/1729 final */ http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52007SC1729&from=EN

EC, 2012. *Innovating for Sustainable Growth: A Bioeconomy for Europe.* http://ec.europa.eu/research/bioeconomy/pdf/bioeconomycommunicationstrategy_b5_brochure_web.pdf

EC, 2015a. *DIRECTIVE (EU) 2015/1513 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources*: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L1513&from=ES

EC 2015b *Closing the loop - An EU action plan for the Circular Economy* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614

EC(SCAR), 2015. *Key principles for a sustainable bioeconomy, "Sustainable Agriculture, Forestry and Fisheries. A Challenge for Europe".* 4th SCAR Foresight Exercise. http://ec.europa.eu/research/scar/pdf/ki-01-15-295-enn.pdf

FAO, 2009. *High Level Expert Forum: How to Feed the World 2050.* www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

Finnish Ministry of Employment and the Economy with participation form other Ministries, 2014. *Sustainable growth from bioeconomy. The Finnish Bioeconomy Strategy*. www.tem.fi/files/40366/The_Finnish_Bioeconomy_Strategy.pdf

Global Food Security, 2013. *Global Food Security Strategic Plan 2011-2016*. www.foodsecurity.ac.uk/assets/pdfs/gfs-strategic-plan.pdf

Golden, J. S., Handfield, R. B., Daystar, J. & McConnell, T.E., 2015. *An Economic Impact Analysis of the U.S. Bio-based Products Industry – A Report to the Congress of the United States of America*. www.biopreferred.gov/BPResources/files/EconomicReport_6_12_2015.pdf

Hamer, A., Mooren, M., Siemers, W., Both, D., Kwant, K., 2016. *Monitoring Bio-based Economy in Nederland 2015.* www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2016/03/03/monitoring-bio-based-economy-in-nederland-2015/monitoring-bio-based-economy-samenvatting.pdf

IASS (Müller, A., et al.), 2015. *The Role of Biomass in the Sustainable Development Goals: A Reality Check and Governance Implications*. Institute for Advanced Sustainability Studies working paper. www.iass-potsdam.de/sites/default/files/files/the-role-of-biomass_iass_working_paper_2nd_edition.pdf

IEA Bioenergy Task42, 2014. *National BioEconomy Strategies IEA Bioenergy Implementing Agreement Countries. BioEconomy Survey 2014.* www.iea-bioenergy.task42-biorefineries.com/upload_mm/0/7/4/dbb99e14-1cc0-4ad1-a00b-3541c2550db9_BioEconomy%20Survey%20IEA%20Bioenergy%20IA%20Countries_website.pdf

MAFF (Japanese Ministry of Agriculture, Forestry and Fisheries) The Cabinet and National Biomass Policy Council, 2012. *Reference 6. Biomass Policies and Assistance Measures in Japan* – Allusion to the National Plan for the Promotion of Biomass Utilization (2010), and The Biomass Industrialization Strategy (2012). www.maff.go.jp/e/pdf/reference6-8.pdf

MAFF (Japanese Ministry of Agriculture, Forestry and Fisheries, 2013. *Biomass Town Plan: Japan's experience in ASEAN countries.* www.maff.go.jp/e/biomass.html

Lang, C. 2016. *Cornerstones of Bioeconomy*. Presentation to the 4th Bioeconomy Stakeholders' Conference in Utrecht. www.bioeconomyutrecht2016.eu/static/bioeconomyutrecht2016.eu/Media/CL_cornerstones_12042016.pptx

Matis and the Nordic Council of Ministers, 2014. *Future Opportunities for BE in the West Nordic Countries.* www.matis.is/media/matis/utgafa/Bioeconomy-in-the-West-Nordic-countries-37-14.pdf

Ministerio de Agricultura, Ganadería y Pesca de Argentina, Unidad para el Cambio Rural (UCAR), 2015. *Bioeconomía. Cambio estructural, nuevos desafíos y respuestas globales: Una ventana de oportunidad para las producciones basadas en Recursos Naturales Renovables. Tendencias, diagnósticos y prospecciones.* www.ucar.gov.ar/images/publicaciones/Documento%20Bioeconomia.pdf

MOSTI (Malaysian Ministry of Science, Technology and Innovation) and Bioeconomy Corp (Malaysian Bioeconomy Development Corp), 2012. *Bioeconomy Malasya. Enriching the Nation, Securing the Future. Presentation of the Bioeconomy Transformation Programme.* www.biotechcorp.com.my/bioeconomy-malaysia/bioeconomy-transformation-project/resources

MOSTI (Malaysian Ministry of Science, Technology and Innovation) and Bioeconomy Corp (Malaysian Bioeconomy Development Corp), 2013. *Bioeconomy. Community Development Programme. Presentation*. www.biotechcorp.com.my/bioeconomy-malaysia/bioeconomy-transformation-project/resources

MOSTI (Malaysian Ministry of Science, Technology and Innovation) and Bioeconomy Corp (Malaysian Bioeconomy Development Corp), 2013, 2014 and 2015. *Malaysian Bioeconomy Transformation Programme. Annual Report.* www.biotechcorp.com.my/bioeconomy-malaysia/bioeconomy-transformation-project/resources

National Bioeconomy Panel, 2014. *Denmark as growth hub for a sustainable bioeconomy*. http://naturerhverv.dk/fileadmin/user_upload/NaturErhverv/Filer/Indsatsomraader/Biooekonomi/Denmark_as_growth_hub_for_a_sustainable_bioeconomy_statement_by_the_Danish_Bioeconomy_Panel.pdf. The recommendations are used for the "Government's plan for growth for water, bio and environmental solutions" (2013) and the "Government's plan for growth for food" (2013).

OECD, 2009. *The Bioeconomy to 2030: Designing a Policy Agenda. Main findings and policy conclusions.* www.oecd.org/futures/long-termtechnologicalsocietalchallenges/42837897.pdf

Osmakova, A., 2015. *The current situation of the biotechnological and bio-economic development in Russia.* (Presentation). www.efi.int/files/images/capacity_building/ylp/presentations/osmakova_bioeconomy_in_russia.pdf

Overbeek, G., de Bakker, E., Beekman, V., Davies, S., Kiresiewa, Z., Delbrück, S., Ribeiro, B., Stoyanov, M., Vale, M., 2016. *Review of bioeconomy strategies at regional and national levels*. BioSTEP. http://bio-step.eu/fileadmin/BioSTEP/Bio_documents/BioSTEP_D2.3_Review_of_strategies.pdf

Philp, J., 2015. *Global Perspectives on the Global Bioeconomy*. Presentation to the USDA Agricultural Outlook Forum 2015. www.usda.gov/oce/forum/2015_Speeches/JPhilp.pdf

Philippidis, G., M'barek, R. and Ferrari, E., 2016. *Drivers of the European Bioeconomy in Transition (BioEconomy2030) - an exploratory, model-based assessment*. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC98160/lfna27563enn.pdf

Piotrowski, S., Carus, M. and Carrezael, D., 2016. *European Bioeconomy in Figures*. Nova Institute, March 2016. http://bio-based.eu/download/?did=42475&file=0

Popov, V., 2011. *Prospects of bioeconomy in the Russian Federation*. (Presentation). http://ec.europa.eu/research/bioeconomy/pdf/vladimir_popov.pdf

Ronzon, T., Santini, F. and M'Barek, R., 2015. *The Bioeconomy in the European Union in numbers. Facts and figures on biomass, turnover and employment*. European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Spain, 4p. http://biobs.jrc.ec.europa.eu/sites/default/files/generated/files/documents/BioeconomyFactsheet_Final.pdf

Russian Federation. The Government, Ministry of Economic Development, Biotech 2030, Lomonosov Moscow State University, 2012. *State Coordination Program for the Development of Biotechnology in the Russian Federation until 2020 "BIO 2020". Summary*. http://bio-economy.ru/upload/BIO2020%20(eng)%20-%20short.pdf

Scottish Enterprise, the Scottish Government, 2015. *The Biorefinery Roadmap for Scotland*. www.scottish-enterprise.com/~/media/se_2013/chemical%20sciences/biorefineryroadmapforscotland.pdf

Secretaría de Estado de Investigación, Desarrollo e Innovación de España, 2016a. *The Spanish Bioeconomy Strategy: Horizon 2030*. Spanish Ministry of Economy and Competitiveness. http://bioeconomia.agripa.org/download-doc/102159

Secretaría de Estado de Investigación, Desarrollo e Innovación de España, 2016b. *The Spanish Bioeconomy Strategy: Horizon 2030. The 2016 Bioeconomy Action Plan*. Spanish Ministry of Economy and Competitiveness. http://bioeconomia.agripa.org/download-doc/102157

The Dutch Cabinet, 2012. *Framework memorandum on the Bio-based Economy*.

The Interdepartmental Working Group for the Bioeconomy, Flemish Government, Environment, Nature and Energy Department, 2014. *Bioeconomy in Flanders. The vision and strategy of the Government of Flanders for a sustainable and competitive bioeconomy in 2030.* http://ebl.vlaanderen.be/publications/documents/55157

The Nordic Council of Ministers and the European Union Strategy for the Baltic Sea Region, 2015. *2015-2018 Strategy and Action Plan Towards a Baltic Sea Region Bioeconomy*. www.bsrbioeconomy.net/seminars/warsawpresent/DBSR_Bioeconomy_2015_2018_Workshop%20paper.pdf

Trigo E., Regúnaga M., Costa R., Wierny M. and Coremberg A., 2015. *The Argentinean Bioeconomy: scope, present state and opportunities for its sustainable development*. Bolsa de Cereales de Buenos Aires. ISBN 978-987-97337-7-6. www.bolsadecereales.com/descargar-documento1-12/documentos-031f0387667c2e685bedc91a1736ec67

US Government (White House), 2012a. *National Bioeconomy Blueprint*. www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

US Government (White House), 2012b. *Presidential Memorandum -- Driving Innovation and Creating Jobs in Rural America through Bio-based and Sustainable Product Procurement*. www.whitehouse.gov/the-press-office/2012/02/21/presidential-memorandum-driving-innovation-and-creating-jobs-rural-ameri

US Government, 2016. *Federal Activities Report on the Bioeconomy*. www.biomassboard.gov/pdfs/farb_2_18_16.pdf

USDA, 2011. *Bio-based Economy Indicators*. www.ciras.iastate.edu/publications/Bio-based_Economy_Indicators.pdf

USDA, 2016. USDA *Resumes Incentives to Grow and Harvest Biomass for Energy and Bio-based Products*. Release No. 0047.16. www.fsa.usda.gov/news-room/news-releases/2016/nr_20160523_rel_0047

Vassilieva, Y. (USDA Foreign Agricultural Service), 2012. *Program on Development of Biotechnology in Russia through 2020.* http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Program%20on%20Development%20of%20Biotechnology%20in%20Russia%20through%202020_Moscow_Russian%20Federation_6-7-2012.pdf

Vassilieva, Y. (USDA Foreign Agricultural Service), 2013. *Russian Government Roadmap for Development of Biotechnology.* http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Russian%20Government%20Roadmap%20for%20Development%20of%20Biotechnology_Moscow_Russian%20Federation_9-20-2013.pdf

WEF, 2010. *The Future of Industrial Biorefineries*. www3.weforum.org/docs/WEF_FutureIndustrialBiorefineries_Report_2010.pdf

Wierny M., Coremberg A., Costa R., Trigo E. and Regúnaga M. 2015. *Measuring The Bioeconomy Quantifying The Argentine Case*. Bolsa de Cereales de Buenos Aires. ISBN 978-987-97337-9-0. www.bolsadecereales.com/descargar-documento1-13/documentos-00255a0b4a5db87f228fe924010a14dc

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ENVIRONMENT – CLIMATE CHANGE – BIOENERGY – MONITORING AND ASSESSMENT
FAO - ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

The crosscutting nature of bioeconomy offers a unique opportunity to address in a comprehensive manner interconnected societal challenges such as food security, natural resource scarcity, fossil resource dependence and climate change, while achieving sustainable economic development. Bioeconomy is a reality and it has generated increasing interest in many parts of the world. Indeed, in recent years, several strategies and programmes have been developed at international, national and regional levels. Moreover, one can consider that bioeconomy plays an important role in many developing countries, given the importance of their agricultural sector and the use of biomass to produce energy, medicinal plants and as building material, in addition to food, feed and fiber. Moreover, the World Economic Forum estimates that the revenue potential for new business opportunities in the biomass value chains could globally amount to about USD 295 billion by 2020 that is three times the amount of 2010. However, achieving sustainable bioeconomy development faces many challenges. These concern not only ensuring food security but also addressing climate change and managing natural resources in a sustainable way, managing competition between different uses of biomass, while guaranteeing that bioeconomy benefits everybody. Therefore, guidance in how to shape bioeconomy strategies, policies, programmes and operations to that effect is very timely.

At the 2015 Global Forum for Food and Agriculture, FAO received a mandate to coordinate the international work on 'food first' sustainable bioeconomy from 62 Ministers of Agriculture present at the event. In that line, this overview is the first step in the development of sustainable bioeconomy guidelines. It aims at informing policy makers, practitioners and entrepreneurs on how sustainability has been addressed in official bioeconomy strategies at international, national and regional levels all over the world. This work also looks at action plans related to some of these strategies.

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