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CELEBio

D.3.1 Guidelines for Croatian Action Plan

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Summary

Croatia has great potential to foster bioeconomy development. With a strong foothold in wood processing, food and beverage industry, there is room for significant innovation activities and new business models.

There is however a lack of communication between important stakeholders and leaders of the bioeconomy sector, which could be improved in the short term and close the circle of material and energy management in the processing industries.

The establishment of organisations/agencies that are oriented solely on bioeconomy, and which rely on data from databases and import/export information of bio-potentials and bio-products (initially organized by Croatia) will be very helpful and will help advancements in bioeconomy development.

Connecting all stakeholders, introducing financing for environmentally friendly practices, raising of general awareness, education and organization of domestic value chains are considered by national stakeholders very important for the short term.

Sustainable management and use of existing land and natural resources (soil, water, air, …) must implement innovative approaches, new ways of obtaining value from „green resources", maximum utilization of information technologies, new social networks for stakeholders networking, construction of new scientific and vocational capacities.

Encouragement of further innovation projects and supporting existing best practice examples will steer investments in biorefineries that can utilize domestic potentials.

Research and innovative solutions must be encouraged by connecting research and academia with industry as well as various economic sectors.

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1. Introduction

The aim of the chapter is to present a set of specific, attainable, relevant biobased value chains, and time-based guidelines for development of Croatian Bioeconomy Strategy. The work has capitalised on the findings of the work in CELEBIO[1] and is structured in four sections.

The first presents the current state of bioeconomy, discusses the country's comparative strengths and opportunities, and provides an overview of the existing policy regime per value chain stage (i.e. biomass production, conversion, distribution, end use).

The second introduces the Bioeconomy Vision, possible value chains and outlines how they fit to the three main priorities[2] from the 2018 Update of the European Bioeconomy Strategy[3]: (a) Strengthen and scale-up the bio-based sectors, unlock investments and markets; (b) Deploy local bioeconomies rapidly across Croatia; (c) Understand the ecological boundaries of the bioeconomy.

The third provides facts tailored to each value chain in terms of current exploitation of biomass raw materials, future actions that could steer innovative and resource efficient market uptake for biobased products, potential interventions and expected added value. This information has resulted from the consultation with national stakeholders within the duration of the project. This section also includes information on the relevance to the UN Strategic Development Goals (SDGs), selected relevant projects and markets for the biobased products that will derive from each value chain.

Finally, the fourth part provides an implementation plan, jointly developed with stakeholders, which includes time specific goals for reaching the Vision.

[1] https://celebio.eu/wp-content/uploads/2020/07/Croatia-Country-Report.pdf
[2] https://ec.europa.eu/research/bioeconomy/pdf/bioeconomy_line_actions.pdf#view=fit&pagemode=none
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0673&from=EN

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2. Bioeconomy in Croatia

2.1. Current state

Bioeconomy in Croatia had an annual turnover of eleven billion Euros in 2017 which translates to 52,000 Euros per person employed in the sector with the EU27 average figure being 127,000 Euros.

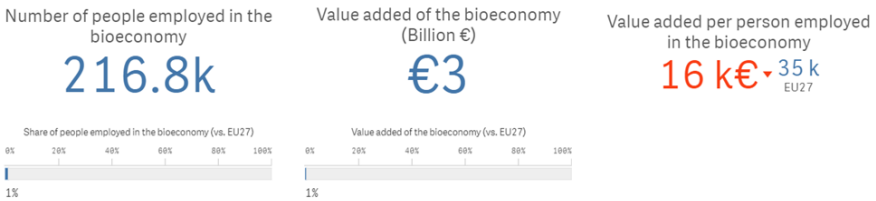

Figure 1Jobs and wealth in the Croatian bioeconomy in 2017 (source: JRC and nova-Institute[4])

The value added from the bioeconomy sector in the country was 3 billion Euros and in the same year there were 216,800 people employed.

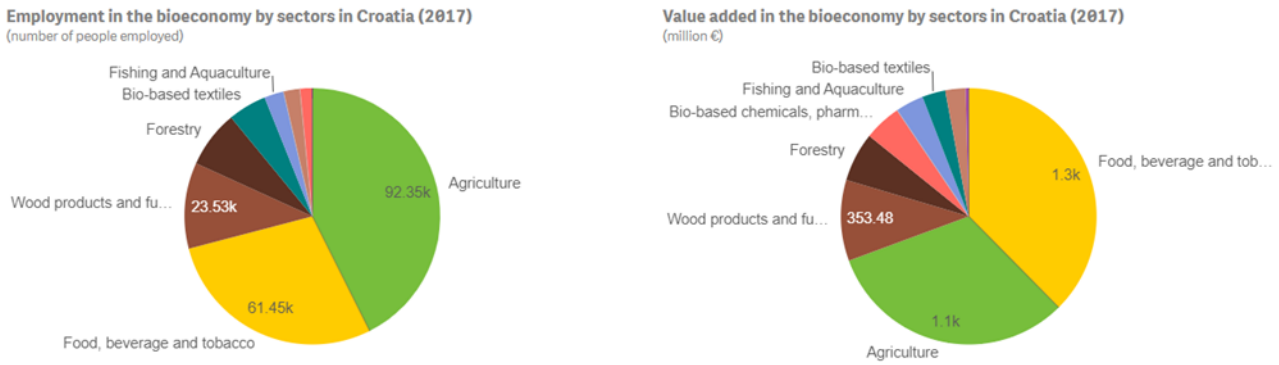

Figure 2 Employment and value added in the bioeconomy by sectors in Croatia in 2017 (source: JRC and nova-Institute[5])

Agriculture remains the biggest sector in terms of employment (42.5% of the total number of people employed) with food, beverage, and tobacco as well as wood products and furniture following with much smaller shares (28.3% and 10.9% respectively). In terms of value added the aggregate category of food, beverage, and tobacco, is first with 1.3 billion Euros and agriculture follows with 1.1 billion Euros, forestry, wood products and furniture are third with 0.35 billion Euros.

[4] *https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html*
[5] *https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html*

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2.2. Strengths, opportunities and barriers

	• Unused potential available from primary residues, secondary residues and unused lands • Roadside cost relatively low and good road connectivity within the country • Still many underutilised biomass resources • Non-utilised arable land • Rural Development Program • Cost of biomass resources are relatively low in comparison to many regions in the EU	• Still many biomass resources that can be mobilised • Because of harbours (coastal and inland), local biomass resources can be combined with imported resources to strengthen security of supply • Unused land resource is significant, so opportunities to produce low-ILUC biomass on abandoned lands • Expansion of family farms (both in continental and coastal area) into tourism sector (and diversification to other potential sectors) to generate additional income, entrance to new market - ecotourism • Production of healthy food for a European market • Europe is a trend the Croatian market can connect to	• The risk for loss of HNV farmland when demand for biomass takes off • Lack of rural population to produce and collect the biomass in the long term • No market for high added value biomass, uses only low-quality chains for heat/electricity • Impact on the environment – soil erosion and leaching • Favourable work conditions outside of Croatia – increasing trend of labour outflow • Raising competitiveness and agricultural development in the EU market could pose a problem for Croatian farmers and their future placement of value-added products
	• A long tradition in forestry and wood processing industry • Tradition of sustainable management of forests - FSC • 150 wood processing companies have FSC COCs • Skilled and qualified workforce as result of long tradition • Large state-owned forest • Knowledge of cascading use of wood • Significant additional mobilisation of primary forest resources possible and also already planned • Forest processing industry is growing and leads to more secondary forestry residues	• Mobilisation of unused biomass • Development of new bio-based products on lignocellulosic base • Private forest owners	• Climate changes in terms of - increasing numbers of forest fires - drought - prolonged vegetation season - mild winters suitable for diseases and pests - infestations with insects and diseases atypical for this geographical and climatic area etc. • Energy poverty

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	• Development of waste management sector • Existing and development of new infrastructure that can be used for energy/material recovery • High existing potential for utilization of existing waste streams, which are currently still going to landfills • Development of separate waste collection on household level	• Implementation of "Waste Market" • Innovative ways of biodegradable waste utilization are possible given that this still needs to be largely build up • Knowledge transfer from more advanced countries in EU • Utilization of biodegradable waste that is currently landfilled • Financing from EU funding, aligned with financing of waste management system (waste management centers)	• Lack of recognition for the opportunities in waste utilization within Bioeconomy principles • Negative public opinion in terms of waste separation, utilization for energy/recovery purposes

2.3. Policy mechanisms relevant to bioeconomy in Croatia

Some of the policy mechanisms presented in this section have a "final date" until 2020, therefore, new strategies that will be developed for the future period should to be taken into consideration for any future decision.

Strategies:

- **National Development Strategy of Republic of Croatia until 2030 (adopted in 2021)**

  The Croatian National Development Strategy is the overarching document aiming to provide strategic guidance to all development policies and lower-ranking strategic planning documents. With a vision to create a competitive, innovative and safe country, with recognizable identity and culture, a country with preserved resources, quality life standards and equal opportunities for everyone, the Government has decided to employ a comprehensive and evidence-based process using a participatory and bottom-up approach. In order to achieve that vision the strategy is focused on four development areas (sustainable economy and society, strengthening their resilience to crises, a green and digital transition, and balanced regional development) as well as 13 strategic objectives and 23 impact indicators.

- **Low Carbon Development Strategy of Republic of Croatia – (to be revised during 2021)**

  Low Carbon Strategy sets a path of transition towards sustainable and competitive economy, in which development is achieved with very low greenhouse gas (GHG) emissions. The goals of GHG emissions reduction by 2030 and 2050 in Croatia will be conducted within the political framework, set by the European Union. New EU growth strategy, formulated through European Green Deal plan, sets a goal of transition into a fair and prosperous society, with modern, resource-efficient and competitive economy, in which by 2050, total net emissions will equal to zero. The main goal of this strategy is determining the specific goals, related to specific sectors, in which emission reductions need to be achieved, in order to achieve the main goals of GHG reduction.

- **Energy Development Strategy to 2030 with a View to 2050 for Republic of Croatia (Official Gazette No. 25/2020)**

  Croatian Energy Development Strategy presents a step towards accomplishing low-carbon energy vision and secures the transition to a new era of energy policy, which enables accessible, secure and high-quality energy supply, without additional burden on the national budget, in terms of national supports and subsidies. The foreseen energy transition process will be capital-intensive, without the inventive measures, but with anticipated engagement of private sector/capital in financing of RES projects.

- **Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030[6]**

  The key objectives outlined in the Integrated Energy and Climate Plan are the reduction in greenhouse gas emissions for the Republic of Croatia for the year 2030, the share of RES in the gross final energy consumption and energy efficiency, expressed as consumption of primary energy and direct consumption of energy

[6] https://mzoe.gov.hr/UserDocsImages/UPRAVA%20ZA%20ENERGETIKU/Strategije,%20planovi%20i%20programi/hr%20necp/Integrated%20Nacional%20Energy%20and%20Climate%20Plan%20for%20the%20Republic%20of_Croatia.pdf

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- **Waste Management Strategy for the Republic of Croatia (OG No. 130/05)**

  The goal of this Strategy is to establish a framework within which Croatia will reduce generated waste amounts, and sustainably manage the produced waste. The Strategy, but also its implementing document – Waste management plan – are a part of a continuous waste management planning process, which is reflected on all levels (from national to local) and various sectors (water management, health, urban planning, etc.). This document is in alignment with the EU legislative. Although old and in need for renewal (the original document is from 2005), it still sets the basis for sustainable waste management concept.

- **Smart specialisation strategy 2016-2020. (new document in development – covering period 2021-2027)**

  S3 presents a comprehensive assessment of the country's governance structure, innovation facilitating instruments, and key innovation assets –research and human capital. It proposes a strong monitoring and evaluation (M&E) framework and provides a sectoral analysis of five priority sectors of the economy and their innovation potential. The main purpose of Smart Specialization is to transform the Croatian economy and increase its competitiveness by concentrating knowledge resources and linking them to a limited number of priorities.4 The identification of the Smart Specialization priorities will allow concentration of research capacities and infrastructure. This will provide advantage to both public and private sector and will bring together the critical mass of researchers who will jointly work on strategic R&D topics with goal of research excellence and its commercialization. The Croatian S3 embraces product, process, service, marketing and organisational innovations in line with the definitions laid out in the Oslo Manual: (1) product innovations - market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems; (2) process innovations - implementation of a new or significantly improved production process, distribution method, or supporting activity; (3) marketing innovations - significant changes to design, packaging, product promotion, placement, and pricing; (4) organisational innovations - new or improved business practices for organising procedures, work responsibilities and decision making, service delivery, and external relations.

- **Industrial Strategy of the Republic of Croatia 2014.-2020. (new document in development – covering period 2021-2027)**

  The main objective of Croatian industry has been defined by this strategy, and it states the following: repositioning of identified strategic activities in the global value chain towards the development of activities that create added value. Alongside the main goal, several other goals have been defined, and they are the following:

  1. Increase in industrial production at an average annual rate of 2,85%
  2. Increase in the number of new employees by 85.619 by the end of 2020., of which at least 30% are highly educated
  3. Increase in labour productivity by 68.9% between 2014.-2020.
  4. The increase in export between 2014.-2020. by 30% and transformation of export structure in favour of export products with high added value

- *In development:*

  Agriculture Strategy for Republic of Croatia for Period 2020-2030
  Aquaculture Strategy for Republic of Croatia for Period 2020-2030

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2.4. Sector-specific framework

2.4.1. Agriculture

- **Rural Development Programme of the Republic of Croatia for the Period 2014-2020 (new document in development – Strategic plan for period 2023-2027)**

The European Common Agricultural Policy (CAP) provides a framework for financial support to farmers through Pillar 1 - Direct Payments, and Pillar 2 - Rural Development. The new CAP 2014-2020 has been presented in 2014, and the Member States has adapted their national approach within this framework. The CAP 2014-2020 has been in force since 2014.
The Rural Development Program of the Republic of Croatia for the period 2014-2020, by SWOT analysis and needs assessment, defines the priorities and areas of intervention, the selection of relevant measures and the allocation of funding based on expected outcomes. One of the goals of the Program is resource efficiency and climate change resilience in agriculture and forestry, emphasizing that renewable energy production from these sectors is a priority for developing the bioeconomy and reducing greenhouse gases by 2020. Furthermore, the importance of the use of wood biomass, biomass from agriculture and solar energy in agriculture and the food preparing and food processing industry is emphasized.
The program defines 18 measures aimed at increasing the competitiveness of Croatian agriculture, forestry and the processing industry, as well as improving living and working conditions in rural areas in general.

- **Agricultural Land Law (OG No. 20/18, 115/18)**

Defines agricultural land, regulates agricultural land management, protection and usage of such land, land conversions and related fees, management of state-owned agricultural land etc. Agricultural land in Croatia is arable land, gardens, meadows, pastures, orchards, olive trees, vineyards, fish farms, reeds, wetlands and other lands that, with an acceptable economic cost, can be put to the purpose of agricultural production. Forest land not covered with forest or land covered with initial or degradation forest types (maquia, garigue etc.) and which are suitable for agricultural production are also considered as agricultural land.

- **Determination of vulnerable areas (OG No. 141/15)**

Vulnerable areas are areas where enhanced protection of water against pollution by nitrates of agricultural origin is required. In order to achieve a general level of protection against nitrates from all surface bodies, including coastal and groundwater bodies, the principles of good agricultural practice shall be applied in accordance with the agricultural regulations for which appropriate incentive measures may be adopted. This Decision identifies sensitive areas in the Republic of Croatia in the Danube river basin district and in the Adriatic catchment area. The Danube river basin district is entirely defined as a sensitive area. In the Adriatic river basin district, all areas designated as eutrophic, areas intended for the abstraction of water for human consumption and protected areas of nature constitute a sensitive area.

- **Action Program for the Protection of Water from Pollution Caused by Nitrates of Agricultural Origin (OG No. 60/17)**

This Program entered into force on 1 July 2017 and has been adopted for a period of four years from the date of its entry into force. The difference from I. Action Program for Protection of Water from Pollution Caused by Nitrates of Agricultural Origin, is that during one calendar year the farmers can fertilize agricultural land with manure up to a limit of application of nitrogen of 170 kg / ha of nitrogen (N). Transitional period for the construction of suitable storage tanks for manure storage and disposal is over. Accordingly, as of 1 July 2017, manure storage and disposal tanks, by their size, must satisfy the collection of manure for a six-month period.

- **Law on woody short rotation coppices (OG No. 15/18, 111/18)**

  This Law regulates the establishment, cultivation and use of woody or other short rotation coppices. The purpose of this Law is to create the conditions for the production of biomass from crops as a renewable and environmentally sustainable energy product on the principles of economic sustainability, social responsibility and environmental acceptability. For the purposes of this Law, considered coppices are intensive plantations of fast-growing species of trees or other plants that are grown on agricultural or forest land in a short period, no longer than eight years between the two cutting or harvesting, in order to achieve a high yield of biomass for energy purposes. Short rotation coppices could be grown on: 1. forest land, if this is not contrary to the forest management plan, 2. agricultural land that is valued as other agricultural lands (PŠ) and 3. other arable agricultural lands (P3), which is overgrown with perennial vegetation, with the approval of the Croatian Agricultural and Forestry Advisory Service.

- **Ordinance on short rotation coppice producer registry (OG No. 110/18)**

  The Ordinance proscribes content, structure and management of Short rotation coppice producer registry and provides registry application form.

- **Ordinance on the list of plant species for the establishment of short-rotation woody crops and the methods and conditions under which they may be grown (OG No. 16/19)**

  The Ordinance provides list of native and foreign plant species, including their crossbreeds, which is allowed to use for the establishment of woody short-rotation plants.

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2.4.2. Forestry

- **Forest Law (OG 68/18, 115/18, 98/19)**

  Regulates the overall forest management, cuttings, forest monitoring, financing, usage rights for planting perennial plantations on forest land without tree cover, forest infrastructure issues etc. Only marked trees can be cut, the markation is done by the licenced personnel. In general, clear cutting is prohibited as is branch cutting, collecting and removing moss, humus, peat etc. All activities at forest land need to be done in accordance to forest management plans.

- **Ordinance on forest management (OG 97/18)**

  Defines all relevant conditions and purpose of all forest management plans (for both private and state forests etc.). Since all activities at forest land need to be done in accordance to forest management plans, the latter gives this Ordinance significance.

- **Law on implementation of EU Regulation related to wood and wood products market (OG 25/18, 16/20)**

  Obligations of operators who place timber and timber products on the market to counter the trade in illegally harvested timber. In line with European Timber Regulation

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2.4.3. Biowastes

- **Law on sustainable waste management (OG No. 98/19)**

The Law defines measures for the prevention or reduction of possible waste adverse effects; also it establishes the sustainable waste management system, waste hierarchy including waste to energy field, planning in waste management sector, waste transport, permits for waste management, what can be considered as a byproduct etc. For energy recovery, one needs to be registered in a specific register. Energy recovery is allowed for vegetal waste from agriculture and forestry, vegetal waste from food processing industry if used for heat production, fibrous vegetal waste from pulp and paper industry if used at its place of origin with heat production, wood waste except that having hazardous substances (heavy metals) and wood waste from construction, cork waste. Imports of mixed municipal waste for energy production is forbidden. The Law defines targets for biodegradable municipal waste and its landfilling, that is maximum amount of biodegradable municipal waste that can be landfilled in Croatia. In line with European Waste Framework Directive (2008/98/EC)

- **Waste Management Plan for Republic of Croatia for period 2017-2022 (OG No. 03/2017)**

Waste Management plan in Croatia are created for a 6-year period. It determines the direction of waste management in Croatia, based on the analysis of the current state of the waste sector and goals determined within the Law on sustainable waste management. Withing the plan, current waste types, amounts and origin are determined, but also the current waste management plants that are included in the system (maps with existing and planned facilities). The plan provides guidance for waste reuse and recovery, aligned with principles of environment protection and economy growth. This document is the basis for development of waste management plans on local levels (municipalities, cities, etc.). Specifically, it provides the general technical specifications for buildings and equipment for waste treatment and management in Croatia.

- **Ordinance on thermal treatment of waste (OG No. 75/16)**

Determines the modes and conditions of operation, starting conditions and shutdown of incineration and co-incineration facilities for solid or liquid waste. It also determines types of control for waste entering the facility and management of outputs to the environment (air, soil, water). Moreover, it determines waste management within the incineration and co-incineration facilities, but also specific conditions for other thermal treatment methods (gasification, pyrolysis, etc.).
Additionally it should be mentioned that this ordinance is not applicable for the following waste types: vegetal waste from agriculture and forestry, vegetal waste from food industry if the produced heat is reused, cork waste, radioactive waste, waste of animal origin and waste from experimental facilities for research and development (for purpose of thermal processes improvement and under 50 t per year).

- **Ordinance on waste oil management (OG No. 124/06)**

Determines the management of waste oils; persons liable to pay compensations; types and amounts of compensations; means, deadlines and amounts for compensations payment and other questions regarding waste oils management. The goal of this ordinance is to set up a collection system for waste oils, for environmentally- and human health-friendly recovery and/or treatment purposes.

- **Ordinance on management of wastewater treatment sludge when used in agriculture (OG No. 38/08)**

The ordinance sets the conditions under which wastewater sludge usage in agriculture is allowed and when it is prohibited. In agriculture it is allowed to use treated sludge when the concentrations of heavy metals and organic substances are below the thresholds set for sludge and soil. Also, sludge needs to be stabilized (without pathogens). Monitoring of sludge and soil is prescribed.

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- **Ordinance on by-products and end-of-waste status (OG No. 117/14)**

  This Ordinance prescribes the content of the application for entry in the End-of-waste Register and the By-Product Register, specific criteria for the abolition of waste status, including limit values for pollutants and the harmful effects of substances or objects on the environment, specific criteria for the determination of by-products, the contents of certificates of entry in the End-of-waste Register and the By-Product Register, content and the manner of keeping the End-of-waste Register and the By-Product Register, as well as the manner and conditions for the implementation of European Union regulations establishing the criteria for the abolition of the waste status of certain types of waste.

2.4.4. Biowastes

- **Regulation on the quality of biofuels (OG No. 141/05, 145/10, 33/11)**

  This Regulation prescribes limit values for the quality characteristics of biofuels placed on the domestic market, the method of determining the quality of biofuels and the method of demonstrating compliance. This Regulation seeks to place biofuels of the prescribed quality on the domestic market as substitutes for diesel or gasoline for transport purposes, in pursuit of the objectives of meeting climate change commitments, environmental security of supply and promotion of renewable energy sources.

- **Law on Biofuels for Transport (OG No. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18)**

  This Law regulates the production, trade and storage of biofuels, the use of biofuels in transport, the adoption of programs and plans to encourage the production and use of biofuels in transport, the powers and responsibilities to establish and implement policies to encourage the production and use of biofuels in transport, and measures to encourage production and use biofuels in transportation, and encouraging the research and development of new, advanced biofuels that do not compete with food crops. For the purposes of this Law, the following products shall be considered as biofuels:

  1. biodimethyl ether is a dimethyl ether produced from biomass for use as biofuel,
  2. biodiesel is a fatty acid methyl ester (FAME) produced from vegetable or animal oil, which has the properties of diesel, to be used as a biofuel,
  3. bioethanol is ethanol produced from biomass and/or the biodegradable fraction of waste for use as biofuel,
  4. biomethanol is methanol produced from biomass for use as biofuel,
  5. biogas is a gaseous fuel produced from biomass and / or from a biodegradable part of waste, which can be purified to the quality of natural gas, to be used as biofuel for blending with natural gas or generator gas,
  6. biohydrogen is hydrogen produced from biomass and / or from the biodegradable fraction of waste to be used as biofuel,
  7. bio-ETBE (ethyl tert-butyl ether) is an ETBE that is produced on the basis of bioethanol. The volume percentage of bio-ETBE recognized as biofuel is governed by the biofuel quality regulation,
  8. bio-MTBE (methyl-tert-butyl ether) is a biomethanol-based fuel. The volume percentage of bio-MTBE that is recognized as biofuel is regulated by the biofuel quality regulation,
  9. pure vegetable oil is oil produced from oilseed plants by compression, extraction or similar processes, crude or refined but not chemically modified, in cases where it is compatible with certain types of engine and with appropriate emission conditions;
  10. Synthetic biofuels are synthetic hydrocarbons or mixtures of hydrocarbons produced from biomass

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- **Law on the establishment of alternative fuels infrastructure (OG No. 120/16)**

  This law establishes a common framework of measures for establishing alternative fuel infrastructures to minimize oil dependency and mitigate the negative impact of transport on the environment. The law establishes minimum requirements for the construction of alternative fuel infrastructure, including filling sites, establishes common technical specifications for filling and supply sites, information requirements for users, as well as the manner of fulfilling reporting obligations on the implementation of alternative fuel infrastructure establishment measures.

- **Regulation on air emission limit values of pollutants from stationary sources (OG No. 117/12, 90/14)**

  The regulation defines air emission limit values for certain pollutants from stationary sources, monitoring and reporting, measures for emission reduction etc. Air emission limit values for CO, SO2, NO2, particulate matter are set for boilers using biomass as fuel. Emission limit values are also defined for waste combustion and co-firing (SO2, NO2, TOC, HCl, HF etc.). In line with European Industrial Emissions Directive (2010/75/EC)

- **Decision on publication of rules on state support for environment protection (OG No. 154/08)**

  The Decision sets detailed rules for receiving state support for environmental protection activities, by entrepreneurs. Support is given for activities related to RES, waste management, energy savings, research in environment protection field, cogeneration and district heating. Support can also be in the form of reduced or exempted taxes for environment protection. The new Decision on guidelines for state support policy for the period 2014-2016 (OG 130/13) states that energy savings, promotion of RES and high-efficient cogeneration are main goals in the mentioned period.

- **Tariff System for Electricity Production from Renewable Energy Sources and CHP (OG No. 133/13, 151/13, 20/14)**

  In Croatia, renewable energy is mainly supported through a feed-in tariff. Every producer, who holds the status of "qualified producer" and has signed a formal agreement with the Croatian Energy Market Operator (HROTE) has the right to receive an incentive depending on the type of RES technology and power output of his RES-E plant or PV installation, as is defined in the Tariff System.

- **Regulation on the Fee to Encourage the Production of Electricity from Renewable Energy Sources and CHP (OG No. 144/11, 128/13)**

  This regulation determines the manner of use, the amount, calculation, collection, allocation and payment of fees that are designed to encourage the production of electricity from RES.

- **Fund for Environmental Protection and Energy Efficiency Law (OG No. 107/03, 144/12)**

  The Fund for Environmental Protection and Energy Efficiency awards interest-free loans, investment grants/subsidies and donations, to renewable energy projects through a tendering process. They apply to all natural and legal persons with a seat in Croatia.

- **HBOR Loan Programme for Environmental Protection, Energy Efficiency and Renewable Energy Sources**

  Renewable energy loans are issued by the Croatian Bank for Reconstruction and Development (HBOR). In accordance with the provisions of the Environmental Protection Law (OG 80/13), the State is bound to support and finance projects aiming at environmental protection. The HBOR is obliged to support projects aiming at environmental protection. On this basis, the HBOR has launched the Loan Programme for Environmental Protection, Energy Efficiency and Renewable Energy, which supports investments in primary sources, such as initial funding, land, buildings, equipment and devices.

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3. Vision and implementation plan

The Vision for the **Croatian Bioeconomy** was developed during the National Workshop, where various stakeholders provided their inputs on current situation and their vision of the Croatian Bioeconomy. These inputs were summarized in the following table:

- ✓ ***Sustainable activation of existing land resources and all available sources (soil, water, air, …) through implementation of innovative approaches, new ways of obtaining value from „green resources", maximum utilization of information technologies, new social networks for stakeholders networking, construction of new scientific and vocational capacities***
- ✓ ***Development of various associations and organizations that encourage the implementation of Croatian sustainable bioeconomy (through communication with relevant stakeholders, organization of seminars, workshops, etc.)***
- ✓ ***Utilization of RES in a sustainable manner, with environment protection in mind (reduction of primary resources consumption)***
- ✓ ***Helping the existing biomass industry to survive in new, low-carbon environment, within the cooperation with innovative industry, scientific disciplines and SMEs***
- ✓ ***Stimulating circular economy, development of new business models, resolving waste management problems, development of new workplaces***
- ✓ ***Development of bio-based markets and competitiveness***
- ✓ ***New value chains for biomass***
- ✓ ***Identification of potentials and networking between stakeholders on topic of circularity within bio-based potentials***
- ✓ ***Development of SME sector and innovative solutions, but also rural areas through better employment***

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3.1. Strengthen and scale-up the bio-based sectors, unlock investments and markets

This section focuses the Croatian Action Plan on value chains selected within the CELEBio project and discussed on several round tables within the project activities, national workshop organized by CELEBio team and in communication with project partners. The value chains selected are determined on regional level, due to project's character (examination of the situation within 6 observed countries). In terms of the obtained information and data within the project scope, these value chains have potential for market uptake of domestic raw materials and are suitable to foster innovation for the existing industrial infrastructure.

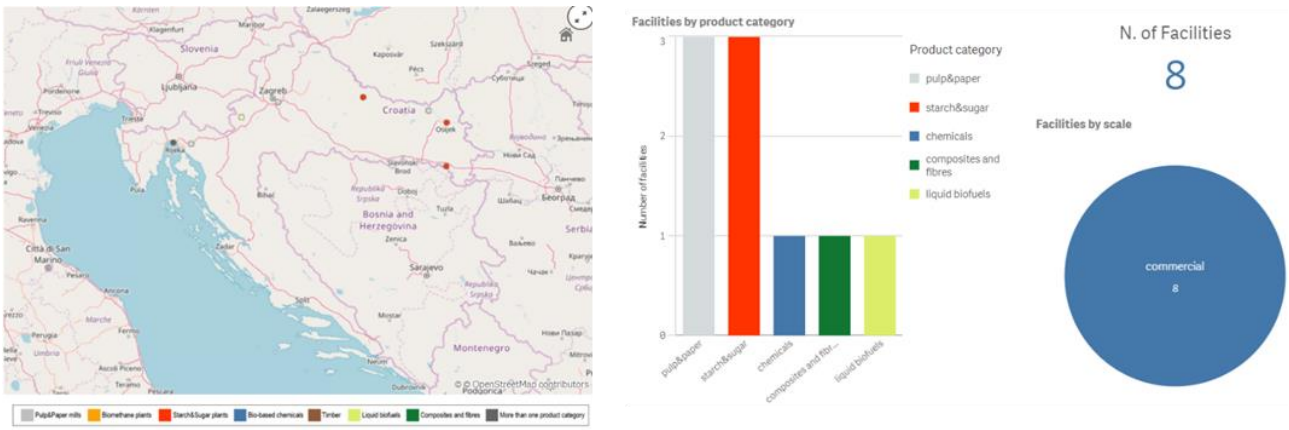

Figure 3 Biorefineries in Croatia

(source: https://datam.jrc.ec.europa.eu/datam/mashup/BIOBASED_INDUSTRY/index.html)

Figure 3 provides and overview of the biorefineries in Croatia. There are currently eight facilities operating in the country within the pulp and paper, starch and sugar, chemicals, composites and fibre, and liquid biofuels. Croatia has great potential to foster bioeconomy development. With a strong foothold in wood processing and food and beverage industry, there is room for significant innovation activities and new business models. Regional leaders in bio-based activities such as Bio-Mi d.o.o., Mi-plast d.o.o., EcoCortec d.o.o. and Weltplast d.o.o. could be used as examples of good practice. However, there is still a lack of communication between important stakeholders and leaders of the bioeconomy sector in Croatia, which could be a potential for improvement and closing the circle of material and energy management in each company.
CELEBIO has also engaged with national stakeholders through several round tables and organization of national workshop, to understand their perspectives of the Croatian bioeconomy and validate the value chains with strong potential to uptake indigenous raw materials, foster the development of innovative products and contribute to the development of Croatian bioeconomy. As aforementioned, the value chains are selected on a regional level basis, within the project scope. The number of value chains satisfies the pre-determined project concept, of covering three sectors (agriculture, forestry, waste management). However, it is important to point out that there are many more potential value chains that can be Croatia-specific, and which were out-of-scope of this project, thus not mentioned in this report.

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3.2. Deploy local bioeconomies rapidly across Croatia

The value chains mentioned above and selected by national stakeholders fit well the regional distribution of biomass raw materials across Croatian regions.

3.2.1. Agriculture

Agriculture, forestry and fishing generate 3.0 % of Croatian GDP. About 1.5 million hectares are utilised agricultural land, of which 54.1% refers to arable land and gardens; orchards, vineyards and olive groves occupy 4.9%, and permanent grasslands covering 40.9% of the used surface7. Cereals and oilseeds are mainly cultivated in the Pannonian region, which covers 55% of the national territory and is characterized by moderately warm and humid climates8.

The most important crops in Croatia are cereals and oil crops, e.g. sunflower and rape. Permanent crops cover an intermediate % age of the cropping area in comparison to the rest of the EU countries.

The most important crops in Croatia are cereals and oil crops, e.g. sunflower and rape. Permanent crops cover an intermediate percentage age of the cropping area in comparison to the rest of the EU countries. The increase in crop production in the overall structure of agricultural production after Croatia's accession to the European Union is due to, among other things, significant changes in the economic environment.

Changes in production over the past period are mainly a reflection of market needs for these products and to a lesser extent climate conditions and the prices of oilseeds themselves. The Republic of Croatia is self-sufficient with the production of oilseeds, especially sunflowers, soybeans and rapeseed. Oil crop residues are used for feed (protein cake), energy (husks), chemical compound for detergent, soups and cosmetics (technical fatty acid) and biogas substrate.

Residues from fruit processing (pits, pulp, water) represent an excellent opportunity to improve cost efficiency of agrifood processing companies. This is particularly urgent for fruit processing companies. While fruit growing agrotechniques are outdated, food processing industry is able to keep up the pace with the technological development. Generating yield from waste streams just started to be considered as a good opportunity to improve competitiveness. It is likely that hesitation lies in the necessity to step out from the current marketplace and food processing as core business. The value chains selected by the national stakeholders are:

• Poultry (meat) side streams:
○ (Slaughterhouse waste) → pet food, taurine production
○ (feathers) → keratin-based sponge and absorbent materials
○ (chicken litter) → renewable nitrogen sourcing → AD (biogas / digestate) → protein for chicken feed
• Unused lands → lignocellulosic crops (SRC, lignocellulosic grasses, …) → bioproducts (biobased markets)
• Secondary residues from food processing → electricity and heat (anaerobic digestion process) → digestate → biorefinery → bioplastic, pharmaceutical industry, construction industry

[7] Državni zavod za statistiku, Statistički ljetopis 2018.
[8] The Republic of Croatia 2017, Croatian Chamber of Economy, Zagreb June 2017, ISSN 1846-9183

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3.2.2. Forestry

Forests in Croatia have predominantly natural structure (95%) and are characterised by diversity and productivity differently distributed within the country, ranging from very productive oak and beech forests in the eastern and central part of the country to degraded macchia and bush-wood forests in the south. From total forest land 79% of area are deciduous forests, 16% coniferous and 5% degraded forests in form of shrubs (Strategy of spatial development (OG 106/2017).

Forests are considered as one of the most important resources for Croatian economy, both as energy source and feedstock for wood processing industry (table 3.4). In the previous General FMAP period (2006-2015) the overall forest cut (felling) was achieved at 60% of total area proscribed for cut and accounted for 86% of proscribed cut volume in all forests.

Wood processing and furniture production is an important segment of Croatian economy. It represents 6.14 % of industrial production, contribution 3.6 % to the GDP. There are ~40 sawmills with maximal capacity of stemwood processing 1,1 mil. m^3/annually (Energy strategy, White book, 2019).

Most important wood products include furniture (tables, chairs, beds, …), furniture elements, flooring, dredged boards etc. There are more than 3,500 companies related to wood industry. It is evident that Croatia has well developed wood processing and furniture industry, mostly located in areas with better access to wood supply such as continental Croatia.

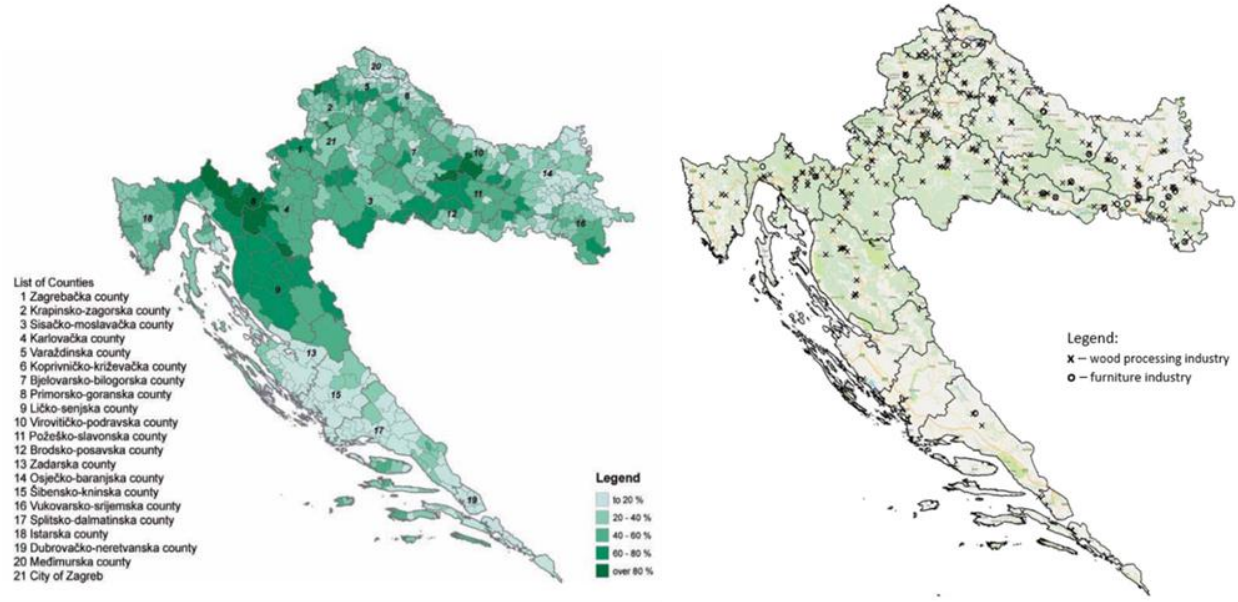

Figure 4: Share of woodland in municipalities/towns (Source.Wisdom)(LEFT) & Distribution of wood processing subjects and furniture industry (Source: Strategy for wood processing and furniture production development, with action plan 2017-2020)(RIGHT)

The value chains selected by the national stakeholders are:

Secondary wood residues → lignin, hemicellulose, cellulose → bioproducts (advanced biofuels, bioplastics, biopolymers, fibres, chemicals)

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3.3. Understand the ecological boundaries of the bioeconomy

- **Land use change**

Land use is related to raw material production. Emissions from land use change can be significant in some circumstances, however, the simple notion of land use change emissions is not sufficient reason to exclude biomass from the list of worthwhile technologies for climate change mitigation, bioeconomy and circular economy. The value chains selected for the Croatian bioeconomy comprise of residual and waste fractions so there is no risk expected from their mobilisation and future exploitation.

- **Biodiversity**

Forest biomass: High risks can be anticipated.

- Loss of dead wood and stumps may negatively influence species diversity and soil fauna. Contrary to this, leaving them all on the ground may result in increased fertilisation (N and wood ash) and negative impacts on vegetation
- Wood residues are generated from forests – the same applies for the above comment

Agricultural biomass: Moderate risks can be anticipated without sustainable practices. Biodiversity loss when harvesting too many crop residues. This may also have adverse effect on soil biodiversity
Biowastes: Positive in regions where it avoids landfill

- **Soil & Carbon stock**

Forest biomass: Increased risk of soil erosion; risk to loose soil organic carbon; risk to loose nutrients and risk of reduced soil fertility and soil structure when overharvesting forest residues
Moderate risks due to debates that using the wood in panel boards, creates a carbon stock in comparison to combustion of the wood
Agricultural biomass: Moderate risk to lose soil organic carbon when overharvesting crop residues; risk to loose nutrients when overharvesting.
Leaching from residues can have a moderate impact on soil.
Biowastes: Leaching from residues can have a negative impact on soil.

- **Water**

Forest biomass: No effect on the quantity; If no removal leads to increased fertilisation the leaching on N to water may increase
biomass: Moderate risks can be expected.

- Utilization of agricultural residues may lead to leaching from them to water receivers and have a negative impact on the environment.
- Leaching from residues can have a moderate impact on water receivers.

Biowastes: Leaching from residues can have a negative impact on water receivers.

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- **Air**

Forest biomass: High risks can be anticipated.

- Negative impact on the environment due to utilization of forests that produce biodiversity and oxygen.
- Emissions from plants that utilize the wood residues

Agricultural biomass: Moderate risks can be expected.

- Agricultural residues have some elements that are volatile and their utilization can have a negative impact on the climate change and air, due to emissions.

High risks can be anticipated

- Emissions from plants that utilize secondary residues (e.g. biomass and biogas plants) can have a negative impact on the climate change.

Biowastes: Emissions from landfills are reduced, no particles existence in the air.

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Feedstock		Sustainability risks (high- red; moderate- yellow; low- green)				
		Land use (iLUC risk)	Biodiversity	Soil & Carbon stock	Water	Air
Primary forestry production	Stemwood from thinnings & final fellings	Utilization of land that can be potentially used for other purposes	Loss of dead wood and stumps may negatively influence species diversity and soil fauna. Contrary to this, leaving them all on the ground may result in increased fertilisation (N and wood ash) and negative impacts on vegetation	Increased risk of soil erosion; risk to loose soil organic carbon; risk to loose nutrients and risk of reduced soil fertility and soil structure when overharvesting forest residues	No effect on the quantity; If no removal leads to increased fertilisation the leaching on N to water may increase.	Negative impact on the environment due to utilization of forests that produce biodiversity and oxygen
Primary forestry production	Stem and crown biomass from early thinnings					
Primary forestry residues	Logging residues from final fellings					
Secondary residues from wood industries	Saw mill residues	Utilization of land that can be potentially used for other purposes	Wood residues are generated from forests – the same applies for the above comment	There are debates that using the wood in panel boards, creates a carbon stock in comparison to combustion of the wood	None	Emissions from plants that utilize the wood residues
Secondary residues from wood industries	Other wood processing industry residues					
Agricultural residues	Straw/stubbles	To achieve sustainable agricultural practices, some of the residues need to be left on the agricultural field. If all the residues are utilized for other purposes, sustainability will not be generated and agricultural fields will be degraded and ruined.	Biodiversity loss when harvesting too many crop residues. This may also have adverse effect on soil biodiversity	Moderate risk to loose soil organic carbon when overharvesting crop residues; risk to loose nutrients when overharvesting	Utilization of agricultural residues may lead to leaching from them to water receivers and have a negative impact on the environment.	Agricultural residues have some elements that are volatile and their utilization can have a negative impact on the climate change and air, due to emissions.
Secondary residues of industry utilising agricultural products	By-products and residues from food and fruit processing industry	Resources utilization to generate secondary residues can have a moderate impact on the environment due to the fact that some land use is specifically oriented towards producing secondary residues.	None	Leaching from residues can have a moderate impact on soil.	Leaching from residues can have a moderate impact on water receivers.	Emissions from plants that utilize secondary residues (e.g. biomass and biogas plants) can have a negative impact on the climate change.
Biodegradable municipal waste	Biodegradable waste	Plants and centres for biodegradable waste utilization can occupy land that can be used for other purposes.	Positive in regions where it avoids landfill	Leaching from residues can have a negative impact on soil.	Leaching from residues can have a negative impact on water receivers.	Emissions from landfills are reduced, no particles existence in the air

Figure 5 Sustainability risks from the exploitation of biomass raw materials for bioeconomy in Croatia (red: high risk; yellow: moderate risk; green: no/ positive impact) [9]

[9] source: information gathered and analyzed during project activities and national workshop

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4. Value chains for the Croatian bioeconomy

This section provides facts tailored to 3 value chains in terms of current exploitation of raw materials, future actions that could steer innovative and resource efficient market uptake for biobased products, potential interventions and expected added value. This information has resulted from the consultation with national stakeholders within the duration of the project. While national stakeholders have detected many more value chains, assessment of only three were under the scope of the scientific coordinators. This section includes information on the relevance to the UN Strategic Development Goals (SDGs), selected relevant projects and markets for the biobased products that will derive from each value chain.

- **Agriculture**

  Main aim of the selected value chains is to:
  - Support livestock and crop production; Involvement of rural citizens in rural development
  - Exploit high residue potential; Local food processing industries offer opportunities as the negative balance of food export and import is growing

- **Forestry**

  Main aim of the selected value chains is to:
  - Development of rural business activities by mobilising new value chains in the context of circular economy
  - New legislation divides State and non-state forests and makes access to funds from state easier (?)
  - Research and Innovation activities towards higher added value products from forest biomass and to increase the share of RES

- **Waste management**

  Main aim of the selected value chains is to:
  - Utilize the produced municipal biodegradable waste, instead of sending it to landfills
  - Implementation of existing technologies of waste treatment and utilization of valuable nutrients and energy content
  - Potential for innovation – production of valuable resource for various industries (bioplastics, pharmaceutical, construction, etc.)

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4.1. Poultry meat streams

Value chain	SDGs	Examples of relevant projects
Poultry (meat) side streams: ▪ **(Slaughterhouse waste) → pet food, taurine production** ▪ **(feathers) → keratin-based sponge and absorbent materials** ▪ **(chicken litter) → renewable nitrogen sourcing → AD (biogas / digestate) → protein for chicken feed**		

Current exploitation of biomass raw materials

- Although some producers raise poultry specifically for their feathers (boas, feather fans, masks, costume accessories, etc.), they are often considered a by-product of poultry production (and often a waste by-product). There is no utilisation of the significant poultry waste streams for biobased products
- Low-level of utilisation of chicken litter for biogas and electricity production. Chicken litter is a waste side stream, presenting a problem for the poultry producer, since it requires adequate management. Moreover, chicken litter contains significant amounts of N and P, which can be lost through volatization of NH3 or runoff as derivatives of phosphorus. Proper estimation of the nutrients content of chicken litter and proper litter handling are necessary to ensure that application rates minimize emissions from the litter. After extracting the nutrients, the remains can be used in AD process, for biogas production. Digestate, as a by-product of the process, can be utilized for protein production, for chicken feed, since it is depleted from N/P surplus. However, the efficiency and commercial aspect of these processes is questionable, due to requirement for specialising the process to satisfy specific needs of each producer. Additionally, presentation of the new products is also problematic, due to its origin as a waste stream.

Future actions

- Communication with food industry leaders and leaders in pet food production, on possibilities of utilization of products developed this side stream. Utilization of processes that enable use of slaughterhouse waste as a source for pet food production (establishing processes for biorefineries).
- Connecting relevant stakeholders (chemical, construction, materials industry with farmers - feather producers), to increase the collaboration and put the new products on the markets. Implementation of study tours to educate and inform interested stakeholders in existing practices and innovative processes.

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Potential interventions

- Climate & Energy Fund: Subsidy schemes for biogas installations
- Standards for agricultural biomass
- Introduce feedstock premiums
- Regulation on agricultural raw materials for biofuels and bioliquids

Expected added value

- Reduced nitrates in the soil.
- Sustainable energy
- Soil carbon sequestration

Product Group	Market size Europe
Agro-chemicals Fertilisers	M 1,000 – 10,000 kt
Sustainable Energy	L >10,000 kt

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4.2. Industrial crops in marginal land

Value chain	SDGs	Examples of relevant projects
Unused lands → lignocellulosic crops (SRC, lignocellulosic grasses, …) → bioproducts (biobased markets)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND	GRACE Web site http://www.grace-bbi.eu; Magic – Marginal Lands for Growing Industrial Crops (magic-h2020.eu)

Current exploitation of biomass raw materials

- No large commercial plantations
- Good experience with rotation forestry plants and perennial grasses

Future actions

- Regulations on SRC and products from biorefineries
- Establishment of bio-based products' market
- Regulation and strategies on utilization of unused lands
- Incentivization of SRC production and utilization of unused lands
- Introduction of innovative technologies and solutions for utilization of unused lands

Potential interventions

- Create tax incentives to support such action and raise the public awareness of the traditional/historical cultivation of hemp in the region, and tout its benefits.

Expected added value

- Land will be brought back to use; new industries created; lower carbon-footprint by growing locally; replacement of non-biodegradable products (auto plastic interiors).

Product Group	Market size Europe
Cosmetics	S <1,000 kt
Paints & coatings	
Plant based-chemicals	M 1,000 – 10,000 kt
Fertilisers	
Sustainable Energy	L >10,000 kt

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4.3. Forest based value chains

Value chain	SDGs	Examples of relevant projects
Secondary wood residues → lignin, hemicellulose, cellulose → bioproducts (advanced biofuels, bioplastics, biopolymers, fibres, chemicals)		EFFORTE Web site https://www.luke.fi/efforte/ BIOFOREVER Web site https://www.bioforever.org

Current exploitation of biomass raw materials

- Increased logging (5-6 mill. m3 annually), largely on account of emergency logging due to damaged forest stands (climatic events, pests), emergency logging. 75% of coniferous wood (70% of timber harvested) sold as logs, other pulp & paper, plywood. 56% of deciduous wood used as firewood; From the point of view of the long-term perspective, this is a category that will gain in importance with changes in forest stands (growing share of beech). On the long-run (due to climate change), beech production will increase, bringing additional potential for biorefining processes and the subsequent production of new bio-based materials.
- Low value-added of timber harvested in Croatian forests.
- Fragmented ownership structure, which makes it difficult to establish efficient supply chains; 76% of forests in Croatia are privately owned, 314,000 owners, average size of forest holding is 2.9 hectares.

Future actions

- Increased commercial use of roundwood within Croatia, strengthening technologically more advanced alternatives to the energy use of lower quality wood assortments; optimization of logistics flows, primary processing at the local level and biorefining.

Potential interventions

- Forest Certification
- Introduce innovation financing for food SMEs and industries
- Regulation on agricultural raw materials for bioeconomy

Expected added value

- Bring lower quality wood to better use than energy use, i.e. bio-based processes (biorefinery)

Product Group	Market size Europe
Cosmetics Paints & coatings	S <1,000 kt
Plant based-chemicals	M 1,000 – 10,000 kt
Sustainable Energy	L >10,000 kt

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4.4. Biowaste value chains

Value chain	SDGs	Examples of relevant projects
Secondary residues from food processing → electricity and heat (anaerobic digestion process) → digestate → biorefinery → bioplastic, pharmaceutical industry, construction industry	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND	AgriChemWhey Web site https://www.agrichemwhey.com/; agrimax Web site http://www.agrimax-project.eu; DEMETER Web site http://www.demeter-eu-project.eu; EXCornSEED Web site https://www.excornseed.eu/

Current exploitation of biowaste raw materials

In Croatia, waste management is currently one of the largest challenges in the environmental sector and certainly one of the most demanding areas in terms of adjustment to the standards of the European Union. Currently, municipal waste management in Croatia is undergoing a radical transformation from decentralized disposal of non-treated waste on numerous local sub-standard landfills within counties to centralized waste management and Waste Management Centres (WMC) serving the needs of one county or, in some cases, of several counties. The WMC concept has been adopted by the Croatian Government in its National Waste Management Plan (2017).

Future actions

- Acceleration of introduction of end of waste legislation to facilitate utilisation of some of biowastes
- Stimulate the turning of bio-waste, residues, and discards into valuable resources

Potential interventions

- Incentives for the use of waste for biogas production (subsidies) and fostering the development of clean and renewable energy production. This could include penalties and rewards for energy production, depending on their environmental impact.
- National wide recycling and waste separation campaign and implementation of this type of education in schools.

Expected added value

- Increased use of urban/municipal waste, cleaner energy, reduced environmental impact, potential to improve revenue of all stakeholders
- Efficient system of urban waste collection, improvements possible in higher share of energy utilisation (biogas)
- New opportunities for eco-construction options in integration of renewable energy

Product Group	Market size Europe
Bioplastics Construction materials	S <1,000 kt
Plant based-chemicals	M 1,000 – 10,000 kt
Sustainable Energy	L >10,000 kt

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5. Implementation plan

	2020	2025	2030
Technology	Encouragement of research and innovative solutions, connecting research with private sector, connecting various sectors (multidisciplinary)	• Abandonment/modification of current waste management system (on Croatian level) • Waste separation and reuse, existing biomass distribution (added value criteria) • Waste separation and reuse, existing biomass distribution (added value criteria)	• Cascading principle of smart biomass utilization (biomass pyramid value chain) • Mapping and analysis of existing state-of-art, connecting biomass with existing and planning of new plants, institution synergy, strengthening logistic centers for collection and treatment of biomass • Encouragement of new materials development and energy independence of islands
Environment			
Economy		• EU funds utilization, higher transparency in EU funds allocations for research and development, eradicate corruption in various sectors connected to bioeconomy • Establishment of regulated waste market and utilization of waste as a resource, energy efficiency improvement in construction and building sector, development of national bioeconomy strategy	
Society	• Establishment of organisations/agencies that are oriented solely on topic of bioeconomy, and which rely on data from databases and import/export information of bio-potentials and bio-products (initially organized by Croatia) • Connecting all stakeholders, subsidies for environmentally-friendly practices, raising of general awareness, education, organization of value chains • Connecting various stakeholders – rural sector, scientists, researchers, policy-makers and decision makers, etc.		• Centralization of biomass capacities regulation • Inventarisation and digitalisation of all potentials, stakeholders and resources, within the strategic framework
Policy	• Development of national strategy and action plan	• Subsidies for production of bio-based plastic packaging • Prevent non-professional and suspicious import of biowaste, gain control on plant management (biowaste, biogas, biomass), permissions to manage certain waste types, etc., and include general public in decision making • Introduction of strategic guidelines in practice	

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5.1. Actors and funding opportunities

Action[1]	Actors involved	Funding instruments
Encouragement of research and innovative solutions, connecting research with private sector, connecting various sectors (multidisciplinary) (T)		National financing Horizon Europe, LIFE, Cohesion fund ERDF, ESIF, RFCS
Establishment of organisations/agencies that are oriented solely on topic of bioeconomy, and which rely on data from databases and import/export information of bio-potentials and bio-products (initially organized by Croatia) (S)		National funds, Horizon Europe LIFE, BBI JU, LIFE
Connecting all stakeholders, subsidies for environmentally-friendly practices, raising of general awareness, education, organization of value chains (S)		National financing Cohesion fund, LIFE Action Plan on financing sustainable growth
Connecting various stakeholders – rural sector, scientists, researchers, policy-makers and decision makers, etc. (S)		Action plan on sector development Cohesion Fund
Development of national strategy and action plan (P)		National co-financing, Horizon Europe, Cohesion Fund
Abandonment/modification of current waste management system (on Croatian level) (T)		Cohesion Fund, Action plan on waste management
Waste separation and reuse, existing biomass distribution (added value criteria) (T)		Cohesion Fund, national co-financing
EU funds utilization, higher transparency in EU funds allocations for research and development, eradicate corruption in various sectors connected to bioeconomy (Econ)		Cohesion Fund, National Bioeconomy Strategy and Action Plan
Establishment of regulated waste market and utilization of waste as a resource, energy efficiency improvement in construction and building sector, development of national bioeconomy strategy (Econ)		Bioeconomy Action Plan, Cohesion Fund, national co-financing
Subsidies for production of bio-based plastic packaging (P)		National co-financing, Environmental Protection and Energy Efficiency Fund, Bioeconomy Action Plan
Prevent non-professional and suspicious import of biowaste, gain control on plant management (biowaste, biogas, biomass), permissions to manage certain waste types, etc., and include general public in decision making (P)		Environmental Protection and Energy Efficiency Fund, national funds
Introduction of strategic guidelines in practice (P)		Bioeconomy Strategy and Action Plan, Environmental Protection and Energy Efficiency Fund, national and private financing
Cascading principle of smart biomass utilization (biomass pyramid value chain) (T)		National and private financing, EU funds (LIFE, Horizon Europe, ERDF etc.)
Mapping and analysis of existing state-of-art, connecting biomass with existing and planning of new plants, institution synergy, strengthening logistic centers for collection and treatment of biomass (T)		National and private financing, EU funds (LIFE, Horizon Europe, ERDF etc.)

[1] T: Technology; Env: Environment; Econ: Economy; S: Society; P: Policy

6. Potential socio- economic impacts of Croatian Bioeconomy Action Plan

	Create 1,000 new jobs in agriculture, forestry and food processing industry[10][11][12]
	Leverage 50 million € private investments within ten years[13]
	Cluster creation. At least ten new collaborations between raw material providers and industrial actors
	Eight new biobased value chains embedded in agriculture, food, and forest industries. Produce ten new patents and IP rights, Support the creation of ten spin-offs and start-ups.

[10] *S2Biom project; www.s2biom.eu*
[11] *Robert Pollin, James Heintz, and Heidi Garrett-Peltier June 2009. The Economic Benefits of Investing in Clean Energy Department of Economics and Political Economy Research Institute (PERI) University of Massachusetts,Amherst.*
[12] *Panoutsou, C.; Chiaramonti, D. Socio-Economic Opportunities from Miscanthus Cultivation in Marginal Land for Bioenergy. Energies 2020, 13, 2741. https://doi.org/10.3390/en13112741*
[13] *BBI JU, https://www.bbi.europa.eu/projects*

7. Potential of environmental impacts of Croatian Bioeconomy Action Plan

	Reduce emissions by 55%[14]
	Contribute to the sustainable management of natural resources and foster efficient water use. Support a circular and sustainable bioeconomy in Europe.
	Biodiversity
	Local resources for products, energy and fuels

[14] *European Green Deal. 2020. https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en#:~:text=The%20Commission%E2%80%99s%20proposal%20to%20cut%20greenhouse%20gas%20emissions,more%20ambitious%20path%20for%20the%20next%2010%20years.*