

LIFE Environment and Resource Efficiency project

"Nutrient recycling circular economy model for large cities – water treatment sludge and ashes to biomass to bio-energy "

Project Acronym: NutriBiomass4LIFE
Project Number: LIFE17 ENV/LT/000310

Policy recommendations

Report prepared by

UAB "Pageldynių plantacija"

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Preface

The purpose of this document is to provide overview of NutriBiomass4LIFE project coherence with EU and national policies and recommendations for policy implementation improvement.

For the implementation of the NutriBiomass4LIFE project, a subsidy is awarded from the EU LIFE program, the EU's funding instrument for environment and climate action. The funding of the project also come from the Swedish Energy Agency and Ministry of Environment of the Republic of Lithuania.

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II. About the NutriBiomass4LIFE Project

The Nutribiomass4LIFE project was launched on 1 July 2018 and will be running until the end of September 2023. Within the framework of this project, 6 beneficiaries from Lithuania and Sweden aim to create and demonstrate the first of its kind on the EU level full scale self-sustainable closed loop circular economy model for large cities' nutrient rich waste - municipal wastewater treatment sludge and biomass ashes – recycling into renewable energy for city's needs via environment friendly biomass plantation phytoremediation filter. The circular economy model is based upon Vilnius city, the capital of Lithuania (550 thousand population).

The specific objectives of the project included:

- promoting resource efficiency through reuse of nutrients (less usage of mineral fertilizer) and decrease in transportation distances and flows;
- promoting waste management pyramid priorities via changing path from landfilling and incineration of nutrient rich waste towards reuse in biomass growth improvement;
- mitigation of food chain contamination risks via changing path of nutrient rich waste from uncontrolled usage in food crop growing towards 100% legally compliant and monitored non-food biomass yield improvement;
- creating new best practices for dried MWTS digestate usage for non-food biomass;
- developing new business models to make biomass growing / forestry on marginal and less suitable to agriculture soils economically attractive via substantial biomass yield improvement;
- promoting soil organic content improvement via bio-solids applications;
- promoting renewable energy production;
- promoting afforestation of less suitable for agriculture / marginal lands;
- contributing significantly to climate change impact reduction by sequestrating significant volume of CO2 in the whole circular economy model value chain, promoting renewable energy production, soil carbon content improvement;
- promoting of EU and national legislation and policies and contributing to their development by promoting safe and environment friendly reuse of nutrients from wastes.

The Coordinating beneficiary:

1. UAB "Pageldynių plantacija" (Lithuania)

Associated beneficiaries:

2. Forest and Landowners Association of Lithuania (Lithuania)
3. Lithuanian Research Centre for Agriculture and Forestry (Lithuania)
4. UAB "Kirtimu katiline" (Lithuania)
5. UAB "Vilniaus vandenys" (Lithuania)
6. Swedish University of Agricultural Sciences (Sweden)

For more information, please visit the project's website: www.nutribiomass.eu.

III. List of Abbreviations and Partner Acronyms

NutriBiomass4LIFE	EU LIFE project "Nutrient recycling circular economy model for large cities – water treatment sludge and ashes to biomass to bio-energy ", No. LIFE17 ENV/LT/000310
CCE	calcium carbon equivalence
CE	Circular economy
CO2	Carbon dioxide
Corg	Organic carbon
CRCF	Carbon Removal Certification Framework
dmt	Dry matter ton (t)
DMWTSD	Dried granulated municipal waste-water treatment sludge digestate
ETS	European Emission trading system
EU	European Union
FSC®	Forest Stewardship Council®
g	gram, 1 kg = 1000 g
GHG	Greenhouse gases
kg	kilogram, 1 t = 1000 kg
LULUCF	Land Use, Land-use Change and Forestry
ha	hectare, 1 ha = 1000 square meters
K	Potashium, total
km	kilometre, 1 km = 1000 m
KV	UAB "Kauno vandenys", Kaunas municipal water supply and sewage water treatment plant
LAND 20-2005	"Rules of waste-water treatment sludge usage in fertilization and land reclamation LAND 20-2005" issued by the Minister of environment of the Republic of Lithuania
mg	milligram, 1 g = 1000 mg
MWTS	municipal waste-water treatment sludge
N	Nitrogen, total
N_{min}	Mineral nitrogen
NECP	National energy and climate plan
P	Phosphorus, total
PP	UAB "Pageldyniu plantacija"
r. or reg.	administrative district
RED II	Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources
RED III	Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652
RES	Renewable energy source
sen.	regional units of administrative district
SOC	Soil organic carbon
SSD	Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (Sewage Sludge Directive)
t	metric ton, 1 t = 1000 kg
UWWTD	Urban Waste Water Treatment directive (91/271/EEC) and revision proposals adopted by council on October 16, 2023
VV	UAB "Vilniaus vandenys", Vilnius municipal water supply and sewage water treatment plant

Introduction

1.1 Purpose and Aim

The purpose of this document is to reveal NutriBiomass4LIFE project coherence with EU and national policies and recommendations for policy implementation improvement.

1.2 Structure

The document is divided into the following chapters:

- Chapter 1 “Coherence and impact of policies”
- Chapter 2 “Policies related to biomass plantations establishment” discusses coherence and implications to EU and national policies and their measures for biomass plantations establishment.
- Chapter 3 “Policies related to sewage sludge usage for fertilization” discusses coherence and implications to EU and national policies and their measures for sewage sludge usage for fertilization of biomass plantations.
- Chapter 4 “Policies related to biomass ashes usage for fertilization” discusses coherence and implications to EU and national policies and their measures for biomass ashes usage for fertilization of biomass plantations.
- Chapter 5 “Policies related to biomass conversion to renewable energy” discusses coherence and implications to EU and national policies and their measures for biomass conversion into renewable energy.
- Chapter “Conclusions” provides recommendations for policy improvement.

1 Coherence and impact of policies

Circular economy model developed by NutriBiomass4LIFE is composed of multiple actions therefore is coherent with multiple EU and national policies, specific measures, and legal regulations. Implementation of such policies are expected to lay down background for sustainability of developed NutriBiomass4LIFE CE model to become a business model after the end of the project.

On the other hand, implementation of NutriBiomass4LIFE project revealed that certain measures implemented under certain EU policies have incoherence with other policies. Such incoherencies impose certain limitation on smooth continuation of the actions of NutriBiomass4LIFE project after implementation of the project. We can see tendencies to resolve such policy limitations, but due to strong lobby power of some interest groups the changes in the policy measures will take time.

2 Policies related to biomass plantation establishment

Under the European Green Deal, a number of various commitments and specific targets are being proposed and implemented. Tree planting is widely regarded as one of the solutions to climate change and biodiversity improvement. The European Union has made a pledge to plant additional three billion trees by 2030 which foresees that new trees should be planted not only in forests but also in rural and urban areas.

Poplars established on agricultural land as perennial short rotation agricultural crop (SRC) and grown for longer rotation (e.g. up to 20 years) are probably the best tool for biodiversity increase, soil health and carbon removal in agriculture. Unfortunately, the measures and tools implemented by various EU policies leave this efficient tool in some kind of “a grey zone”. From the point of practical implementation of agricultural policies such crops are often seen more like forestry measure, while from forestry policy implementation it is not considered a forestry instrument. This problem is reflected in the EU policies and their implementation measures, which are in great favor of forestry promotion and agroforestry promotion in agriculture, while tree growing on agricultural land as an exclusive activity (short rotation coppice or short rotation forestry) is left without a clear role and direction.

2.1 Biomass plantation establishment coherence with EU policies

A roadmap to implement 3 billion tree planting is supported by EU’s Biodiversity Strategy and other key strategies and initiatives under the European Green Deal at implementation level, in particular such as the Certification Framework for Carbon Removals and the Soil Mission.

Planting of poplars on agricultural land provides the synergistic benefits of improved land use efficiency and income diversification, enhanced biodiversity, soil conservation and carbon sequestration.

2.1.1 EU biodiversity and soil policies

Under the European Green Deal, the EU’s Biodiversity Strategy tackles the protection and restoration of nature by making a number of various commitments, among them biodiversity-friendly afforestation, reforestation and tree planting.

Poplars, planted on agricultural land are considered agricultural crops, therefore biodiversity and other policy baseline, first of all, should be compared with agricultural activities. Besides that, studies show that biodiversity in poplar stands are much grater than in pure coniferous forests.

Poplar plantations, compared to most of agricultural practices, in particular crop growing, are considered a useful strategy for the following objectives related to ecosystem services and biodiversity:

- Improving overall biodiversity.
- Contributing towards preserving biodiversity at forests – trees grown on agricultural land can provide significant volume of additional biomaterial, which is needed by different bioeconomy sectors: from traditional renewable energy and wood processing sector to advanced biofuels and bio-chemicals and so reducing pressure on traditional forests, especial forests with high biodiversity.
- Creating buffer zones (e.g. riparian buffers), when poplar plantations are established surrounded by agricultural landscape.
- Establishing biological corridors to enhance landscape connectivity and landscape - level biodiversity.
- Transformation from conventional to organic agriculture, leading to a decreased need for pesticides and fertilisers as NutriBiomass4LIFE poplar establishment is implemented without pesticides and mineral fertilizers. This is especially useful as poplars planted at lower density are favourable to pollinators.
- Reclamation and rehabilitation of degraded or abandoned agricultural land.
- Improving support for ecosystem services and regulating aspects such as nutrient cycling, soil formation, water regulation, erosion control, etc.
- Adapting to climate change, in particular, by creating micro-climates which regulate extreme temperatures and become a shelter during heatwaves for wild animals, birds, insects and cattle.
- Mitigating climate change through increased carbon sequestration.

The EU Soil Strategy for 2030, adopted in 2021 as part of the European Green Deal, provides the framework towards protecting and restoring soils and ensuring that they are used sustainably. In particular, the attention is paid to soil health and its improvement.

Due to falling leaves and the continuous renewal of fine roots, poplars inject organic matter into the soil, feeding the flora and fauna there and increasing biological activity to make it a living and fertile soil. In addition, their root system improves the soil structure. Porosity increases, allowing better infiltration, the storage of water and further promotion of biological activity. Finally, poplars create a temperate microclimate favourable to the development of microbial populations, microfungi and microfauna (e.g. lumbrics, etc.). This all leads towards significant nature-based improvement of soils, especially degraded after intensive agricultural usage.

Given extensive root system, poplars contribute to recycling of the excessive macro nutrients other mineral elements from the soil, which accumulated in the soils due to extensive fertilization over long period.

2.1.2 EU climate policies

Poplars grown on agricultural land are probably the most efficient carbon removal tool in agriculture in terms of carbon removal per ha of land. Establishment of longer (20 year) rotation poplars on agricultural land can remove and permanently store 250-300 tCO_2/ha. Comparing to traditional forestry, established poplar plantations remove carbon 3-4 times faster than established traditional forest tree species. That is an important consideration when we have to take urgent steps towards removing CO_2.

On 21 November, 2023 European Parliament adopted Carbon Removal Certification framework. Carbon Removal Certification framework defined four different types of activities covered by the certification framework, that will be able to benefit from their contribution to meet EU climate targets: carbon removal, carbon farming sequestration, carbon farming emissions reduction and carbon storage in products.

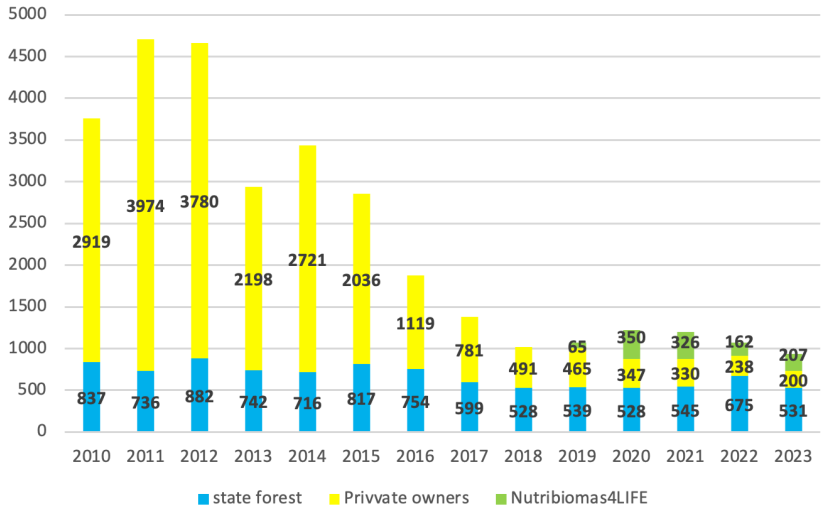
Establishment of poplars has clearly significant carbon removal footprint and complies with carbon farming initiative, but benefitting from Carbon Removal Certification framework will depend on developed carbon removal methodologies, which already posing certain questions: whether short rotation trees on agricultural land will be considered forestry or agricultural activity. From the forestry point, the problems may arise from definition of "monoculture forest". There are intentions to exclude monoculture forest (by default) due to lower biodiversity compared to mixed forest establishments, but not comparing to baseline of lower biodiversity monoculture agriculture. From forestry point, poplars can be considered a "monoculture forestry" (although this is an agricultural activity) as definition usually narrowly looks at the composition of number of tree species, not at a whole ecosystem mix. Nevertheless, poplar plantation with constant grass cover as an ecosystem has greater biodiversity than coniferous forests. Comparing to other cropping systems in agriculture, poplars as agricultural crops are one of the most diverse agricultural ecosystems, but policy instruments in agriculture usually address agroforestry solely.

2.2 Biomass plantation establishment coherence with national policies

Biomass plantation establishment under NutriBiomass4LIFE CE model is fully coherent with national policies which are mainly facilitated by the key EU policies. In Lithuania, special attention can be paid to climate policies as poplars, established during NutriBiomass4LIEF, are becoming an important carbon removal instrument in Lithuania.

Although the public policies toward planting of new trees and forest establishment vocally have always been in heavy support of tree planting and new forest establishment, unfortunately the real policy measure taken have had absolutely an opposite effect. This can be seen when comparing Lithuania's afforestation measure development as presented in Picture 2-1, including poplar plantations established by NutriBiomass4LIFE project. As it can be seen from the picture bellow, from 2016 private forest establishment actions decreased substantially as national authorities took efforts to demotivate private owners' forest establishment efforts by decreasing forest establishment payments from Rural development program. Although in 2018 these payments for forest establishment were reinstated, the interest of private owners for forest establishment was killed by authorities which were responsible for forest establishment promotion.

Picture 2-1. Afforestation in Lithuania (ha)



NutriBiomass4LIFE brought a new lifeline for private owners to plant trees on agricultural land and that doubled private owners tree planting results in Lithuania. Taking into account low afforestation efforts from state forestry, NutriBiomass4LIFE established poplars totalled 25% of all Lithuania's afforestation efforts during the last four year period.

This remarkable NutriBiomass4LIFE efforts in Lithuania's afforestation efforts is important in terms of implementation of climate policies. Initial Lithuanian National energy and climate plan for 2021-2030 was targeting that private and state forest owners' efforts for afforestation could reach 15000 ha per year. At the end of 2013 Lithuanian National energy and climate plan for 2021-2030 was revised as afforestation measures failed completely, and the new target was set at 1000 ha per year level, which without NutriBiomass4LIFE's efforts would not be achievable again.

Besides shift in policies regarding subsidies to landowners for establishment of forests on agricultural land, in Lithuania people moved out of afforestation of agricultural land because of extremely strict regulation regarding usage of forest land. In Lithuania it is not allowed to do anything on forest land: neither to build house, nor wind power mill, nor some other infrastructure. Besides that, owners of forest are skipped out of certain non-wood rights – they do not have right to hunt or sell hunting right, they cannot restrict others from mushroom, berry, or other good gathering from their properties, etc. Al the restrictions and insufficient property rights lead to the situation, that after the forest is established on agricultural land, the land value loses its value by several times.

Poplar establishment do not receive any subsidies, but there is no requirement to change land purpose from agricultural land to forest land, which is now getting more valuable to landowners. In Lithuania there is no clear definition on maximum allowed age per rotation of such plantations. The limiting factor, which defines when the private land planted with poplars can be converted to agricultural land is the age of trees, which is defined in the Law on forests – over 20 years. Members of the NutriBiomass4LIFE consortium proposed national authorities to have a clearer definition of the age of short rotation plantations, which are grown on agricultural land. Currently in the new draft Law on forests, there is a definition related to short rotation plantations (short rotation coppice), which will define the age of rotation of such plantations – up to 20 years.

3 Policies related to sewage sludge usage for fertilization

Sewage sludge usage for fertilization in agriculture has been under strong policy influence since adoption of the EU Sewage sludge directive in 1986. Since then many new technologies and policies have emerged, but sewage sludge usage problematic has not decreased, but even got new life under policies of Green Deal and Circular economy.

3.1 Sewage sludge usage for fertilization coherence with EU policies

3.1.1 Sewage sludge directive

NutriBiomass4LIFE CE model strongly relied on SSD, as it should ensure protection of the environment, and, in particular, of the soil and water, when sewage sludge is used in agriculture. DMWTSD, which was used during implementation of NutriBiomass4LIFE project, is considered as a waste, and was used to fertilize biomass plantations in full compliance with SSD.

In particular, the following regulations of SSD applied to NutriBiomass4LIFE project:

- Usage of MWTS in agriculture – DMWTSD both was used in agriculture (short rotation plantations established on agricultural land) and forestry (established forest plantations only), and in both cases regulations of SSD were followed, although SSD does not regulate usage of MWTS in forestry.
- Definition and requirements on treatment of sludge, as the SSD requires sludge to be treated before spreading on land - the DMWTSD of VV undergoes thermo-hydrolysis and anaerobic treatment before application in biomass plantations.
- Compliance to concentration of heavy metals in soil – ex-ante soil analysis was performed for each respected 5 ha area of NutriBiomass4LIFE biomass plantations to ensure compliance to SSD.
- Definition of sludge quality (contamination limits) – VV and other municipal waste-water treatment plants regularly conducted chemical analysis of their MWTS to ensure sludge quality compliance to heavy metal limits to be allowed for usage in agriculture.
- Compliance to annual quantities of heavy metals which may be inputted into agricultural soil – based on soil analysis and MWTS analysis NutriBiomass4LIFE project ensured compliance to annual quantities of heavy metals which may be introduced into agricultural soil.
- Compliance of other restrictions on the usage of MWTS in certain times or areas - NutriBiomass4LIFE respected other requirements of SSD to ensure that the risk of leakage of contaminants into ground and surface waters is minimised.

Although legal basis of SSD is related to the functioning of the EU internal market, MWTS is purely a local product (type of waste), which due to low economic value and high transportation costs have to be managed nationally and even better locally close to production source (municipal waste-water treatment plant). NutriBiommass4LIFE demonstrated, that sewage sludge can be successfully used in circular way even for large municipalities, where large areas for fertilization are needed. In this case to meet MWTS recycling demand of large municipal wastewater treatment plants the effective distance from large municipal waste-water treatment plant to nutrient reusage fields may be expanded from traditional 50 km (the distance is reasonable to smaller municipal wastewater treatment plants) to 100 km.

3.1.2 Circular economy and nutrient recovery

The new Circular economy action plan ((COM(2020) 98), which was adopted on 11 March, 2020, is one of the core stones of the European Green Deal. While building on circular economy actions implemented since 2015, the new Circular economy Action Plan provides a future-oriented agenda for achieving a cleaner and more competitive Europe, while reducing the negative impacts of resource extraction and use of the environment.

Circular economy Action Plan outlines wastewater and sewage sludge as the core objects for facilitating recovery of nutrients by contributing to EU aim to reduce its dependency on imports of nutrients from third countries, moving towards energy efficiency and carbon neutrality. This can be achieved by removing nutrients from wastewater and sludge and making sewage sludge for direct reuse in agriculture through the development of EU Integrated Nutrient Management Plan.

In March 2023 the new Critical Raw materials Act was announced, in which phosphate rock and phosphorus are on the EU's critical raw materials list, which means incentives for recovering phosphorus from wastewater and sewage sludge and direct reusage of sewage sludge, should be increased. In addition to phosphorus, nitrogen recovery from wastewater and sewage sludge is very important not only from the point of nutrient recovery, but even more important from carbon neutrality targets, as GHG emission from nitrogen production processes is many times higher than from production of phosphorus fertilizer.

The landfilling Directive (1999/31/EC), which aims at reducing the amount of waste, which is landfilled, contributes towards decrease of landfilling of sewage sludge towards increase in sewage sludge usage in agriculture and in for energy recovery (incineration).

The Waste Framework Directive (2008/98/EC) sets a waste hierarchy requiring to prioritise sewage sludge reusage in agriculture / forestry and nutrient recovery over energy recovery or disposal. The Waste Framework Directive allows to adopt national 'end-of-waste' criteria which recognise the status of sewage sludge digestate and/or of compost as products and no longer as a waste, that may facilitates sewage sludge reusage in agriculture. The Fertilising Product Regulation 2019/1009 establishes end-of-waste criteria for EU fertilising products containing certain materials derived from sewage sludge as well. However, under such criteria only part of sewage sludge may switch from waste to fertilizing product classification. Still, a major part of sewage sludge may be used in agriculture under the status of waste, which imposes stricter requirements and additional costs related to its treatment, transportation, application to soil and reporting.

NutriBiomass4LIFE project developed model where processed sludge (dried digestate) is used as a waste in non-food crop production in full compliance with SSD, which ensures full nutrient (nitrogen, phosphorus and carbon) recovery and usage in circular way.

3.1.3 Zero pollution policy

Zero Pollution Action Plan was developed under the European Green Deal vision to achieve a zero pollution by 2050. Zero Pollution Action Plan aims at preventing pollution for air, water and soil and achieving levels no longer considered harmful to health and natural ecosystems and at securing soil quality.

The EU Soil Strategy for 2030, adopted in 2021 as part of the European Green Deal, provides the framework towards protecting and restoring soils, and ensuring that they are used sustainably. The strategy replaced the former Thematic Strategy for Soil Protection. The EU soil strategy refers to the evaluation of the SSD, since SSD can contribute to sustainable use of soil, as it outlines quality standards for agricultural soil at the EU level.

In the Soil strategy, the EU committed to adopt the new Soil Health Law to protect and restore soils and ensure that they are used sustainably, and in July 2023 a legislative proposal for a Directive on Soil Monitoring and Resilience (the Soil Monitoring Law) was proposed. The renaming from Soil Health to Soil Monitoring Law indicates that the focus has switched to observing soil health rather than ensuring its health improvement not including legally binding targets or requiring mandatory plans. In particular, Soil monitoring law outlines review of SSD related to inclusion of microplastic pollution monitoring from sewage sludge, also puts heavy emphasis on organic soil carbon improvement, where direct application of sewage sludge may contribute to the solution.

Sewage sludge not only enhances fertility of soils through its organic and nutrient content, but it can also foster soil health improvement through soil structure improvement and soil organic carbon (humus) accumulation, which implements soil sustainability and climate neutrality targets. Lime-treated sludge can also help reduce the acidity of agricultural soils. With expansion of anaerobic digestion practices in sludge management due to implementing renewable energy and climate polices, a more sewage sludge in a form of digestate will be available for fertilization purposes. Sludge digestate has numerous advantages over low processed sewage sludge:

- Sewage sludge digestate-derived fertilizing products have a high nitrogen availability which makes them efficient alternatives to synthetic fertilisers.
- Sewage sludge digestate use is contributing to maintain soil fertility in contrast to using synthetic fertilisers. Sewage sludge digestate contains significant concentrations of humus-effective carbon and in long term it is a key in maintaining soil fertility as well as soil microbiota to ensure high crop yields and sustainable land management.
- Dry sewage sludge digestate, as a more stable form of organic fertilizer, has a strong potential to contribute to reduction of nutrients losses through the leaching in water and air.
- Sewage sludge digestate is a circular product and can displace GHG emissions and natural gas consumption inherent to the production of synthetic fertilisers.

In October 2023, the Council adopted the proposal on the new Urban Waste Water Treatment directive, that sets requirements form the collection and treatment waste water in the EU to protect the environment from the adverse effect of discharges of urban waste water. Under Article 20 (former 14) of the UWWTD the sewage sludge has to be treated, recycled and recovered whenever appropriate in accordance with the waste hierarchy as defined as defined in Article 4 of Waste Directive 2008/98/EC and the actions to better monitor and reduce pollution at source from upstream and non-domestic discharges have to be introduced to help improving the quality of the sludge produced and ensure its safe use in agriculture. Additionally, the new UWWTD orders to ensure a proper and safe recovery of nutrients, including the critical substance phosphorus and nitrogen, from the sludge, therefore minimum recovery rates should be defined at the EU level.

Upstream wastewater discharge monitoring is an essential to reduce risks of contamination in wastewater and sewage sludge. The new UWWTD introduces principles polluter pays for certain type of contaminants – like microplastics. Besides empowering modern water cleaning technologies to minimize nitrogen and phosphorus content in discharged water to the environment, wastewater treatment plants will need to introduce upstream monitoring systems to reduce contaminants which are not possible to clean (e.g. heavy metals, microplastics) at waste water treatment plants. Pathway to sewage sludge incineration limits wastewater treatment plant motivation and efforts to monitor and manage upstream contaminant reduction, as heavily contaminated sludge can be incinerated without limitations. Unfortunately, not all wastewater contaminants end in sewage sludge – significant part (depending on the type of contaminant) is discharged to the environment with cleaned wastewater from wastewater treatment plants (at low concentrations but with many times higher discharged water volume comparing to sewage sludge volume).

NutriBiomass4LIFE project contributes at implementation of Zero Pollution policy, by complying to SSD regulation, that prevents harmful effects of sewage sludge usage on soil, vegetation, animals and people, in general and specifically as regards prevention of pollution by heavy metals. Additionally, by switching DMWTSD towards non-food crop fertilization, NutriBiomass4LIFE CE model eliminates all risks related to contamination of food chain and risks to human health.

3.1.4 EU energy and climate policies

The EU energy policy targets to reduce supply dependency from imports from outside the EU, while moving towards a low-carbon economy.

RED II and revised by RED III set overall share of renewable energy and share of renewable energy in certain sectors. In March 2022, in its REPowerEU Communication, the Commission outlined a plan to advance these targets to well before 2030 in view of increasing Union's independence from Russian fossil fuels and reduce EU demand for Russian gas.

All sewage sludge, under current EU legal framework, is considered as renewable energy source and can contribute to renewable energy in two ways: production of biogas (biomethane) through anaerobic digestion and heat/power production through incineration.

RED II /RED III and REPowerEU Communication pay special emphasis for sewage sludge processing by anaerobic digestion and production of biomethane for transportation needs. RED II /RED III prioritizes sewage sludge usage as a feedstock for the production of biogas for transport and advanced biofuels and sets its contribution to a share of final consumption of renewable energy in the transport sector double to sewage sludge energy content (Annex IX).

Anaerobic digestion is a growing sewage sludge treatment method as it allows the production of biogas concomitantly with sludge use in agriculture: while the process generates biogas the resulting digestate can be used on land as fertilizer in parallel. The key limitation of anaerobic digestion treatment is heavy metals concentrations in sewage sludge which are not decreased by the process and may be limiting factor categorizing sewage sludge digestate as a fertilizing product. Nevertheless, as it is demonstrated by Nutribiomas4LIFE project, sewage sludge digestate can be used as fertilizer in biomass plantations based on SSD regulations as a waste without harming environment and people.

There are two major types of energy recovery from sewage sludge technologies, which differ in their approach to compliance to Circular economy policy and the principle of the waste hierarchy established by Waste Framework Directive. The first one – a simple co-incineration of sewage sludge in waste incineration plants or cement production facilities without nutrient recovery.

The second one – more modern, mono-incineration of sewage sludge with potential phosphorus recovery from ashes. The last one technology is employed by some European countries (Germany, Netherlands, Austria) that implement policies that discourage the application of sludge to land and/or encouraging phosphorus recovery from sewage sludge. Phosphorus recovery from sewage sludge ash is currently more expensive to implement and operate compared to the revenues generated from selling fertilisers, which limits the potential for widespread implementation. This treatment route also does not allow for the recovery of the organic nitrogen and organic matter contained in the sludge, which is provided by direct fertilization option with sewage sludge.

The Energy policy directing sludge to incineration (or co-incineration which aims only at energy recovery) for heat / power production impedes the recovery of the organic nutrients in sludge. RED II /RED III define that the principle of the circular economy and the principle of the waste hierarchy established in Directive 2008/98/EC should be respected in national legislations to produce bioenergy, but limitations are imposed only on developing support schemes for bioenergy production.

Implementation of NutriBiomass4LIFE project showed, that there is major incoherence related to final sewage sludge application between Circular economy / nutrient recovery policies with EU energy and climate policies. There is a lack of unified strategy to ensure that sewage sludge governance also encourages circularity, recovery or recycling.

Although RED II /RED III prohibits development of support schemes for bioenergy production that disregard principle of the circular economy and the principle of the waste hierarchy established in Directive 2008/98/EC, EU Emission Trading Scheme indirectly subsidizes sewage sludge incineration without nutrient recovery over reusage of sewage sludge on land or nutrient recovery.

Waste incineration plants, being a subject of EU Emission Trading Scheme, have to pay for their CO_2 emissions generated from waste incineration. As sewage sludge is classified as renewable energy source, using sewage sludge to produce energy allows to reduce emissions allowances needed. It is estimated that due to saving on emission allowances, waste incineration plant can save from 0,8 (in case of DMWTSD of VV) to 1,4 (in case of DMWTSD of KV) emission allowances per one tone of incinerated DMWTSD, or 55-100 eur / dmt of DMWTSD. Sewage sludge digestate has lower carbon content per dmt, therefore it has lower energy content per dmt of DMWTSD comparing to unprocessed sludge. Additionally, depending on anaerobic digestion technologies employed, substantially different volumes of biogas can be produced from the same dmt of unprocessed sewage sludge. Consequently energy (and organic carbon) content in processed sewage sludge digestate may differ even two times.

Higher financial benefits (profit) can be achieved by cement production plants as cement producers receive free emission allowances, therefore they are able to sell saved emission allowances at a profit. Even on 25 April 2023 the Council adopted the reform of EU Emission trading System with gradual phase out of free emission allowances from 2026 to 2034. The reform foresees that issue of free

emission allowances to all ETS sectors, which currently receive free emission allowances, will be gradually (with exception of cement and fertilizer industries) phased down starting from 2026, making sewage sludge incineration at cement plants still financially attractive option.

Overall, the carbon footprint for the different sludge management routes differs. The direct use-on-land of untreated, lime stabilised sewage sludge and in particular sludge processed by anaerobic digestion have a strong net negative carbon footprint and can therefore act as a climate change mitigation strategy, in contrast to sludge incineration pathways.

NotriBiomass4LIFE model, which used sewage sludge, processed by anaerobic digestion, has the biggest negative carbon footprint due to combination of multiple factors: (1) sequestration of CO_2 in soil (adding organic carbon to soil), (2) potential to substitute synthetic fertilizers, produced through energy-intensive processes, (3) CO_2 sequestration in biomass of trees due to increased yields from applications of nutrients from sewage sludge and (4) replacement of fossil fuels by producing biogas through anaerobic digestion sludge processing. Unfortunately, Emission trading system through free emission allowances subsidizes the worst sewage sludge management pathway - incineration at cement production plants.

On 21 November, 2023 European Parliament adopted Carbon Removal Certification framework (CRCF). The aim of the proposed regulation of certification framework for carbon removal is to facilitate the deployment of high-quality carbon removals through a voluntary EU certification framework with high climate and environmental integrity. Carbon removals also constitute a new business model in the voluntary carbon market. This initiative is instrumental in ensuring the soil's capacity to absorb and store carbon and promoting other carbon farming activities (including tree planting) to sequester and store carbon.

Carbon Removal Certification framework defined four different types of activities covered by the certification framework, that will be able to benefit from their contribution to meet EU climate targets: carbon removal, carbon farming sequestration, carbon farming emissions reduction and carbon storage in products. Carbon Removal Certification framework is expected to be implemented by 2030, but it may finally set framework for NutriBiomass4LIFE model to benefit from its contribution to climate targets and to equal ground with sewage sludge incineration alternative. It is clear that NutriBiomass4LIFE CE model has clear negative carbon footprint, but benefitting from Carbon Removal Certification framework will depend on developed carbon removal methodologies, which already posing certain questions: whether short rotation trees on agricultural land will be considered forestry or agricultural activity, whether there will be methodologies for carbon storage in soil while applying biosolids to soil, whether sewage sludge biosolids will be included in carbon removal certification, etc.

Introduction of the new Urban Waste Water Treatment directive and call to the Commission to set legal background to ensure a proper and safe recovery of nutrients (phosphorus and nitrogen) from sewage sludge by setting minimum recovery rates at the EU level hopefully will clearly prioritize sewage sludge reuse and recycling over incineration for energy purposes only. Introduction of obligations to reuse and recycle sewage sludge with removal of financial incentive to incinerate sludge without recycling option will change the flows of sewage sludge management and NutriBiomass4LIFE CE model will gain competitiveness over current incineration flows.

3.2 Sewage sludge usage for fertilization coherence with national policies

National policies reflect EU policies and their measures, although as EU policies set general directions there are possibilities for wider interpretation on the national level. Sewage sludge usage for fertilization within NutriBiomass4LIFE CE model has been in full coherence with national policies and regulations, but implementation of the EU policies on the national level reveals that certain provisions of EU Waste Framework Directive and Circular Economy policies are disregarded giving a clear priorities and incentives to waste incineration over reuse or recycling.

3.2.1 Implementation of EU Sludge directive

Implementation of SSD regulations related to application of sewage sludge on agricultural land is governed by "Rules of waste-water treatment sludge usage in fertilization and land reclamation LAND 20-2005" issued by the Minister of environment of the Republic of Lithuania.

LAND 20-2005 defines that processed sewage sludge can be used (1) in agriculture, (2) in woody biomass growing – short rotation plantations established on agricultural land and forest plantations and (3) in land reclamation and sets different requirement for each category of application regarding sludge quality criteria, fertilization rate, monitoring and permitting procedures.

NutriBiomass4LIFE follow the path of sludge usage in woody biomass growing – short rotation plantations established on agricultural land and forest plantations, which allows to use 11 dmt/ha of DMWTSD once in three years (appr. 3 times more than in agriculture) but requires more complicated permitting procedure and monitoring plan.

Comparing to SSD, Lithuania has much stricter regulation on heavy metal concentration limits when it is allowed to use sewage sludge in agriculture and biomass plantations as defined in table 3-1.

Table 3-1. Comparison of heavy metal limits (mg/kg) in sewage sludge according to SSD, LAND 20-2005 and Fertilizing products requirements

Heavy metal limits (mg/kg)	Cd	Cr	Ni	Cu	Pb	Zn	Hg	As
SSD	20-40		300-400	1000-1750	750-1200	2500-4000	16-25	
LAND 20-2005, I category	<1,5	<140	<50	<300	<140	<800	<1,0	
LAND 20-2005, II category	1,5-5,0	140-170	50-70	300-1000	140-150	800-2500	1,0-1,5	
Fertilizing products	<2,0	<70 and <2 (Cr VI)	50	<300	<120	<800	<1,0	<40

Sewage sludge of both I and II categories (LAND 20-2005) as a waste can be used for fertilization both in agriculture and biomass plantations, following the procedures defined in LAND 20-2005. Sewage sludge digestate or compost, which meets Fertilizing product criteria, can be excluded from waste category, and used as fertilizing product.

3.2.2 National regulation on circularity

Lithuania does not have its circular economy strategy and therefore there is no clear policy directing towards circular economy pathway.

Although Lithuanian Law on Waste management defines the same waste hierarchy requiring to prioritise sewage sludge reusage in agriculture / forestry and nutrient recovery over energy recovery or disposal (as in the EU Waste Framework Directive (2008/98/EC)), currently there is no other

legislation which would oblige wastewater treatment plants to follow circularity path over incineration.

On July 3, 2020 Ministry of Environment issued new version of "Rules of waste-water treatment sludge usage in fertilization and land reclamation LAND 20-2005" regulation which came into force on January 1, 2021 and which had a clear shift towards circular economy prioritising sewage sludge usage in agriculture and biomass plantations. Based on the waste hierarchy requiring to prioritise waste management as defined by the Waste Framework Directive (2008/98/EC), it was defined that sewage sludge can be incinerated or used for landfill coverage only in case fertilization option is not available.

Unfortunately, this important legislative provision was not respected by wastewater treatment plants and sewage sludge was supplied for incineration disregarding fertilization availability. The election and the change of the Government and the new management of the Ministry of the Environment under the lobby of big company (cement producer) very quickly reversed circular economy pathway towards incineration economy. The legislation, that sewage sludge can be incinerated without phosphorus recovery only if fertilization option is not available, was abolished from June 14, 2021, and today in Lithuania sewage sludge incineration without phosphorus recovery is again treated equally in the pyramid of waste management as reusage (fertilization) or recycling of sewage sludge.

3.2.3 Pollution risk management

One of the primary tasks of LAND 20-2005 is to ensure that sewage sludge usage will be used on agricultural land and biomass plantations safe and with no harm for soil, water, animals, and humans.

One of the pollution prevention measures was to establish heavy metal concentration in sewage sludge limits, as it is outlines in table 10-1. Lithuania has established much stronger heavy metal limits compared to outlined in SSD, which significantly limits pollution risks.

Another pollution risk minimizing tool – regulation on sewage sludge application rate. According to LAND 20-2005 sewage sludge can be applied only once in three years both in agriculture and biomass plantations. In agriculture sewage sludge application is limited by nitrogen (140 kg/ha) and phosphorus (40 t/ha) limits. Based on nitrogen and phosphorus concentrations in sewage sludge it is estimated that on average 2-3 dmt/ha of sewage sludge can be applied in agriculture once in three years. In biomass plantations it is allowed to apply 11 dmt/ha of sewage sludge once in three years (or 3,6 dmt/ha/year on average). Existing high restrictions on heavy metal limits in sewage sludge and low application rates ensure were low risk for contamination and pollution. Based on LAND 20-2005 requirements and actual heavy metal concentrations in sewage sludge in Lithuania there is no risk that soil contamination limits set by SSD will ever be reached when regularly applying sludge to the soil. The same low risk situations exists regarding risk of leaching contaminants into water.

LAND 20-2005 sets environmental permitting and monitoring procedure. During implementation of Nutribiomass4LIFE, starting 2021 project permitting procedures were simplified - after regulation revision permitting is handled by Environmental Protection Agency with approval of monitoring plan by Lithuanian Geological service within shorter period. After revision since 2021, municipalities were relieved from permitting process with granting more active role in monitoring. While preparing fertilization plan for the environmental procedures, higher risk zones for leaching as defined in LAND 20-2005 must be excluded from fertilization area.

NutriBiomass4LIFE promotes sewage sludge usage in non-food biomass plantations according to special regulation defined in LAND 20-2025. LAND 20-2025 regulates, that soil and water monitoring plan has to be developed for fertilization of biomass plantations:

- To ensure concentration limits of heavy metals in soil are note breached – soil analysis has to be repeated before each following fertilization if initial soil analysis shows that concentrations of heavy metals exceed background (national average) concentrations in soil.
- To ensure concentration limits of heavy metals and macro nutrients (N and P) in drainage and ground water are note breached – water analysis has to be performed after each fertilization.

Water monitoring requirements for heavy metals in water were introduced since 2021 and are applied for biomass plantations fertilization only. NutriBiomass4LIFE water monitoring actions showed that there are low no risks associated with leakage of heavy metals in water form biomass plantations fertilized with sewage sludge if sewage sludge quality parameters and fertilization rate limits are respected.

The following modifications to water monitoring while fertilizing with sewage sludge would be reasonable:

- To cancel excessive and expensive requirements for heavy metal monitoring in water in biomass plantations – all the water monitoring analysis during NutriBiomass4LIFE project showed that heavy metal concentrations in water are even below detectable levels imposed for drinking water requirements.
- Instead of heavy metal monitoring in water, monitoring of macro nutrients fractions can be expanded by including nitrate nitrogen ($NO_{3\text{-}N}$) to unify the requirements for water monitoring in manure and sewage sludge while fertilizing agricultural crops and biomass plantations.
- To change requirement to perform ground water monitoring, if drainage system water monitoring is not available (there is no drainage system installed), to perform water monitoring by installing water collection lysimeters. Ground water monitoring is extremely expensive and is installed for monitoring of heavy pollution sources like higher risk for water pollution manufacturing facilities, petrol stations, etc. – up till now no one ground water monitoring system was installed for sewage sludge fertilization monitoring. Lysimeter monitoring systems are widely used in research and practical nutrient leakage monitoring.

3.2.4 Energy recovery from sewage sludge

After the first EU circular economy package was adopted in 2015, many EU countries started to slow down or even stopped investments into waste incineration. Contrary, initial Lithuania's investment into waste incineration capacities were slow, but much accelerated after adoption of EU circular economy package. These latest investment into waste incineration in Lithuania were mainly driven by state - the state-controlled energy company got exclusive right to invest into waste incineration. In Lithuania waste incineration is still publicly presented as part of circular economy and waste incineration plants are presented as flagships of circular economy – a clear example of "green washing".

In 2020 big new waste incineration facilities started their operations in Lithuania - Kaunas Waste incineration plant and DMWTSD incineration at Akmene cement production plant. Additionally, in 2021 EU subsidised waste incineration plant started its operations in Vilnius. Today large waste incineration capacities and their extreme profitability in Lithuania are the key obstacle for moving towards circular economy. Extreme profitability (over 50% EBIDTA or even EBIT) of waste incineration business is mainly defined by monopolistic conditions, direct and indirect subsidies and long-term state policies not directed at promoting municipal waste sorting and recycling. Such a high profitability of waste incineration businesses means, that Lithuania, without proper regulation directing waste from incineration towards recycling or reuse, will not be able to meet its circular economy obligations.

The Law on Waste management classifies sewage sludge as biodegradable waste and Lithuanian Law on Renewable energy resources attributes biodegradable waste to biomass, from which renewable energy is produced. Therefore, sewage sludge is considered as renewable energy source both in terms production of biogas through anaerobic digestions and in terms of heat and power produced through incineration with or without nutrient recovery.

From 2020, after opening waste incineration facilities in Kaunas (waste incineration plant) and Akmene (cement producer), dry sewage sludge digestate was redirected to incineration facilities, primary at Akmene cement plant in the North of Lithuania. The key reason for incineration to be the most competitive for DMWTSD management option in Lithuania is that sewage sludge is classified as biomass, therefore sewage sludge incineration considered as carbon neutral energy production, that allows to save on Emission allowances – from 0,8 to 1,4 tCO_2 DMWTSD incinerated. As the majority of municipal waste (which also has about 50% (fresh weight) of biodegradable waste in it) is being incinerated, there is sufficient supply of municipal waste for waste incineration plants in Vilnius, Kaunas and Klaipeda, so today waste incineration plants are not willing to offer cheaper incineration prices comparing to municipal waste. But this situation will change in future if significant part of municipal waste, as required by EU regulation, will be redirected towards composting (biodegradable part) and recycling.

Cement producer can offer less expensive option for dry sewage sludge digestate management to waste-water treatment plants due to policies to subsidise incineration. By incinerating dry sewage sludge digestate cement producer replaces coal burning and saves appr. from 1,6 (in case of DMWTSD of VV) to 2,8 (in case of DMWTSD of KV) emission allowances per one tone of replaced tone of coal, or 110-200 eur t/ replaced coal. Additionally, cement producer on the EU level are provided with free emission allowance to cover their CO_2 emissions (i.e. cement producers as the biggest CO_2 emitters are exempted from principle “polluter pays”). By incinerating sewage sludge cement producers are capable directly to profit from selling of free emissions allowances saved by incinerating sewage sludge and that provides waste incineration with solid financial competitive advantage, comparing to sewage sludge recycling or reusing options.

Comparing carbon footprint, sewage sludge reusage in offered NutriBiomass4LIFE CE model has much bigger negative carbon footprint than incineration at cement production facility. In case of incineration of sewage sludge at cement production facility, cement producer can directly benefit from lower CO_2 emissions comparing to coal usage through EU subsidy (sale of free emission allowances). In case of sewage sludge usage in much more carbon negative pathway - in fertilization of biomass plantations,

financial benefit is received not by land/ forest owners, who are engaged in this pathway, but by the state that will account carbon sequestration and storage due to biomass yield increase after fertilization.

This means, EU subsidizes the more pollutive option – sewage sludge incineration over sewage sludge recycling in biomass plantations. Unfortunately, short rotation forestry cannot benefit from its huge CO_2 sequestration potential, as carbon sequestration is included in LULUCF calculations and benefits the state, which provides free emission allowances to real CO_2 polluters, but not those who sequestrate CO_2.

Even comparing to other waste incineration options, it can be observed how EU policy to grant cement producers with free emission allowances supports much higher CO_2 emissions. In Lithuania all dry sewage sludge, from all the cities (except Vilnius, where implementation of NutriBiomass4LIFE took place) has been transported for incineration without any phosphorus recovery at cement producer facilities in the North of Lithuania. This accounts over 1000 of heavy trucks annually going back and forward annually (up to 400 km per one way trip) and emission of huge volume of CO_2 from transportation. On the other hand, there are waste incineration plants which can incinerate sewage sludge locally without any or with minor emissions of CO_2 from transportation. But these waste incineration facilities do not receive free emission allowances as cement producer, therefore cannot compete for sewage sludge incineration locally with cement producer. This once more reveals, that in this particular case, EU climate policy evidently support the most CO_2 pollutive option.

4 Policies related to biomass ashes usage for fertilization

Return of biomass ashes to the soil is the most sustainable utilization of biomass ashes as minerals in biomass ashes that were extracted by trees from soil are returned to soil. In this case the quality of biomass ashes have to be controlled to avoid possible contamination of soil. The quality of biomass ashes is not a problematic in case all regulations are followed by biomass energy producers and wood waste is not mixed into raw wood chips.

Biomass ashes application in soil as fertilizer and/or soil improver is not regulated on the EU level, and the main regulation is passed to the national level. According to the new EU Fertiliser Regulation 2019, the countries may apply less strict limits for applications of biomass ashes in top soils, but may not export the biomass ashes to other countries as CE marked product for applications in top soils. After processing and stabilization, biomass ashes may fulfil the criteria to be used as component for inorganic macronutrient fertilizers, liming materials or inorganic soil improvers under the EU Fertilizing Products Regulation.

Different countries have various regulation frameworks for application of biomass ashes to soil. Biomass ashes application in agriculture and forestry is a common practice in Northern European countries where biomass as a renewable energy source has significant share in total energy production, consequently leading to higher volumes of biomass ashes available.

In Lithuania, application of biomass ashes on soil is regulated by special regulation approved by the minister of environment in 2011 – “Regulation on management and application of biomass ashes”. This regulation was developed based on Sludge directive, therefore some requirements for application

of biomass ashes in agriculture and forestry are costly and excessive. The regulation on biomass ashes application almost has not been changed since adoption and require certain improvement.

National regulation sets very stringent quality requirements for biomass ashes application in CE. There is questionable distinction in quality requirements while applying biomass ashes in forestry and agriculture: the quality (concentrations of heavy metals) requirements of biomass ashes are less stringent when applying on food crops (agriculture), comparing to non-food (forest) application. Many of limiting requirements for heavy metal concentrations in biomass ashes for application in agriculture and forestry in Lithuania are almost ten times more stringent than those defined by EU regulation on fertilizing products (2019/1009), regulation frameworks in Sweden and other EU countries.

Table 4-1. The highest limiting values of contaminants in biomass ashes for different applications (mg/kg)

Name of element	Lithuania	Lithuania	Sweden	EU regulation of fertilizing products			
mg/kg	Agriculture and land reclamation	Forestry	Forestry	Liming material	Organic soil improvers	Inorganic soil improvers	Organo-mineral fertilizers
Boron (B)	250	200	800				
Chromium (Cr)	30[1]	20[1]	100[1]	2[2]	2[2]	2[2]	2[2]
Cuprum (Cu)	200	100	400	300	300	300	300
Nickel (Ni)	30	20	70	90	50	50	50
Zink (Zn)	1500	1000	min. 500 max7000	800	800	800	800
Vanadium (V)	150	150	70				
Cadmium (Cd)	5	3	30	2	2	2	3
Lead (Pb)	50	40	300	120	120	120	120
Arsenic (As)	3	3	30	40	40	40	40
Mercury (Hg)	0,2	0,2	3	1	1	1	1

[1] t highest limit of total Chromium (Cr) concentration (mg/kg)

[2] highest limit of hexavalentchromium (CrVI) concentration (mg/kg)

There are also questionable quality distinction comparing biomass ashes and municipal solid waste incineration ashes while applying them in civil engineering – for the application of biomass ashes in road construction the highest allowed heavy metal concentrations in municipal solid waste incineration ashes are many times higher as they are based on leaching concentrations while those set for biomass ashes are based on total concentrations.

Limits for application rates (t/ha) of biomass ashes defined in national regulation lack scientific background as defined in NutriBiomass4LIFE report “Biomass ashes recycling in NutriBiomass4LIFE circular economy model” and make liming capabilities pf biomass ashes very limited, especially when it is allowed to apply biomass ashes at very limited rates only once in three years. Current national legislation allows very restricted rates of biomass ashes to be reused in agriculture/forestry, which can neither change acidity level to targeted, nor ensure maintenance stable acidity level. It would be reasonable to set biomass ashes application limits based on two factors: phosphorus inputs (40 kg/ha/year) and liming needs based on pH of soil and liming capabilities of biomass ashes based on calcium carbon equivalence (CCE) of biomass ashes.

There are other excessive and questionable requirements which make application of biomass ashes in agriculture and forestry less attractive and economically inefficient for land-owners.

5 Policies related to biomass conversion to renewable energy

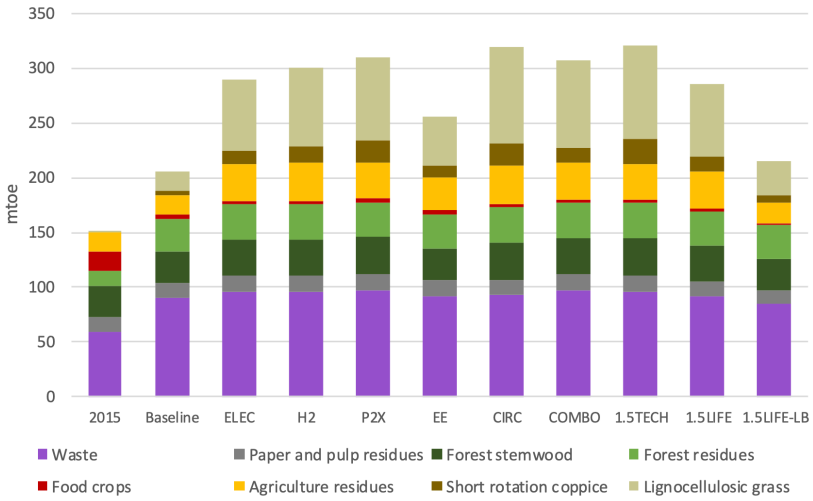
Growth in the use of renewable energy sources (RES) has diverse benefits for society such as mitigating climate change, reducing the emission of air pollutants and improving energy security. Biomass energy is the primary renewable energy source all over the world. Although during recent years we can see significant growth in other renewable sources, like wind and solar, biomass still holds appr. 70 % share among all global renewable energy sources.

In October 2023 EU formally adopted an update of the Renewable Energy Directive that, among other measures, increases the binding 2030 target from 32% to 42.5%, with the aim of achieving 45%. Each Member State will contribute to this common target, while no targets were introduced for individual countries.

In 2022, the share of renewable energy in the EU reached, i.e. 23% increased by +1.1% from 2021. Among renewable energy sources in the EU, the largest by far is solid biomass. Solid biomass is widely used in electricity generation, industry and residential heating. Combined, it represented 41% of the total renewable energy supply in Europe in 2021. It is followed by wind (13%), hydropower (12%), liquid biofuels (8%) and biogas (6%). Heat pumps and solar photovoltaics each represented less than 6% of all renewables. However, they are the fastest growing sources, having increased by more than 13% between 2020 and 2021.

In November 2018, the Commission in the Communication COM(2018) 773 “A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy” outlined the importance of biomass based energy. In the Communication, the increasingly important role of short rotation coppice (willows and poplars) was outlined in different scenarios analyzed. As it can sees from the picture bellow, the role of short rotation coppice was expected to increase manyfold and to surpass the food crop share used in bioenergy.

Picture 5-1. Break down of bioenergy feedstock in 2050



Source: Communication COM(2018) 773 “A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy”

Unfortunately no policy instruments have been employed to employ potential of short rotation coppice and the situation has not changed so far.

5.1 Coherence with EU policies

5.1.1 Coherence with energy policies

On Oct. 9. 2023, the Council adopted the new Renewables Energy Directive (RED III), which set raised the 2030 target for the share of renewable energy in the EU's overall energy consumption from 32% to 42.5%.

RED III sets the following targets for RES in different sub-sectors:

- For heating and cooling, RED III sets a 49% indicative target for renewable energy share in buildings in 2030 as well as a binding annual increase of +1.1% from 2026 to 2030.
- For industry, the directive requires an annual increase for the use of renewable energy of +1.6% as well as a 42% share for renewable hydrogen used by industry in 2030.
- In transport, member states can choose between a binding target of a 14.5% reduction of greenhouse gas intensity from the use of renewables by 2030 or a binding share of 29% of renewables within final energy consumption in transport.

The same renewable energy directive sets certain standards for governance of environmental sustainability of bioenergy used in the EU, and provides tools that can be used to limit or minimize risks to ecosystems related to biomass for bioenergy sourcing. This attempt comes with the tool of biomass for energy certification for sustainability criteria. Biomass plantations grown as agricultural crops are “agricultural plantations” and not considered a forest. In majority of cases biomass supplied form such “agricultural plantations” is considered sustainable, taking into account that they are not established on peatlands, grasslands with high biodiversity and not on former forest land.

5.1.2 Coherence with environmental and climate policies

The EU Biodiversity Strategy for 2030 (COM/2020/380), places an important objective for afforestation in the EU and also calls for legislative instruments to restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters. To minimize the risks of unintended impacts on biodiversity, afforestation interventions should be addressed in foreseen actions of the EU Biodiversity Strategy for 2030 including appropriate safeguards and guidelines to promote ecologically and economically sound interventions. Such biodiversity and environmental aspects are considered when establishing NutriBiomass4LIFE poplar plantations on agricultural land.

A risk exists of a potential mismatch between policy signals: RED stimulates bioenergy demand by economic operators (and forest bioenergy policies by counting forest bioenergy towards national renewable energy target), while LULUCF disincentivises countries to harvest beyond certain limits.

Biomass plantation establishing on marginal lands are fully coherent with EU environmental and climate policies. Such biomass plantations are much richer in biodiversity than any other cropland. Even comparing to grasslands, such poplar plantations on agricultural land are not less biodiverse than grasslands and in many cases can provide even higher biodiversity. In terms of climate change

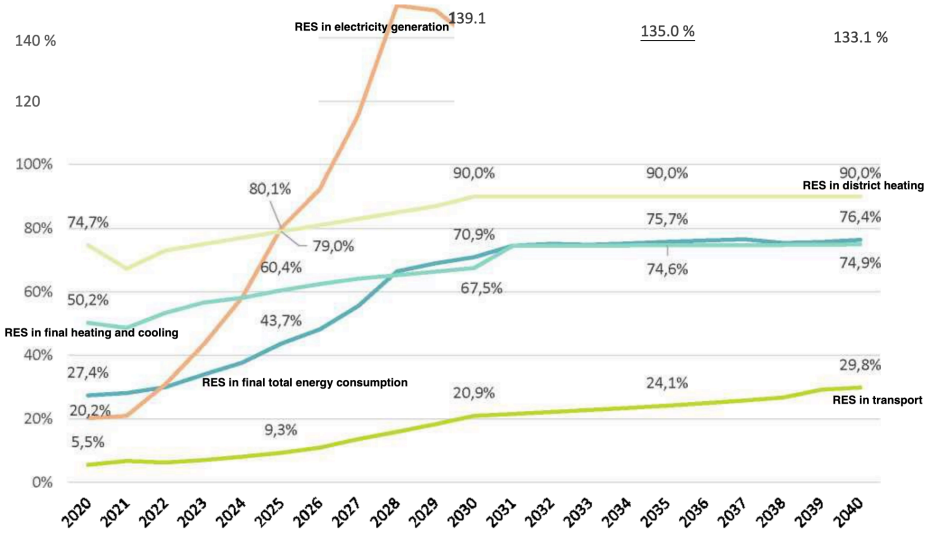
mitigation, NutriBiomass4LIFE poplar plantations are probably the most efficient carbon removal tool among all other agricultural practices. Biomass energy production from NutroBiomass4LIFE poplar plantations with the target to maximize carbon removal through extension of rotation periods and sourcing biomass according cascading wood use principles, sets the stage for plantation biomass usage for bioenergy on forest biomass usage principles: plantation biomass energy to be produced from thinnings and final harvesting residues.

5.2 Coherence with national policies

In Lithuania in 2022 renewable energy in final energy consumption increased by +1,5% and totalled 29,6% comparing to 28,1% in 2021. In Lithuania solid biomass has much higher share in total renewable energy mix than in total EU and has holds 78% share (2021). In 2022, in Lithuania wood fuel consumption declined almost by 9,5% which was the consequence of decline in wood biomass usage in CHPs, district heating and industrial boilers.

Biomass in Lithuania plays a key role in renewable energy production. In 2023 renewed National energy and climate plan foresees that 90% of the district heating sector will remain based on biomass (RES) – this includes a biomass share in municipal waste incinerated.

Picture 5-2. Targeted share of RES in gross final energy consumption and relevant sectors (NECP of Lithuania)



In the district heating system, several major changes are projected in the NECP of Lithuania. Vilnius CHP plant to be fully operational in 2023 (actually delayed to 2024) which will have heat production capacity of 240 MW (approximately 60 MW for the waste unit and around 180 MW for biomass). By 2030, new and upgrades of existing district heating installations of around 190 MW are expected.

It is expected that in short term biomass consumption for district heating will increase due to engagement of Vilnius CHP but in long term district heating production will decrease – by 11.3 % and 21.4 % in 2030 and 2040 respectively. This decrease is expected due to energy efficiency improvement measures (renovation of buildings, increasing consumer awareness, etc.) and efficiency gains in energy production.

The provisions of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources on sustainability and greenhouse set stricter sustainability requirement for biomass usage in energy sector. From 1 May 2023, the Renewable Energy Act of Lithuania introduced the requirement for all market participants in the Lithuanian energy resources market to use only biomass that meets sustainability requirements when using biomass in installations for the production of electricity, heat and/or cooling with a total rated thermal input of 20 MW or more (according RED III it will be changed to 5 MW and more input). In addition to voluntary certification schemes for biomass, which are recognized by the European Commission, voluntary national scheme has been assigned to BALTPOOL, an energy exchange operator while selling biomass through the energy exchange.

All biomass supplied from NutriBiomass4LIFE plantations meet sustainability criteria of voluntary national scheme. In addition, in 2023, all NutriBiomass4LIFE plantations were certified for sustainable forest management under Forest Stewardship Council® (FSC®) certification requirements. It is assumed that FSC® certified biomass supplied for renewable energy production is in full compliance of sustainability criteria of voluntary national sustainability certification scheme.

Conclusions

The key lessons we learned from NutriBiomass4LIFE project interaction with policies and measures:

- Circular economy model developed by NutriBiomass4LIFE is composed of multiple actions in coherence with multiple EU and national policies, specific measures, and legal regulations.
- Poplars established on agricultural land as perennial short rotation agricultural crop (SRC) and grown for longer rotation (e.g. up to 20 years) are probably the best tool for biodiversity increase, soil health and carbon removal in agriculture. The problems is that implementation of the EU policies, their measures and tools leave short rotation biomass coppice in some kind of “a grey zone”. From the point of practical implementation of agricultural policies such crops are often seen more like forestry measure, while from the forestry policy implementation it is not considered a forestry instrument. This problem is reflected in the EU policies and their implementation measures: policies outline support for afforestation measure and agroforestry in agriculture, while tree growing on agricultural land as an exclusive activity (short rotation coppice / short rotation forestry) is left without a clear role and direction. **Short rotation coppice as agricultural activity could find their role in agroforestry systems to benefit from EU policy implementation.**
- Establishment of polars can be incentivised by benefitting from their carbon removal potential. Establishment of poplars has clearly significant carbon removal footprint and complies with carbon farming initiative, but benefitting from Carbon Removal Certification framework will depend on developed carbon removal methodologies, which already are posing certain uncertainties: whether short rotation trees on agricultural land will be considered forestry or agricultural activity. From the forestry point, the problems may arise due to the definition of “monoculture forest”. There are intentions to exclude monoculture forests (by default) due to lower biodiversity compared to mixed forest establishments, but not comparing to baseline of lower biodiversity monoculture agriculture. From forestry point, poplars can be considered a “monoculture forestry” (although this is an agricultural activity) as definition usually narrowly looks at the composition of number of tree species, not at a whole ecosystem mix. Comparing

to other cropping systems in agriculture, poplars as agricultural crops are one of the most biodiverse agricultural ecosystems, but policy instruments in agriculture usually address agroforestry solely. **Short rotation coppice as agricultural activity could be included into Carbon Removal Certification framework under agroforestry methodologies.**

- Implementation of NutriBiomass4LIFE project revealed strong incoherence among Circular economy and Waste policies on one hand and Energy policy on the other hand. The Waste Framework Directive (2008/98/EC) sets a waste hierarchy requiring to prioritise sewage sludge reusage in agriculture / forestry and nutrient recovery over energy recovery or disposal. Contrary, under EU energy policy, via RED, sewage sludge is attributed to renewable energy source and can contribute to renewable energy in two ways: production of biogas (biomethane) through anaerobic digestion and heat/power production through incineration. Although RED II /RED III prohibits development of support schemes for bioenergy production that disregard principle of the circular economy and the principle of the waste hierarchy established in Directive 2008/98/EC, EU Emission Trading Scheme indirectly subsidizes sewage sludge incineration without nutrient recovery over reusage of sewage sludge on land or nutrient recovery. Typically, sewage sludge is incinerated without nutrient recovery either at waste incineration plants or cement plants, which are subjects to EU Emission Trading Scheme and can save 55-100 eur / dmt of DMWTSD incinerated due not paying for CO2 emissions.
- Even higher financial benefits (profit) can be achieved by cement production plants as cement producers receive free emission allowances, therefore they are able to sell saved emission allowances at a profit, i.e. double the profit. Even on 25 April 2023 the Council adopted the reform of EU Emission trading System with gradual phase out of free emission allowances from 2026 to 2034. The reform foresees that issue of free emission allowances to all ETS sectors, which currently receive free emission allowances, will be gradually (with exception of cement and fertilizer industries) phased down starting from 2026, making sewage sludge incineration at cement plants still financially attractive option.
- During the last three years DMWTSD from all Lithuania's wastewater treatment plants (except delivered to NutriBiomass4LIFE project) moved for incineration at Akmene cement plant. It is estimated that about 20 thousand tons of DMWTSD will be incinerated at cement production plant annual till changes in policies will eliminate financial benefits for incineration. This may be achieved, under the following policy changes (1) **when EU Commission will set obligatory targets for member states for nutrient (nitrogen and phosphorus) recovery from sewage sludge as defined in the new Urban Waste-Water Treatment directive adopted by the Council in October, 2023 and (2) when policies, direct and indirect subsidies will be weight against climate impact results, i.e. removing sewage sludge incineration without nutrient recovery (i. e. co-incineration with other types of waste) from RED III list of renewable resources for renewable energy production.**
- The Waste Framework Directive (2008/98/EC) sets a waste management hierarchy, but there is "a grey zone" which puts significant share of waste without a clear final management destination. E.g. share of "processed" sewage sludge still accounts about 35% of total sludge management in Lithuania – this sludge is typically goes to landfills under different category name – "reclamation of landfills", therefore officially not considered as landfilling. According to official records Lithuania is one of the leaders for composting of different types of waste in the EU, but the problem that this composting does not have anything with nutrient recovery

and circular economy – simply composted waste goes for landfilling. **There is a need to revise categories of waste management and everything that goes to landfills (e.g. after composting) to be attributed to landfilling.**

- Return of biomass ashes to the soil is the most sustainable utilization of biomass ashes as minerals in biomass ashes that were extracted by trees from soil are returned to soil. The quality of biomass ashes is not a problematic in case all regulations are followed by biomass energy producers and wood waste is not mixed into raw wood chips. Currently in Lithuania only about 5% of biomass ashes are used for fertilization purposes. The key limitation on usage of biomass ashes for fertilization purposes is excessive national regulation, which makes fertilization with biomass ashes financially unattractive. **There is a need to revise old national regulation to improve utilization of liming potential (increase application rates based on scientific recommendations) of biomass ashes and reducing administrative barriers.**