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

Land mobilization report for NutriBiomass4LIFE circular economy model

WEB Report prepared by

UAB “Pageldynių plantacija”

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Preface

The purpose of this document is to provide insights on land mobilization during implementation of the project NutriBiomass4LIFE. Over 4 years of implementation of the project 175 land plots were mobilized for the establishment 900 ha of new biomass plantations for Nutribiomass4LIFE project purposes. Additionally, 1550 ha already existing biomass plantations were mobilized for municipal waste-water treatment sludge and biomass ashes recycling.

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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Table of Contents

I. LIST OF TABLES AND FIGURES I

II. ABOUT THE NUTRIBIOMASS4LIFE PROJECT 1

III. LIST OF ABBREVIATIONS AND PARTNER ACRONYMS 2

1. INTRODUCTION 3

1.1. PURPOSE AND AIM 3
1.2. STRUCTURE 3

1. LAND MOBILIZATION FOR BIOMASS PLANTATIONS ESTABLISHMENT 4

2. MOBILIZATION OF EXISTING BIOMASS PLANTATIONS 7

2.1 MOBILIZATION OF EXISTING BIOMASS PLANTATIONS BEFORE IMPLEMENTATION OF THE PROJECT 8

2.2 MOBILIZATION OF EXISTING BIOMASS PLANTATIONS DURING IMPLEMENTATION OF THE PROJECT 8

2.3 ADDITIONAL AVAILABILITY OF BIOMASS PLANTATIONS FOR CE MODEL 9

3. CARBON FOOTPRINT 9

4. CONTINUATION 10

4.1 MOBILIZATION OF AGRICULTURAL LAND FOR BIOMASS PLANTATION ESTABLISHMENT 10

4.2 MOBILIZATION OF EXISTING BIOMASS PLANTATIONS IN OTHER REGIONS OF LITHUANIA 11

5. CONCLUSIONS 12

6. APPENDIXES 13

I. List of Tables and Figures

Picture 1-1. Annual mobilization of net land area for NutriBiomass4LIFE biomass plantation establishment, based on established land area 4
Picture 1-2. Land mobilization radius for NutriBiomass4LIFE plantation establishment..... 5
Picture 1-3. Land mobilized for Nutibiomass4LIFE biomass plantation establishment by districts 5
Picture 1-4. Land mobilized for Nutibiomass4LIFE biomass plantation establishment by usage..... 6
Picture 1-5. Land mobilized for NutriBiomass4LIFE biomass plantations establishment by soil type 7
Picture 2-1. Mobilization radius of existing biomass plantation for NutriBiomass4LIFE project..... 8
Picture 2.3-1. Additional 980 ha of existing biomass plantation available for CE model..... 9
Table 3-1. Nutribiomass4LIFE carbon footprint from land mobilization..... 10
Picture 4.1-1. Land mobilized in 2023-2024 for Nutibiomass4LIFE continuation by districts 11
Picture 4.1-2. Lands mobilized for NutriBiomass4LIFE continuation in 2023-2024 by soil type 11

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
A1	land mobilization actions of the project NutriBiomass4LIFE
AGROLAB	Lithuanian Research Centre for Agriculture and Forestry
CCE	Calcium carbon equivalence
ANC	area facing natural constraints
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
EU	European Union
FSC	Forest Stewardship council
ha	hectare, 1 ha = 1000 square meteres
kg	kilogram, 1 t = 1000 kg
km	kilometre, 1 km = 1000 m
KK	UAB "Kiritimų katilinė"
LAND 20-2001	Lithuanian regulation on sewage sludge application for fertilization purposes
LMSA	Forest and landowner's association of Lithuania
MWTS	Municipal waste-water treatment sludge digestate
PP	UAB "Pageldyniu plantacija"
PE	UAB "Kirtimu katiline"
r. or reg.	administrative district
sen.	regional units of administrative district
t	metric ton, 1 t = 1000 kg
VV	UAB "Vilniaus vandenys"

1. Introduction

1.1. Purpose and Aim

The purpose of this document is to reveal results of land mobilization actions (A1) during implementation of the project NutriBiomass4LIFE.

1.2. Structure

The document is divided into five main chapters:

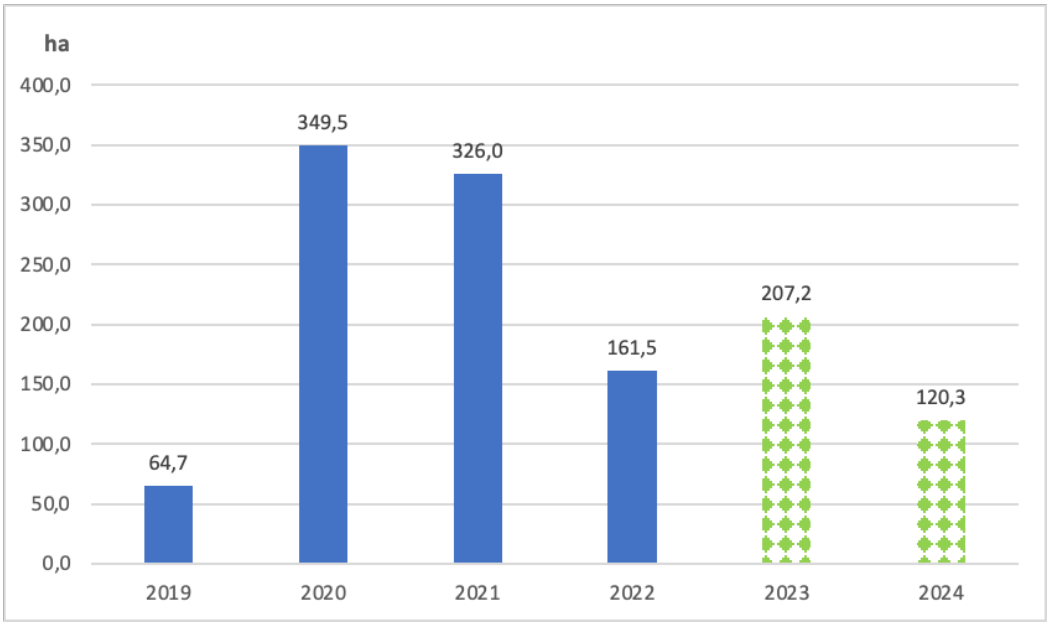
- Chapter 1 “Land mobilization for biomass plantations establishment” provides information of land plots mobilized for NutriBiomass4LIFE biomass plantation establishment.
- Chapter 2 “Mobilization of existing biomass plantations” provides information on already existing biomass plantations mobilized for NutriBiomass4LIFE project.
- Chapter 3 “Carbon footprint” discloses CO2 footprint of land mobilization activities during implementation of NutriBiomass4LIFE project.
- Chapter 4 “Continuation” provides information on land mobilized for biomass plantation establishment in 2023 and 2024 as a project continuation activities and already existing biomass plantations mobilized in other regions of Lithuania to ensure project replication activities.
- Chapter 5 “Conclusions” provides the major findings from land mobilization actions (A1) of the project NutriBiomass4LIFE.
- Appendix provides information on all land plots mobilized during implementation of the project and fact sheets on all selected land plots for biomass plantation establishment: location (with google maps link), size of land plot, usage areas, potential area for biomass plantation establishment, fertility value, restrictions, maps of land plot location, usage restrictions, type of soil, soil texture of arable layer and base layer.

1. Land mobilization for biomass plantations establishment

During implementation of NutriBiomass4LIFE project 901,7 ha of poplar plantations were established on newly mobilized agricultural land. For this purpose, during 2018-2022 total 197 new land plots with combined 1228 ha area was engaged on which 901,7 ha ha of poplar plantations were established. The efficient poplar establishment area totalled 73,4% of overall area of mobilized land plots. Excluding traditional forest land on mobilized land plots, efficient poplar establishment area totalled 80%. This poplar not used land was utilized to set aside for environmental purposes while certifying poplar plantations for sustainable forest management (FSC) – to maintain original land purpose and biodiversity, which prevailed before establishment of biomass plantations. .

In the Picture 1-1. annual mobilized net areas of land are presented, based on poplar planted areas that year (2019-2022). Additionally, land mobilization data for year 2023-2024 is provided, which was/will be planted as a project continuation action and more widely presented in the chapter "Continuation"

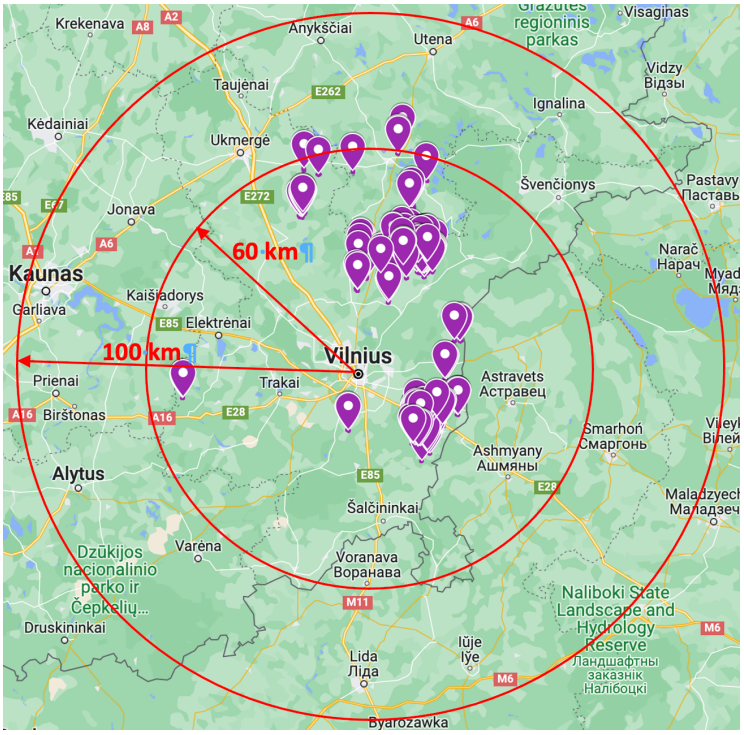
Picture 1-1. Annual mobilization of net land area for NutriBiomass4LIFE biomass plantation establishment, based on established land area



The purpose of land mobilization was to ensure biomass plantation availability for nutrient rich waste recycling at reasonable proximity from nutrient waste producer – Vilnius waste-water treatment plant and Kirtimų katilinė biomass boiler. The target area was 60 km radius from Vilnius city and with possibility to expand this area till 100 km radius.

All the NutriBiomass4LIFE lands for biomass plantations were successfully mobilized within 60 km radius from Vionius city. The average distancce of all estanlished Nutribiomass4LIFE plantations is 37 km from Vilnius.

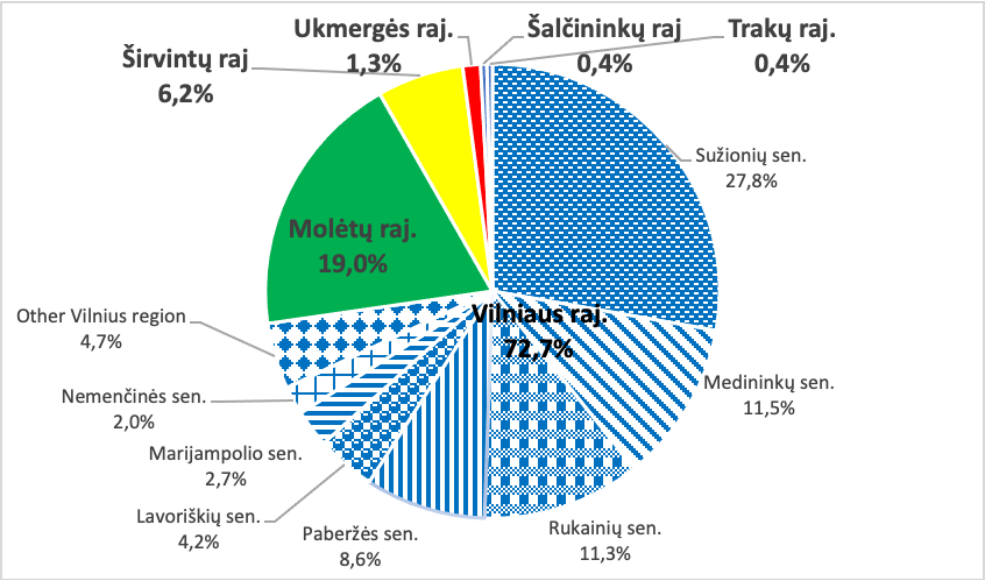
Picture 1-2. Land mobilization radius for NutriBiomass4LIFE plantation establishment



As it can be seen from Picture 1-2, land for NutriBiomass4LIFE plantations was mobilized in certain clusters – close proximity from each other, which provides efficiency in terms of management and nutrient recycling.

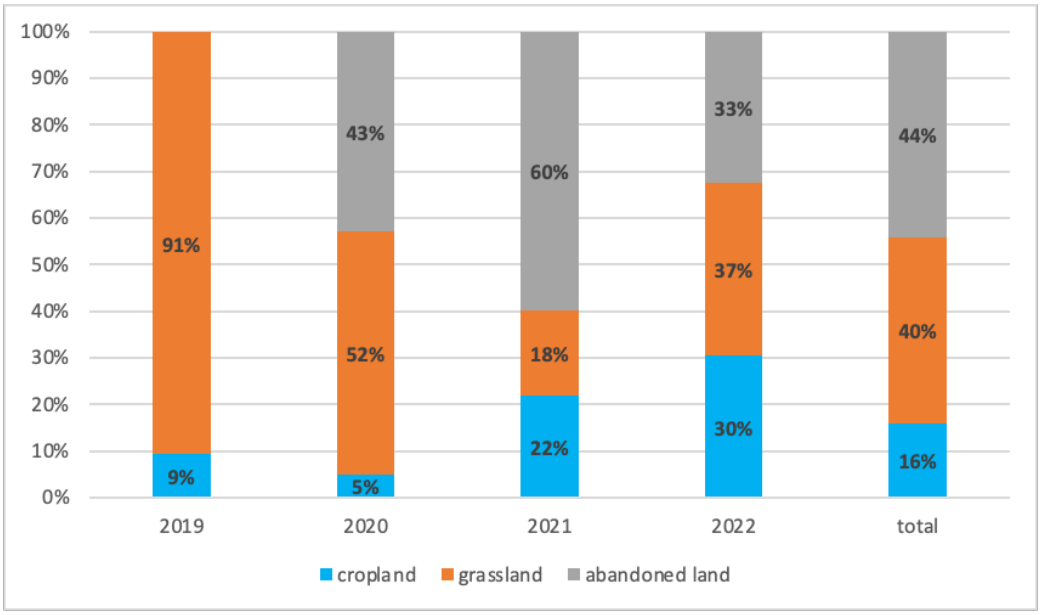
The majority of lands for biomass plantations were mobilized in Vilnius district (72,7%), Molėtai district (19%) and Širvintai district (6,2%). In Vilnius district the leading administrative units with lands mobilized were Sužionių sen. (28%), Medininkų sen. (12%) , Rukainių sen. (11%) and Paberžės sen. (9%).

Picture 1-3. Land mobilized for Nutibiomass4LIFE biomass plantation establishment by districts



Targeted areas for NutriBiomass4LIFE for biomass plantation establishment have been located in the EU defined areas facing significant natural constraints (ANC), meaning, that traditional agricultural activities have not been popular due to low fertility of land. Over the last thirty years this led to the situation that Vilnius and surrounding regions have accumulated significant volumes land areas which were abandoned and not used in agriculture. This was well revealed in mobilized land portfolio, that was used for NutriBiomass4LIFE plantation establishment. Over the project period (2019-2022) the majority of mobilized agricultural lands can be characterised as abandoned agricultural lands (44%) and grasslands (40%). Croplands, planted with NutriBiomass4LIFE poplar plantations, contributed only to 16% of total land area mobilized.

Picture 1-4. Land mobilized for Nutibiomass4LIFE biomass plantation establishment by usage



While mobilizing lands, particular attention was paid to soil types. It is evident that establishment of NutriBiomass4LIFE biomass plantations in the regions that were defined as areas with significant natural constraints prescribed that we had to deal with specific types of soils which can be characterised by their low fertility.

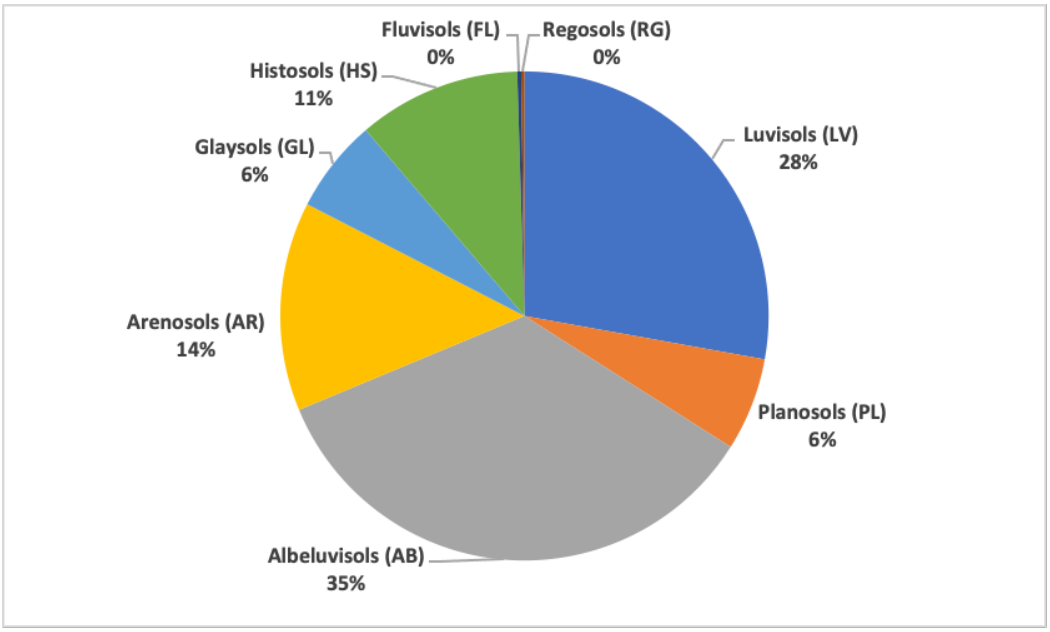
The soils types in NutriBiomass4LIFE Target area are very much diverse – especially on larger sites we have different soil types present.

The majority of soil types mobilized for NutriBiomass4LIFE poplar plantation establishment included Albeluvisosl (AB) – 35 %, and Luvisols (LV) – 28%. Luvisols (LV) are the most fertile soil type in the ANC areas and are followed by Albeluvisosl (AB).

Poplar establishment on organic (Histosols (HS)) were risky due to high nutrient imbalance and increased autumn frost risks. Dry sandy soils (Arenosols (AS)) also became riskier for poplar establishment and growth, because increasing repetition of big droughts during vegetation season significantly influenced poplar growth, especially in the early stages while developing root systems. Therefore, we tried to limit mobilization of such soils as Histosols (HS) and Arenosols (AS), nevertheless

in the portfolio of land mobilised for NutrioBiomass4LIFE plantation establishment, Arenosols (AS) total 14% and Histosols total 11%.

Picture 1-5. Land mobilized for NutriBiomass4LIFE biomass plantations establishment by soil type



One more important characteristic of the lands mobilized for NutriBiomass4LIFE plantation establishments is the size of land plots. The size defines efficiency of poplar plantation establishment and management and nutrient rich waste recycling. Therefore, as a land plot is larger – it can be utilized more efficiently. Total 197 new land plots with combined 1228 ha area was engaged on which 901,7 ha of poplar plantations were established, meaning that the average poplar established land plot totalled 4,58 ha. The largest land plot mobilized for poplar plantation establishment was 92,41 ha on which 79,7 ha of poplars were established.

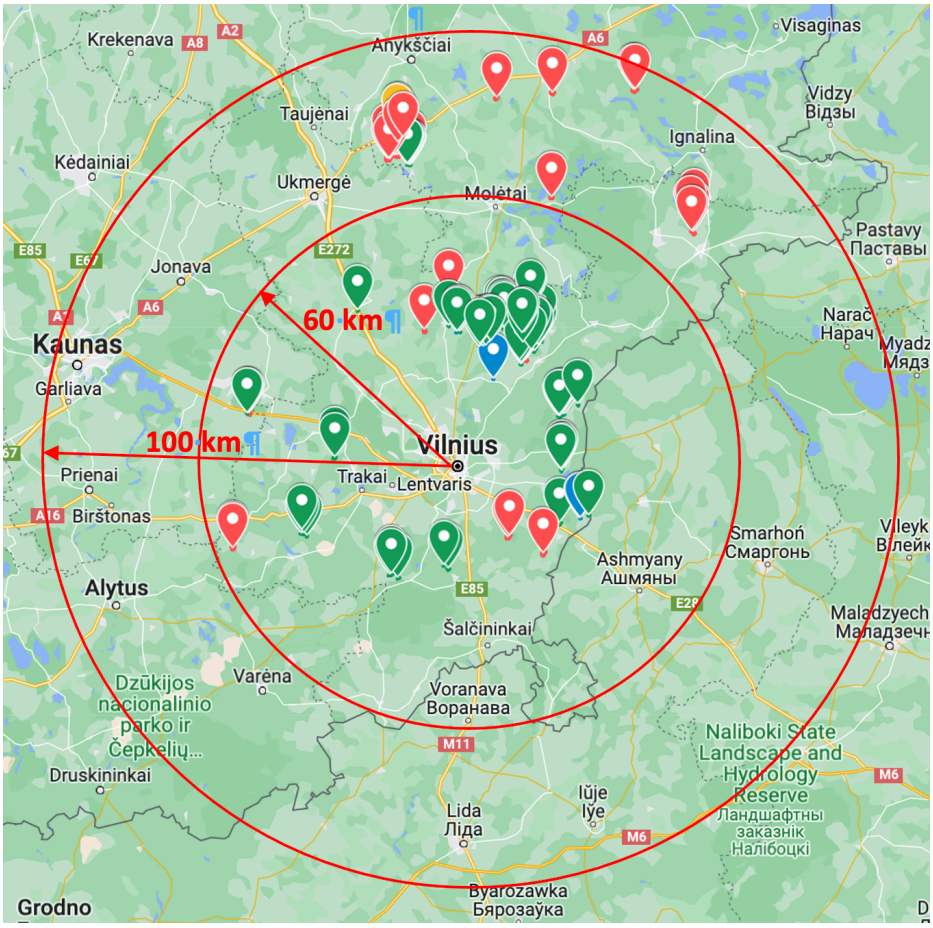
Some of mobilized land plots could be consolidated into larger settings, as they were bordering with others. We can consolidate land plots to 108 sets, therefore the average poplar established land set plot totalled 8,34 ha. The largest land plot set mobilized for poplar plantation establishment was 127,4 ha on which 105,8 ha of poplars were established.

2. Mobilization of existing biomass plantations

In addition to land plots mobilized for NutriBiomass4LIFE plantation establishment, 900 ha of existing biomass plantations were provided by PP before implementation of the project.

During implementation of the project we faced the problem of delayed environmental permitting due to ambiguous interpretation of national sludge legislation (LAND 20-2001), therefore till the legislation was amended additional existing biomass plantations were mobilized for the project to ensure smooth nutrient rich waste recycling by expanding the land mobilization distance from Vilnius waste water treatment plant from 60 to 100 km.

Picture 2-1. Mobilization radius of existing biomass plantation for NutriBiomass4LIFE project



2.1 Mobilization of existing biomass plantations before implementation of the project

Before the project PP already owned and managed 1093 ha of land area within 60 km distance from Vilnius established with biomass plantations: 832 ha in Vilnius district, 160 ha in Trakai district, 24 ha in Širvintai district, 28 ha in Kaišiadorys district and 49 ha in Elektrėnai district. Out of this total area 60 ha were conventional forest, which could not be used for nutrient recycling, Therefore, the remaining 1033 ha were mobilized for nutrient rich waste recycling (287 ha of hybrid aspen and 746 ha of poplar plantations), out which 900 ha, after subtracting safety zones, were included in the NutriBiomass4LIFE project (Annex table 6.2).

2.2 Mobilization of existing biomass plantations during implementation of the project

During implementation of the project PP faced the challenge of delayed environmental permitting due to ambiguous interpretation of national sludge legislation, therefore till the legislation was amended additional 680 ha of land with 756 ha of existing biomass plantations were mobilized for the project to ensure smooth nutrient rich waste recycling by expanding the land mobilization distance from Vilnius waste-water treatment plant from 60 to 100 km (red marks of map area in picture 2-1 spotted between 60 to 100 km radius from Vilnius). In this expanded area established biomass plantations were

mobilized in Anykščiai and Švečionys districts, where MWTS and biomass ashes were used for recycling during NutriBiomass4LIFE project implementation.

Information on these additionally mobilized 980 ha plantations for NutriBiomass4LIFE CE model is presented in Annex table 6.3.

2.3 Additional availability of biomass plantations for CE model

While implementing the project, additional availability of 980 ha of existing biomass plantations (hybrid aspen) within 60 km radius from Vilnius (Annex table 6.4) was arranged as biomass plantation mobilization risk reduction measure. These plantations may be used for nutrient rich recycling activities continuation therefore these biomass plantations have not been included in CO2 sequestration calculations for NutriBiomass4LIFE CE model.

Absolute majority of these additional plantations are located in the South (Šalčininkai district) and South West (Trakai district) of Vilnius (picture 2.3-1).

Picture 2.3-1. Additional 980 ha of existing biomass plantation available for CE model



3. Carbon footprint

Carbon footprint of land mobilization action (A.1) was calculated based on car fuel consumption, while exclusively travelling to investigate potential sites for NutriBiomass4LIFE plantations establishment.

Other CO2 emissions, related to travelling to investigate potential sites for NutriBiomass4LIFE plantations establishment combined with other project actions, are included into carbon footprint of other actions.

CO2 negative emissions (sequestration) from mobilized biomass plantations during NutriBiomass4LIFE project are recorded under “Biomass plantation establishment” action (B1) carbon footprint.

It is estimated that carbon footprint from land mobilization during NutriBiomass4LIFE project implementation **equalled to 4,1 tCO2.**

Table 3-1. Nutribiomass4LIFE carbon footprint from land mobilization

items	fuel CO2 footprint, kgCO2/l	fuel consumption, l/100km	travel distance, km	CO2 footprint, t CO2
Visiting land plots with petrol cars	2,3	8	19882	3,7
Visiting land plots with diesel cars	2,7	15	1180	0,5
				4,1

4. Continuation

Land mobilization for nutrient rich waste recycling continuation is important to ensure project continuation and replication activities.

After national sludge directive (LAND20-2001) was amended in 2021 by decreasing maximum allowed municipal waste-water treatment sludge recycling in biomass plantation rate to 11 t/ha, consequently, to recycle 9000 t of MWTS per year biomass plantation area has to be increased from planned 1800 ha to 2454 ha. This means that even to recycle 100% of MWTS of Vilnius city, we still need additional biomass plantations available for nutrient rich waste recycling.

In addition to that, land mobilization for new biomass plantations establishment and mobilization of existing plantations is needed in other regions of Lithuania to replicate the developed NutriBiomass4LIFE circular economy model.

To continue activities and to replicate the model to other cities/regions in Lithuania we are setting the following plant for land mobilization activities:

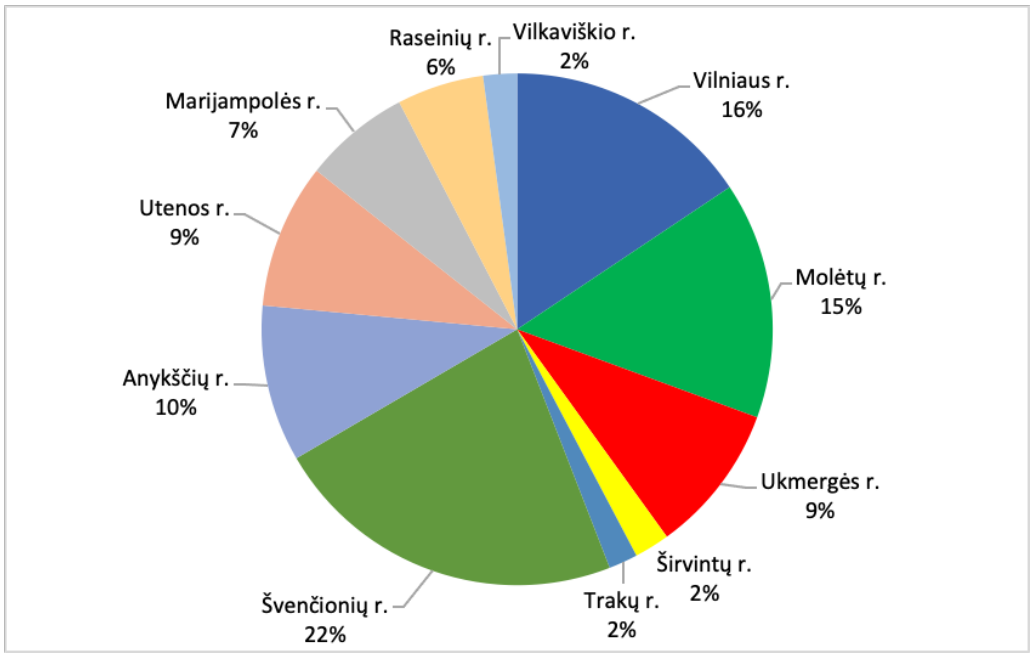
1. In the next ten years each year to mobilize 200-300 ha on agricultural land for biomass plantations establishment which can be used for nutrient rich waste recycling.
2. In one year after completion of NutriBiomass4LIFE project to complete mobilization of existing biomass plantations in other regions of Lithuania.

4.1 Mobilization of agricultural land for biomass plantation establishment

Land mobilization actions of NutriBiomass4LIFE project (A1) were completed in the middle of 2020, as we reached project goal for new biomass plantations establishment – 900 ha.

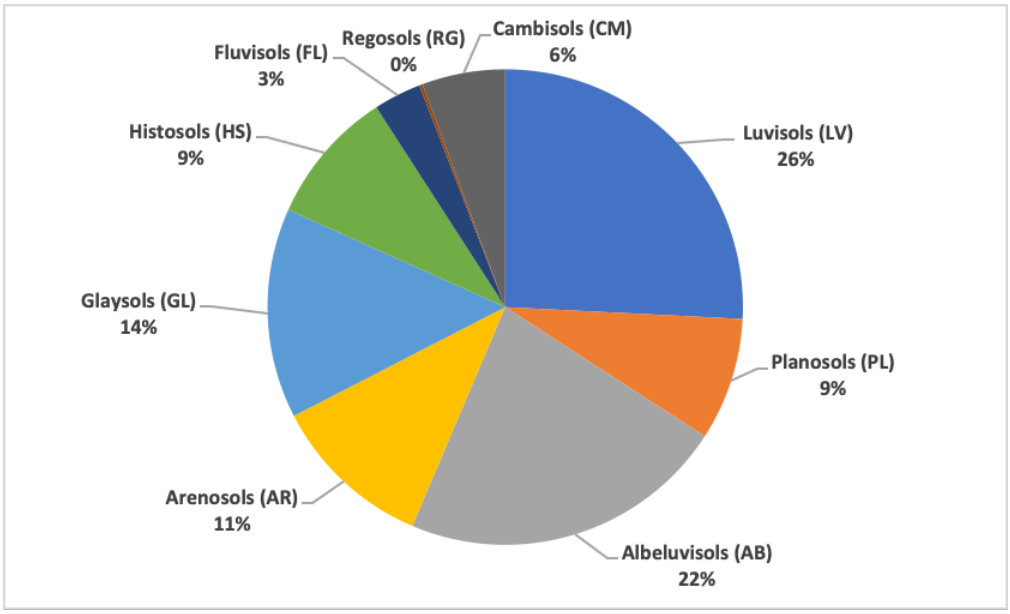
After completion of the project scope, land mobilization actions were continued as project continuation actions. (Annex table 6.5) Post project mobilization of land already was expanded in other regions of Lithuania. Besides mobilization of land in in Vilnius districct (51,2 ha), Molėtai districct (49 ha), Ukmergė districct (31 ha), Širvintai districct (7,3 ha) and Trakai districct (6 ha), land for biomass plantations establishment was also mobilized in Švenčionys districct (73,7 ha), Anykščiai districct (32,4 ha), Utena districct (30,0 ha), Marijampolė districct (22,0 ha), Raseiniai districct (18,0 ha) and Vilkaviškis districct (7,0 ha).

Picture 4.1-1. Land mobilized in 2023-2024 for Nutibiomass4LIFE continuation by districts



Soil types of land, mobilized for continuation of NutriBiomass4LIFE model in 2023-2024, also were characterized by great variation with prevailing Luvisols (LV) – 26% and Albeluvisols (AB) – 22%.

Picture 4.1-2. Lands mobilized for NutriBiomass4LIFE continuation in 2023-2024 by soil type



4.2 Mobilization of existing biomass plantations in other regions of Lithuania

Multiplication of the project in other parts of Lithuania, besides mobilization of land and establishment of new biomass plantations requires mobilization of already existing biomass plantations which according to national legislation can be involved in the recycling of nutrient rich waste.

In 2023 we mobilized already existing 554 ha of biomass (hybrid aspen) plantations (Annex table 6.6) for continuation of NutriBiomass4LIFE activities in other districts of Lithuania – Kelmė district (55,00

ha), Pagėgiai district (30,85 ha), Plungė district (79,26 ha), Raseiniai district (10,70 ha), Rokiškis district (54,41 ha), Šilutė district (167,02 ha), Tauragė district (19,07 ha), Telšiai district (41,21 ha), Utena district (40,15 ha), Vilkaviškis district (33,95 ha) and Zarasai district (22,11 ha).

5. Conclusions

Project targets to mobilize sufficient land for NutriBiomass4LIFE CE economy model were completed in full.

Mobilization of agricultural land for biomass plantation establishment for engaging them in CE activities for nutrient rich waste recycling has been and will continue to be a challenging activity. To ensure MWTS recycling of large cities large areas with over a thousand of ha of biomass plantations are needed. The task is much easier when we are talking of building similar CE models for smaller cities, when 100-200 ha of land is needed to be engaged.

The key lessons we learned from land mobilization for biomass plantation establishment for CE model activities:

- Mobilization of land for biomass plantation establishment is a key to replicate NutriBiomass4LIFE CE model.
- To mobilize land for biomass plantation establishment is getting harder as EU policy is contradictory and national policy implemented by the latest government even become unfavourable. For landowners and farmers still there is a little rationale to establish and grow trees even on low fertility agricultural land which is not economically feasible for conventional agriculture.
- More than half a of existing biomass plantations in Lithuania has been already mobilized for CE model, therefore further expansions of areas for nutrient recycling is dependent on possibilities to mobilize agricultural land fir new biomass plantation establishment.
- While mobilizing land for poplar biomass plantation establishment it is important to avoid such soils as Histosols (HS) and Arenosols (AS).
- Good access to land plot is essential to ensure nutrient rich waste recycling – there should be good road to heavy load trucks to transport nutrient rich waste till the land plot.
- Size of land plot is very important for efficiency of CE model, but experience shows that average size of land plots mobilized for biomass plantations establishment is decreasing.
- Abandoned and not used in agriculture lands is still an option to expand biomass plantations more rapidly.

6. Appendixes