

LIFE Environment and Resource Efficiency project

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

NutriBiomass4LIFE

LIFE17 ENV/LT/000310

UAB „KIRTIMŲ KATILINĖ“ · Vilniaus vandenys · Pageldynių plantacija · SLU · LIETUVOS AGRARINIŲ IR MIŠKŲ MOKSLŲ CENTRAS

1. Objectives

The objective of the Nutribiomass4LIFE project is to create and demonstrate full scale self-sustainable closed loop circular economy model for large cities' nutrient rich waste recycling.

Within Nutribiomass4LIFE circular economy model dried municipal wastewater treatment sludge digestate and biomass ashes are recycled into renewable energy for city's needs via environmentally friendly biomass plantation filter. The circular economy model is based upon Vilnius city, the capital of Lithuania (550 thousand population).

The specific objectives of the project:

- 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 CO_2 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.



2. Project data.

NutriBiomass4LIFE was a project financed by the LIFE programme (the EU's funding instrument for the environment and climate action). The total allocated budget of the project was €4,031,237, of which €2,418,140 was EU financial contribution, €925,444 co-funding by the Ministry of Environment of Republic of Lithuania and €74,900 co-funding Swedish Energy Agency (Energimyndigheten). The project lasted 63 moths from July, 2018 to September 2023. The project was implemented by the consortium which was made up for six partners: UAB "Pageldynių plantacija", UAB "Vilniaus vandenys", UAB "Kirtimų katilinė" , Lithuanian Research Centre for Agriculture and Forestry, Forest and Land Owners Association of Lithuania and Swedish university of agricultural sciences.

Project partners:

Pageldynių plantacija

UAB "Pageldynių plantacija" was a coordinator of the project. UAB "Pageldynių plantacija" is a private SME which invests into novel biomass plantation establishment and management.

UAB "Pageldynių plantacija" was responsible for NutriBiomass4LIFE circular economy model development and demonstration, was involved in agricultural land mobilization, environmental permitting, biomass plantation establishment, and production of energy biomass.

Vilniaus vandenys

UAB "Vilniaus vandenys" is the largest water supply company in Lithuania and operates water supply and wastewater networks in Vilnius City and neighbouring regions.

UAB "Vilniaus vandenys" was responsible for dry municipal water treatment sludge digestate supply to the project and recycling in NutriBiomass4LIFE plantations.

e-energija
UAB „KIRTIMŲ KATILINĖ"

UAB "Kirtimų katilinė" is a private biomass boiler (19,2MW) in Vilnius city that supplies heat to municipal district heating network.

UAB "Kirtimų katilinė" was responsible biomass conversion into heat for Vilnius population and supply of biomass ashes to the project and recycling in NutriBiomass4LIFE plantations.

LIETUVOS AGRARINIŲ IR MIŠKŲ MOKSLŲ CENTRAS

Lithuanian Research Centre for Agriculture and Forestry (LAMMC) a state research institute conducting R&D in the fields of agronomy and forestry, ecology, environmental sciences, biology, biophysics, botany and zoology.

LAMMC was responsible for soil and water sampling, laboratory analysis and monitoring after fertilization with nutrient rich waste, woody biomass, dry municipal water treatment sludge digestate and biomass ashes quality analysis.

Forest and Land Owners Association of Lithuania (LMSA) is the largest national organization representing interest of family forest owners in Lithuania and in the EU.

LMSA was responsible for development and implementation of communication and dissemination tools and actions and was involved in land mobilization for biomass plantation establishment.

SLU

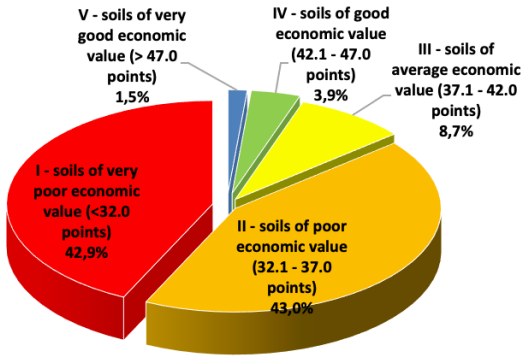
Swedish university of agricultural sciences (SLU) is one of the world's top ten research and educational institutions in plant and animal sciences (CWUR).

The Short rotation Forestry group from the Department of Crop Production Ecology was responsible for modelling of biomass growth, life cycle assessment (LCA), demonstration activities in Sweden.

3. Empowering nutrient rich waste through circularity

According to soil analysis, performed by LAMMC, the absolute majority of biomass plantations included in NutriBiomass4LIFE model were established on poor quality soils, which are not suitable for conventional agriculture. According to the soil productivity index 86% of NutriBiomass4LIFE plantations were established on marginal - very poor or poor productivity soils.

Share of soils according productivity score



Soil analysis revealed that marginal mineral soils of NutriBiomass4LIFE plantations are extremely short of mineral nitrogen – 53% of soils have critically low mineral nitrogen levels and 33% - low nitrogen levels (total 86%). 42% of mineral soils have critically low plant available phosphorus (P_2O_5) levels and 22% are low in plant available phosphorus (P_2O_5) levels (total 64%). 22% of mineral soils have critically low plant available potassium (K_2O) levels and 33% are low in plant available potassium (K_2O) levels (total 55%).

Marginal soils are also higher acidity soils – relatively acidic (pH_{KCl} ≤5,5) soils had 41% share in total NutriBiomass4LIFE mineral soils.

Despite absolute majority of biomass plantations are established on grasslands and abandoned lands, still 78% of the mineral soils are characterized as having very low and low SOC levels.

The project research results show that nutrient rich waste recycling in biomass plantations may increase biomass yield on marginal lands by 12%-20%. This may make tree farming on marginal lands more attractive not only from environmental but form economical point as well.

Nutrient rich waste quality analysis revealed, that the quality of nutrient rich waste is sufficient to ensure usage in circular way – sewage sludge has had rich concentrations of nitrogen (N), which is of primary importance for plant growth on nitrogen deficient soils, phosphorus (P), calcium (Ca) and organic carbon (C_{org}), which is very important for soil health improvement to restore humus content. Correspondingly, biomass ashes are rich in phosphorus (P) and calcium (Ca).

NutriBiomass4LIFE circular economy model offers many benefits to multiple actors through nutrient rich waste circularity.

Farmers / landowners with the help of nutrient rich waste recycling receive possibility to earn additional revenues on marginal lands, where conventional agricultural activities are not rational.

Municipal wastewater treatment plants receive possibility to solve sewage sludge utilization problem in sustainable and less costly way.

Biomass boilers ensure supplies of biomass for energy production and sustainable and less costly utilization of their waste – biomass ashes.

Society benefits from reduced risk of contamination of food chain, lower cost for heat and sewage water supplies, les risk to environment as trees act as phytoremediation filter, greener environment through established trees and substantial CO_2 removals.

4. NutriBiomass4LIFE circular model in action

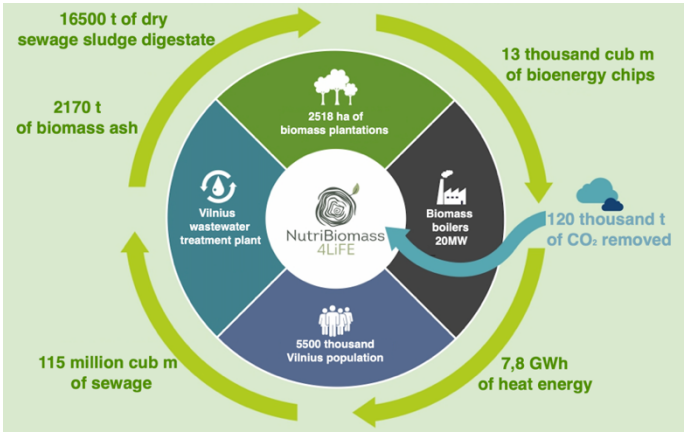


5. Achieved results

The key achieved results of the Nutribiomass4LIFE project are:

- Fully sustainable circular economy model for large city nutrient rich waste recycling in biomass plantations was developed and demonstrated, all of its components proved to be function and operational.

- 1616 ha of existing woody biomass plantations for nutrient rich waste recycling and 902 ha of agricultural land for new poplar plantation establishment were mobilized.



- 902 ha of new poplar plantations were established on marginal and less suitable to agriculture lands within 60 km radius around Vilnius, by planting 1,5 million poplar trees.

- 2518 ha of biomass plantations were certified and managed under sustainable forestry management standards (FSC)

- 16500 dmt of pelleted dried municipal wastewater sludge digestate and 2170 t of biomass ashes were reused for biomass yield improvement within NutriBiomass4LIFE circular economy model.

- The project reused 797 t of total nitrogen (N), 383 t of total phosphorus (P), 101 t of total potassium (K) and 1014 t of calcium (Ca).

- The soil quality (soil organic carbon and nutrient balance) was improved on 1957 ha area within the project area.

- 7,8 GWh of energy biomass were supplied from Nutribiomass4LIFE plantations and converted into heating energy for Vilnius city.

- 119861 tCO_2 were removed by Nutribiomass4LIFE circular economy model during project implementation period.

- 4 green work places were created.

Replication and transfer

Nutribiomass4LIFE circular economy model can be transferred to put nutrient rich waste of large and small cities into full circularity.

When transferring the NutriBiomass4LIFE model it is important to consider national regulation, land availability for biomass plantation establishment, technologies used for wastewater treatment sludge processing and policies.

The EU Commission rights to set obligatory targets for member states for nutrient (nitrogen and phosphorus) recovery defined in the new Urban Waste-Water Treatment directive adopted by the Council in October, 2023 open additional prospects for NutriBiomass4LIFE model replicability and transfer.

6. Efficient carbon removal instrument

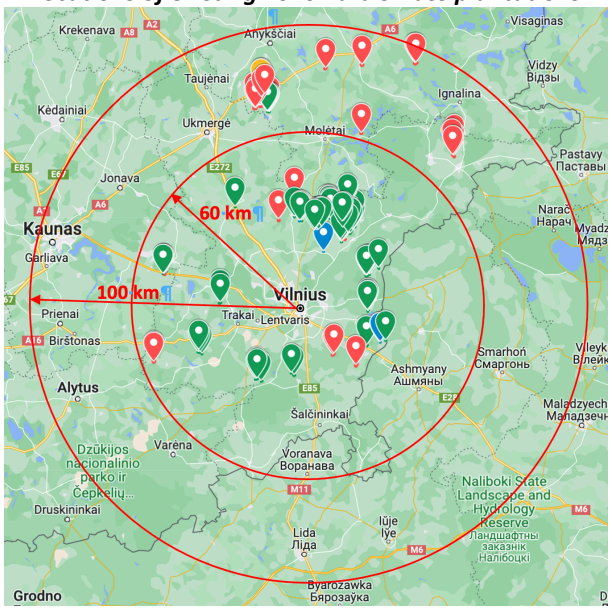
NutriBiomass4LIFE circular economy model proved to be very efficient tool for rapid CO_2 removal in agriculture. 902 ha of newly established biomass plantations during the project executed only 7% their carbon removal and storage capabilities by removing 15,000 tCO_2.

It is estimated that during the next 12 years 902 ha of newly established NutriBiomass4LIFE poplar plantations additionally will remove 210,000 tCO_2 and permanently will store in poplar ecosystem.

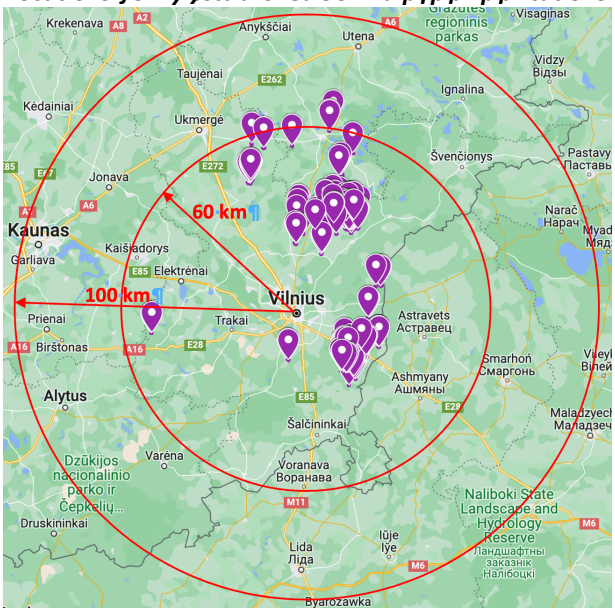
Four-year transformation of 120 ha site into nature-based carbon storage



Locations of existing 1616 ha biomass plantations



Locations of newly established 902 ha poplar plantations





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For more information:

www.nutribiomass.eu