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EU sustainability criteria for energy biomass in the Slovak land law

ABSTRACT: The cultivation of energy biomass in Slovakia is regulated by multiple legal acts, requiring an interdisciplinary approach. Navigating the relevant legal norms can be challenging for biomass growers. The Renewable Energy Directive supports the European Green Deal goals, particularly climate change mitigation and emission reduction, by promoting renewable energy, including sustainably grown biomass on agricultural and forest land. The main objective of this article is to evaluate the transposition of the Directive into Slovak law, especially in relation to the sustainability criteria for biomass cultivation. The cultivation of biomass alone does not guarantee the achievement of the Green Deal's objectives. These can only be fulfilled through properly defined, verified, and respected sustainability criteria. However, EU-level criteria are unlikely to fully reflect the national specificities of all 27 Member States. Therefore, while the EU legislation emphasizes environmental aspects, it also allows Member States to introduce additional sustainability criteria – at least for biomass fuels. Despite this flexibility, the Slovak legislator has transposed the Directive almost

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verbatim, without creating a systematic legal framework for biomass growers and processors. The current legislation requires a unified terminology, harmonized procedures for establishing stands on agricultural and forest land, as well as certainty regarding subsidy mechanisms throughout the entire cultivation period. This article is intended not only to help potential biomass growers navigate the complex legal framework but also to provide some proposals for local and national policymakers.

KEYWORDS: sustainable criteria, energy biomass, land use management, fast-growing plants

Introduction

Renewable energy and sustainable development are key to addressing global climate challenges. Sustainability, as defined by the Brundtland Report (1987), means meeting present needs without compromising those of future generations. In energy policy, it requires balancing ecological integrity, economic stability, and social equity (Eze et al. 2023). Renewable energy is widely seen as essential for sustainable development due to its economic and environmental benefits (Ray 2019), but its success depends on effective policy and regulation (Drago and Gatto 2022). According to EU law, renewable energy refers to *energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, osmotic energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas* (Art. 2(1), Directive 2018/2001). Internationally, bioenergy development aims to improve green energy's volume, quality, and overall performance (Kotrla and Prčík 2020). Bioenergy crops are key to climate mitigation strategies using biogenic carbon, alongside biomass for heat (Taylor et al. 2019). In many European countries, biomass remains the most significant renewable energy source (Mandalová et al. 2017). Key challenges in energy law include tackling climate change, environmental impacts, and economic governance (Heffron 2023). Despite major EU legislation such as the 2019 Electricity Market Directive, the 2018 Renewable Energy Directive, and the 2012 Energy Efficiency Directive, significant obstacles remain (Mauger 2023). Countries like Slovakia are aligning national legislation with sustainability goals to promote renewable energy, particularly biomass, which holds significant potential for producing heat, electricity, and transport fuels, especially from agricultural biomass grown on arable land (Prčík and Kotrla 2015).

The EU initially set a binding target of at least 32% renewable energy in gross final consumption by 2030, with Slovakia contributing 19.2%. This target was later raised to 42.5%, aiming for 45%. Slovakia's updated Integrated National Energy and Climate Plan (2021–2030) commits to a 25% share (Slovakia – NECP 2025). According to the Slovak Energy Policy (2014), biomass has the highest energy potential among domestic renewables. The Low-Carbon Development Strategy (2020) also highlights biomass as Slovakia's key renewable source, supporting energy self-sufficiency, economic growth, and emission reductions (Slovak Environment Agency 2020). Biomass can be used in substrates for urban green infrastructure like green roofs and walls

(Novotný et al. 2023), while waste biomass from green areas can serve as energy feedstock (Zardzewiały et al. 2023). Wood biomass is a major component of renewable energy production, sourced mainly from forest land, unmanaged agricultural land with forest cover, and residues from wood-related industries (Slovakia – NECP 2025). Slovakia has 2.032 million hectares of forest (41.46% of its area), with about 61% located in protected areas (Moravčík 2012). Fast-growing trees for biomass can also be cultivated on agricultural land under certain conditions (Fig. 1).

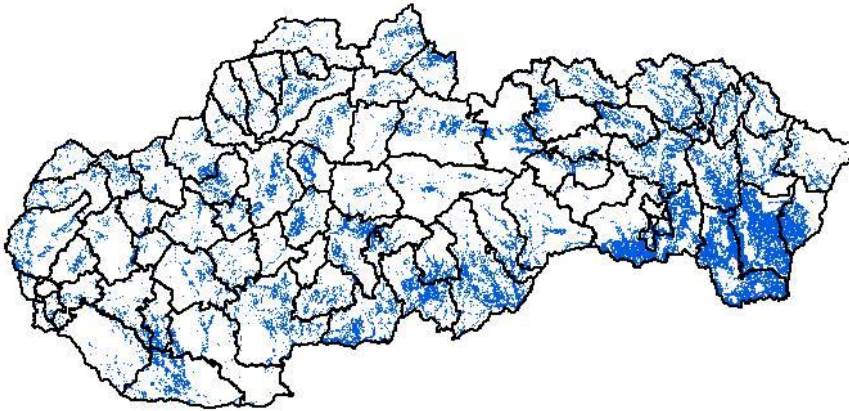


Fig. 1. Areas potentially suitable for growing fast-growing trees. Suitable areas marked with blue color

Source: Research Institute of Soil Science and Soil Protection Bratislava; soil maps, 2019

Rys. 1. Obszary potencjalnie odpowiednie do uprawy szybko rosnących drzew. Odpowiednie obszary zaznaczone na niebiesko

The highest potential in the cultivation of energy plants with respect to specific soil acreage at the regional level is in the Prešov region (99.95%), the Žilina region (99.89%), the Košice region (99.51%), the Banská Bystrica region, (98.94%) and the Trenčín region (83.02%) – the regions of middle and eastern Slovakia. The regions with the area of 5th–9th soil quality below 50% of total agricultural land are the Bratislava region (46.35%), the Nitra region (39.56%), and the Trnava region (32.7%) – the regions of western Slovakia (Prčík and Kotrla 2015). Agricultural crops such as grain corn, sorghum, oilseed rape, clover, legume mixtures, and other forage crops are also used for energy purposes, but data on cultivated area, yields, or the number of farms involved are unavailable (Green Report 2024).

1. Literature review

Despite the existence of supportive legal frameworks, major barriers still hinder the effective enforcement of renewable energy laws. Oduro et al. (2024) and Susskind et al. (2022) identify inadequate infrastructure, financial constraints, and lack of public acceptance as key challenges, emphasizing the need for legal certainty and robust enforcement mechanisms. Several studies explore how sustainability criteria can be embedded in legal and policy frameworks (Pavlovskaja 2014; Lu et al. 2020). According to Lu et al. (2020), governments are developing regulations that promote environmentally friendly renewable energy. However, sustainability criteria for biofuels remain globally unharmonized (Smart Freight Centre 2022). The literature consistently stresses the importance of a coherent legal framework (Chen 2021; Belaid et al. 2021). Institutional effectiveness plays a crucial role (Rahman et al. 2022), while legal and institutional frameworks themselves can pose obstacles to the energy transition (Gutermuth 2000). Sustainable energy law plays a key role in tackling climate change, requiring legal and policy innovation (Hodas 2023). Slovakia's Energy Law and its National Energy and Climate Plan (2021–2030) offer a framework for renewable energy development, but the country lags in regulatory quality and enforcement (Greener Strategy 2019). Strengthening legal certainty and enforcement mechanisms is essential for a sustainable energy future. As an EU member state, Slovakia must also ensure proper transposition of EU directives and contribute to the Union's international climate commitments. This article aims to assess the transposition of the Renewable Energy Sources Directive into Slovak law, focusing on sustainability criteria for biomass cultivation on agricultural and forest land. This requires identifying the national legislation and related regulations implementing the directive. While biomass cultivation offers environmental benefits, its social and economic impacts, such as land and water competition, food security concerns (Subramaniam et al. 2020), food market instability, invasive species, and wildlife-related diseases (Verdade et al. 2015), as well as broader ecosystem effects (Garg et al. 2023) are less explored. At the same time, bioenergy crops can support soil restoration and reuse of abandoned land (Alaejos et al. 2023; Fernández et al. 2020; Verdade et al. 2015). EU regulations emphasize environmental sustainability, but poor implementation can lead to adverse effects. Clear sustainability criteria and their proper legal transposition are essential to achieving the directive's goals, including climate change mitigation (at least local climate change through green infrastructure), carbon sequestration, and reduced fossil fuel dependency. A comprehensive review of national rules is therefore necessary to inform future legal and policy development, requiring an interdisciplinary approach.

2. Results and discussion

The legal framework governing energy biomass is multifaceted and comprehensive, encompassing regulatory provisions at the international, European Union, and national levels (Fig. 2).

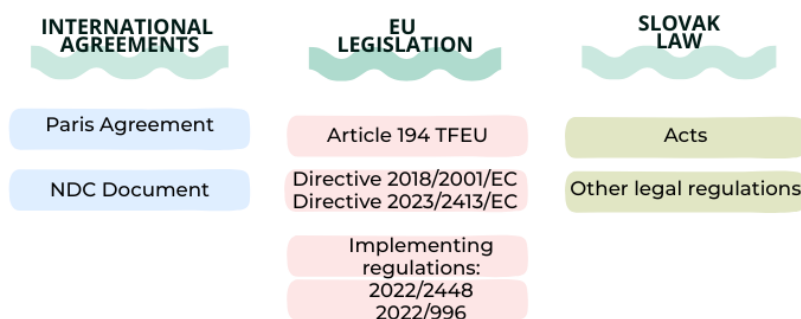


Fig. 2. General legal framework governing energy biomass on international, EU, and Slovak level

Fig. 2. Ogólne ramy prawne regulujące kwestie związane z biomasą energetyczną na poziomie międzynarodowym, unijnym i słowackim

Since the European legislator obliges directives as a regulatory instrument, these legal acts must be transposed into the national legal systems of the Member States. Directive 2018/2001/EC has been transposed into Slovak law through several legal acts, particularly energy laws and environmental laws. The most important act is the Act No. 309/2009 Coll. on the Promotion of Renewable Energy Sources (hereinafter as Act no. 309/2009 Coll.), which, together with three implementing decrees¹, help to achieve the Directive objectives.

The structure of the legislation is considerably more complex. To enhance clarity, the regulatory pathway of the transposition process is illustrated in Figure 3. This regulatory pathway chart visually organizes the transposition process of EU law into Slovak legal norms, serving as a clear starting point for understanding the applicable legal norms and their interactions. Such a diagram facilitates navigation through overlapping jurisdictions and varying legal authorities.

Act No. 309/2009 Coll. serves as a *lex specialis* to other energy laws, notably Act No. 251/2012 Coll. on energy and Act No. 657/2004 Coll. on thermal energy, which act as *lex generalis* for matters not specifically covered by the Renewable Energy Sources Act. The Act regulates the support conditions for producing biomethane and renewable electricity, and outlines the rights

¹ Decree of the Ministry of the Economy of the SR No. 373/2011 Coll., implementing certain provisions of Act No. 309/2009 Coll.; (2) Decree of the Ministry of the Environment of the SR No. 271/2011 Coll., establishing sustainability criteria and targets for reducing greenhouse gas emissions from fuels; (3) Decree of the Ministry of the Economy of the SR No. 397/2023 Coll., establishing the requirements for the declaration of a biomass grower or supplier.

Transposition of Directive 2018/2001

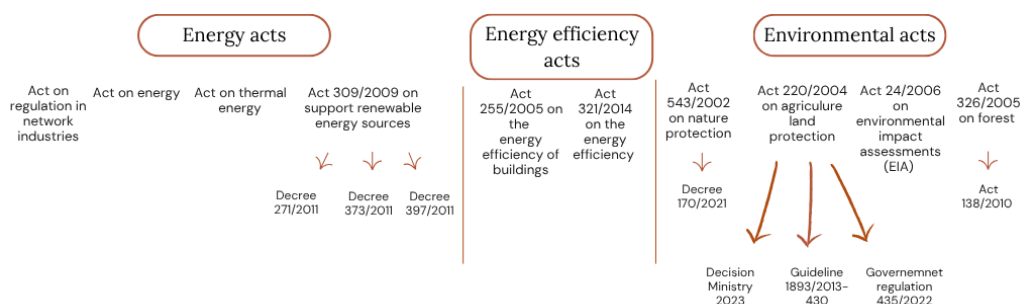


Fig. 3. Transposition of EU Directive 2018/2001 into the Slovak Law and related regulations

Rys. 3. Transpozycja dyrektywy UE 2018/2001 do prawa słowackiego i powiązanych przepisów

and obligations of producers of electricity, biomethane, and heat generated from biomass-based fuels², as well as other market participants who place fuels and other energy products intended for transport purposes on the market.

Act No. 309/2009 Coll. defines key terms, many based on Directive 2018/2001. The latest amendment aligns terms like renewable energy and biomass with the Directive's definitions. However, the current legal definition of renewable energy does not include osmotic energy, introduced in Directive 2023/2413, the second amendment to Directive 2018/2001. It should be transposed by May 21, 2025, therefore, a new amendment to the Act is expected.

2.1. Alignment of Slovak law with EU sustainability criteria

The sustainability criteria for biofuels, bioliquids, and biomass fuels, as stated in paragraph 14h of the Act no. 309/2009 Coll., are based on Article 29 of Directive 2018/2001/EU. This alignment ensures the smooth operation of the EU internal energy market and facilitates cross-border trade in these fuels. Land use and forestry-related sustainability criteria are further governed by Decree No. 271/2011 Coll., Decree No. 397/2023 Coll., and other relevant regulations on agricultural and forest land. Article 29 of the Directive is directly transposed into §3 of Decree No. 271/2011 Coll. Specifically, paragraphs 3(5)–3(8) address criteria for agricultural biomass, while paragraphs 3(9)–3(10) set criteria for forest biomass.

There are three groups of sustainability criteria for agricultural biomass. The first group (§3(5)) prohibits the use of raw materials from land with high biodiversity value as of January 2008. This includes: (a) primary forests or undisturbed wooded areas, (b) species-rich and non-

² The 2022 amendment extended sustainability criteria to heat producers using biomass, even without electricity generation (Explanatory report to the Act no. 363/2022 Coll., amending the Act no. 309/2009 Coll.).

degraded forests, unless proven not to harm conservation, (c) protected areas or habitats of rare/endangered species, unless proven non-conflicting, (d) highly biodiverse grasslands over 1 ha, unless harvesting is needed for their preservation.

The only absolute restriction on agricultural biomass production is for primary forests and undisturbed wooded areas. In all other cases, production is allowed unless it harms nature conservation or the status of the area. In Slovakia, comprehensive data on forest types is lacking, but partial insights are available. The civic association “Prales” mapped 10,180 hectares of primeval forests between 2009 and 2015, representing just 0.5% of Slovak forests (CVTI 2020). In the highest level of protection (non-intervention), 72,621 hectares are protected, including 7,000 ha of primeval forests, since about 31% of them lie outside this zone (National Forest Centre 2022; CVTI 2020). Additionally, 124,542 hectares (6.4% of forests) are designated for natural development without interventions for at least 10 years (National Forest Centre 2022).

Another absolute exemption in the Directive, heathlands, has not been transposed into Slovak law. Article 29(3)(e) of the Directive fully prohibits agricultural biomass production in heathlands, without exceptions. In Slovakia, official data on the total area of heathlands is unavailable. However, the State Nature Protection has monitored 90% of the heathlands and shrub communities in subalpine and alpine zones, covering 76,436 m² (about 7.6 hectares) (State Nature Protection 2024). Most heathlands are found in the Záhorie region in western Slovakia and in the northern mountain areas.

The second group of criteria (§3(6)) prohibits using agricultural biomass from land with high carbon stock as of January 2008, such as wetlands, continuous forests, or land over 1 ha with trees over 5 m and 10–30% canopy cover, unless it's proven that carbon levels remain compliant with sustainability rules. The Decree defines a wetland as land that is covered with or saturated by water permanently or for a significant part of the year. Defining wetlands is crucial due to the lack of scientific or legal consensus on their definition. Wetlands in Slovakia cover an estimated 49,000 hectares, about 1% of the country's territory (Ramsar Convention 2025). Additionally, there are 72 national, 467 regional, and 1,050 local wetlands, though their total area is undocumented (SAV 2022). Similarly, the term continuously forested area is defined as land covering more than one hectare, with trees higher than five metres and a canopy cover of more than 30 %, or trees capable of reaching these thresholds in situ. In the first two cases, the production of agricultural biomass is prohibited. However, on land with 10–30% canopy cover, production is allowed if greenhouse gas savings criteria are met. However, these criteria (§3(6) of the Decree) shall not apply if, *at the time of the extraction of the raw material, the land is in the same condition as it was in January 2008* (§3 (7)). This means that if agricultural biomass production does not harm the environment, the sustainable criteria are not applicable.

The third group of sustainability criteria (§3(8)) prohibits biofuels, bioliquids, and biomass fuels from peatlands as of January 2008, unless no drainage of undrained land occurred. While production is not absolutely prohibited, peatlands must be preserved. Slovak peatlands cover about 26,000 ha, or 0.57% of the country (Fazekašová et al. 2021).

The sustainability criteria for forest biomass are defined in two subparagraphs, both starting similarly as follows: *Biofuels, bioliquids, and biomass fuels produced from forest biomass shall*

meet the sustainability criteria if [...], causing uncertainty whether the criteria apply cumulatively or alternatively. Therefore, the principle of indirect effect should be applied, interpreting these rules in accordance with Art. 29(6) and (7) of Directive 2018/2001. According to the diction of Article 29 (6) biofuels, bioliquids, and biomass fuels produced from forest biomass [...] shall meet the following criteria to minimise the risk of using forest biomass derived from unsustainable production. Article 29 (7) states that biofuels, bioliquids and biomass fuels produced from forest biomass [...] shall meet the following land-use, land-use change, and forestry (LULUCF) criteria. While the first group of sustainability criteria focuses on the legality of extraction, the preservation and restoration of forest functions, the second group is focused on the so-called LULUCF criteria, aimed at ensuring that carbon stocks in soil are preserved and that greenhouse gas emissions are reduced or limited. This implies that the conditions of both subparagraphs must be met cumulatively.

The first group of sustainability criteria for forest biomass (§ 3(9)) is defined as follows: *Biofuels, bioliquids, and biomass fuels from forest biomass meet the sustainability criteria if*

a) the country of harvest has law, monitoring and enforcement systems ensuring that (1) harvesting is legal; (2) the forest is reforested; (3) protected areas including wetlands and peatlands are safeguarded; (4) soil quality and biodiversity are preserved, and (5) long-term forest productivity is maintained or improved,

b) *if such evidence is lacking, equivalent management systems must exist at the forest resource level to ensure the same criteria.*

Sustainability criteria are ensured either by national or regional legislation protecting forests and biodiversity, or by management systems from forest biomass producers if laws are lacking.

The second group of sustainability criteria for forest biomass (§ 3(10)) is defined as follows: *Biofuels, bioliquids, and biomass fuels produced from forest biomass meet the sustainability criteria if*

a) the country or regional organisation of forest biomass origin is party to an international agreement and includes land use emissions and removals in its climate commitments, or applies legal standards to conserve and enhance carbon stocks and prove that land use emissions do not exceed removals,

b) if such evidence is lacking, equivalent forest-level management systems must ensure long-term maintenance or enhancement of carbon stocks and sinks.

For forest biomass from EU Member States, point a) applies. The EU and its Member States have adopted and updated their nationally determined contribution (NDC) under the Paris Agreement in 2023 (Berrich et al. 2024). The EU has updated this NDC document in 2023³. The EU Council submitted the updated NDC to the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC).

Compliance with sustainability criteria is proven through documents required by law. Slovak producers placing fuels with sustainable fuels or bioliquids on the market, and suppliers of biomass fuel, electricity, or heat, issue a sustainability certificate confirming adherence to criteria

³ <https://unfccc.int/sites/default/files/NDC/2023-10/ES-2023-10-17%20EU%20submission%20NDC%20update.pdf>

and greenhouse gas savings, only if under supervision. Supervision verifies compliance, and the mass balance system and requires registration in the competent entities' register. Biomass growers or suppliers prove compliance via a declaration confirming adherence to Directive (EU) 2018/2001 and CAP standards, without mandatory greenhouse gas verification. This declaration is attached to the sustainability certificate and kept for five years (Decree No. 397/2023 Coll.).

Biofuels, bioliquids, and biomass fuels from agricultural biomass meet sustainability criteria if carbon balance, soil quality, and soil carbon management comply with Act No. 220/2004 Coll., including soil organic matter rules. Forest biomass biofuels meet criteria if the supplier has a state-approved forest management program under Act No. 326/2005 Coll., ensuring sustainable harvesting, regeneration, and responsible forest management.

Under Section 14h(14) of Act No. 309/2009 Coll., all parties in the biofuel supply chain must provide origin data, keep records for five years, and share information with authorities. On October 12, 2023, the Ministry appointed the National Agricultural and Food Centre (NAFC) to manage the database of areas meeting sustainability criteria.

2.2. Special sustainability criteria for biomass cultivation

In 2023, 0.36% of Slovakia's sown area was used for energy crops (e.g., maize, rape, sorghum, clover), with both area and grower numbers down 20% from 2022 (Green Report 2024). Agricultural land is also used for fast-growing species like poplars and willows. In 2023, fuel wood biomass supply totaled 1.3 million tons, continuing a decline from 1.45 million tons in 2015 (Green report from forestry, 2024). Fast-growing plants are key biomass sources due to their quick growth, low chemical input needs, and carbon absorption. In Slovakia, they are cultivated on agricultural and forest land under specific legal rules.

2.2.1. Fast-growing plants on the agricultural land

The Soil Protection Act (no. 220/2004 Coll.) sets sustainability rules for growing fast-growing energy plants on agricultural land. A 2013 amendment introduced a special procedure (§18a) for establishing these stands without full land withdrawal. They may only be planted on land that: (1) is in quality class 5–9 (in Slovakia, soil is classified into nine quality classes by the assessed soil-ecological unit code, with class one being the most fertile and productive.); (2) is contaminated and unfit for food/feed use; or (3) is in class 3–4 but in floodplains, waterlogged, or wind-eroded areas. However, planting is prohibited in areas with nature protection levels 3–5 under Act No. 543/2002 Coll. on Nature and Landscape Protection.

These rules apply to a fast-growing plant stand defined as *a stand of such plants cultivated to produce woody biomass on an area exceeding 1,000 m² for a maximum period of 20 years* (§18(1), Act No. 220/2004 Coll.).

The 20-year limit is based on expert evidence. Energy stands are classified by cutting cycles: very short (2–3 years), shorter (5–8 years), and short (10–20 years) (Bartko 2011). After 20 years, trees lose effectiveness, and there's public interest in preserving agricultural land. Legislators feared longer periods could lead to permanent conversion to forest land. The 1,000 m² threshold likely aligns with §16 of Act No. 220/2004 Coll., which exempts such areas from needing consent for land planning. It may also reflect traditional family house plots, which were around 1,000 m² larger than today's average of 500 m².

Legally defined stands must be registered in the fast-growing plants register, managed by the district office, unless the area is under 1,000 m². The Act does not list specific species, but farmers using EU funds must follow Regulation No. 435/2022 Coll., which defines fast-growing woody plants as 16 listed species (e.g., *Salix*, *Populus*, *Fraxinus*, *Alnus*, *Carpinus*, *Betula*) with a harvest cycle of 5–10 years (typically 8). Only two, green alder (*Alnus viridis*) and basket willow (*Salix viminalis*)⁴, are not native to Slovakia⁵.

Cultivating non-native species requires approval from nature protection authorities (§7, Act No. 543/2002), unless listed in Annex 2 of Decree No. 170/2021 Coll. Farmers must get approval to grow *Alnus viridis* or *Salix viminalis*, as they are not listed. Outside built-up areas, approval is always needed for non-native species; within built-up areas, only if over 1,000 m². For fast-growing stands, approval is always required regardless of size, as the 1,000 m² threshold is part of the legal definition. Approval is granted only if no harm to native species or habitats occurs and may include cultivation conditions. If approval is denied, the authority may issue a decision, including an order to destroy non-native species if their impact cannot be mitigated. If approved, the applicant must register the fast-growing woody plants at the district office using the form from the Methodological Guidelines (1893/2013–430). The application must include: (1) proof of land ownership or lease; (2) owner's consent if not in the contract; (3) land area details (cadastral map or plan); (4) statement from the nature protection authority; and (5) soil quality class confirmation. The district office notifies the municipality and relevant state bodies about the registration. The applicant receives a certificate with the registration number, dates, land area, recultivation duties, and protection rules, which is also sent to the central land registry. Establishing fast-growing tree stands requires expertise in biomass energy and compliance with complex legal regulations, especially on agricultural and forest land.

The Soil Protection Act focuses mainly on environmental sustainability criteria for fast-growing trees, with social and economic factors only indirectly addressed by limiting land use duration. The legislator aims to prevent permanent loss of agricultural land, ensuring food security. However, it is worth reconsidering if this applies to all land types, especially lower-quality land (classes 5–9), contaminated, or waterlogged areas, where sustainable use options may differ.

⁴ Until January 1, 2025, sweet chestnut (*Castanea sativa*) qualified for direct payments as a fast-growing woody plant. Regulation No. 414/2024 Coll. removed it, likely due to its value for both wood and fruit, with the latter supported under coupled income for selected fruit species. Also, agroforestry rules prohibit combining fast-growing woody plants with fruit-bearing woody plants (§2(g), point 2, Regulation No. 435/2022 Coll.).

⁵ List of native tree species of Slovakia https://www.sopsr.sk/files/zoznam_stromov.pdf

2.2.2 Fast-growing plants on the forestland

The cultivation of fast-growing plants on forest land is governed by Act No. 326/2005 Coll., which refers to them as “energy stands” or “forest plantations”.

An energy stand is a forest with a primary production function, typically lasting up to 15 years, mainly for energy use (§2(s)). These stands have short harvesting cycles (up to 10 years) but may grow 20–30 years, depending on site conditions and species (e.g., willow, poplar, acacia) (Guidelines 2023). The production function of an energy stand, which provides material benefits from forest growth and forestry processes, is typically limited to 15 years, with products mainly for energy production. However, some of these products may exceptionally be used for other purposes.

A forest plantation is a forest stand consisting of one or two tree species, planted in a regular arrangement and of uniform age, with a primary production function intended for industrial use. These plantations are usually established in locations with high production potential (§2(t)). The definition is very similar to the EU one according to which *plantation forest means a planted forest that is intensively managed and meets, at planting and stand maturity, all the following criteria: one or two species, even age class, and regular spacing; it includes short rotation plantations for wood, fibre and energy, and excludes forests planted for protection or ecosystem restoration, as well as forests established through planting or seeding, which at stand maturity resemble or will resemble naturally regenerating forests* (Art. 2(11), Regulation 2023/1115). Willow and poplar are primarily used for establishing forest plantations with a production period of 20–30 years (Guidelines 2023).

Energy stands and forest plantations are classified as production forests, focused on wood and biomass production while maintaining non-productive forest functions. The Forest Act allows clear-cutting when natural regeneration is ineffective (§18(1), Act No. 326/2005 Coll.), but it must be included in a forest management program or land management project.

Cultivating non-native tree species requires approval from the District Office as part of the binding opinion for a forest management program, typically valid for 10 years. This program ensures sustainable forest management (§2(i), Act No. 326/2005 Coll.), maintaining forest biodiversity, resilience, productivity, and ecological functions. It aligns with Article 7(a) and Article 1(2) of the Protocol on sustainable forest management (no. 304/2013 Coll.) covering goals like preserving forest area, promoting wood use (including biomass), conserving biodiversity, supporting climate mitigation, protecting natural forests, and involving local communities in forest governance. Forest management programs are the first to include both environmental and socio-economic sustainability criteria. While EU and Slovak laws mainly focus on environmental aspects, the Directive allows little room for Member States to add national socio-economic criteria due to its maximum harmonization. Still, national rules for cultivating fast-growing plants on agricultural land could go beyond environmental concerns and also address social and economic impacts. Forest management programs offer a useful model for this broader approach.

Only forest reproductive material meeting the requirements of Act No. 138/2010 Coll. may be used to establish energy stands or forest plantations. Such use is classified as “another forestry

purpose” under §2(z), with less strict requirements than for regeneration or afforestation material need not come from recognized sources. However, imported material always requires approval from the National Forestry Centre.

Act No. 24/2006 Coll. on Environmental Impact Assessment applies in cases of deforestation or first afforestation involving land use change, and when using uncultivated or semi-natural areas for intensive agriculture. “Semi-natural areas” lack a uniform definition but typically involve human-influenced lands that retain natural features. The goal is to identify areas with conservation or environmental value that could be lost if altered (EU 2015).

Establishing energy stands, especially on forest land, involves complex legal requirements. If these cannot be included in the legal act, a clear methodological guide or manual would help founders navigate the process and meet sustainability criteria.

2.3. Energy biomass in law and policy: proposals and perspectives

The cultivation of energy crops in Slovakia peaked in 2012, when the Ministry of Agriculture recorded 240 hectares of fast-growing woody plants (Kazda 2014). By 2013, the area dropped to 120.3 hectares, and by 2014 to just 12.1 hectares (Gondová 2015). More recent data are lacking. This decline is linked to unclear subsidy policies and a 2013 legislative change requiring registration and setting local conditions for stand establishment. However, the problem goes beyond registration. The key barriers are economic, such as low wood chip prices, lack of stable subsidies, and long return on investment (over 10 years). Compared to conventional crops, energy trees require longer harvest cycles, making expansion unlikely under current conditions.

Another major challenge is making production economically viable and tackling the dysfunctional biomass market. Alternative uses for energy trees and herbs, such as in construction or medicine, are mostly still in research. There is also a lack of education on selecting and cultivating suitable species to maximize yield while minimizing costs and respecting local conditions. Local infrastructure, such as biogas plants, is insufficient, and long-distance biomass transport raises transaction costs, reducing efficiency. Uncertain subsidies, unclear laws, and frequent legal amendments between planting and harvest further discourage growers. Additionally, energy trees cannot be planted on any agricultural land; growers must comply with legal requirements and national food security priorities.

The area of abandoned agricultural land in Slovakia is growing, especially in regions with soil suitable for energy tree cultivation (Fig. 4). Unused land increased from 464,830 hectares in 2016 (Porvaz 2019) to 544,948 hectares in 2023 (Green Report 2024). The Žilina, Trenčín, and Prešov regions have the most abandoned land, with soils in the 5th to 9th quality class suitable for energy trees. In contrast, the Nitra, Trnava, and Košice regions, with the highest-quality soils, have the least abandoned land (Porvaz 2019).

Energy crops and trees help maintain soil fertility by providing nutrients, preventing wind and water erosion, reducing evaporation and nutrient runoff, and stabilizing water flow, thus

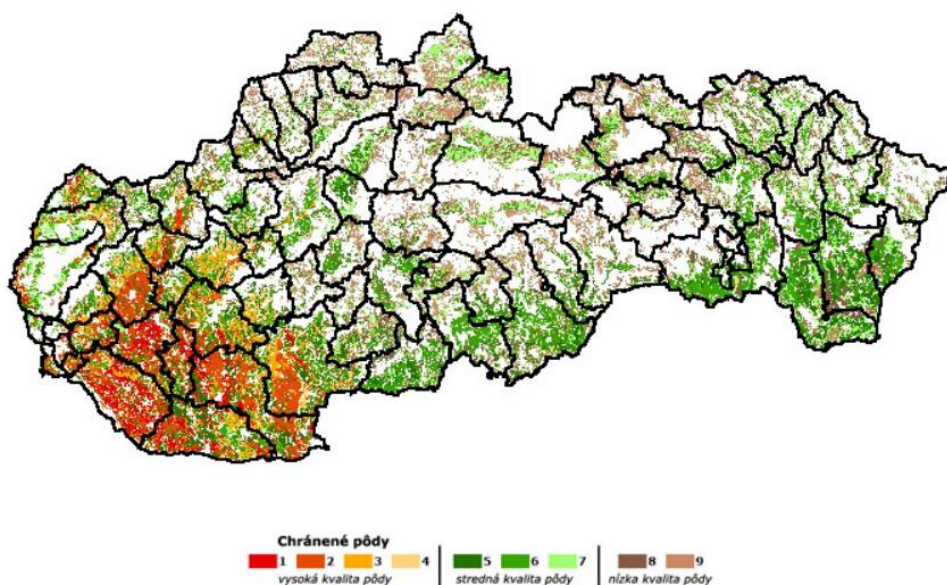


Fig. 4. Soil quality in Slovakia. Classes 1–4 = high soil quality; 5–7 = medium soil quality; 8–9 = low soil quality
Source: Research Institute of Soil Science and Soil Protection Bratislava; soil maps, 2024

Rys. 4. Jakość gleby na Słowacji. Klasy 1–4 = wysoka jakość gleby; 5–7 = średnia jakość gleby; 8–9 = niska jakość gleby

lowering eutrophication of nearby waters (Sluka et al. 2007). Their cultivation leaves soil in good condition with a positive nutrient balance after harvest (Porvaz 2019). However, extraction methods, harvesting intensity, artificial structures, and species choice must avoid long-term soil degradation or water quality harm (Sluka et al. 2007). These risks can be minimized through proper legislation and well-designed subsidy policies.

Strategic documents and national regulations show that bioenergy governance, especially energy crop cultivation, involves at least four ministries: the Ministry of Economy (lead on renewable energy), Ministry of Agriculture and Rural Development (responsible for cultivation on agricultural and forest land), Ministry of Environment (overseeing environmental impacts, sustainability, emissions, and biodiversity), and Ministry of Investments, Regional Development and Informatization (managing EU funds). This institutional fragmentation requires effective inter-ministerial cooperation to ensure alignment across energy, agricultural, and environmental policies, particularly in subsidy management to promote energy self-sufficiency. In the absence of effective coordination, legal ambiguities continue to undermine legal certainty. Even more concerning is the presence of inconsistent terminology within the legislative framework of individual ministries themselves. For example, differences between “energy stand” and “forest plantation” in the Forest Act and “fast-growing woody plants” in the Agricultural Land Protection Act create legal uncertainty in the biomass sector. A unified legal framework defining key terms

and setting conditions for cultivating energy woods and herbs, including agricultural energy crops, is essential to address the improvement of biomass production. Such a framework should be developed through interdepartmental collaboration and include harmonized procedures for establishing, maintaining, and removing stands on both agricultural and forest land.

The legal framework should explicitly specify the circumstances under which an environmental impact assessment is mandated and clearly identify the woody and herbaceous species eligible for cultivation for energy purposes. This framework must reference the pertinent provisions of the Act and Decree on Nature and Landscape Protection, which regulate the conditions and species requiring permits issued by district authorities. A unified, coherent regulation would streamline administration and offer legal clarity for growers through a single, comprehensive reference.

To address the low biomass production in Slovakia, municipal spatial development plans could facilitate the establishment of fast-growing tree plantations, as municipalities possess the most detailed knowledge of their territories and are therefore well-positioned to identify suitable areas for cultivating trees and herbs for energy biomass in accordance with existing legislation. This would speed up application reviews and help applicants more easily identify appropriate areas, compared to navigating complex Slovak laws. Inspiration can be drawn from Austrian Climate and Energy Model Regions program, which tasked regions with preparing renewable energy measures to combat climate change (Gaduš and Gaduš Jr. 2019). In Slovakia, there is currently no information indicating that any municipal spatial plan contains measures related to the use of renewable energy sources, particularly focusing on the cultivation and use of biomass energy.

At the same time, subsidies for cultivating fast-growing woody plants and paludiculture are regulated by Government Regulation No. 435/2022 Coll.; however, this regulation does not extend subsidy eligibility to energy crops grown on forest land. This gap highlights the need for integrating renewable energy considerations, including biomass cultivation, into spatial planning to better support and incentivize biomass production. Also, it raises concerns that land reclassified from agricultural to forest may become ineligible for support. A comprehensive subsidy scheme is needed to support all energy crop growers, regardless of land type. The regulation recognizes paludiculture – agriculture and forestry on wet or rewetted peatlands (Ozola et al. 2023) as an agricultural activity. According to Commission Implementing Regulation 2024/2746, paludiculture involves managing undisturbed or rewetted peatlands for commercial biomass. However, the Slovak Ministry of Agriculture's guidance limits subsidy eligibility to waterlogged agricultural soils. Experts warn against supporting paludiculture on protected or biodiverse peatlands, recommending its use on already degraded or intensively exploited ones instead (Frelüh Larsen et al. 2024). Therefore, support for energy woody crops should be provided through a dedicated scheme, such as eco-schemes or investment support, tailored to growers' needs while protecting soil and biodiversity. Incentivizing biomass cultivation on marginal or degraded lands would boost its economic appeal, reduce food security risks, and enhance soil quality, biodiversity, and broader social functions such as recreation, education, and environmental awareness. If project-based support is introduced, it should also consider the economic and social aspects of

the target area – such as regional unemployment rates, job creation potential, local community involvement in biomass cultivation, and opportunities to use biomass locally to enhance the efficiency and impact of renewable energy sources. In addition to subsidies, market regulation measures for biomass producers – similar to those applied to some agricultural commodities – are also needed. Possible improvements could involve implementing auctions, establishing long-term contracts, providing support to producer organizations, or conducting intervention purchases. However, currently, no regulation defines the procedures for announcing, conducting, and evaluating auctions under §19 of Act No. 309/2009 Coll. Regulation No. 202/2019 Coll. refers to this provision, but only briefly outlines the conditions for participation in the auction (Gaduš and Gaduš Jr. 2019). Although the Regulatory Office for Network Industries can issue auction-related regulations, the law clearly assigns this responsibility to the Ministry. This highlights the lack of a coordinated approach in Slovak legislation, which fails to address the full cycle of biomass production, storage, distribution, processing, and use. For producers, securing reliable, ideally local, outlets is vital. This would encourage cultivation, support local processing industries, and foster regional circular economies.

A major barrier remains the lack of information and education on energy crop cultivation. The legal framework is complex and fragmented, making it difficult for most potential growers to navigate. Educational initiatives for farmers, municipalities, and investors are therefore essential. These would raise awareness, boost interest in energy crops, and help prevent unintentional legal violations.

A new, consolidated legal framework for energy crops should clearly define and list all eligible crops, including those grown for energy on both agricultural and forest land. It should specify conditions for their establishment, cultivation, registration, support, harvesting, use, and market placement, as well as outline the roles of public authorities. Crucially, it must also establish mechanisms for effective coordination among key ministries.

Conclusion

Slovak legislation on biomass cultivation for energy use is fragmented across multiple legal acts of varying force, incorporating transposed EU laws. A comprehensive mapping of the pertinent regulations reveals that both EU and national frameworks predominantly emphasize environmental sustainability, with economic and social dimensions addressed primarily as indirect benefits within environmental objectives. This prioritization aligns with the overarching strategy of climate change mitigation and emissions reduction, pursued through stringent environmental criteria, green governance frameworks, and infrastructure development. Nonetheless, continuous and rigorous monitoring of these criteria, alongside their assessment methodologies, is imperative to ensure their effective contribution to the intended policy goals. A comparative analysis of EU and Slovak national criteria reveals that Slovakia has largely

transposed Directive 2018/2001 (Article 29) verbatim, even though the current wording of the Directive (Article 29(14) of Directive 2018/2001) allows Member States to *introduce additional sustainability criteria in the case of biomass fuels*. However, Article 29 (12) stipulates that *Member States shall not refuse to take into account, on other grounds of sustainability [...] biofuels and bioliquids obtained in accordance with this Article*. This explains the cautious national approach, but both national and European legislators should consider the key role of the directive as a legal instrument. Its task is to establish minimum criteria that must be respected throughout the EU while leaving room for Member States to adapt them to national conditions. Indeed, exhaustively harmonized sustainability criteria at the EU level are inherently limited in their capacity to fully address the diverse national specificities present across the 27 Member States. Finally, energy biomass cultivation is increasingly relevant to local governments' green strategies. As a renewable energy source, it can boost municipal energy self-sufficiency, cut emissions, and support local economies through heat source diversification. Slovak municipalities are now expected to reflect low-carbon strategies in their planning, and therefore, it is crucial to have clear formulations and a clearly defined legal framework for biomass production, creating opportunities to integrate biomass energy into local climate and energy policies while ensuring sustainability, legal compliance, and economic efficiency.

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Kryteria zrównoważonego rozwoju UE dotyczące biomasy energetycznej w słowackim prawie gruntowym

Streszczenie

Uprawa biomasy energetycznej na Słowacji jest regulowana wieloma aktami prawnymi, co wymaga podejścia interdyscyplinarnego. Poruszanie się po odpowiednich normach prawnych może stanowić wyzwanie dla producentów biomasy. Dyrektywa w sprawie odnawialnych źródeł energii wspiera cele Europejskiego Zielonego Ładu, w szczególności łagodzenie zmian klimatycznych i redukcję emisji, poprzez promowanie energii odnawialnej, w tym biomasy uprawianej w sposób zrównoważony na gruntach rolnych i leśnych. Głównym celem niniejszego artykułu jest ocena transpozycji dyrektywy do prawa słowackiego, zwłaszcza w odniesieniu do kryteriów zrównoważonego rozwoju w uprawie biomasy. Sama uprawa biomasy nie gwarantuje osiągnięcia celów Zielonego Ładu. Można je zrealizować jedynie poprzez odpowiednio zdefiniowane, zweryfikowane i przestrzegane kryteria zrównoważonego rozwoju. Jednak kryteria na poziomie UE prawdopodobnie nie odzwierciedlają w pełni specyfiki krajowej wszystkich 27 państw członkowskich. Dlatego też, chociaż prawodawstwo UE kładzie nacisk na aspekty środowiskowe, pozwala ono również państwom członkowskim na wprowadzenie dodatkowych kryteriów zrównoważonego rozwoju – przynajmniej w odniesieniu do paliw z biomasy. Pomimo tej elastyczności słowacki ustawodawca transponował dyrektywę niemal dosłownie, nie tworząc systematycznych ram prawnych dla producentów i przetwórców biomasy. Obecne przepisy wymagają ujednolicenia terminologii, harmonizacji procedur dotyczących zakładania plantacji na gruntach rolnych i leśnych, a także pewności co do mechanizmów dotacji w całym okresie uprawy. Niniejszy artykuł ma na celu nie tylko pomóc potencjalnym producentom biomasy w poruszaniu się po skomplikowanych ramach prawnych, lecz także przedstawić kilka propozycji dla lokalnych i krajowych decydentów politycznych.

SŁOWA KLUCZOWE: kryteria zrównoważonego rozwoju, biomasa energetyczna, zarządzanie użytkowaniem gruntów, rośliny szybko rosnące