SUSTAINABLE USE OF BIOMASS IN THE V4 COUNTRIES

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Visegrad Fund

Published with the kind support
of the International Visegrad Fund
within the project V4 Energy Think Tank
Platform 2024

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November 2024

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INTRODUCTION

Primary solid biomass (PSB) is an important energy source in Europe and in the Visegrad 4 (V4) countries alike. Biomass has remained the largest single renewable energy source in both the EU and the V4, despite the rapid growth of new renewable energy technologies such as PV and wind. Moreover, biomass energy has increased both in absolute and relative terms in the EU and even more so in the V4. Therefore, the V4ETT Project decided to organise a workshop to discuss the sustainable use of biomass for energy in the V4 countries. This paper provides a summary of the workshop support material and the discussion.

THE POLICY CONTEXT OF PRIMARY SOLID BIOMASS FOR ENERGY

Primary solid biomass is cheap, accessible and technologically simple, but there are many problems, which have become more acute as climate change concerns have increased the demand for PSB. Primary solid biomass can originate from forest biomass or other sources. In several countries there are different segments of PSB used for energy that do not originate from forest land. These can be grouped into three categories: (i) wood grown and harvested on land use categories other than forest land, such as grasslands, orchards, vineyards, gardens, land along linear installations such as railways and motorways, (ii) agricultural residues such as hay, husks, cobs, etc., (iii) energy crops grown on arable land, such as herbaceous energy grasses and woody energy coppices. All these categories of PSB have their specific characteristics. Due to the limitations of this work, in this section we mainly focus on the policy context of forest biomass. Note that in the statistical section we try to include all supply side PSB categories.

Critical aspects of forest biomass resources

Renewability of primary solid biomass needs to be assessed with due diligence. Among various sources of PSB we focus on forest biomass. Renewability of forest biomass has been taken for granted, given the biological capacity of forests to produce wood perpetually. However, there are complex ecological limits to forest regeneration. Ongoing climate change has highlighted these ecological limits. Changing patterns of precipitation, heat waves and species migration are putting increasing pressure on the regenerative capacity of forests. Forests respond with abrupt acute events (bark beetle calamity, forest fires) and chronic stress (declining growth, species loss). Therefore, forest biomass should be regarded as a renewable but depletable resource. Moreover, some types of forest biomass resources are not renewable at all:

primary (virgin) forests are unique ecological entities that cannot be recreated after human disturbance. Similarly, old-growth forests have a high ecological value due to the long period of time without human disturbance. Therefore, primary and old-growth forests should definitely be banned from energy harvesting and prevented from using the renewable label.

Sustainability is a concept that should be applied with caution for forest biomass. The term has a narrow interpretation that ignores the ecological services of forests as used in forestry terms[1]: sustainability is considered satisfied if the annual harvest amount of forest wood is less than the annual biological increment. It is important to note that both figures in this formula are subject to considerable uncertainty. Annual harvesting figures are aggregated from many harvesting records, which are supposedly subject to on-site inspection. However, there are many factors that lead to under-reporting of harvest: lack of property protection, lack of proper on-site inspection, all of which lead to illegal harvesting. On the other hand, annual biological increment is usually calculated using computer models that apply growth functions based on decades of field measurements, making the annual growth figure more of an estimate than an accurate data point, and possibly failing to capture new growth patterns as they change with climate change.

Air pollution is a serious issue for biomass. All forms of primary solid biomass emit very high levels of air pollutants when burned. Even high-tech installations struggle to keep their sulphur-oxide and dust emissions low. Households use inferior combustion technology: high water content of the biomass and insufficient oxygen result in extremely high emissions of particulate matter (PM10 and PM2.5) in addition to highly toxic CO. Poor ventilation and low stacks usually make both indoor and outdoor air quality so poor that household biomass combustion is a major source of unhealthy levels of exposure to pollutants. Together with internal combustion engines, household use of solid fuels (coal and biomass) produces so much airborne solid emission that air pollution has become the biggest health risk in Europe in the recent years, according to the European Environmental Agency. Its figures for 2020 show that 74–78% of the population breathes dangerous levels of PM2.5, while 43–48% of the population suffers unsafe levels of PM10, according to WHO guidelines.[2] Exposure to concentrations of fine particulate matter pollution above the 2021 WHO guideline levels will cause at least 238,000 premature deaths and more than 175,000 years of life lost to disease and disability in the EU in 2020.[3]

Climate neutrality of biomass energy is a concept that has been questioned by scientists and experts.[4] Although the carbon stored in forest biomass comes from the atmosphere and not from fossil deposits, it is released back into the atmosphere when burned for energy. The specific carbon emission of fuelwood is the highest of all combustible fuels, higher than that of coal or

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1 European Academies' Science Advisory Council (EASAC)—Multi-functionality and Sustainability in the European Union's Forests https://easac.eu/publications/details/multi-functionality-and-sustainability-in-the-european-unions-forests/

2 EEA: Air pollution is the biggest environmental health risk in Europe. https://www.eea.europa.eu/themes/air/air-pollution-is-the-single

3 EEA: Air quality in Europe 2022 https://www.eea.europa.eu/publications/air-quality-in-europe-2022

4 Commentary by the European Academies' Science Advisory Council (EASAC) on Forest Bioenergy and Carbon Neutrality https://easac.eu/fileadmin/PDF_s/reports_statements/Carbon_Neutrality/EASAC_commentary_on_Carbon_Neutrality_15_June_2018.pdf, Chatham House: The Impacts of the Demand for Woody Biomass for Power and Heat on Climate and Forests https://www.chathamhouse.org/2017/02/impacts-demand-woody-biomass-power-and-heat-climate-and-forests Woody Biomass for Power and Heat Impacts on the Global Climate https://www.chathamhouse.org/2017/02/woody-biomass-power-and-heat

lignite. However, according to international conventions, the release of carbon in the forest sector must be accounted for when the wood is harvested, with all the uncertainties discussed above.

Probably the most important unaccounted for carbon emissions are related to harvesting. The vast majority of emissions from harvesting come from soil disturbance. The annual loss of soil organic carbon from harvesting is estimated to be up to 0.3 tonnes of CO2 equivalent per cubic metre of timber harvested. The subsequent loss of soil carbon results in emissions of approximately 33 tonnes of CO2 equivalent per hectare of harvested forest land over a 5-year period.[5] There are significant additional emissions along the biomass supply chain most of which are included in other sectoral inventories.[6] However, biomass combustion for energy is rewarded with a zero emission factor, giving it a false image of climate neutrality, when in fact biomass burning is severely depleting humanity's extremely constrained carbon budget of as of the Paris Agreement.

Recent policy problems

Imbalanced policy incentives have benefited biomass-to-energy. In the V4, as in other EU MSs, there have been many direct and indirect support schemes for biomass as a renewable energy source. Meanwhile, there have been no incentives to support forest-based carbon removal and storage. As a result, forestry companies produce biomass for material and energy without receiving any climate benefits. Conversely, companies producing electricity and/or heat from biomass fuels benefit from decreasing carbon costs (e.g.: under the EU ETS).

Rapid decline of forest carbon sequestration is foreseen in strategic government documents in many EU MSs and in the V4 countries. This is due to a number of factors such as the ageing forest stock, the growing intensity of harvesting due to rising demand pressure, the failure of afforestation plans and, last but not least, the onset of climate change.

Soaring demand for biomass energy has added to the problems. In the short term, the recent European energy crisis has prompted many households and businesses to switch to biomass. In the medium term, ever-increasing renewable energy targets are driving additional demand for biomass, as long as its renewability and climate neutrality are advocated. In the long term, many governments are planning new biomass energy installations equipped with carbon capture and storage (CCS). Biomass energy with CCS (BECCS) technology promises to produce energy and remove carbon at the same time. It could become one of the high-cost technologies that climate policy decides to support in the 2030s and 2040s.

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5 Nature Scientific Reports: Forest soil carbon is threatened by intensive biomass harvesting https://www.nature.com/articles/srep15991; FAO Soil Organic Carbon Accumulation and Greenhouse Gas Emission Reductions from Conservation Agriculture: A literature review https://www.fao.org/4/i2672e/i2672e.pdf

6 There are additional greenhouse-gas emissions associated with the forest biomass supply chain. Studies indicate that the fossil fuels used for harvesting, processing and transportation of forest biomass release approximately 31 to 35 kg CO2eq emissions per cubic metre of harvested timber. (EFI Forest biomass, carbon neutrality and climate change mitigationhttps://efi.int/sites/default/files/files/publication-bank/2019/efi_fstp_3_2016.pdf, Nature Communications Earth & Envirnomnet: Economic factors influence net carbon emissions of forest bioenergy expansion https://www.nature.com/articles/s43247-023-00698-5)

Forthcoming policy changes

The new LULUCF Regulation[7] has ended the ‘no debit’ rule for the overall LULUCF emissions target and, as part of the “Fit for 55” policy package, set an absolute EU-wide negative emissions target for the LULUCF sector of 310 MtCO2eq by 2030. The overall EU target is broken down to Member States. The national targets are ambitious for most MS, including the V4 countries. As shown in the table below, the 2030 targets under the LULUCF Regulation require more than a doubling of the carbon sequestered in the LULUCF sector, which is ultimately the Forest Land category.

Table 1. The V4 LULUCF sector emissions: 2020 data and 2030 target, kt CO2eq

	2020 data	2030 target
CZ	14 240	-1 228
HU	-6 723	-5 724
PL	-21 428	-38 089
SK	-6 458	-6 821
sum	-20 370	-51 862

sources: the National Inventory Reports of the V4 countries and the EU LULUCF regulation

The EU ETS2[8] is the EU scheme to introduce an emissions trading scheme for the EU transport and buildings sectors, with the aim of reducing greenhouse gas emissions from fossil fuels in the end-use sectors. In the buildings sector solid biomass heating will be given a competitive advantage over fossil fuels, potentially leading to a significant shift in space heating to biomass.

The EU Carbon Removals Certification Framework Regulation[9] aims to provide a regulatory framework for the certification of permanent carbon removals, carbon farming and carbon storage in products. Among other things, the Framework will facilitate investment in bioenergy with carbon capture and storage (BECCS) and increased use of primary solid biomass, mainly forest wood, as material for products to replace fossil and carbon-intensive material use.

The EU Industrial Carbon Management Strategy[10] has set annual carbon removal targets by milestone years for industrial CCS technologies, including BECCS. The removal targets are very ambitious: 50 Mt CO2eq by 2030, 280 Mt by 2040 and 450 Mt by 2050, the latter being approximately as much as 1/3rd of the EU ETS annual cap in 2024 (1386 mt CO2eq).

7 Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework

8 EU ETS2 is regulated in the EU ETS Directive https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/ets2-buildings-road-transport-and-additional-sectors_en

9 CRCF: https://climate.ec.europa.eu/eu-action/carbon-removals-and-carbon-farming_en

10 ICMS: https://ec.europa.eu/commission/presscorner/detail/en/qanda_24_586

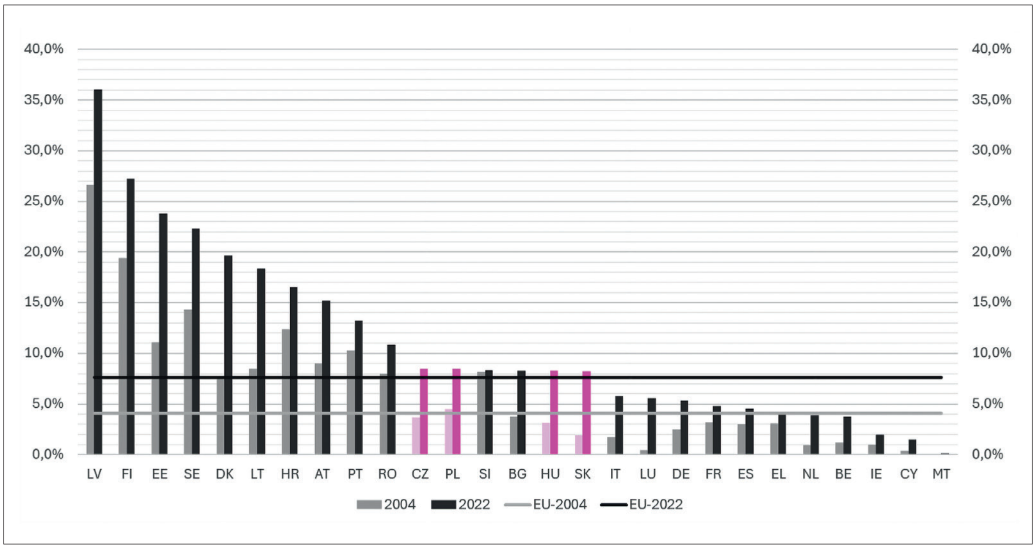
SUPPLY AND DEMAND FOR PRIMARY SOLID BIOMASS

In this section, we use official data sources to describe the production and consumption of PSB in the V4 countries and compare them with the EU. We use the EUROSTAT for the “Energy balances” of PSB, and we used EUROSTAT “Roundwood, fuelwood and other basic products (for_basic)” to collect data on production, imports and exports of fuelwood, woodchips, wood pellets. We also used national statistics to collect data about harvesting residues and non-wood biomass utilized for energy.

Energy balances and dynamics of changes

The use of PSB includes all non-forest and forest biomass used for energy in the transformation and final energy consumption sectors. The share of PSB in total energy supply is shown in the graph below.

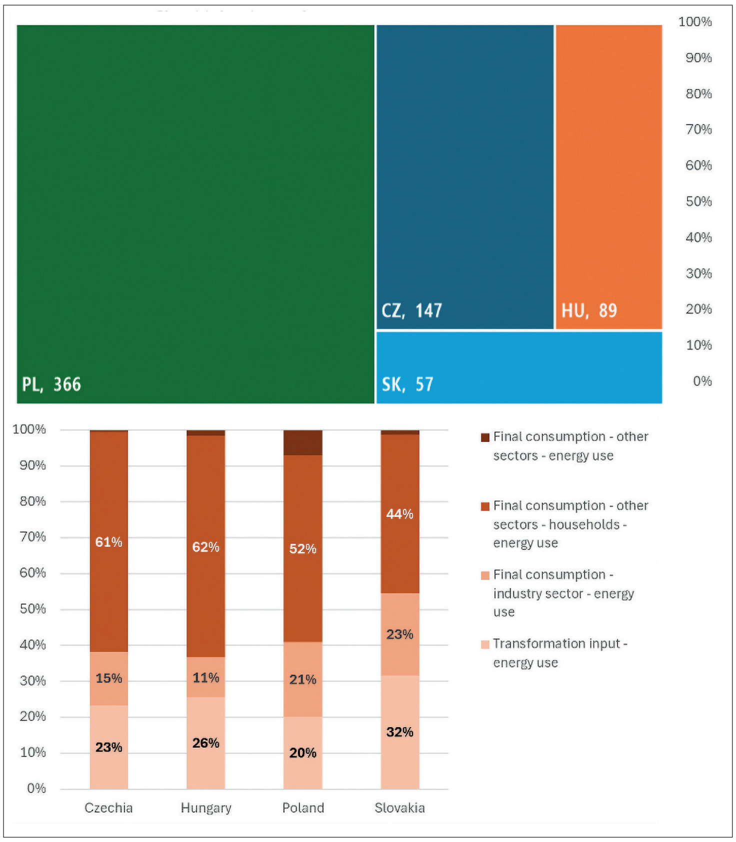
Figure 1. The share of primary solid biofuels in total energy supply, %, in the EU27 and the V4, 2004, 2022



source: own chart based on EUROSTAT

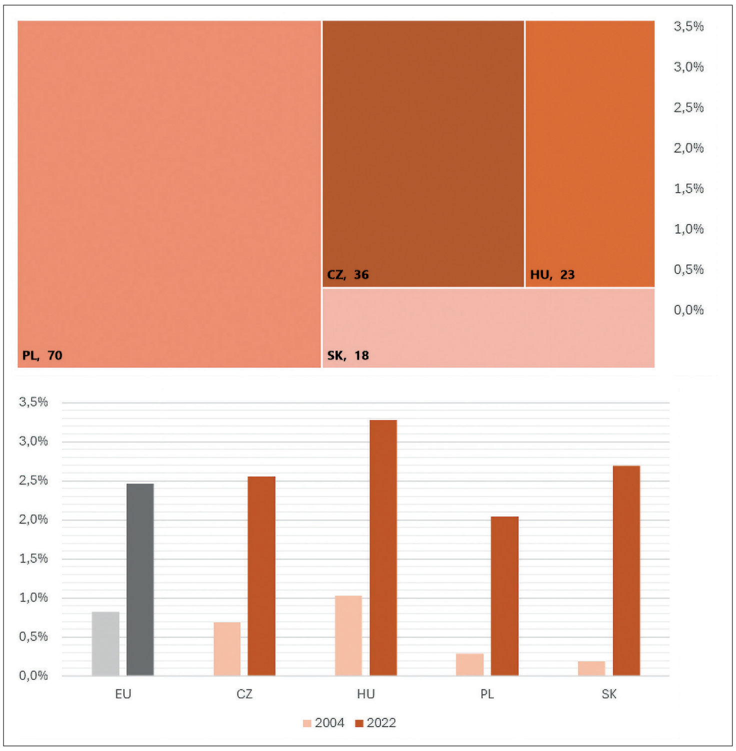
Interestingly, the V4 countries have a very similar share of PSB in their total energy supply (8.2 to 8.4% in 2022), very close to the EU27 average (7.6%). Note that the depicted growth in PSB shares shown over the last two decades is the product of a decreasing total energy supply and an increasing PSB use. All but 3 EU MS decreased their total energy supply (including CZ, HU and SK but excluding PL among the V4 group) and all but 2 MSs increased their total PSB supply over the same period (including all V4). The growth in PSB supply between 2004 and 2022 ranges from 200% (CZ) to 400% (SK).

Figure 2. Total energy supply of primary solid biomass, (PJ) and share of sectors (%) in the V4



source: own chart based on EUROSTAT

Figure 3. Transformation input of PSB, (PJ, 2022) and share of PSB in transformation input for energy, (%, 2004, 2022) in the V4



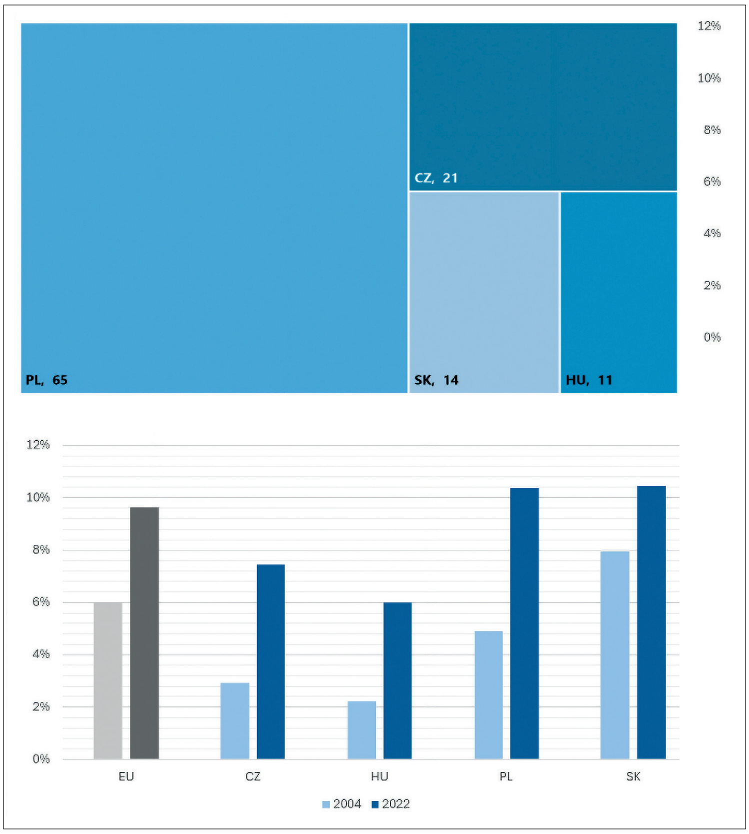
source: own chart based on EUROSTAT

The total energy supply of PSB varies from year to year due to country-specific reasons, such as salvage logging after storm damage or bark beetle calamity. The regional market reflects such surges in supply, so that planned harvests are delayed elsewhere, causing production to fall in some other countries. The sectoral share of PSB for energy is more stable in the countries where the technology park requires PSB on a permanent basis. Below is a brief overview of the three main energy segments: transformation, industry and households.

The transformation sector includes power plants, heating plants and cogeneration plants, both commercial and autoproducer installations. In all the V4 countries, PSB for transformation has grown faster than the EU average. This explains why the share of the V4 countries in the total use of PSB for transformation in the EU doubles from 5.6% in 2004 to 11% in 2022.[11]

In the EU all but 1 MSs increased their PSB demand for transformation between 2004 and 2022. The EU average increase was 260%. Half of the MSs increased their use of PSB for transformation inputs by more than 400% including PL and SK. Meanwhile, 19 out of the 27 MSs decreased their total transformation input over the same period, including CZ, HU and SK from the V4 but excluding PL, which increased its total transformation input by 10% over this period. The EU27 average decrease in total transformation input was 13%.

Figure 4. Final consumption of PSB in the industry sectors (PJ, 2022) and share of PSB in final energy consumption of industry sectors (%, 2004, 2022) in the V4

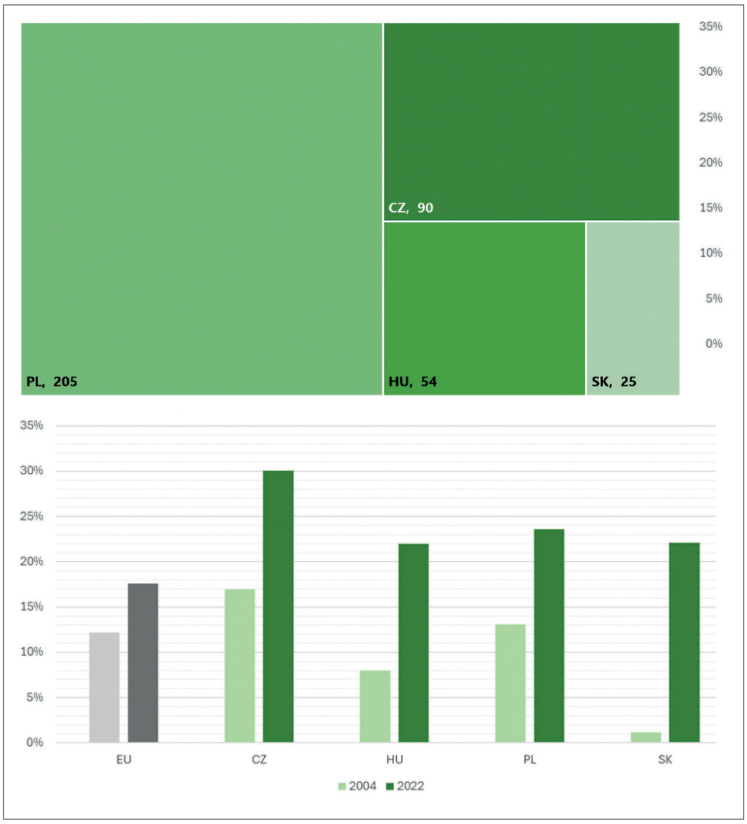


source: own chart based on EUROSTAT

11 Even higher increase is seen in 2021. Note that no temperature correction is applied to these data. Longer and/or colder winters increase consumption of most energy products per se.

Industrial sectors use PSB for their heat demand in their technologies. In the V4, PSB for final energy consumption in the industrial sectors has grown faster than the EU average of 32%. In 20 out of 27 MSs, the industrial sectors increased their final energy consumption of PSB between 2004 and 2022. Meanwhile, in 22 out of 27 MSs the total final energy consumption of the industrial sectors decreased over the same period, including CZ, PL and SK from the V4, the EU average decrease was 18% for the total final energy consumption of the industrial sectors when all other energy products are considered.

Figure 5. Final energy consumptions of PSB by households (PJ, 2022) and the share of PSB in final energy consumption of households (%, 2004, 2022) in the V4



source: own chart based on EUROSTAT

Households have been using biomass for energy in residential buildings for a long time. The household sector is the largest of the biomass using sectors in the V4 and it is the household sector where PSB has gained its largest share among other types of fuels, compared to other sectors. The share of PSB in the final energy consumption of households is much higher in the V4 (22%–30%) than the EU average (18%) in 2022. The V4 group, which represents 14% of the EU population, consumes 21% of the total household PSB in the EU.

While EU households reduced their total final energy consumption between 2004 and 2022, they increased their PSB final energy consumption by 33% over the same period. The growth rate for household PSB in the V4 group is much higher. (86%–1800%)[12].

12 Part of the observed increase in household PSB can be explained by substantial changes in the statistical methodology behind the energy balance data.

To conclude this section, it is important to note that an even higher increase is recorded in 2021 in all the energy segments discussed above, so the observed growing trend is likely to be a fundamental change and not just the effect of the energy crisis in 2022.

The supply-demand gap

The energy balances analysed above must represent the balance between the consumption and production of fuel types. Consumption data are the sum of official data reports and statistics derived from survey observations. In the case of fuels other than PSB, production data are obtained by accounting for "Primary production" from official data sources and the balance of exports and imports of each fuel. However, in the case of primary solid biomass, there is a unique way of providing production data: instead of using official data sources (i.e.: forest authority harvest data), "Primary production" data of primary solid biomass is generated to exactly balance the sum of consumption data (minus the balance of exports and imports). In other words, it is not based on official biomass production data but is simply generated as input data needed for the energy balance, assuming that some kind of biomass production must have taken place somewhere to statistically balance the consumption data.

In an attempt to replace invented primary production data with official data sources, we collected and aggregated data on primary solid biomass production, i.e. fuelwood production from forests and agricultural residues sold for energy use. In this section, we present our results.

The stacked columns in shades of brown represent the demand for PSB by transformation and final consumption sectors. The stacked columns in shades of green represent the supply of PSB types. The column in blue is the balance of exports and imports, presented in terms of net imports. The vertical axis represents the same amount of biomass in energy terms (TJ) for the supply and demand categories. Supply data in cubic metres have been converted to Joule using typical firewood parameters and technology assumption.[13]

The Czech forest sector suffered a severe bark beetle outbreak during the observed period, resulting in extensive sanitary harvesting and the dumping of much of this timber on export markets. The salvage harvest mostly ended up in roundwood product categories other than fuelwood, woodchips or residues. Thus, even during this crisis, the domestic fuelwood consumption far exceeded the domestic supply of PSB, according to the data we were able to collect. The unexplained gap of 70%–72% between demand and supply data narrowed to a still significant 43%–53% after 2019, as planned domestic fuelwood production increased and salvage exports ceased.

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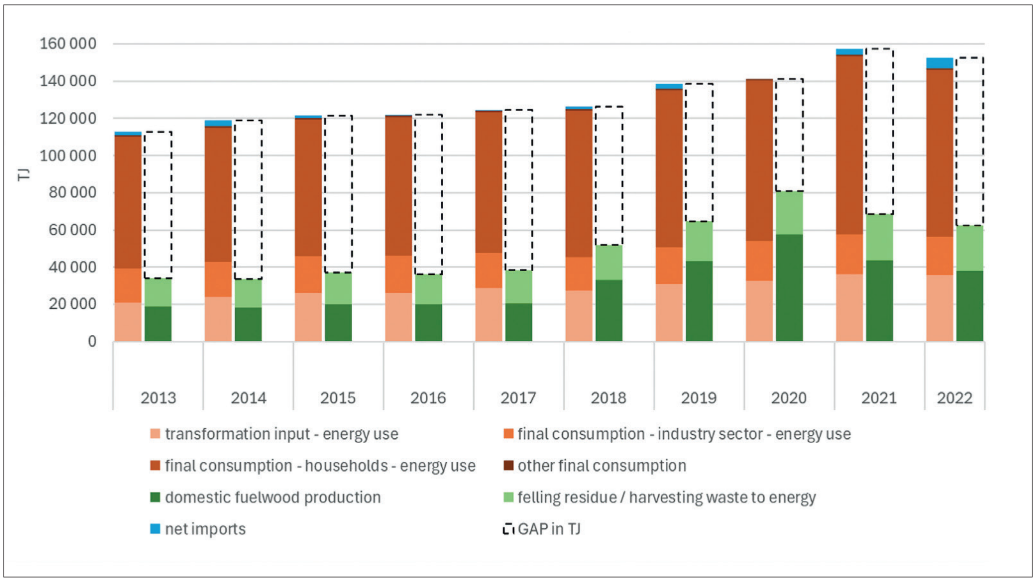
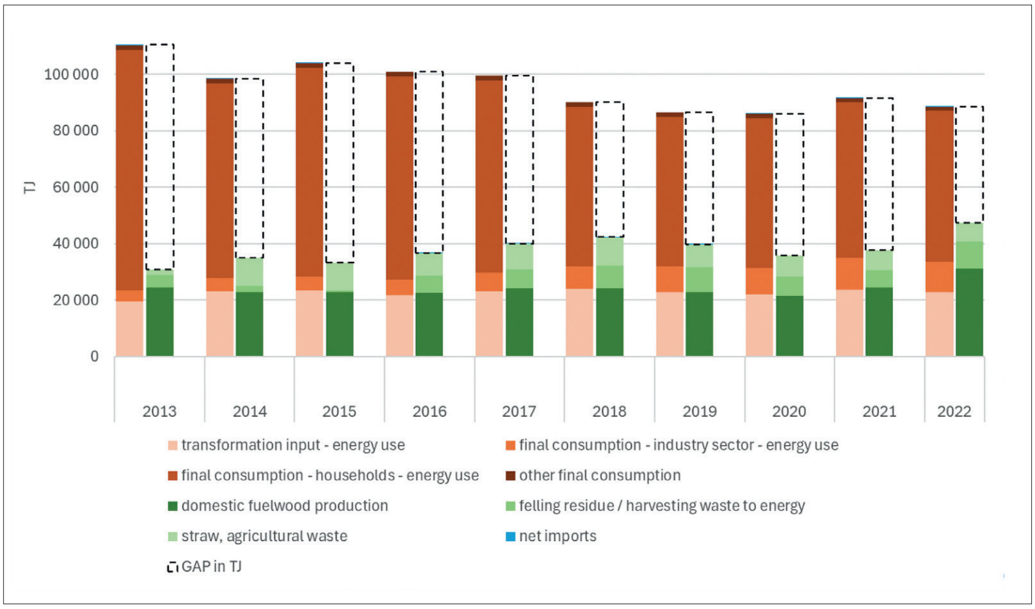
13 Unit transformations were made based on utilization technologies. For energy balances, the authorities assume a certain amount of energy recovered from the steam generated from the water content of biomass, thus the applied transformation of biomass volume to energy is made with factors higher than the Net Heating Value (but lower than the Gross Heating Value). Conversely, in the household sector the biomass heating facilities are suitable only for simple incineration of firewood with no technical capacity to recover the energy content of the water steam, which is assumed to be lost to the environment. Accordingly, the applied specific energy content of household firewood is the Net Heating Value of firewood.
NHV: the heat of combustion less the heat of water condensation per unit mass of wood with observed moisture content. The parameters we use in our calculations are as follows: GHV: 19 MJ/kg, water moisture content: 30% v/v, ash content: 3% v/v, the latent heat of water evaporation: 2.2 MJ/kg. Calculation with these parameters returns a NHV of 12,2 MJ/kg. Basic wood density is set according to average assortments of firewood species, resulting heating values of 8.6-11 GJ/m3.

Figure 6. Supply and demand of primary solid biomass for energy in the Czech Republic, 2013–2022, TJ



source: own chart based on EUROSTAT

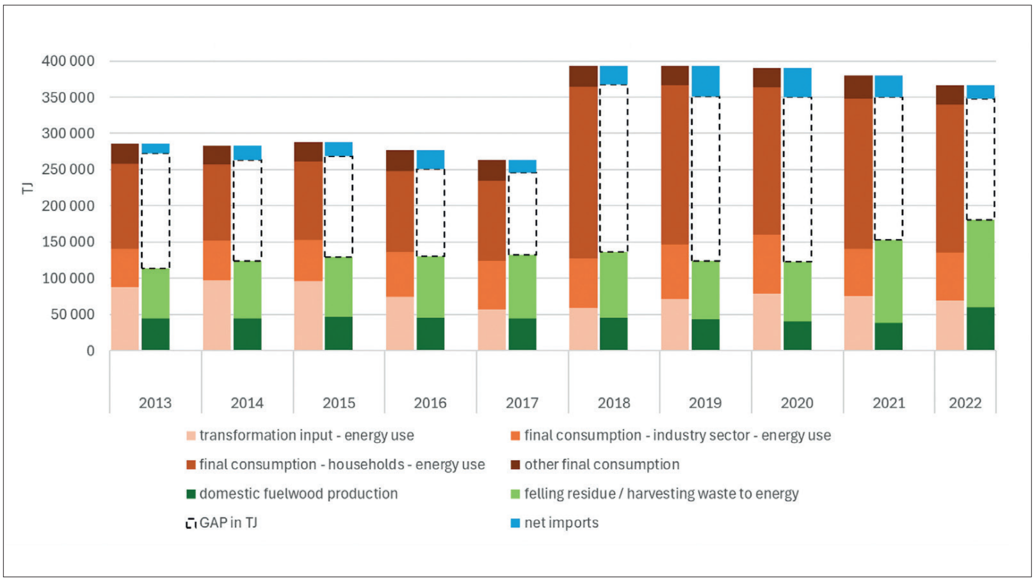
Figure 7. Supply and demand of primary solid biomass for energy in Hungary, 2013–2022, TJ



source: own chart based on EUROSTAT

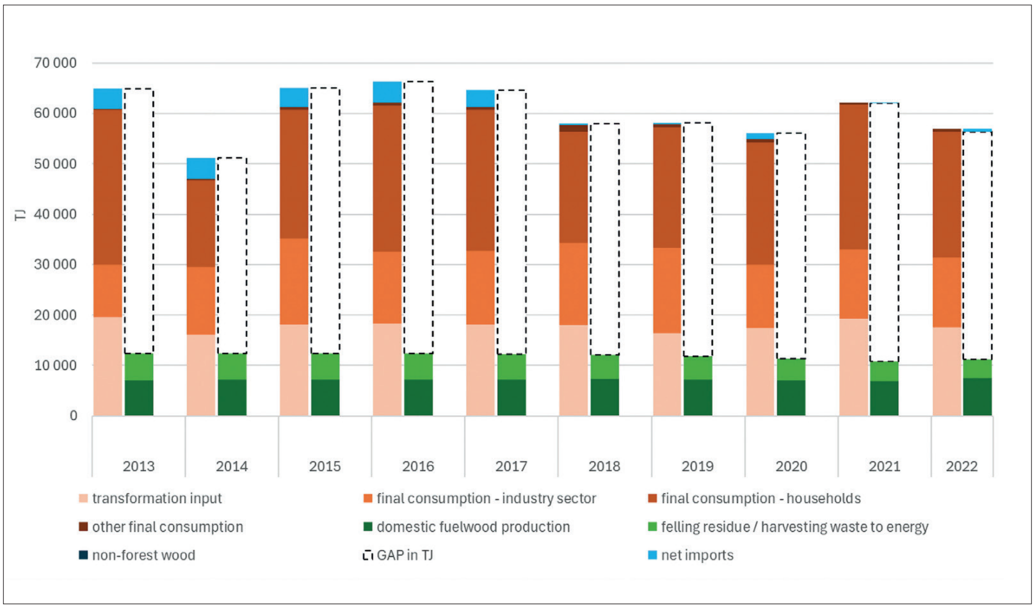
Hungary is one of the countries where significant amounts of non-forest PSB have been identified. The data was collected by interviewing the national energy authority responsible for energy statistics. However, even after taking into account this non-forest PSB production, there is still a significant gap between the supply and demand data for PSB in Hungary ranging from 46% to 72% of the PSB consumption data reported in the official energy balance.

Figure 8. Supply and demand of primary solid biomass for energy in Poland, 2013–2022, TJ



source: own chart based on EUROSTAT

Figure 9. Supply and demand of primary solid biomass for energy in Slovakia, 2013–2022, TJ



source: own chart based on EUROSTAT

In Poland, in addition to a similar gap, there is another uncertainty in the official data: in 2018, significant changes were introduced in the statistical methodology for estimating the final energy consumption of PSB by households. This change was not applied retrospectively, so there is an unexplained upward shift of PSB demand in the energy balance in 2018, which further increased the gap from around 40–45% to 55–60%. It should be noted that Poland is the only V4 country to report significant net imports in the fuelwood product categories.

The supply-demand gap is also very explicit in the case of the Slovak official data. The annual variability of PSB consumption data is coupled with a rather low variability of domestic fuelwood production data. The surge in exports is explained by a wave of salvage logging similar to that in the Czech Republic, but in the Slovak case it also manifests itself in the fuelwood product categories. The gap between the official demand and supply data ranges from 76% to 82% in the period of 2013–2022.

The gap observed in all the V4 countries is likely to be explained by a combination of illegal logging, unregistered imports of woodfuels, use of roundwood product categories other than fuelwood, wood from non-forest land, burning of household waste, and statistical issues on both the energy and forestry side (sampling, methodology, modelling, etc.).

RECENT AND PROJECTED TRENDS OF FOREST CARBON SEQUESTRATION AND BIOMASS ENERGY

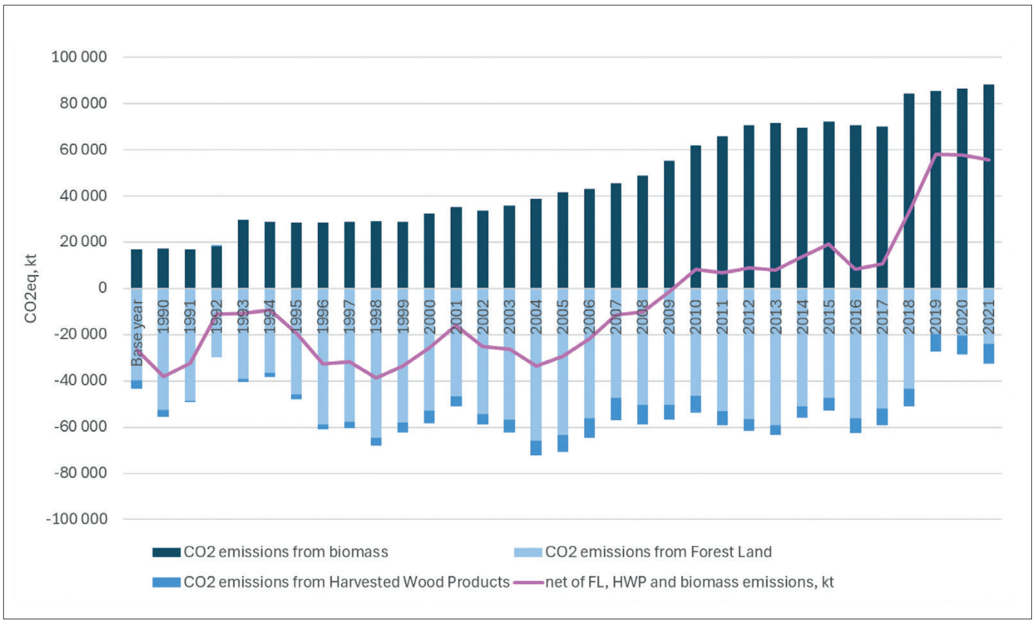
In this section, we summarise data on the negative emissions from forest lands in the V4 achieved through net forest growth, which translates into net carbon sequestration. We examine historical trends in carbon sequestration and make comparisons with carbon emissions from biofuels. Our analysis is based on the National Inventory Reports (NIR) published yearly under the Intergovernmental Panel on Climate Change (IPCC) for carbon emission and sequestration data. Then we add future policy trends for forest carbon sequestration and biomass energy production according to the National Energy and Climate Plans of the V4 countries.

The trend we found is alarming: rising CO2 emissions from biomass combustion, diminishing carbon sequestration by forests and very slowly increasing carbon sequestration by harvested wood products. The balance of negative emissions from the Forest Land and the Harvested Wood Products categories and positive emissions from biomass combustion turned from negative to positive in 2010 rising to as much as 55–58 million tonnes by 2019–2021. CO2 emissions from biomass increased from 1.8% to 14.2% of the total GHG emissions of the V4 group.

Against this trend, it is important to assess how government policies are tackling the problem. We reviewed the National Energy and Climate Plans of the V4 countries to summarise the impact of policies and measures on biomass use for energy and carbon removal by forests.

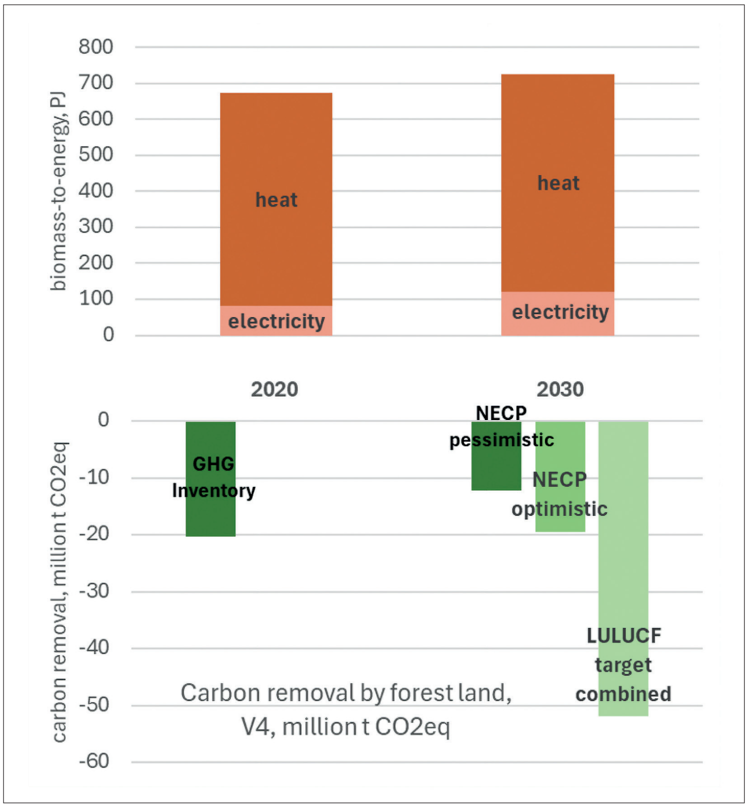
According to the reviewed energy plans and policies of the V4, biomass electricity is expected to increase by 49% between 2020 and 2030. Biomass heat is planned grow only moderately at 2%, still accounting for more than 600 PJ. Meanwhile, policy makers in the V4 countries seem to accept that they are losing significant forest carbon stocks. In the pessimistic case, the annual carbon sequestration rate of their forests falls from 20 million tonnes of CO2 equivalents per year in 2020 to 12 million tonnes in 2030, a loss of 40%. Even under the most optimistic scenarios, the combined carbon sequestration of V4 forest lands will be no more than 19 million tonnes of CO2eq by 2030. This is less than half of the combined V4 LULUCF targets for 2030 (-51.9 Mt CO2eq) set in the EU LULUCF Regulation (see Table 1.)

Figure 10. CO2eq emissions from biomass, Forest Land and Harvested Wood Products in the V4, 1990–2021, kt



source: own chart based on National Inventory Reports of the V4 countries

Figure 11. Policy plans for biomass-to-energy and carbon removal by forests in the V4, 2030



source: own chart based on NECP of the V4 countries

CONCLUSIONS AND POLICY RECOMMENDATIONS

Forest biomass is not an unlimited renewable energy source. It never was, and its limitations and scarcity have become even more apparent recently. The V4 countries are also experiencing a decline in the biomass capacity of their forests, due to ageing stocks and extreme losses caused by unusual weather patterns, probably due to accelerating climate change. Growing demand is putting more pressure on forest resources while authorities struggle to monitor, control and verify marketed timber against existing sustainability criteria.

It is very important to note that the growing demand for primary solid biomass as an energy fuel has been driven by a combination of policies. The unqualified claims of renewability and climate neutrality remain, although both have been questioned by many experts. These concepts need to be refined, and current government policies reconsidered in order to protect the capacity of forests and those households that have had to rely on firewood as their only affordable fuel for space heating.

From a broader climate policy perspective, it is critical that the integrity of biomass energy with climate policy is reassessed. The V4 countries are losing their forest carbon stocks at an alarming rate, as well as the capacity of their forests to sequester carbon. While all the V4 countries present ambitious biomass energy policies, very little is said about their policy plans to halt the declining trends in their forest carbon stocks and increase their annual forest carbon sequestration to meet their new LULUCF targets.

And the most critical issue that the V4 administrations should address is the significant uncertainty in the production and consumption data of primary solid biomass for energy. The uncertainty is so high that up to 60–80% of the PSB energy use reported in the national energy balances cannot be justified by the PSB supply reported by the national authorities of the V4 countries. Until this major administrative failure is corrected, no additional biomass energy support schemes (e.g.: BECCS) should be introduced.

The V4 countries should prepare for an unchanging EU policy environment in which CO2 emissions from biomass combustion are likely to remain free of charge and most of their forest production is likely to tick the sustainability check-box. Meanwhile, the land-use sector will be subject to increasingly stringent negative emissions targets. It should be a priority for the V4 countries to work out their complex policy approach to the forest—biomass—energy—climate interdependency in order to prevent unforeseen losses of their forests and to keep fuelwood affordable for those households that have no other options to meet their domestic energy needs.