Burning up the carbon sink:
How the EU's forest biomass policy undermines climate mitigation, and how it can be reformed

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November 4, 2022

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Executive Summary

Background: Meeting EU climate targets and achieving climate stability requires significantly increasing carbon storage in forests. But new data from the UNFCCC shows that most EU countries are losing or have lost their forest and land carbon sinks. Logging forests for energy appears to be an important driver of land carbon sink loss. Scientists have repeatedly warned that burning forest biomass for 'zero carbon' renewable energy actually increases net carbon pollution, undermining climate mitigation. Now, as the current fuel crisis leads to accelerating logging and panic-buying of firewood, the consequences of the EU's failure to ramp up clean technologies like solar thermal and heat pumps, instead continuing to depend on wood-burning for meeting renewable energy goals, are becoming more apparent. Recognizing that accelerating use of forest biomass is undermining the EU's climate and nature goals, the European Parliament has recently endorsed new policies, including a phase-down of primary woody biomass ('PWB,' biomass sourced directly from forests) for counting toward renewable energy targets. However, the proposed policy contains major loopholes that if not remedied, could render it just as ineffective as the existing RED II policy. As many policymakers lack information on biomass and its impacts, this report presents basic data from Eurostat and the UNFCCC on the types and amounts of fuels burned in each member state, the current state of the forest and land carbon sink, and the role of biomass in meeting renewable energy targets. Its conclusions can help policymakers revise the RED III biomass rules in Trilogue to ensure that biomass burned in the EU genuinely reduces emissions compared to fossil fuels and avoids continued forest degradation, allowing the EU to achieve its climate and nature targets.

Key findings

Treatment of biomass as a favored, subsidised 'zero carbon' fuel has driven a steep increase in use: Overall use of solid biomass in 2020 was 239% what it was in 1990. Use in the energy sector (heat and power) increased more than 1,000%, while industrial use increased 185% and residential/commercial self-heating increased 167%. Most of the increase has occurred since 2002, when the EU's first renewable energy policy promoting biomass went into effect. In 2020, 47% of biomass was burned for residential/commercial self-heating, 30% by the energy sector (including in electricity-only plants), and 22% in the industrial sector.

While biomass consists of a variety of materials, the majority is wood. More than half the wood burned in the EU for energy is sourced directly from forests ('primary woody biomass' or PWB); the balance is post-consumer waste and mill residues ('secondary woody biomass' or SWB). Nearly all residential use is PWB; larger facilities likely track PWB/SWB usage.

Some member states depend on imported biomass, particularly Belgium, Denmark, Italy, and the Netherlands. All these countries import wood pellets from countries where illegal and/or damaging forest harvesting is occurring. A recent investigation shows illegal logging of protected areas in eastern European countries that supplies residential wood pellets in Italy. Belgium, Denmark, and the Netherlands are importing pellets from Estonia, where protected areas are logged for pellets and the country has lost its forest carbon sink, despite large-scale wood pellet plants being certified 'sustainable' by the Sustainable Biomass Program. Wood pellets from Canada are now known to be linked to destruction of primary and old growth forests. The world's largest wood pellet company, based in the US, is known to be logging some of the most carbon-rich forests in the United States.

Current harvesting levels are degrading the EU's carbon sink. The EU lost about a quarter of its annual land sector carbon sink between 2002 and 2020, and the majority of member states are experiencing steep declines or have completely lost their land carbon sinks (Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Netherlands, Portugal, Slovenia). New data show a sharp decline in the forest carbon sink in Sweden, due in part to high logging levels. There is a clear link between biomass harvesting and land sink loss in some member states. Government researchers in Finland presented detailed statistics on energy use of wood and specifically identified roundwood burning as one driver for loss of the sink, while in Estonia, more than half the volume of wood harvested is being used for fuel or pellet

production. Latvia is home to several large wood pellet plants, with pellets also being exported. In some other countries, for instance Austria, there is a clear pattern where the carbon sink decreases as biomass use increases.

Biomass harvesting will put even the unambitious 2030 land sink targets out of reach, as well as 'net zero' by 2050. Biomass harvesting is driving forest degradation that will make achieving the 2030 climate targets impossible. The targets are unambitious because modeling conducted by the European Commission assumed forest biomass use will increase 50% by 2050, limiting potential carbon storage by forests. The model compensates for a weak land sink by assuming bioenergy with carbon capture and storage (BECCS) will store 250 million tons of CO_2 each year by 2050. This is a dangerous illusion - BECCS cannot, and will not, work at the scale that would be necessary to achieve meaningful net negative emissions. To achieve climate stability will require a much larger amount of carbon storage in forests, which will be impossible unless biomass harvesting is significantly reduced. **This is the most important message of this report.**

Biomass burning will put achieving cleaner air out of reach. As the EU prepares to revise the Air Quality Directive, the Commission impact assessment finds that compliance with WHO standards would save hundreds of thousands of lives per year and yield astonishingly large net benefits of €38 to €123 billion annually for health and the environment, as well as increasing GDP by up to 0.44% and personal consumption by up to 0.57%. However, the study is clear that benefits will not occur without significantly reducing biomass burning.

While biomass counts as a large share of renewable energy, actual useful energy generated is much lower. Burning solid biomass accounted for about 40% of energy counted toward the EU's renewables target in 2020. However, the EU's protocol for tallying renewable energy counts the energy content of *un*burned wood used for residential/commercial heating and industrial heat and power toward renewable energy targets, no matter how inefficiently it's burned, meaning the role of biomass in producing 'useful' energy is lower than its share suggests.

Renewable heating is dominated by biomass. Residential self-heating with biomass burning accounts for the largest share of renewable heating, which can instead come from solar thermal and ground- or air-source heat pumps. Biomass use tends to be highest in eastern European countries. Several countries, including Hungary, Poland, and Slovakia, have revised survey methods for counting residential wood-burning, producing abrupt increases in reported biomass use that allowed countries to achieve their renewable energy targets without additional action.

Only a minority of renewable electricity comes from burning biomass. As electricity generation tends to be the least efficient use of wood, any proposal to phase this use out quickly and replace it with clean electricity should be relatively easy to accomplish.

Policy Recommendations

The findings lead directly to the following priority asks for the Trilogue:

- **Stop financial support for energy from primary woody biomass** – reserve the funds for cleaner renewables such as geothermal, solar and wind that will help EU citizens afford their energy bills (Art 29.6, 29.1, 29.11)
- **Restrict the volume of primary woody biomass (PWB) which can count toward renewables targets** via a cap based on 2017 levels, and immediately institute plans for a phase-down by 2027 of PWB counting toward renewable energy targets (Arts 29.6, 29.1, 29.11)
- **Ensure the definition of PWB is science-based** (in line with the JRC definition) **and get rid of exemptions and loopholes** so it can be enforced and investors are given clear legal guidance (Art 2.2)
- **Make the cascading principle at least an EU implementing act** to ensure comparable and fair application across the EU and increase added value from the EU's wood supply and processing chains. (Art 3.3)
- **Immediately exclude biomass from primary forests, old growth forests, and wetlands from counting toward renewable energy targets** to ensure RED incentives are not driving further degradation of these biodiverse and carbon-rich ecosystems (Article 29.3, 29.4 as adopted by the European Parliament)

EU biomass policy reform is needed now

As the EU seeks to increase its climate ambition, the role of forest biomass is increasingly under fire. Many scientists, including from the European Commission (EC), acknowledge that far from being 'zero carbon' or 'carbon neutral,' burning forest wood for energy increases emissions for decades to centuries, with future offsetting uncertain as forests become more degraded. Scientists now warn that increasing renewable energy targets without reducing the climate and ecosystem impacts of forest biomass is a recipe for climate failure.

What EC scientists say about the carbon and ecosystem impacts of burning forest biomass

Logging and burning forest wood increases emissions for decades to centuries: Burning forest biomass emits more CO_2 than burning fossil fuels per unit energy produced,[1] and impacts last decades or longer. The EC's 2016 biomass impact assessment states, "*compared to crops which regrow over short periods, forest biomass is part of a much longer carbon cycle. A forest stand typically takes between decades and a century to reach maturity. Recent studies have found that when greenhouse gas emissions and removals from combustion, decay and plant growth (so-called biogenic emissions from various biological pools) are also taken into account, the use of certain forest biomass feedstocks for energy purposes can lead to substantially reduced or even negative greenhouse gas savings compared to the use of fossil fuels in a given time period (e.g. 20 to 50 years or even up to centuries).*"[2]

The simple problem is that burning trees emits CO_2 quickly, but regrowing trees to offset net CO_2 emissions takes much longer. Nor does 'sustainable' management provide a solution. As the impact assessment states, "*Sustainable forest management practices … play a role in mitigating the risk of overharvesting of forests. As such, **they cannot guarantee that an increase in forest biomass for energy will deliver greenhouse gas savings***."

The Joint Research Centre 2021 report[3] examined both climate and ecosystem impacts of forest biomass. Like the 2016 assessment, it concludes that forest biomass has large and long-lasting emissions impacts. It also examines the use of logging residues in depth. Scenario 1 from that report, 'coarse woody debris,' which along with stemwood constitutes the largest share of forest biomass burned in the EU, has high climate and ecosystem impacts (lowest red quadrant, Figure 1). The JRC clarified the definition of 'coarse woody debris' in a Q&A[4]: "*Downed or standing dead wood of dimension greater than 10 cm of diameter under bark at the large end*."

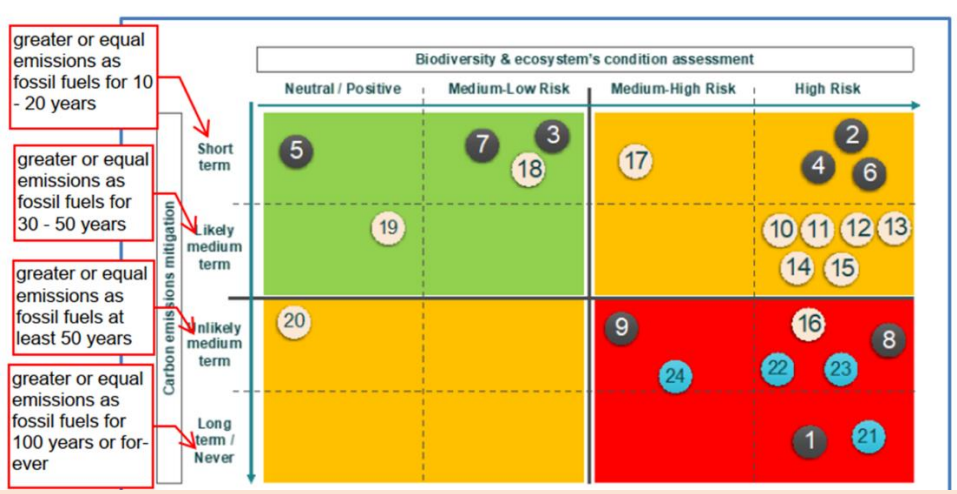

Figure 1. Annotated summary of net CO_2 emissions impacts and ecosystem impacts of biomass scenarios covered in the JRC report. Scenario 1 is 'coarse woody debris removal. Scenario 5 is "Fine Woody Debris (Slash - Coniferous) removal below landscape threshold," other scenarios at link.[5]

[1] https://forestdefenders.eu/biomass-plant-co2-emissions-an-explanation/
[2] https://ec.europa.eu/energy/sites/ener/files/documents/1_en_impact_assessment_part4_v4_418.pdf
[3] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC122719/jrc-forest-bioenergy-study-2021-final_online.pdf
[4] Question 9, https://knowledge4policy.ec.europa.eu/bioeconomy/faq-study-use-woody-biomass-energy-production-eu_en
[5] Page 9, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC122719/jrc-forest-bioenergy-study-2021-final_online.pdf

The EC's 2016 impact assessment on biomass sustainability concluded that to ensure that bioenergy contributes to climate change mitigation, the full lifecycle emissions including biogenic carbon must be considered. However, the EU's Renewable Energy Directive (RED) does not do this – it simply treats burning biomass as having 'zero' biogenic emissions. Despite increasing warnings from the scientific and advocacy community that biomass energy increases net emissions over climate-relevant timeframes, and increasing evidence that forests are being logged for fuel not only in the EU but in countries supplying the EU with biomass, policymakers continued to endorse unchecked wood-burning in the EU's Renewable Energy Directive published at the end of 2018 (RED II).

Ironically, policies cementing logging and burning forest biomass in the RED II were endorsed just as the LULUCF Regulation[6] was being revised to count forest and other land carbon sequestration toward the EU's climate targets. Both the RED and the LULUCF Regulation are supposed to contribute to achieving the EU's legislated goal of achieving 'net zero' emissions by 2050. In reality, they contradict each other, with the RED providing incentives and billions in member state subsidies to log and burn forests for energy, while the LULUCF Regulation takes steps, albeit small ones, toward rebuilding carbon storage in the land sector.[7] To align the EU's renewable energy policy with the goals of reducing emissions and restoring nature, a major reform of EU biomass policies is needed, particularly since in addition to undermining the EU's forest carbon sink, logging forests for fuel is undermining key EU nature objectives by promoting activities that degrade forests.

In July 2021, the European Commission (EC) formally recognized that biomass policy was in need of reform with a package of new policy proposals (RED III). Unfortunately, these proposals fell dramatically short of being able to help effect the reduction in biomass use that will be required to help the EU's land carbon sink to recover to levels of even a few years ago, much less grow to the extent needed to deliver the 2030 land sink targets and net zero by 2050. In 2022, as part of its consideration of the EC's policy package, the European Parliament's Environment Committee voted to strengthen the approach, recommending an end to counting primary woody biomass[8] toward renewable energy targets in the RED. That proposal was somewhat weakened by the Industry Committee, and the final package of amendments, some slightly overlapping and some contradictory, was finalized in a vote by the full Parliament on September 14, 2022.[9] The next stage is the Trilogue negotiations between Parliament and national governments, when a fully realized, consistent policy is supposed to emerge.

Meanwhile, since early 2022, the war in Ukraine and the consequent fuel crisis that has gripped the EU has intensified pressure on forests as people have rushed to stockpile firewood and buy new wood-burning stoves.[10] A recent investigation into illegal logging for wood pellet production in eastern European countries shows the problem of illegal harvesting for biomass already represents a significant threat to the EU's forests,[11] and demand for wood will likely rise to unprecedented levels in the coming months. Wood shortages and firewood theft are causing increasing desperation, pointing towards an obvious conclusion – that dependence on wood and the consequent crisis would have been much reduced if the EU had years ago doubled down on heat pumps, solar thermal, clean electricity for renewable heating and building insulation/energy efficiency, instead of continuing to rely on residential biomass burning to meet renewable energy goals – literally a 'prehistoric' strategy.

Far from benefiting the public, the EU's promotion of biomass as renewable energy is profoundly harmful because it reduces the incentive to promote cleaner alternatives. Biomass heating is the largest source of fine

[6] LULUCF = Land Use, Land Use Change, and Forestry

[7] See https://www.pfpi.net/wp-content/uploads/2021/11/PFPI-EU-Land-Sink-Target-report-Nov-23-2021.pdf

[8] While the definition of PWB should essentially overlap the RED II definition of forest biomass as "biomass from forestry," the definition adopted by the ENVI committee excludes biomass from forests impacted by certain stressors from the definition.

[9] For a brief overview, see https://forestdefenders.eu/european-parliament-vote-signals-the-beginning-of-the-end-for-forest-biomass-as-renewable-energy/

[10] https://www.euractiv.com/section/energy-environment/news/firewood-prices-shortages-spell-cold-winter-for-europes-poorest/

[11] https://nyti.ms/3MOrhCE

particulate matter, contributing to more than 1,000 premature deaths per day even before the pandemic[12] and billions per year in health costs.[13] A recent European Commission impact assessment[14] for the revision of the Air Quality Directive[15] finds that reducing air pollution in line with World Health Organization standards would save hundreds of thousands of lives per year and yield astonishingly large net direct benefits of €38 to €123 billion per year[16] for health and the environment (including reduced impacts on crops and forests that are damaged by air pollution), as well as increasing GDP by up to 0.44% and personal consumption by up to 0.57%. However, as biomass heating is the largest source of fine particulate matter, the assessment is clear that benefits will not be achievable without a significant reduction in biomass burning.[17]

Nonetheless, *all* biomass, even that burned using the most inefficient, polluting burners, is counted toward Union and member state renewable energy targets. Energy poverty is a serious problem in the EU, and many people still depend on wood heating for survival. For those people, the EU's biomass policy locks them into continuing dependence on wood-heating and forces them to compete for increasingly limited resources with subsidised large-scale wood-burning power plants. A single 50 MW biomass electricity plant burns as much wood per year as around 180,000 homes and can receive around €16 million in renewable energy payments at typical subsidy rates. EU citizens pay out around €17 billion a year in taxpayer funds for bioenergy subsidies,[18] funding that could instead support clean energy. For example, the 205 MW Polaniec biomass power station in Poland received about €65.4 million in subsidies in 2021.[19] Meanwhile, Poland is trying to accelerate deployment of heat pumps,[20] an effort that would greatly benefit from a yearly infusion of support such as the Polaniec plant receives. A tree can only be cut and burned once, but money spent on genuinely renewable heating is a long-term investment.

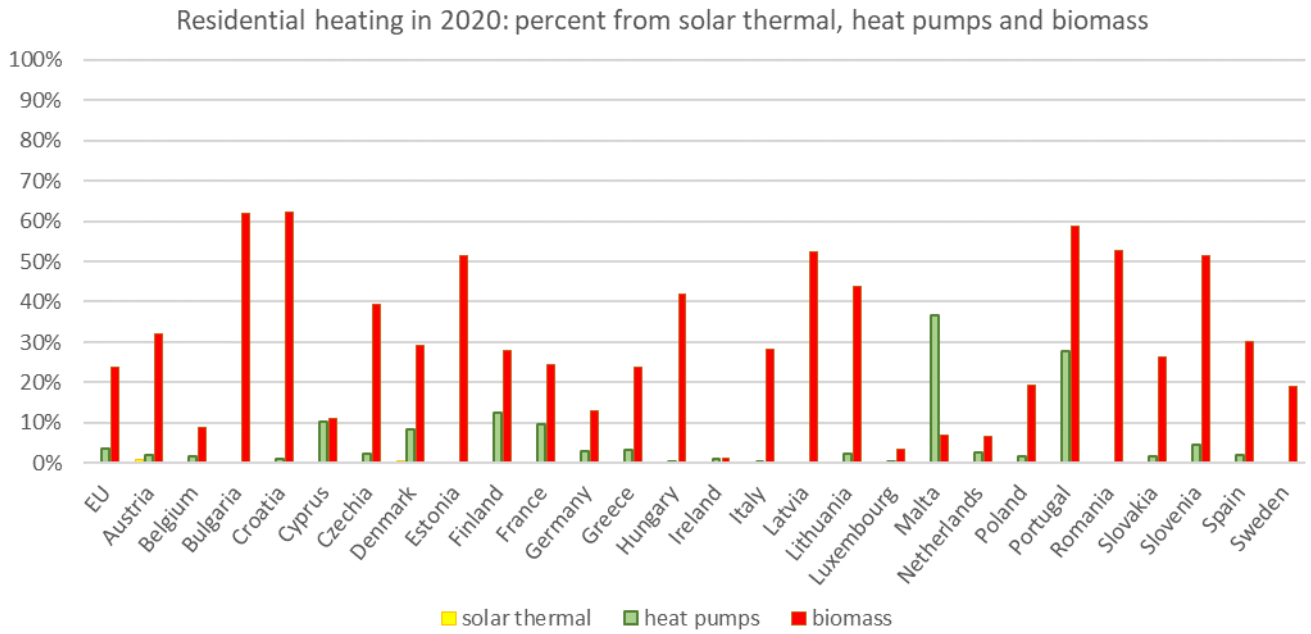

Figure 2. The percent total home self-heating provided by solar, heat pumps, and biomass.[21] Solar is included, but is so low it is difficult to detect. These data differ from the member state graphs below that show percent renewable heating provided by biomass.

[12] https://forestdefenders.eu/wp-content/uploads/2021/05/FDA-air-pollution-factsheet.pdf
[13] https://www.newscientist.com/article/2314156-health-impacts-of-wood-burning-cost-eu-and-uk-e13-billion-a-year/
[14] https://eur-lex.europa.eu/resource.html?uri=cellar:a5235624-55f8-11ed-92ed-01aa75ed71a1.0001.02/DOC_1&format=PDF
[15] https://environment.ec.europa.eu/publications/revision-eu-ambient-air-quality-legislation_en
[16] Depending on the assumptions made about the value of years of life lost, versus what people are willing to pay to avoid health impacts that could shorten their lives.
[17] The impact assessment states that fine particulate emissions from residential heating "can be reduced in the model optimisation by addressing biomass burning, since the role of coal is declining and so abatement potential around coal becomes less and less relevant"
[18] https://op.europa.eu/en/publication-detail/-/publication/be5268ba-3609-11ec-bd8e-01aa75ed71a1/language-en
[19] Revenues from certificates of origin was 312,180 PLN in FY 2021 (Financial report for ENEA Elektrownia Poÿaniec SA, 2021).
[20] https://wapo.st/3DlQjFZ
[21] Disaggregated final energy consumption in households - quantities [nrg_d_hhq]

Figure 2 shows consequences of inadequate support for clean heating. Solar thermal and heat pumps lag far behind biomass as a source of heating (solar thermal barely even shows up on the chart). Failure to meet the real need for clean heating means people are locked into continuing to burn wood, even as EU policymakers congratulate themselves on setting ever more ambitious renewable energy targets. Important to the EU's climate and nature restoration goals, *none* of the EU's current 'sustainability' criteria for biomass apply to residential heating, meaning the largest share of wood burned in the EU is not covered by any such requirements. Reforming policy to ensure that burning PWB no longer counts toward renewable energy targets would not prevent people from burning wood, but it would induce member states to invest in clean technologies like geothermal, solar, and genuinely clean electrification, giving people alternatives. However, instead of endorsing attempts to replace dependence on wood with clean energy, some policymakers appear to be arguing that ending treatment of wood-burning as renewable energy amounts to a 'ban' on burning wood. In fact, no one is proposing to ban anything (except for certain municipalities that are finding the pollution load from wood-burning intolerable).

The purpose of this report

Going into the Trilogue, where the RED biomass policy will be finalized, there is still much confusion concerning how much biomass is burned, where it is burned, its role in providing renewable energy, and its apparent connection to accelerating loss of the EU's forest carbon sink. This report attempts to address those questions.

Graphical presentation of Eurostat data helps illustrate the use of biomass, the types of materials burned and the kinds of energy it has provided since 1990, as well as its role in counting toward the EU's renewable energy targets since 2004.[22] Data that member states have submitted to the UNFCCC, supplemented by additional data as available, illustrate the status of the land and forest carbon sink in EU member states since 1990, as far as it is currently understood.[23] While there are a number of deficiencies and inconsistencies in the data,[24] a general picture emerges, that in allowing dependence on wood-burning as 'renewable' energy to continue, the EU has made a profound error. The best time to fix a mistake being immediately after making it, and the next best time being now, we hope that it's not too late for the Trilogue to dramatically strengthen bioenergy reforms to ensure that burning wood does not continue to undermine the EU's climate and nature goals.

A note on methodology

In the following graphs and analyses, data from Eurostat that were presented on an energy basis (usually terajoules, but sometimes other units) have been converted where appropriate to equivalent tonnes of green wood, making certain assumptions.[25] This introduces small errors for certain feedstocks,[26] and some may object to 'backing out' black liquor to the tonnes of wood that its energy content represents, given that the wood was harvested for the purpose of pulp and paper manufacture. Nonetheless, given the predominance of wood as a source of fuel, and the relatively small differences in carbon content and energy content of biomass fuels that constitute a small share of total biomass use, the approach is worthwhile for its simplicity.

[22] Eurostat data for production and consumption from dataset "Complete energy balances [nrg_bal_c]"; data on renewable energy shares from https://ec.europa.eu/eurostat/web/energy/data/shares

[23] https://unfccc.int/ghg-inventories-annex-i-parties/2022

[24] Likely including the dreaded 'unknown unknowns'

[25] That green wood is about 45% moisture content (wet weight basis) and that bone dry wood is about 20,004 kg/kg.

[26] For details on the energy content of fuels, see Table 1 at https://iopscience.iop.org/article/10.1088/1748-9326/aaac88/pdf

Findings: Biomass use and land carbon sink impacts in the EU

These findings include summary statistics for the time-series graphs of biomass use, its contribution to renewable energy, and the land carbon sink for each member state. Hyperlinks are provided in the text to jump to appropriate graphs. **Graphs are best viewed as a two-page spread.** This section also contains highlighted commentary on proposed policy reforms.

Biomass use has more than doubled since 1990, and renewable energy policies are the main driver

Overall use of solid biomass in 2020 was 239% what it was in 1990[27] for the EU as a whole, with even greater increases in some member states. Most of this increase has occurred since 2002 (Figure 3), when the EU's first renewable energy policy actively promoting biomass went into effect.[28]

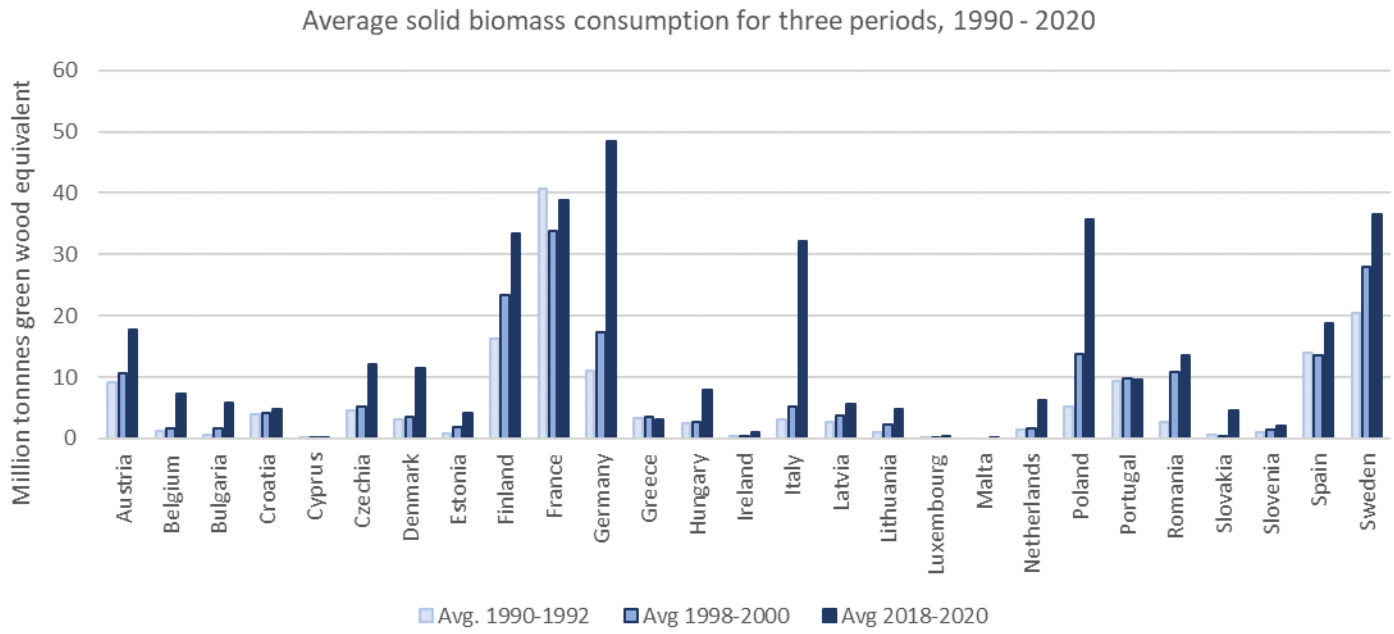

Figure 3. Average biomass consumption for three 3-year periods based on Eurostat consumption data. Most member states have seen a significant increase.

Wood is the predominant form of biomass burned, and official statistics probably underreport actual use

While heat and power facilities in the EU burn a variety of materials, most of the biomass burned in the EU is wood (Figure 4). Sweden, Finland, and Portugal get around half their wood energy input by burning black liquor, a byproduct of the pulp and paper industry. Wood pellet production is growing, but wood pellets still constitute a minority of wood burned for energy.

[27] Some portion of this increase may be due to changes in how or whether biomass use was reported, rather than an actual increase. See for instance Germany.

[28] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0077&from=en

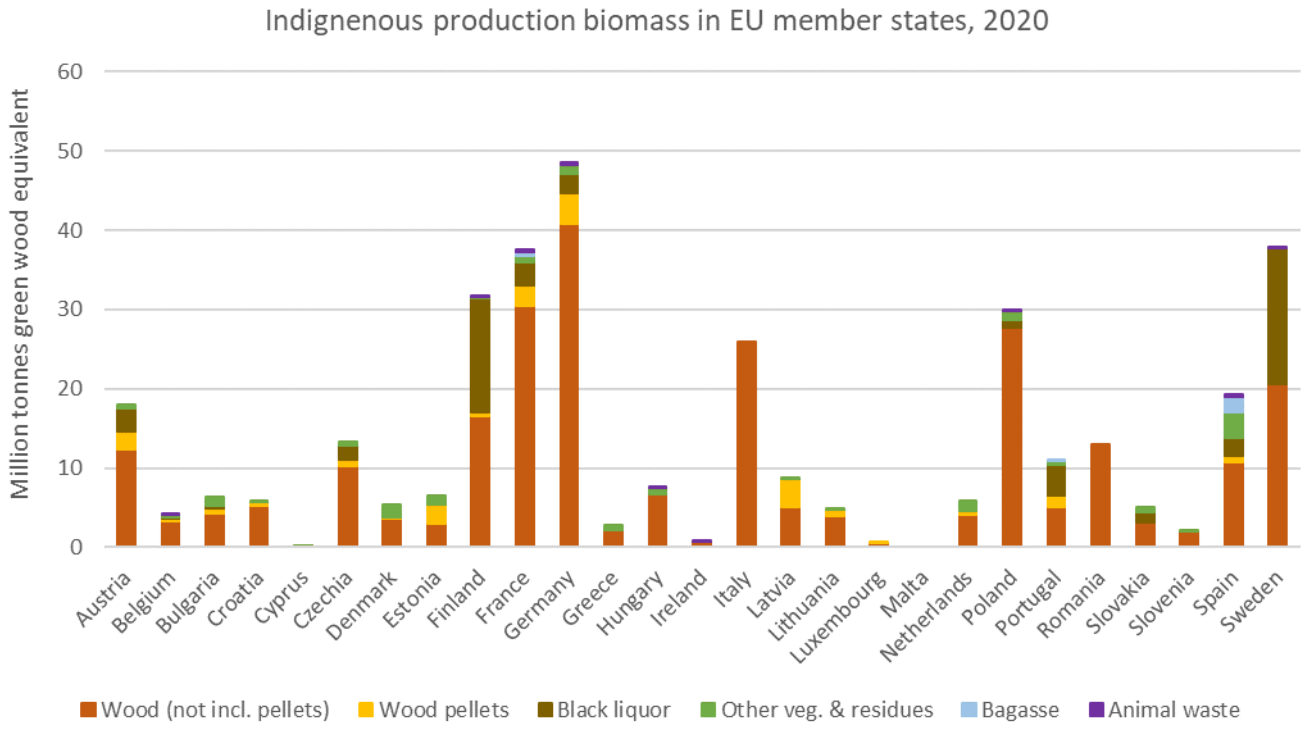

Figure 4. Biomass production in member states. Wood constitutes the majority of biomass burned, though industrial consumption of black liquor plays a meaningful role in Finland and Sweden. These data do not distinguish between primary and secondary wood.

Relevance to EP proposal: According to the Joint Research Centre, about half the wood burned in the EU as of around 2016 was primary woody biomass (PWB), meaning wood sourced directly from forests, and half was secondary woody biomass (SWB), meaning post-consumer wood and mill residues like sawdust, offcuts, and black liquor (a byproduct of the pulp and paper industry).[29] The amount coming from PWB is likely greater now, as biomass use continues to increase but sources of mill residues do not (see member state carbon flux graphs). Any proposal to limit and ultimately phase out counting PWB toward renewable energy targets will require criteria that can be implemented at the facility level. There is no current EU-wide database that identifies sectoral use, much less facility-level use, of PWB versus SWB. However, tracking such information would not be challenging. Most residential use of wood is of PWB, and operators of individual energy sector and industrial boiler operators likely know what type of wood they are burning, and may even report these data, as in Finland.[30]

It is critical in any case that the EU develop better data on the amount and types of wood burned for energy. The JRC found that wood reported as *used* for manufacturing and energy exceeds wood reported as *harvested* by more than 20% for the EU overall, with large differences among member states.[31] The gap is mostly attributable to energy use of wood, whether it be for residential heating, industrial use, or the energy sector (see next section for more detail on how energy sector use is likely underestimated). The JRC concludes *"The current significant gap in data represents a major obstacle to the effective governance of wood-based bioenergy policies at national scale…**Without reliably knowing how much and what type of forest biomass is used for bioenergy, no effective policy can be implemented**."*[32] This is a strong argument for disqualifying energy from PWB from counting toward renewable energy targets as soon as possible. The phase-out should be swift and certain.

[29] https://publications.jrc.ec.europa.eu/repository/handle/JRC122719
[30] https://forestdefenders.eu/yes-finland-is-devouring-its-forests-for-biomass-fuel/
[31] For example, researchers in Hungary determined that households' use of biomass is higher than the official figure for the total domestic supply of biomass. https://wwf.hvgblog.hu/2022/09/14/tobb-tuzifa-kellene-iden-de-eddig-sem-tudtuk-hogy-mennyi-van/
[32] https://publications.jrc.ec.europa.eu/repository/handle/JRC122719

Residential use and other building self-heating represents the majority of wood burned

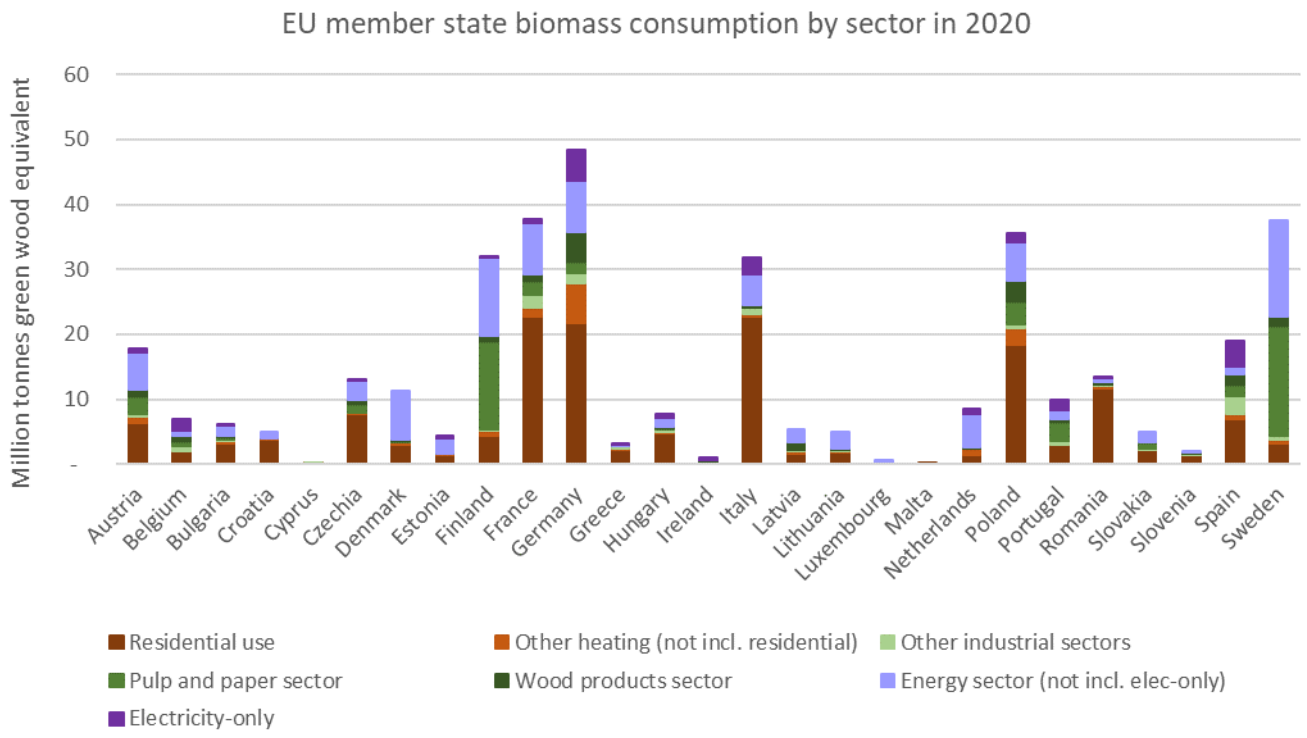

Figure 5. Consumption of solid biomass by sector. Residential heating accounts for the largest use.

Figure 5 shows reported biomass consumption by sector in 2020.

- The largest portion (47%) of wood is burned for self-heating of homes and commercial properties (dark and light brown). Average consumption in the EU for building self-heating over 2018-2020 was equivalent to 178 million green tonnes of wood, an increase from 1990 of 186%. The majority this wood is certainly PWB, though some pellets burned for building heating are made from sawmill residues, considered to be SWB. However, *total* pellet consumption in the EU (including pellets burned in the energy sector for heat and electricity) was around 23 million tonnes in 2021,[33] translating to about 38 million tonnes of green wood, indicating that pellets supply only a minority of building self-heating. Relevance to EP proposal: Logging for residential heating is widespread in the EU, but is poorly characterised since much of this logging does not get reported in official statistics. Logging for building self-heating, including for pellets burned in in this sector, appears to be increasingly responsible for degradation of the EU's forests **but is not subject to any sustainability criteria in the RED.** Particularly given the current fuel crisis, the best way to reduce self-heating with wood and give the EU's forests a chance to recover is to stop counting residential wood-burning toward targets, which will induce member states to deploy clean renewable heating and electrification more swiftly.
- Energy sector use (heat plants and combined heat and power plants, light purple; electricity-only plants, dark purple) was 30% of total use in 2020. Converting Eurostat data on energy input to green tonnes produces an estimate of 111 million tonnes total and 19 million tonnes in electricity-only plants in 2020. Use in this sector was more than ten times in 2020 what it was in 1990. Relevance to EP proposal: The Eurostat data likely underestimate the actual amount of wood burned. While fuel use by large plants is relatively well-characterized – for instance, data from the EU's Large Combustion Plant database indicates that total biomass use by plants 50 MW and greater was around 64 million tonnes green wood equivalent

[33] https://bit.ly/3FsNtQW

in 2020[34] – fuel use by small heat and combined heat and power (CHP) plants may be greater than reported by Eurostat. As evidence: a 2013 survey coordinated by the European Biomass Association[35] identified 4,079 biomass plants greater than 1 MW energy input in the EU burning wood to generate heat, electricity, and combined heat and power, consuming around 129 Mt of green wood fuel, which is equivalent to the 2020 estimate for the *entire* energy sector, including large plants. As the JRC has concluded, it is impossible to implement effective policy when such uncertainties exist.

- Industrial sector use (greens) accounts for 22%, most of which is black liquor used in Finland and Sweden, as can be seen in Figure 4. The industrial sector does burn PWB, however, because the amount of SWB that industries self-generate is not enough to fuel their boilers, especially considering that some mill residues are sold as feedstock for other products such as panelboard. Use in this sector in 2020 was 167% what it was in 1990.

Per capita biomass use varies greatly across the EU, and explains some differences in total use

The amount of biomass consumed varies by the geographical and population size of member states. Figure 6 shows biomass consumption per capita for all biomass (blue) and residential self-heating (brown; this does not include heating plants or CHP plants). The figure helps put overall use into perspective. For instance, while Germany and France have the highest consumption overall (Figure 5), their per capita use is similar to the EU average. Certain countries with small populations, including Finland and Sweden, have some of the highest per-capita use due to intensive use of biomass energy by the wood products industry. Estonia and Latvia are large biomass exporters, and while consumption per capita is already high, the values would be 50% and 63% higher, respectively, if the data showed total biomass production per capita instead of consumption.

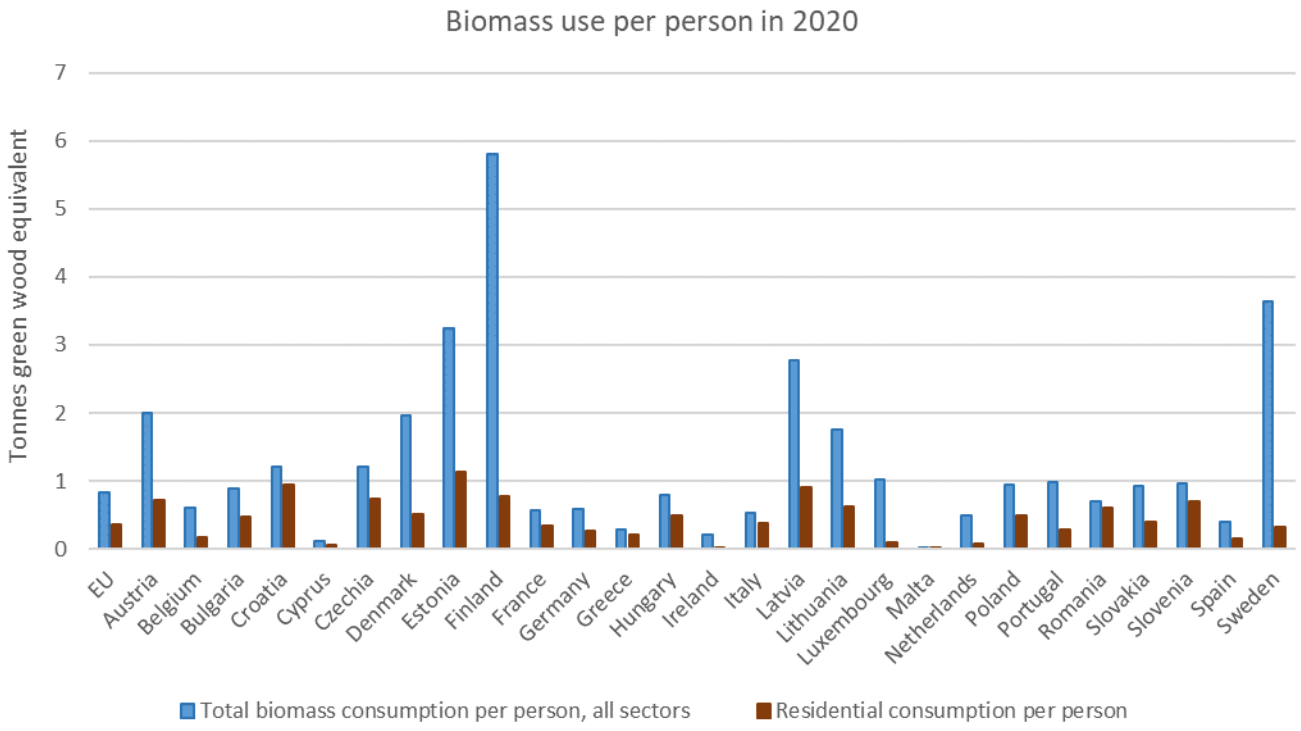

Figure 6. Biomass use for energy per capita, 2020. Residential heating represents self-heating only, not district heating plants.

[34] Table FS_2_Detailed emissions and energy input from LCP, at https://www.eea.europa.eu/data-and-maps/data/lcp-9/user-friendly-tables-in-excel/lcp_extract_xlsx.zip

[35] BASIS Bioenergy. Project results (updated 17.03.2016) At https://bit.ly/3SQe8KP

Some member states already depend on imported biomass

Exports and imports of biomass account for differences between biomass production (Figure 4) and consumption (Figure 5) at the member state level. Eurostat publishes data on imports and exports of wood burned for energy, including fuelwood, 'wood pellets and other agglomerates,' and 'chips, particles and residues.' Because it is not possible to separate the portion of chips and residues that is utilized for energy versus material products, only the fuelwood data (Figure 7) and wood pellet data (Figure 8) are shown here.

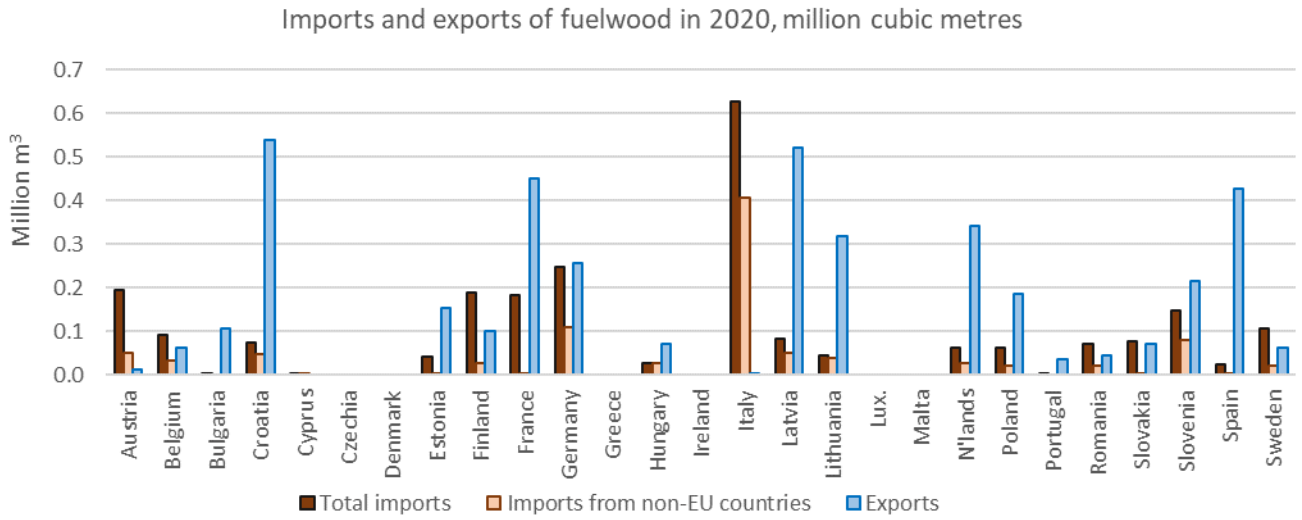

Figure 7. Imports and exports of fuelwood, generally meaning firewood, in units of cubic metres. Exported fuelwood is kiln-dried using natural gas or wood for heat and is shipped on pallets all over the EU and beyond.[36] Since one cubic metre of wood 'over bark' is approximately equivalent to one tonne of green wood,[37] the values essentially also represent million green tonnes.

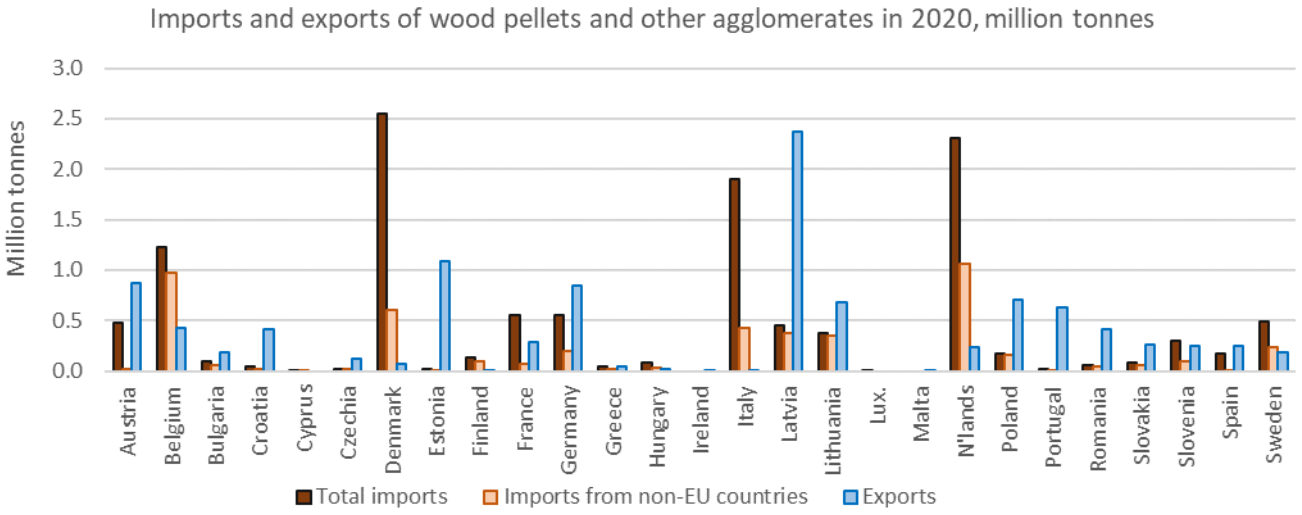

Figure 8. Eurostat data in tonnes of wood pellets. Assuming a moisture content of around 10%, one tonne of wood pellets represents around 1.64 tonnes of green wood at typical moisture content,[38] though the true amount of wood associated with pellet manufacture from stemwood is much greater when parts of the tree harvested but not manufactured into pellets are taken into account.

[36] For example, see VliTimber in Lithuania (https://www.vlitimber.eu/products/). The company ships their 'carbon neutral' (as they claim) firewood to EU countries, the United States, and New Zealand (https://www.vlitimber.eu/company/).

[37] https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2019/sources-4/timber/conversion-factors-4/

[38] Assumes moisture content of 45%.

Certain countries stand out in the import-export data.[39]

- Belgium's large increases in biomass electricity at the least efficient electricity-only plants are fueled by wood pellet imports (see consumption data). Showing that it's possible for member states to go beyond EU policies, the Flemish environment minister has banned further pellet imports to the Rodenhuize biomass plant (1.5 million tonnes per year coming from Russia, Chile, and Canada), saying "*If we protect and plant forests in Flanders, we can hardly allow unceremoniously cutting down the taiga in Russia to stoke up in our backyard?*" Interestingly, while the basic Eurostat imports dataset shows that Belgium imported over a million tonnes of wood pellets in 2020, a more detailed country-to-country trade dataset[40] does not record *any* imports for Belgium in *any* year. Such discrepancies among Eurostat datasets are unfortunately not uncommon and raise real questions about accountability and how 'sustainability' standards can be enforced, if basic data are not available.
- Italy imports large amounts of both fuelwood and wood pellets, due in part to an aggressive push by the government to encourage residential wood heating. Some of the pellets burned in Italy are known to be imported from illegally sourced wood in Romania, as shown by a recent story in the New York Times.[41]
- Denmark has lost its carbon sink completely and depends heavily on imported wood, including eucalyptus chips that Denmark imports from Brazil to partially fuel a Copenhagen biomass plant that consumes 1.2 million tonnes of wood chips per year.[42] This source is off the books regarding its impact on land carbon stocks and sinks, since loss of carbon from Brazil's forests will not show up in the European carbon accounts. The Eurostat country-to-country pellet trade dataset shows Denmark imported wood pellets in 2020 from Germany, Estonia, Latvia, Lithuania, Poland, Portugal, Sweden, Russia, Ukraine, Canada, and the US.[43]
- Latvia and Estonia are important exporters, supplying Denmark, France, Italy, the Netherlands, and the United Kingdom. Both have essentially lost their land carbon sink. Lithuania is a smaller exporter but is nonetheless supplying pellets to several countries, including Denmark, France, Italy, and the Netherlands. Lithuania has seen a sharp decrease in its carbon sink in recent years.
- The Netherlands imports large amounts of wood pellets to fuel electricity plants it has converted from coal to biomass. In 2020, according to Eurostat's country-to-country dataset, it imported wood pellets from Belgium, Germany, Estonia, Latvia, Lithuania, Poland, Portugal, Russia, Canada, and the United States.

The relatively small amounts of exports for certain member states belie the enormous damage being done by the wood pellet industry, as shown by several investigations.

Estonia. A multi-reporter investigation published in 2021[44] worked with NGOs to demonstrate massive damage by the wood pellet industry in Estonia, a country that has now completely lost its natural forest carbon sink. Biomass harvesting by the wood pellet industry there is sanctioned and approved under the Sustainable Biomass Program (SBP), for which all the big Estonian and Latvian pellet plants are certified.[45] Relevant to the EP proposal, the SBP essentially mirrors the same 'sustainability' requirements required under the RED II, all of which are likely

[39] The Eurostat dataset 'Roundwood, fuelwood and other basic products [for_basic]' contains the import/export data.
[40] Imports of biofuels by partner country [nrg_ti_bio]
[41] https://nyti.ms/3MOrhCE
[42] https://nyheder.tv2.dk/samfund/2020-02-23-koebenhavn-braender-trae-fra-amazonas-for-at-hjaelpe-klimaet
[43] The Eurostat dataset 'Imports of biofuels by partner country [nrg_ti_bio]' contains information on the importing and exporting countries.
[44] https://www.theguardian.com/world/2021/jan/14/carbon-neutrality-is-a-fairy-tale-how-the-race-for-renewables-is-burning-europes-forests
[45] Pages 6, 28, 42, 52 at https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

to be carried forward under RED III. The fact that these 'certifications' have nonetheless allowed to total loss of the forest carbon sink demonstrates their essential uselessness.

Eastern European countries. The New York Times[46] covered an NGO investigation of illegal logging for pellet manufacture in eastern European countries. Using government timber transport data, GPS trackers, satellite imagery and field visits, environmental NGOs in Slovakia, Poland, Bulgaria and Romania documented clear evidence of the direct link between logging in Natura 2000 sites and wood utilization in biomass facilities. The investigations demonstrated that the biomass industry is not just using residues of the sawn timber industry but is sourcing wood from additional logging within EU forests. The investigations focused on Natura 2000 sites - forests the EU claims to be 'protected' - but in some cases, stemwood was also sourced directly from Natural Parks and National Parks.[47] Relevance to the EP proposal: protected areas are already supposed to be off-limits for biomass that's counted toward renewable energy targets, but these rules only apply to biomass burned in facilities over a certain size, and not to residential biomass use,[48] which is what much of the protected area biomass is used for. The sustainability standards for biomass are, and will continue to be, essentially performative – a 'show' of rules that don't apply to the majority of wood harvested for fuel, or can't be implemented, or both. The RED III process runs a real risk of continuing this performance, which is why it is essential to stop qualifying forest biomass (PWB) toward the EU's renewable energy targets as soon as possible.

Canada. Recent exposés by the BBC[49] and the Canadian Broadcasting Corporation[50] have shown that Drax, the world's second-largest wood-pellet producer, is logging Canadian primary and old growth forest for feedstock. This is relevant to provisions in the EP proposal that disqualify biomass logged from primary and old growth forests from counting toward renewable energy targets. These recent investigations demonstrate the difficulty of crafting definitions and rules that can be implemented and will genuinely protect forests. A central scandal shown in the BBC documentary is that Drax sends logs harvested from primary forests to mills to be chipped into sawdust, then ships this sawdust back to the pellet manufacturing plant to be processed into pellets as 'mill residues.' This practice is forbidden under the RED II rules, which specify what qualifies as true mill residues.[51] The BBC documentary also shows how Drax claims the logged areas are not actually primary forests, because they have roads nearby. They also claimed the forests 'needed' to be logged because of a few standing dead trees that, according to them, present a fire risk. None of this is surprising given that Drax understands that continuing to log these carbon-rich forests for wood pellets is central to its business model, a fact that is also demonstrated by Drax's interventions in the RED legislative process,[52] interventions that are no doubt ongoing. Relevant to the EP proposal, the definitions of primary forests and old-growth forests currently included are not consistent with those used elsewhere, including the Convention on Biological Diversity, to which the EU is a signatory. Accordingly, the definitions of primary forest and old growth forest should be made distinct and should be consistent with those of the CBD, if not identical. The definitions should also be added to Article 2.[53]

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[46] https://nyti.ms/3MOrhCE

[47] https://us.eia.org/report/the-eus-renewable-energy-policies-driving-the-logging-and-burning-of-europes-protected-forests/

[48] Pages 7, 10, 11 at https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

[49] Film at https://www.youtube.com/watch?v=qadWRkPkKus; article at https://www.bbc.com/news/science-environment-63089348

[50] Film at https://www.youtube.com/watch?v=5lAlqhyaMQQ

[51] Recital 42, RED II: "'*residue' means a substance that is not the end product(s) that a production process directly seeks to produce; it is not a primary aim of the production process and the process has not been deliberately modified to produce it*;"

[52] https://forestdefenders.eu/the-us-pellet-industry-is-trying-to-gut-eu-biomass-policy-reforms/

[53] CBD definition of **primary forest**: "*A primary forest is a forest that has never been logged and has developed following natural disturbances and under natural processes, regardless of its age*" (at https://www.cbd.int/forest/definitions.shtml). This definition can include forest areas that are surrounded by roads. The definition stipulates that in Europe the term can have a more expansive meaning: "*In much of Europe, primary forest has a different connotation and refers to an area of forest land which has probably been continuously wooded at least throughout historical times (e.g., the last thousand years). It has not been completely cleared or converted to another land use for any period of time. However traditional human disturbances such as patch felling for shifting cultivation, coppicing, burning and also, more recently, selective/partial logging may have occurred, as well as natural disturbances. The present cover is normally relatively close to the natural composition and has arisen (predominantly) through natural regeneration, but planted stands can also be found. However, the suggested definition above would include other forests, such as secondary forests*."

United States. There have been multiple investigations of the wood pellet industry in the United States that have demonstrated again and again that the industry consistently lies when it claims to only use mill residues or forest residues as pellet feedstock. These investigations have been largely ignored by most EU policymakers, who seem content to accept the industry's representations and do not seem concerned about outsourcing forest damage. Meanwhile, the forest destruction and social damage continues, as illustrated by investigations on feedstock sourcing[54] and environmental justice depredations[55] at US-based Enviva, the world's largest wood pellet company. Ending imports of wood pellets made from forests of the US and Canada should be a top priority, constituting a kind of litmus test for the efficacy of RED biomass reform.

Biomass harvesting is degrading the EU's carbon sink

Scientists have long warned that continued use of biomass will undermine the EU's forest carbon sink. Now, that process is accelerating. Intensive harvesting of EU forests, including for biomass, has contributed to steep declines and even the total collapse of the forest and land carbon sink in certain member states, especially in recent years (see member state graphs). Recent data on land sector carbon flux show:

- The EU lost about a quarter of its annual carbon uptake in the land sector between 2002, when the first renewable energy policy incentivising biomass use went into effect, and 2020, the latest year for which data on every EU member state are available.
- The majority of member states are experiencing steep declines in their forest and/or land sinks (Bulgaria, Croatia, France, Germany, Lithuania, Slovakia) or have effectively lost their sinks (Austria, Belgium, Bulgaria, Czechia, Denmark, Estonia, Finland, Germany, Ireland, Latvia, Netherlands, Portugal, Slovenia). While these trends are related to a variety of factors, as the member state graphs below demonstrate, in many cases the trend is contemporaneous with an increase in biomass use.
- Even Sweden, where it's common to hear that forestry is 'sustainable' and where the forest sink has been relatively stable, is seeing a decrease. New data from the Swedish Environmental Protection Agency shows a 'substantial reduction' in the forest and land carbon sink due to declining forest growth and high logging levels in recent years. The agency's press release acknowledges "*The sharp decline in net storage may mean that Sweden will find it difficult to reach the EU's common climate goals linked to the land use sector*."[56] While Sweden's use of bioenergy occurs mostly in the industrial sector (Figure 5), the financial benefits of bioenergy – including its exemption from carbon taxes – is an important factor enabling continuation of the intensive 'Swedish model' of forestry.

In some member states the link between degradation or loss of the land carbon sink and biomass energy is clear.

While much of the bioenergy generated in Finland is from black liquor, direct burning of forest wood is increasing and exceeds its use for other products.[57] Finnish government researchers presented detailed statistics on energy use of wood[58] specifically identifying roundwood burning as a driver for total loss of the land sink in 2021. They

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CBD definition of **old growth forest**: "*Old growth forest stands are stands in primary or secondary forests that have developed the structures and species normally associated with old primary forest of that type have sufficiently accumulated to act as a forest ecosystem distinct from any younger age class*."

[54] https://www.nrdc.org/sites/default/files/global-markets-biomass-energy-devastating-us-forests-202209.pdf; https://www.politico.com/news/magazine/2021/03/26/biomass-carbon-climate-politics-477620

[55] https://www.cnn.com/interactive/2021/07/us/american-south-biomass-energy-invs/

[56] https://www.naturvardsverket.se/om-oss/aktuellt/nyheter-och-pressmeddelanden/nettoinlagringen-av-koldioxid-i-vaxande-trad-minskar-kraftigt/

[57] https://forestdefenders.eu/yes-finland-is-devouring-its-forests-for-biomass-fuel/

[58] The volume of roundwood burned as energy increased by 14 per cent from the previous year to 12.9 million cubic metres. In addition, 17.7 million cubic metres of various by-products and wood residues, including bark and logging residues, were consumed in energy generation.

stated, "*The growing demand for forest industry products and especially the increased use of forest energy drove the total consumption of unprocessed roundwood in 2021 to a record-high level in the history of the statistics.*"[59]

In Estonia, overlaying data on biomass production with total harvesting[60] shows that more than half the volume of wood harvested is being used for fuel or pellet production. Like Estonia, Latvia is home to several large wood pellet plants owned by Graanul Invest that utilize trees purposefully harvested for wood pellet production. It can literally be said therefore that some of the forest carbon sink of Estonia and Latvia is being liquidated in the skies of Belgium, Denmark, and the Netherlands, all countries that import wood pellets from the Baltics.

In many countries, the data show the carbon sink decreasing as biomass use has increased, but characterizing the role of biomass can be challenging. A variety of factors are contributing to degradation of the land carbon sink, including poor forest management that has replaced resilient and carbon-rich natural forests with plantations and managed forests. Replacement with plantations represents essentially a permanent transfer of forest carbon to the atmosphere, as well as increasing forest susceptibility to climate-change related factors of drought, pest infestation, and fires. Such disturbances may not themselves cause a significant or immediate loss of ecosystem carbon if forests are left alone to recover, but salvage logging does immediately reduce land carbon stocks. This is relevant to the EP proposal because the loopholes in the definition of PWB, as discussed below, would leave wood from salvage logging out of the definition of PWB and allow it to continue to count toward renewable energy targets even after PWB no longer qualifies. As salvage logging constitutes an increasing share of total logging in some member states, this would allow massive amounts of forest wood to continue to be burned for so-called 'zero carbon' renewable energy, when in fact logging this wood strips carbon out of the forest and often damages forest recovery.

One thing is clearly not a driver of forest sink loss – there has been no big additional transfer of forest carbon into harvested wood products in recent years (HWP). Production of HWP (tracked for UNFCCC reporting purposes as paper, panelboard, and sawn wood products[61]) has remained largely stable in most EU member states since 1990, which also means that the amount of mill residues and other SWB that can be burned for energy is also stable. Meanwhile, consumption of biomass for energy has increased steeply, with new biomass harvested directly from forests meeting much of the demand. Studies using satellite data has detected an abrupt loss of forest carbon density in European forests, with biomass harvesting playing a role.[62] The ability of the biomass industry to burn nearly any kind of wood, even if it is considered 'low value' for other purposes, has provided a lucrative incentive for much more intensive logging than in the past.

Relevance to EP proposal:

Capping biomass use: Damage to the EU's carbon sink is happening at current levels of logging, so the EP's proposal to 'cap' use at the 2017-2022 average essentially locks in continuing damage or even worse damage, if 2022 wood use levels rise significantly. In any case, 2016 is the most recent year for which the JRC has compiled data on use of PWB at the member state level. The cap should be set at or below 2017 use levels.

Phase down in biomass use: for the forest carbon sink to recover, and nature restoration goals to be realised, harvesting must be reduced – there is no other way. The current proposal for the EC in Article 33 to 'review a phase-down of biomass counting toward targets, with potential delivery in three years, is far too weak. The cap

[59] https://www.luke.fi/en/news/roundwood-consumption-rose-to-a-recordhigh-level-in-2021
[60] Page 20 at https://bit.ly/3TPaORl; original data at https://envir.ee/media/5111/download
[61] https://unfccc.int/topics/land-use/workstreams/land-use-land-use-change-and-forestry-lulucf/guide-to-topics-under-lulucf-negotiations/harvested-wood-products
[62] Ceccherini, G., et al. (2020). Abrupt increase in harvested forest area over Europe after 2015. Nature 583(7814): 72-77. At https://www.researchgate.net/publication/342615330_Abrupt_increase_in_harvested_forest_area_over_Europe_after_2015.; Ceccherini, G., et al. (2021). Reply to Wernick, I. K. et al.; Palahí, M. et al. Nature 592(7856): E18-E23. At https://doi.org/10.1038/s41586-021-03294-9.

and phase down language should be combined, made more concrete, and moved to Article 29 of the RED. The phase-down should be initiated as soon as possible – 2024 at the latest – and should be largely complete by 2027. It may take longer for some member states to replace the capacity now met by biomass with truly zero-emissions renewable energy. The EU should suspend penalties for member states that fall short of renewable energy targets if this is related to the PWB phase-down, or plough those penalties back into clean energy deployment to make up the gap left by disqualifying PWB from counting toward targets.

Definition of 'primary woody biomass': The EP's proposal to use the JRC definition of primary woody biomass, but then alter it by excluding certain categories of wood, is unscientific. The exemption of certain types of forest wood also makes it hard to implement.

The current definition is:
'primary woody biomass' means all roundwood felled or otherwise harvested and removed. It comprises all wood obtained from removals, i.e., the quantities removed from forests, including wood recovered due to natural mortality and from felling and logging. It includes all wood removed with or without bark, including wood removed in its round form, or split, roughly squared or in other form, e.g., branches, roots, stumps and burls (where these are harvested) and wood that is roughly shaped or pointed. This does not include woody biomass obtained from sustainable wildfire prevention measures in high-risk fire prone areas, woody biomass obtained from road safety measures, and woody biomass extracted from forests affected by natural disasters, active pests or diseases to prevent their spread, whilst minimising wood extraction and protecting biodiversity, resulting in more diverse and resilient forests, and shall be based on guidelines from the Commission [Am. 42];

Everything after the first three sentences should be deleted as indicated (shading). Excluding these categories of wood from the definition of PWB not only renders the definition meaningless, it deliberately re-inserts a high-carbon form of biomass into the RED. The science is clear that logging and burning even dead (salvaged) trees is a net source of CO_2 emissions exceeding those from fossil fuels for long periods.[63] Including these exemptions is an invitation for more and more wood to be defined as meeting these exemptions, which will likely lead to 'business as usual' for biomass extraction.

The 2030 land sink targets appear to be out of reach for many member states

The graphs below of UNFCCC land sector carbon data also include the proposed 2030 land sink targets for each member state and the EU as a whole. These targets are extremely unambitious – as explained elsewhere,[64] climate and renewable energy modeling conducted by Commission scientists assumed use of forest biomass will increase 50% by 2050, which made it impossible for the model to resolve on a bigger (more negative) amount of carbon sequestration in 2030 and 2050. The modelers enable the model to sequester a total of 600 million tonnes of CO_2 annually by 2050 by assuming bioenergy with carbon capture and storage (BECCS) will provide 250 million tonnes of CO_2 uptake, meaning the land sector only has to provide 350 million tonnes of sequestration annually. This is a dangerous illusion. Policymakers are either unaware of accounting trick introduced to make the numbers work, or they have bought into this dangerous illusion, and are ignoring the warnings of some of the world's most prominent climate scientists that BECCS cannot, and will not, deliver 'negative' emissions.[65,66]

Findings: The role of biomass in counting toward the EU's renewable energy targets

The EU has sectoral renewable energy targets for transport, heating/cooling, and electricity. Burning solid biomass for energy makes a contribution to the heating/cooling and electricity targets. The following section

[63] See, e.g., Laganiere paper and online model, at https://apps-scf-cfs.rncan.gc.ca/calc/en/bioenergy-calculator
[64] See https://www.pfpi.net/wp-content/uploads/2021/11/PFPI-EU-Land-Sink-Target-report-Nov-23-2021.pdf
[65] For example, see https://theconversation.com/climate-scientists-concept-of-net-zero-is-a-dangerous-trap-157368
[66] It is not an exaggeration to say that if policymakers continue to naively trust models that depend on BECCS, climate mitigation efforts will be largely doomed, particularly since it is this very assumption that allows forest exploitation to continue at current levels.

evaluates the proportion of those targets provided by biomass. The member state graphs show data from 2004 onward, the first year for which the Eurostat SHARES database contains data.

Solid biomass accounts for a large share of all renewable energy

In 2020, burning solid biomass accounted for about 40% of the energy the EU counted toward renewable energy targets. As Figure 9 demonstrates, the proportion was much higher in some member states.

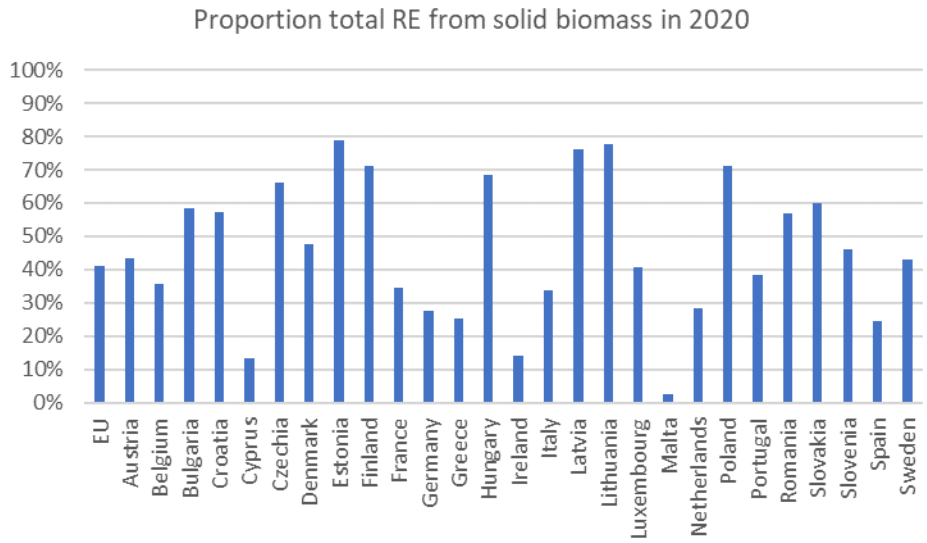

Figure 9. The proportion of all renewable energy for transport, heating/cooling, and electricity that was derived by burning solid biomass in 2020. This graph represents a 2020 snapshot for each member state show below.

Some summary statistics:

- 99% of the EU's population lives in a country where biomass energy provided 25% or more of all energy counted as renewable in 2020 (all countries except for Cyprus, Ireland, and Malta).
- 30% of the EU's population lives in a country where burning solid biomass provided more than 40% of the energy counted as renewable (Austria, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, Hungary, Latvia, Lithuania, Luxembourg, Poland, Romania, Slovakia, Slovenia, Sweden).

Residential biomass heating dominates other uses

- The role of biomass in providing renewable heating is explained more below, but it's useful to note here that biomass burned for residential heating accounted for about 20% of the EU's total renewable energy in 2020. As explained below, the EU's protocol counts the energy content of unburned biomass toward targets for the categories of building self-heating and industrial heat and power, meaning that these categories appear to be more important for providing renewable energy than they really are.
- 36% of the EU's population lives in a country where residential use of biomass provided at least 25% of all energy counted toward renewable energy targets in 2020 (Bulgaria, Croatia, Czechia, Estonia, Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia)
- 18% of the EU's population lives in a country where residential heating provided at least 40% of all energy counted toward targets (Croatia, Czechia, Hungary, Poland, and Romania).

The fact that wood has literally been burned for heating since prehistory, and that there has always been a core of people who heat with wood, means that once the EU adopted renewable energy targets, member states who were already burning a lot of wood for residential heating had a head start on achieving the targets.

Biomass provides a small share of renewable electricity

Biomass still plays a relatively small role in providing renewable electricity at the EU level, although more conversions of coal plants to biomass could increase this dramatically. Currently,

- Electricity from biomass accounted for less than 10% of renewable electricity for the EU in 2020
- 85% of the EU's population in 2020 lived in a country where biomass provided less than 20% of renewable electricity
- Only 15% lived in a country where biomass provided at least 25% of renewable electricity (Czechia, Estonia, Finland, Hungary, Luxembourg, Poland).

Burning biomass for heat and power is generally inefficient, but there is no technology other than waste incineration that is less efficient than electricity-only biomass plants. These plants often burn green wood chips, leading to an average efficiency of around 31% for plants in the EU,[67] meaning there are three units of wood carbon emissions for every unit of wood energy converted to electricity. Plants burning dried chips or wood pellets can achieve higher efficiencies and thus lower CO_2 (and conventional air pollution) emissions per unit energy generated, but manufacturing and drying these fuels create large emissions 'upstream.'

Relevance to EP proposal: Figure 3 shows that electricity-only plants still only consume a minority of wood in the EU, meaning that while efforts to end use of such plants are welcome (such as the proposed amendment to limit subsidies to electricity-only plants), they fall far short of what's needed to stop forest destruction for biomass. Further, exemptions to the EP amendments, especially one allowing an electricity-only plant to continue receiving subsidies if it is unable to convert to cogeneration, render the proposal effectively meaningless.

The EU's renewable energy tally method disproportionately weights residential wood-burning

Residential/commercial self-heating not only constitutes the majority of the biomass burned in the EU, but it is also allowed to count disproportionately toward targets due to how the renewable energy share (RES) is calculated.[68] For any biomass fuel consumed for residential/commercial heating, as well as any biomass consumed by industry (whether for heat *or* power generation), the RES calculation counts the energy 'input,' that is, the energy content of the fuel, even if the actual energy generated ('energy output' or 'useful' energy) is much lower due to very low efficiency with which fuel energy is converted into sensible heat or electricity. The RES protocol does count energy output for biomass electricity (generated at electricity-only and combined heat and power plants), and also 'derived heat,' which is useful heat generated at heating plants and combined heat and power plants (Table 1).

Type of biomass energy	**What's counted**
Electricity at electricity-only and CHP plants	Energy output (electricity generated)
Derived heat at heating and CHP plants	Energy output ('useful' heat)
Industrial sector heat and electricity	Energy input – energy inherent in biomass, no matter how inefficiently burned
'Other' heating, including residential heating	Energy input – energy inherent in biomass, no matter how inefficiently burned

Table 1. How the EU counts biomass energy toward renewable energy targets.

[67] Efficiency was calculated using energy input data from Eurostat dataset nrg_bal_c, "transformation energy use and final consumption by households," energy output data are from nrg_bal_peh, "gross energy production."

[68] This section is based on the calculations and equations from the Eurostat SHARES database, available at https://ec.europa.eu/eurostat/web/energy/data/shares

What this means is that for residential heating, for instance, burning a tonne of firewood for heating will count as providing around 14.5 gigajoules of renewable energy, even though on average, given the energy lost during combustion, and energy lost up a chimney, only about 50 – 60% of energy in the wood is converted to useful heat that can warm a room. Counting the energy input of unburned biomass used for industrial heat and power and for home and commercial heating provides an incentive to member states to meet renewable energy targets with low efficiency wood-burning.

While counting energy content in unburned wood helps member states easily achieve targets, other incentives driving biomass use are renewable energy subsidies for heat and electricity, and exemptions from carbon taxes for biomass power plants. Such direct and indirect subsidies reward development of new plants and conversions of coal plants to biomass. The subsidies can be worth millions each year to an individual plant,[69] and they total billions each year for the EU overall.[70] Such subsidies, especially those for electricity-only plants, encourage massive use of biomass for relatively little power generation, due to the low efficiency of the technology.

Relevant to the EP proposal, if one goal of the EU's renewable energy policy is to incentivize clean electrification, the biomass policy fails to deliver that. It encourages meeting renewable energy targets with residential wood-burning and other low-efficiency uses and supports electricity generation that not only emits more CO_2 per unit energy generated than fossil fuels, but also as much or more conventional air pollution.

Biomass provides the overwhelming majority of renewable energy in the heating sector

Summary points:

- Solid biomass burning accounted for 76% of renewable heating for the EU as a whole in 2020
- 99.7% of people in the EU live in countries where at least 51% of renewable heating came from burning solid biomass in 2020 (all member states except Cyprus and Malta)
- 26% of the EU's population lives in a country where at least 85% of renewable heating came from burning biomass in 2020 (Austria, Bulgaria, Croatia, Czechia, Estonia, Finland, Hungary, Latvia, Lithuania, Luxembourg, Poland, Romania, Slovakia, Slovenia).

Residential use accounts for the biggest share of biomass in the heating sector

Summary points:

- For the EU overall, residential biomass provided 40% of the energy counted as renewable in the heating sector overall in 2020
- 90% of the EU's population lives in a country where residential biomass provided at least 25% of renewable heating (all MS except Cyprus, Denmark, Finland, Ireland, Luxembourg, Malta, Netherlands, Sweden)
- 53% of the EU's population lives in a country where residential biomass heating provided at least 40% of renewable heating (Bulgaria, Croatia, Czechia, Estonia, France, Greece, Hungary, Italy, Poland, Romania, Slovakia, Slovenia).
- In five countries (Croatia, Czechia, Hungary, Romania, and Slovenia), residential heating provided more than 60% of renewable heating.

[69] As mentioned above, the 205 MW Polaniec biomass power station in Poland received about €65.4 million in subsidies in 2021.
[70] https://op.europa.eu/en/publication-detail/-/publication/be5268ba-3609-11ec-bd8e-01aa75ed71a1/language-en

Some countries have 'increased' renewable energy with new survey methods for residential biomass

Several member states have shown abrupt increases in residential wood-burning due to a shift in survey methodology for tallying wood use. In at least three cases (Hungary, Poland, Slovakia) this allowed the country to claim it has achieved renewable energy targets without doing anything additional. Other countries that appear to have abrupt increases in residential heating include Belgium, Italy, and Slovenia.

This issue as expressed in Hungary was covered in the 'Paper Tiger' report[71]. That section is reprinted here:

> "In 2015, Hungary officially revised its methodology for assessing residential wood use, basing the new numbers on household surveys rather than harvesting reports, and applying the new methodology retroactively to 2010. The result was a 250% increase overnight in reported residential wood consumption, which then allowed Hungary to claim it had exceeded its EU-mandated renewable energy target at that time. It is an open secret[72] that much of the wood use reported by Hungary – and counted toward its renewable energy targets – may be harvested illegally. The market analysis[73] observed that other member states had apparently also seen a large overnight increase in estimates of residential wood use, including Belgium, Croatia, Czechia, Italy, the Netherlands, the UK, and Sweden."

In Poland, an article titled "Poland has achieved its 2020 RES target thanks to improved statistics"[74] explains, "*The Central Statistical Office has changed the method of calculating the share of renewable energy sources. Due to the fact that there is a much greater use of wood in domestic boilers, fireplaces and kitchens, the share of RES in 2020 exceeded 16%. Thus, according to new statistics, Poland has achieved the mandatory EU target and will avoid penalties. However, Eurostat still wants to verify Polish data*." As the Polish data for this report were obtained from Eurostat, it appears the verification occurred.

The Slovakian situation was explained in an article in Euractiv[75]:

> "Slovakia suddenly became one of the EU's leading countries when it comes to green energy consumption, according to new figures published by Eurostat based on 2019 data regarding household biomass consumption.
>
> The new figures, provided by Slovakia and published by the EU's statistical office, show that the country increased its share of renewables in its energy mix between 2018 and 2019 by five percentage points, from 11.9 to 16.9%.
>
> This means the country's 2020 target of 14% has been reached even though the opposite was widely expected.
>
> …the increase in renewables consumption in heating and cooling was due mainly to growing consumption of solid biomass by Slovak households… the unexpected leap was caused by the new data coming from a survey of households…"

A solar industry representative was quoted in that article as to how this sudden achievement of targets could influence the country's renewable energy future. Indeed, the same could be said for the EU overall, where the use of residential heating from biomass to achieve targets effectively caps deployment of clean heating and green electrification. Europe's citizens are now paying the price.

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[71] https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

[72] It is also an open secret, as admitted by the Hungarian Energy Authority and probably known at the EU Commission, that Hungary counts garbage-burning by households as 'solid biomass,' so this is contributing to renewable energy targets.

[73] REKK (Foundation for Regional Energy and Infrastructure Policy Cooperation). Renewables Statistics. Policy Brief 01, 2017. At https://rekk.hu/downloads/academic_publications/rekk_policybrief_hu_2017_01.pdf

[74] https://wysokienapiecie.pl/43415-polska-osiagnela-cel-oze-na-2020-dzieki-poprawie-statystyki/

[75] https://www.euractiv.com/section/politics/short_news/slovakia-suddenly-a-frontrunner-in-renewable-energies/

Note on terms used in the member state graphs of land sector carbon flux

FRF represents the UNFCCC category of 'forests remaining forests,' which excludes afforested land.

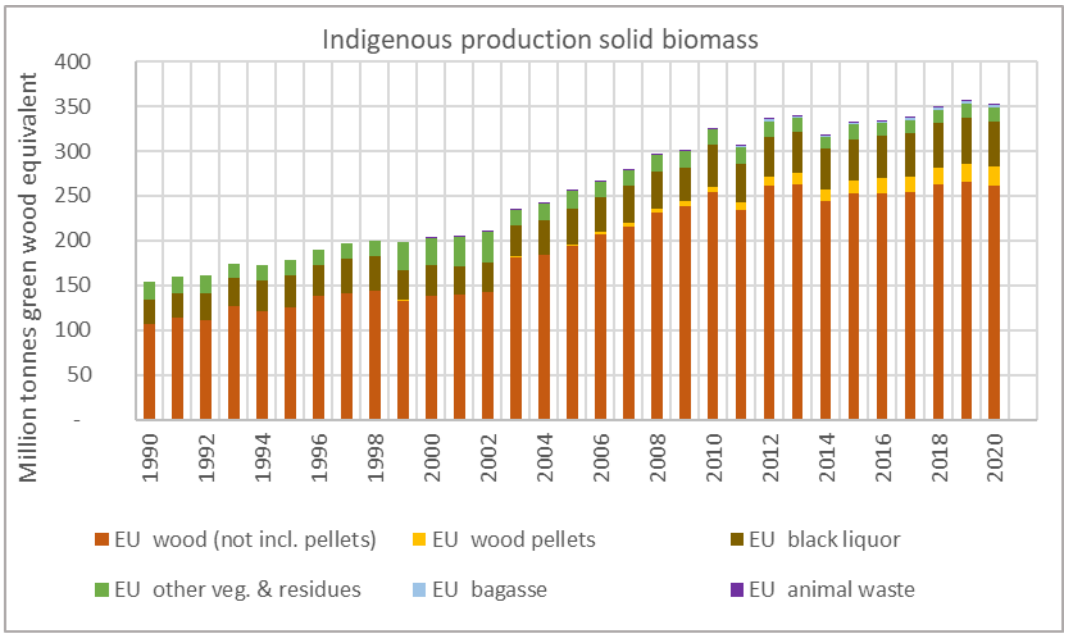
HWP is harvested wood products - paper, panelboard, and sawn wood products.

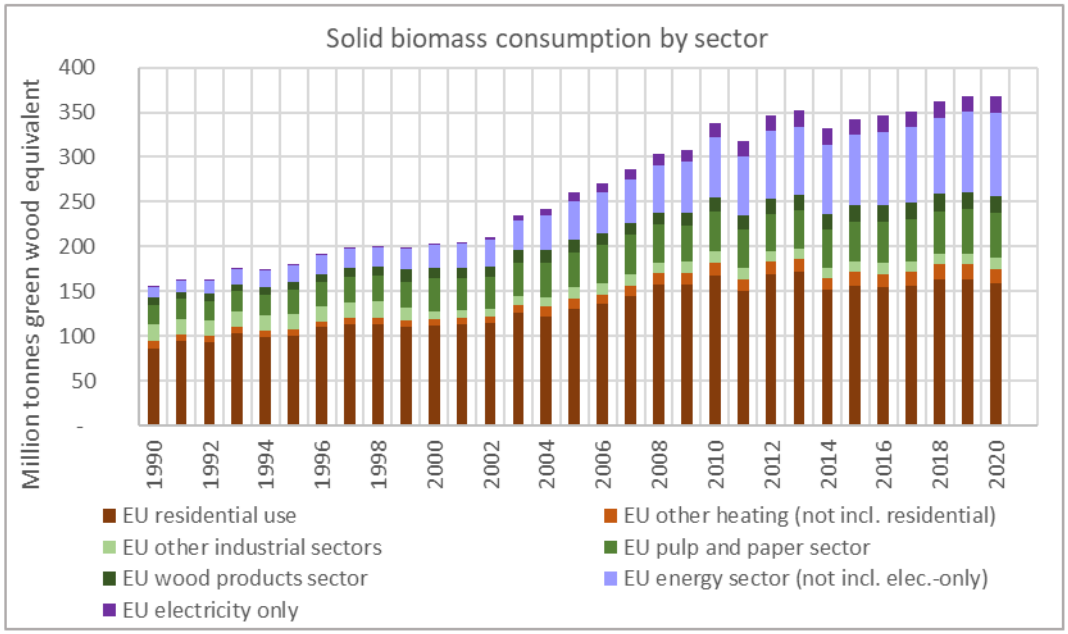
The land sector represents carbon flux associated with different types of land, including agriculture, but does not include climate-forcing non-CO_2 trace gas emissions from agriculture (N_2O, CH_4)

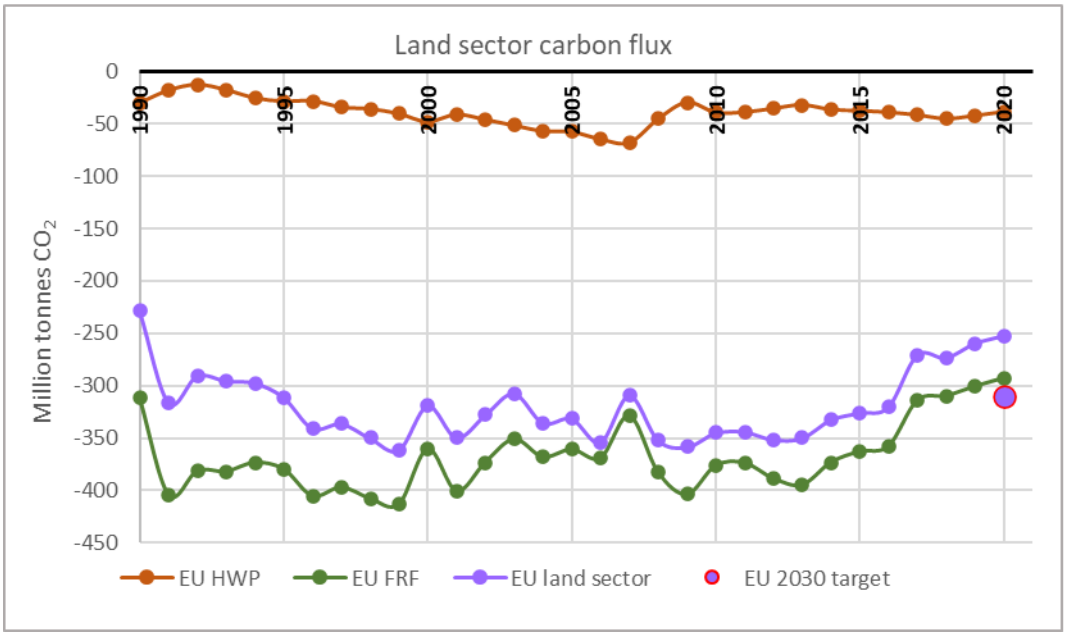
The following graphs are best viewed as a two-page spread.

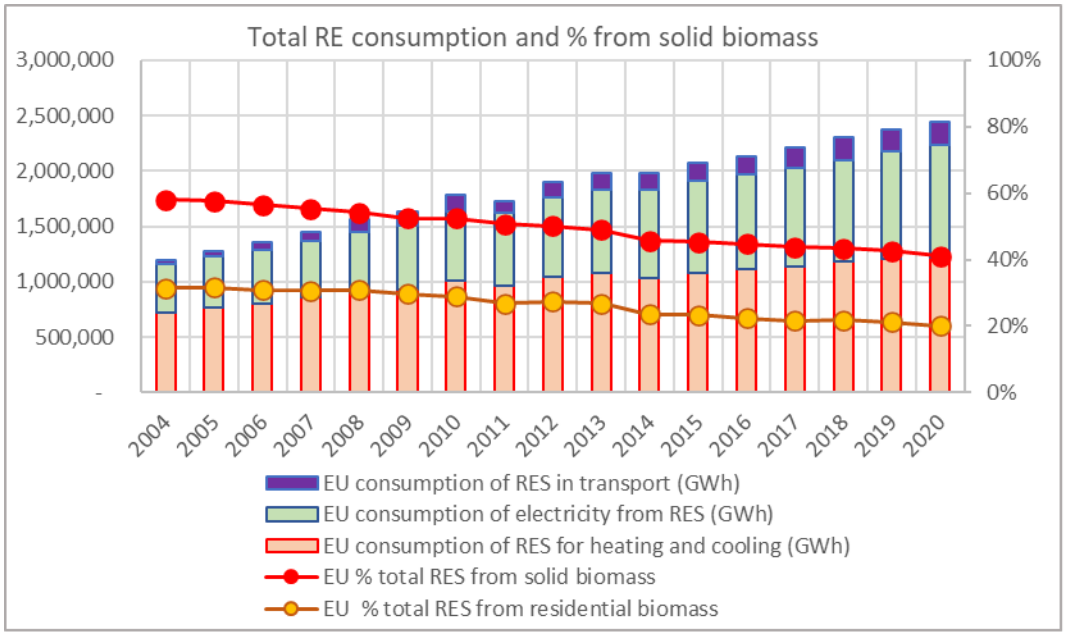
Member state graphs

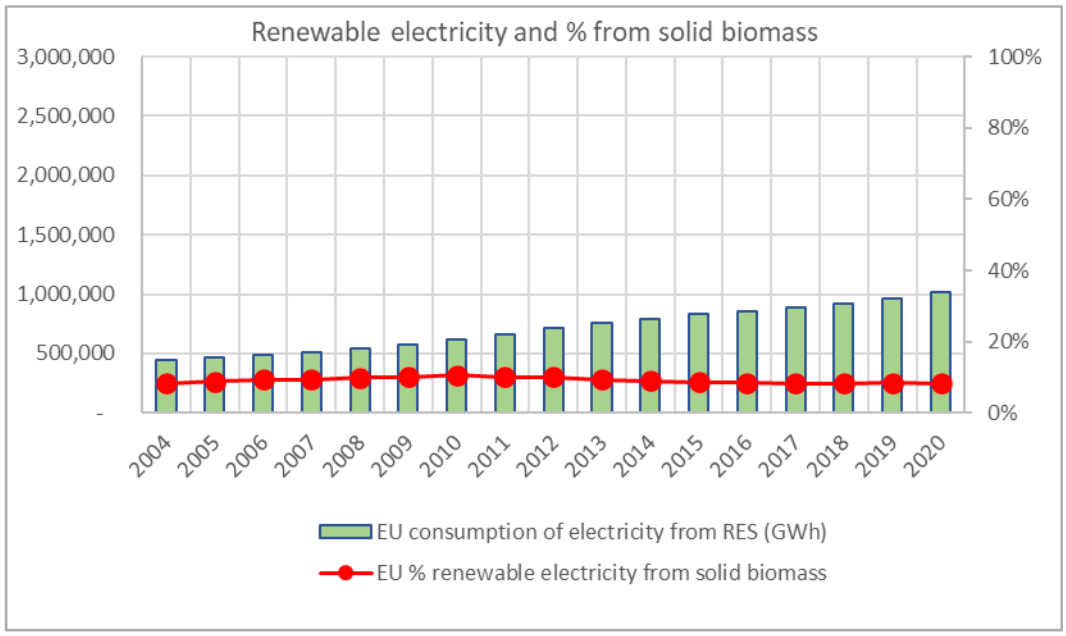
EU

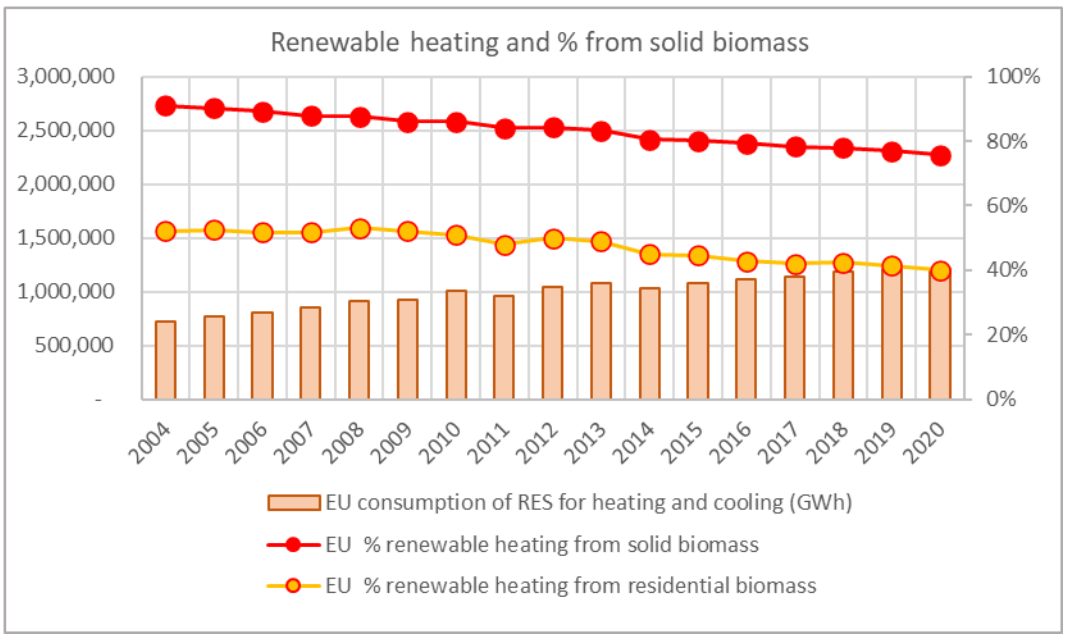




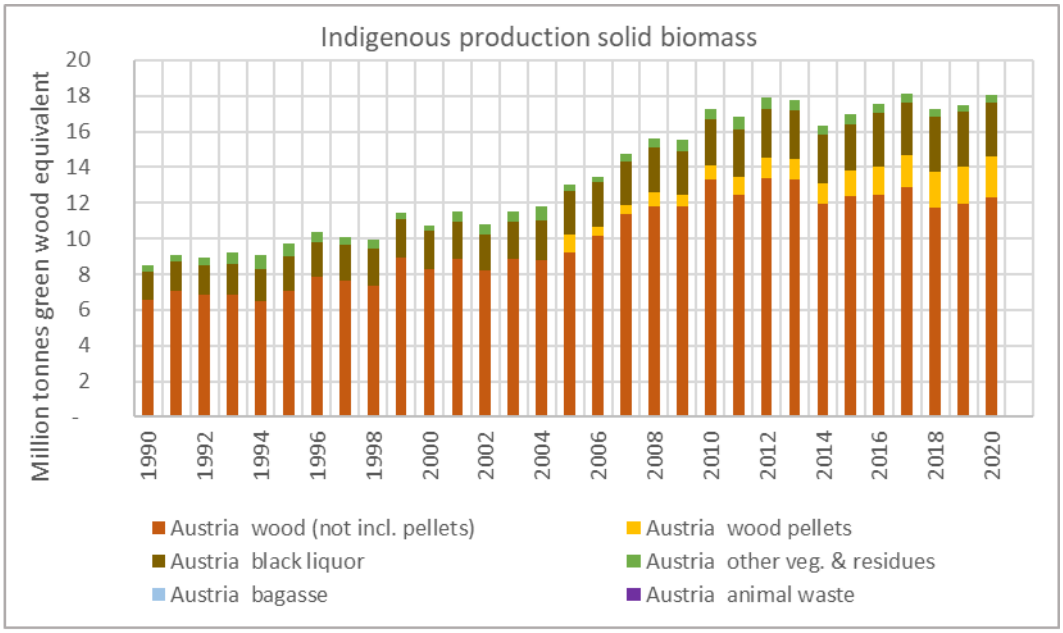


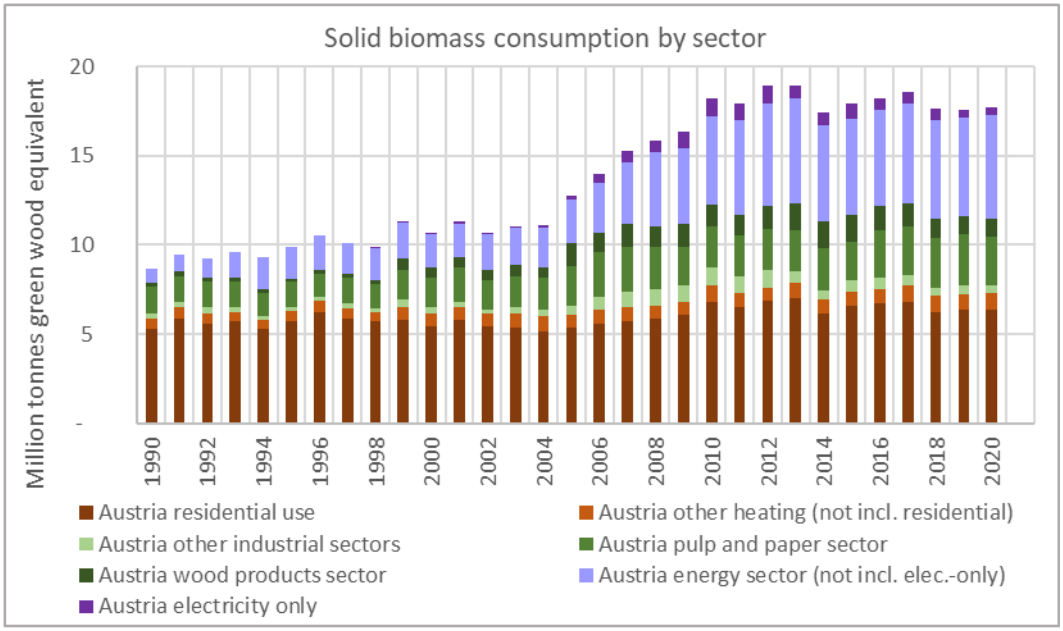

Total RE consumption and % from solid biomass
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
EU consumption of RES in transport (GWh)
EU consumption of electricity from RES (GWh)
EU consumption of RES for heating and cooling (GWh)
EU % total RES from solid biomass
EU % total RES from residential biomass

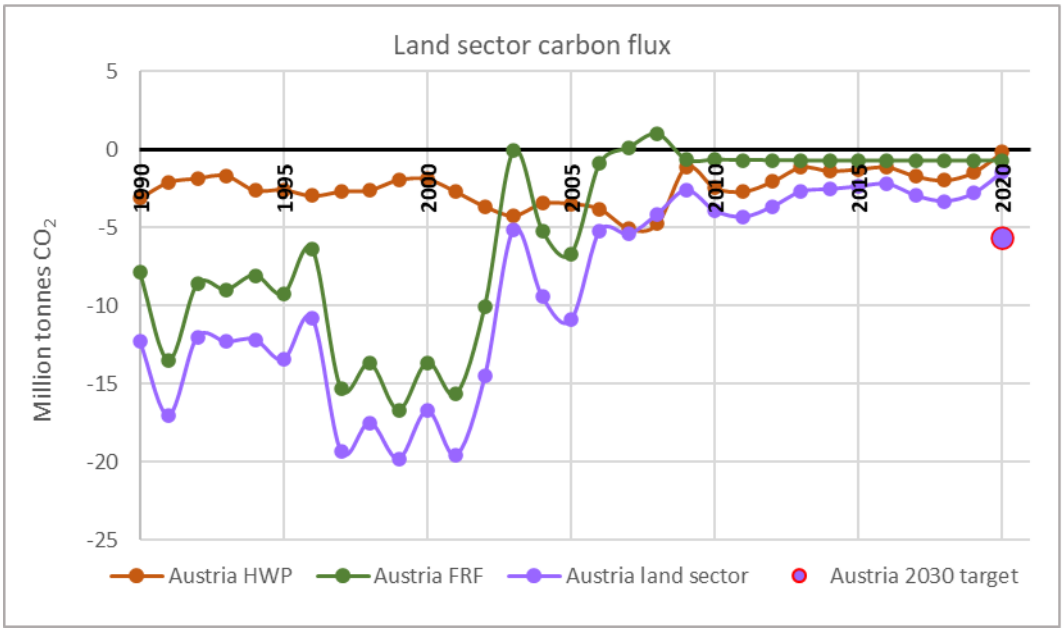

Renewable electricity and % from solid biomass
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
EU consumption of electricity from RES (GWh)
EU % renewable electricity from solid biomass

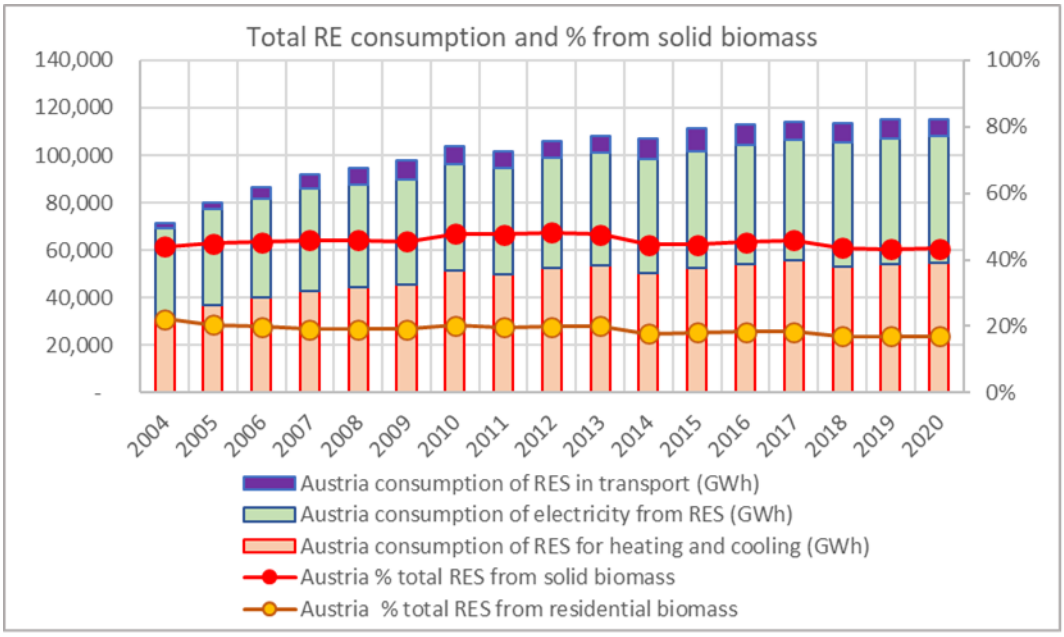

Renewable heating and % from solid biomass
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
EU consumption of RES for heating and cooling (GWh)
EU % renewable heating from solid biomass
EU % renewable heating from residential biomass

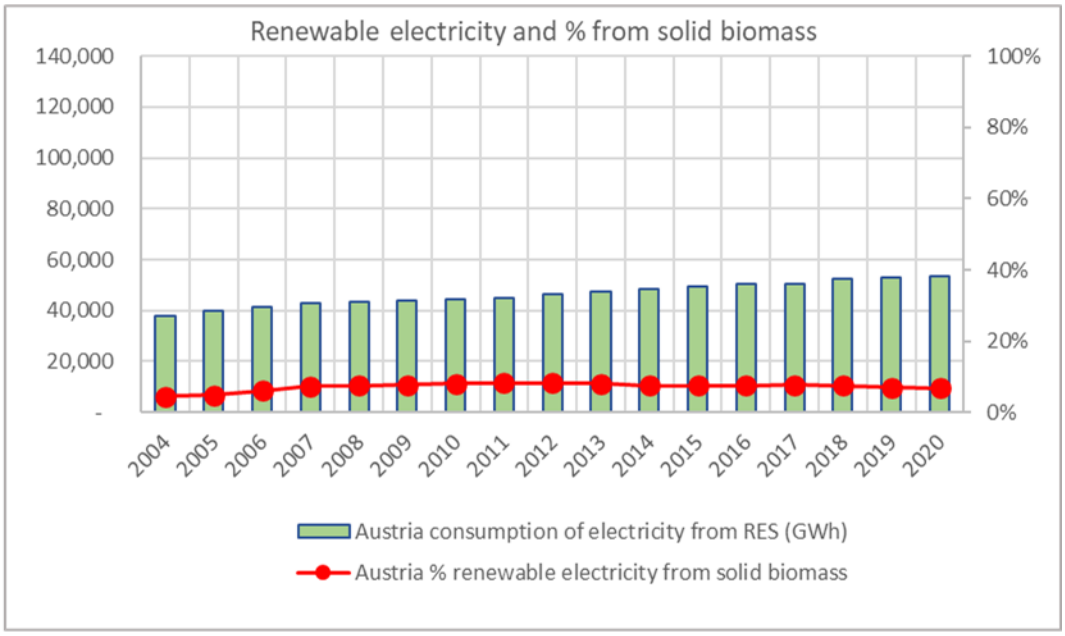
Austria

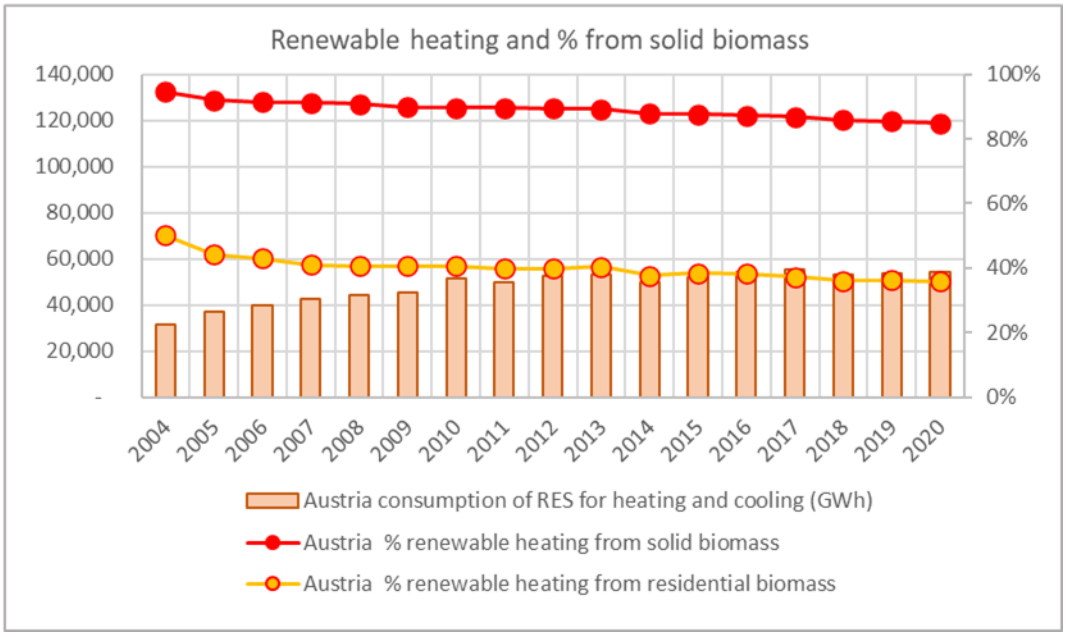

Indigenous production solid biomass
Million tonnes green wood equivalent
20
18
16
14
12
10
8
6
4
2
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Austria wood (not incl. pellets)
Austria wood pellets
Austria black liquor
Austria other veg. & residues
Austria bagasse
Austria animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
20
15
10
5
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Austria residential use
Austria other heating (not incl. residential)
Austria other industrial sectors
Austria pulp and paper sector
Austria wood products sector
Austria energy sector (not incl. elec.-only)
Austria electricity only

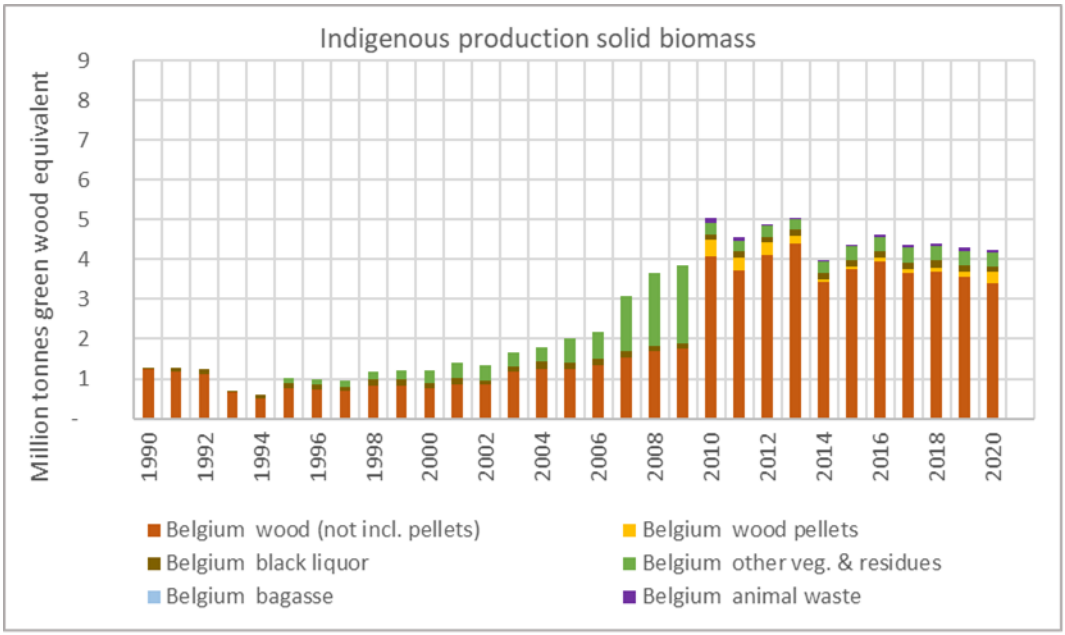

Land sector carbon flux
Million tonnes CO_2
5
0
-5
-10
-15
-20
-25
1990
1995
2000
2005
2010
2015
2020
Austria HWP
Austria FRF
Austria land sector
Austria 2030 target


Total RE consumption and % from solid biomass
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Austria consumption of RES in transport (GWh)
Austria consumption of electricity from RES (GWh)
Austria consumption of RES for heating and cooling (GWh)
Austria % total RES from solid biomass
Austria % total RES from residential biomass


Renewable electricity and % from solid biomass
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Austria consumption of electricity from RES (GWh)
Austria % renewable electricity from solid biomass

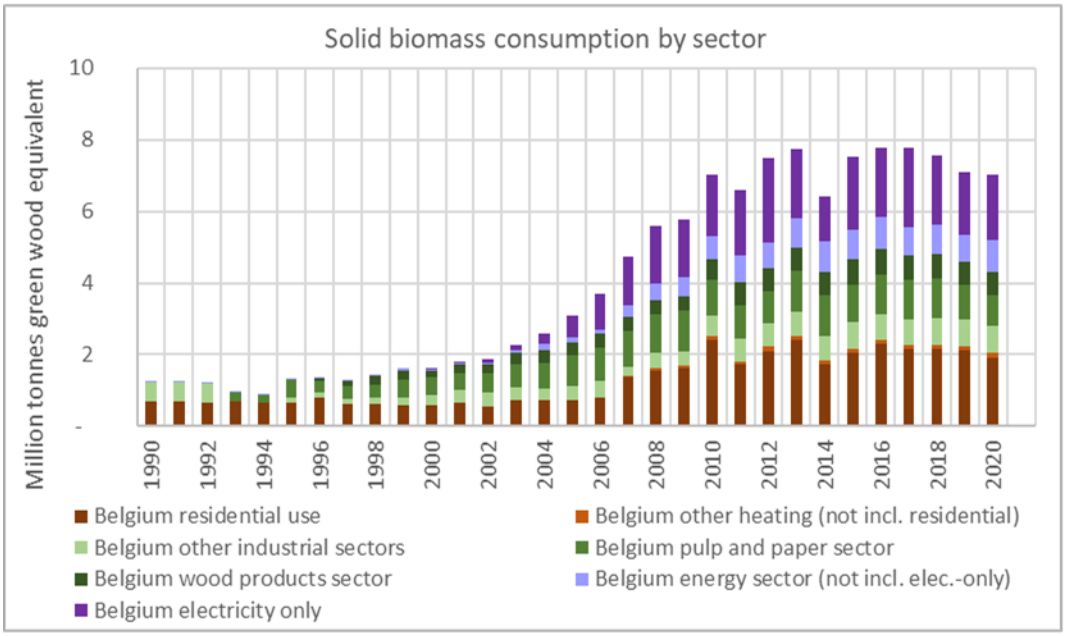

Renewable heating and % from solid biomass
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Austria consumption of RES for heating and cooling (GWh)
Austria % renewable heating from solid biomass
Austria % renewable heating from residential biomass

Belgium

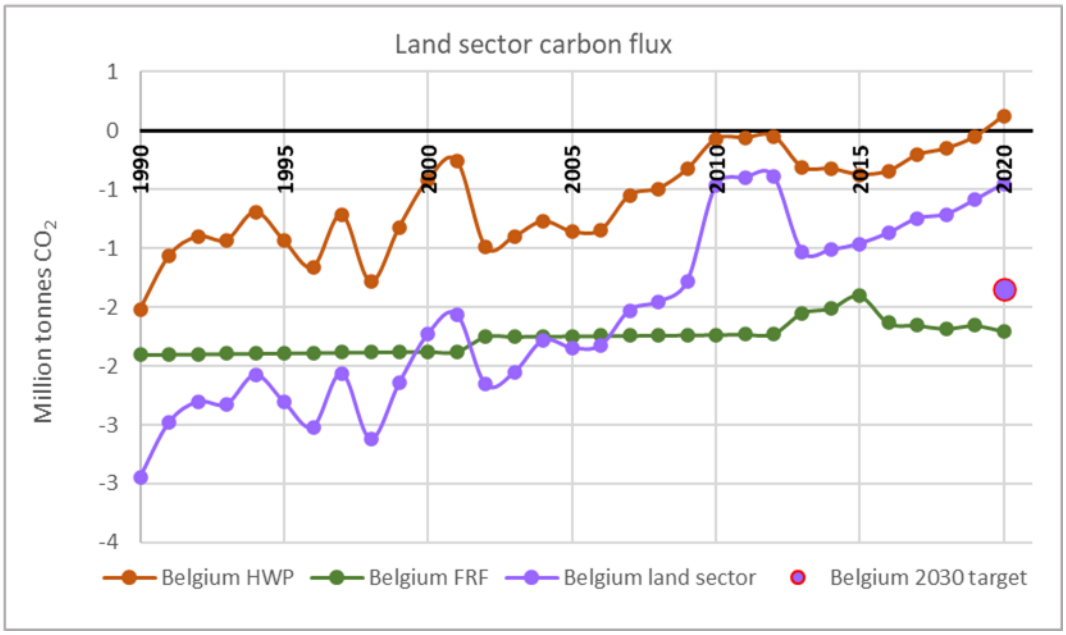


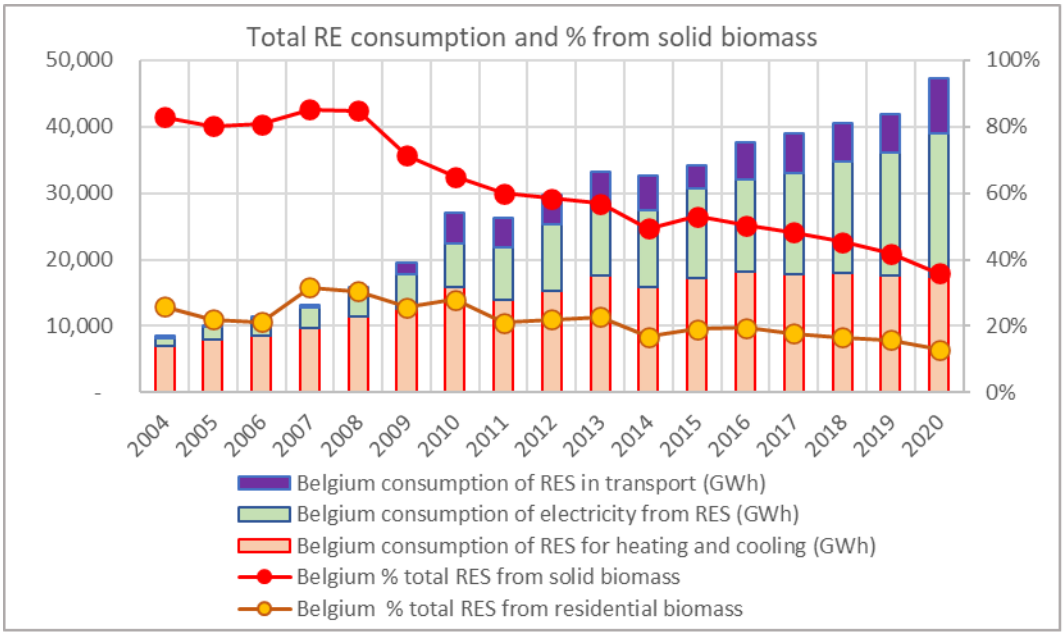
A large increase in electricity generation at electricity-only plants is likely fueled with wood pellet imports.

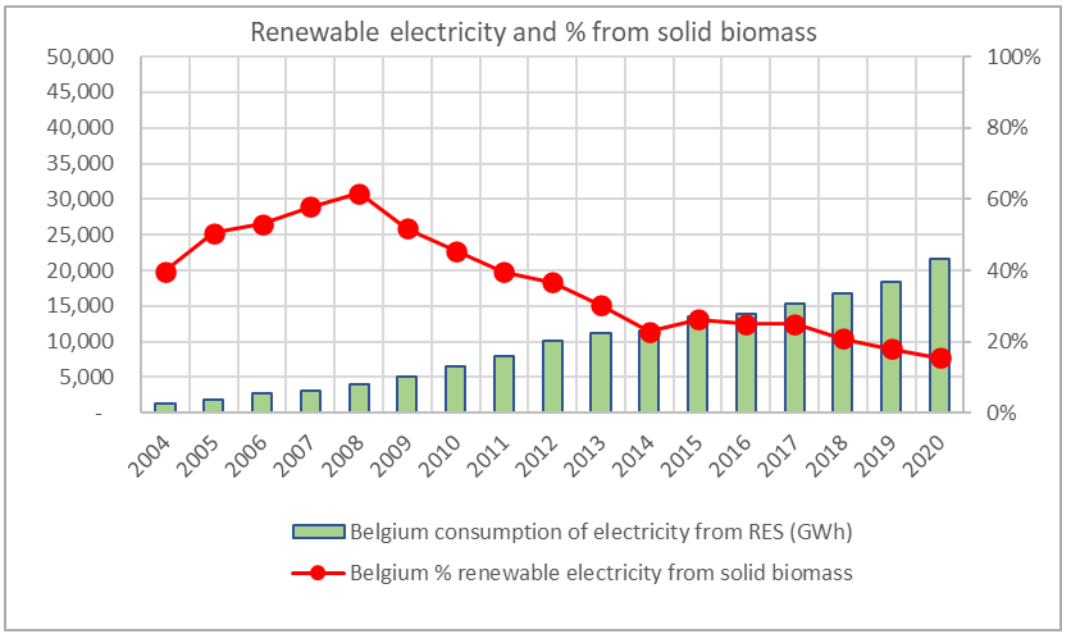
Belgium's residential wood use jumped in 2010, which as mentioned above is an artefact of new survey methods.

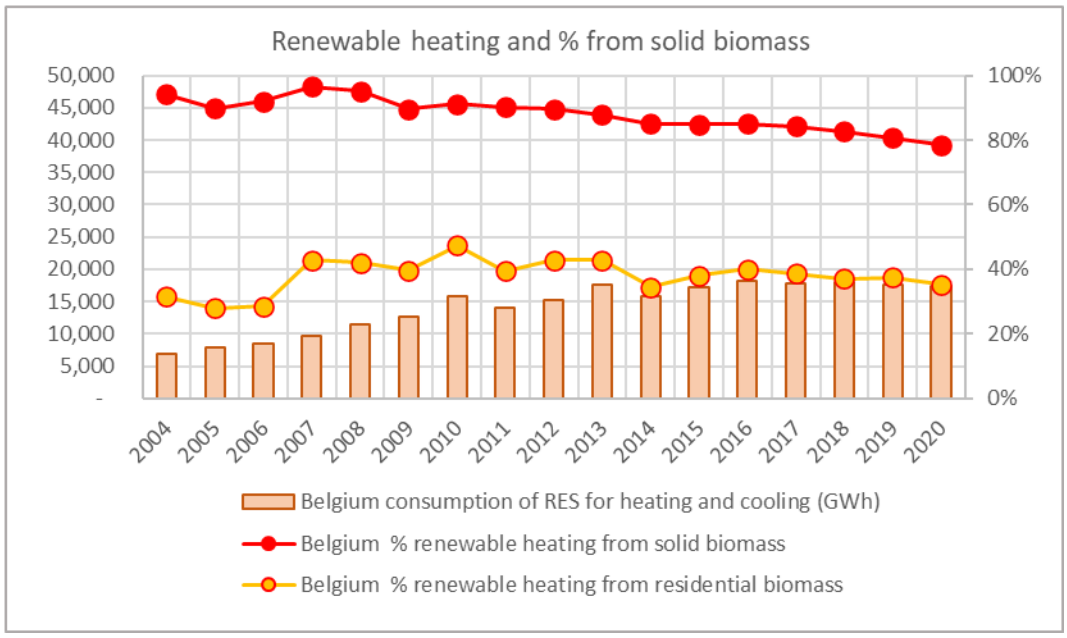


The HWP sector is a net source of emissions, not a sink, in recent years.

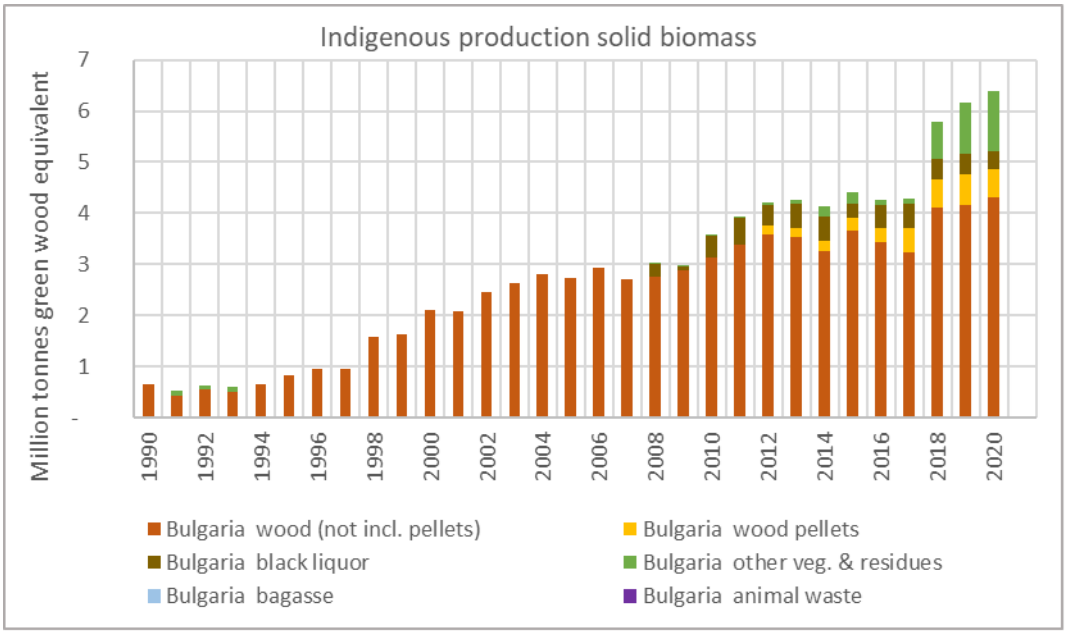



Total RE consumption and % from solid biomass
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Belgium consumption of RES in transport (GWh)
Belgium consumption of electricity from RES (GWh)
Belgium consumption of RES for heating and cooling (GWh)
Belgium % total RES from solid biomass
Belgium % total RES from residential biomass

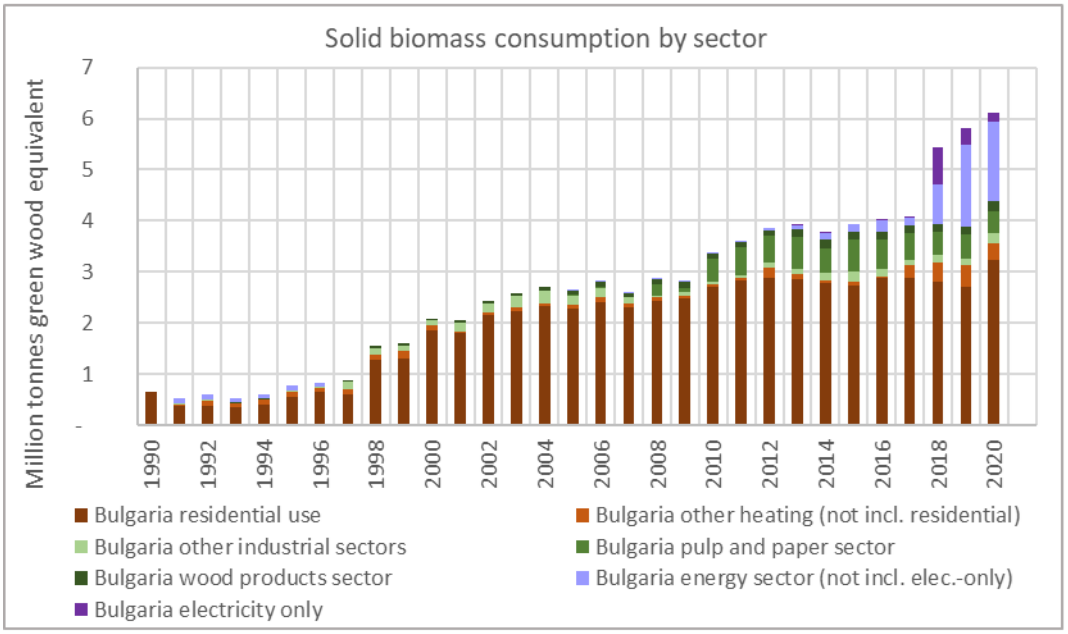

Renewable electricity and % from solid biomass
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Belgium consumption of electricity from RES (GWh)
Belgium % renewable electricity from solid biomass

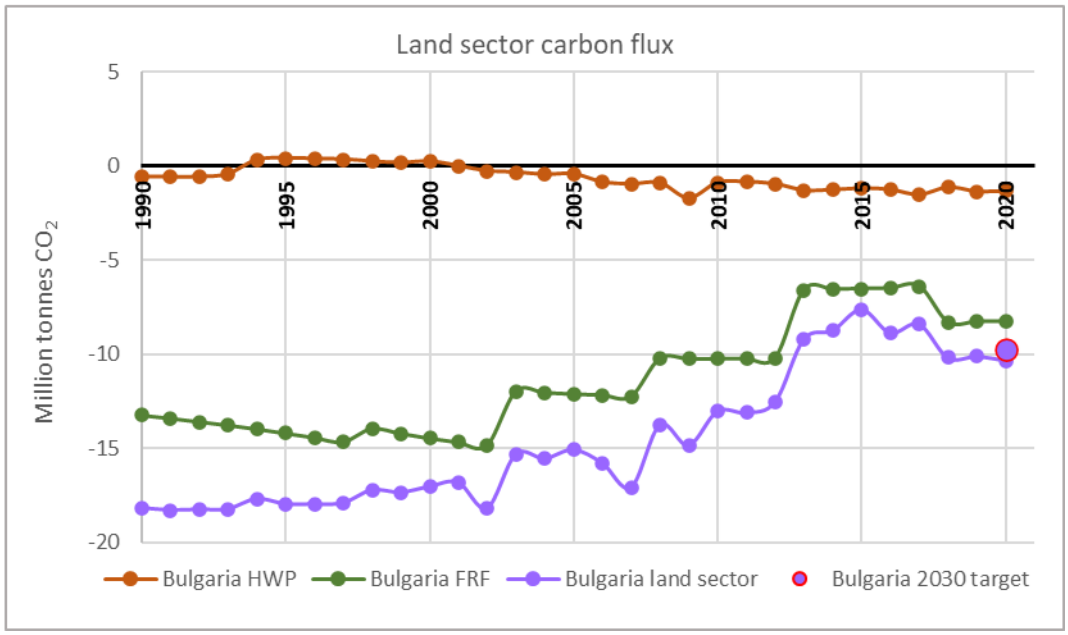

Renewable heating and % from solid biomass
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Belgium consumption of RES for heating and cooling (GWh)
Belgium % renewable heating from solid biomass
Belgium % renewable heating from residential biomass

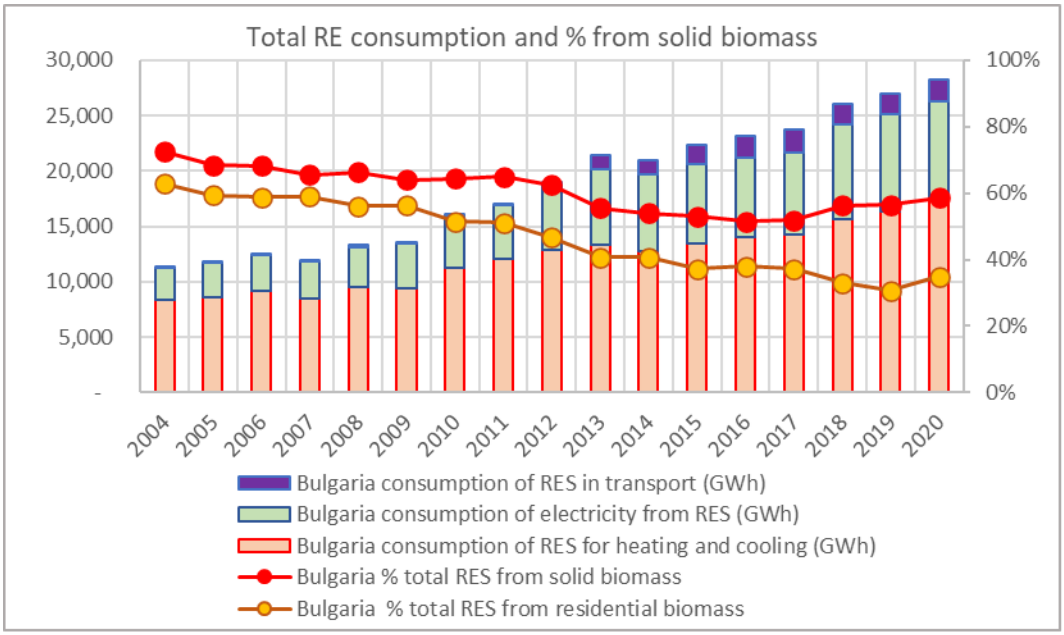
Bulgaria

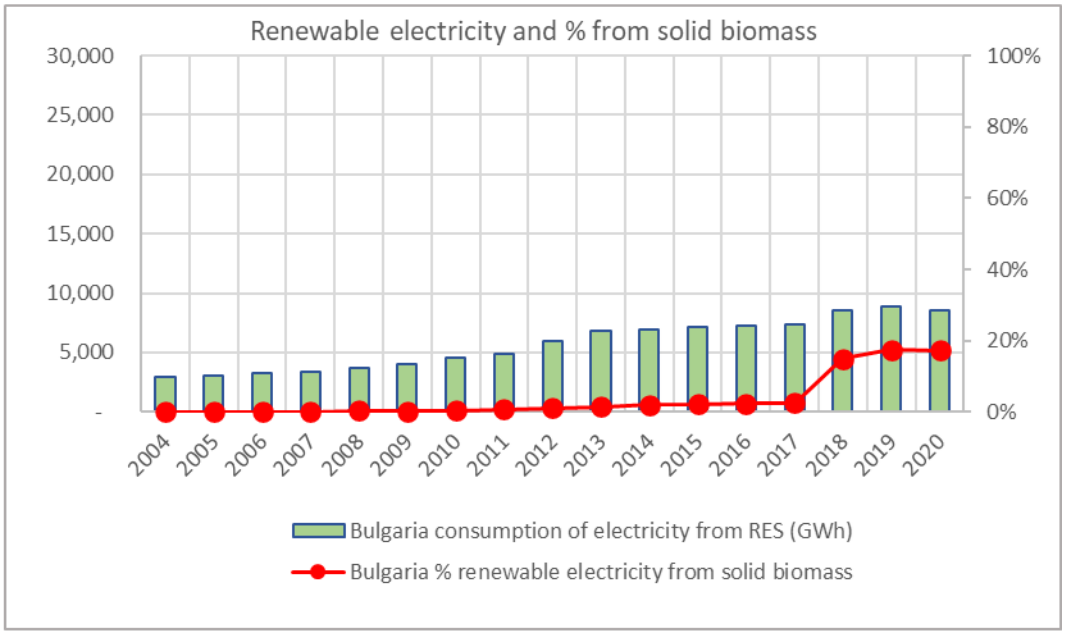


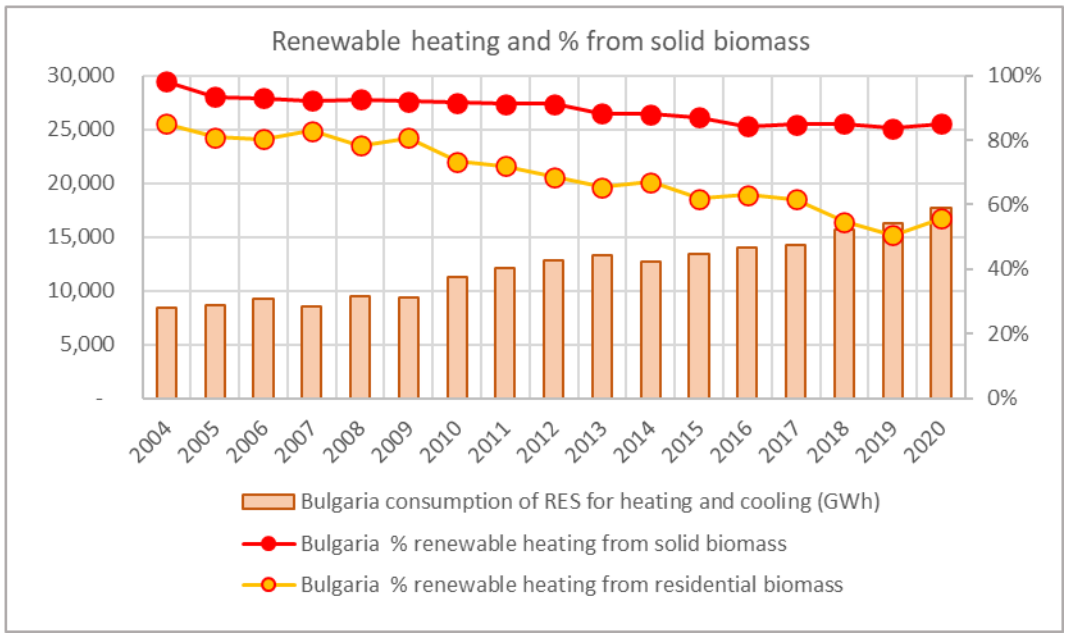
Residential wood-burning has increased steadily. Some portion of recent energy sector generation is likely fueled with agricultural residues (see previous graph).



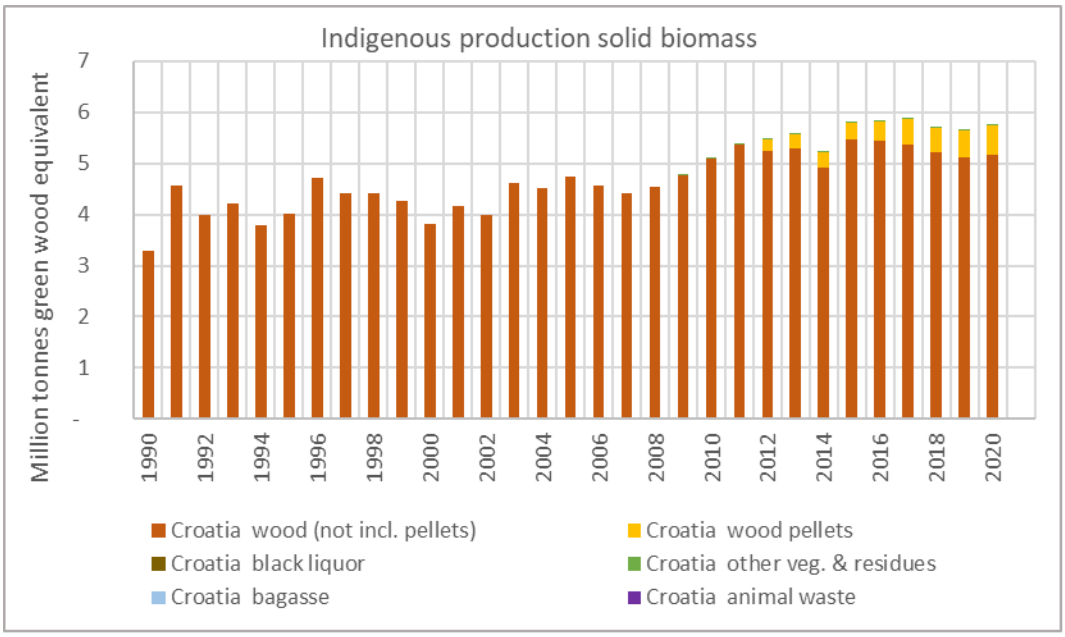


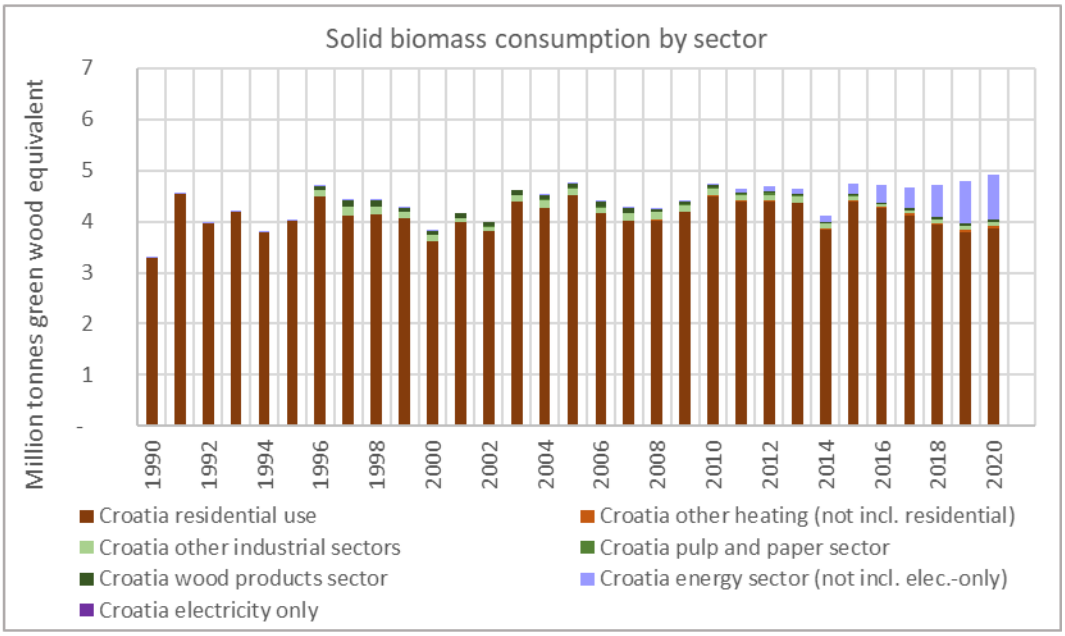

Total RE consumption and % from solid biomass
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Bulgaria consumption of RES in transport (GWh)
Bulgaria consumption of electricity from RES (GWh)
Bulgaria consumption of RES for heating and cooling (GWh)
Bulgaria % total RES from solid biomass
Bulgaria % total RES from residential biomass

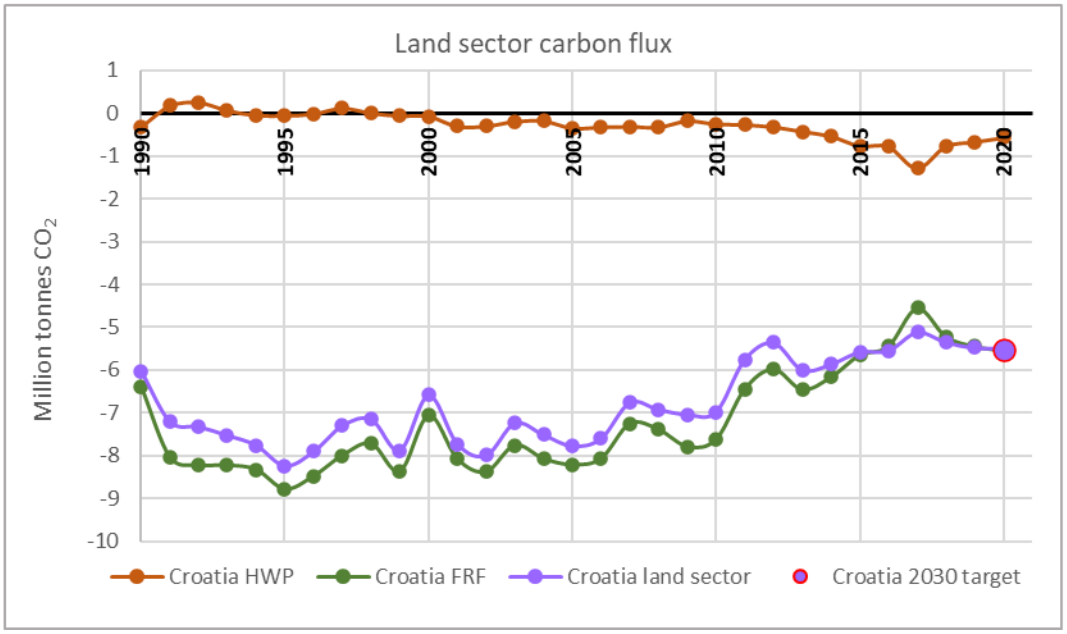

Renewable electricity and % from solid biomass
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Bulgaria consumption of electricity from RES (GWh)
Bulgaria % renewable electricity from solid biomass

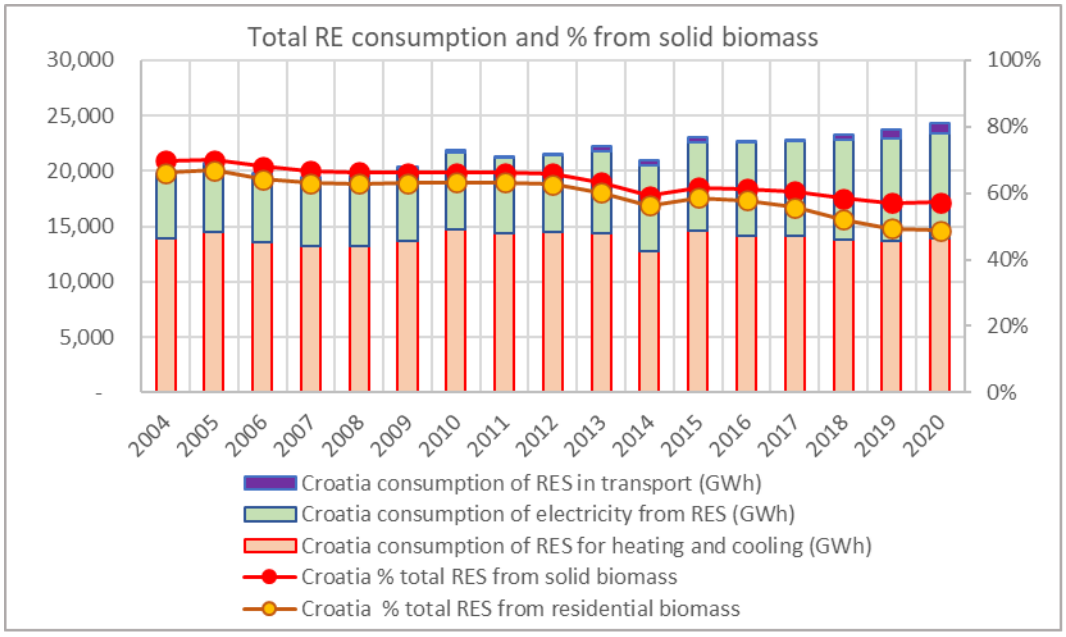

Renewable heating and % from solid biomass
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Bulgaria consumption of RES for heating and cooling (GWh)
Bulgaria % renewable heating from solid biomass
Bulgaria % renewable heating from residential biomass

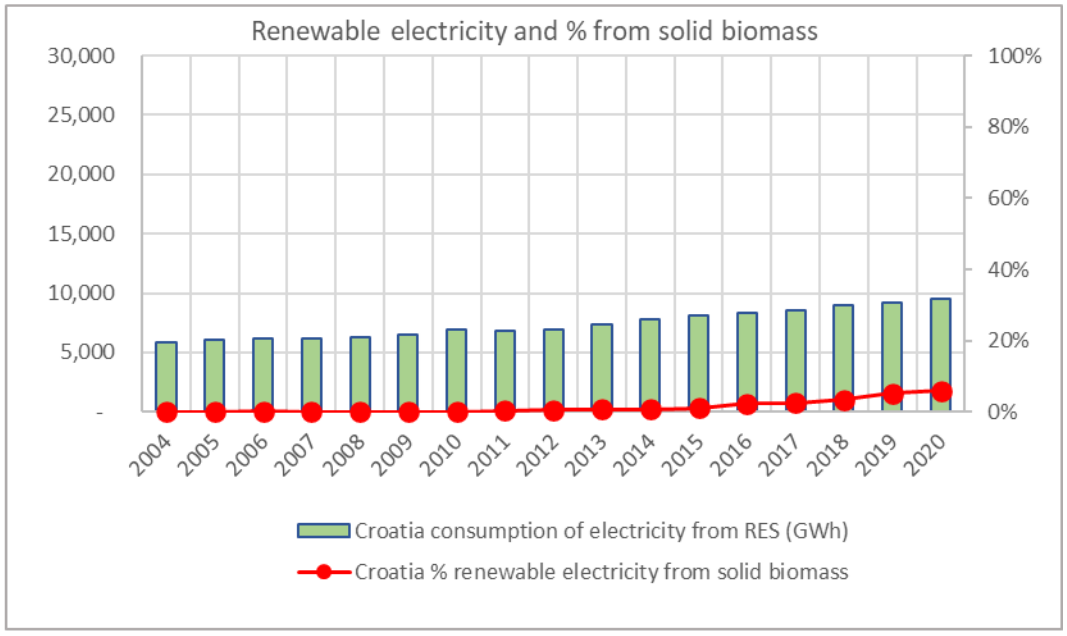
Croatia

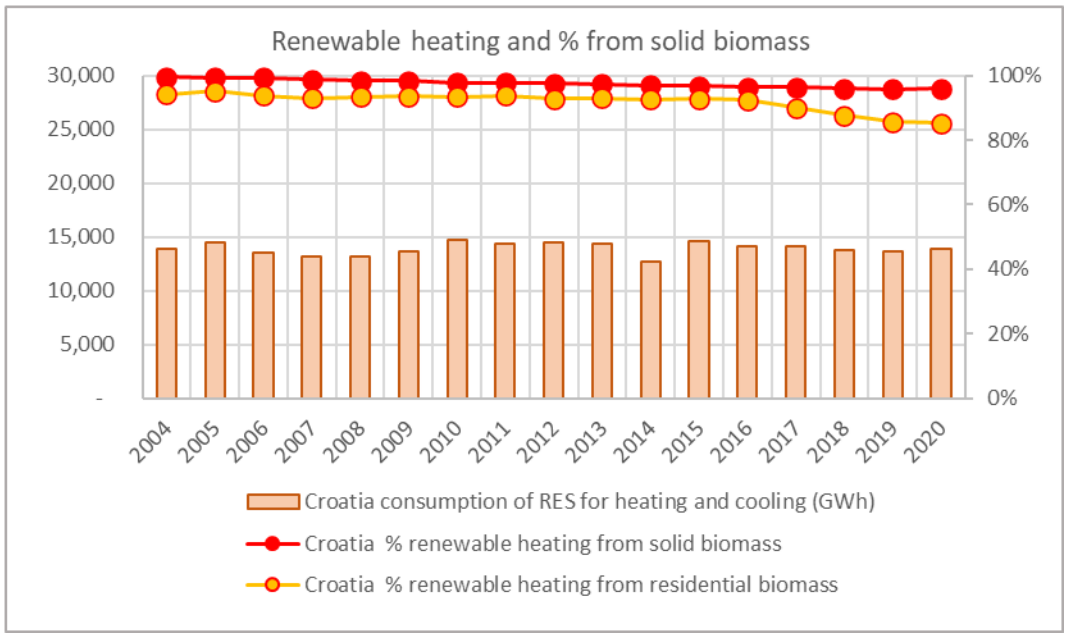

Indigenous production solid biomass
Million tonnes green wood equivalent
7
6
5
4
3
2
1
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Croatia wood (not incl. pellets)
Croatia wood pellets
Croatia black liquor
Croatia other veg. & residues
Croatia bagasse
Croatia animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
7
6
5
4
3
2
1
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Croatia residential use
Croatia other heating (not incl. residential)
Croatia other industrial sectors
Croatia pulp and paper sector
Croatia wood products sector
Croatia energy sector (not incl. elec.-only)
Croatia electricity only

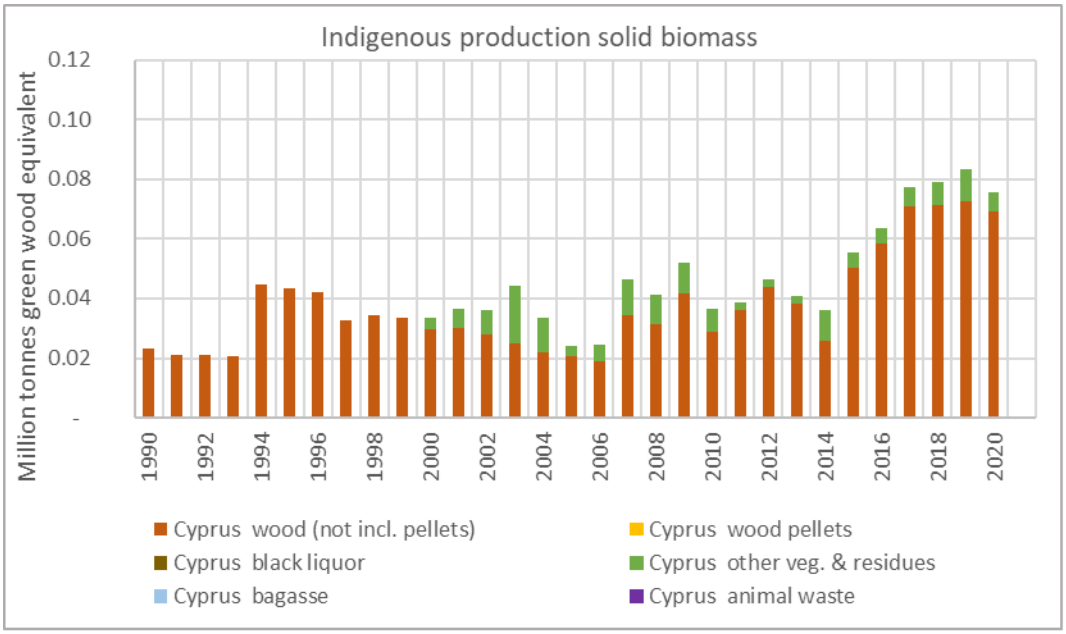

Land sector carbon flux
Million tonnes CO2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
1990
1995
2000
2005
2010
2015
2020
Croatia HWP
Croatia FRF
Croatia land sector
Croatia 2030 target


Total RE consumption and % from solid biomass
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Croatia consumption of RES in transport (GWh)
Croatia consumption of electricity from RES (GWh)
Croatia consumption of RES for heating and cooling (GWh)
Croatia % total RES from solid biomass
Croatia % total RES from residential biomass

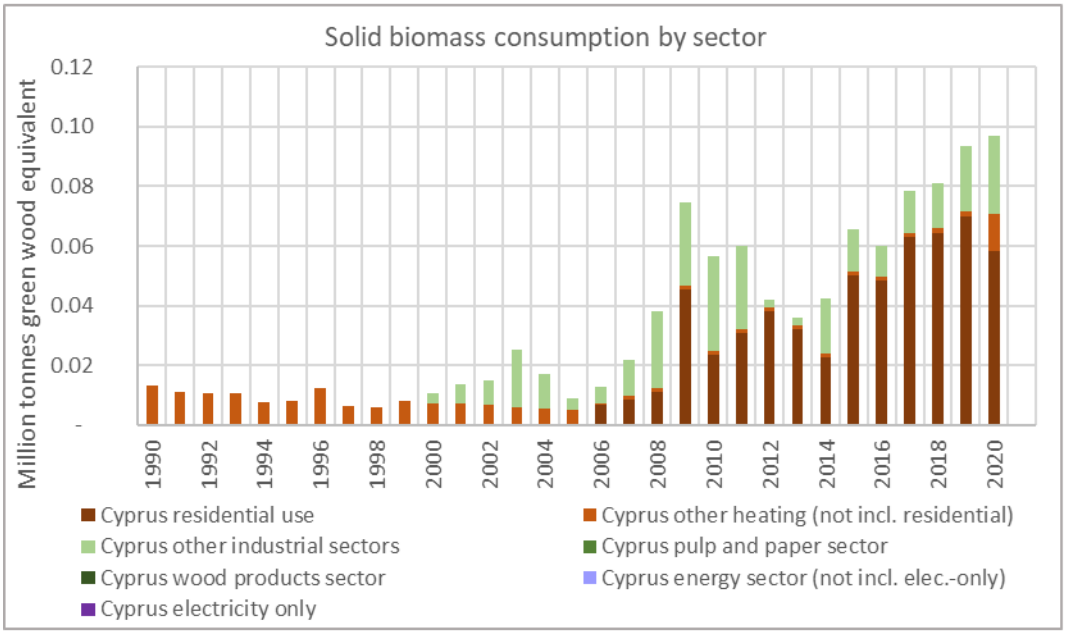

Renewable electricity and % from solid biomass
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Croatia consumption of electricity from RES (GWh)
Croatia % renewable electricity from solid biomass

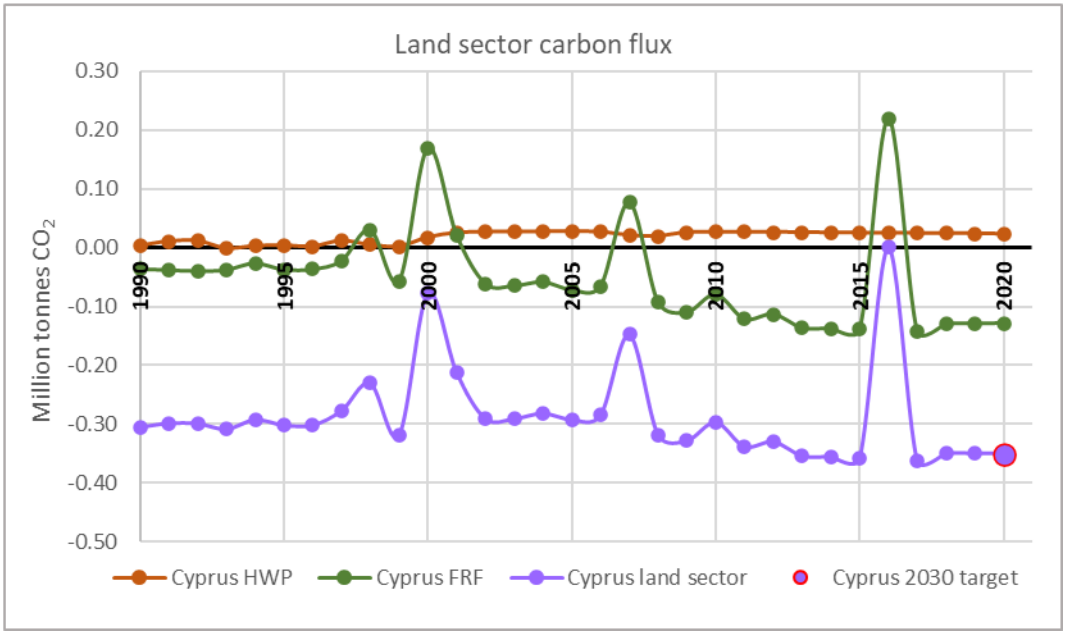

Renewable heating and % from solid biomass
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Croatia consumption of RES for heating and cooling (GWh)
Croatia % renewable heating from solid biomass
Croatia % renewable heating from residential biomass

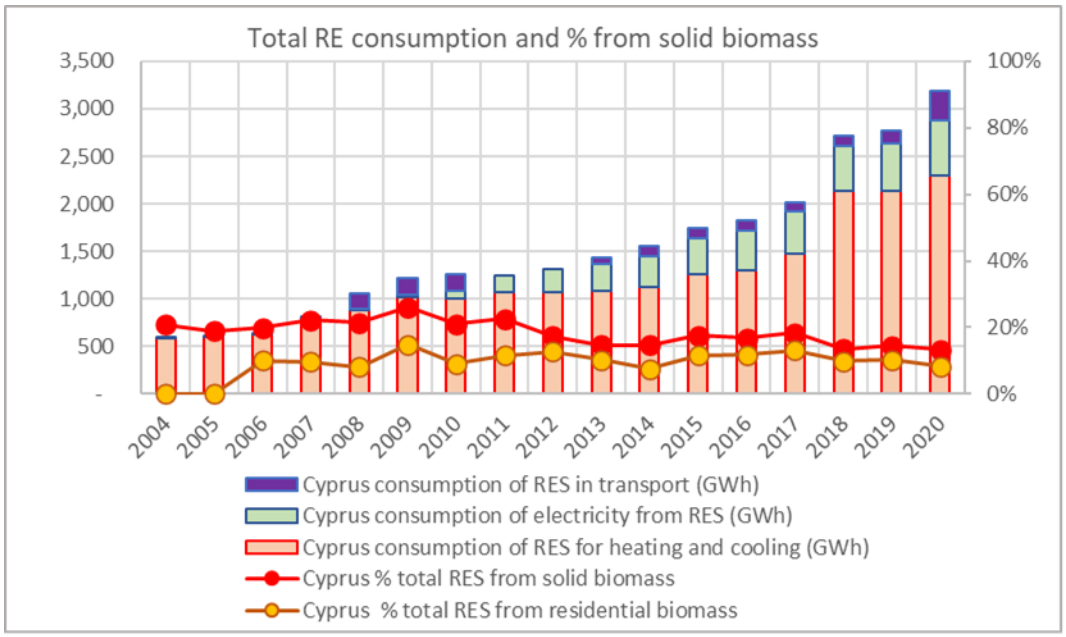
Cyprus

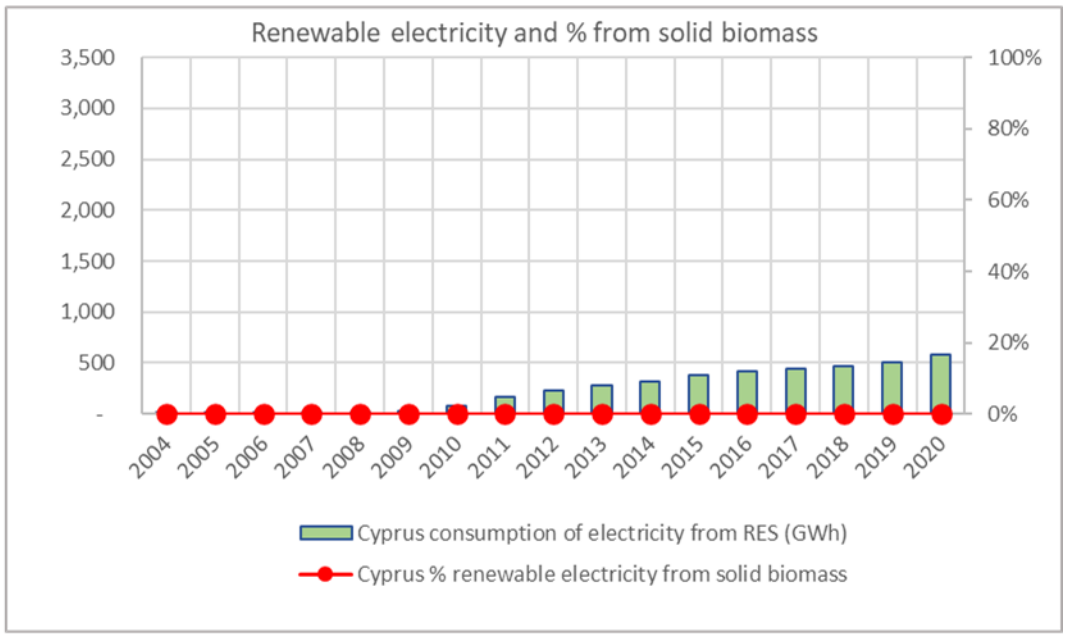


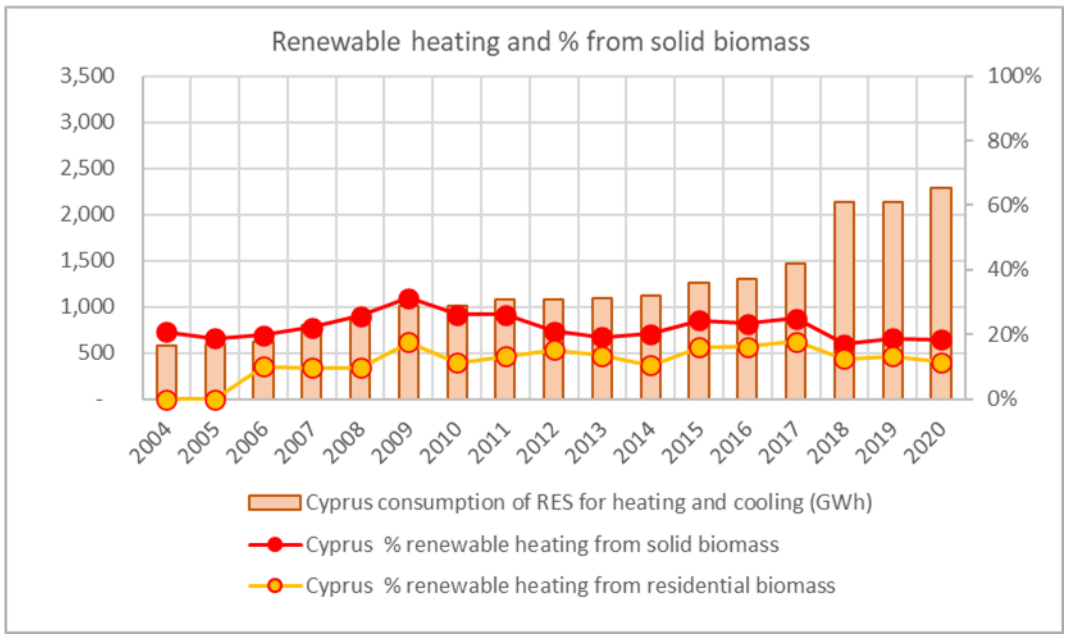
The abrupt increase in residential wood-burning after 2006 suggests an artefact in the data, either poor reporting or a revision in surveying methods applied retroactively, such as that which occurred in Hungary. See explanation above.



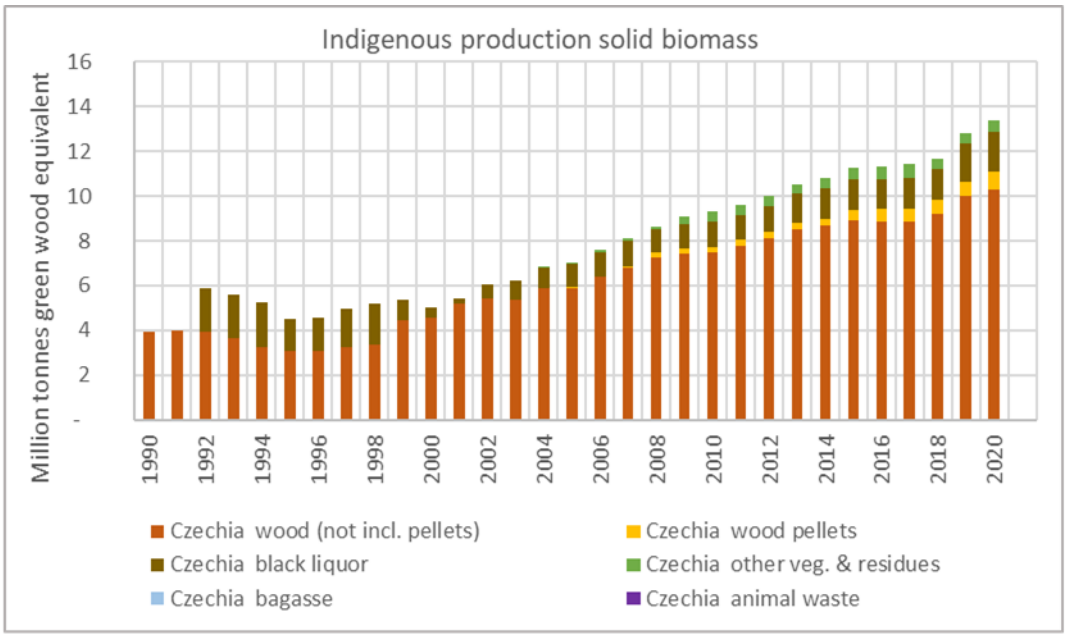


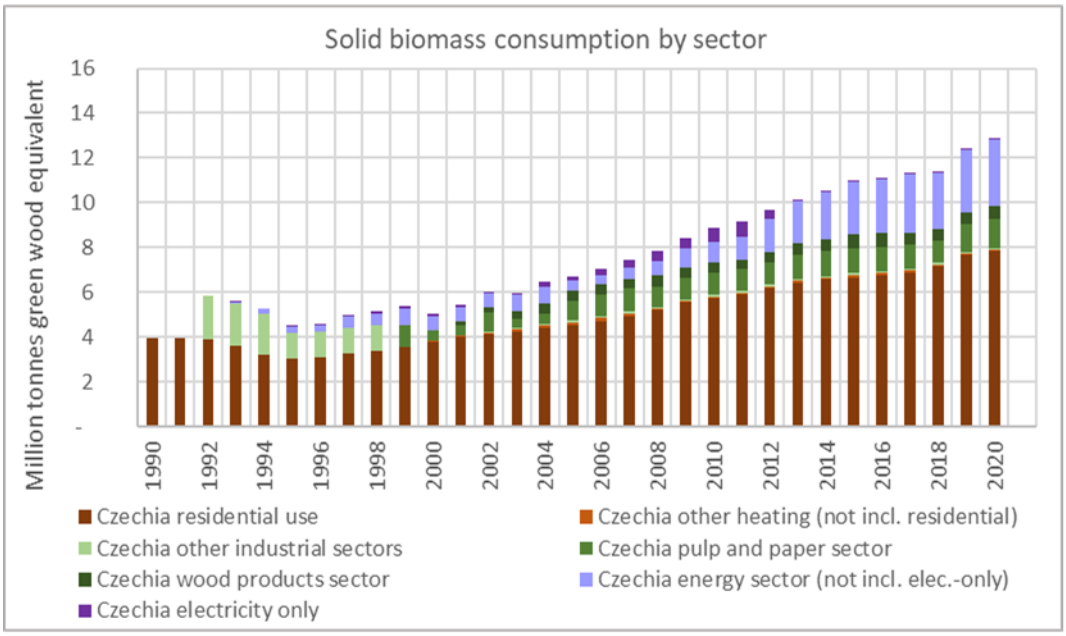

Total RE consumption and % from solid biomass
3,500
3,000
2,500
2,000
1,500
1,000
500
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Cyprus consumption of RES in transport (GWh)
Cyprus consumption of electricity from RES (GWh)
Cyprus consumption of RES for heating and cooling (GWh)
Cyprus % total RES from solid biomass
Cyprus % total RES from residential biomass


Renewable electricity and % from solid biomass
3,500
3,000
2,500
2,000
1,500
1,000
500
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Cyprus consumption of electricity from RES (GWh)
Cyprus % renewable electricity from solid biomass

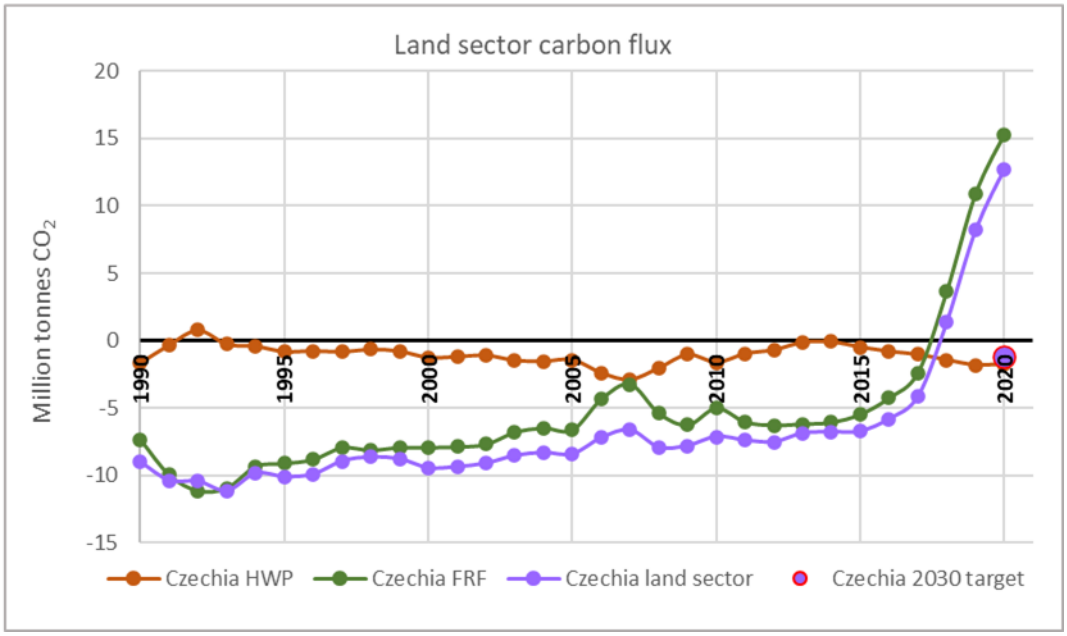

Renewable heating and % from solid biomass
3,500
3,000
2,500
2,000
1,500
1,000
500
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Cyprus consumption of RES for heating and cooling (GWh)
Cyprus % renewable heating from solid biomass
Cyprus % renewable heating from residential biomass

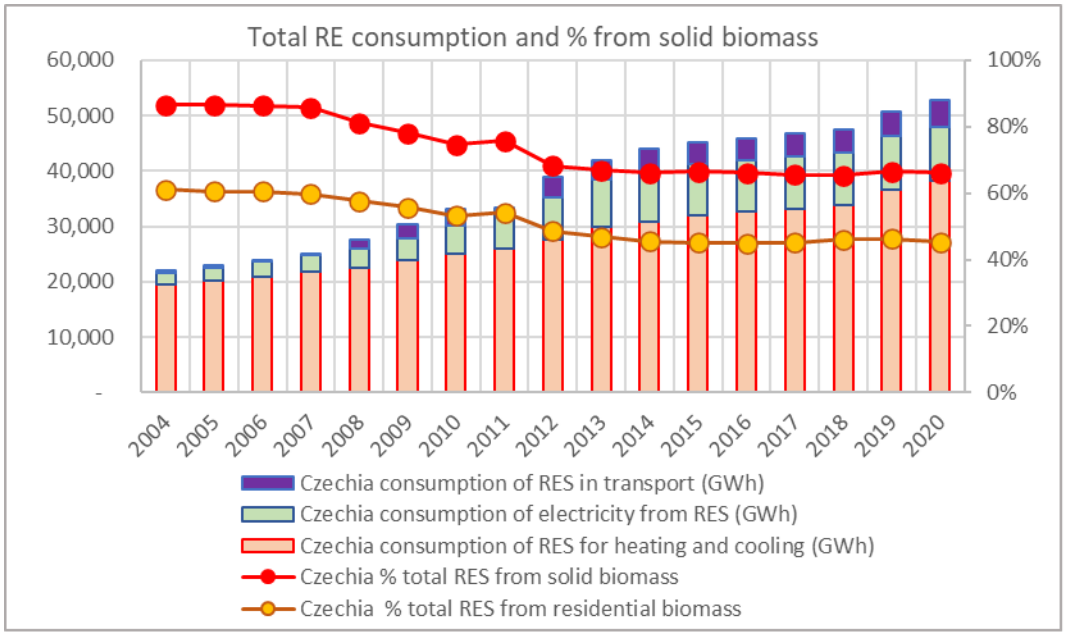
Czechia

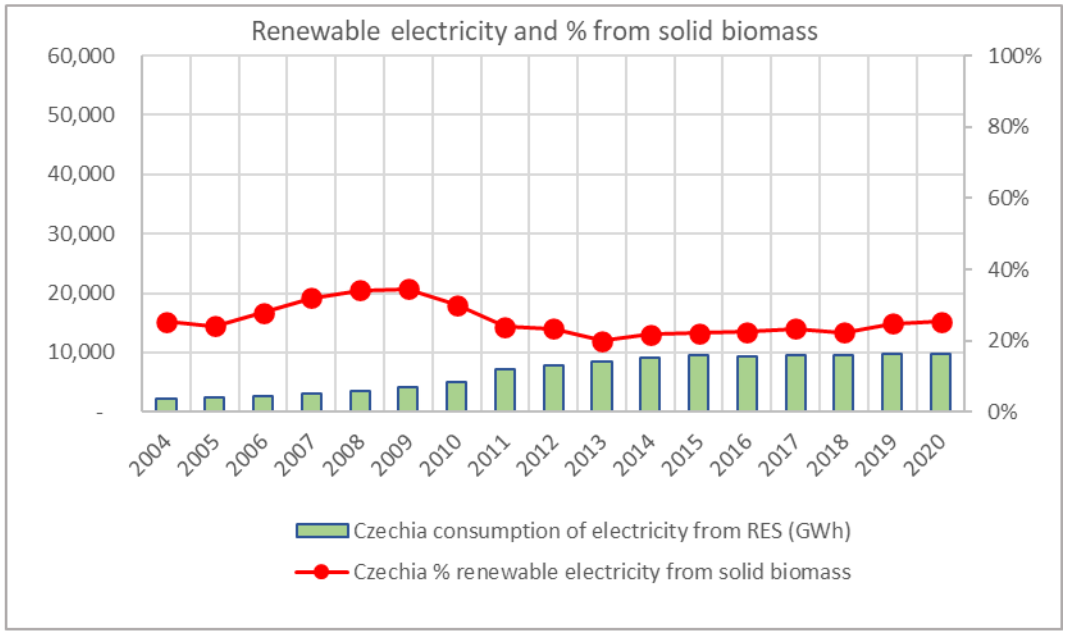




The abrupt loss in the forest and land carbon sinks in recent years is related at least in part to bark beetle damage. According to EU data, salvage logging accounted for 95% of all logging in 2019.[i]




Total RE consumption and % from solid biomass
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Czechia consumption of RES in transport (GWh)
Czechia consumption of electricity from RES (GWh)
Czechia consumption of RES for heating and cooling (GWh)
Czechia % total RES from solid biomass
Czechia % total RES from residential biomass


Renewable electricity and % from solid biomass
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
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2011
2012
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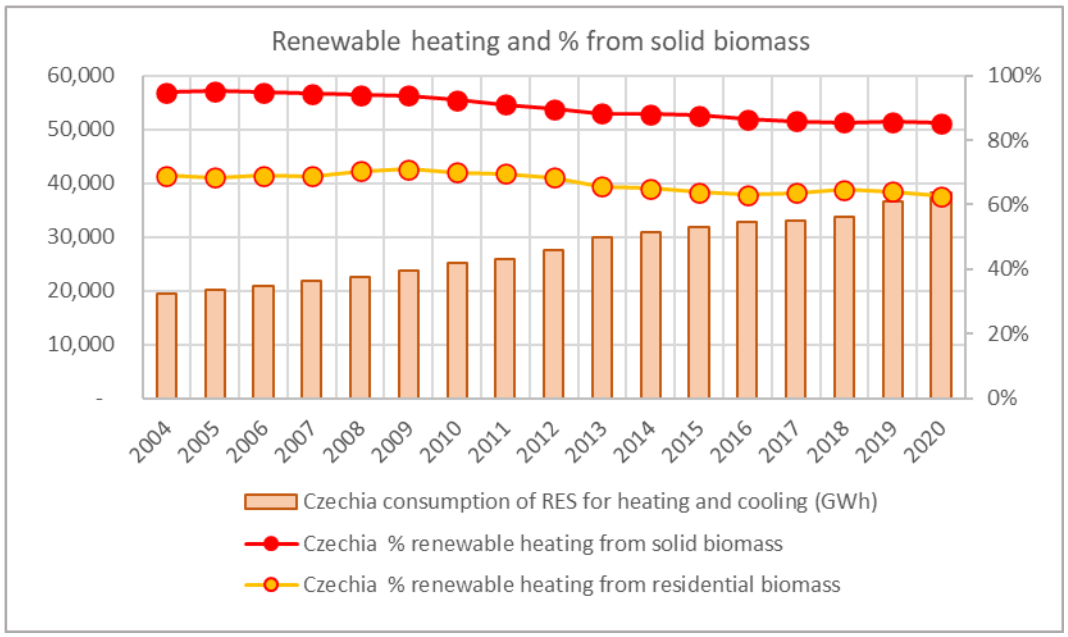
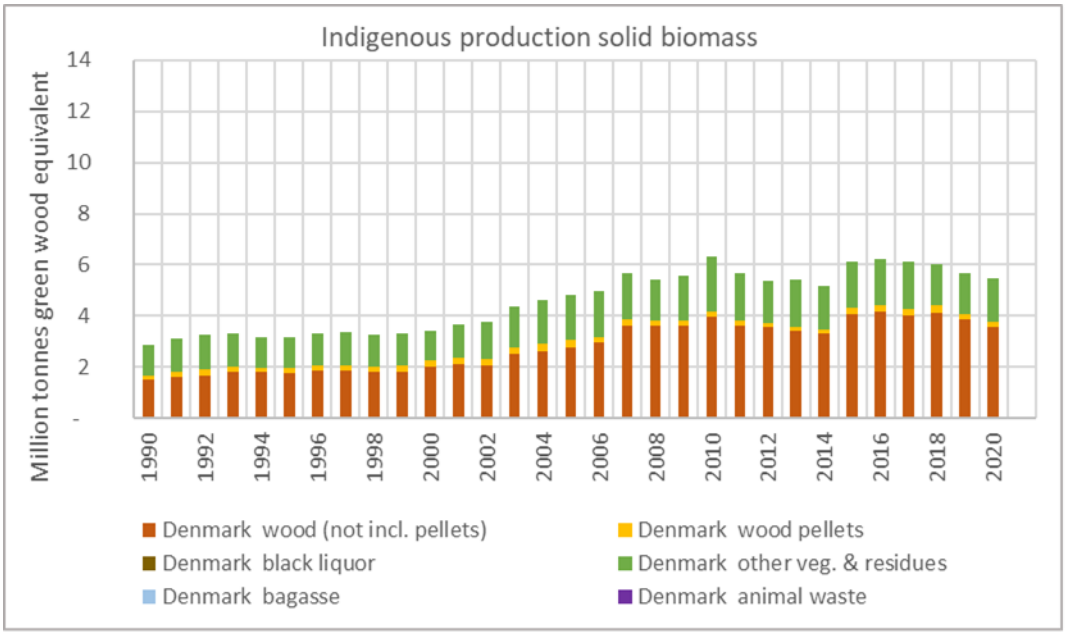
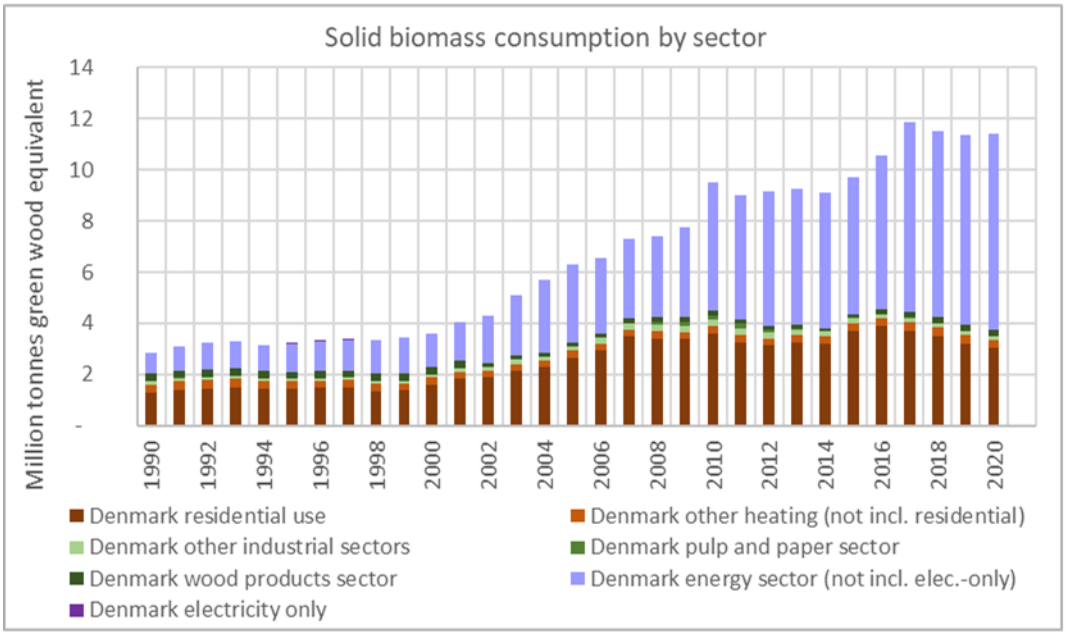
2015
2016
2017
2018
2019
2020
Czechia consumption of electricity from RES (GWh)
Czechia % renewable electricity from solid biomass


Renewable heating and % from solid biomass
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Czechia consumption of RES for heating and cooling (GWh)
Czechia % renewable heating from solid biomass
Czechia % renewable heating from residential biomass

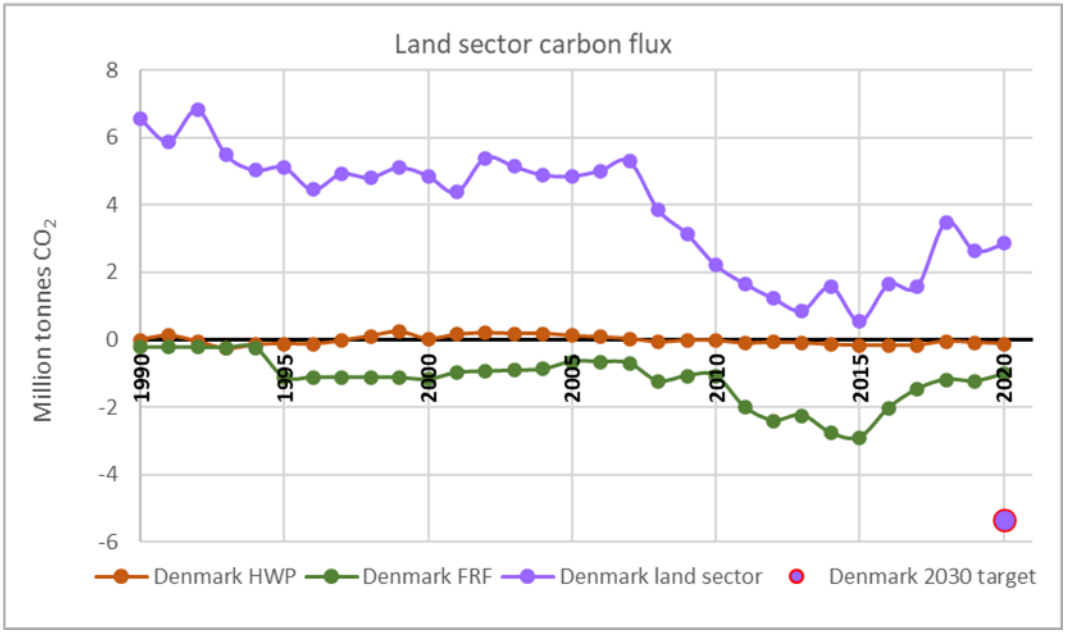
Denmark

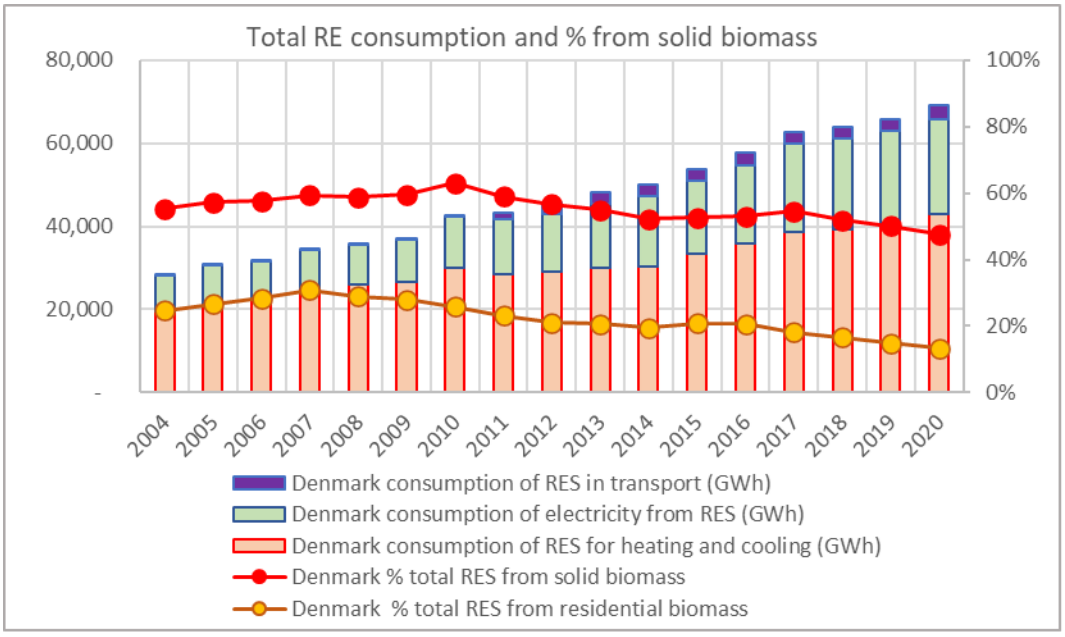


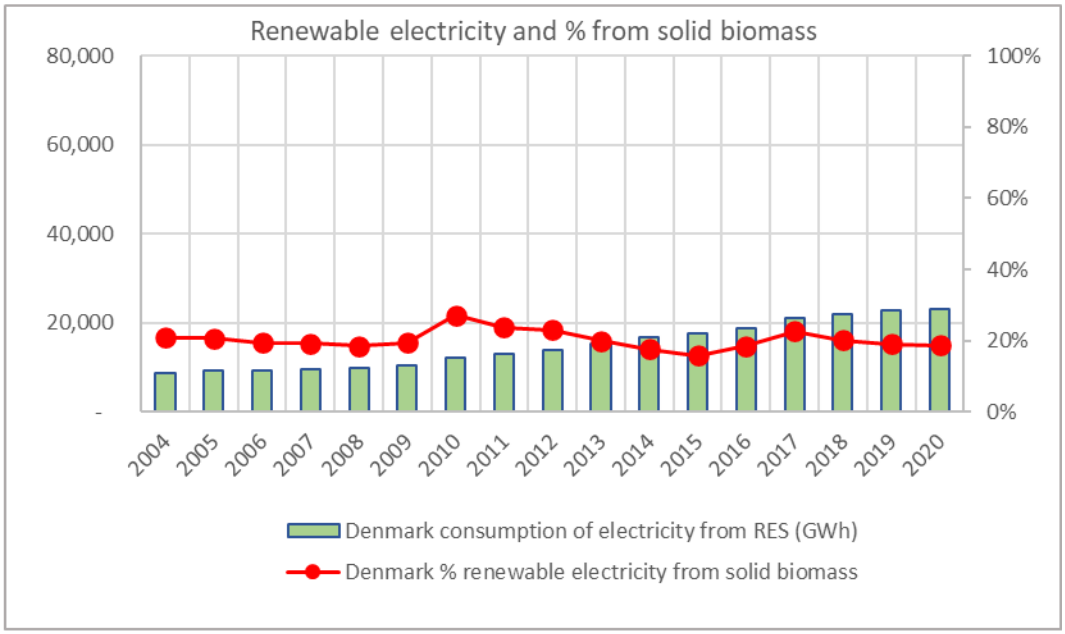
It appears that nearly all wood recorded as harvested in Denmark is allocated to residential heating, while a surge in energy sector generation is primarily fueled from wood chip (Brazil) and wood pellet imports from EU countries that are losing or have lost their carbon sinks, including Estonia and Latvia. See section above. Meanwhile, Denmark is one of few countries that are tackling the problem of wood smoke pollution.[ii]

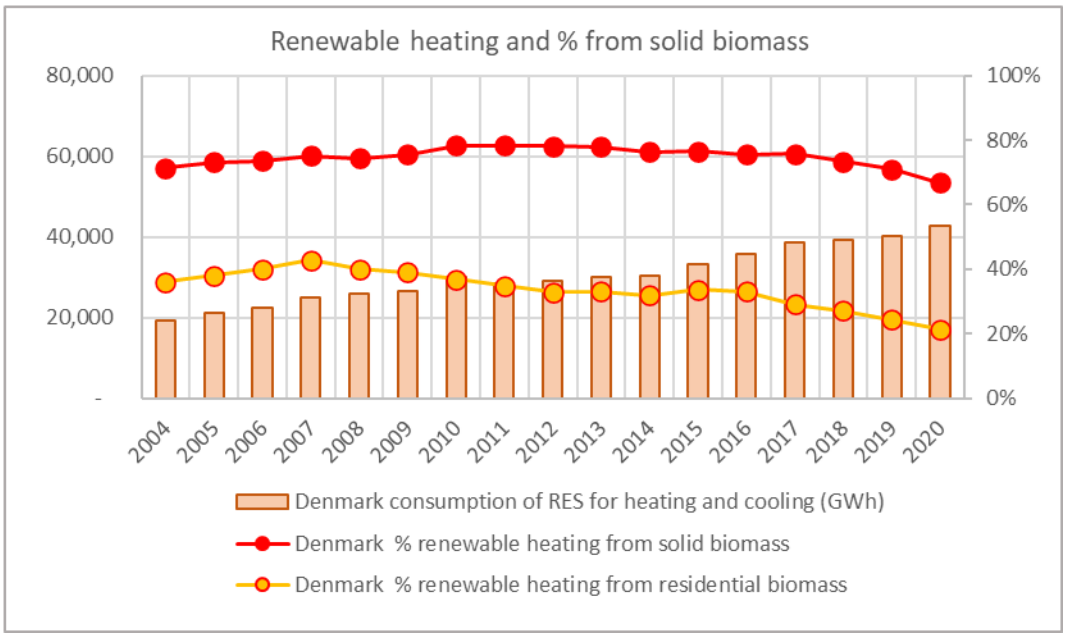


Full reporting of Denmark's land sector carbon flux data to the UNFCCC[iii] reveal that massive carbon losses from croplands and grasslands account for Denmark's land carbon sector being a net source of greenhouse gas emissions. This reporting does not include climate-forcing trace gases from agriculture, which are reported in the agriculture sector.



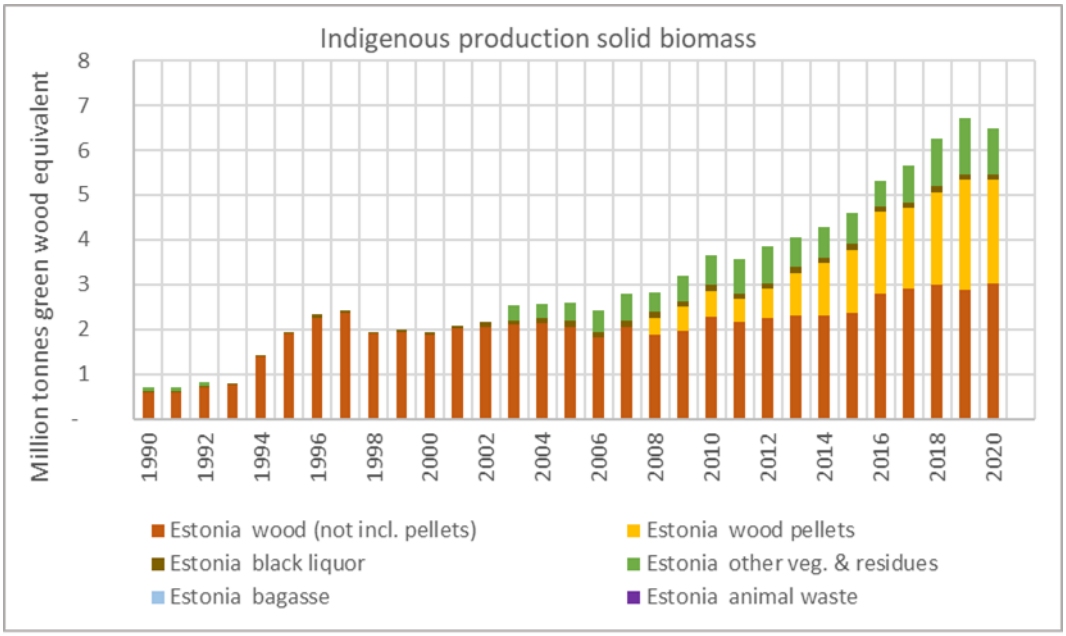

Total RE consumption and % from solid biomass
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Denmark consumption of RES in transport (GWh)
Denmark consumption of electricity from RES (GWh)
Denmark consumption of RES for heating and cooling (GWh)
Denmark % total RES from solid biomass
Denmark % total RES from residential biomass

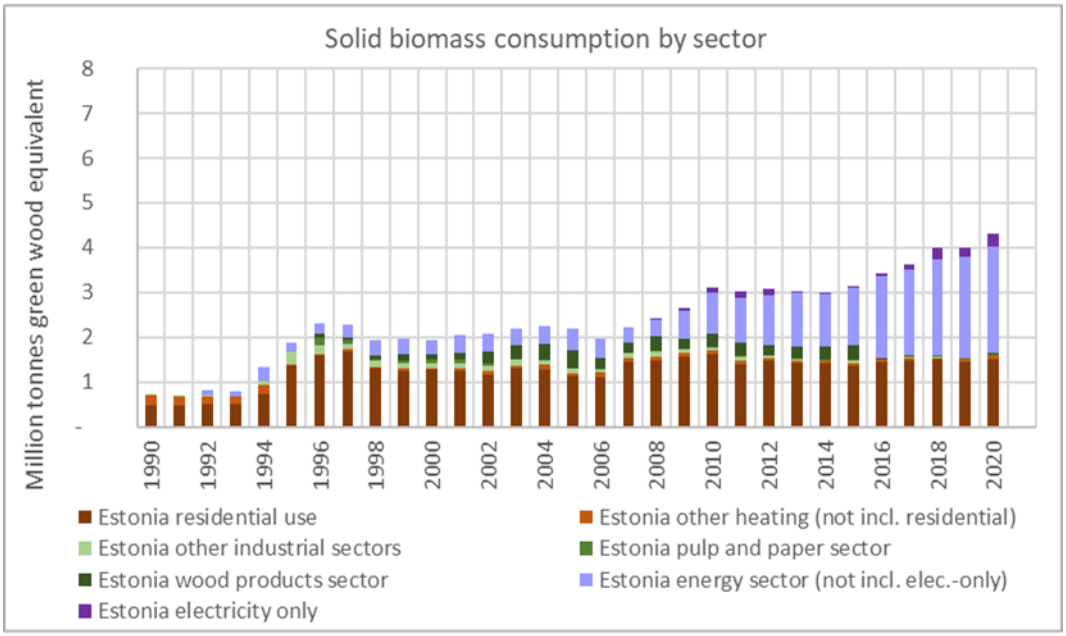

Renewable electricity and % from solid biomass
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Denmark consumption of electricity from RES (GWh)
Denmark % renewable electricity from solid biomass


Renewable heating and % from solid biomass
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Denmark consumption of RES for heating and cooling (GWh)
Denmark % renewable heating from solid biomass
Denmark % renewable heating from residential biomass

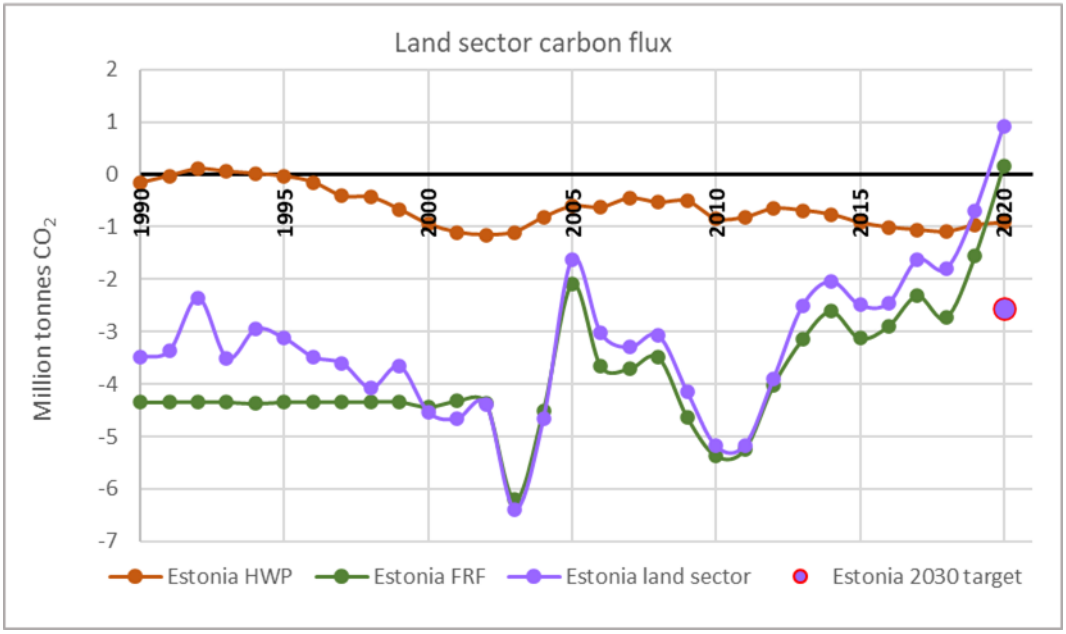
Estonia

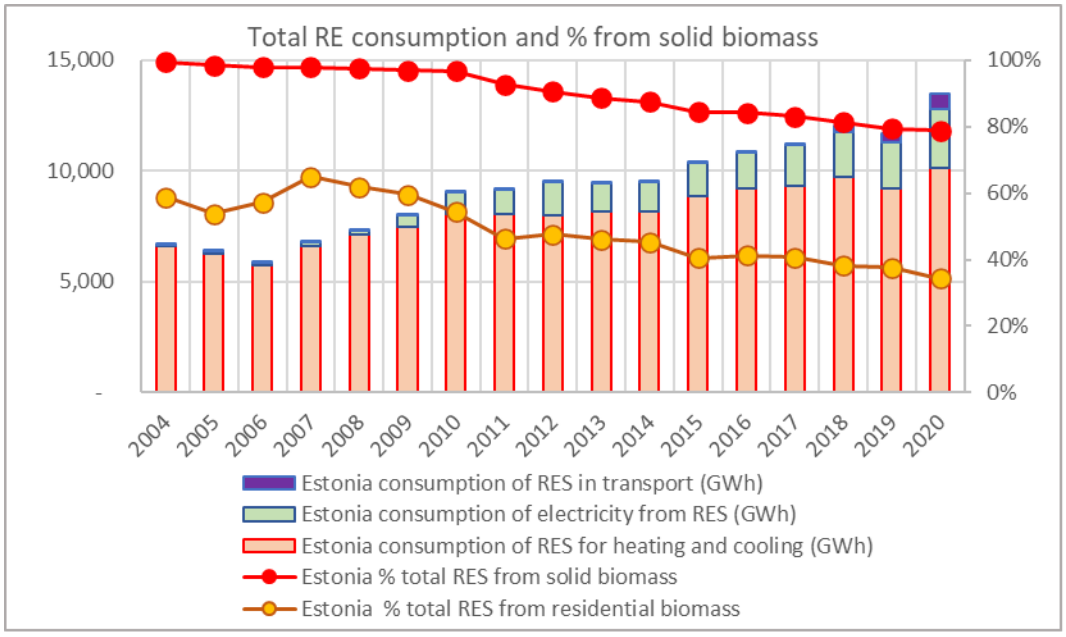
A large increase in pellet production is mostly servicing power plants outside Estonia. Comparing wood used for energy with total harvesting shows that energy wood has represented more than half of wood harvested in recent years. [iv]

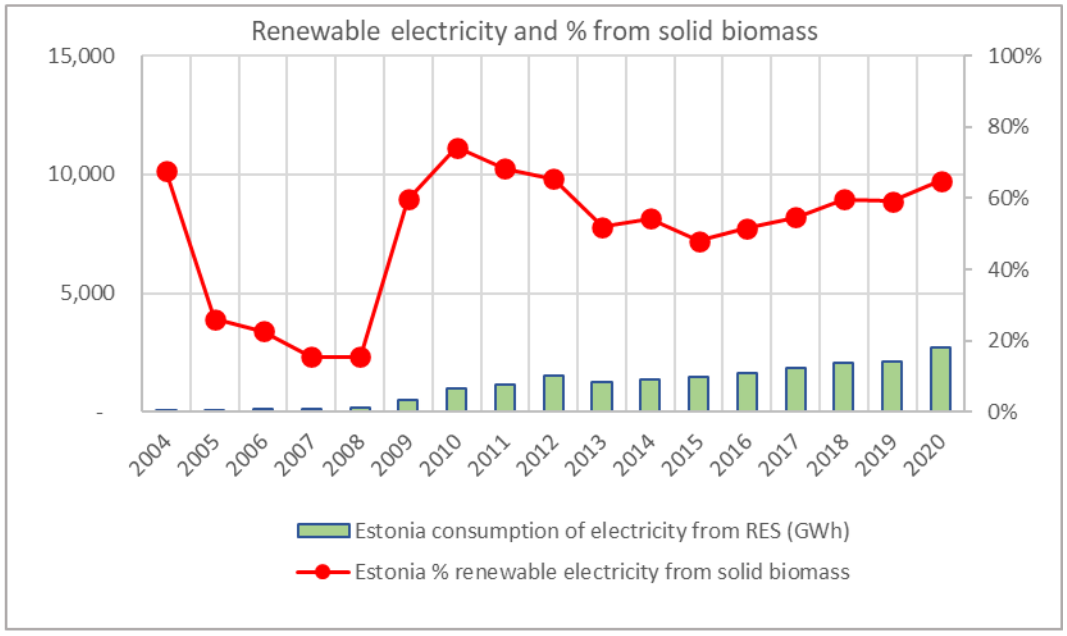


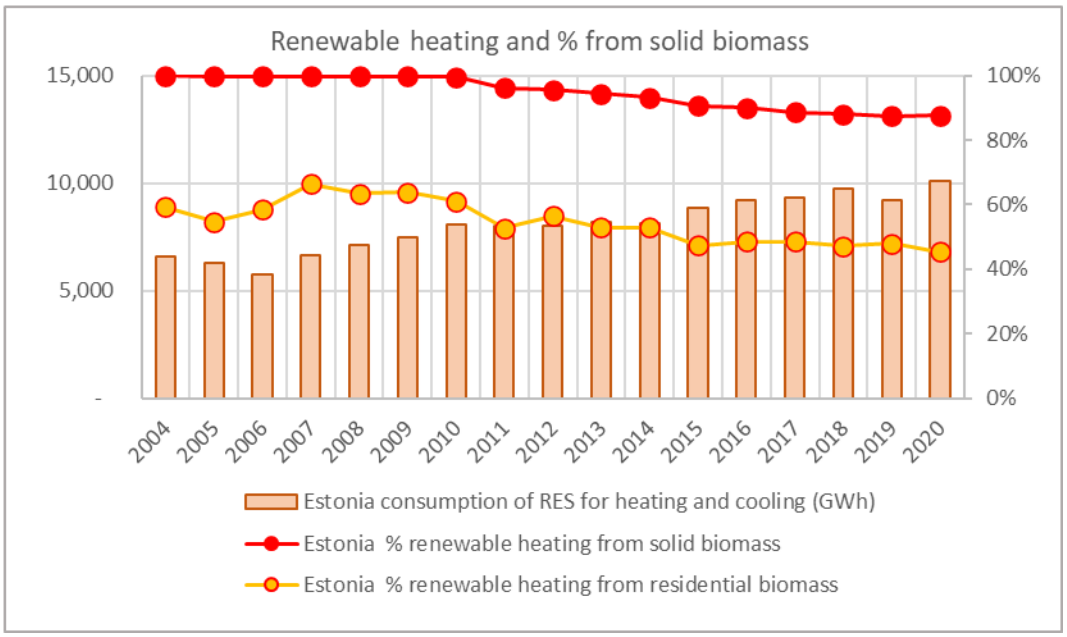


An abrupt loss in the carbon sink has accompanied the surge in wood pellet production in Estonia.



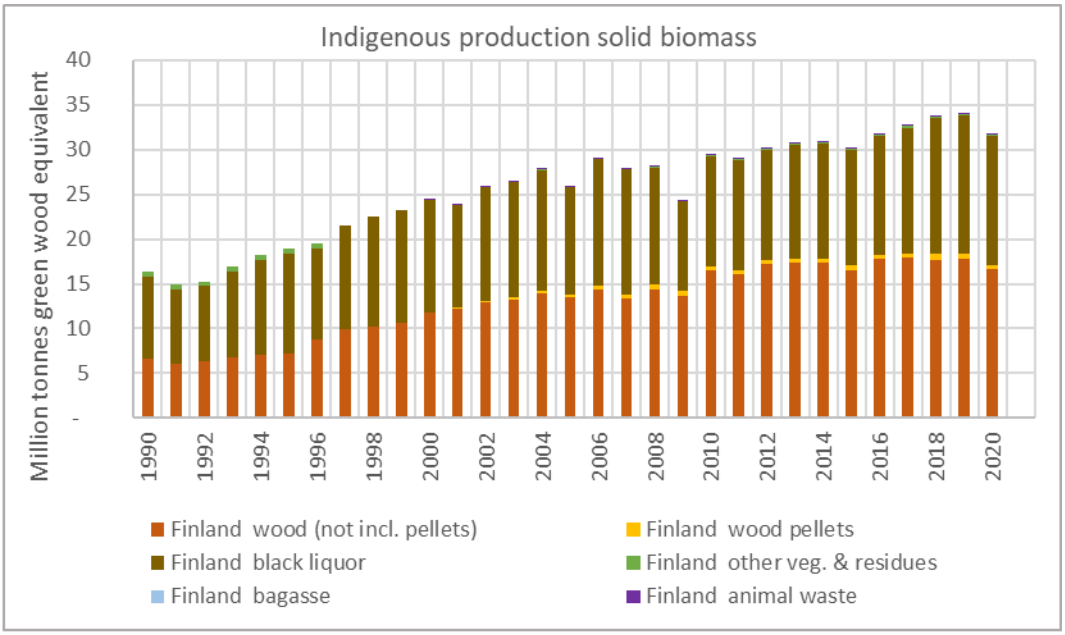

Total RE consumption and % from solid biomass
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Estonia consumption of RES in transport (GWh)
Estonia consumption of electricity from RES (GWh)
Estonia consumption of RES for heating and cooling (GWh)
Estonia % total RES from solid biomass
Estonia % total RES from residential biomass


Renewable electricity and % from solid biomass
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Estonia consumption of electricity from RES (GWh)
Estonia % renewable electricity from solid biomass

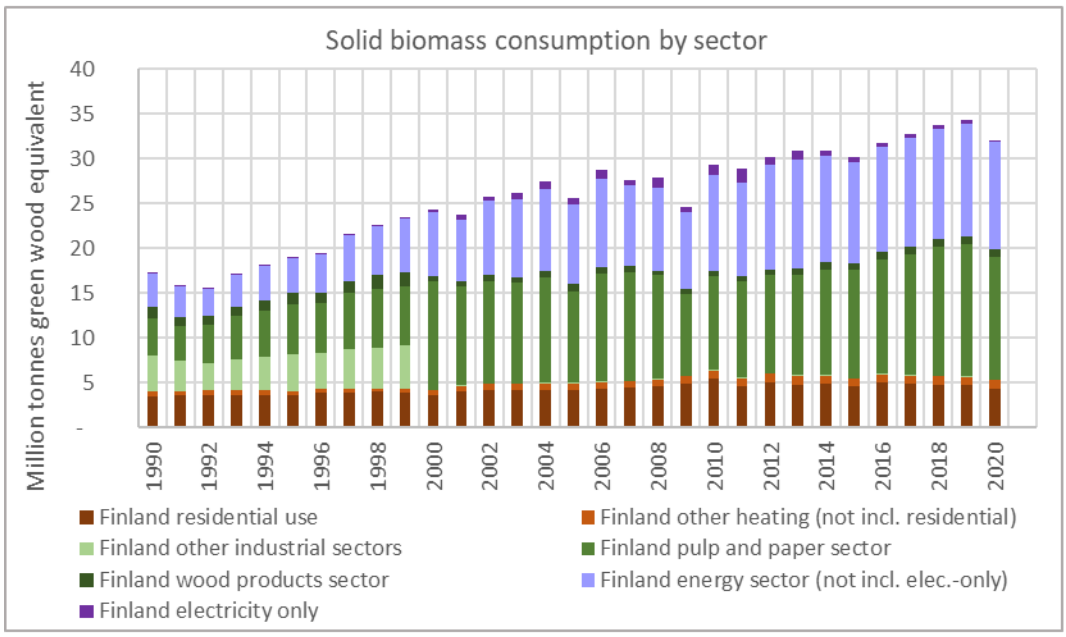

Renewable heating and % from solid biomass
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Estonia consumption of RES for heating and cooling (GWh)
Estonia % renewable heating from solid biomass
Estonia % renewable heating from residential biomass

Finland

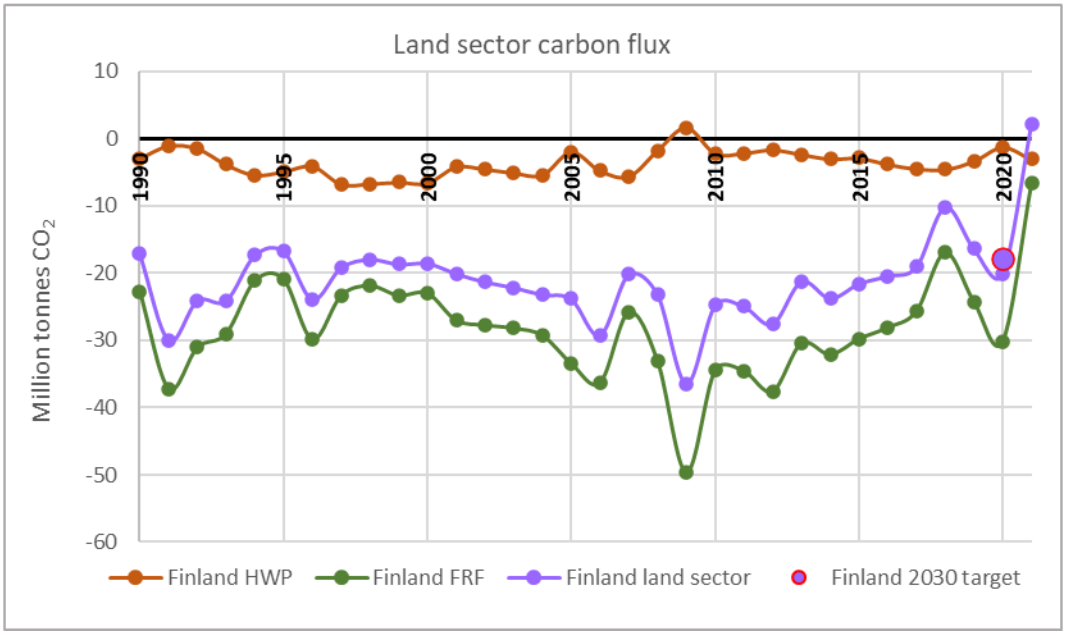
Black liquor from pulp/paper manufacture provides a significant portion of biomass burned in Finland, as is also the case in Sweden.

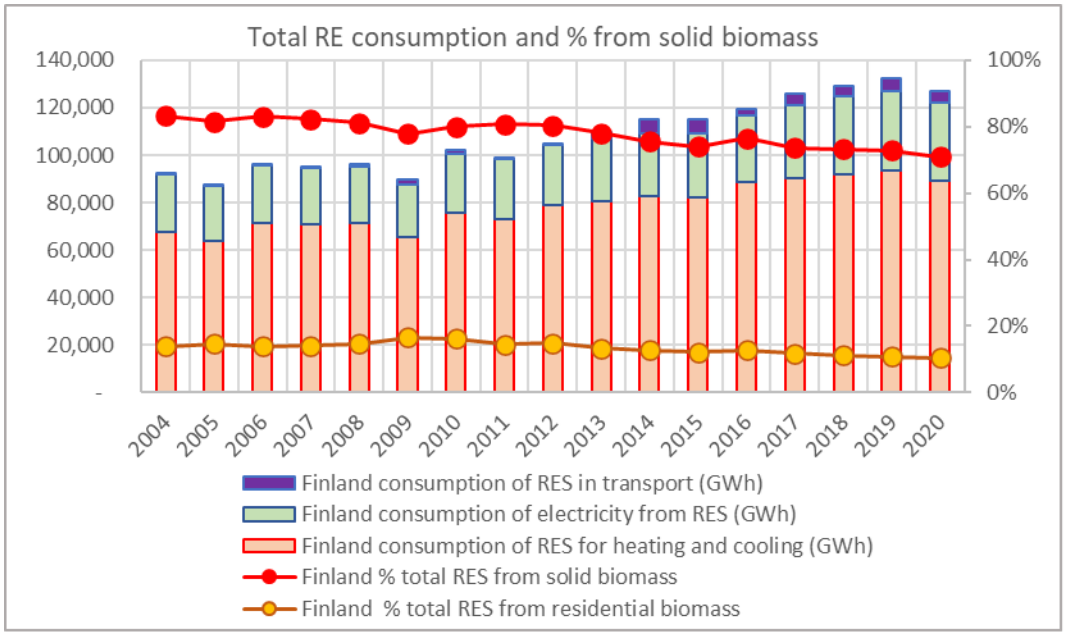


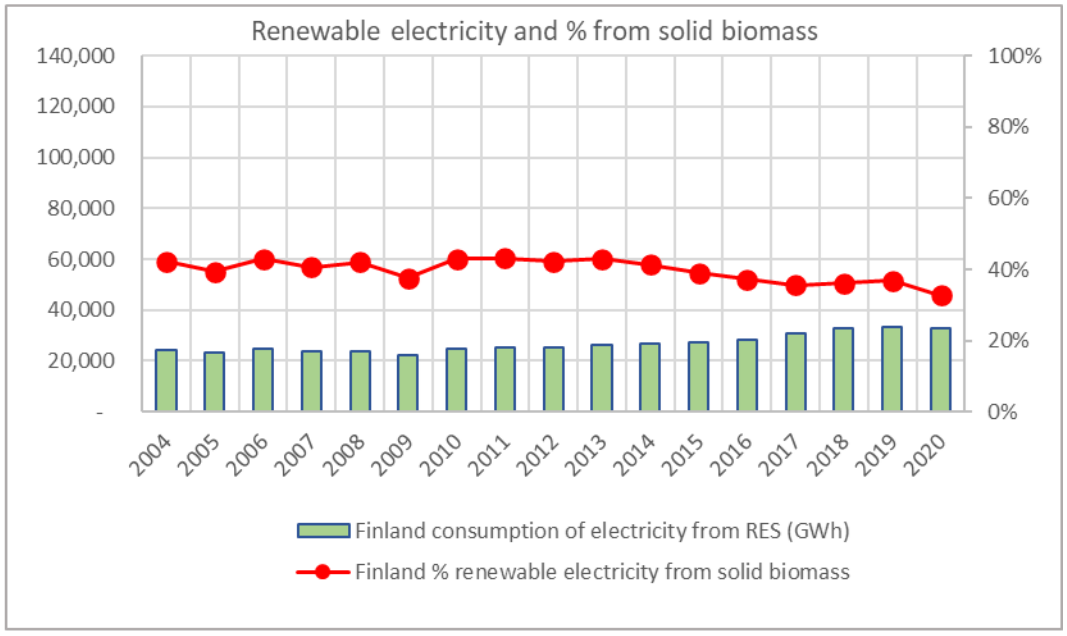
Industrial heat and power generation accounts for a large share of Finland's biomass consumption. This sector likely consumes all the black liquor shown in the production data.

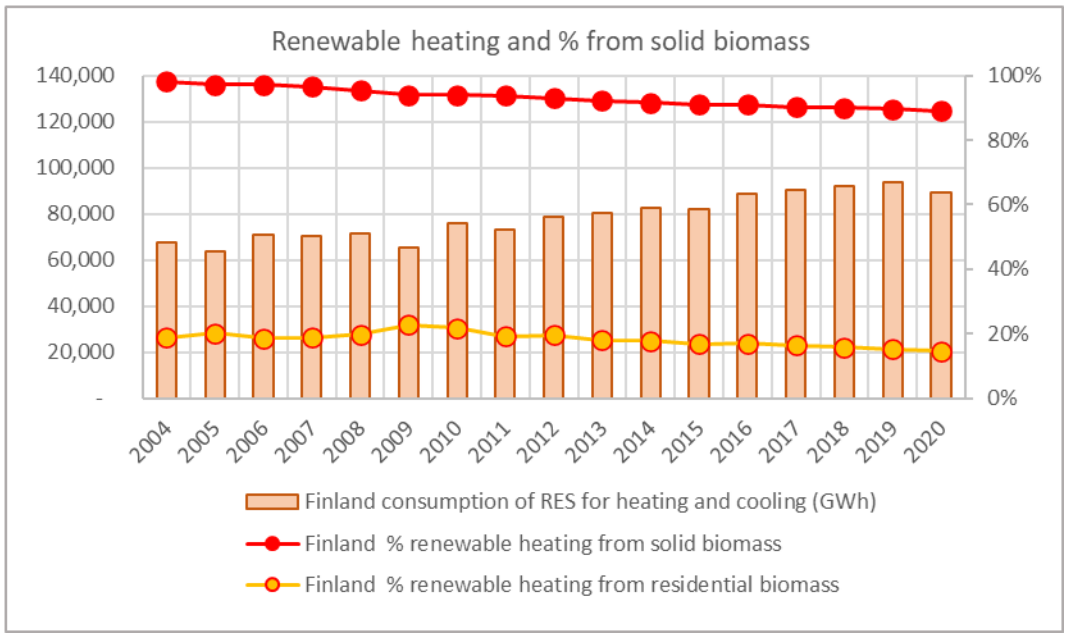


This graph includes preliminary data published by Statistics Finland, showing the loss of the land carbon sink in 2021.[v]



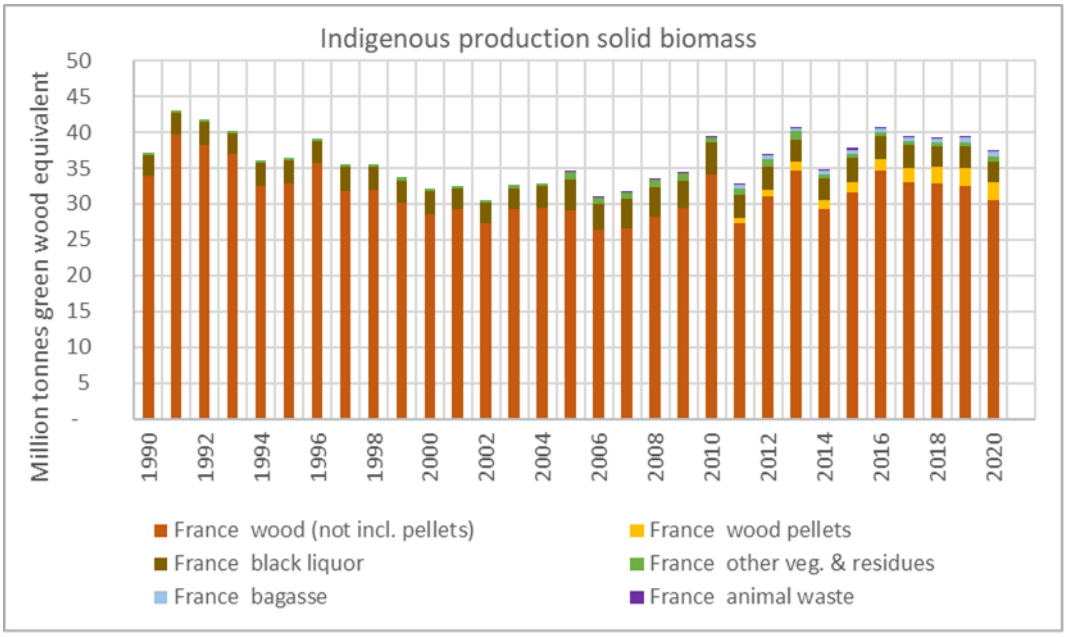

Total RE consumption and % from solid biomass
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Finland consumption of RES in transport (GWh)
Finland consumption of electricity from RES (GWh)
Finland consumption of RES for heating and cooling (GWh)
Finland % total RES from solid biomass
Finland % total RES from residential biomass

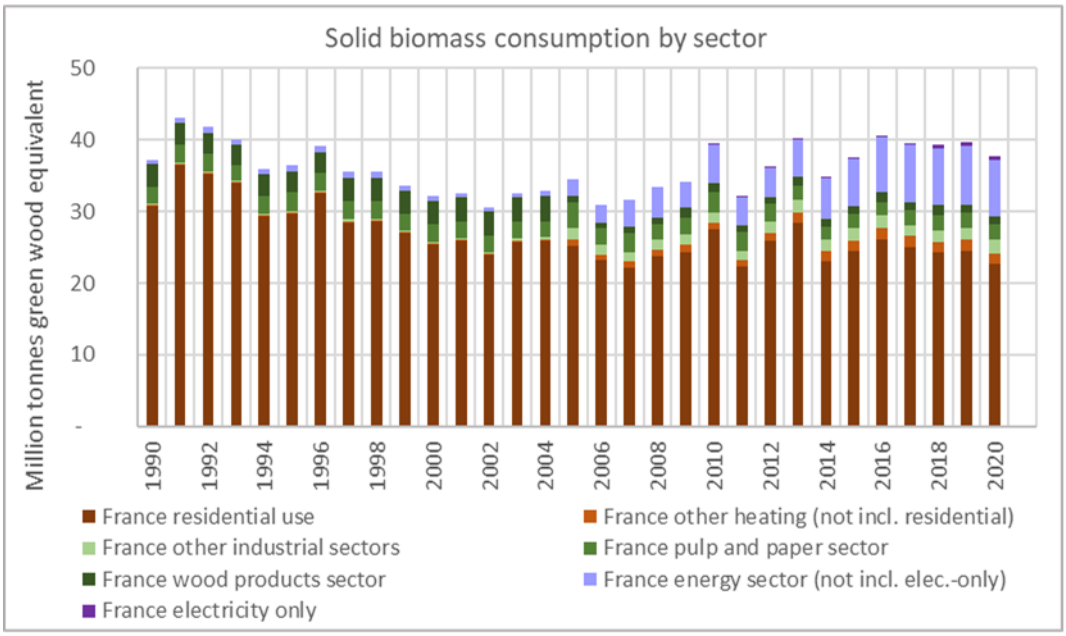

Renewable electricity and % from solid biomass
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Finland consumption of electricity from RES (GWh)
Finland % renewable electricity from solid biomass


Renewable heating and % from solid biomass
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Finland consumption of RES for heating and cooling (GWh)
Finland % renewable heating from solid biomass
Finland % renewable heating from residential biomass

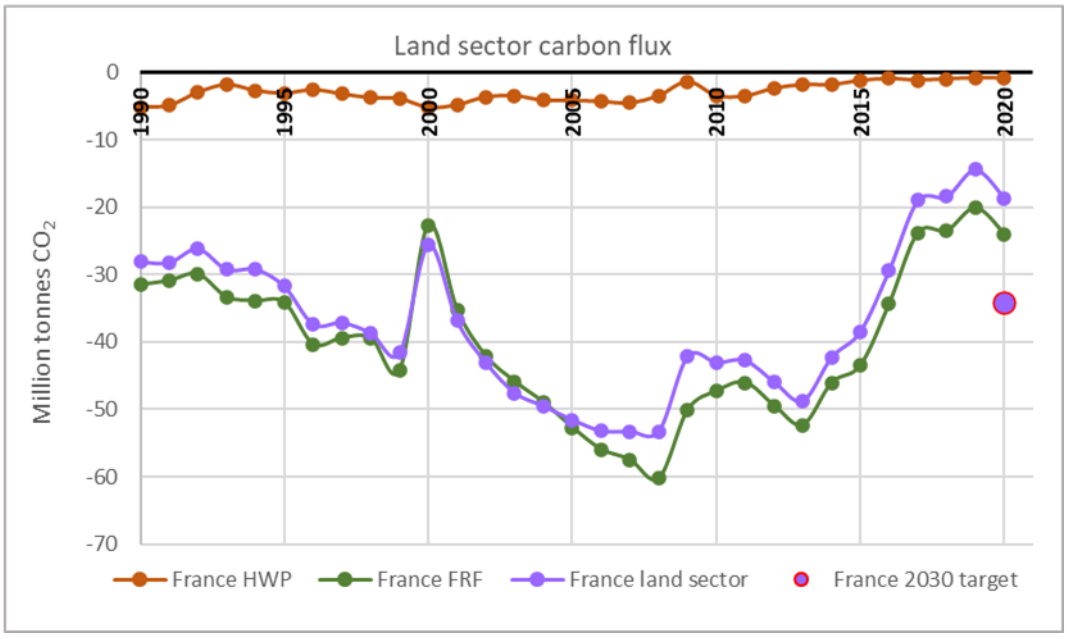
France

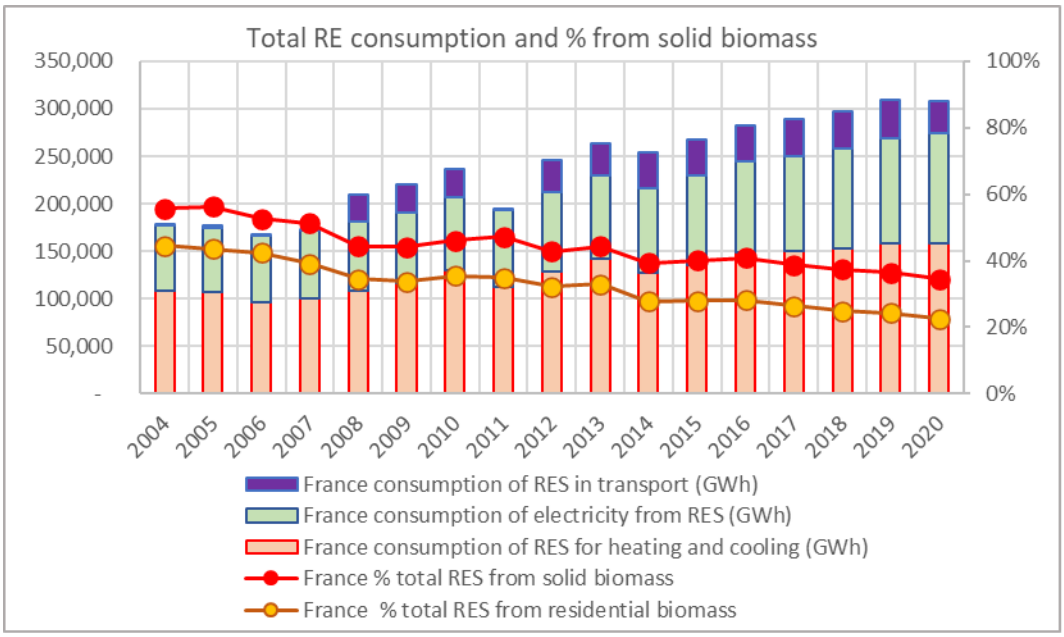
France's size means it consumes large amounts of wood for energy, even if per capita consumption is relatively low.

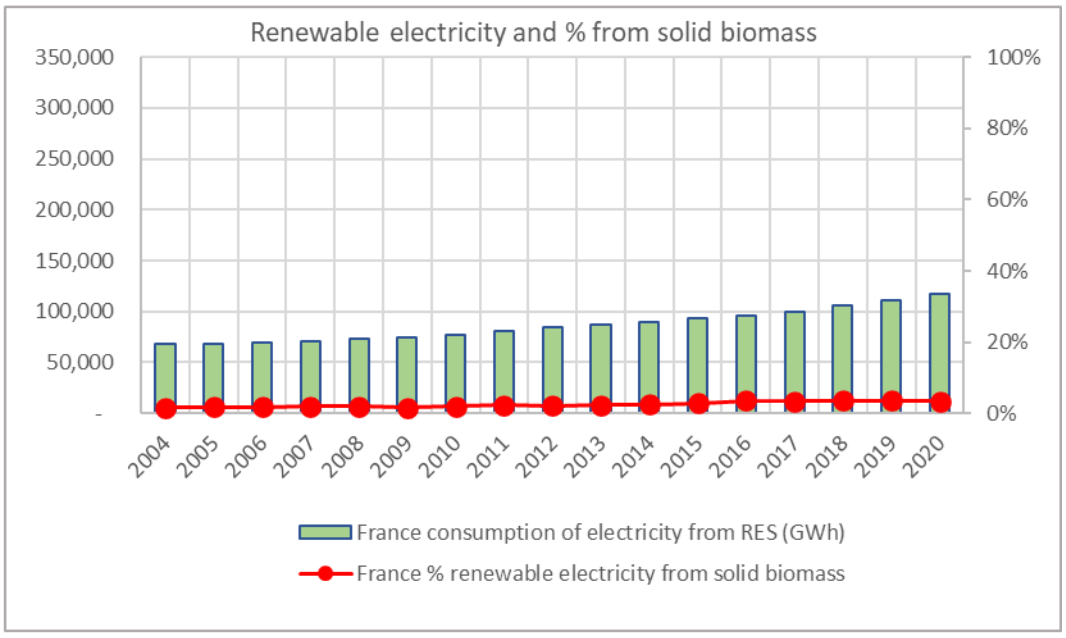


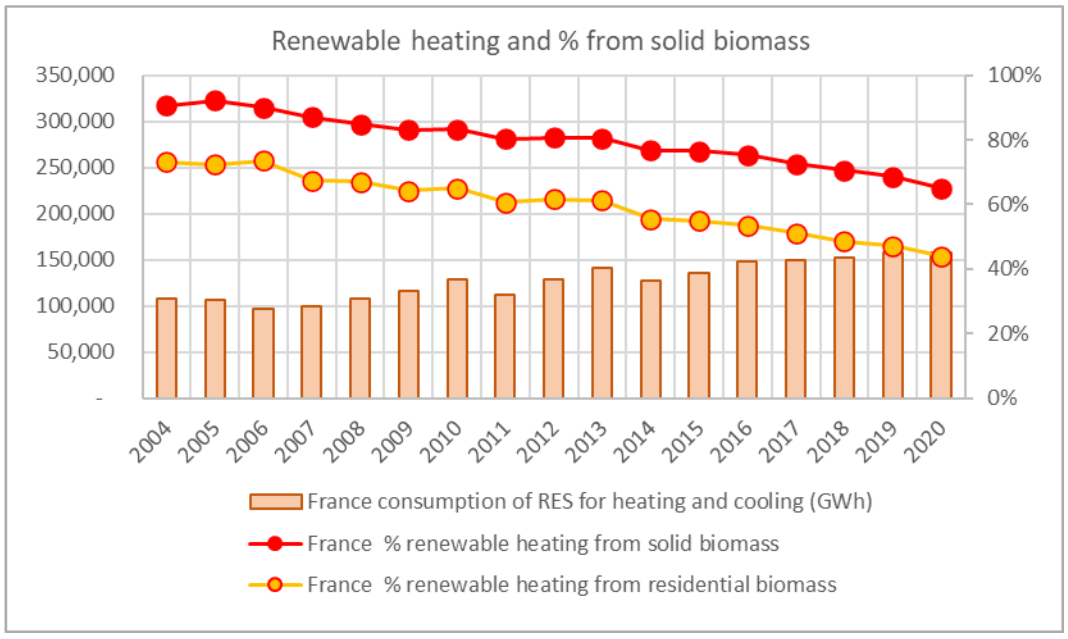


Despite relatively little growth in biomass production, France's forest and land carbon sink have shrunk dramatically since the early 2000's. Unlike Germany, where there has been considerable salvage logging, EU data show less than 5% logging is salvage in the most recent years' data.[vi]




Total RE consumption and % from solid biomass
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
France consumption of RES in transport (GWh)
France consumption of electricity from RES (GWh)
France consumption of RES for heating and cooling (GWh)
France % total RES from solid biomass
France % total RES from residential biomass

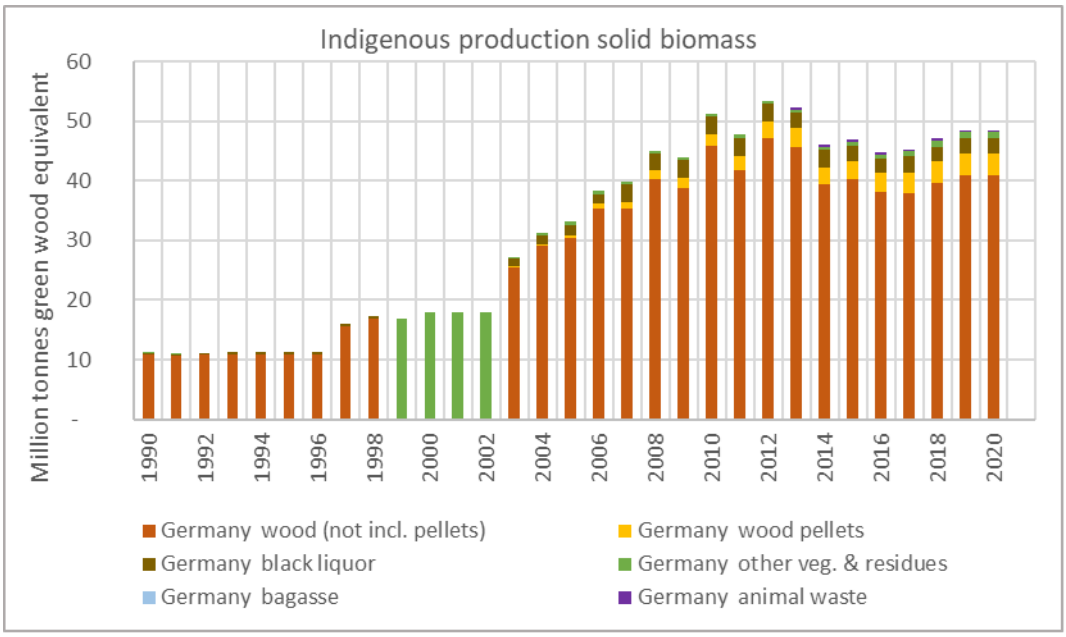

Renewable electricity and % from solid biomass
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
France consumption of electricity from RES (GWh)
France % renewable electricity from solid biomass

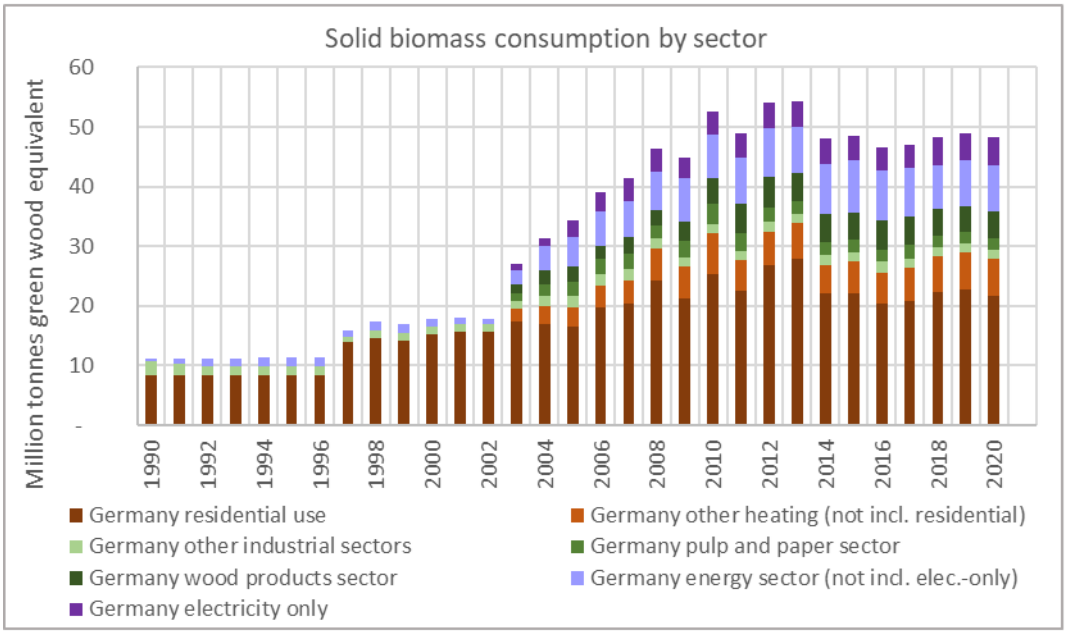

Renewable heating and % from solid biomass
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
France consumption of RES for heating and cooling (GWh)
France % renewable heating from solid biomass
France % renewable heating from residential biomass

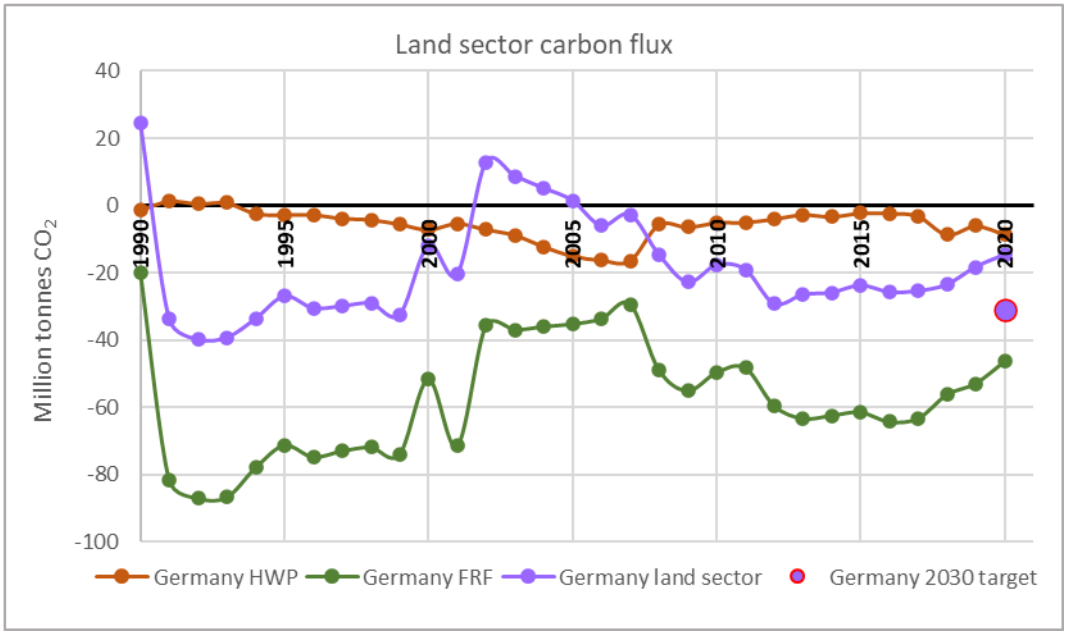
Germany

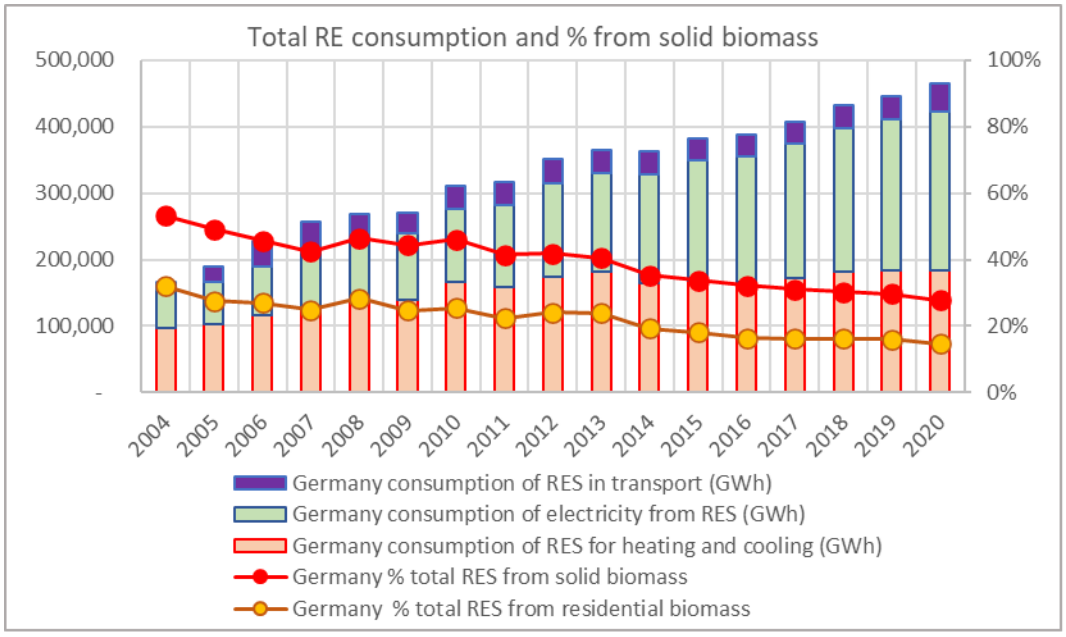
As is the case for France, Germany's size means it consumes massive amounts of wood for energy, if the per capita consumption is relatively low (see Figure 6). The 1999-2002 period where Germany reports no wood being burned, but a surge in "other vegetal material and residues," is surely a coding error. Likewise, some of the increase in production, and residential use in the second graph, is likely due to better reporting, and does not represent an actual increase.

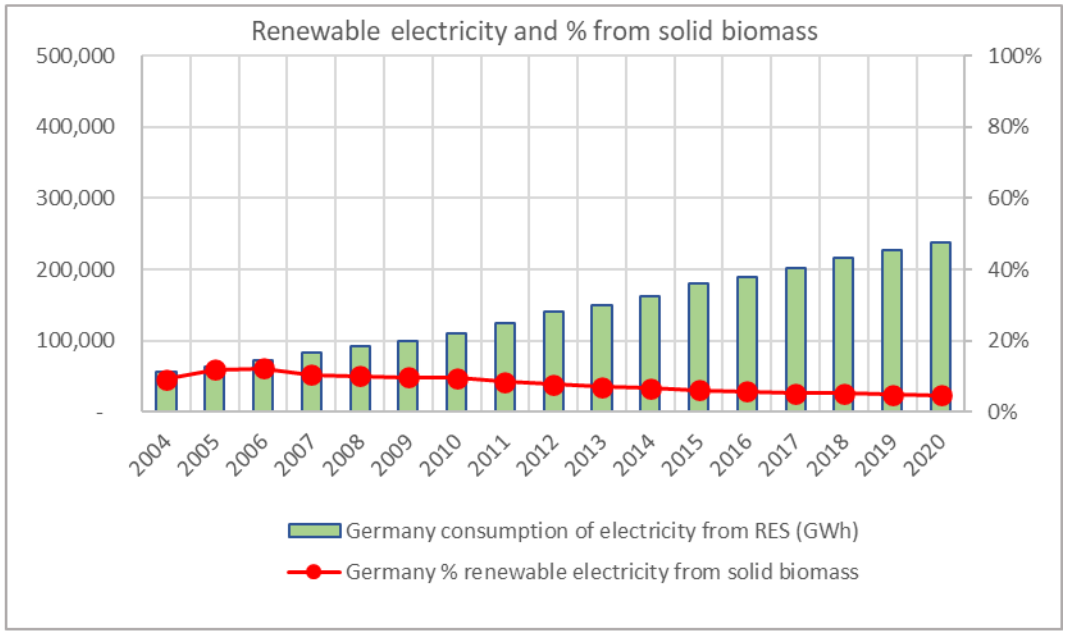
The data show an abrupt increase in energy sector biomass consumption after 2002, presumably as a consequence of the EU's 2001 directive on renewable electricity sources.[vii]

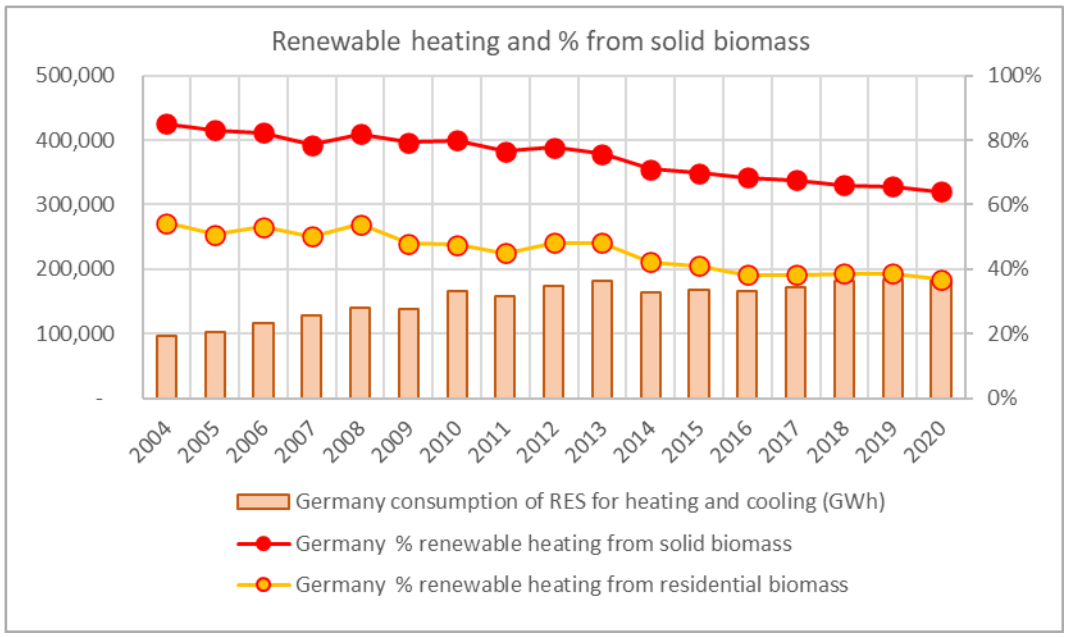




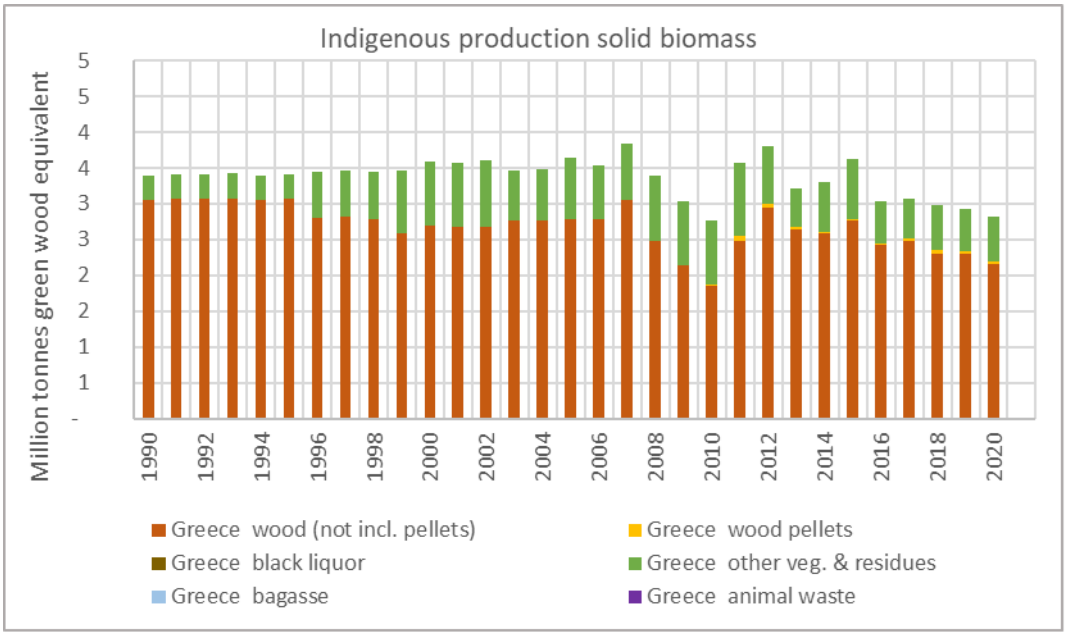


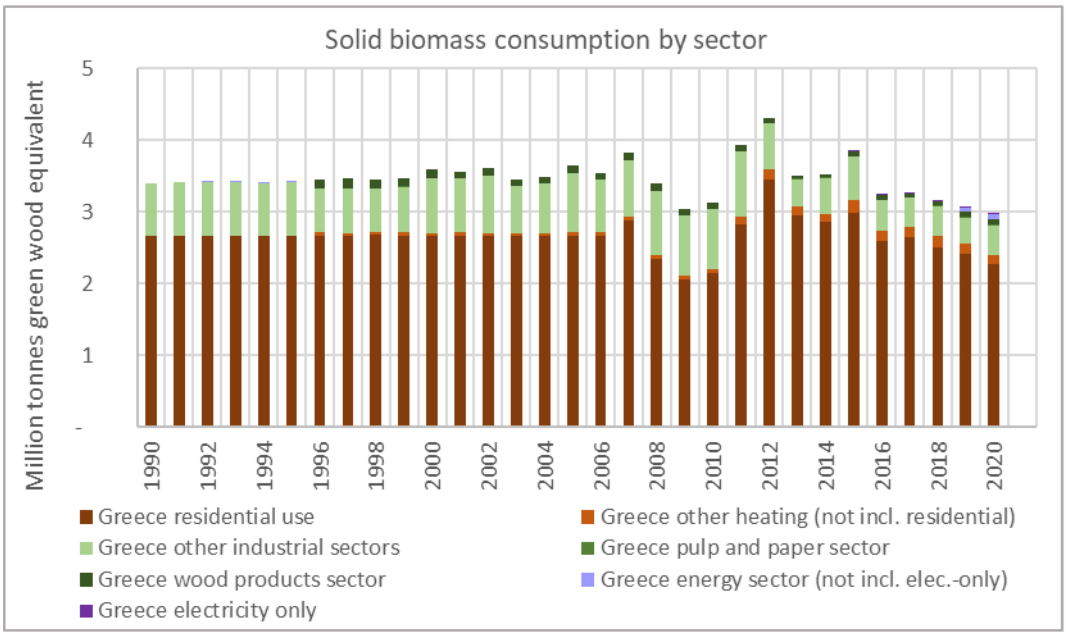

Total RE consumption and % from solid biomass
500,000
400,000
300,000
200,000
100,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Germany consumption of RES in transport (GWh)
Germany consumption of electricity from RES (GWh)
Germany consumption of RES for heating and cooling (GWh)
Germany % total RES from solid biomass
Germany % total RES from residential biomass

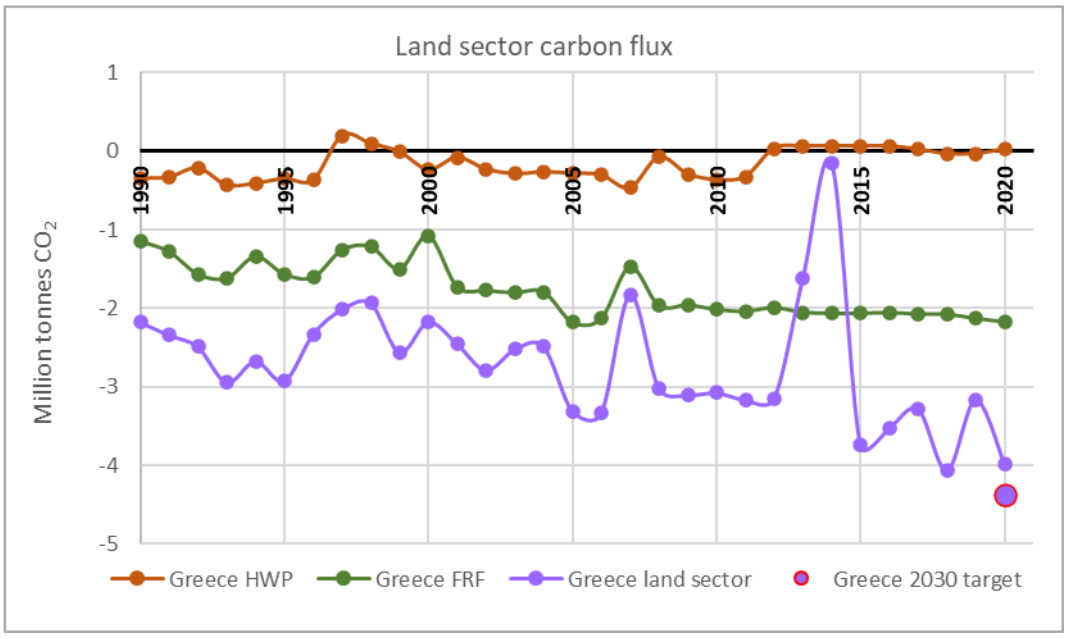

Renewable electricity and % from solid biomass
500,000
400,000
300,000
200,000
100,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Germany consumption of electricity from RES (GWh)
Germany % renewable electricity from solid biomass

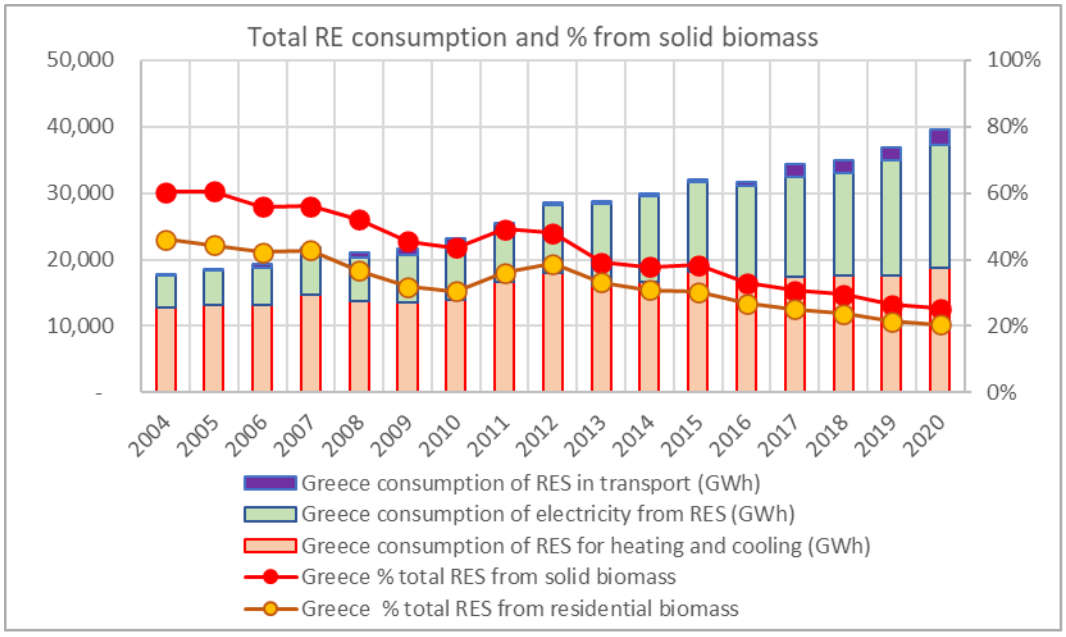

Renewable heating and % from solid biomass
500,000
400,000
300,000
200,000
100,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Germany consumption of RES for heating and cooling (GWh)
Germany % renewable heating from solid biomass
Germany % renewable heating from residential biomass

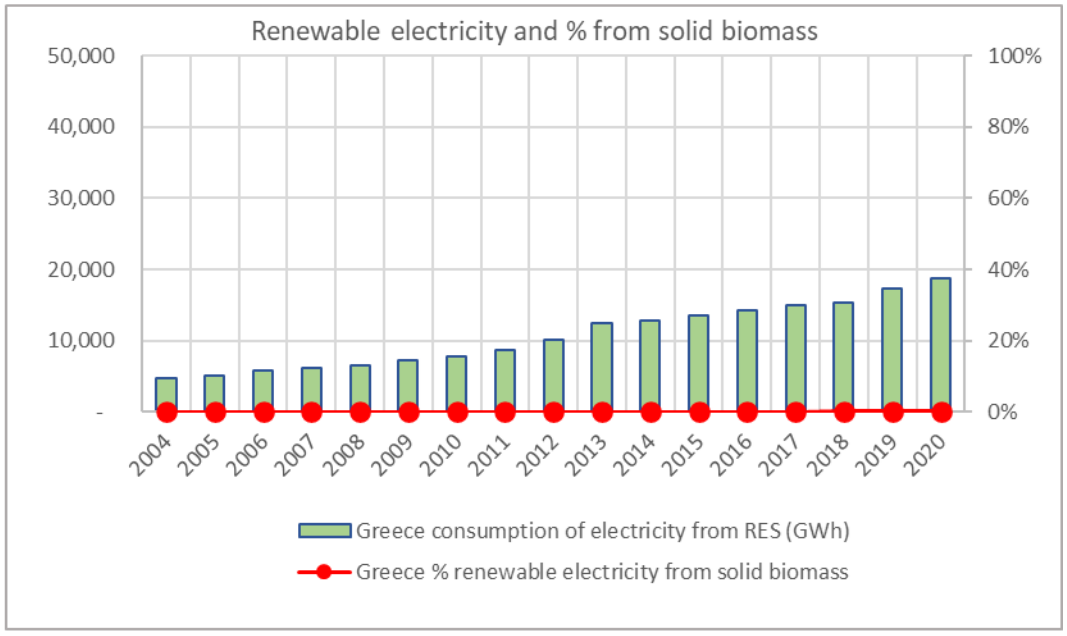
Greece


Indigenous production solid biomass
Million tonnes green wood equivalent
5
5
4
4
3
3
2
2
1
1
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Greece wood (not incl. pellets)
Greece wood pellets
Greece black liquor
Greece other veg. & residues
Greece bagasse
Greece animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
5
4
3
2
1
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Greece residential use
Greece other heating (not incl. residential)
Greece other industrial sectors
Greece pulp and paper sector
Greece wood products sector
Greece energy sector (not incl. elec.-only)
Greece electricity only


Land sector carbon flux
Million tonnes CO_2
1
0
-1
-2
-3
-4
-5
1990
1995
2000
2005
2010
2015
2020
Greece HWP
Greece FRF
Greece land sector
Greece 2030 target


Total RE consumption and % from solid biomass
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Greece consumption of RES in transport (GWh)
Greece consumption of electricity from RES (GWh)
Greece consumption of RES for heating and cooling (GWh)
Greece % total RES from solid biomass
Greece % total RES from residential biomass


Renewable electricity and % from solid biomass
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
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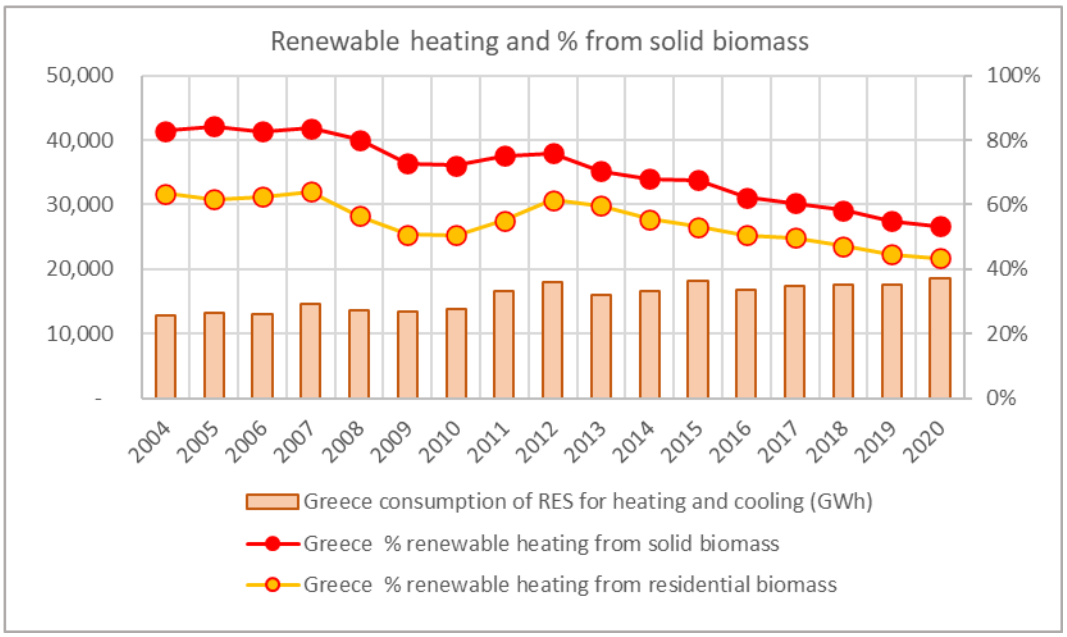
2014
2015
2016
2017
2018
2019
2020
Greece consumption of electricity from RES (GWh)
Greece % renewable electricity from solid biomass


Renewable heating and % from solid biomass
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
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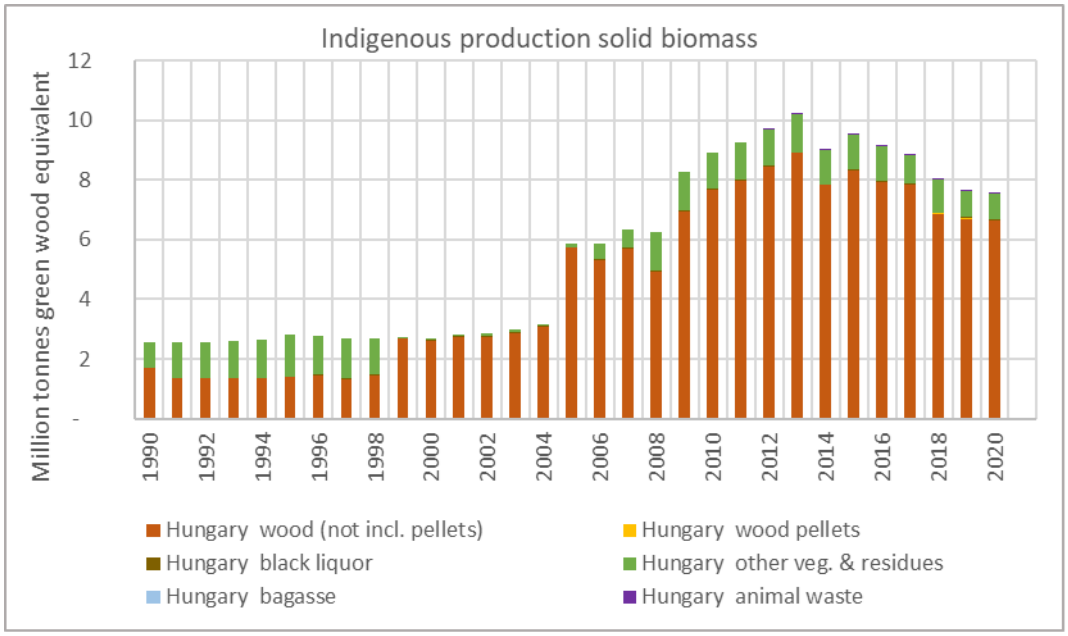
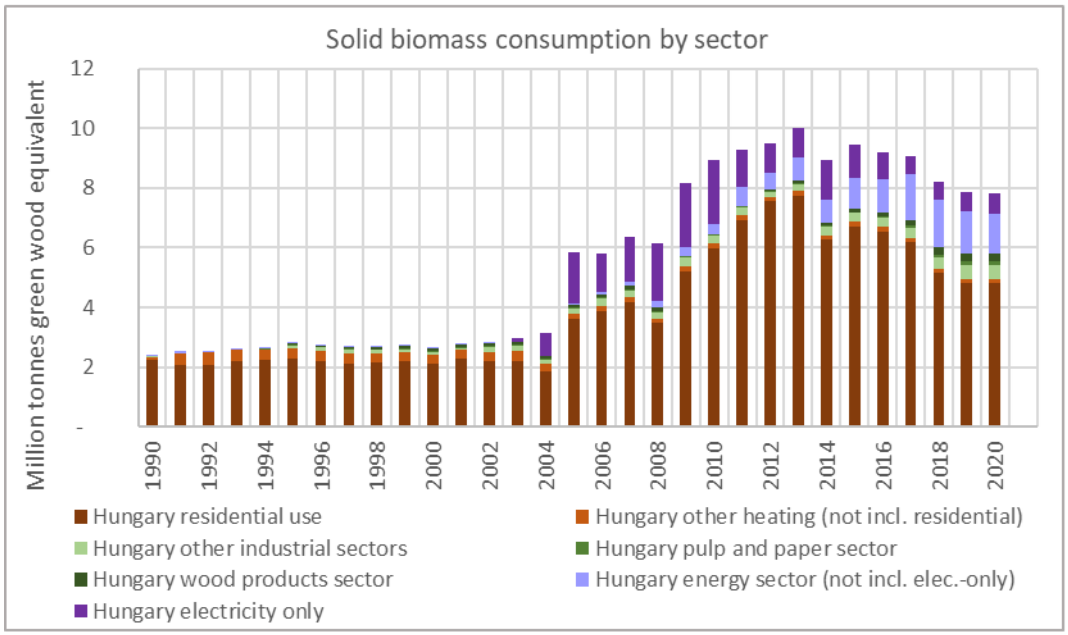
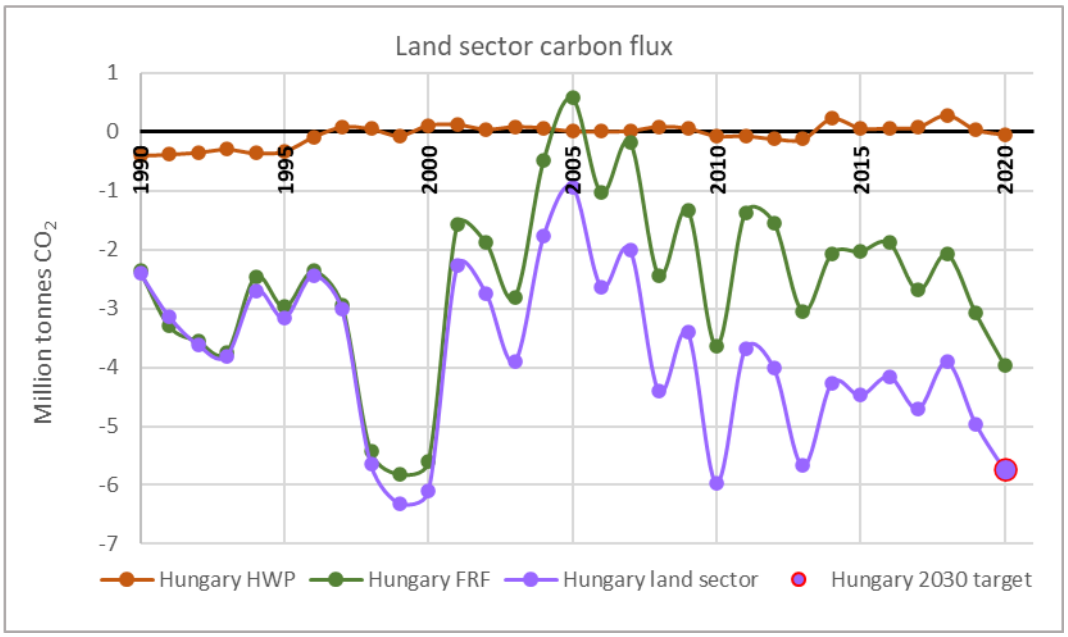
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Greece consumption of RES for heating and cooling (GWh)
Greece % renewable heating from solid biomass
Greece % renewable heating from residential biomass

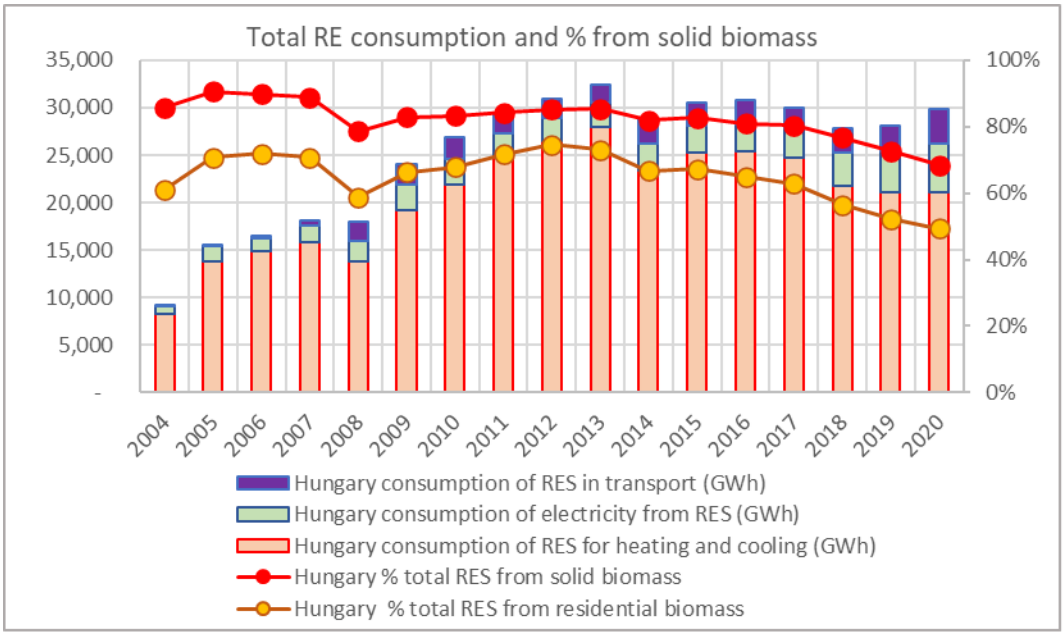
Hungary

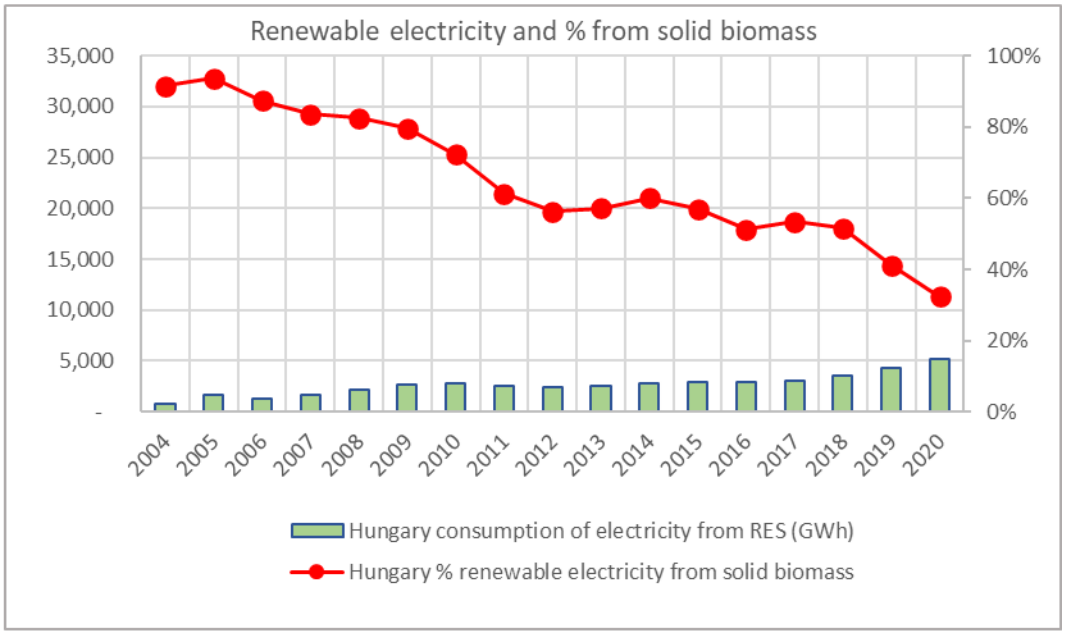


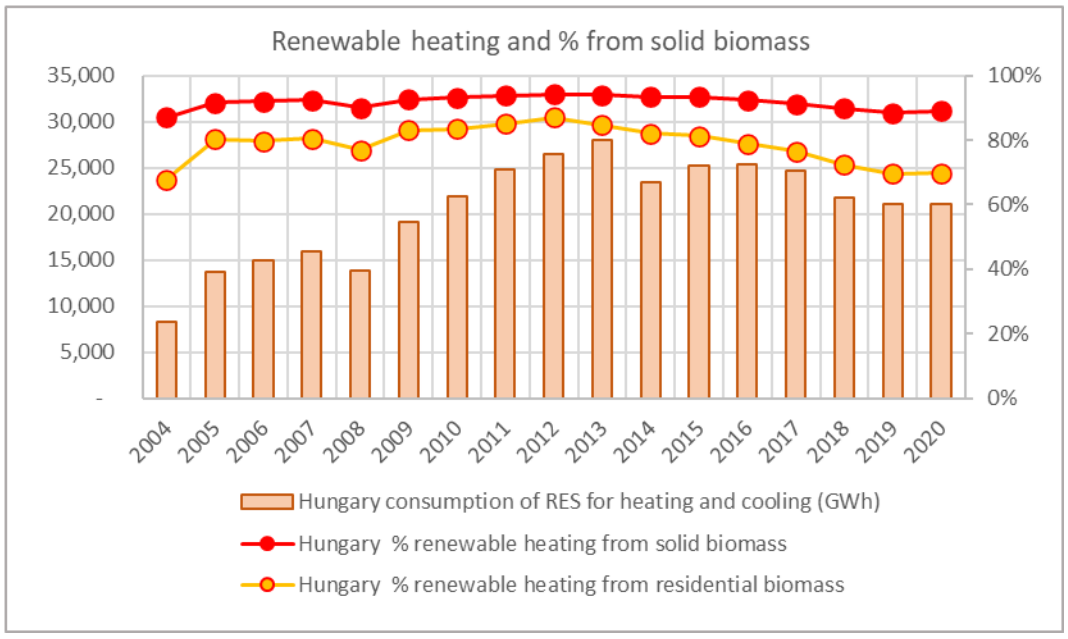


See [section above] on abrupt increase in residential heating that was associated with a change in how these data were collected. This allowed Hungary to claim it had achieved renewable energy targets without having to actually deploy additional clean energy.

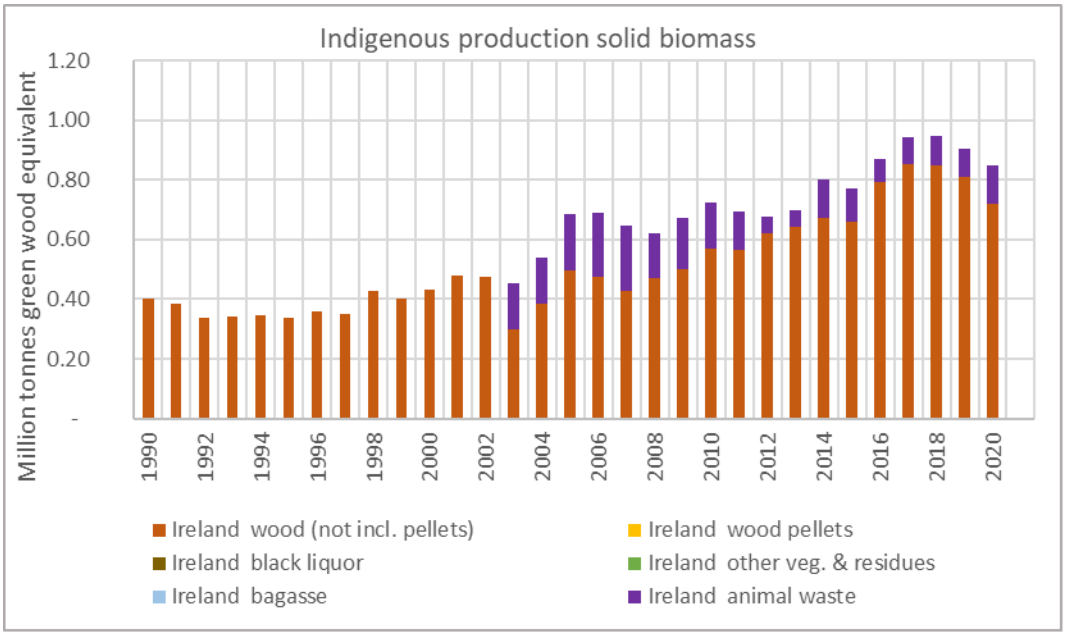


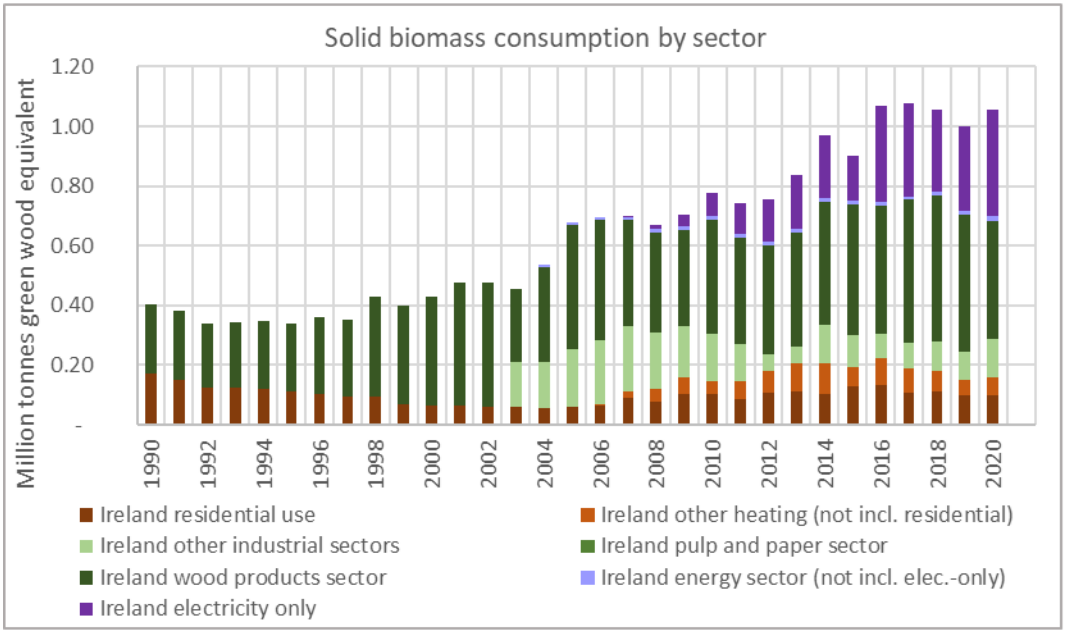

Total RE consumption and % from solid biomass
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Hungary consumption of RES in transport (GWh)
Hungary consumption of electricity from RES (GWh)
Hungary consumption of RES for heating and cooling (GWh)
Hungary % total RES from solid biomass
Hungary % total RES from residential biomass


Renewable electricity and % from solid biomass
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Hungary consumption of electricity from RES (GWh)
Hungary % renewable electricity from solid biomass

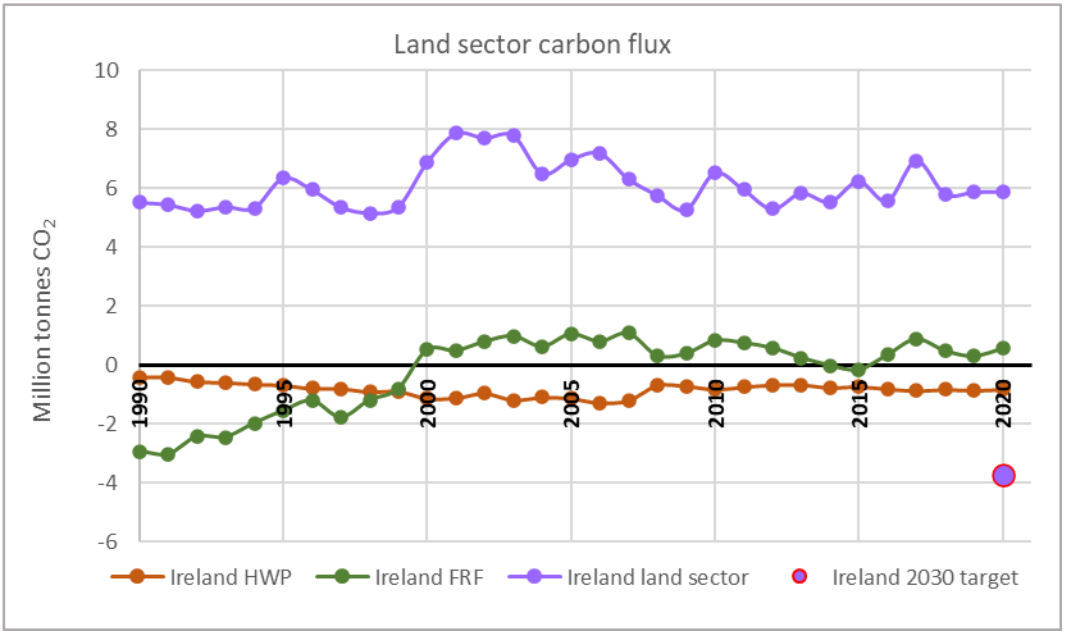

Renewable heating and % from solid biomass
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Hungary consumption of RES for heating and cooling (GWh)
Hungary % renewable heating from solid biomass
Hungary % renewable heating from residential biomass

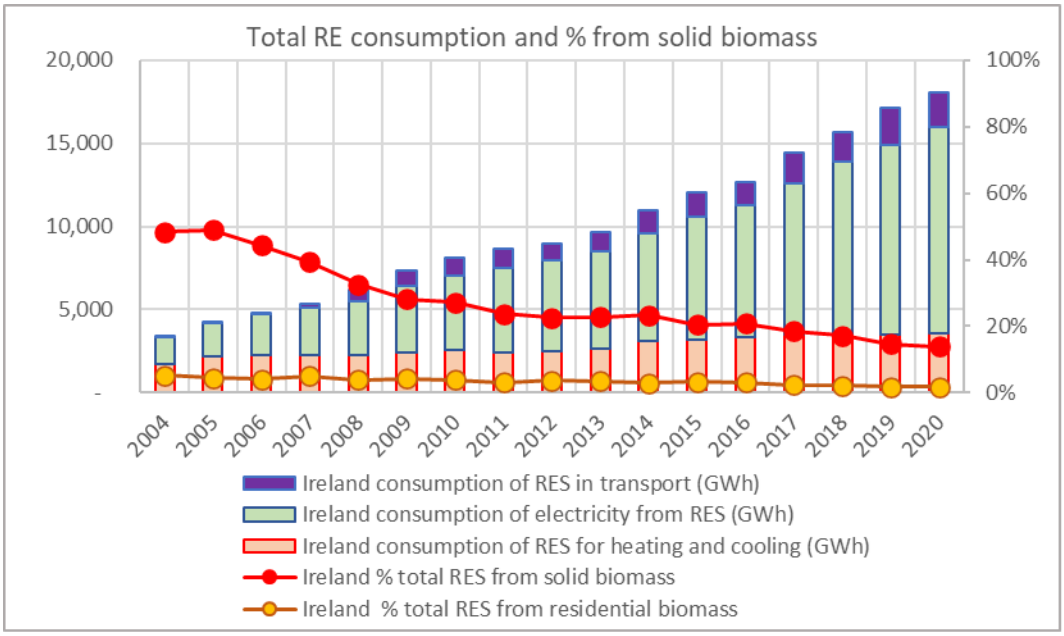
Ireland

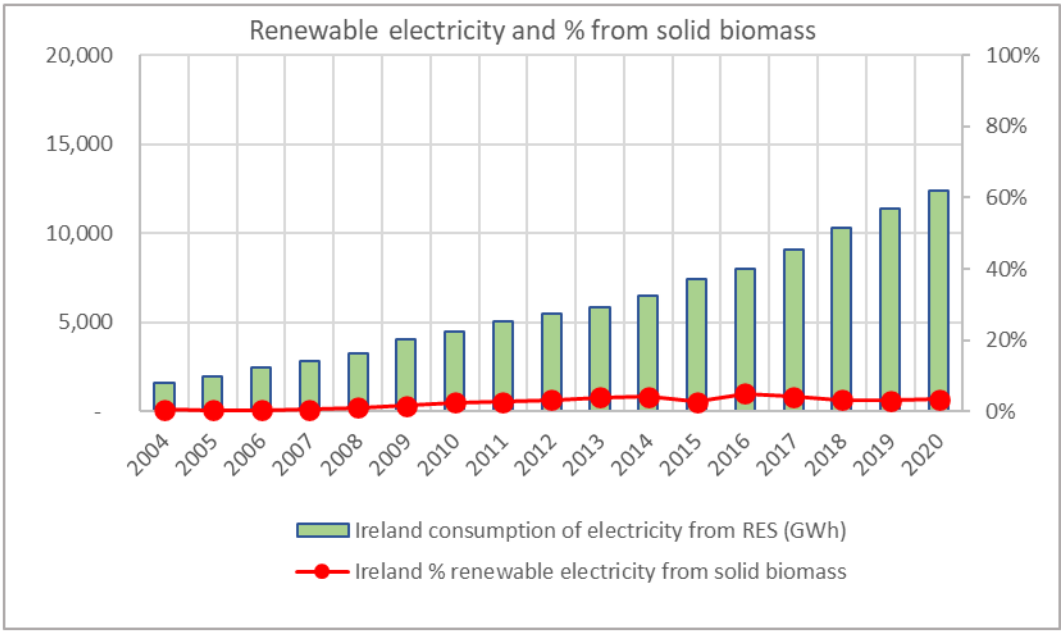


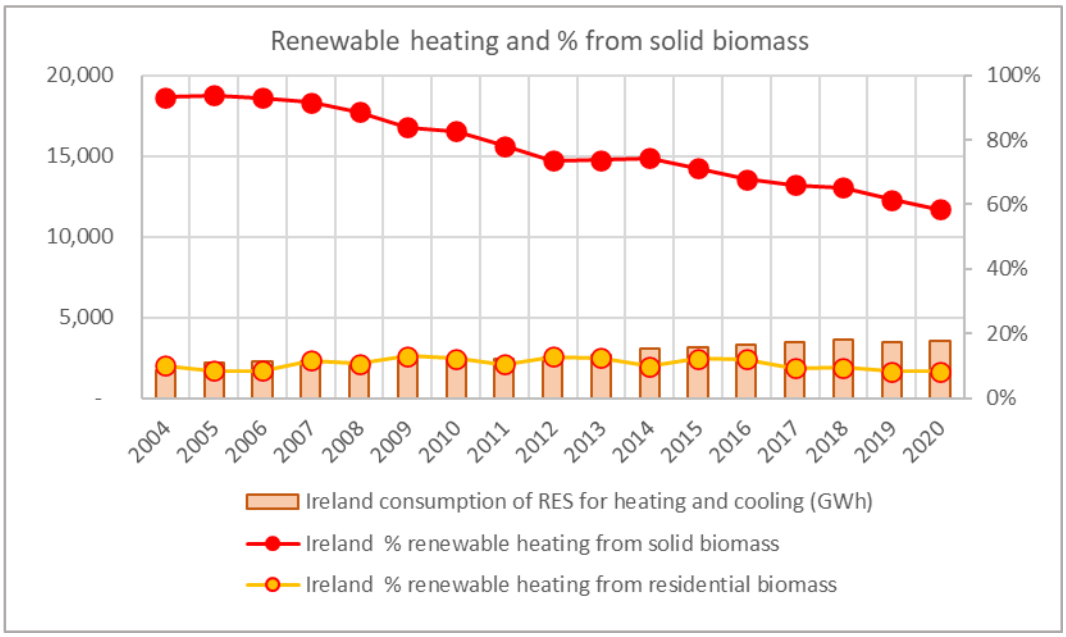


Ireland's natural forests have been lost and degraded so that they are a net source of CO_2. Afforested lands (part of the land sector as shown on this graph) provided 2.9 million tonnes of CO_2 uptake in 2020, but a combined total of around 9 million tonnes of emissions from grasslands and wetlands ensures the land sector overall is a net source of emissions.[viii]



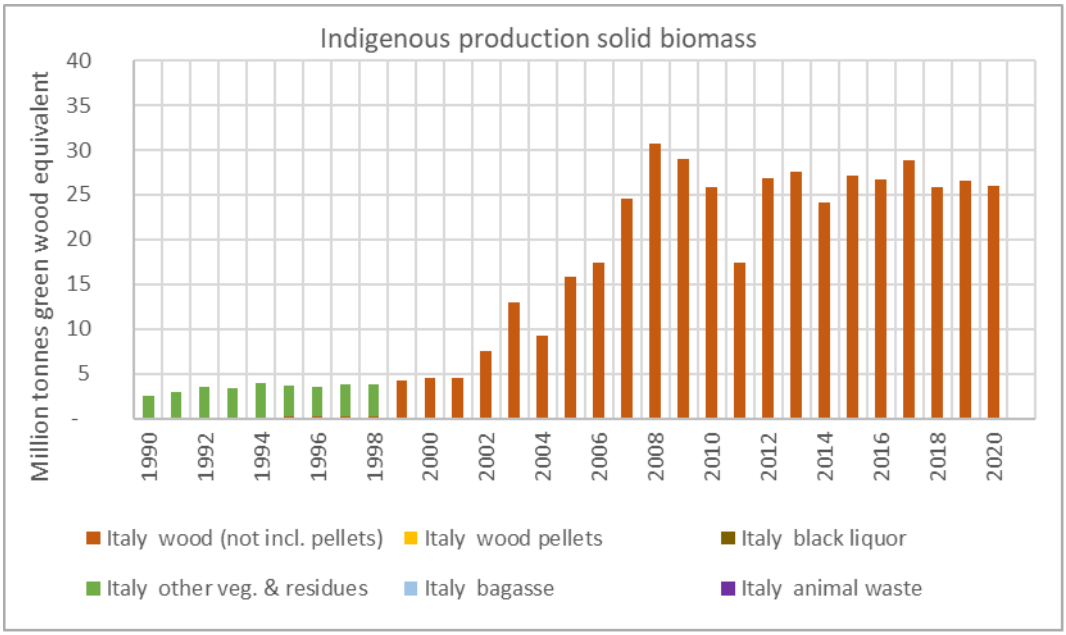

Total RE consumption and % from solid biomass
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Ireland consumption of RES in transport (GWh)
Ireland consumption of electricity from RES (GWh)
Ireland consumption of RES for heating and cooling (GWh)
Ireland % total RES from solid biomass
Ireland % total RES from residential biomass


Renewable electricity and % from solid biomass
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Ireland consumption of electricity from RES (GWh)
Ireland % renewable electricity from solid biomass

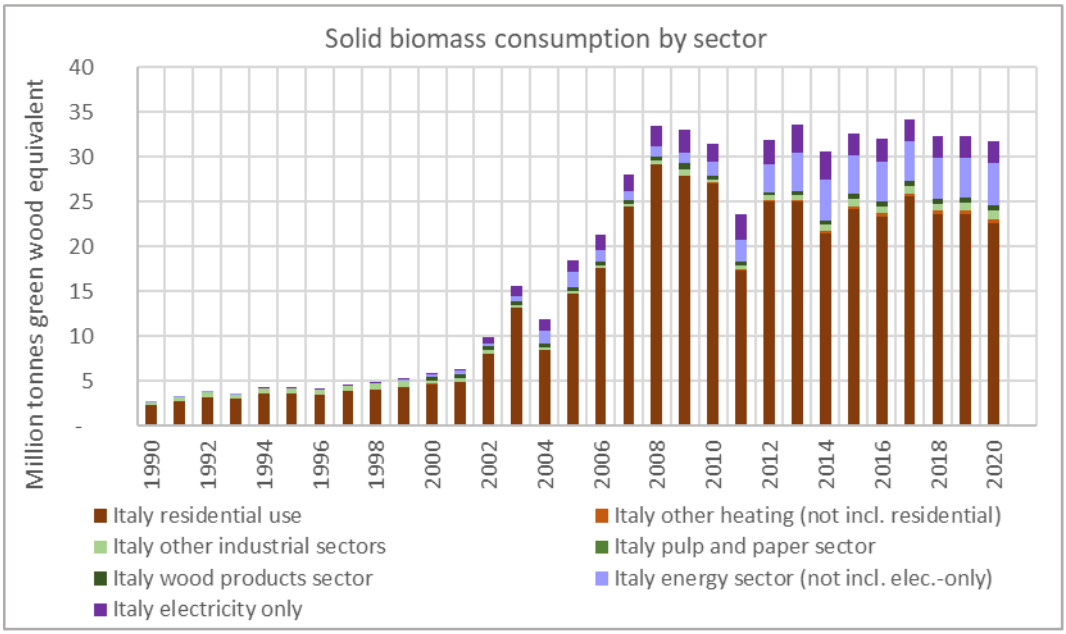

Renewable heating and % from solid biomass
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Ireland consumption of RES for heating and cooling (GWh)
Ireland % renewable heating from solid biomass
Ireland % renewable heating from residential biomass

Italy

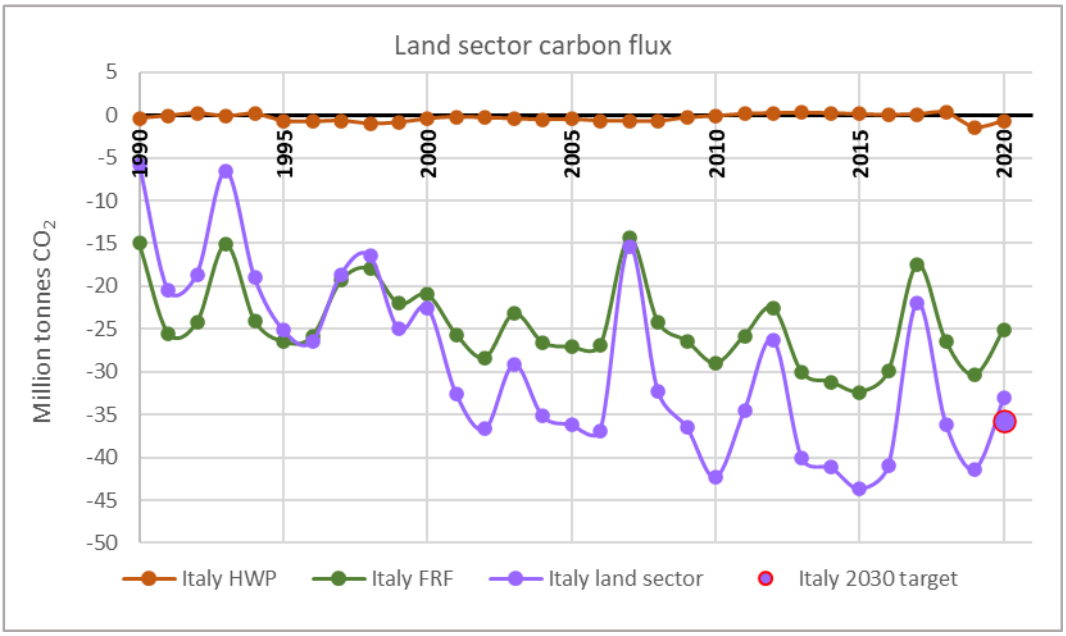
Eurostat data do not include the relatively small Italian wood pellet manufacturing sector, even though the separate exports file shows Italy does export some pellets.

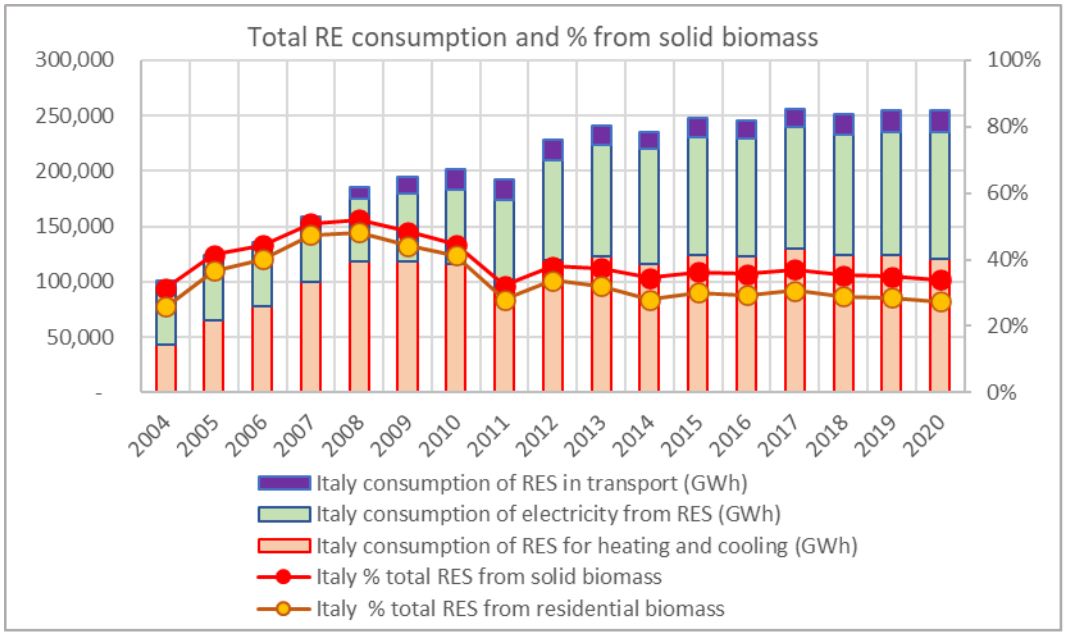


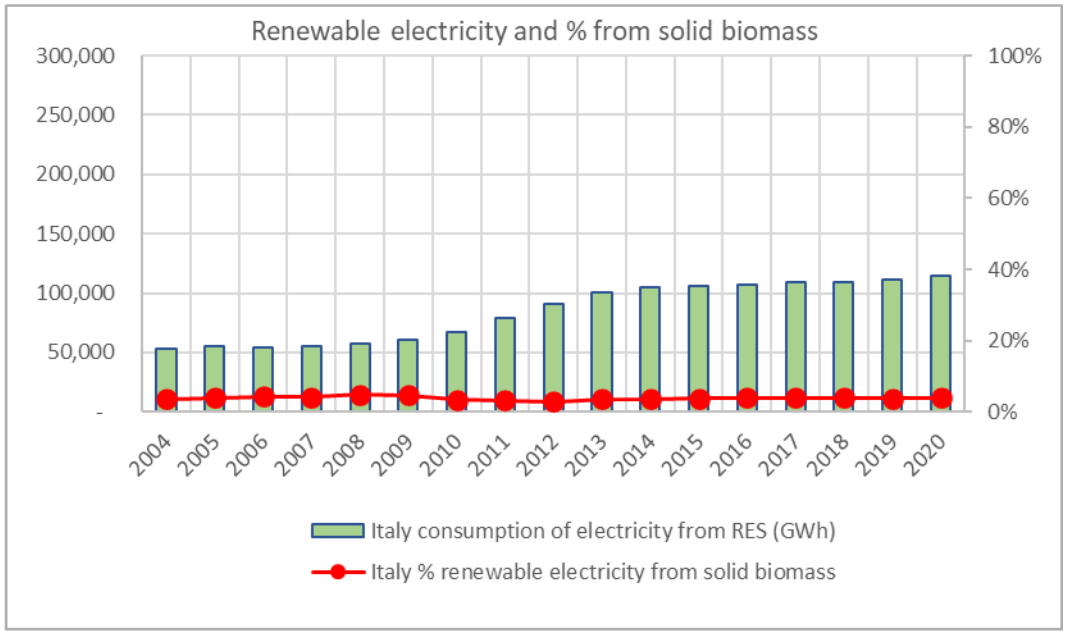
While Italy offers various incentives for residential wood heating, and the country imports both fuelwood and pellets, the abrupt and massive increase in use of wood for residential heating seems likely to be in part an artefact of revised survey methods. Burning wood for heating has allowed Italy to claim it is achieving EU renewable energy targets.

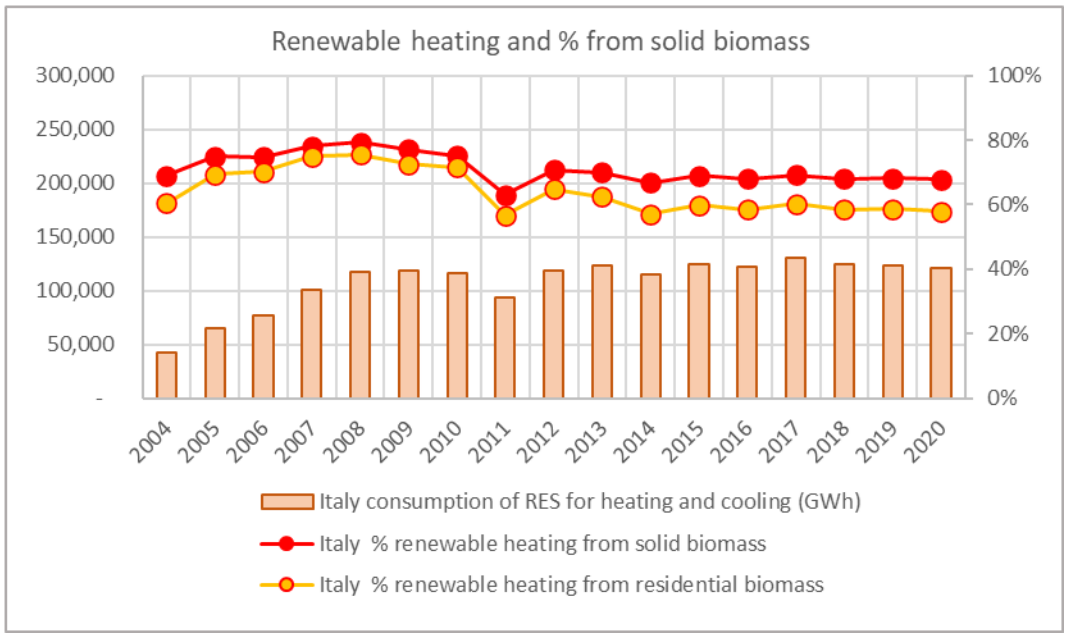


The extreme volatility of Italy's land carbon sector suggests that there is potentially some issue with the data.



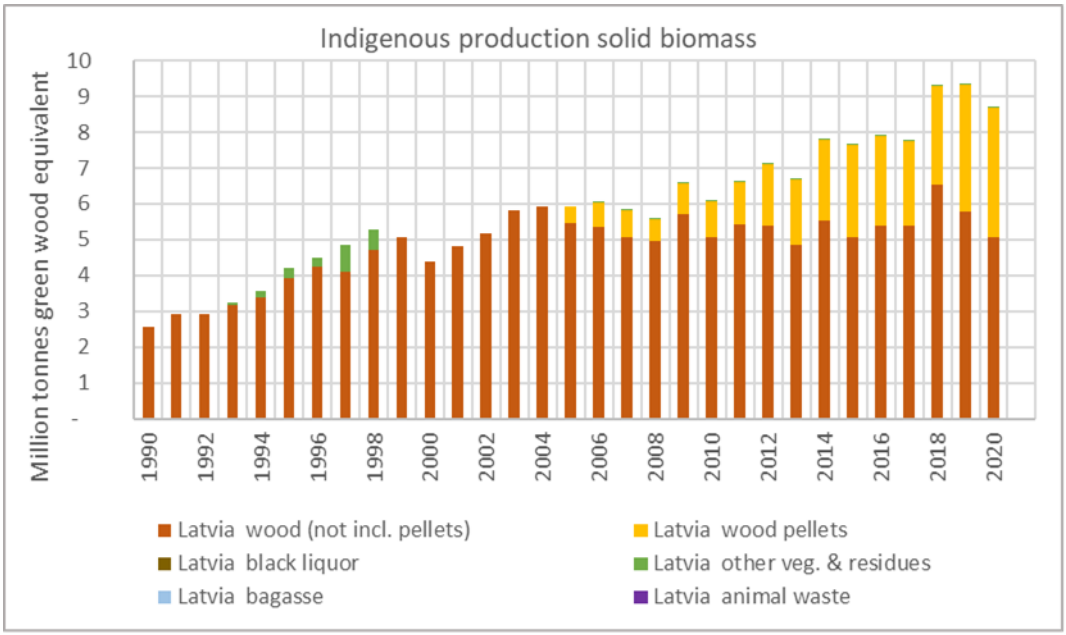

Total RE consumption and % from solid biomass
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Italy consumption of RES in transport (GWh)
Italy consumption of electricity from RES (GWh)
Italy consumption of RES for heating and cooling (GWh)
Italy % total RES from solid biomass
Italy % total RES from residential biomass

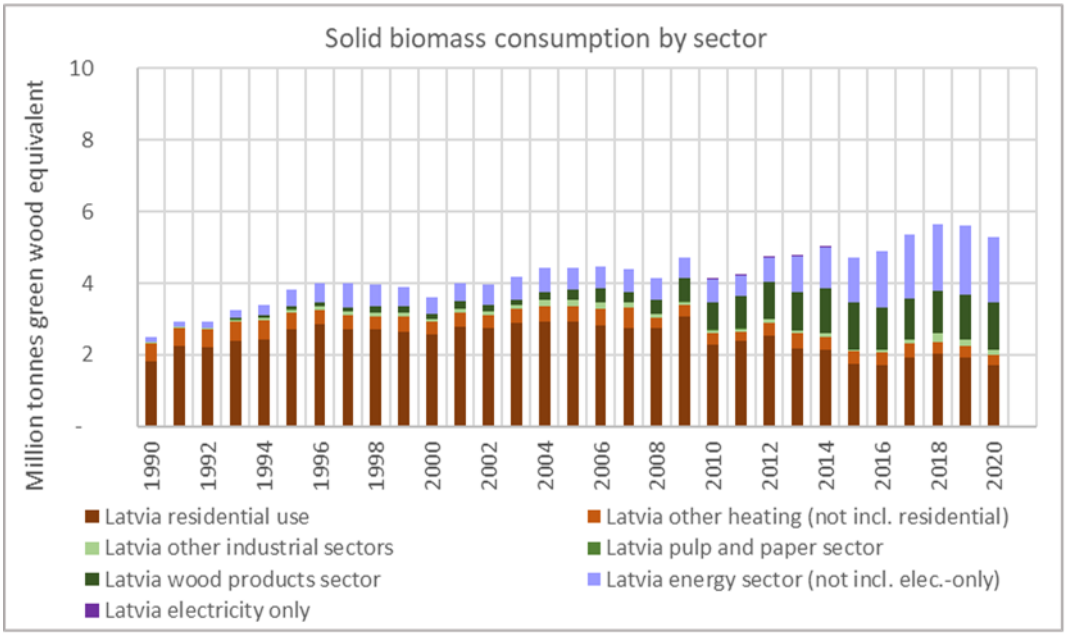

Renewable electricity and % from solid biomass
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Italy consumption of electricity from RES (GWh)
Italy % renewable electricity from solid biomass


Renewable heating and % from solid biomass
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Italy consumption of RES for heating and cooling (GWh)
Italy % renewable heating from solid biomass
Italy % renewable heating from residential biomass

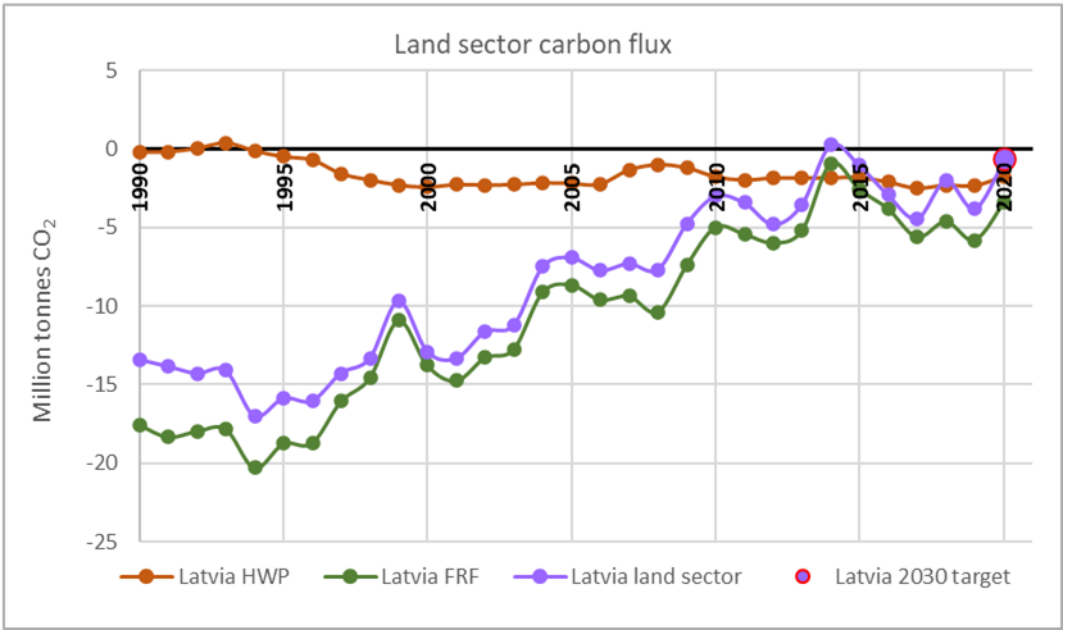
Latvia

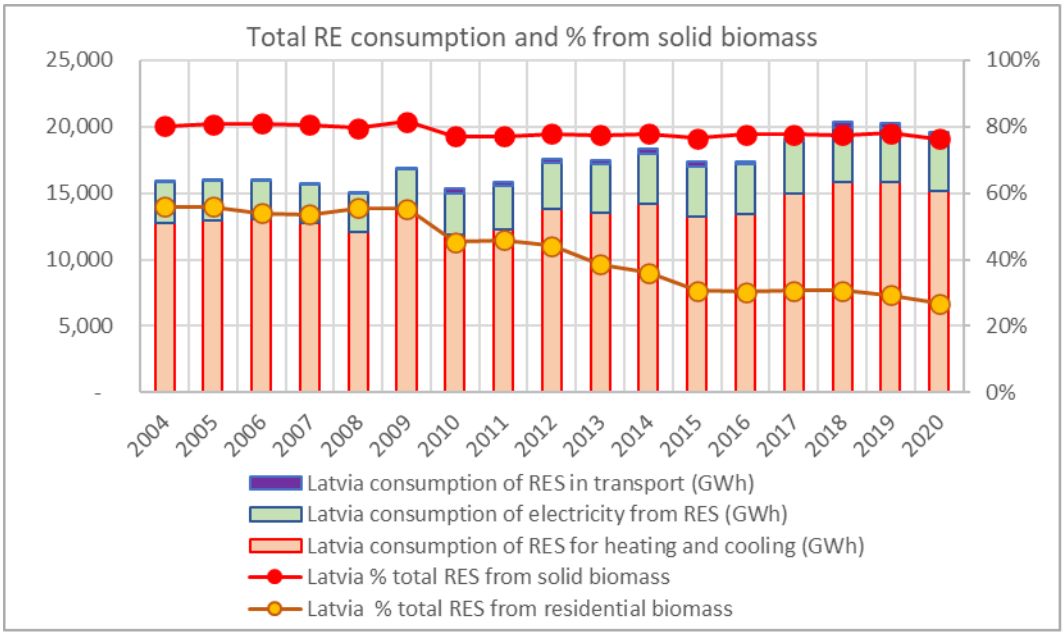
Latvia is producing about 50% more biomass than it is consuming, with the balance exported as wood pellets burned in power plants in a variety of countries.

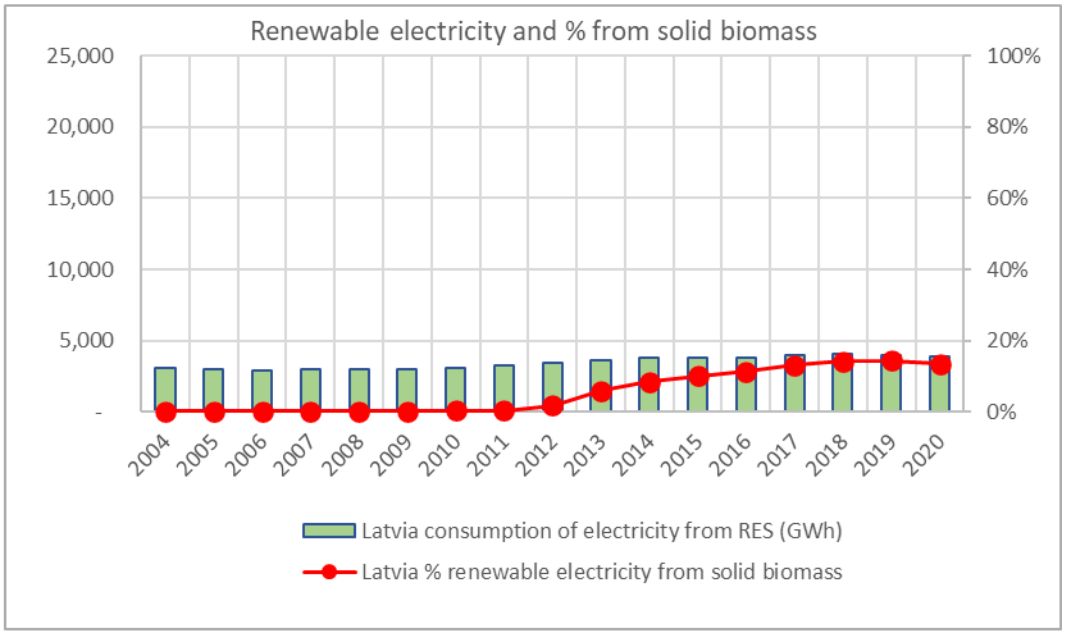


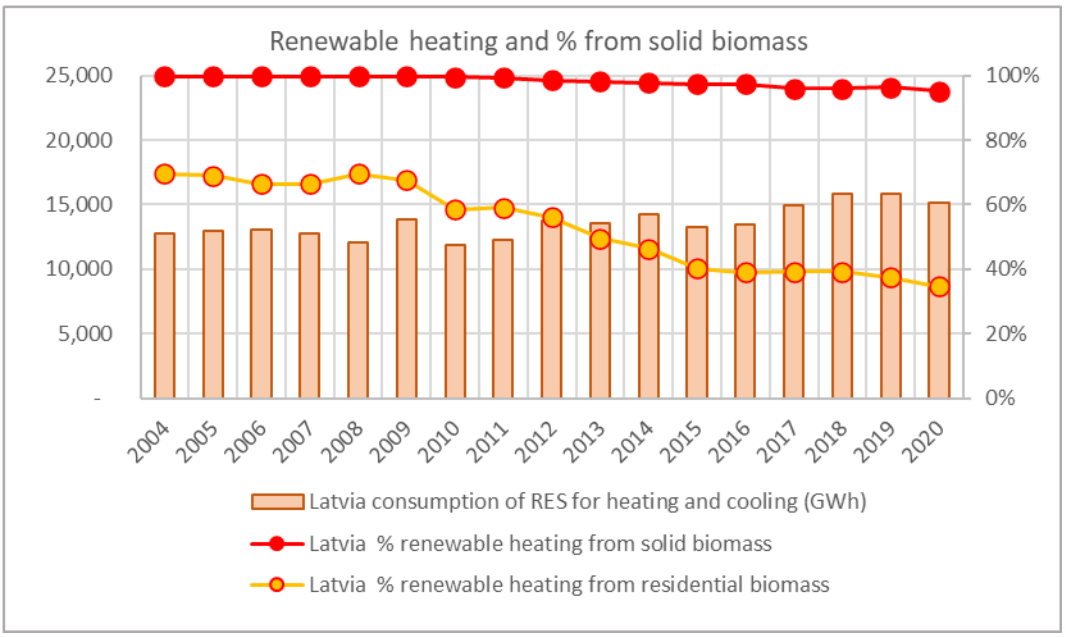


The degradation of Latvia's carbon sink from the early 1990's indicates a totally failed forest management policy. The addition of industrial-scale pellet manufacturing suggests that there will be no recovery of the sink unless harvesting is significantly reduced.

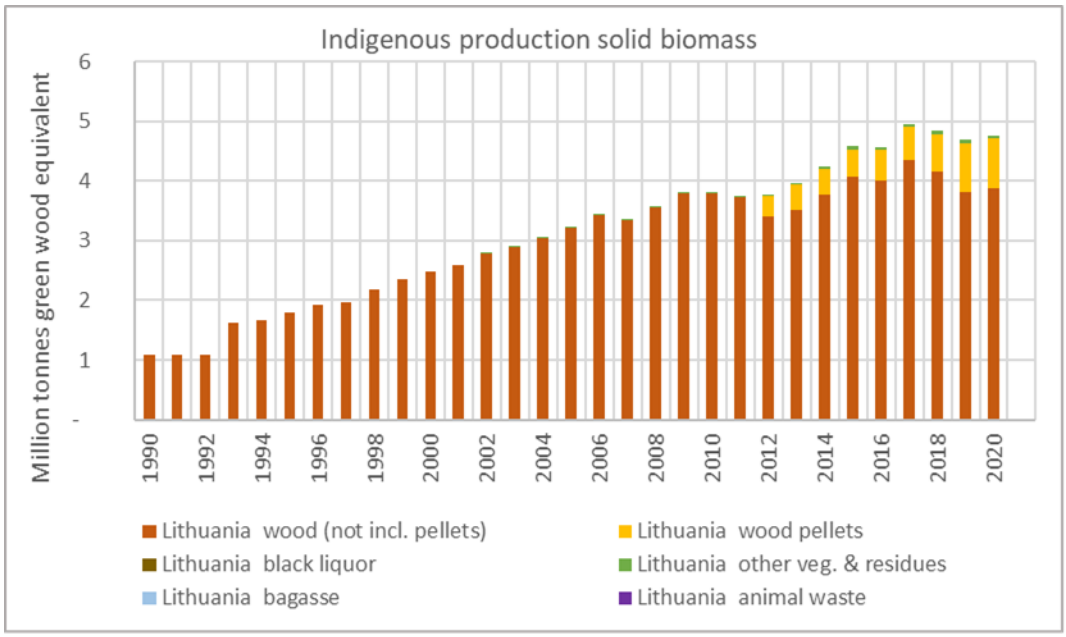


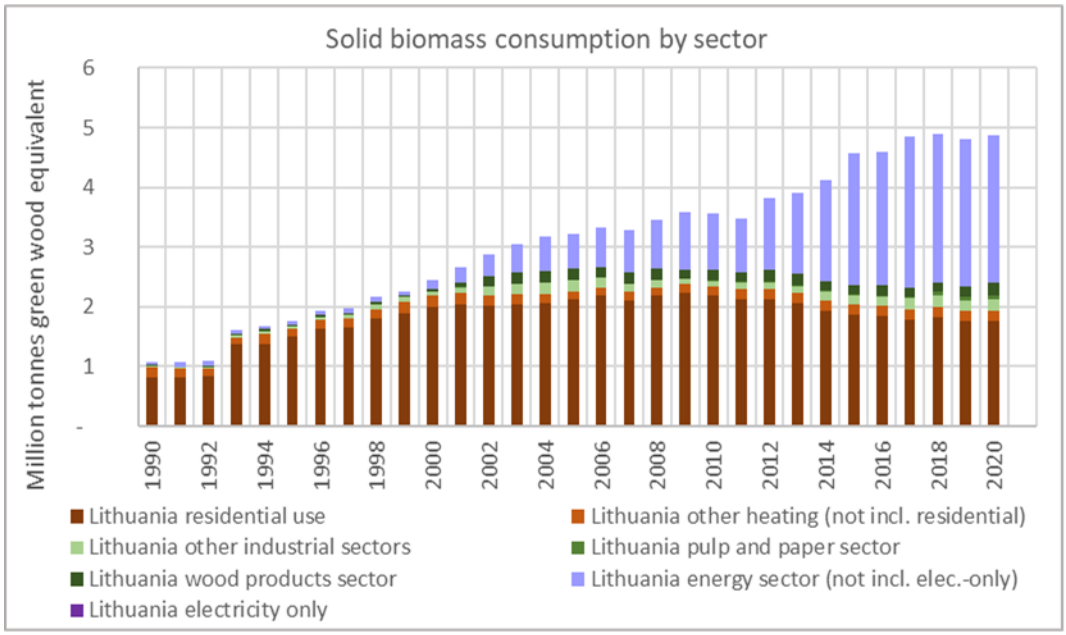

Total RE consumption and % from solid biomass
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Latvia consumption of RES in transport (GWh)
Latvia consumption of electricity from RES (GWh)
Latvia consumption of RES for heating and cooling (GWh)
Latvia % total RES from solid biomass
Latvia % total RES from residential biomass

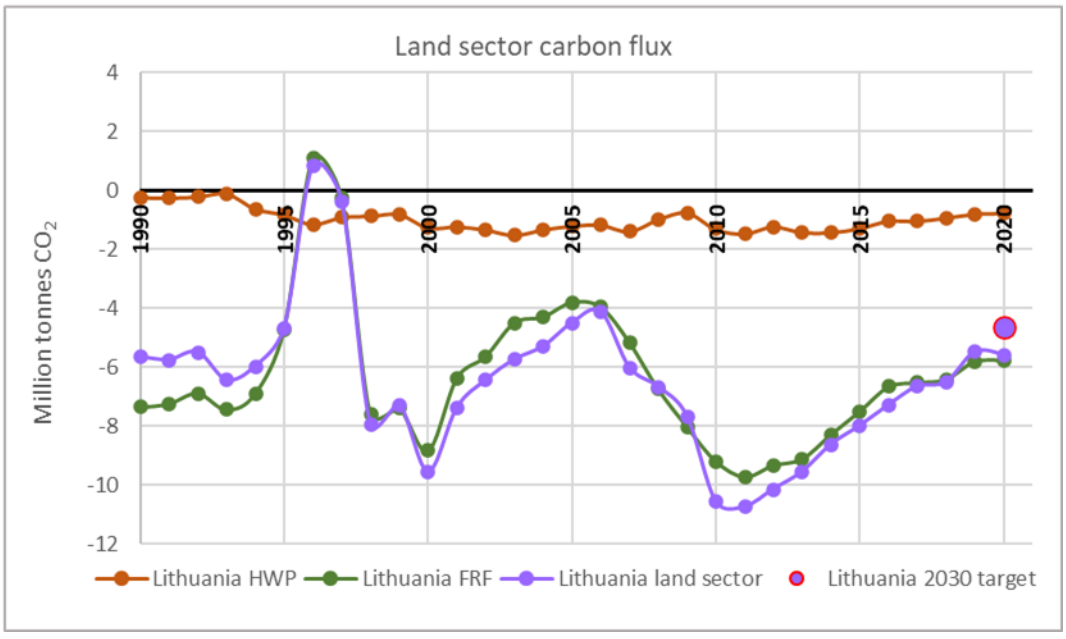

Renewable electricity and % from solid biomass
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Latvia consumption of electricity from RES (GWh)
Latvia % renewable electricity from solid biomass

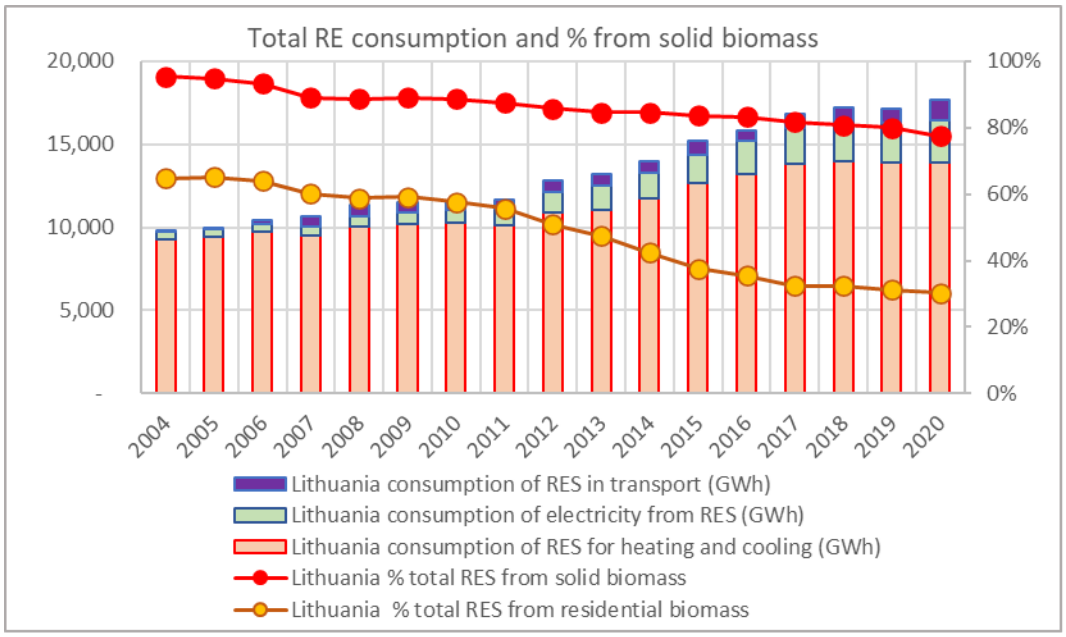

Renewable heating and % from solid biomass
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Latvia consumption of RES for heating and cooling (GWh)
Latvia % renewable heating from solid biomass
Latvia % renewable heating from residential biomass

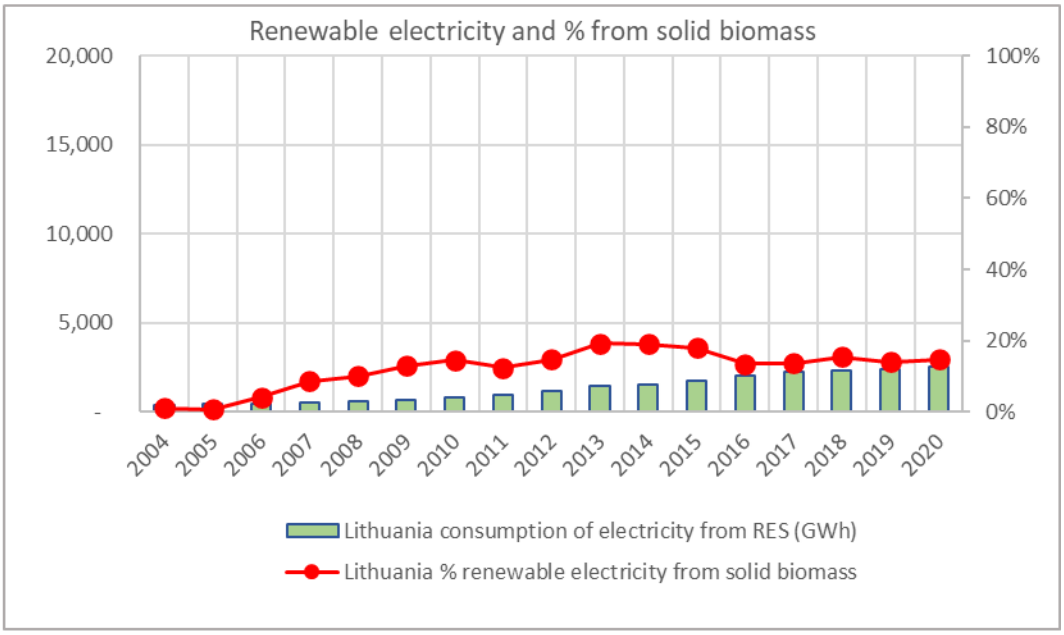
Lithuania

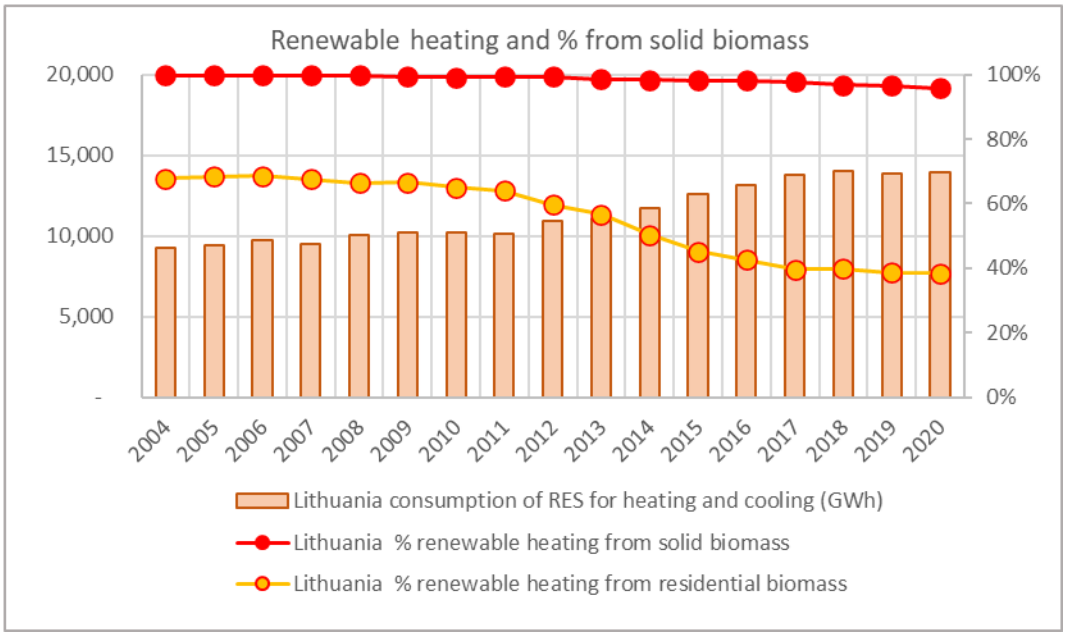

Indigenous production solid biomass
Million tonnes green wood equivalent
6
5
4
3
2
1
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Lithuania wood (not incl. pellets)
Lithuania wood pellets
Lithuania black liquor
Lithuania other veg. & residues
Lithuania bagasse
Lithuania animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
6
5
4
3
2
1
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Lithuania residential use
Lithuania other heating (not incl. residential)
Lithuania other industrial sectors
Lithuania pulp and paper sector
Lithuania wood products sector
Lithuania energy sector (not incl. elec.-only)
Lithuania electricity only

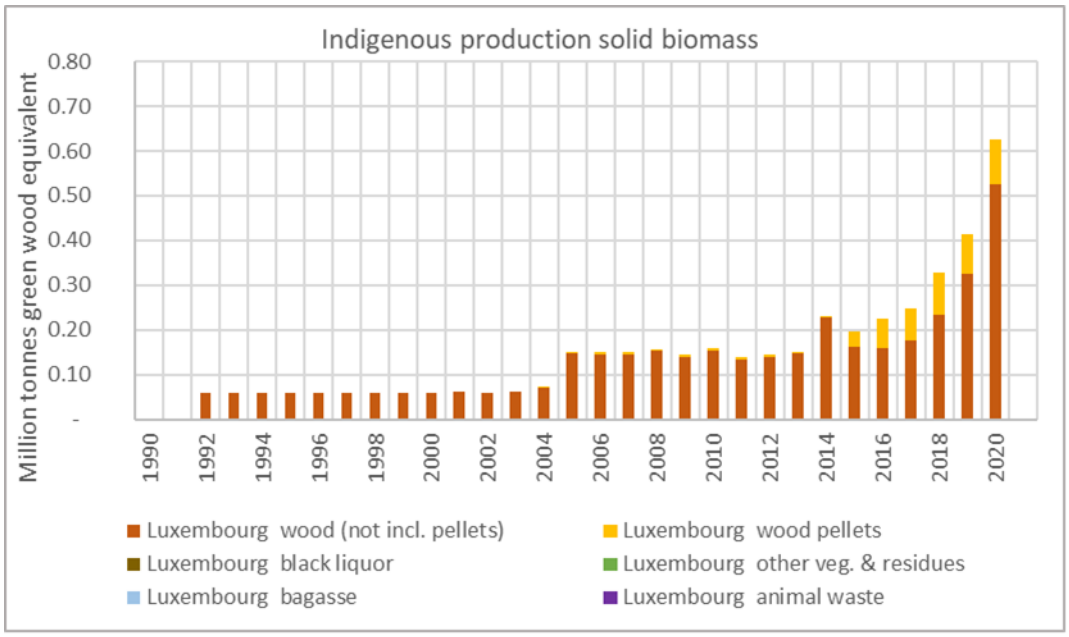

Land sector carbon flux
Million tonnes CO2
4
2
0
-2
-4
-6
-8
-10
-12
1990
1995
2000
2005
2010
2015
2020
Lithuania HWP
Lithuania FRF
Lithuania land sector
Lithuania 2030 target

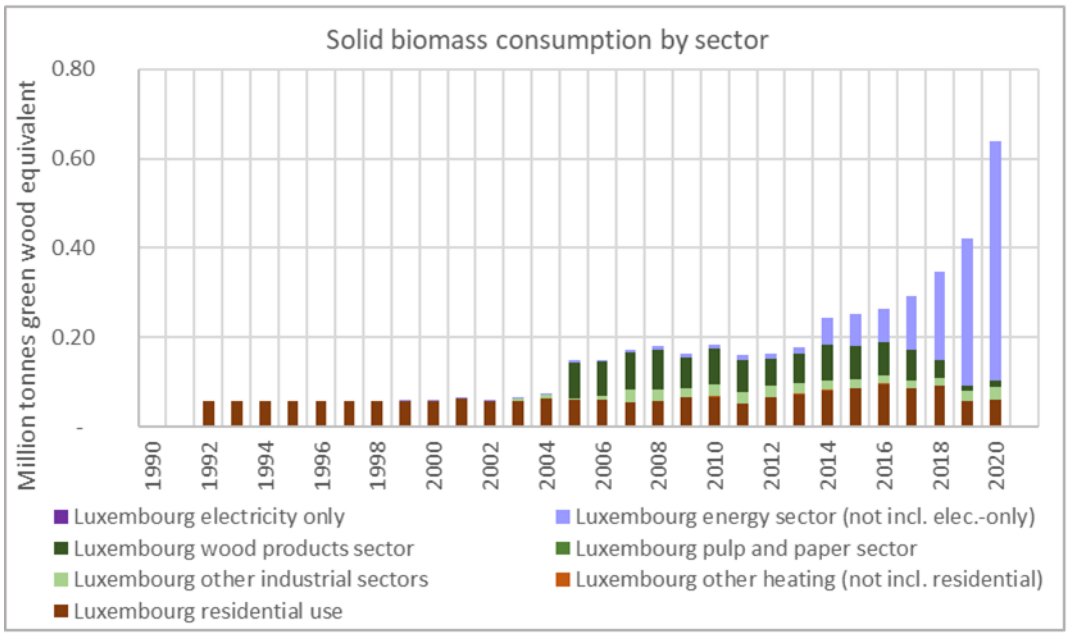

Total RE consumption and % from solid biomass
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Lithuania consumption of RES in transport (GWh)
Lithuania consumption of electricity from RES (GWh)
Lithuania consumption of RES for heating and cooling (GWh)
Lithuania % total RES from solid biomass
Lithuania % total RES from residential biomass

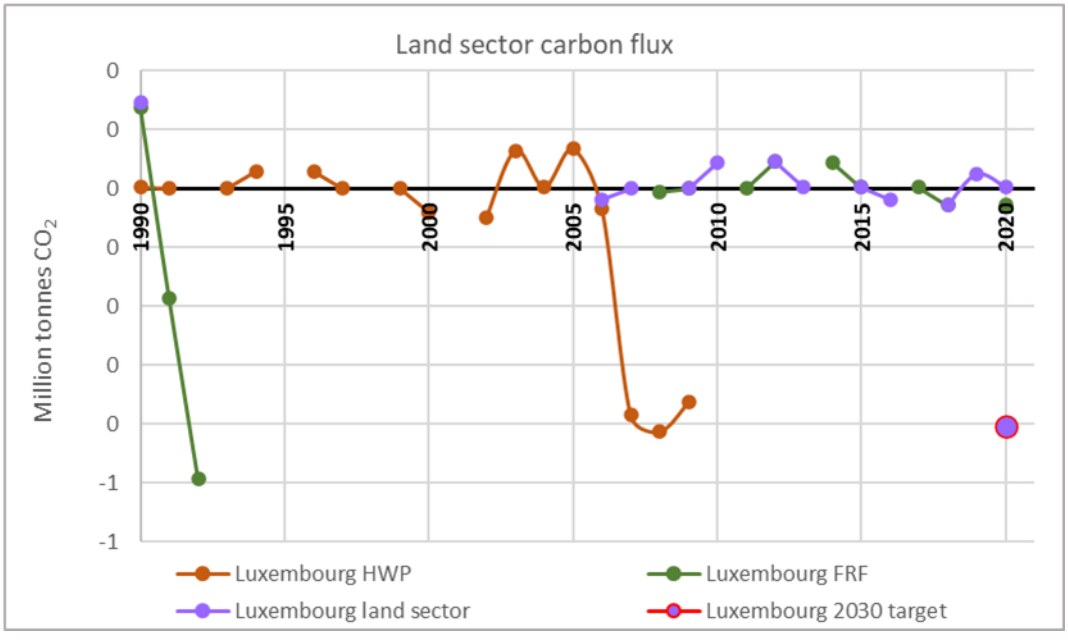

Renewable electricity and % from solid biomass
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Lithuania consumption of electricity from RES (GWh)
Lithuania % renewable electricity from solid biomass

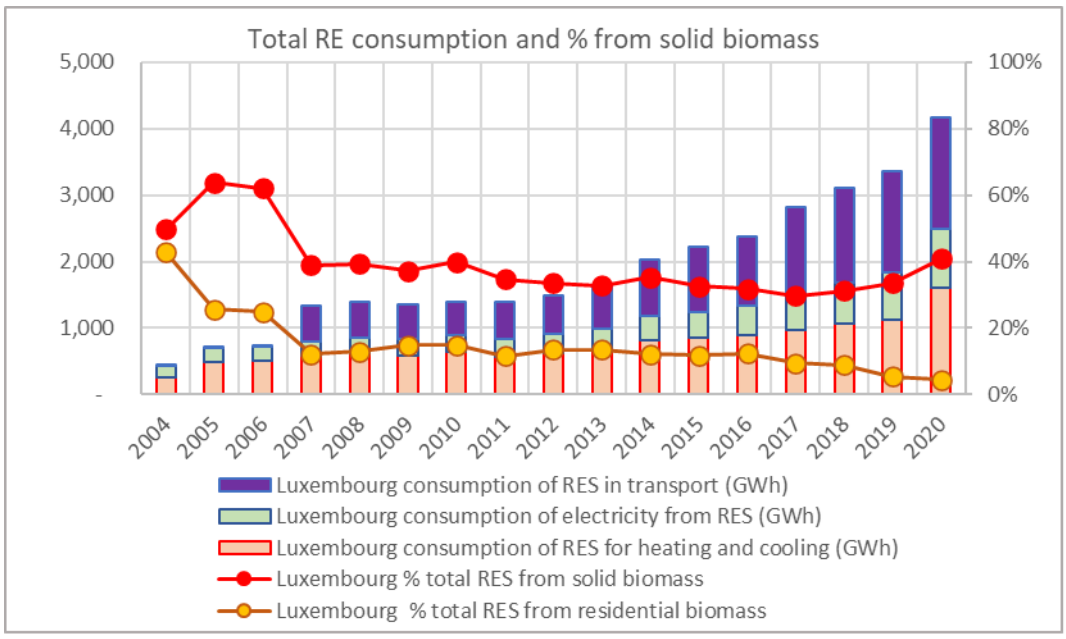

Renewable heating and % from solid biomass
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Lithuania consumption of RES for heating and cooling (GWh)
Lithuania % renewable heating from solid biomass
Lithuania % renewable heating from residential biomass

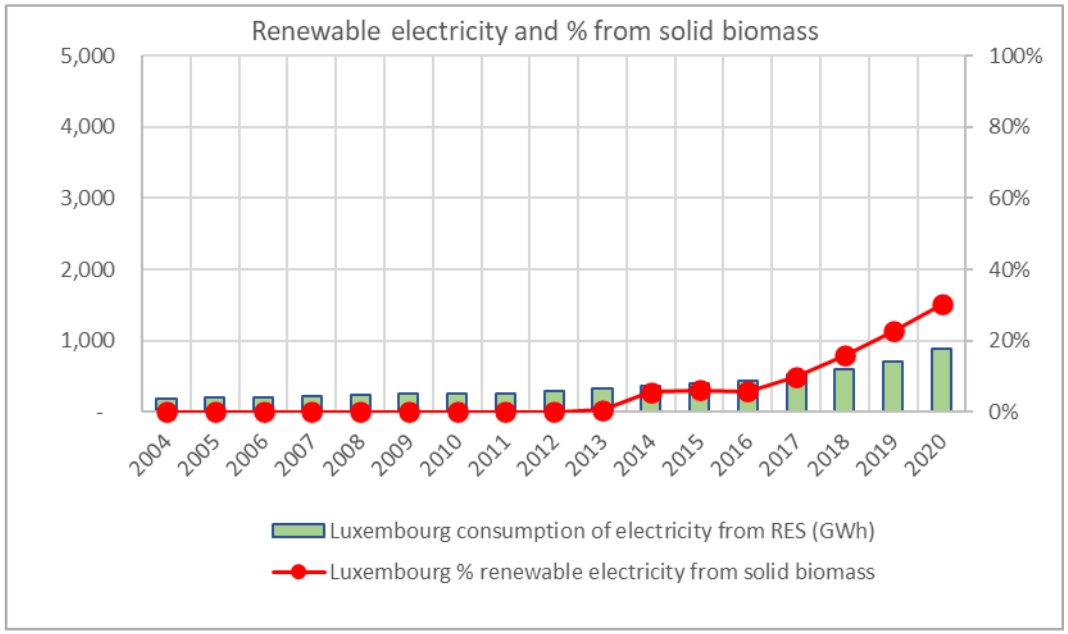
Luxembourg

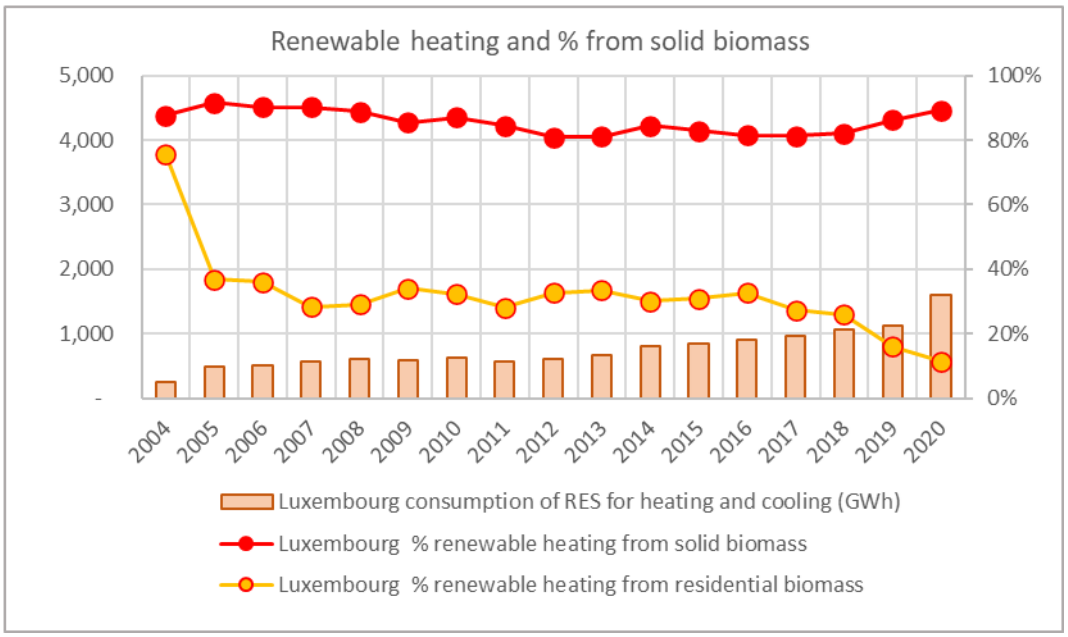

Indigenous production solid biomass
Million tonnes green wood equivalent
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Luxembourg wood (not incl. pellets)
Luxembourg wood pellets
Luxembourg black liquor
Luxembourg other veg. & residues
Luxembourg bagasse
Luxembourg animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
0.80
0.60
0.40
0.20
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Luxembourg electricity only
Luxembourg energy sector (not incl. elec.-only)
Luxembourg wood products sector
Luxembourg pulp and paper sector
Luxembourg other industrial sectors
Luxembourg other heating (not incl. residential)
Luxembourg residential use

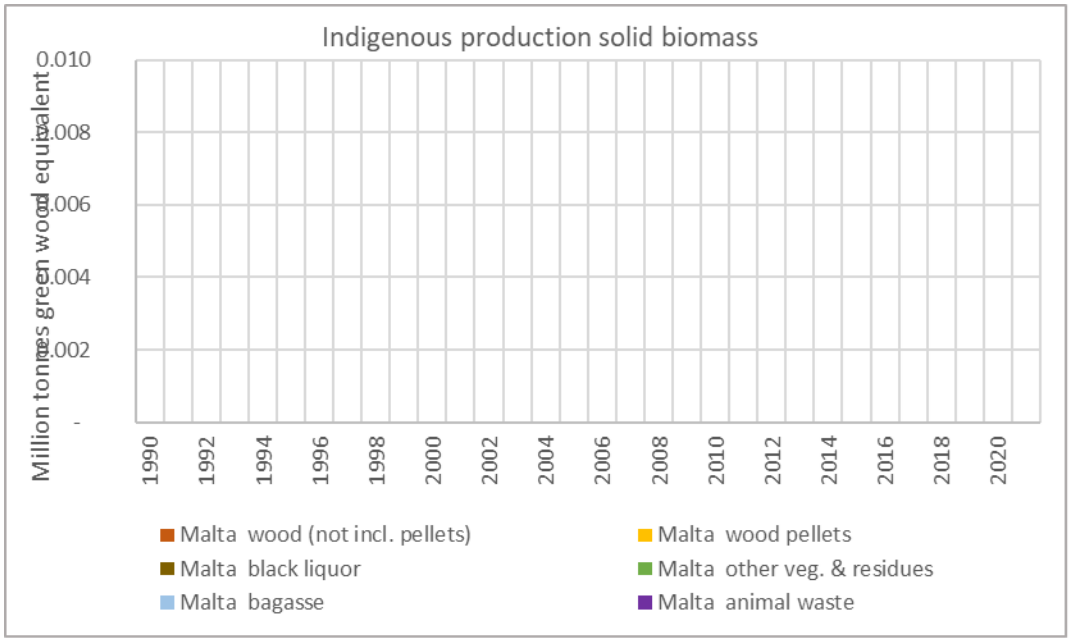

Land sector carbon flux
Million tonnes CO_2
0
0
0
0
0
0
0
-1
-1
1990
1995
2000
2005
2010
2015
2020
Luxembourg HWP
Luxembourg FRF
Luxembourg land sector
Luxembourg 2030 target

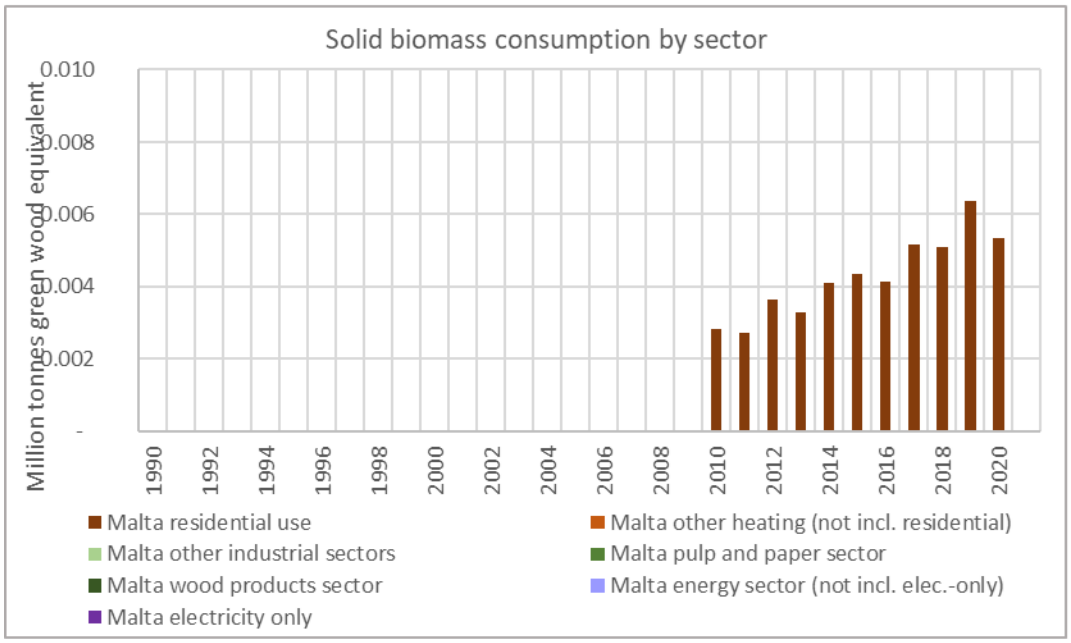

Total RE consumption and % from solid biomass
5,000
4,000
3,000
2,000
1,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Luxembourg consumption of RES in transport (GWh)
Luxembourg consumption of electricity from RES (GWh)
Luxembourg consumption of RES for heating and cooling (GWh)
Luxembourg % total RES from solid biomass
Luxembourg % total RES from residential biomass

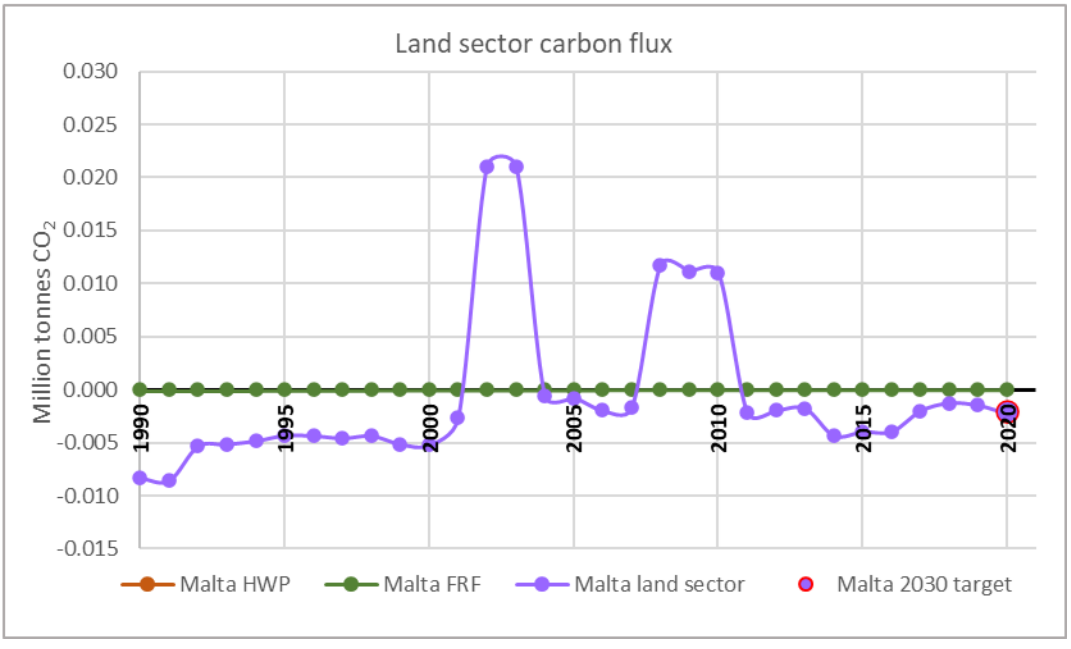

Renewable electricity and % from solid biomass
5,000
4,000
3,000
2,000
1,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Luxembourg consumption of electricity from RES (GWh)
Luxembourg % renewable electricity from solid biomass

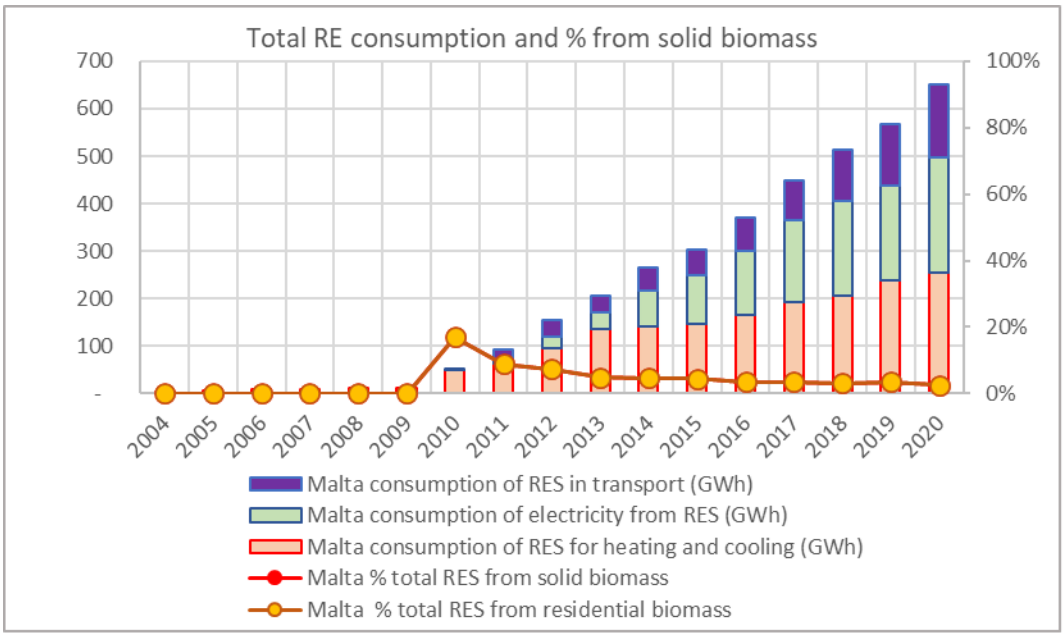

Renewable heating and % from solid biomass
5,000
4,000
3,000
2,000
1,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Luxembourg consumption of RES for heating and cooling (GWh)
Luxembourg % renewable heating from solid biomass
Luxembourg % renewable heating from residential biomass

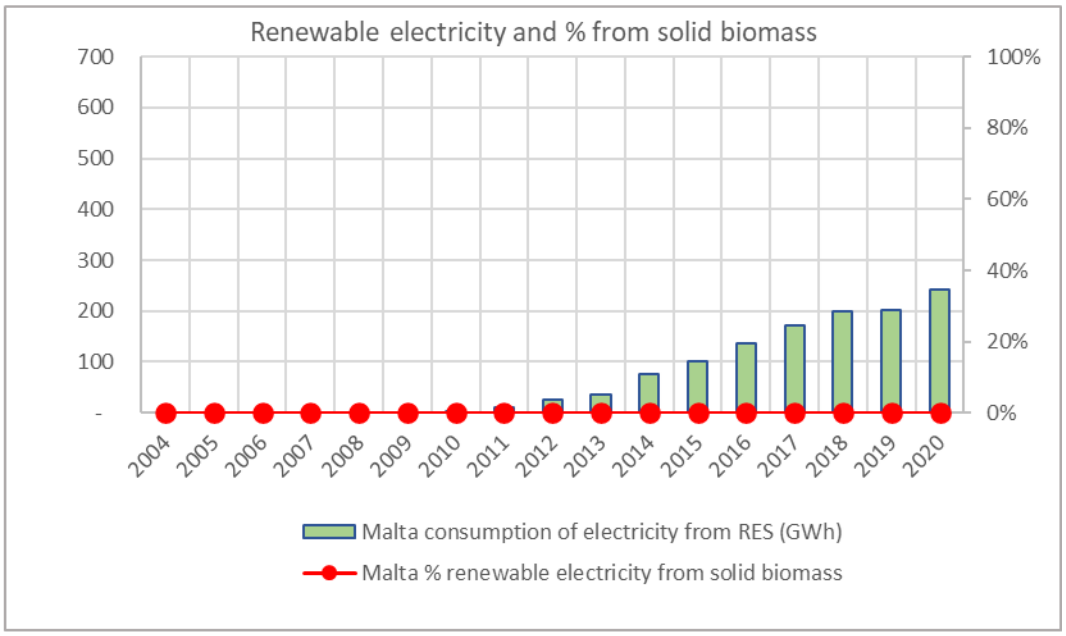
Malta

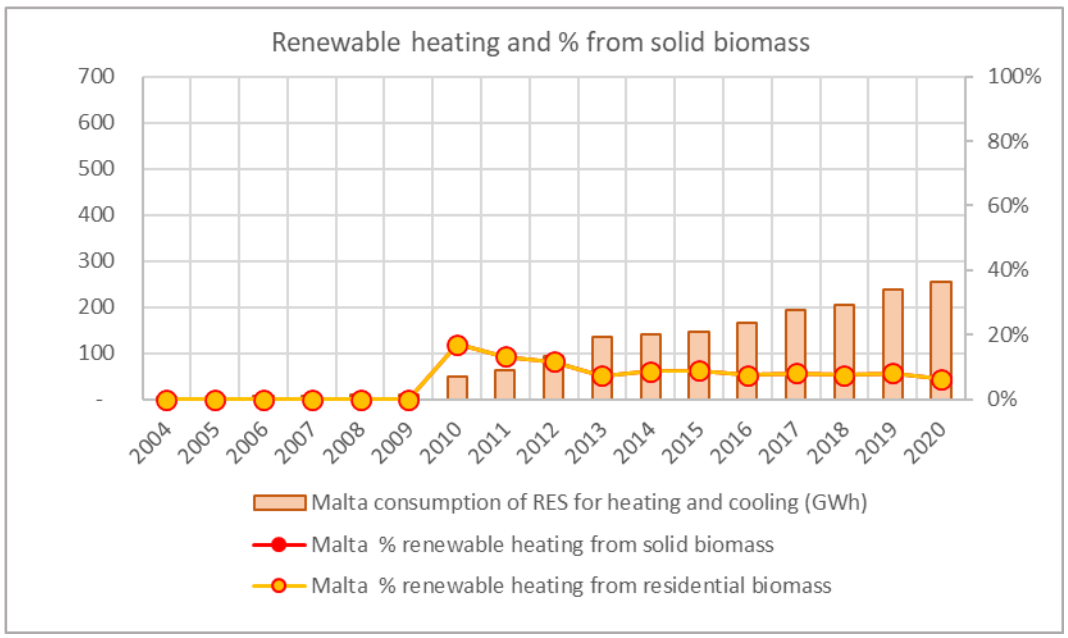

Indigenous production solid biomass
Million tonnes green wood equivalent
0.010
0.008
0.006
0.004
0.002
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Malta wood (not incl. pellets)
Malta wood pellets
Malta black liquor
Malta other veg. & residues
Malta bagasse
Malta animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
0.010
0.008
0.006
0.004
0.002
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Malta residential use
Malta other heating (not incl. residential)
Malta other industrial sectors
Malta pulp and paper sector
Malta wood products sector
Malta energy sector (not incl. elec.-only)
Malta electricity only

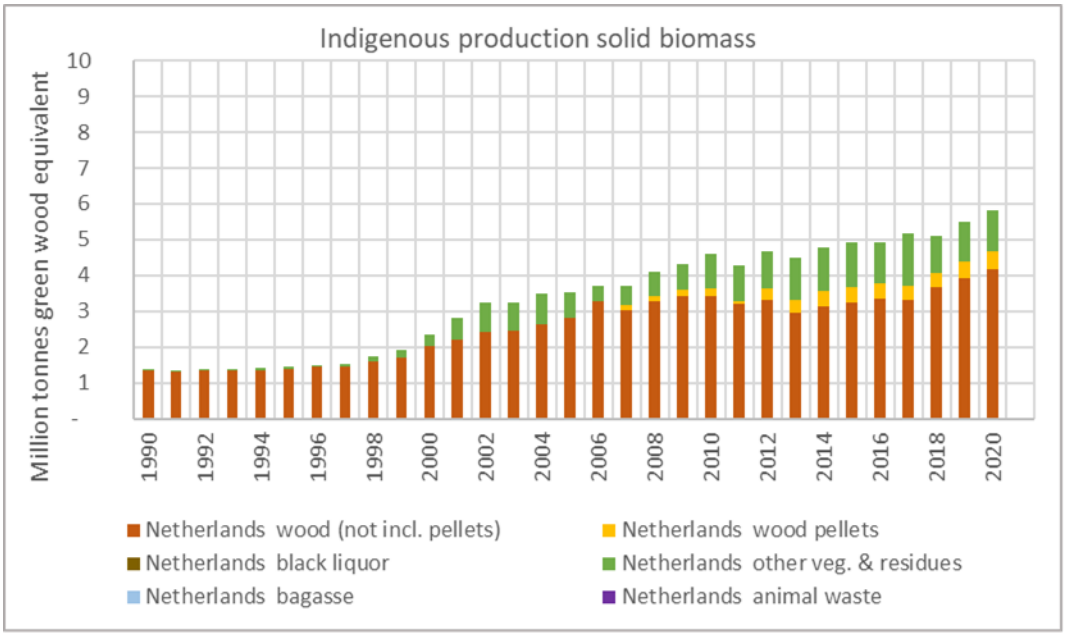

Land sector carbon flux
Million tonnes CO2
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
1990
1995
2000
2005
2010
2015
2020
Malta HWP
Malta FRF
Malta land sector
Malta 2030 target

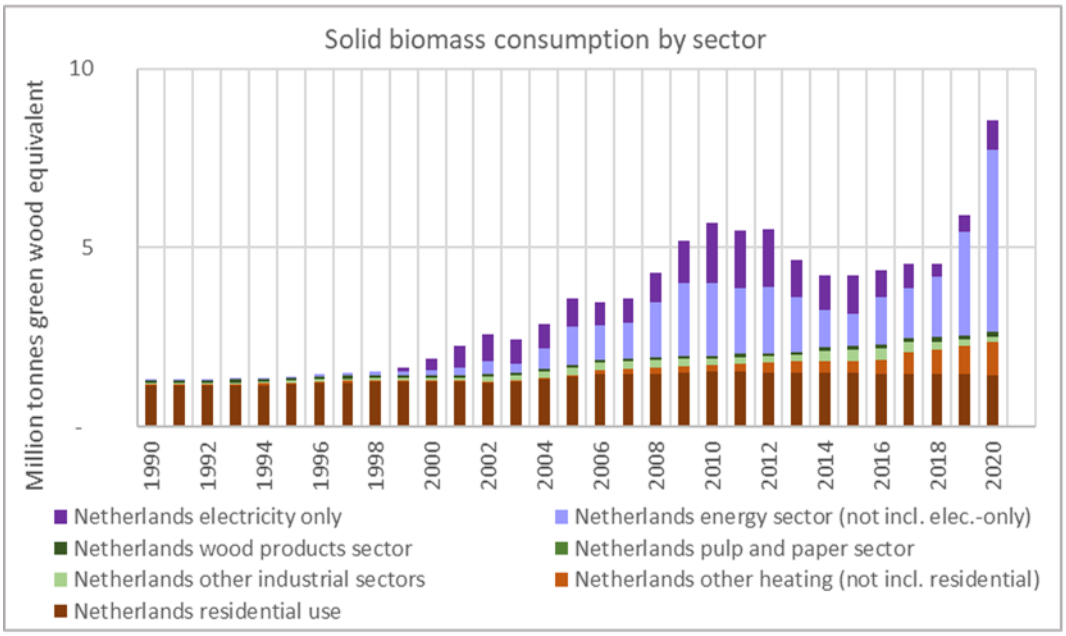

Total RE consumption and % from solid biomass
700
600
500
400
300
200
100
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Malta consumption of RES in transport (GWh)
Malta consumption of electricity from RES (GWh)
Malta consumption of RES for heating and cooling (GWh)
Malta % total RES from solid biomass
Malta % total RES from residential biomass

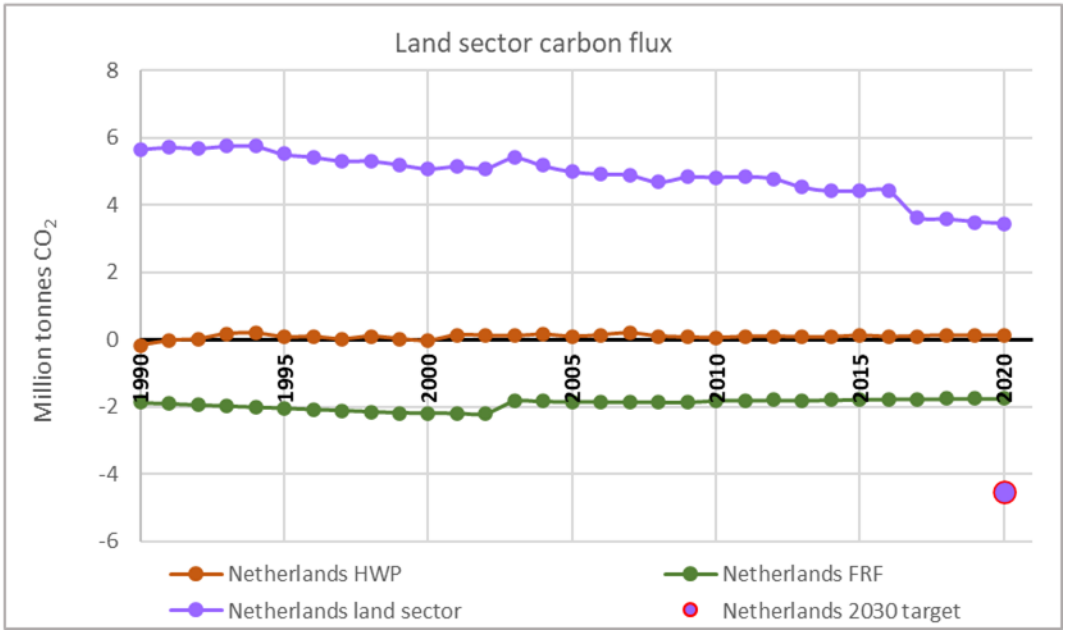

Renewable electricity and % from solid biomass
700
600
500
400
300
200
100
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Malta consumption of electricity from RES (GWh)
Malta % renewable electricity from solid biomass

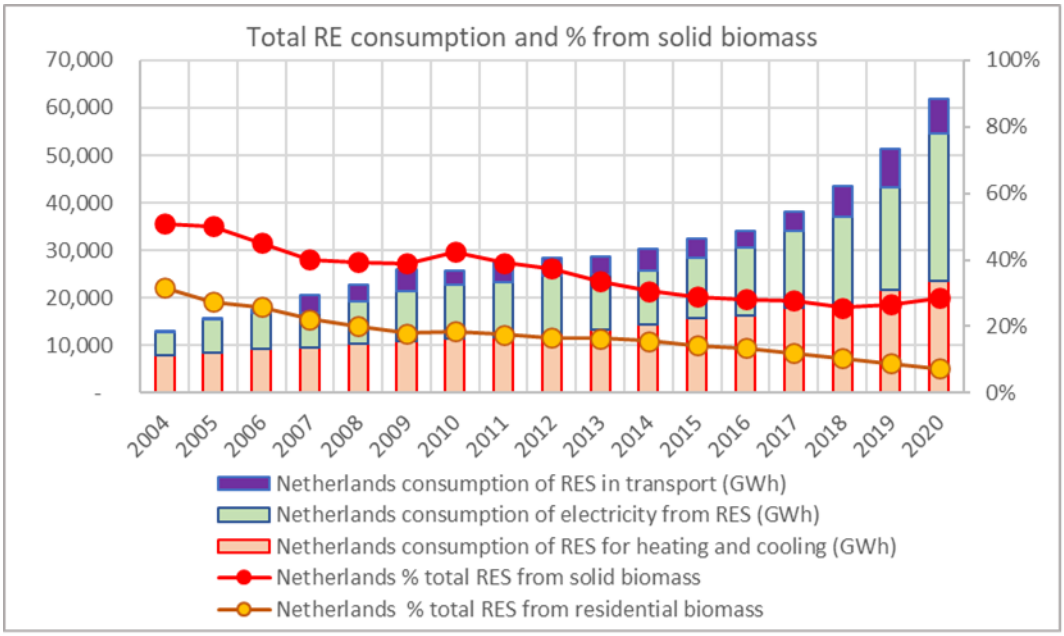

Renewable heating and % from solid biomass
700
600
500
400
300
200
100
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Malta consumption of RES for heating and cooling (GWh)
Malta % renewable heating from solid biomass
Malta % renewable heating from residential biomass

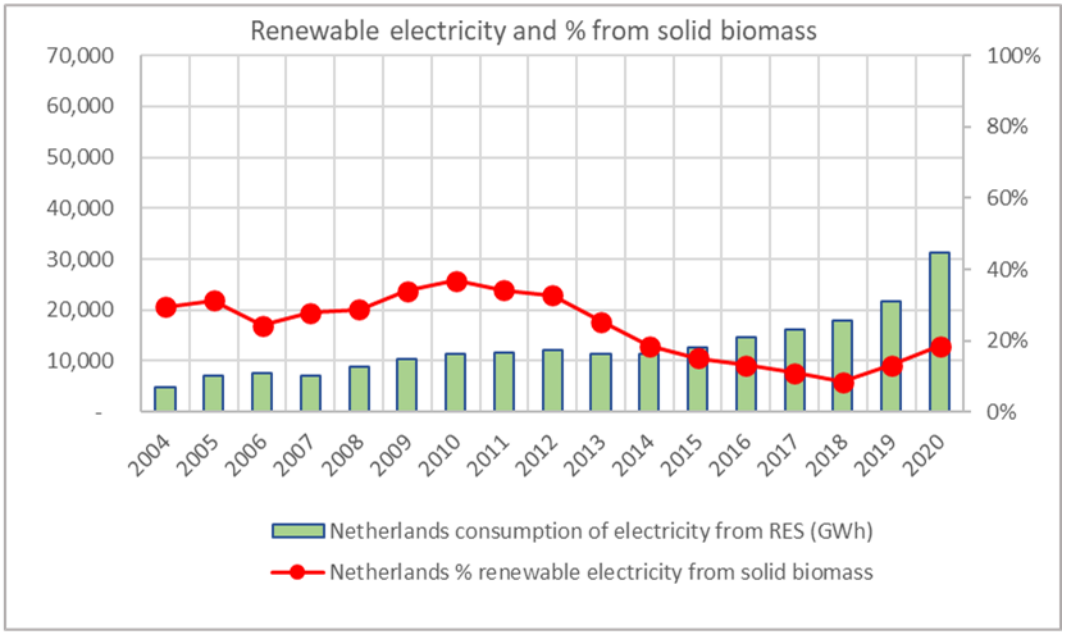
Netherlands

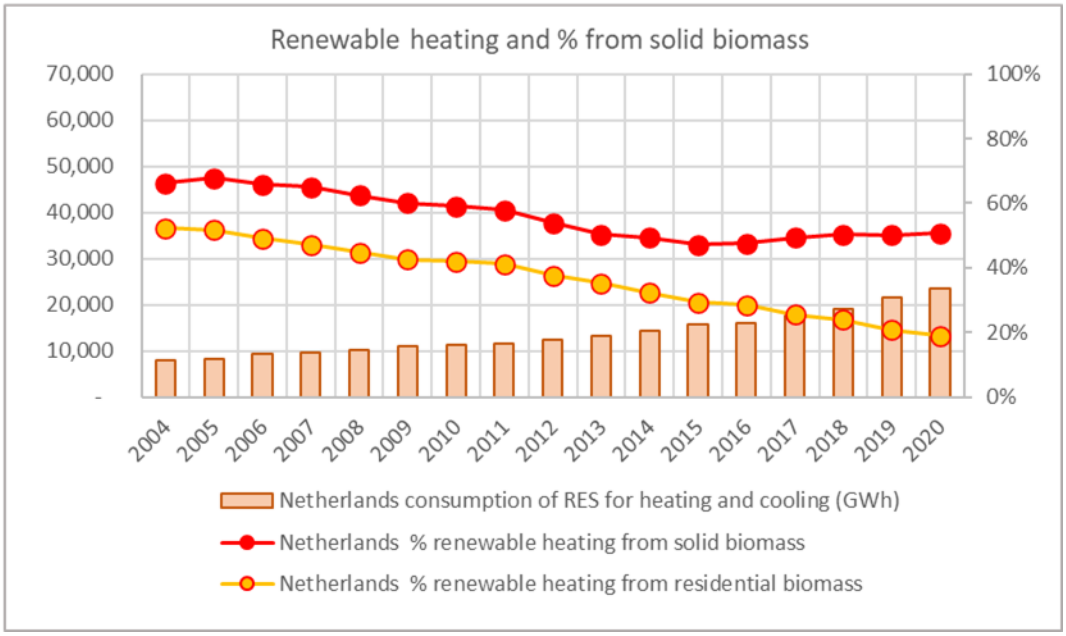




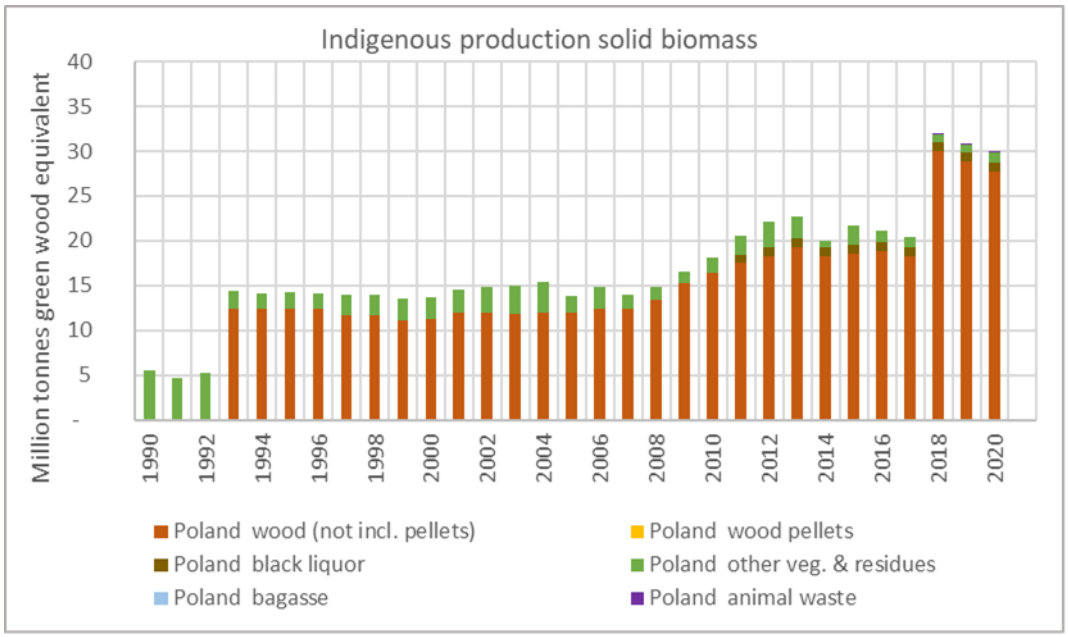



Total RE consumption and % from solid biomass
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Netherlands consumption of RES in transport (GWh)
Netherlands consumption of electricity from RES (GWh)
Netherlands consumption of RES for heating and cooling (GWh)
Netherlands % total RES from solid biomass
Netherlands % total RES from residential biomass

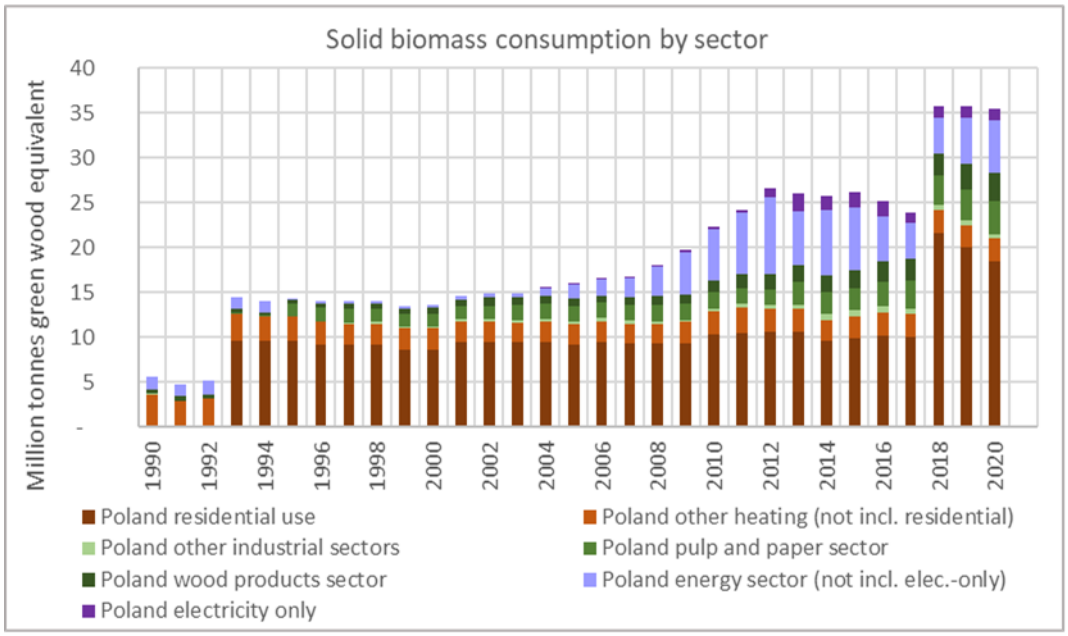

Renewable electricity and % from solid biomass
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Netherlands consumption of electricity from RES (GWh)
Netherlands % renewable electricity from solid biomass

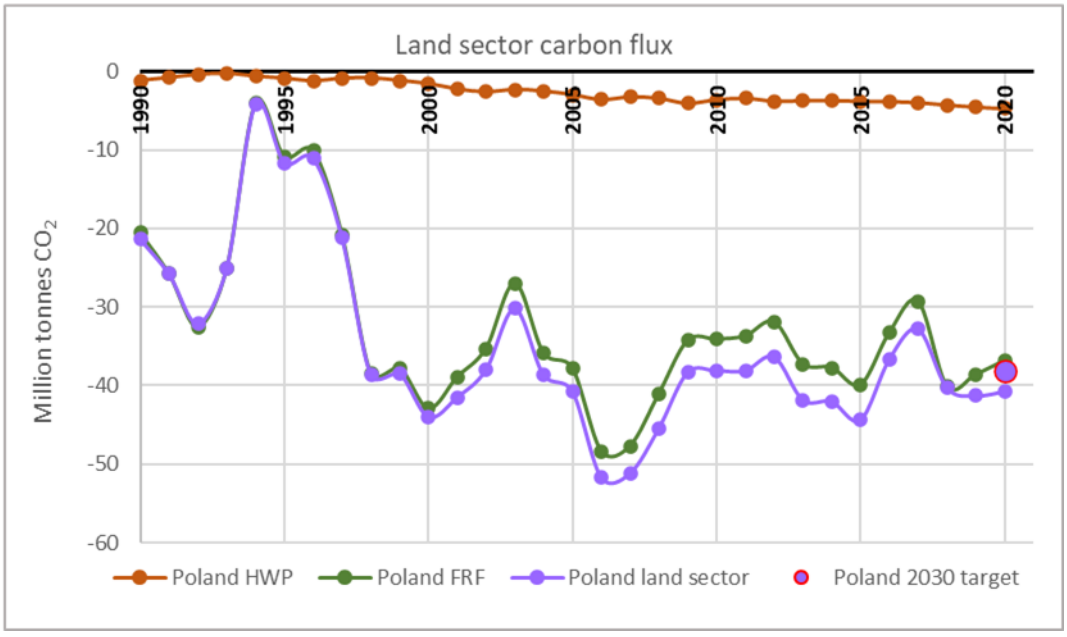

Renewable heating and % from solid biomass
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Netherlands consumption of RES for heating and cooling (GWh)
Netherlands % renewable heating from solid biomass
Netherlands % renewable heating from residential biomass

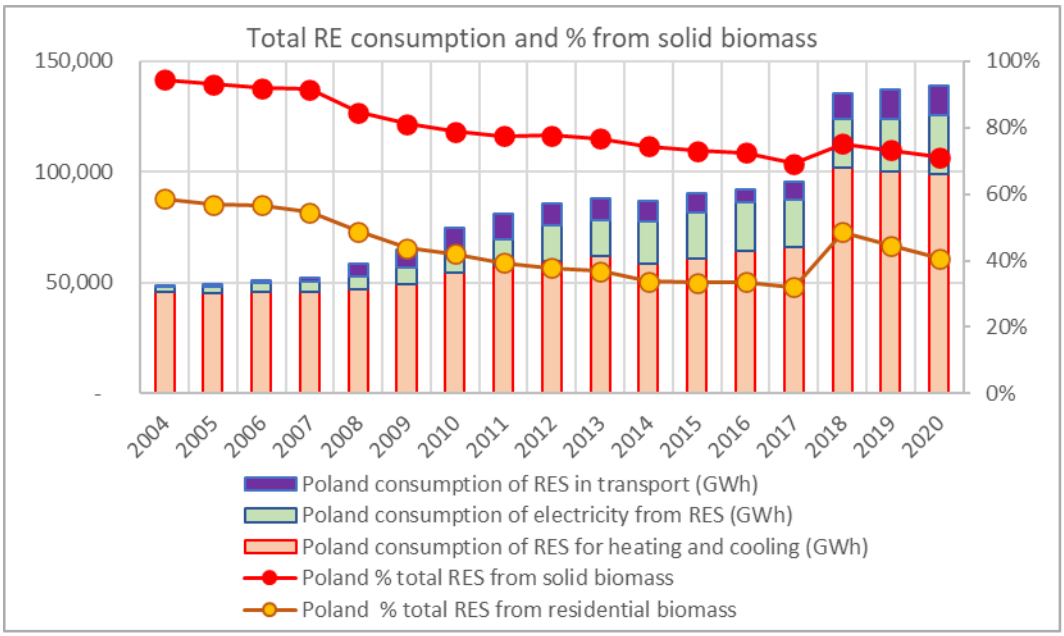
Poland

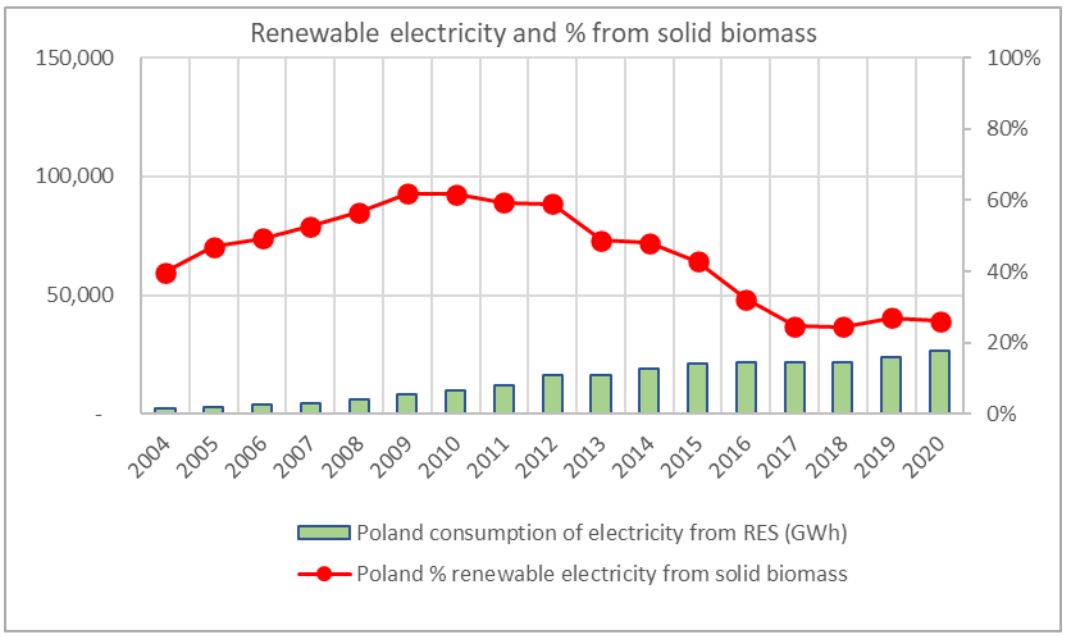


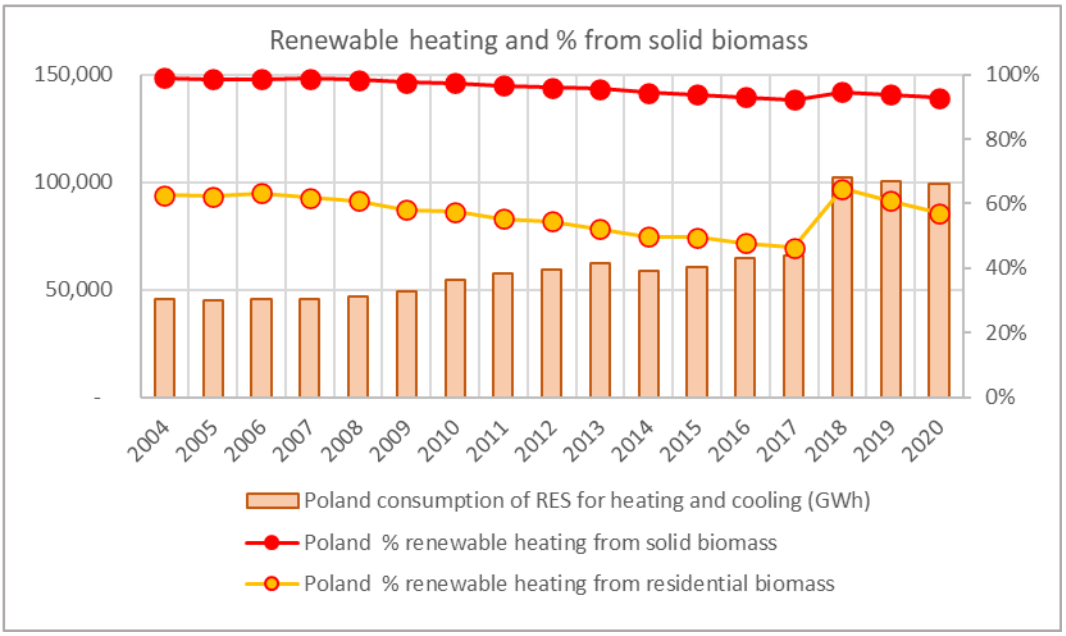
The large jump in residential biomass use in 2018 is due to a change in survey methodology.[ix] It is clearly reflected in the total renewable energy graph on the next page.



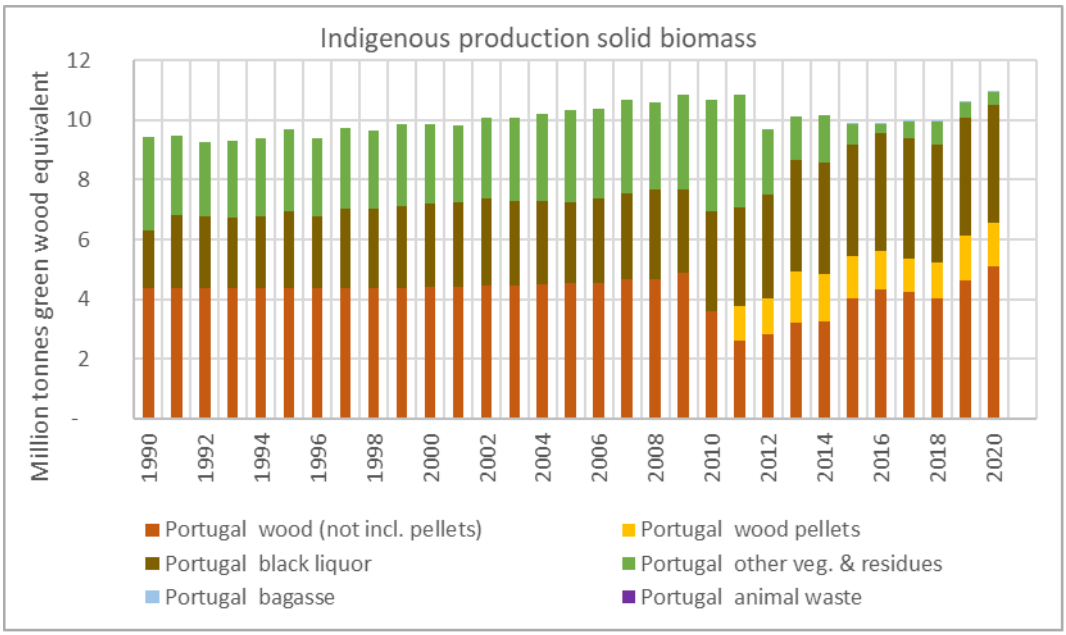


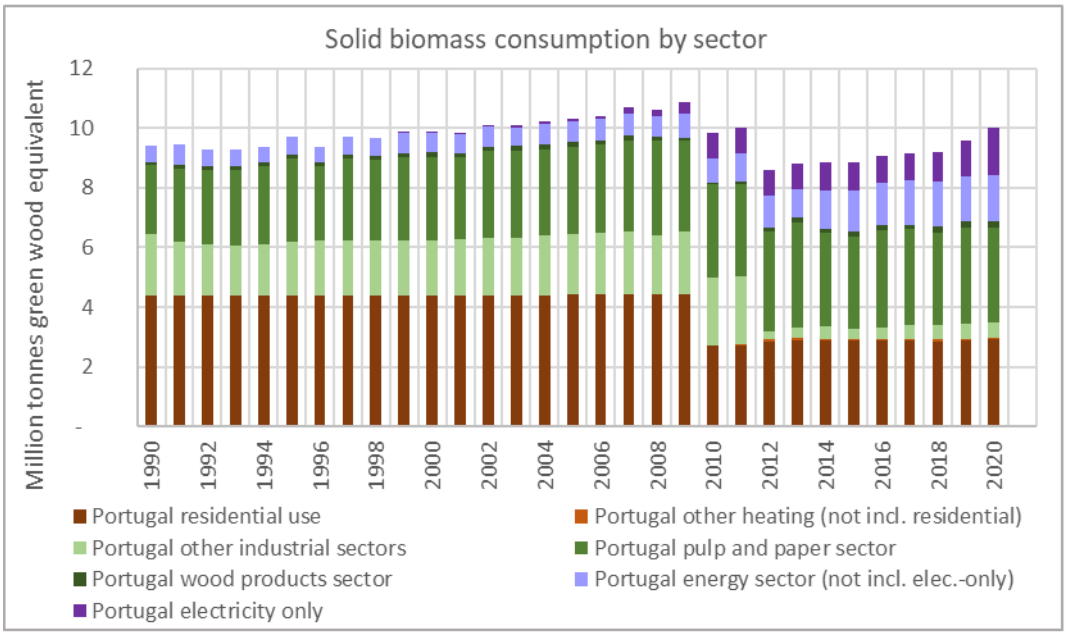

Total RE consumption and % from solid biomass
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Poland consumption of RES in transport (GWh)
Poland consumption of electricity from RES (GWh)
Poland consumption of RES for heating and cooling (GWh)
Poland % total RES from solid biomass
Poland % total RES from residential biomass

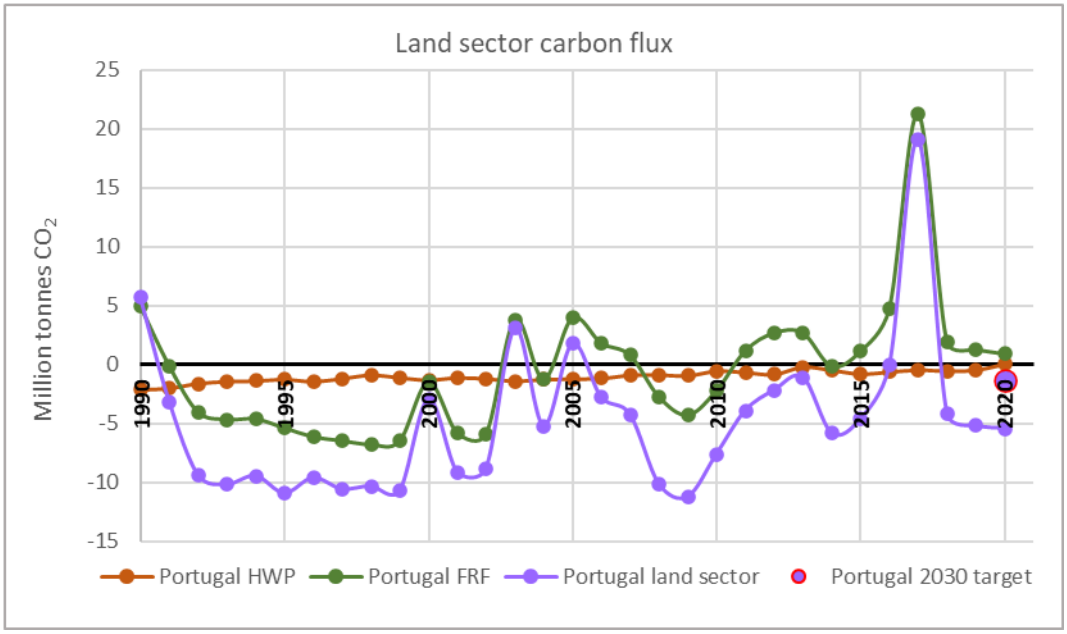

Renewable electricity and % from solid biomass
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Poland consumption of electricity from RES (GWh)
Poland % renewable electricity from solid biomass

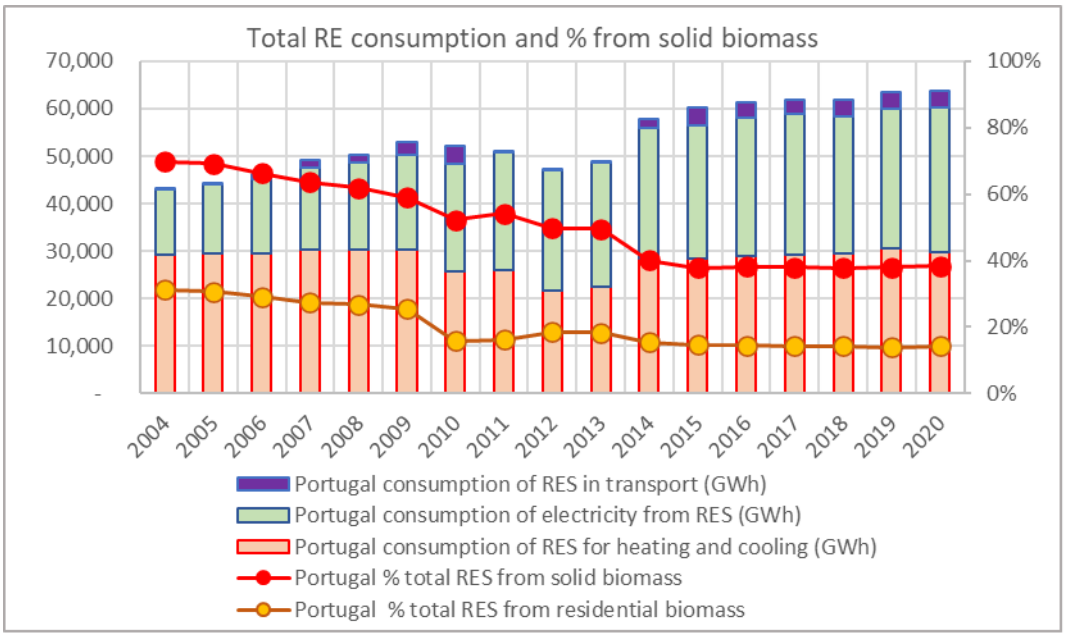

Renewable heating and % from solid biomass
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Poland consumption of RES for heating and cooling (GWh)
Poland % renewable heating from solid biomass
Poland % renewable heating from residential biomass

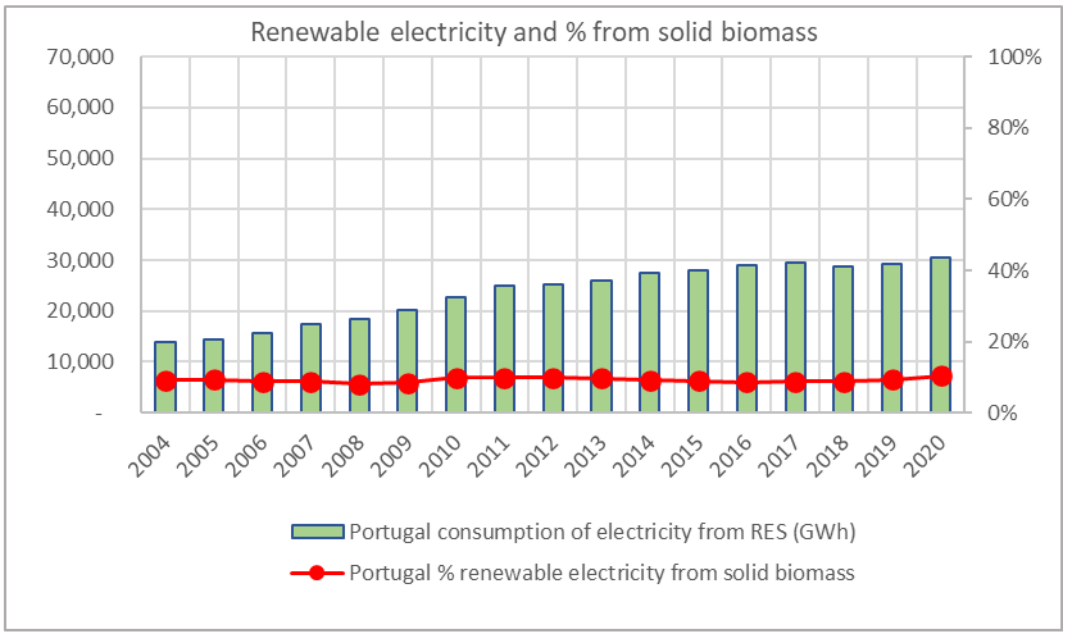
Portugal

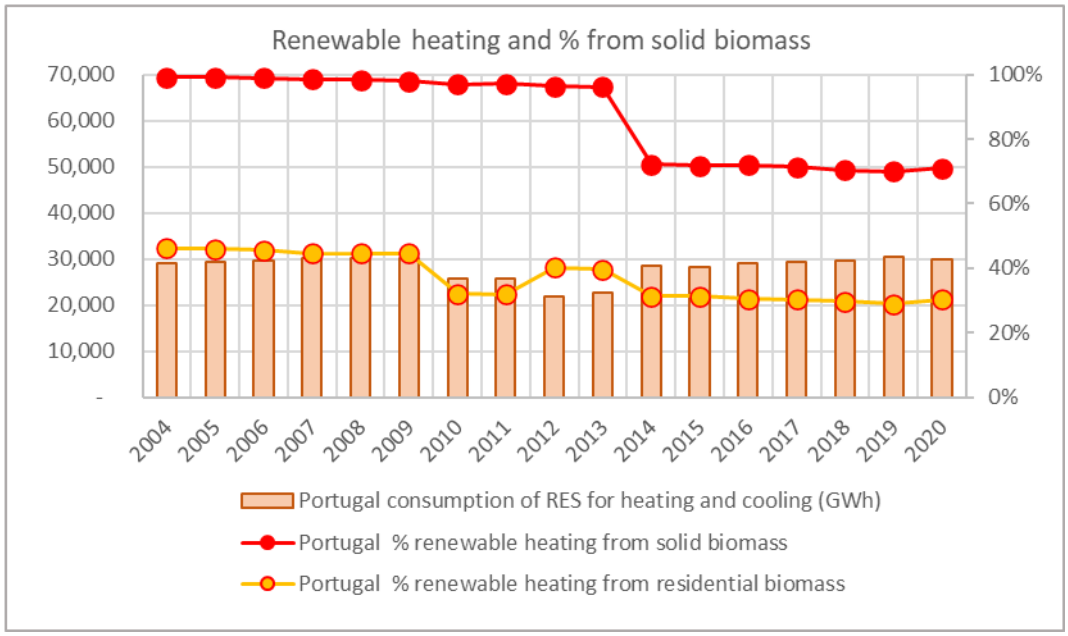

Indigenous production solid biomass
Million tonnes green wood equivalent
12
10
8
6
4
2
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Portugal wood (not incl. pellets)
Portugal wood pellets
Portugal black liquor
Portugal other veg. & residues
Portugal bagasse
Portugal animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
12
10
8
6
4
2
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Portugal residential use
Portugal other heating (not incl. residential)
Portugal other industrial sectors
Portugal pulp and paper sector
Portugal wood products sector
Portugal energy sector (not incl. elec.-only)
Portugal electricity only

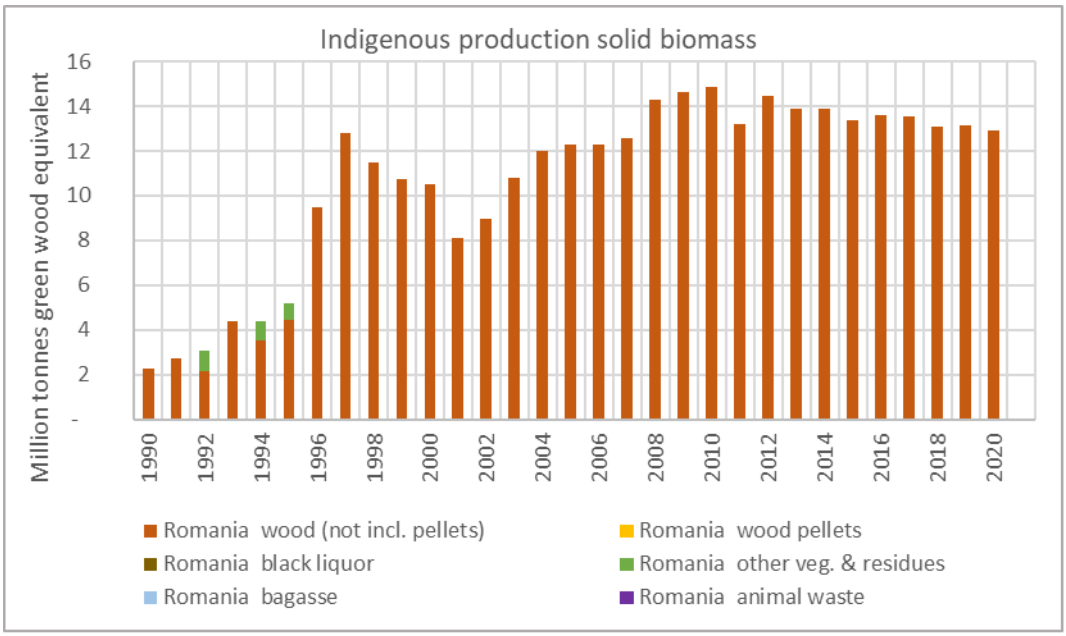

Land sector carbon flux
Million tonnes CO2
25
20
15
10
5
0
-5
-10
-15
1990
1995
2000
2005
2010
2015
2020
Portugal HWP
Portugal FRF
Portugal land sector
Portugal 2030 target


Total RE consumption and % from solid biomass
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Portugal consumption of RES in transport (GWh)
Portugal consumption of electricity from RES (GWh)
Portugal consumption of RES for heating and cooling (GWh)
Portugal % total RES from solid biomass
Portugal % total RES from residential biomass

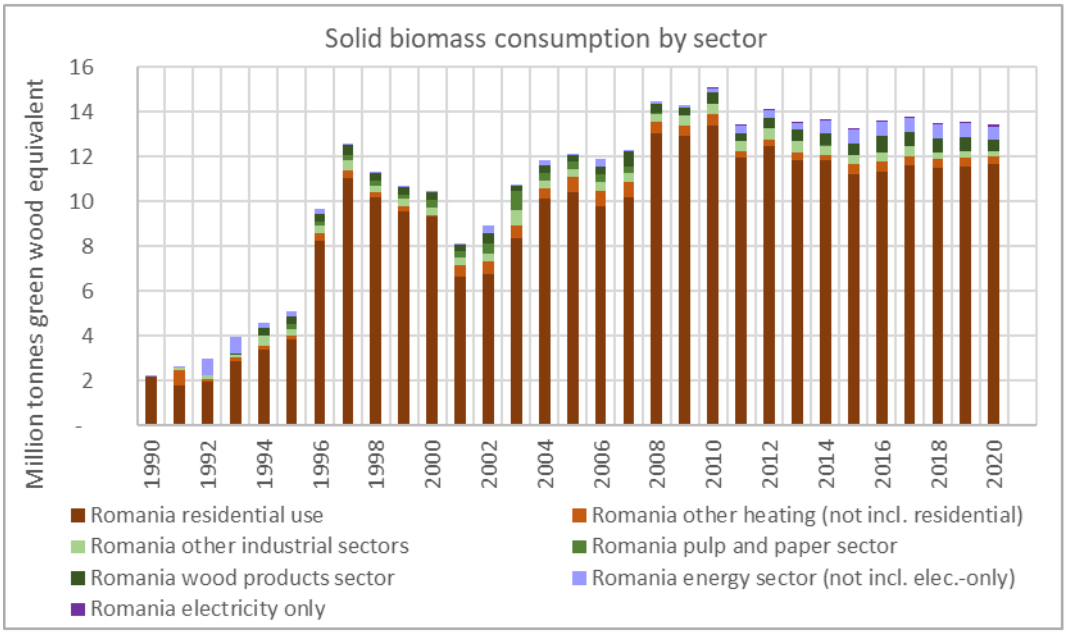

Renewable electricity and % from solid biomass
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Portugal consumption of electricity from RES (GWh)
Portugal % renewable electricity from solid biomass

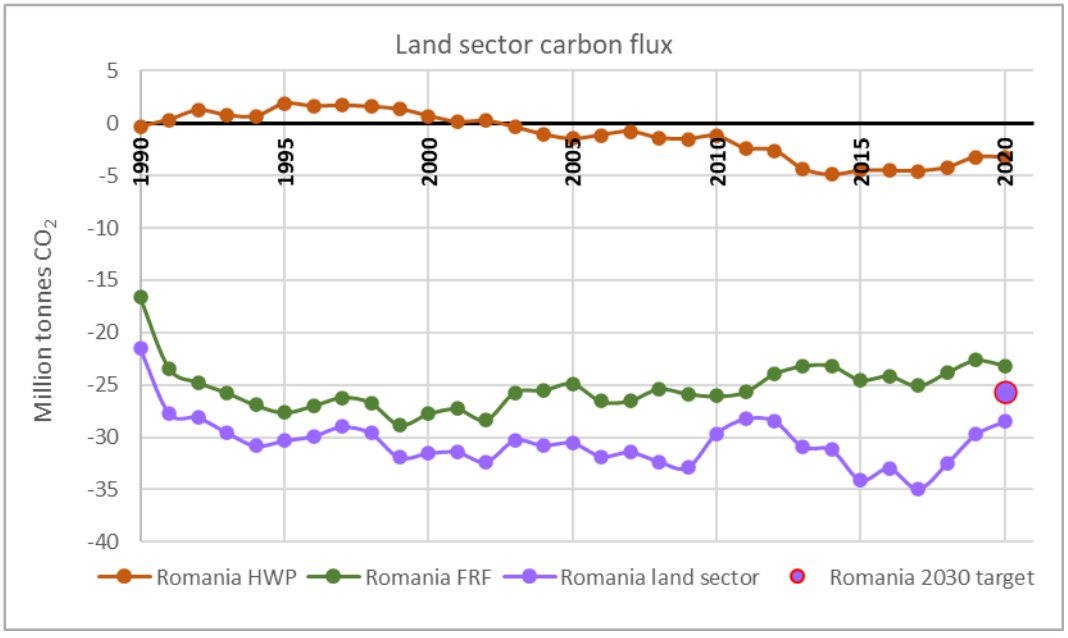

Renewable heating and % from solid biomass
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Portugal consumption of RES for heating and cooling (GWh)
Portugal % renewable heating from solid biomass
Portugal % renewable heating from residential biomass

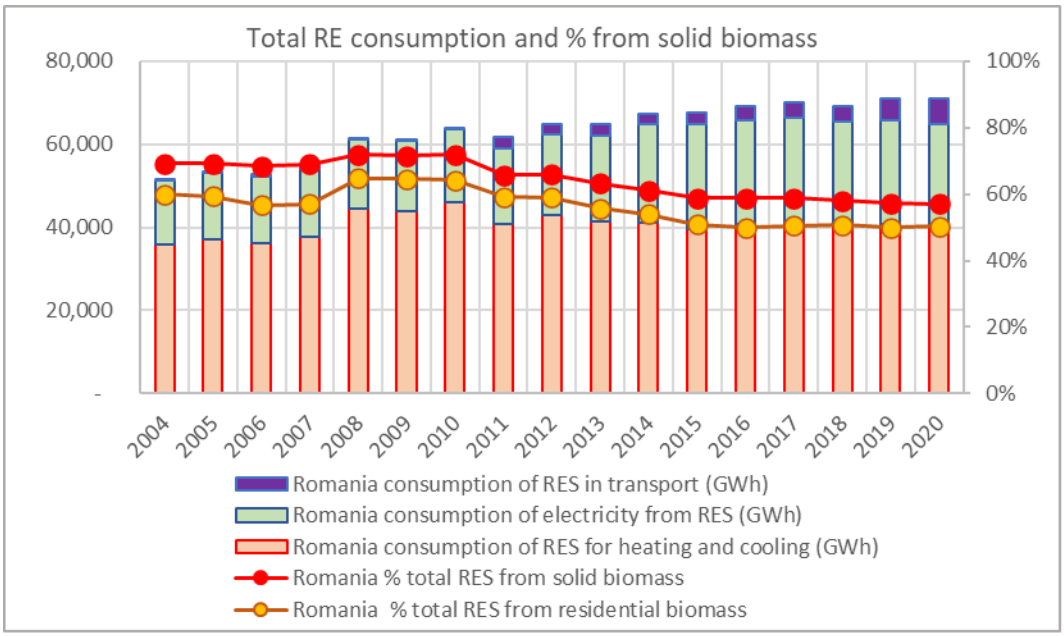
Romania

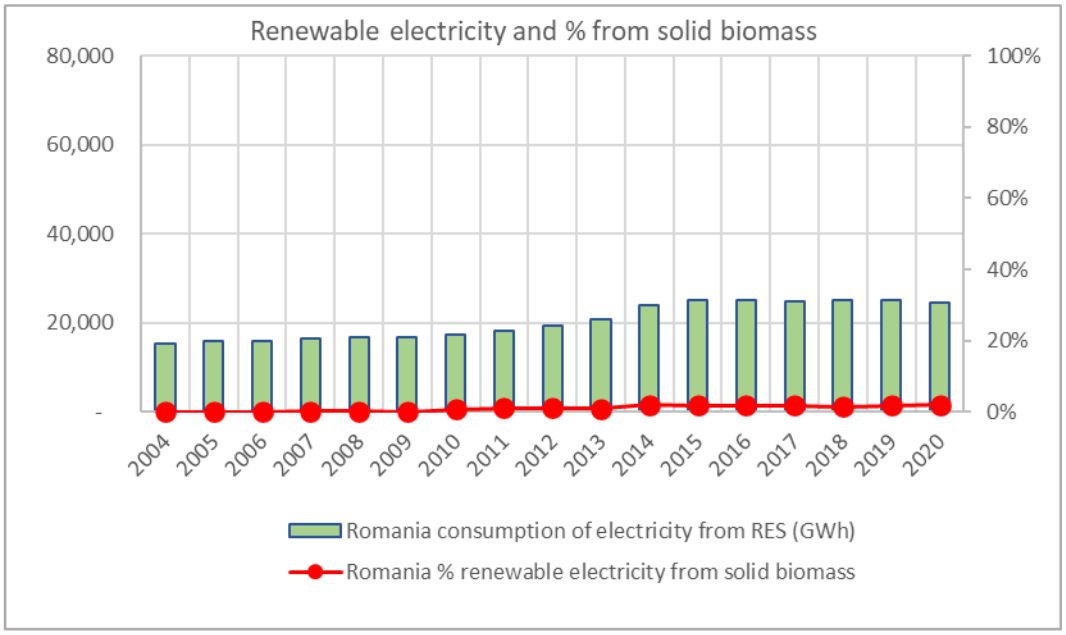


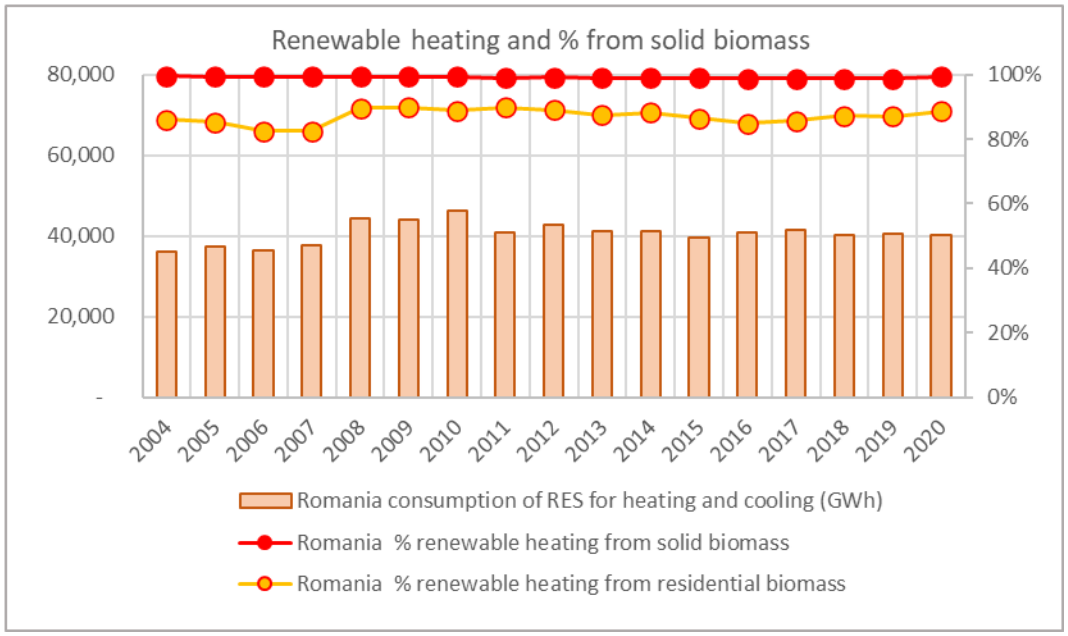
The dependency of Romania on biomass relates almost entirely to use for residential heating. Romania is also one of the countries where wood illegally logged in old growth forests is being traced to biomass and pellet plants.



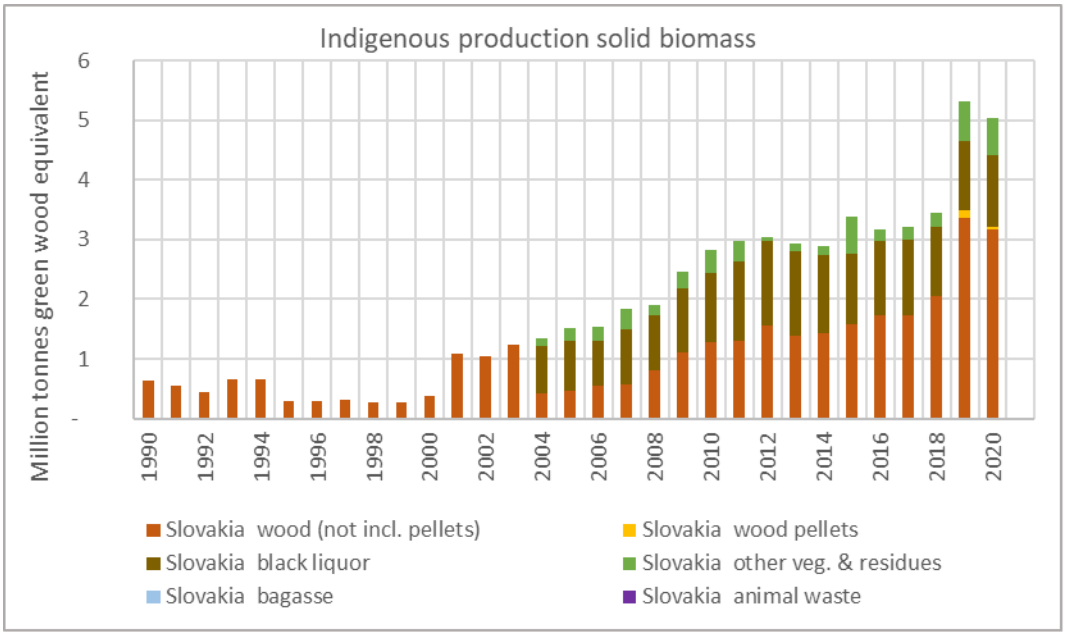



Total RE consumption and % from solid biomass
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Romania consumption of RES in transport (GWh)
Romania consumption of electricity from RES (GWh)
Romania consumption of RES for heating and cooling (GWh)
Romania % total RES from solid biomass
Romania % total RES from residential biomass

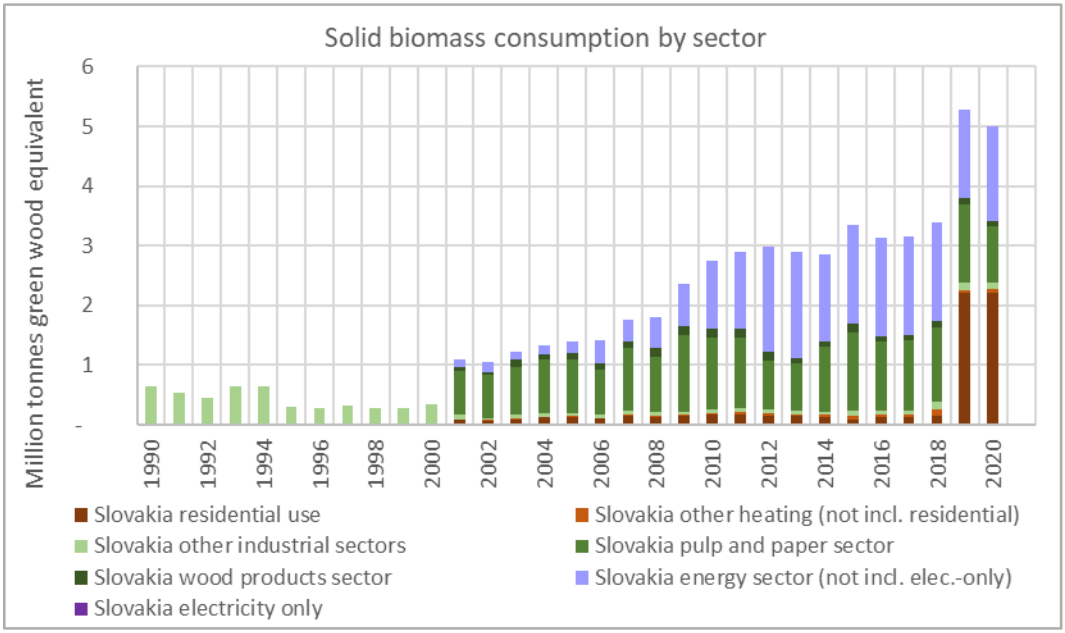

Renewable electricity and % from solid biomass
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Romania consumption of electricity from RES (GWh)
Romania % renewable electricity from solid biomass

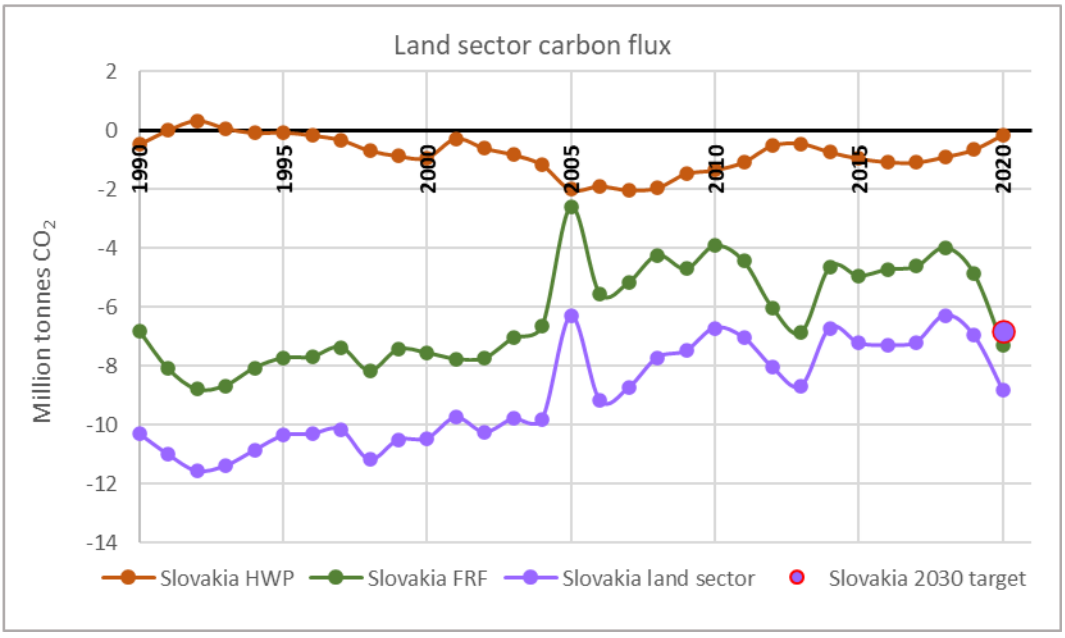

Renewable heating and % from solid biomass
80,000
60,000
40,000
20,000
-
100%
80%
60%
40%
20%
0%
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Romania consumption of RES for heating and cooling (GWh)
Romania % renewable heating from solid biomass
Romania % renewable heating from residential biomass

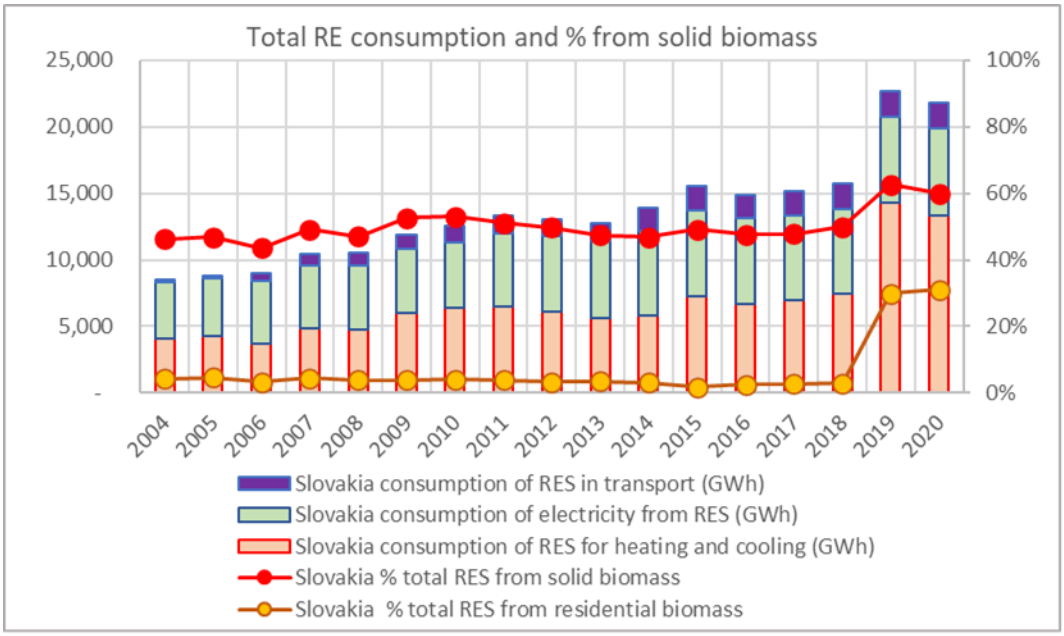
Slovakia

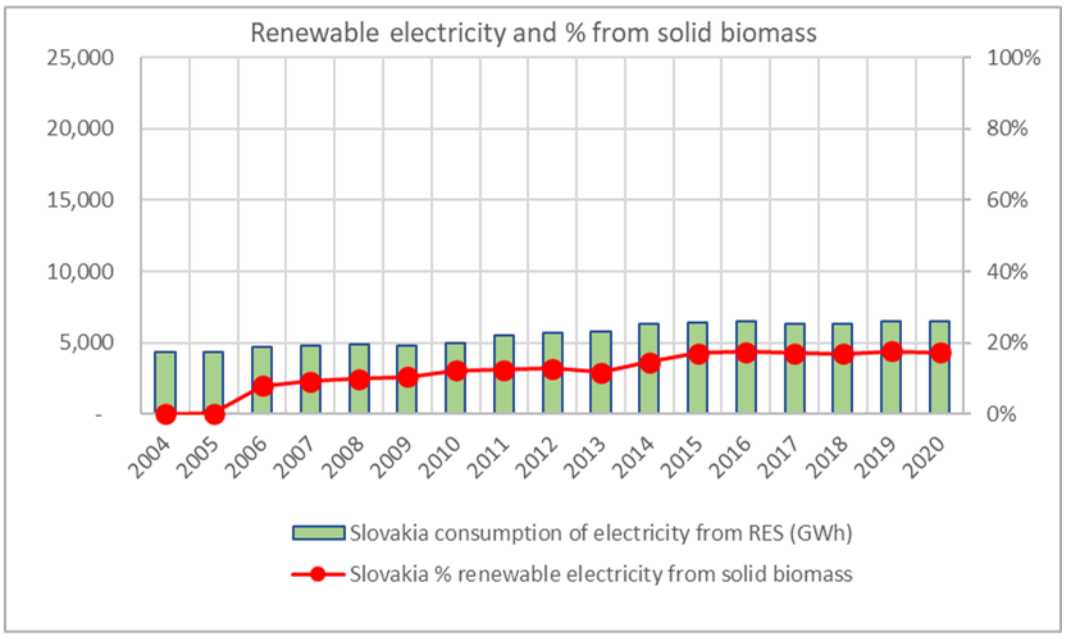


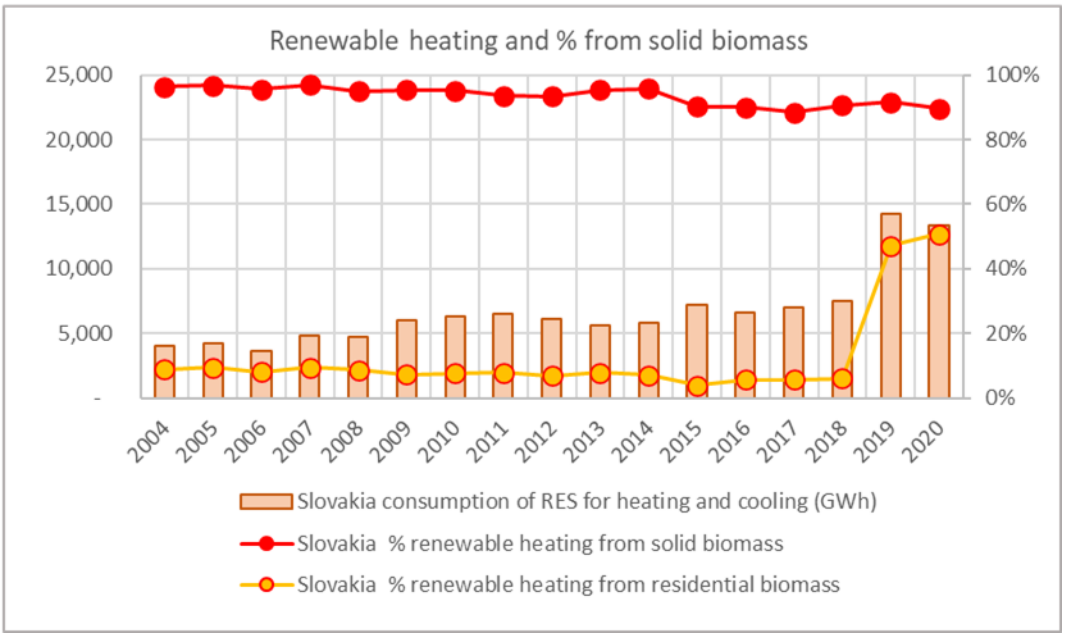
The abrupt increase in wood use for residential heating allowed Slovakia to hit its renewable energy target ahead of time, as explained above.



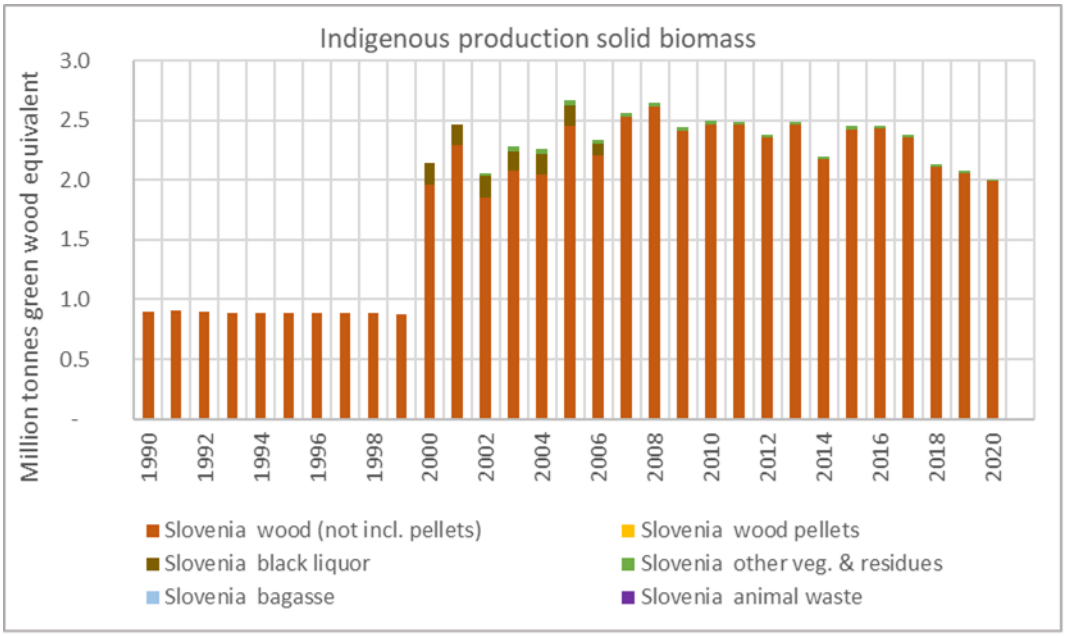



Total RE consumption and % from solid biomass
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Slovakia consumption of RES in transport (GWh)
Slovakia consumption of electricity from RES (GWh)
Slovakia consumption of RES for heating and cooling (GWh)
Slovakia % total RES from solid biomass
Slovakia % total RES from residential biomass

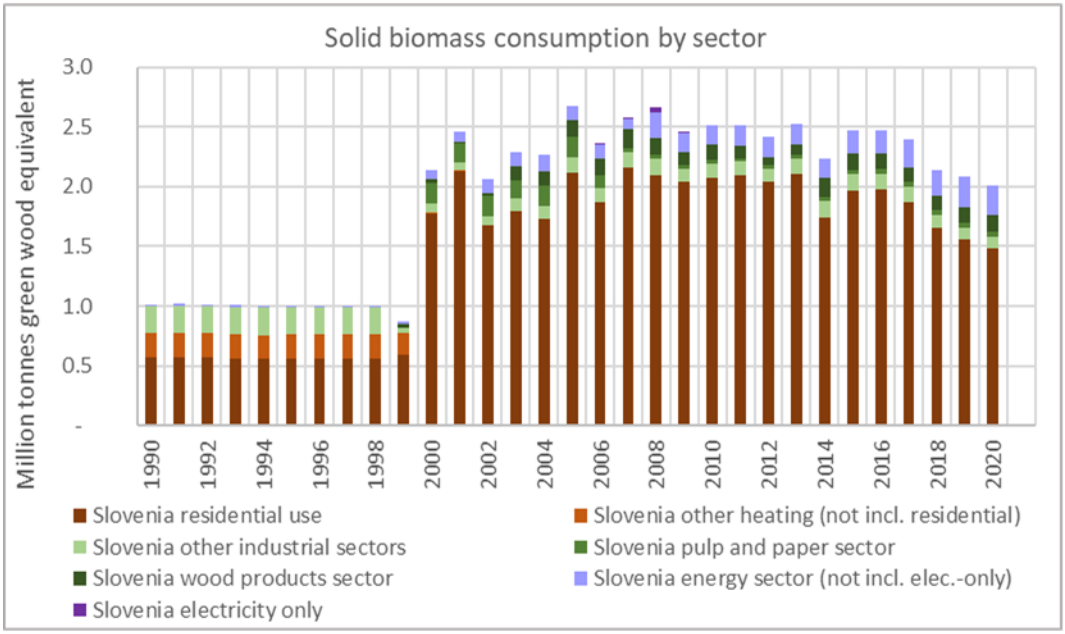

Renewable electricity and % from solid biomass
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Slovakia consumption of electricity from RES (GWh)
Slovakia % renewable electricity from solid biomass


Renewable heating and % from solid biomass
25,000
20,000
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Slovakia consumption of RES for heating and cooling (GWh)
Slovakia % renewable heating from solid biomass
Slovakia % renewable heating from residential biomass

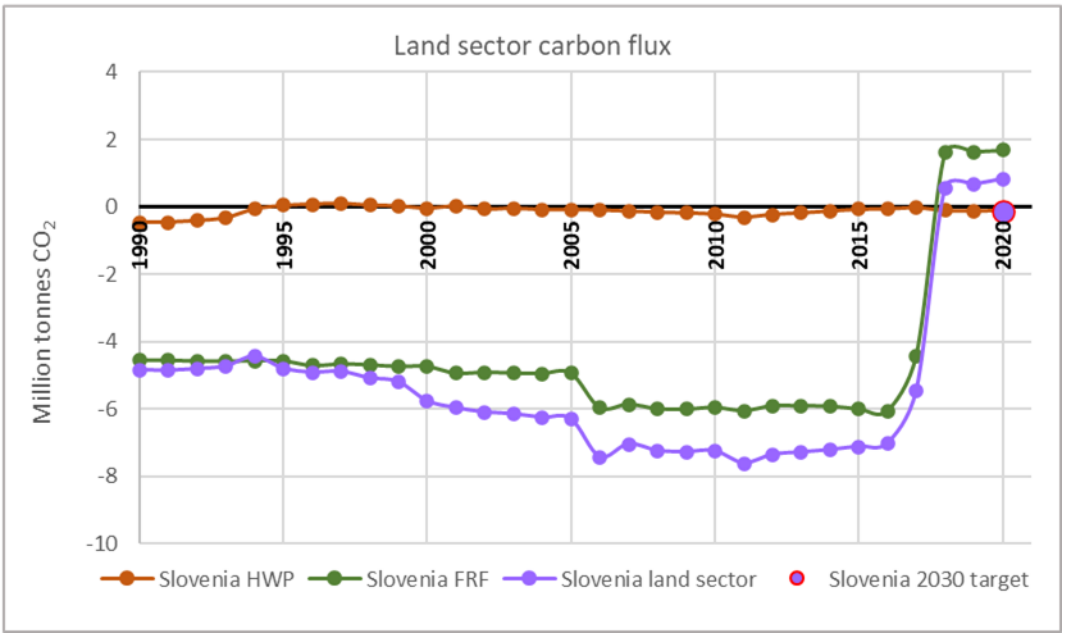
Slovenia

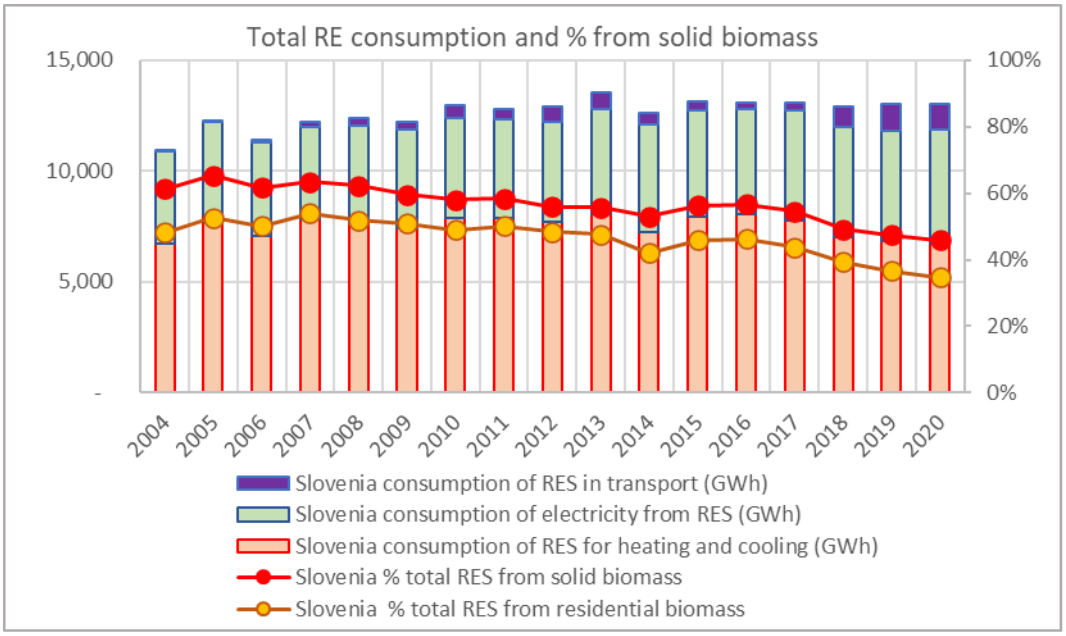


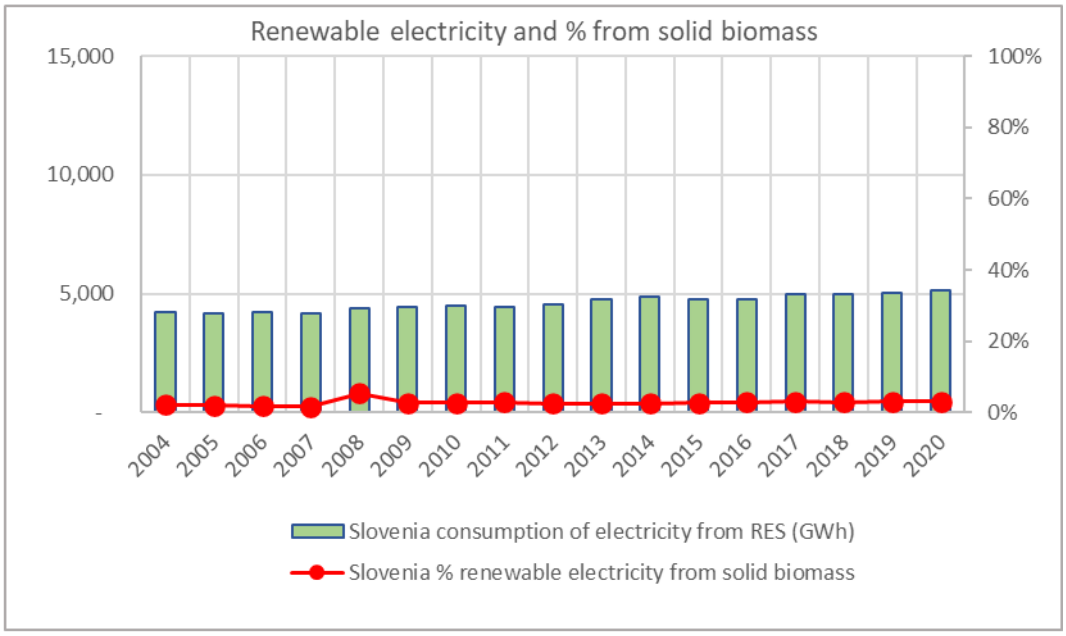
The large and sudden increase in 2000 for wood reported as burned for residential heating is likely an artifact of a change in the methodology for assessing wood-heating. This increase predates the earliest reported data for the RES, which starts in 2004.

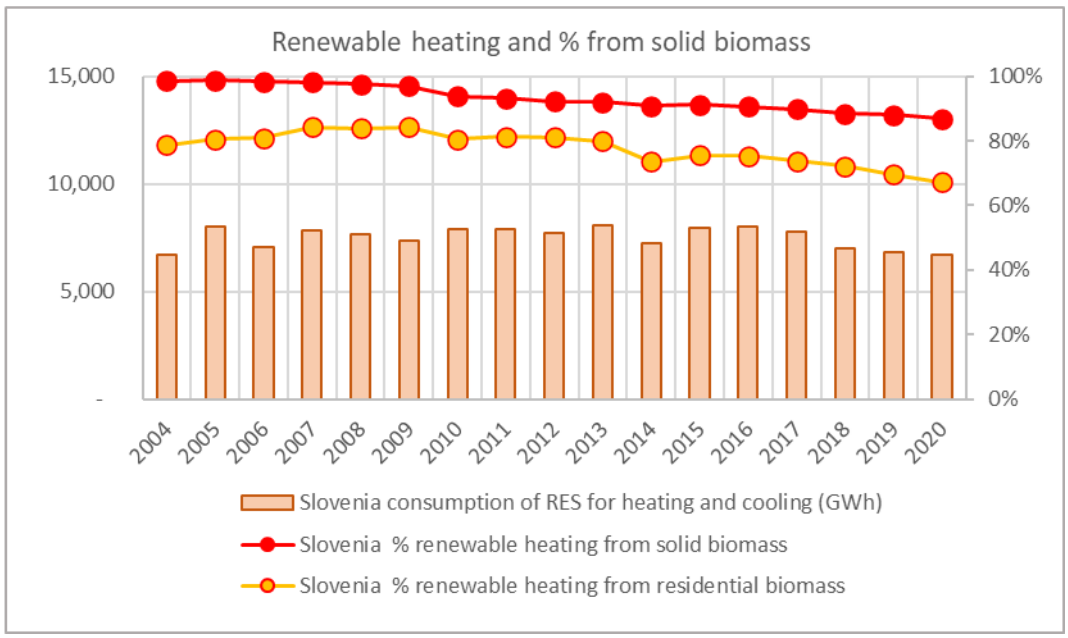


About half of Slovenia's logging was for salvage in 2019, according to EU data.[x] The abrupt loss in the land carbon sink could be related to a variety of factors.

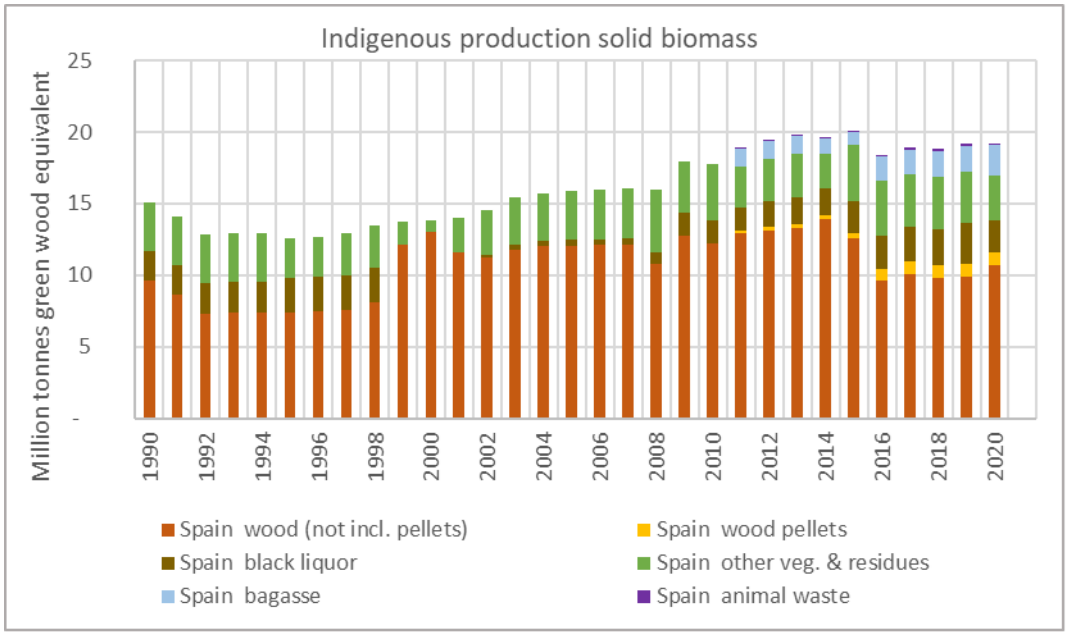


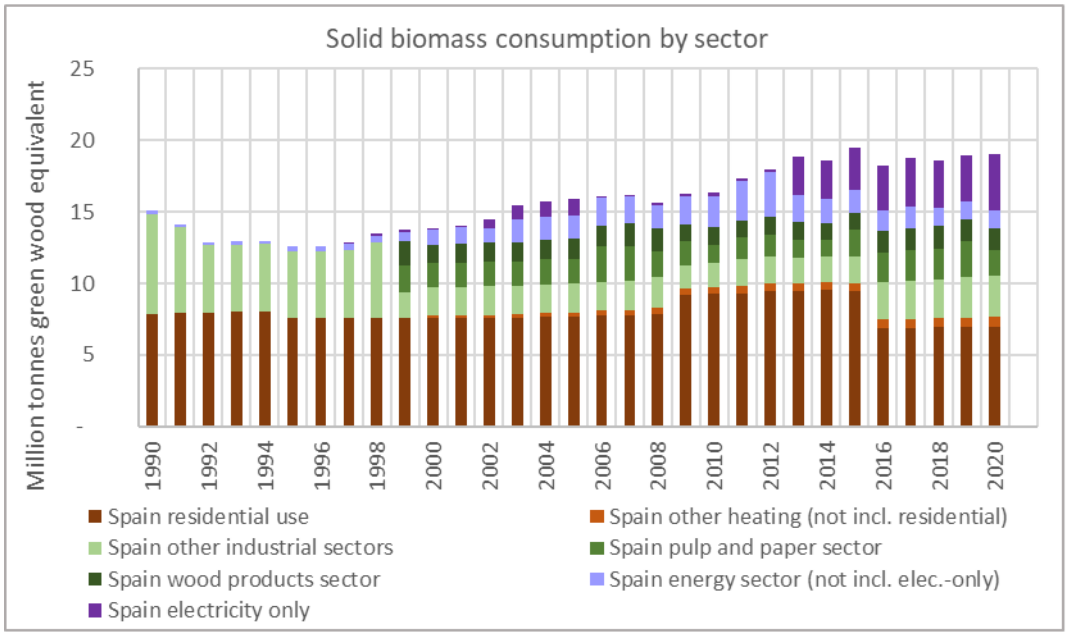

Total RE consumption and % from solid biomass
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Slovenia consumption of RES in transport (GWh)
Slovenia consumption of electricity from RES (GWh)
Slovenia consumption of RES for heating and cooling (GWh)
Slovenia % total RES from solid biomass
Slovenia % total RES from residential biomass

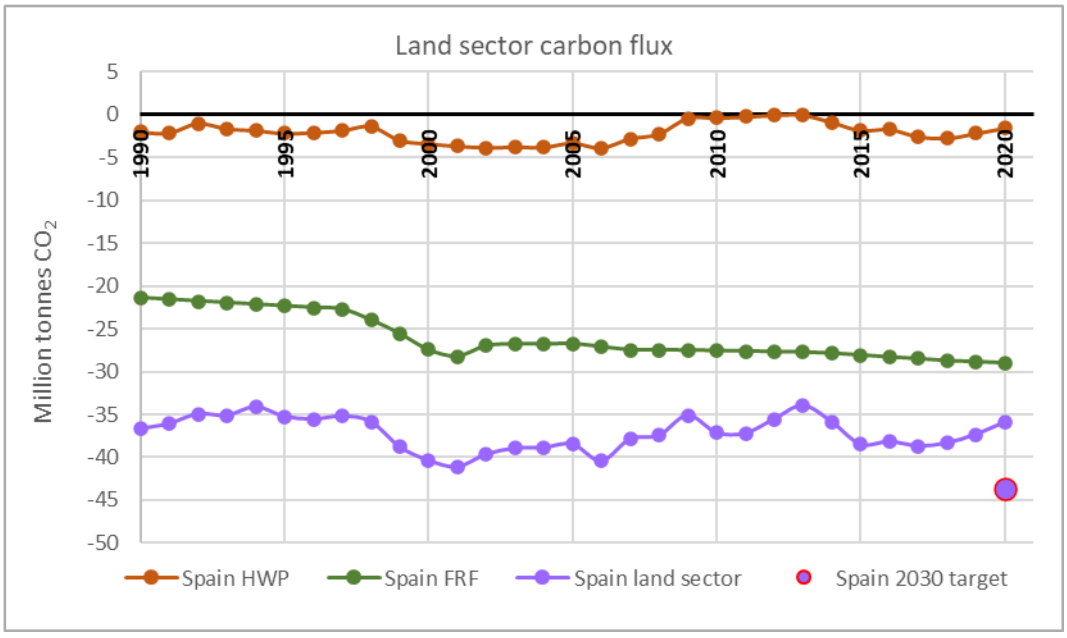

Renewable electricity and % from solid biomass
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Slovenia consumption of electricity from RES (GWh)
Slovenia % renewable electricity from solid biomass

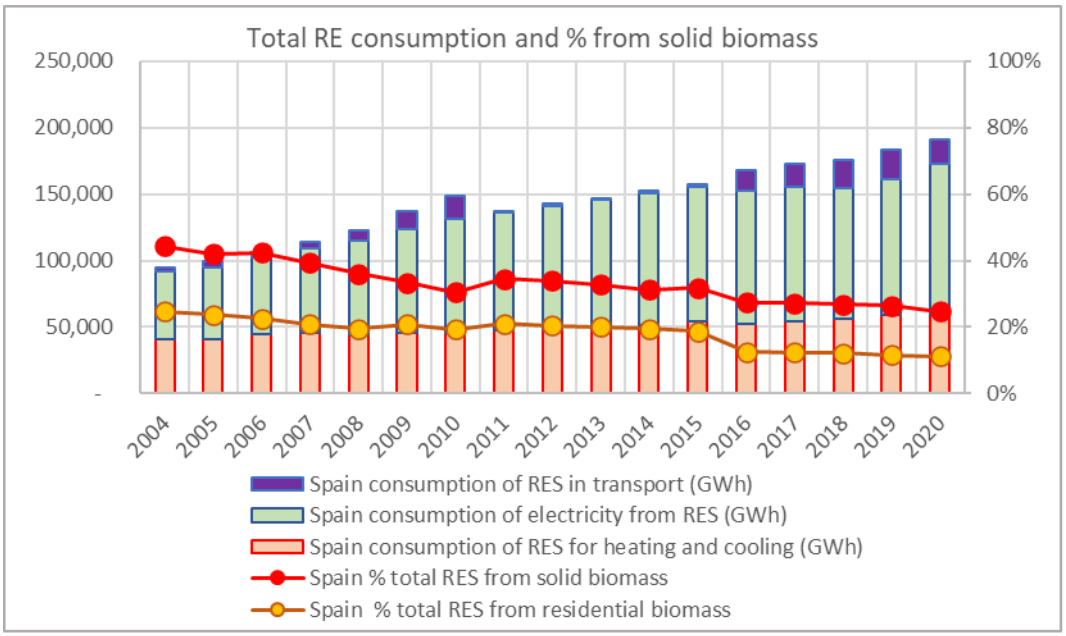

Renewable heating and % from solid biomass
15,000
10,000
5,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Slovenia consumption of RES for heating and cooling (GWh)
Slovenia % renewable heating from solid biomass
Slovenia % renewable heating from residential biomass

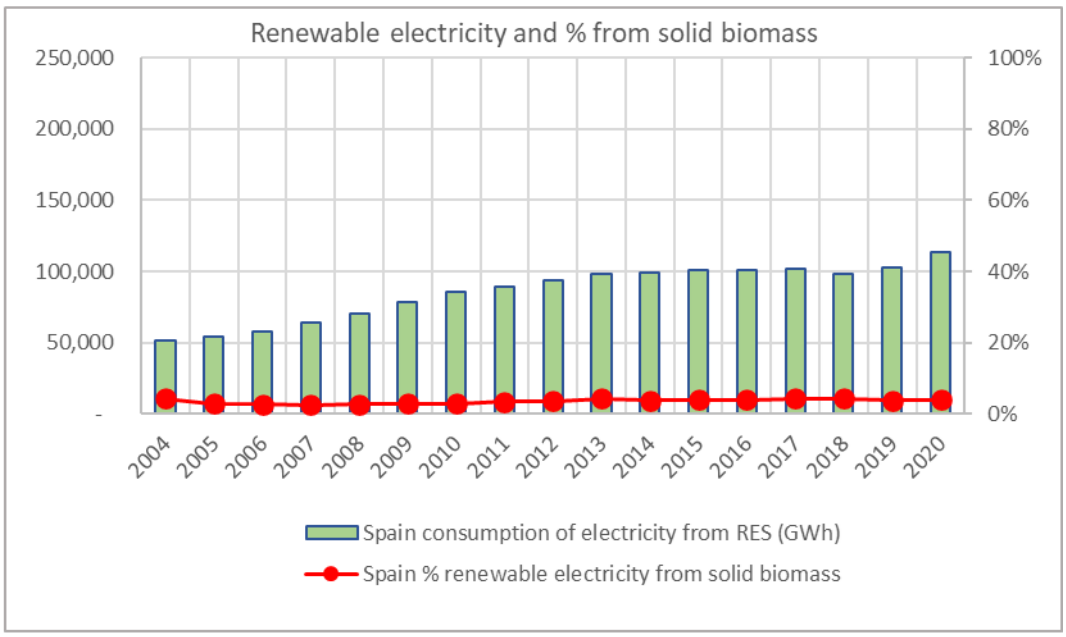
Spain

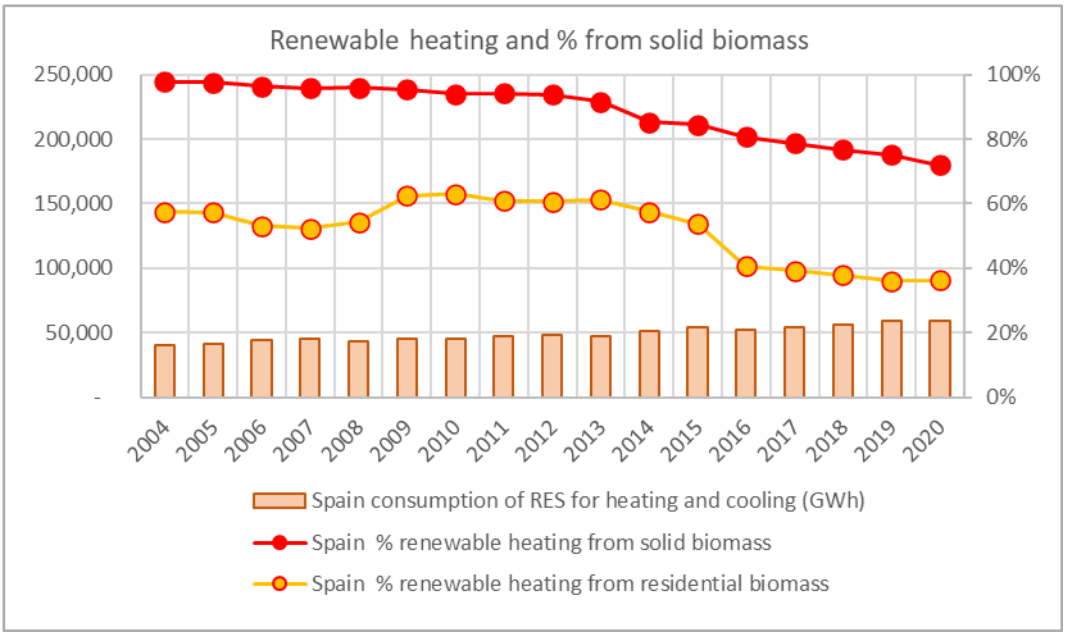

Indigenous production solid biomass
Million tonnes green wood equivalent
25
20
15
10
5
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Spain wood (not incl. pellets)
Spain wood pellets
Spain black liquor
Spain other veg. & residues
Spain bagasse
Spain animal waste


Solid biomass consumption by sector
Million tonnes green wood equivalent
25
20
15
10
5
-
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Spain residential use
Spain other heating (not incl. residential)
Spain other industrial sectors
Spain pulp and paper sector
Spain wood products sector
Spain energy sector (not incl. elec.-only)
Spain electricity only

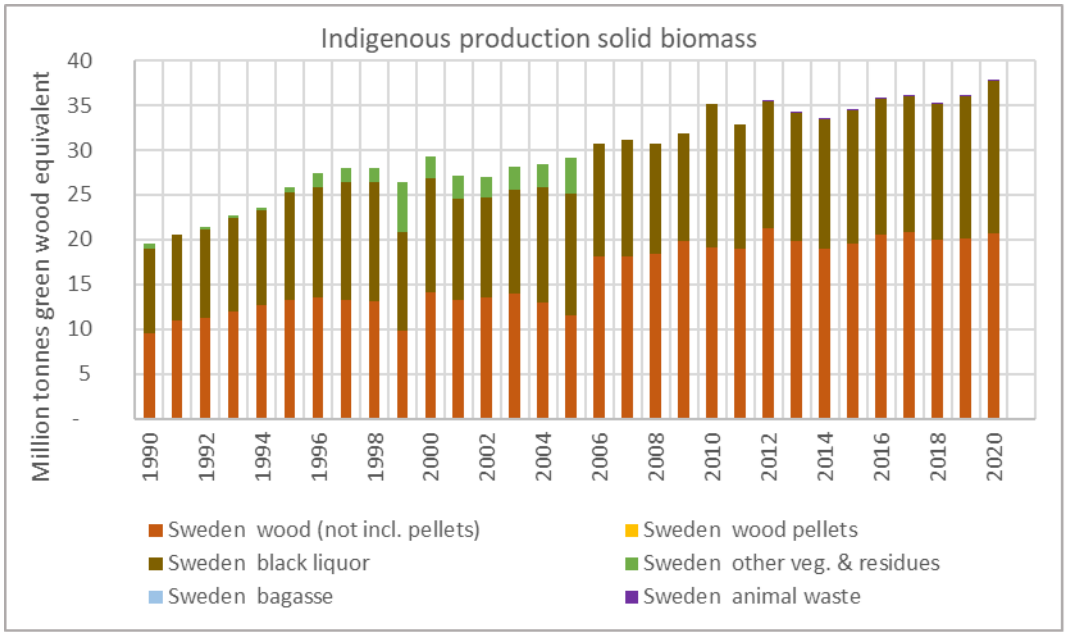

Land sector carbon flux
Million tonnes CO2
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1990
1995
2000
2005
2010
2015
2020
Spain HWP
Spain FRF
Spain land sector
Spain 2030 target

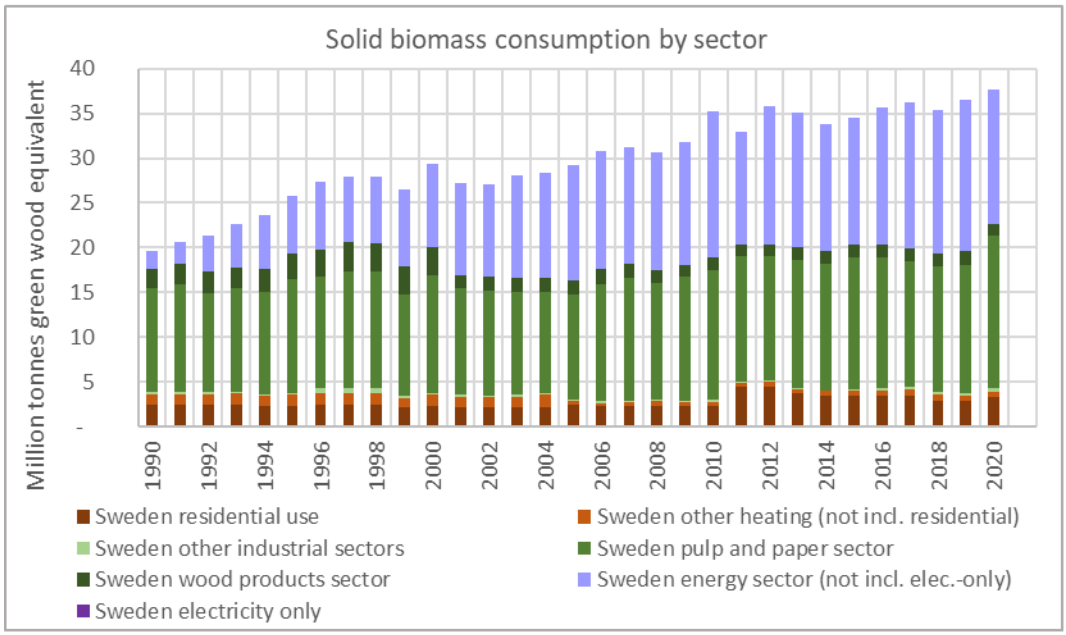

Total RE consumption and % from solid biomass
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Spain consumption of RES in transport (GWh)
Spain consumption of electricity from RES (GWh)
Spain consumption of RES for heating and cooling (GWh)
Spain % total RES from solid biomass
Spain % total RES from residential biomass


Renewable electricity and % from solid biomass
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Spain consumption of electricity from RES (GWh)
Spain % renewable electricity from solid biomass

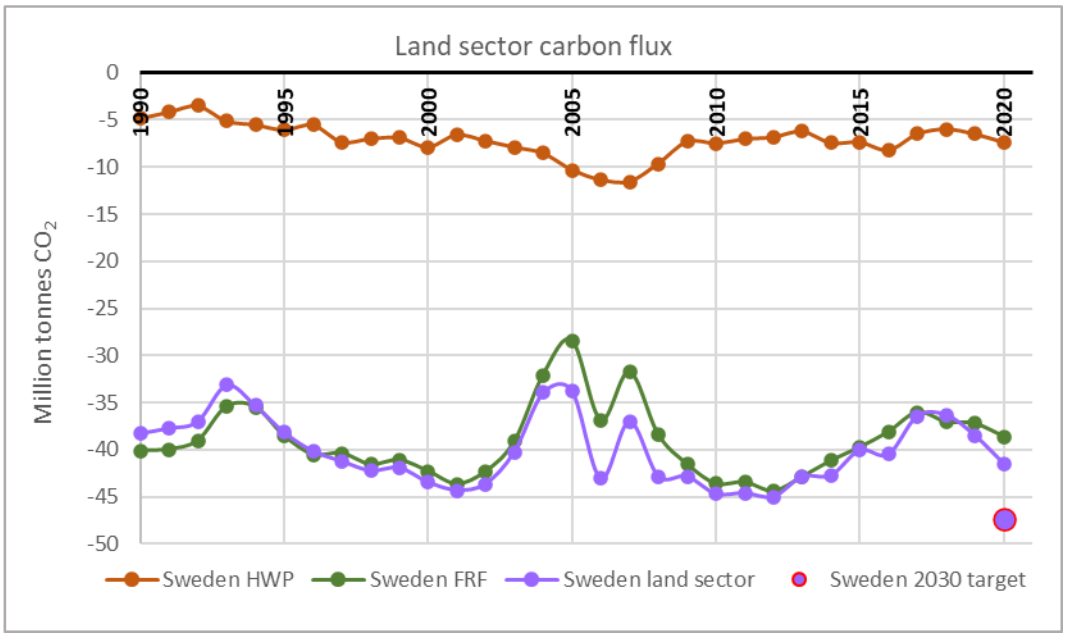

Renewable heating and % from solid biomass
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Spain consumption of RES for heating and cooling (GWh)
Spain % renewable heating from solid biomass
Spain % renewable heating from residential biomass

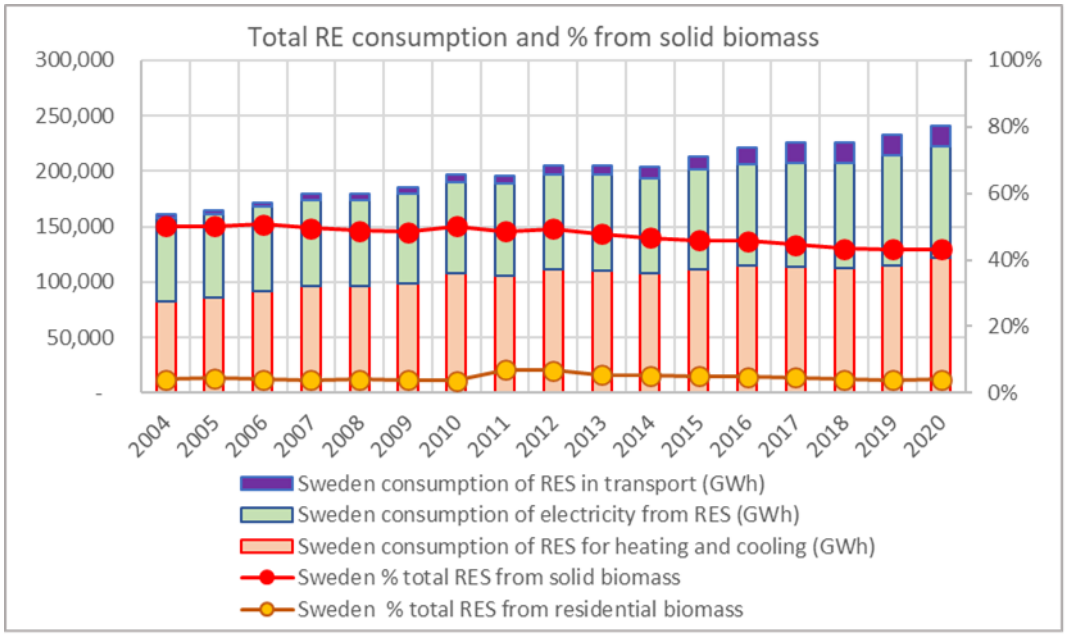
Sweden

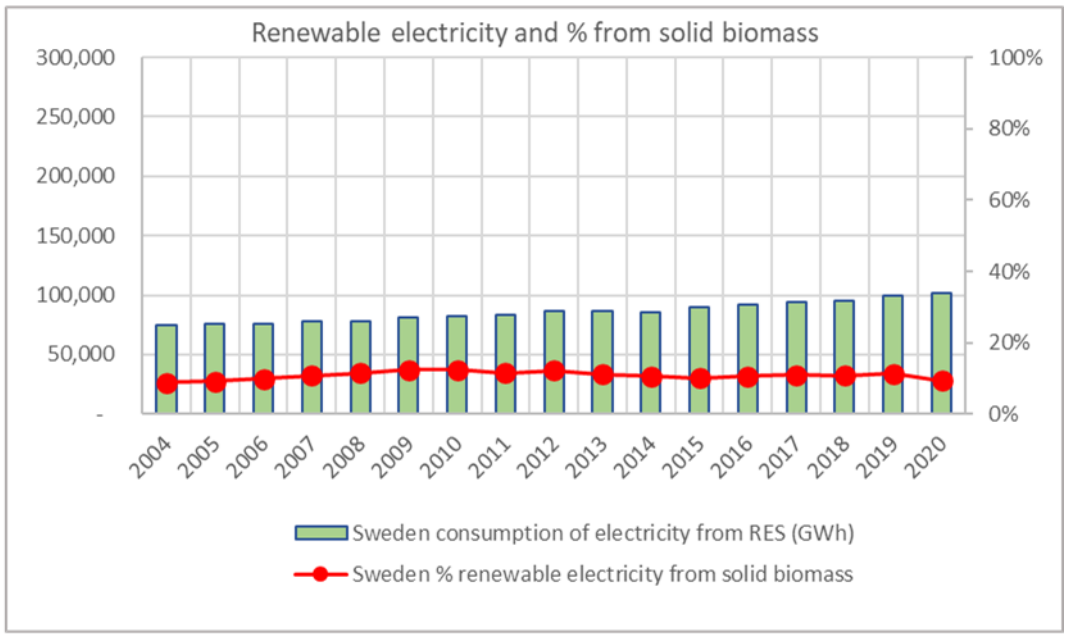


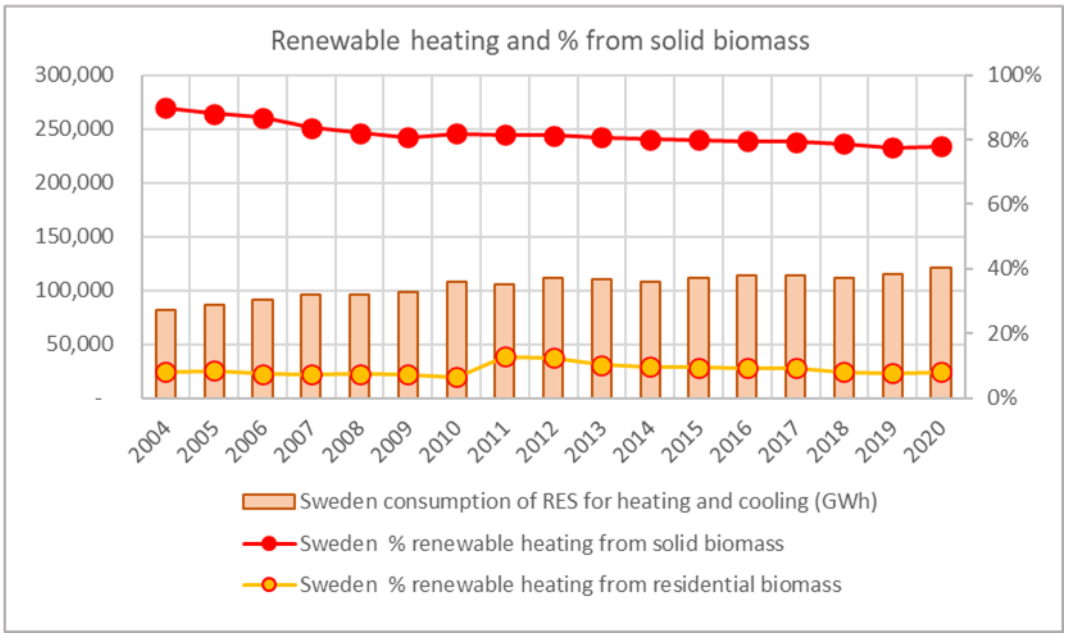


These data do not reflect the relatively large loss in the forest and carbon sink recently reported by government researchers, as explained above.




Total RE consumption and % from solid biomass
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Sweden consumption of RES in transport (GWh)
Sweden consumption of electricity from RES (GWh)
Sweden consumption of RES for heating and cooling (GWh)
Sweden % total RES from solid biomass
Sweden % total RES from residential biomass


Renewable electricity and % from solid biomass
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Sweden consumption of electricity from RES (GWh)
Sweden % renewable electricity from solid biomass


Renewable heating and % from solid biomass
300,000
250,000
200,000
150,000
100,000
50,000
-
100%
80%
60%
40%
20%
0%
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Sweden consumption of RES for heating and cooling (GWh)
Sweden % renewable heating from solid biomass
Sweden % renewable heating from residential biomass

Endnotes

[i] https://forestdefenders.eu/wp-content/uploads/2022/10/MS-salvage-logging-data-DataPortal_annotated.xlsx
[ii] https://eng.mst.dk/air-noise-waste/air/air-pollution-from-stoves/how-to-improve-wood-burning-in-denmark/
[iii] Denmark's full dataset as reported in 2022 can be downloaded at https://unfccc.int/documents/461946.
[iv] Page 20 at https://bit.ly/3TPaORl; original data at https://envir.ee/media/5111/download
[v] https://stat.fi/julkaisu/cktlew2c03aln0a515eyjyxe8
[vi] https://forestdefenders.eu/wp-content/uploads/2022/10/MS-salvage-logging-data-DataPortal_annotated.xlsx
[vii] https://forestdefenders.eu/wp-content/uploads/2022/10/MS-salvage-logging-data-DataPortal_annotated.xlsx
[viii] https://unfccc.int/documents/611860
[ix] "Poland has achieved its 2020 RES target thanks to improved statistics" https://wysokienapiecie.pl/43415-polska-osiagnela-cel-oze-na-2020-dzieki-poprawie-statystyki/
[x] https://forestdefenders.eu/wp-content/uploads/2022/10/MS-salvage-logging-data-DataPortal_annotated.xlsx