

ISSUE PAPER

BURNOUT: E.U. CLEAN ENERGY SUBSIDIES LEAD TO FOREST DESTRUCTION

Addressing our climate emergency requires every country to immediately and dramatically reduce, and then quickly eliminate, its use of fossil fuels such as coal, oil, and gas. Disturbingly, however, many countries in the European Union are replacing fossil fuels with biomass energy. “Biomass energy,” or “bioenergy,” is a catch-all term that refers to the burning of many different types of plant matter—such as trees and forestry residues—as fuel.



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Enviva's Northampton, North Carolina wood pellet manufacturing facility.

Research has shown that cutting down trees and burning them for electricity is a dirty and destructive practice. Burning forest biomass releases large amounts of climate-warming pollution into the atmosphere and destroys crucial carbon-capturing ecosystems, setting us back decades in the fight against climate change right when we most need to be moving forward with urgency.^{1,2} (See Box 1.) But the European Union has erroneously decided to categorize biomass energy as a form of renewable energy and treats biomass as “carbon neutral.”³ That effectively places it on par with solar or wind. On top of that, E.U. member states are providing huge financial subsidies to incentivize this practice. In some member states, biomass energy subsidies now make up a large share of all subsidies available to renewable energy sources.

Biomass is burned for multiple energy uses, including for residential and district heating and for industrial uses. Bioenergy used for residential and district heating is often small in scale and dispersed, and industry can rely on burning waste products like sawdust. Most subsidies, however, are directed toward burning biomass in power plants for electricity and for combined heat and power (CHP) generation.⁴ This usage is particularly destructive for our environment and climate because it generally relies on trees and other biomass taken from forests. This report is focused primarily on this type of bioenergy.

This report is based on research from the consulting firm Trinomics.⁵ It provides the most comprehensive and up-to-date assessment of government subsidies and other forms of financial support offered to biomass energy producers in the European Union.⁶ We focus on the 15 E.U. member states most heavily reliant on bioenergy and cover the period from 2015 to 2018.⁷ The Technical Appendix contains Trinomics’ full report, including a detailed description of methods, analyses, and results.

In 2017 the 15 E.U. member states included in this assessment spent more than €6.5 billion to directly subsidize bioenergy. More than half these subsidies were paid out in just two countries: Germany and the United Kingdom.

The United Kingdom not only is a top subsidizer of bioenergy but relies most heavily on the most damaging type: burning forest biomass for pure electricity production.⁸ Neither France nor the Netherlands currently dedicates a significant share of total renewable energy subsidies to biomass. However, with massive new subsidy payouts recently approved by the Dutch government and a high-profile conversion of a coal plant to burn forest biomass in France, both countries are at serious risk of compromising their climate goals by locking in dirty bioenergy infrastructure for years to come.^{9,10}

Additionally, it is worth noting that hidden subsidies in the form of energy tax exemptions or carbon tax exemptions are granted to E.U. bioenergy producers under the false assumption of biomass “carbon neutrality.” In some instances the value of these exemptions exceeds that of the subsidies evaluated in this report. In Denmark, for example, these hidden subsidies totalled nearly 1 billion euros in 2017.

Burning trees for electricity is not renewable and not a viable climate solution. Critically, no E.U. member state has formally ruled out burning forest biomass for electricity in the future. That can and should change before we publish our next assessment. In the coming years, we hope and expect that in E.U. countries where massive biomass industry subsidies have become entrenched, such as the United Kingdom, policymakers will redirect this financial support toward genuinely zero-emitting and renewable energy sources like solar and wind. Countries considering new policies and incentives to replace aging fossil fuel-based energy infrastructure, both inside and outside the European Union, must rule out incentives for burning forest biomass instead of or alongside coal.

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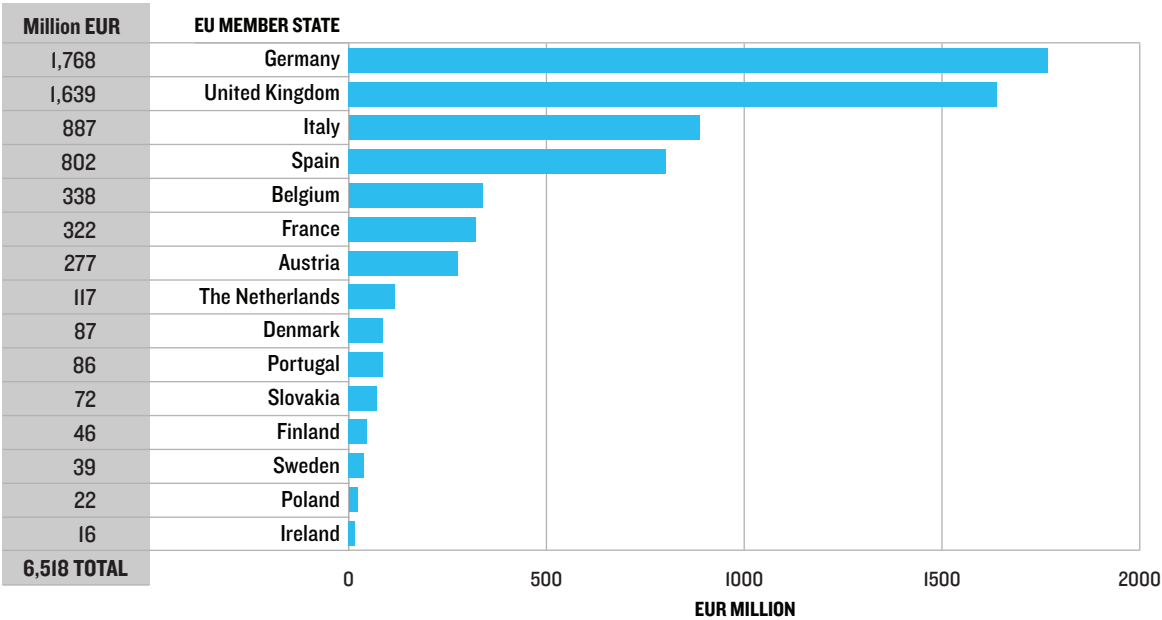


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KEY FINDINGS

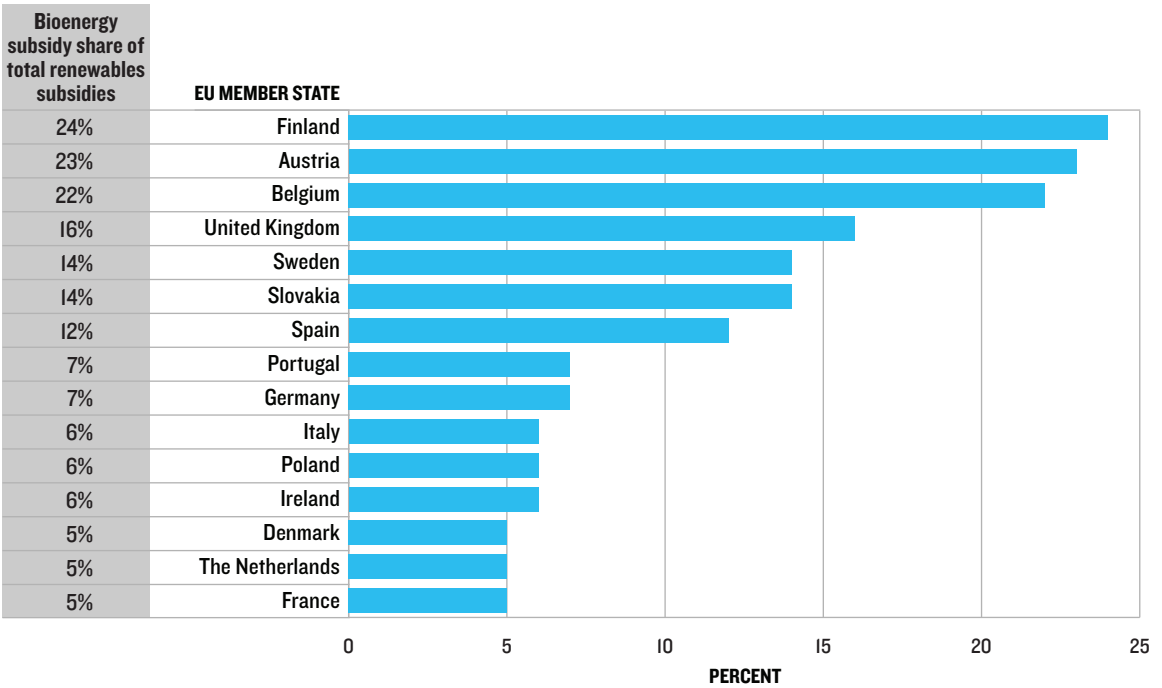
1. In 2017, Germany and the United Kingdom spent more than €1.7 billion and €1.6 billion, respectively, subsidizing the burning of biomass for energy, roughly twice as much as each of the next-highest bioenergy subsidizers, Italy and Spain. Together Germany and the United Kingdom accounted for half the bioenergy subsidies awarded for the year across all 15 E.U. member states assessed (Figure 1).

FIGURE 1: BIOENERGY SUBSIDIES IN 2017 (EUR MILLION)



2. Finland, Austria, Belgium, and the United Kingdom spent the greatest share of their overall renewable energy subsidies on bioenergy, followed by Sweden, Slovakia, and Denmark (Figure 2). Meant to promote clean, renewable energy, these subsidies were essentially wasted.

FIGURE 2: BIOENERGY SUBSIDIES AS A SHARE OF TOTAL RENEWABLE ENERGY SUBSIDIES (%) IN 2016

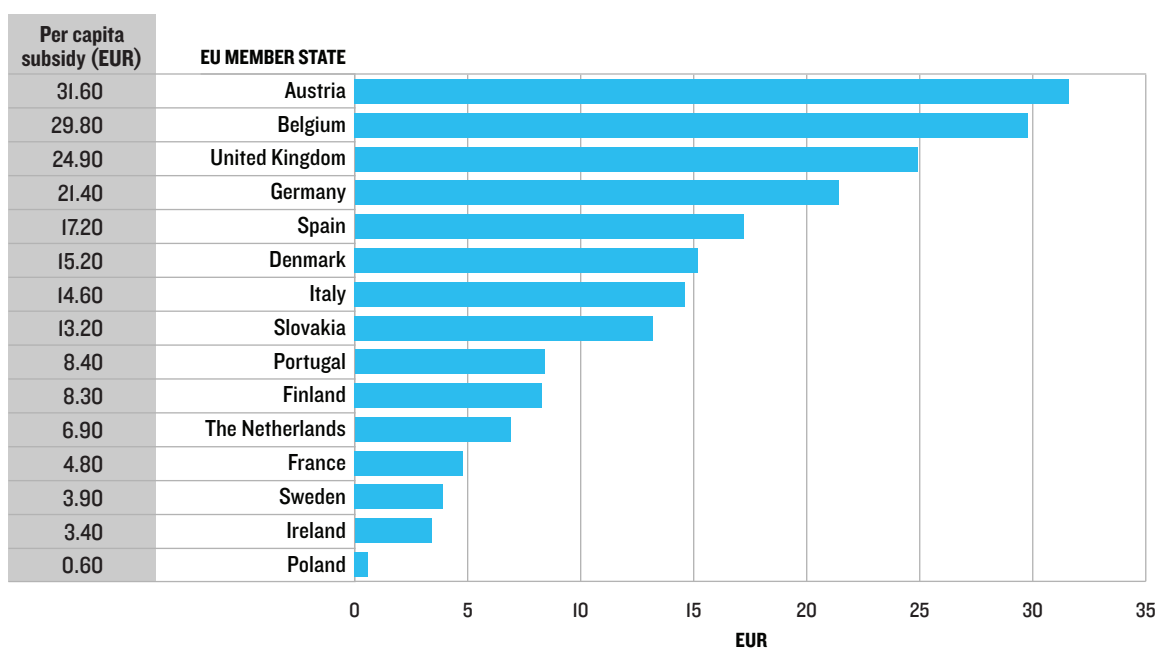


Excluded in the figures above are general energy tax exemptions for biomass. Denmark stands out in granting nearly €1 billion in such hidden subsidies to the bioenergy industry (Table 1). The Technical Appendix contains a detailed explanation in the section titled “Hidden subsidies and carbon neutrality.”

TABLE 1: TAX EXEMPTIONS IDENTIFIED BUT EXCLUDED FROM THE ANALYSIS (2017)				
COUNTRY	TAX EXEMPTION NAME	SUBSIDY VALUE (EUR MILLION)		
		2015	2016	2017
Denmark	Energy tax exemption	806	863	989
Poland	Exemption on excise duty for electricity generation renewables (Stawki podatku akcyzowego)	43	32	25
Sweden	Energy tax act (Energiskatt)	290	328	296

3. Austria spent the most on biomass subsidies per capita in 2017, followed closely by Belgium and the United Kingdom (Figure 3).

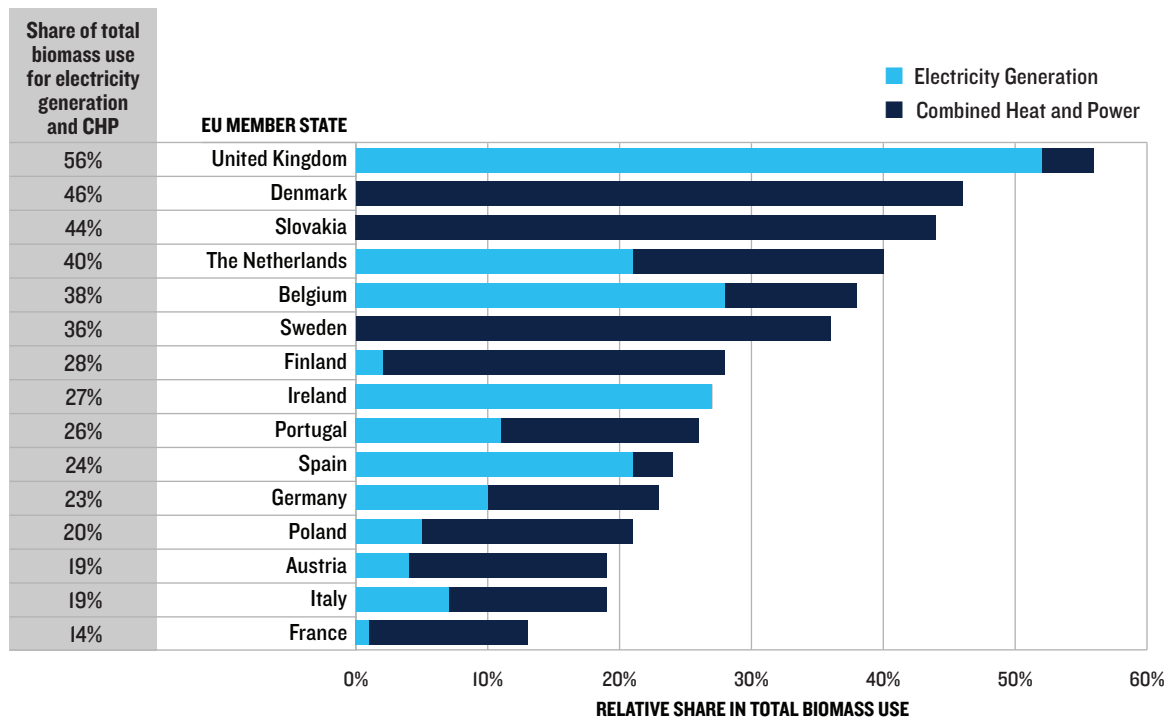
FIGURE 3: PER CAPITA BIOENERGY SUBSIDIES IN 2017 (EUR)



4. No country relies more heavily on the worst form of bioenergy than the United Kingdom (Figure 4). Unlike other E.U. member states, *more than half* of total solid biomass use in the United Kingdom in 2017 was for electricity generation in power plants, which relies primarily on burning the most carbon-intensive type of biomass (e.g., trees and other vegetation taken directly from forests) in the least efficient way (see Box 2).

When biomass burned for combined heat and power (CHP) is considered alongside dedicated electricity-only generation, Denmark, Slovakia, the Netherlands, Belgium and Sweden are also heavy biomass users. CHP plants make more efficient use of biomass fuel by utilizing both the electricity and the heat from burning biomass. As a result, biomass use for CHP generation tends to be less carbon-intensive per unit of energy.¹¹ However, a shift to burning biomass for CHP does not alleviate all—or even most—concerns regarding biomass subsidies. Biomass harvest from forests—regardless of the facility in which it is burned—will almost certainly result in a lasting carbon debt by reducing forest carbon stocks (see Box 1). Additionally, efficiency requirements tied to CHP subsidies vary dramatically from country to country and depending on the size of the facility, and data on CHP plant efficiencies are often not readily available. These efficiency requirements can be challenging to enforce, and there is scope for fraud.¹²

FIGURE 4: SHARE OF TOTAL SOLID BIOMASS USE FOR ELECTRICITY GENERATION IN POWER PLANTS AND FOR COMBINED HEAT AND POWER IN 2017 (%)



BOX I: WOOD-FUELED BIOENERGY WORSENS CLIMATE CHANGE AND DEGRADES FORESTS

BURNING FOREST BIOMASS INCREASES HEAT-TRAPPING CO₂ IN THE ATMOSPHERE

Per unit of electricity, all biomass power plants emit more CO₂ from their stacks than coal plants do, whether they burn biomass in the form of whole trees or harvest residues.¹³ This means that bioenergy, which the European Union treats as “carbon neutral,” actually increases atmospheric CO₂ levels.

Proponents of bioenergy argue that forest regrowth negates this harmful impact on our climate. That is simply not true, even under the best-case scenario in which logged trees are immediately replaced with saplings.¹⁴ This is for three reasons:

1. Older trees have been shown to sequester CO₂ at a higher rate, so a permanent carbon debt is created when an older and larger tree is replaced with a sapling. Not only will it take years (likely decades) for the new tree to reach the size of the felled one, but during that time the

now felled tree would have grown even larger if it had been left in place.¹⁵ This is often referred to as the “forgone sequestration” caused by additional biomass harvest in the forest.¹⁶ It means that biomass harvest reduces a forest’s store of carbon over the long run, compared with what it would be without the additional demand for wood.

2. It is difficult to ensure that harvested trees will be replaced and kept intact.

3. Forest harvesting also releases carbon from the soil.¹⁷

Together, this means that harvesting wood for energy has an immediate and negative impact on the climate, with consequences that can persist for decades or even centuries.¹⁸ Even when biomass energy is generated by burning genuine forestry residues—the leftovers from logging operations, like tree tops and limbs—the result is increased CO₂ in the atmosphere over several decades. This is not compatible with the speed at which countries must cut climate emissions to meet their climate targets under the Paris Agreement or limit global warming to 1.5 degrees Celsius.¹⁹

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In February 2017, the U.K.-based think tank Chatham House challenged the fundamental assumption underlying European renewable energy policy: that burning forest biomass to produce electricity is a “carbon neutral” alternative to fossil fuel use. Its seminal report concludes, “In most circumstances, comparing technologies of similar ages, the use of woody biomass for energy will release higher levels of emissions than coal and considerably higher levels than gas.”²⁰

A subsequent study by the European Academies Science Advisory Council, which represents the consensus views of the national science academies of all E.U. member states, echoed these conclusions.²¹ It warns that E.U. policies are currently biased toward the use of forest biomass, which can release significantly more CO₂ per unit of electricity than fossil fuels over long time frames. The authors express concern that allowing biomass energy to be counted as “carbon neutral” or “zero emissions” gives a false impression of a country’s progress toward reducing climate pollution. The study also states that compared with solar and wind energy, biomass energy does a poor job of reducing CO₂ in the atmosphere and that subsidies for renewables should reflect this.



BIOMASS ENERGY THREATENS FORESTS AND WILDLIFE

Despite the biomass industry’s claims that it sources wood “sustainably,” on-the-ground investigations by media and independent watchdogs over the past decade have exposed the ecologically damaging logging practices—including the clearcutting of iconic wetland forests—used in the United States to source wood for pellets exported by Enviva, the world’s largest wood pellet manufacturer.²² Significant and troubling evidence shows that biomass headed for the E.U. energy market comes from the logging of mature hardwood forests in places like the U.S. Southeast. The investigations also spotlight the vast quantities of whole trees and other large-diameter wood—biomass feedstocks most damaging to the climate—that are entering the industry’s supply chain. Enviva’s pellets are shipped to E.U. power companies, such as Drax Power in the United Kingdom and Ørsted in Denmark.²³

These unsustainable sourcing practices not only destroy carbon stocks but also damage biodiversity in the North American Coastal Plain, a region designated as a global biodiversity hot spot.²⁴

DISCUSSION AND RECOMMENDATIONS FOR E.U. MEMBER STATES

In 2018 the E.U. Parliament had an opportunity to meaningfully reform its policy on biomass energy through an updated Renewable Energy Directive (RED), which mandates renewable energy targets, among other things, within the European Union. Unfortunately, even when faced with mounting evidence that burning biomass for electricity exacerbates climate change and that a massive spike in E.U. demand for biomass was putting some of the world’s most biodiverse and precious forests at risk, European policymakers failed to enact stricter regulation that would have ruled out subsidies for the most carbon-intensive and environmentally damaging forms of biomass burning.



Ørsted Studstrup Power Station in Studstrup, Denmark.

A silver lining of the new RED is that it does allow individual E.U. member states to adopt stronger biomass sustainability standards at the national level. Member states have until December 31, 2019, to develop their National Energy and Climate Plans (NECPs), in which they can lay out a vision of their own clean energy futures. For countries heavily reliant on biomass energy, this must include an immediate shift away from burning forest biomass and toward genuinely zero-emitting and renewable energy sources like solar and wind. And for those considering how best to replace aging fossil fuel energy infrastructure, policies like coal phaseout are urgency needed within NECPs but must not result in new incentives for burning biomass instead of or alongside coal.

Specifically, E.U. member states must:

- Immediately end allocations of any future subsidies for burning forest biomass in power plants that do not use cogeneration technology to produce heat alongside electricity. This includes:
 - ending subsidies for coal-to-biomass conversions;
 - ending subsidies for biomass co-firing with coal; and
 - ending subsidies for new, dedicated biomass-burning power plants.
- Wherever possible, immediately phase out existing subsidies for biomass electricity and redirect savings to genuinely zero-emitting and renewable alternatives, such as solar, wind, and tidal energy.
- For all other bioenergy uses, including for CHP, ban the use of the most carbon-intensive and least sustainable biomass sources, such as whole trees and other large-diameter roundwood, limiting biomass fuel to true wastes and industrial residues. Here, recent reforms enacted in Slovakia can serve as an E.U.-wide model.²⁵
- In their NECPs, limit plans for biomass to what is realistic under the above limitations. In most cases, this means a drastic reduction in reliance on bioenergy from current draft plans.
- Create a supportive policy environment that drives rapid investment in genuinely clean and renewable energy sources, such as solar and wind, energy efficiency, smart resources such as battery storage and demand-side response innovations, and forest conservation.

BOX 2: THE UNITED KINGDOM MUST END EXISTING BIOMASS SUBSIDIES AND REDIRECT FUNDS TO SOLAR AND WIND

No country burns more biomass for dedicated electricity generation than the United Kingdom (Figure 5). Today, more than one-fifth of what the U.K. government treats as renewable energy comes from forest biomass burned in power plants.

Further, the United Kingdom spends the most in subsidies per unit of biomass energy generated (Figure 6). Most U.K. biomass subsidies go to a single company, Drax Power, which operates the world's largest coal-to-biomass conversion project at Drax Power Station. In 2016, Drax imported and burned more wood than the United Kingdom produced.²⁶ U.K. biomass subsidies to Drax total more than £2 million per day despite controversy about the company's impacts on the climate and forests.²⁷ Without reforms, the United Kingdom will continue to waste billions on biomass subsidies for nearly another decade when current subsidies expire in 2027.

FIGURE 5: BIOMASS BURNED TO GENERATE ELECTRICITY IN POWER PLANTS (EXCLUDING CHP)

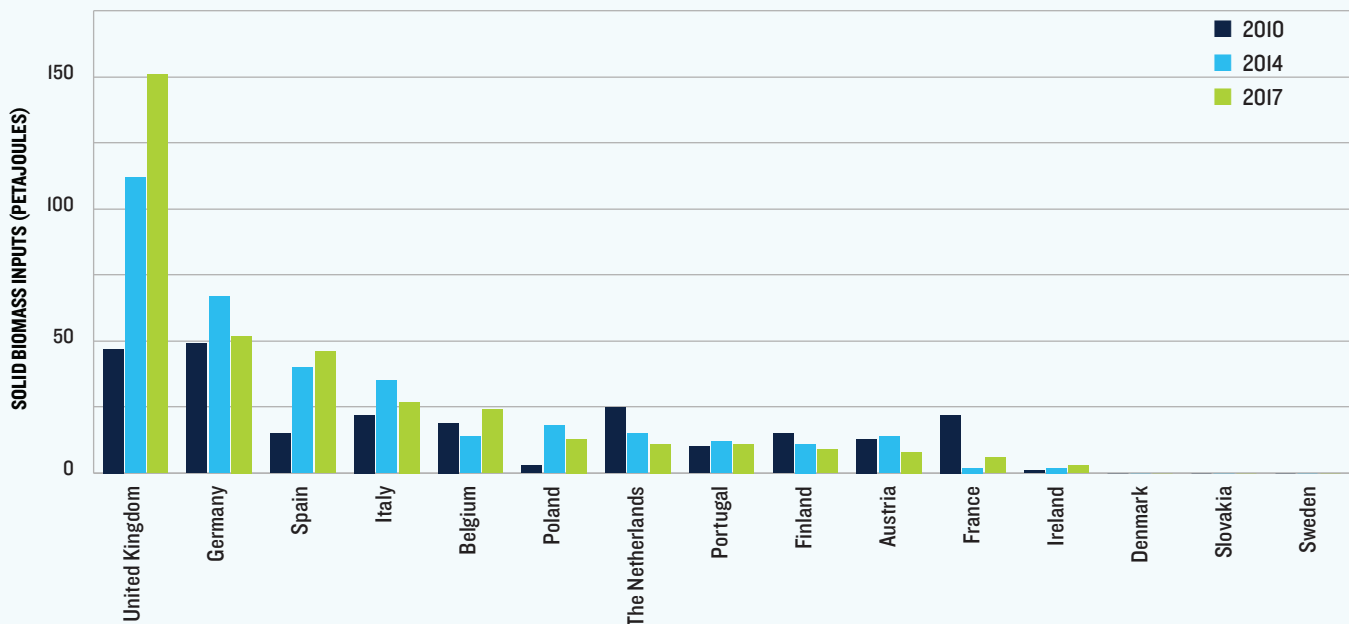
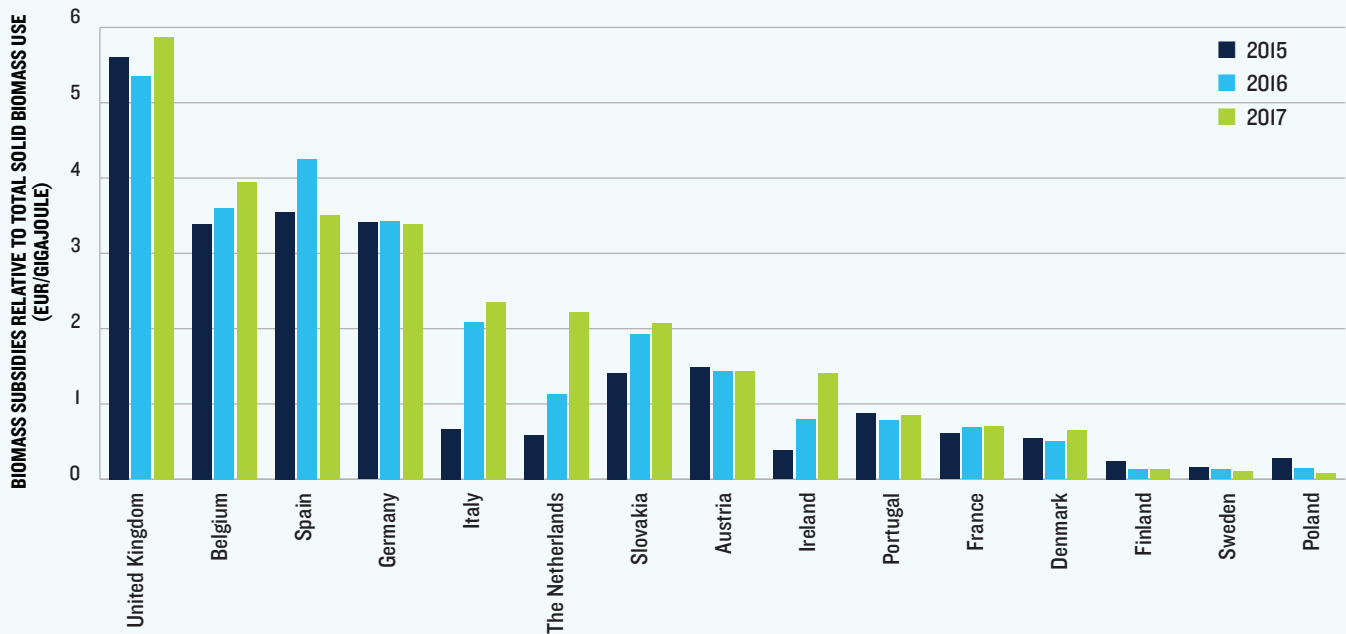


FIGURE 6: SUBSIDIES PER UNIT OF BIOENERGY GENERATED



Aside from the environmental ramifications, coal-to-biomass conversions are uneconomical compared with genuine clean energy alternatives and unnecessary for the United Kingdom's power needs. A 2017 analysis of the U.K. power sector found that by 2025, Drax's existing biomass plants will be more expensive to operate than building completely new solar and wind capacity, even when fully accounting for the costs of integrating solar and wind into the grid.²⁸ Moreover, because biomass conversion is a mature technology, comparatively little cost reduction can be expected in the future, whereas solar and wind prices continue to plummet. Finally, a 2018 study concluded that in 2030 the United Kingdom can meet year-round electricity demand with a grid dominated by solar and wind and having no biomass, even under the most challenging conditions of the year.²⁹

What's worse, biomass electricity is just as much of a climate threat as fossil fuels; Drax's biomass plants actually emit more carbon than coal-fired plants.³⁰ The wood pellet mills that supply Drax release dangerous pollution into the air, including particulate matter associated with a range of public health harms.³¹ So do power plants like Drax Power Station when they burn the pellets.³²

In its 2018 report *Biomass in a Low-Carbon Economy*, the U.K. government's climate adviser, the Committee on Climate Change (CCC), noted that "the production of some biomass feedstocks could lead to larger net GHG emissions than fossil fuel alternatives."³³ The CCC has advised the U.K. government to end support for large-scale biomass electricity projects, stating that "over the next decade Government policies should only support biomass use where this . . . provides cost-effective abatement whilst avoiding 'lock-in' to sub-optimal uses." Meanwhile, in a 2018 progress report on reducing the U.K.'s climate emissions, the CCC lamented that "low-cost, low-risk options to reduce emissions," such as onshore wind, "are not being supported by Government," which it said "penalizes the consumer."



Drax Power Station in Selby, United Kingdom.

At long last, the U.K. government itself appears to be recognizing that burning biomass in power plants is dirty, costly, and unnecessary. In 2018 the nation set a new, lower greenhouse gas emissions threshold for biomass power plants supported by its current renewable energy subsidy scheme, known as Contracts for Difference. Then, in 2019, it said no other plants like Drax's coal-to-biomass conversions will qualify for subsidies.³⁴ But the government also created a giant loophole for existing biomass plants, most notably for Drax, and maintains it will continue paying out existing biomass subsidies until 2027.

The United Kingdom must go further and immediately sunset existing biomass subsidies under its previous subsidy program, known as the Renewables Obligation Certificates scheme, and redirect funds to cheap, clean, and reliable energy sources like solar and wind.

COUNTRY-SPECIFIC RECOMMENDATIONS



AUSTRIA

RECOMMENDATION:

In 2017 nearly one-quarter of all renewable energy subsidies in Austria went to biomass energy, and the country had the highest per capita subsidies for biomass. Austria must urgently phase out existing biomass subsidies and redirect funds to genuinely zero-emitting and renewable forms of energy.



BELGIUM

RECOMMENDATION:

Until recently Belgium was heavily reliant on burning biomass for electricity. However, since 2017 wood-fueled bioenergy has come under intense scrutiny, and multiple high-profile biomass projects have been canceled (this was not captured in our analysis, likely due to a lag in public data availability).³⁵ Belgium should continue to phase out existing subsidies for biomass electricity, redirecting funds to solar and wind.



DENMARK

RECOMMENDATION:

Denmark is second only to Finland in terms of the share of gross electricity generation supplied by bioenergy (see Trinomics Figure 4-4 in Technical Appendix). Denmark must phase out these subsidies and end any incentives for the conversion of power plants from coal and gas to biomass.



FINLAND

RECOMMENDATION:

In Finland biomass electricity supplies the largest share of gross electricity generation of the 15 case study countries (see Trinomics Figure 4-4 in Technical Appendix). Finland also spends the largest share of its total renewable energy subsidies on biomass energy. It must end this addiction to biomass burning for electricity and switch to genuinely zero-emitting and renewable forms of energy.



FRANCE

RECOMMENDATION:

France does not currently rely heavily on biomass electricity. The French government must reject plans to extend the life of a coal-fired power plant at Cordemais by converting it to burn wood pellets, as well as any similar projects in the future.



GERMANY

RECOMMENDATION:

Germany does not subsidize biomass plants with capacities greater than 20 MW.³⁶ This restriction must stay in place. In the context of the country's coal phaseout plan, the government must also rule out coal-to-biomass conversions, through either direct subsidies or carbon pricing that could act as an indirect driver.



IRELAND

RECOMMENDATION:

Ireland has been relying heavily on peat burning for bioenergy.³⁷ This practice is as dangerous for the climate as burning wood and must be ended. At the same time, neither peat nor coal burning should be replaced with burning forest biomass in the future.



ITALY

RECOMMENDATION:

Italy ranks third in total spending on bioenergy subsidies. These generous subsidies should be redirected to genuinely zero-emitting and renewable energy sources.



NETHERLANDS

RECOMMENDATION:

In the past, bioenergy has played a relatively minor role in electricity generation in the Netherlands. However, massive new subsidy payouts—particularly for biomass co-firing (burning biomass together with coal)—have been approved by the Dutch government, and the Netherlands is in danger of locking in years of dirty energy. Further, the country's reliance on wood pellets imported from Russia, the Baltics and, increasingly, North America threatens ecologically sensitive forests in regions like the U.S. Southeast.³⁸

**POLAND****RECOMMENDATION:**

Biomass currently plays a minor role in Poland's energy mix, but there is a danger of big coal-to-biomass conversions. The Polish government must commit to reducing its reliance on coal but not via increased subsidies for burning forest biomass.

**PORTUGAL****RECOMMENDATION:**

As Portugal plans for coal phaseout, coal-to-biomass conversions cannot be an alternative.

Investment in genuinely zero-emitting and renewable energy sources, such as decentralized solar, must be prioritized. Where bioenergy is subsidized, incentives must be tied to meaningful efficiency requirements, favoring CHP.

**SLOVAKIA****RECOMMENDATION:**

In 2016 a relatively high percentage of Slovakia's renewable subsidies went to bioenergy. However, the country passed a law in 2018 under which only the combustion of genuine forestry residues and waste from wood-processing industries will be eligible for subsidies.³⁹ The law is now in place, and it is crucial that it be properly enforced.

This legislation could become a positive blueprint for other E.U. countries.

**SPAIN****RECOMMENDATION:**

Spain is fourth in total spending on bioenergy subsidies across the 15 E.U. member states examined. In the current discussions about coal phaseout, Spain must not make the same mistakes as the United Kingdom in converting coal-fired power plants to burn wood.

**SWEDEN****RECOMMENDATION:**

Sweden uses almost no forest biomass for electricity-only generation in power plants, but it must end the practice of harvesting whole trees for CHP and other forms of bioenergy, and it must stop harvesting old growth forests for any purpose.

**UNITED KINGDOM****RECOMMENDATION:**

No country uses more biomass for electricity production or pays more subsidies per unit of bioenergy generation than the United Kingdom. The country must immediately redirect existing biomass subsidies under the Renewables Obligation Certificates scheme to genuinely zero-emitting and renewable energy sources, such as solar, wind, and wave power.

Endnotes

- 1 M. T. Ter-Mikaelian, S. J. Colombo, and J. Chen, "The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions About Forest Carbon Accounting," *Journal of Forestry* 11, no. 1 (January 2015): 57-68, <http://www.ingentaconnect.com/content/saf/jof/2015/00000113/00000001/art00009>. Sami Yassa, "Think Wood Pellets Are Green? Think Again," NRDC, May 2015, <https://www.nrdc.org/sites/default/files/bioenergy-modelling-1B.pdf>. Mary S. Booth, "Not Carbon Neutral: Assessing the Net Emissions Impact of Residues Burned for Bioenergy," *Environmental Research Letters* 13, no. 3 (February 21, 2018), iopscience.iop.org/article/10.1088/1748-9326/aaac88. Spatial Informatics Group, *The Carbon Impacts of UK Electricity Produced by Burning Wood Pellets from Drax's Three U.S. Mills*, May 27, 2019, https://www.southernenvironment.org/uploads/publications/2019-05-27_Drax_emissions_-_SIG_report_Phase_II.PDF.
- 2 Intergovernmental Panel on Climate Change, "Global Warming of 1.5 °C; Summary for Policymakers," October 2018, https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf.
- 3 Timothy Searchinger et al., "Europe's Renewable Energy Directive Poised to Harm Global Forests," *Nature Communications* 9, art. 3741 (September 12, 2018), <https://www.nature.com/articles/s41467-018-06175-4>.
- 4 Although support instruments for electricity represent only half of the 49 policy instruments identified, financial support for electricity accounted for 72–74% of the total subsidy value in the period 2015–2017. Instruments supporting any energy applications accounted for 14–15%, but this share is largely explained by a single instrument, the Danish energy tax exemption for biomass. Virtually all of the remaining instruments are aimed at supporting the production of heat from biomass. Instruments specifically supporting the use of solid biomass in combined heat and power (CHP) plants are relatively scarce; however, it is important to note that instruments that support electricity production often do not discriminate between power generation only and power generated in CHP plants, meaning that CHP installations do receive support from such instruments. Similarly, instruments supporting multiple or any use of biomass can also support CHP plants.
- 5 Trinomics B.V. is an economic policy consultancy carrying out research and delivering policy advice related to energy, environment, and climate change. See: <https://trinomics.eu/>.
- 6 Trinomics focused on the generation of electricity in power plants and electricity and heat in CHP plants from solid biomass, and on the financial support given to such activities. This included tax expenditures, direct transfers, and indirect transfers. Trinomics excluded general energy tax exemptions for biomass from its subsidy analysis, although the researchers noted that such exemptions do play a role in company investment decisions and their consideration of different energy sources. Trinomics identified a few such exemptions across the case study countries, most notably in Denmark, Poland, and Sweden. A detailed explanation of Trinomics' approach and methodology in inventorying biomass energy subsidies can be found in the Technical Appendix.
- 7 At the time of publication, data from 2018 were available for some, but not all, of the 15 E.U. member countries examined. In each instance where a comparison across countries was made, we used data from the most recent year for which complete information was available for all 15 E.U. member states.
- 8 In power plants, biomass is burned to generate electricity with an efficiency of 25–45 percent; the remainder of the energy is lost as heat. T. Walker et al., "Biomass Sustainability and Carbon Policy Study," Manomet Center for Conservation Sciences, June 2010, www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-full-hirez.pdf.
- 9 Erin Voegelé, "Dutch Biomass Consumption to Reach 2.3 Million Tons by 2020," *Biomass Magazine*, March 13, 2019, <http://biomassmagazine.com/articles/16008/dutch-biomass-consumption-to-reach-2-3-million-tons-by-2020>.
- 10 Bate Felix, "France's EDF in Race to Convert Cordemais Plant From Coal to Biomass," Reuters, March 22, 2019, <https://www.reuters.com/article/us-edf-electricity-cordemais/frances-edf-in-race-to-convert-cordemais-plant-from-coal-to-biomass-idUSKCN1R31YV>.
- 11 T. Walker et al., "Biomass Sustainability and Carbon Policy Study."
- 12 Almuth Ernstring, "Close the Big Biomass 'Combined Heat and Power' Subsidy Loopholes! Guidance Note for Policy-Makers," Biofuelwatch, August 2016, <https://www.biofuelwatch.org.uk/wp-content/uploads/Biomass-CHP-loophole-policy-briefing.pdf>.
- 13 European Academies' Science Advisory Council, "Commentary by the European Academies' Science Advisory Council (EASAC) on Forest Bioenergy and Carbon Neutrality," June 15, 2018, https://easac.eu/fileadmin/PDF_s/reports_statements/Carbon_Neutrality/EASAC_commentary_on_Carbon_Neutrality_15_June_2018.pdf. According to the council, "Carbon emissions per unit of electricity generated from forest biomass are higher than from coal and thus it is inevitable that the initial impact of replacing coal with forest biomass in power stations is to increase atmospheric carbon dioxide levels."
- 14 Spatial Informatics Group, "The Carbon Impacts of UK Electricity Produced by Burning Wood Pellets." Southern Environmental Law Center, "New Report Shows Wood Pellets From Drax's U.S. Mills Increase Carbon Emissions During the Timeframe Necessary to Address Climate Change," https://www.southernenvironment.org/uploads/publications/Biomass_Factsheet_0719_F_Pgs.pdf (accessed October 16, 2019). John Sterman et al., "Does Replacing Coal With Wood Lower CO₂ Emissions? Dynamic Lifecycle Analysis of Wood Bioenergy," *Environmental Research Letters* 13, no. 1 (January 18, 2018), <http://iopscience.iop.org/article/10.1088/1748-9326/aa512/pdf>. Duncan Brack, "Woody Biomass for Power and Heat: Impacts on the Global Climate," Chatham House, February 23, 2017, <https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/2017-02-23-woody-biomass-global-climate-brack-final2.pdf>. Sami Yassa, "Think Wood Pellets Are Green? Think Again." A. Repo et al., "Sustainability of Forest Bioenergy in Europe: Land-Use-Related Carbon Dioxide Emissions of Forest Harvest Residues," *GCB Bioenergy* 7, no. 4 (July 2015): 877-887, <https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.12179>. A. L. Stephenson, and D. MacKay, "Life Cycle Impacts of Biomass Electricity in 2020: Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK," U.K. Department of Energy and Climate Change, July 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/BEAC_Report_290814.pdf.
- 15 N. L. Stephenson et al., "Rate of Tree Carbon Accumulation Increases Continuously With Tree Size," *Nature*, March 6, 2014, <http://www.nature.com/nature/journal/v507/n7490/full/nature12914.html>.
- 16 M. T. Ter-Mikaelian, S. J. Colombo, and J. Chen, "The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions?"
- 17 D. L. Achat et al., "Forest Soil Carbon Is Threatened by Intensive Biomass Harvesting," *Scientific Reports* 5, art. 15991 (November 2015), <https://www.nature.com/articles/srep15991>. S. P. Hamburg et al., "Losses of Mineral Soil Carbon Largely Offset Biomass Accumulation 15 Years After Whole-Tree Harvest in a Northern Hardwood Forest," *Biogeochemistry* 144, no. 1 (June 2019): 1-14, <https://scholars.unh.edu/ersc/209/>. E. D. Vance et al., "Environmental Implications of Harvesting Lower-Value Biomass in Forests," *Forest Ecology and Management* 407 (January 2018): 47-56, https://www.researchgate.net/publication/322176494_Environmental_implications_of_harvesting_lower-value_biomass_in_forests.
- 18 Michael Norton et al., "Serious Mismatches Continue Between Science and Policy in Forest Bioenergy," *Global Change Biology Bioenergy* 11, no. 11 (November 2019): 1256-1263, <https://doi.org/10.1111/gcbb.12643>.
- 19 Mary S. Booth, "Not Carbon Neutral."
- 20 Duncan Brack, "Woody Biomass for Power and Heat."
- 21 European Academies Science Advisory Council, "Multi-functionality and Sustainability in the European Union's Forests," EASAC policy report 32, April 2017, https://easac.eu/fileadmin/PDF_s/reports_statements/Forests/EASAC_Forests_web_complete.pdf.
- 22 NRDC, Dogwood Alliance, and Southern Environmental Law Center, "European Imports of Wood Pellets for 'Green Energy' Devastating US Forests, June 2019, <https://www.nrdc.org/sites/default/files/global-markets-biomass-energy-06172019.pdf>.

- 23 Enviva Partners, LP, “Business Overview,” last updated August 13, 2018, https://ir.envivabiomass.com/sites/envivabiomass.investorhq.businesswire.com/files/doc_library/file/EVA_Investor_Presentation_Aug_2018_vFinal.pdf.
- 24 Critical Ecosystem Partnership Fund, “Announcing the World’s 36th Biodiversity Hotspot: The North American Coastal Plain,” February 18, 2016, cepf.net/stories/announcing-worlds-36th-biodiversity-hotspot-north-american-coastal-plain.
- 25 “MPs Stop Subsidies for Burning Healthy Wood as Biomass,” *Slovak Spectator*, December 10, 2018, <https://spectator.sme.sk/c/22005167/mps-stop-subsidies-for-burning-healthy-wood-as-biomass.html>.
- 26 Biofuelwatch, “Biomass Basics,” <https://www.biofuelwatch.org.uk/2018/biomass-basics-2/#targetText=Right%20now%2C%20Drax%20is%20the,13.2%20million%20tonnes%20of%20wood>, (accessed October 16, 2019).
- 27 Thomas Buchholz, “The Carbon Impacts of UK Electricity Produced by Burning Wood Pellets from Drax’s Three U.S. Mills,” Spatial Informatics Group, May 27, 2019, https://www.southernenvironment.org/uploads/publications/2019-05-27_Drax_emissions_-_SIG_report_Phase_II.PDF.
- 28 Sasha Stashwick, “Money to Burn II: Solar and Wind Can Reliably Supply the United Kingdom’s New Electricity Needs More Cost-Effectively Than Biomass,” NRDC, September 2017, https://assets.nrdc.org/sites/default/files/money-to-burn-ii-uk-biomass-ib.pdf?_ga=2.165636671.1426806616.1526490771-%201380781386.1517278009.
- 29 “Thermal Generation and Electricity System Reliability,” Vivid Economics, June 2018, viveconomics.com/publications/thermal-generation-and-electricity-system-reliability.
- 30 Spatial Informatics Group, “Biomass Stack Emission Estimates for Drax Power Plants in the UK 2013–2017,” March 1, 2017, https://www.southernenvironment.org/uploads/publications/SIG_Drax_stack_emission_calculations_2017-03-01_final.pdf.
- 31 Environmental Integrity Project, “Report Finds Rapidly Growing ‘Green’ Energy Industry Releases Dangerous Air Pollution,” April 26, 2018, <http://www.environmentalintegrity.org/news/biomass-report/>. Environmental Integrity Project, “Louisiana Orders Wood Pellet Plant to Install Air Pollution Controls,” February 5, 2019, <https://www.environmentalintegrity.org/news/louisiana-orders-wood-pellet-plant-to-install-air-pollution-controls/>.
- 32 Letter from the American Lung Association et al. to members of the U.S. Congress, September 13, 2016, <https://www.lung.org/assets/documents/advocacy-archive/health-organizations-letter-biomass.pdf>. U.K. Department for Environment Food & Rural Affairs, “Clean Air Strategy 2019,” January 14, 2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf.
- 33 U.K. Committee on Climate Change, “Reducing UK emissions—2018 Progress Report to Parliament,” June 28, 2018, <https://www.theccc.org.uk/publication/reducing-uk-emissions-2018-progress-report-to-parliament/>.
- 34 U.K. Department for Environment Food & Rural Affairs, “Clean Air Strategy 2019.”
- 35 Energy Outlook, “Biomass for Power Generation: Belgium Policy Update,” May 29, 2017, <http://energy.sia-partners.com/20170529/biomass-power-generation-belgium-policy-update>.
- 36 Bundesministerium der Justiz und für Verbraucherschutz, “Erneuerbare-Energien-Gesetz—EEG 2017,” July 21, 2014, last amended May 13, 2019, https://www.gesetze-im-internet.de/eeg_2014/BJNR106610014.html.
- 37 Emily Toner, “Power From Peat—More Polluting Than Coal—Is on Its Way Out in Ireland,” *Science Magazine*, December 12, 2018, <https://www.sciencemag.org/news/2018/12/power-peat-more-polluting-coal-its-way-out-ireland>.
- 38 Bob Flach, “The Dutch Industrial Market for Biomass,” USDA Foreign Agricultural Service, February 2, 2019, https://gain.fas.usda.gov/Recent%20GAIN%20Publications/The%20Dutch%20Industrial%20Market%20for%20Biomass_The%20Hague_Netherlands_2-5-2019.pdf.
- 39 “MPs Stop Subsidies for Burning Healthy Wood as Biomass,” *Slovak Spectator*, December 10, 2018, <https://spectator.sme.sk/c/22005167/mps-stop-subsidies-for-burning-healthy-wood-as-biomass.html>.



Financial support for electricity generation and CHP from solid biomass

Final Report

Contract details

Natural Resources Defense Council

Financial support for electricity generation and CHP from solid biomass

Presented by

Trinomics B.V.

Westersingel 34

3014 GS Rotterdam

The Netherlands

Contact

Matthew Smith

T: 0031 6 1292 9246

E: matthew.smith@trinomics.eu

Authors

Matthew Smith, Tycho Smit (Trinomics)

Ann Gardiner

Date

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*Financial support for electricity generation
and CHP from solid biomass*

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Glossary

Terms

Biomass—Organic material of nonfossil origin, including much organic waste. Can be converted into bioenergy through combustion, either directly or via derived products.

Solid biomass—Biomass used in the generation of bioenergy. In energy statistics there are five types of solid biomass, namely fuel wood, black liquor, bagasse, animal waste, and vegetal waste.

Combined heat and power (CHP)—Electricity-generating installations where the waste heat is collected and utilized to serve heat demand.

Feed-in tariff (FIT)—A form of operational support whereby energy producers receive a fixed amount of money per unit of energy produced, regardless of energy market prices.

Feed-in premium (FIP)—A form of operational support whereby a subsidy is given on top of the market price. Fixed FIPs provide a fixed amount of subsidy. With sliding FIPs, the level of subsidy depends on the market price; it is often the difference between the costs of energy production and the market price.

Green certificates—Certificates that are awarded by government agencies to producers of renewable energy for every MWh of renewable energy they produce. These certificates can then be used to sell green energy to end users, either directly or via energy retail companies. Green certificates are often combined with renewable energy obligations, which means that energy companies are responsible for delivering a minimum level of renewable energy, which they can attain by either receiving certificates (through renewable energy production) or buying certificates.

Energy Units

Petajoule (PJ)— 10^{15} joules, or 1 million billion joules

Gigawatt-hour (GWh)—1 million kilowatt-hours (kWh)

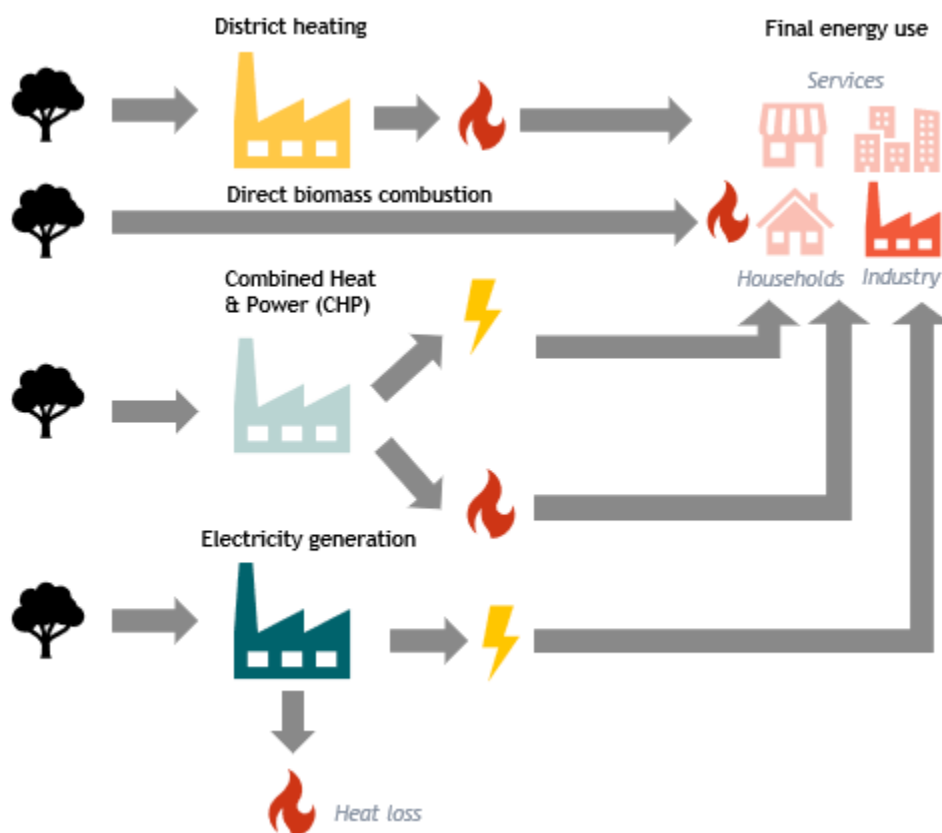
Terawatt-hour (TWh)—1 billion kilowatt-hours (kWh)

Executive summary

Introduction

This study carried out research in 15 European countries to inventory the subsidies provided to solid biomass production, investment, and demand.¹ The subsidies covered included tax expenditures (exemptions and reductions, tax allowances, tax credits, and others), direct transfers (grants, soft loans), and indirect transfers (feed-in tariffs, feed-in premiums, renewable energy quotas, tradeable certificates, and others). The work covered the period 2015 to 2018 and focused on biomass used for electricity or heat, with figure ES-1 summarizing the scope.

Figure ES-1: Illustration of the different energy uses of solid biomass considered in this study



Biomass subsidies increasing

The compilation of subsidy data across the 15 selected countries of interest leads to a total of 46 policy instruments with a total value of just over €6.5 billion in 2017 (table ES-1). Over the period 2015-2017 the total value of the subsidies for energy from solid biomass increased. The lion's share of this growth came from Italy (+645 M EUR), the United Kingdom (+255 M EUR) and the Netherlands (+88 M EUR). A large decrease (-57 M EUR) took place in Poland, relating to a reduction in the prices of green certificates. In 2018, in countries where data were available for that year, the total amount of subsidies showed a small decline from 2017 levels. However, when data from the other countries become available we expect the total to have grown again.

¹ Countries: United Kingdom (UK), Germany (DE), Netherlands (NL), Denmark (DK), France (FR), Italy (IT), Spain (ES), Poland (PL), Sweden (SE), Finland (FI), Portugal (PT), Belgium (BE), Austria (AT), Ireland (IE), and Slovakia (SK).

Table ES-1: Summary of bioenergy subsidies 2015-2018, EUR million

Country	Bioenergy subsidies (EUR million)				
	2015	2016	2017	2018	% Change 2015-2018
Group 1 (2015-2018 data)					
Germany	1,724	1,746	1,768	1,733	0%
Spain	781	948	802	864	11%
Italy	242	740	887	849	251%
Austria	283	275	277	260	-8%
Portugal	86	80	86	77	-11%
Finland	79	47	46	35	-56%
Slovakia	52	67	72	72	40%
Denmark	60	59	87	91	44.5%
Sweden	60	53	39	50	-16%
Subtotal	3,368	4,015	4,064	4,031	19.7%
Group 2 (2015-2017 data)					% Change 2015-2017
United Kingdom	1,384	1,399	1,639		18%
Belgium	279	309	338		21%
France	256	319	322		26%
The Netherlands	29	57	117		309%
Poland	79	39	22		-73%
Ireland	4	9	16		343%
Subtotal	2,031	2,132	2,454		20.9%
Total (Group 1 plus Group 2)	5,399	6,147	6,518		20.7%

Note: Some subtotals and totals may differ from the sum of individual values due to rounding.

Biomass subsidies as a share of total renewable energy subsidies

In eight of the case study countries, subsidies for energy from solid biomass represent less than 10 percent of the total financial support given to renewables. In only four countries—Finland, Austria, Belgium and the United Kingdom—does it account for more than 15 percent of the total support given to renewables. There is generally a clear correlation between the share of renewables support going to biomass and the share of biomass electricity in gross electricity generation. For the use of solid biomass in final energy consumption the correlation with government subsidies seems less pronounced. It should be noted, though, that in many countries the use of biomass for heating is less heavily taxed than the use of other energy carriers, and in many cases no energy taxes apply at all.

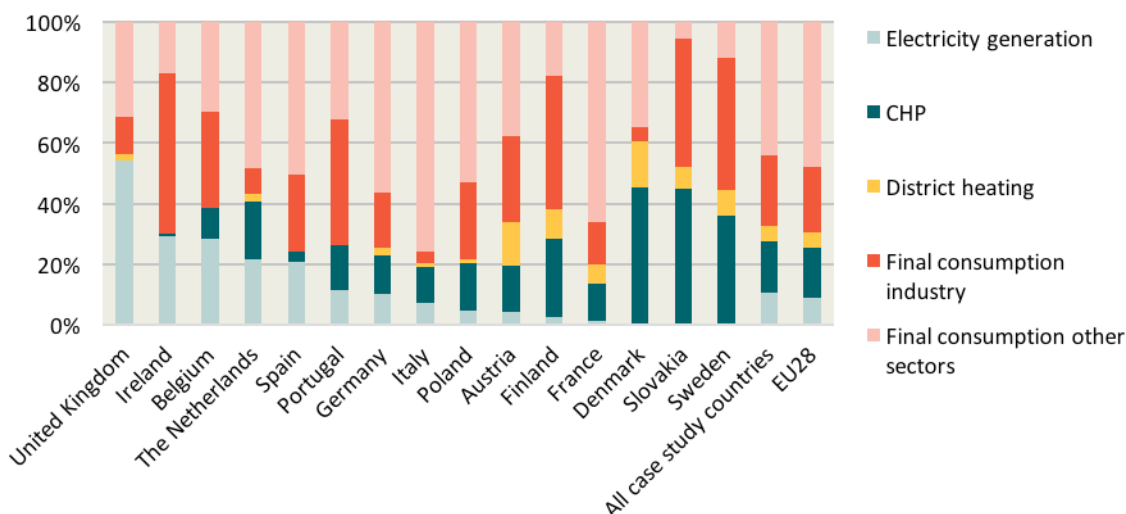
Table ES-2: Overview of the share of biomass in total renewable energy subsidies in 2015 and 2016

Country	Bioenergy subsidies (EUR million)		Renewable energy subsidies (EUR million)		Bioenergy as % of total	
	2015	2016	2015	2016	2015	2016
Finland	79	47	229	194	35%	24%
Austria	283	275	1,096	1,179	26%	23%
Belgium	279	309	1,395	1,378	20%	22%
United Kingdom	1,384	1,399	9,391	8,658	15%	16%
Sweden	60	53	381	368	16%	14%
Slovakia	52	67	474	464	11%	14%
Spain	781	948	9,261	8,179	8%	12%
Portugal	86	80	963	1,137	9%	7%
Germany	1,724	1,746	25,544	26,199	7%	7%
Italy	242	740	12,169	11,877	2%	6%
Poland	79	39	1,019	636	8%	6%
Ireland	4	9	97	160	4%	6%
Denmark	60	59	1,117	1,107	5%	5%
The Netherlands	29	57	863	1,159	3%	5%
France	256	319	5,544	6,497	5%	5%
Total	5,399	6,147	69,541	69,192	8%	9%

Uses of biomass

In the European Union, the lion's share of solid biomass consumed for energy purposes is directly used by end-use sectors. This "final energy consumption" averaged around 70 percent of all solid biomass used for energy in 2017. Of the remaining 30 percent, around 16 percent on average is used by CHP plants, 9 percent for electricity generation, and 5 percent for district heating. The picture is quite similar for the 15 countries investigated in this study (Figure ES-2), with final consumption by industry and other sectors averaging 67 percent of the total in 2017. However, the energy uses of solid biomass vary markedly from country to country. The most striking deviations from the general picture are seen in the Scandinavian countries, where a significant share of the biomass is used in CHP plants, and in some Western European countries, especially the United Kingdom, where a significant share of the solid biomass consumption is used for dedicated electricity generation.

Figure ES-2: Overview of the uses of solid biomass by consumption type in 2017



Introduction

This report is the main deliverable under a May 2019 contract with NRDC. The work was commissioned by NRDC to improve the data available on subsidies to solid biomass for energy uses. This study provides the most up-to-date and comprehensive inventory of these subsidies available.

Objective of the assignment

The objective of this assignment was to gain more insight into the support for bioenergy offered in the European Union, to put this in the context of other renewable energy subsidies, and to analyze the ways in which bioenergy is used.

Scope

This assignment focused on the generation of electricity and heat (in combined heat and power plants) from solid biomass and on the financial support that is given to such activities. We also included any subsidies that incentivized biomass production, direct consumption, or district heating using biomass. Given their direct and indirect relevance, we included subsidies to production, investment, energy demand, and energy savings. Direct subsidies supporting feedstock production were included, but indirect supports were not.

Geographically, this study focused on 15 countries: the United Kingdom (UK), Germany (DE), the Netherlands (NL), Denmark (DK), France (FR), Italy (IT), Spain (ES), Poland (PL), Sweden (SE), Finland (FI), Portugal (PT), Belgium (BE), Austria (AT), Ireland (IE), and Slovakia (SK).

Approach and methodology

The approach was a combination of data gathering from central sources and existing published work, complemented by primary data gathering by country experts for each of the 15 countries.

The work used an approach to energy subsidies based on work at the European Commission on behalf of DG Energy, the latest iteration of which was the *Study on Energy Prices, Costs and Subsidies* published in January 2019.²

Among the key methodological issues is the definition of subsidies. There is not yet an internationally agreed-on definition of what constitutes an energy subsidy. This work draws on definitions used by the Organisation for Economic Co-operation and Development, which characterizes a subsidy as “any measure that keeps prices for consumers below market levels, or for producers above market levels, or that reduces costs for consumers or producers.” This includes the following types of measures:

- **Tax expenditures** (exemptions and reductions of energy taxes, exemptions and reductions in fuel excise taxes, exemptions and reductions of taxes and levies, exemptions and reductions of VAT, tax allowances, tax credits, accelerated depreciation, free allocations under EU-ETS), deduction of investments from income taxes.
- **Direct transfers** (grants, soft loans)
- **Indirect transfers** (feed-in tariffs, feed-in premiums, interruptible load schemes, power purchase agreements, price guarantees [cost support or price regulation], renewable energy quotas, tradeable certificates, capacity mechanisms). For tradable certificates, it is noteworthy that the value of the certificates is generated in the market and not paid by a government institution, in contrast to feed-in tariffs and feed-in premiums, which are paid out by government authorities.

² Report can be accessed here: <https://publications.europa.eu/en/publication-detail/-/publication/d7c9d93b-1879-11e9-8d04-01aa75ed71a1/language-en>

These measures can constitute support to production, demand, investment, or energy savings. Support to demand was included only if it concerned specific support to biomass use. More general support for demand, such as compensations/rebates on overall energy or electricity costs for households, were not included.

Hidden subsidies and carbon neutrality

It should be noted that general **energy tax exemptions** for biomass have been excluded from the scope of this work. We decided against their inclusion due to: (1) the difficulty of identifying such ‘hidden’ exemptions, as they represent an absence of a tax rather than a subsidy as such; (2) an unclear basis for the application of these exemptions (e.g., are they intended to be applied only to specific fuels? Is an exemption explicit?); (3) the complexity of an assumption of a “base case” for the tax (e.g., at what rate would biomass be taxed?—i.e., should the rate default to the same rate that applies to fossil fuel uses, and if so, which?); (4) the resources required to make complete and robust estimates of the value of such exemptions, given the variety of potential variations in the exemption for different use cases and sectors; (5) the difficulty of producing similar values for other renewable energy sources, particularly relevant to the results in chapter 3; and (6) the distorting effect of such exemptions on subsidy totals.

At the same time, we also note that such exemptions do play a role in company investment decisions and their consideration of different energy sources.

We did identify a few such exemptions that are applied across the subject countries, and these are listed in Table 1-1. There may be other such exemptions applicable in the subject countries, but they are difficult to identify.

Table 1-1: Tax exemptions identified but excluded from the analysis

Country	Tax exemption name	Subsidy value (EUR million)		
		2015	2016	2017
Denmark	Energy tax exemption	806	863	989
Poland	Exemption on excise duty for electricity generation renewables (<i>Stawki podatku akcyzowego</i>)	43	32	25
Sweden	Energy tax act (<i>Energiskatt</i>)	290	328	296

We have also excluded **carbon tax exemptions** from the scope of subsidies covered. We recognize that this is a difficult issue, due to the assumption by most tax offices that bioenergy is carbon neutral and therefore is exempt from carbon taxes levied on other fuels, such as those levied in Sweden and Denmark. This carbon neutrality assumption is questionable³ but for the purposes of this report we have accepted it and not considered carbon tax exemptions as a subsidy relative to other fuels.

RD&D subsidies

We have excluded subsidies to research, development, and demonstration (RD&D), as these subsidies are judged not relevant to the scope of this work. While R&D plays an important role in improving bioenergy technology, reducing costs and increasing its attractiveness in the long term, there is no direct correlation between the R&D expenditures in a given year and the level of biomass use in that same year.

³ An example of such debate, in the U.S. context, can be found at <https://www.scientificamerican.com/article/congress-says-biomass-is-carbon-neutral-but-scientists-disagree/>.

Gap filling and estimation

It is often the case that subsidy values are not reported, or are only partially reported, or are aggregated with other values not relevant to this work (e.g., renewable energy as a whole, or all bioenergy including biogas and biofuels). The study team consulted with national agencies to access the best available data for the subsidy estimates, but in many cases estimation techniques were applied to derive subsidy values. The main estimation techniques were applied as follows:

- In cases where only totals for bioenergy or for all renewables were available, we used linear scaling to determine financial support, based on the share of solid biomass in that total.
- In cases where no data were available on actual expenditures on operational support, we assumed all electricity produced from solid biomass received operational support. Values could then be estimated by multiplying the subsidy rates by the production volumes.
- For investment support instruments where there were no data on the costs of individual installations or projects, we assumed that all projects had the same investment size.
- Where monetary flows were accounted in financial years deviating from calendar years, we split the financial years in two to estimate the financial flow for the calendar years, assuming the flows were equal for each month.
- We estimated the value of green certificates by multiplying the total number of awarded certificates by the price per certificate, where possible accounting for price fluctuations within a year.
- To calculate forgone tax income, we applied a weighted average tax rate, based on the remaining energy mix (excluding solid biomass), to the total solid biomass consumption volume.

Where necessary, values were converted to EUR using European Central Bank average annual exchange rates.

We include a table of individual subsidies, sources, and calculation approaches in Annex A of this report.

Support to solid biomass for energy use

This chapter presents an analysis of the data on subsidies for electricity from solid biomass.

Headline results

The compilation of subsidy data across the 15 selected countries of interest leads to a total of 46 policy instruments with a total value of just over €6.5 billion in 2017 (Table 2-1). Over the period 2015-2017 the total value of the subsidies for energy from solid biomass increased. The lion's share of this growth came from Italy (+645 M EUR), the United Kingdom (+255 M EUR) and the Netherlands (+88 M EUR). A large decrease (-57 M EUR) decrease took place in Poland, relating to a reduction in the prices of green certificates. In 2018, in countries where data were available for that year, the total amount of subsidies showed a small decline from 2017 levels. However, when data from the other countries are made available we expect the total to have grown again.

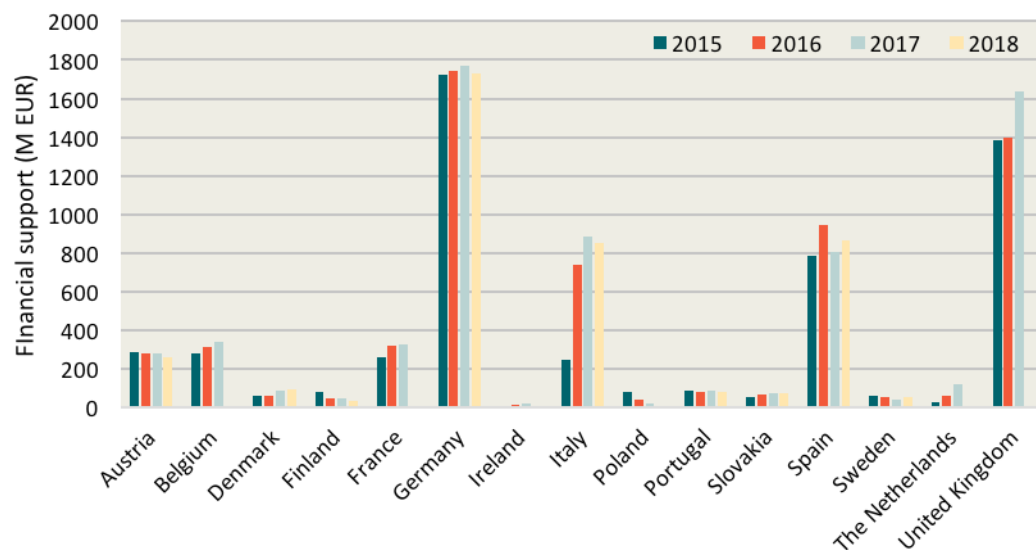
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Country	Bioenergy subsidies (EUR million)				
	2015	2016	2017	2018	Change 2015-2018
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Italy	242	740	887	849	251%
Austria	283	275	277	260	-8%
Portugal	86	80	86	77	-11%
Finland	79	47	46	35	-56%
Slovakia	52	67	72	72	40%
Denmark*	60	59	87	91	44.5%
Sweden	60	53	39	50	-16%
Subtotal	3,368	4,015	4,064	4,031	19.7%
Group 2 (2015-2017 data)					Change 2015-2017
United Kingdom*	1,384	1,399	1,639		18%
Belgium	279	309	338		21%
France*	256	319	322		26%
The Netherlands*	29	57	117		309%
Poland	79	39	22		-73%
Ireland	4	9	16		343%
Subtotal	2,031	2,132	2,454		20.9%
Total (Group 1 plus Group 2)	5,399	6,147	6,518		20.7%

* For the United Kingdom, France, Denmark, and the Netherlands, only partial data were available for 2018.

Note: Some subtotals and totals may differ from the sum of individual values due to rounding.

Figure 2-1: Development of financial support for energy from solid biomass, 2015-2018



Note: Data for 2018 were not available for all countries.

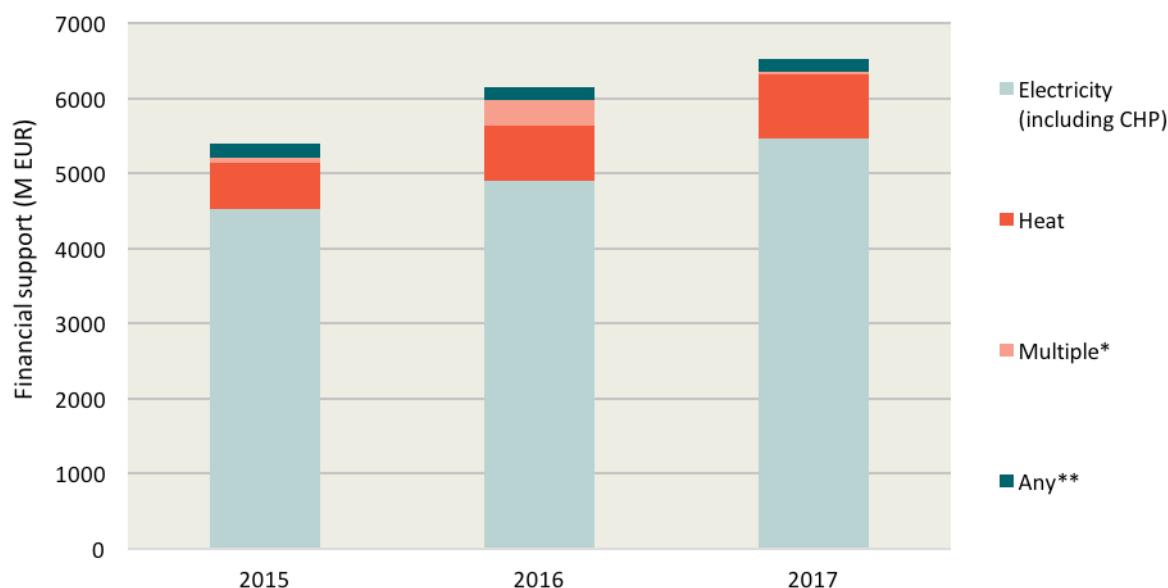
Detailed overall results

Breakdown by energy application

Although support instruments for biomass electricity represent only half of the 46 policy instruments identified, financial support for biomass electricity accounted for 79-83% of the total biomass energy subsidy value in the 2015-2017 period. Instruments supporting heat accounted for 11-13 percent of the total, and the remaining instruments were a mix of those aiming to support multiple or any uses of biomass.

Specific instruments supporting the use of solid biomass in combined heat and power (CHP) plants are relatively scarce and represent a negligible share of the total subsidy value; therefore these are shown within the electricity category in figure 2-2, below. However, it is important to note that instruments that support electricity production often do not discriminate between power generation only and CHP plants, meaning that CHP installations do receive support from such instruments. Similarly, instruments supporting multiple or any use of biomass can also support CHP plants. Some of the investment support instruments also support investments in CHP installations, but for most of those instruments the scope is broader than only CHP.

Figure 2-2: Breakdown of financial support for biomass by energy application



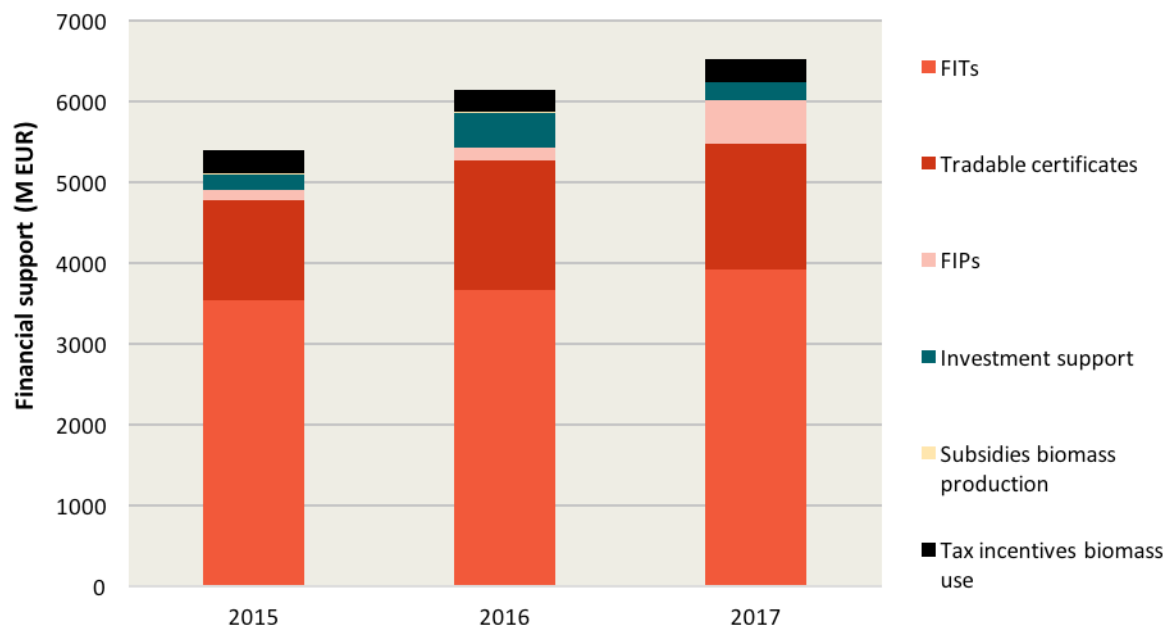
* “Multiple” refers to instruments that support different types of biomass uses. In many cases these are investment support instruments that, for example, support investment in both biomass boilers and (micro)CHP installations. ** “Any” refers to policy instruments that support the use of biomass regardless of the use. Such instruments include tax reductions for biomass use or support to biomass production.

Breakdown by type of policy instrument

Around half of the instruments (24) provide operational support, meaning that financial support is given based on the level of production. In terms of value, these instruments account for 88-92% of the financial support given in the 2015-2017 period. Direct subsidies from the government are still the most common form of operational support, with feed-in tariffs (FITs) representing 60-66% and feed-in premiums (FIPs) 2-8% of the total subsidies given. The remaining operational support takes place via tradable certificates issued by the government, which are then sold on the market. As these tradable certificates provide a financial incentive for energy production with biomass, these instruments can be seen as indirect subsidies.

Tax instruments play a significant role in the support of biomass use in Europe, representing a value of €275-296 million annually. The largest part of these come from Austria, Belgium, and Germany, which have reduced VAT tariffs for wood pellets. (As noted in chapter 1, tax exemptions for bioenergy could also be regarded as subsidies, with examples identified in Denmark, Sweden and Poland. These are not included here in aggregate subsidy values but would substantially increase the totals.) Instruments that provide financial support to investments in biomass boilers or electricity-generating installations are also significant, but more variable, accounting for €184-440 million annually over the period. Last, there are a few instruments that support the production of biomass itself by providing financial support to farmers or forestry industries; these are very small in total, providing €5-8 million annually between 2015 and 2018.

Figure 2-3: Financial support for solid biomass by type of support instrument

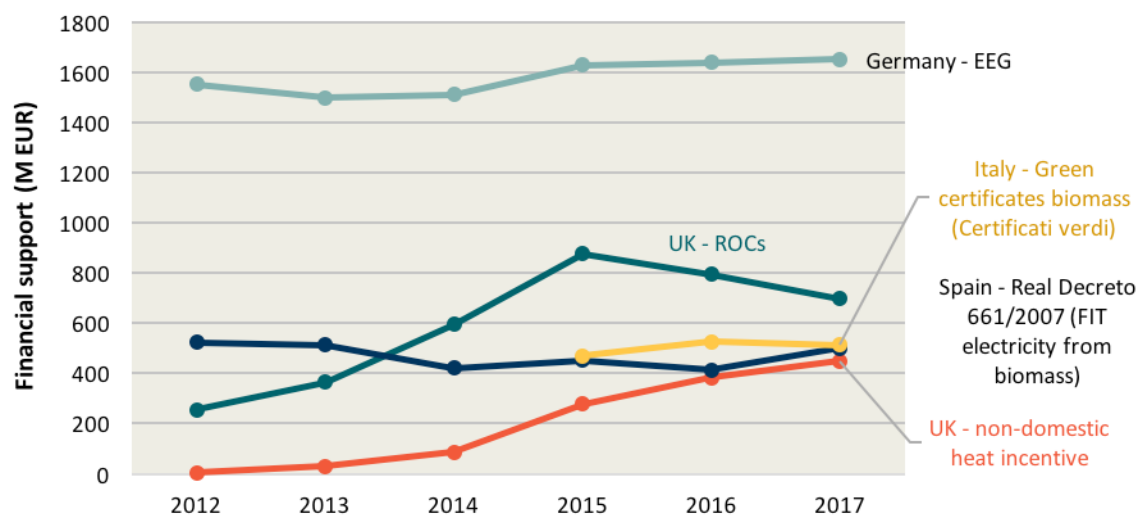


Note that all operational support instruments are indicated in pink/red colors. Additionally, two of the tax incentives for biomass use can be (partly) seen as operational support. Investment support instruments consist of a mix of investment subsidies, loans, and tax incentives.

Long-term developments in the largest instruments

To discern long-term trends in the level of financial support for biomass use for energy purposes, we analyzed the financial flows for support instruments with an annual value greater than €500 million from 2012 onward. Overall, financial support for solid biomass use is on the rise, but in the past few years growth has leveled off. In the United Kingdom, revenues from Renewables Obligation Certificates (ROCs) have decreased a little since 2015, although this is natural as the instrument is being replaced for new installations by a new subsidy policy, Contracts for Difference (CfDs). CfDs were estimated to total around €360 million in 2018, and they are increasing. While biomass is not a key component in most decarbonization strategies, many countries do still foresee a significant role of solid biomass in their future energy mix, particularly for use in retrofitted coal-fired power stations or in industry.

Figure 2-4: Development of financial support levels from 2012-2017 for the 5 largest support instruments



Note that for the green certificates scheme in Italy, data is available only for 2015-2017. Since 2015 the format of the scheme has been reformed and the way of reporting has changed.

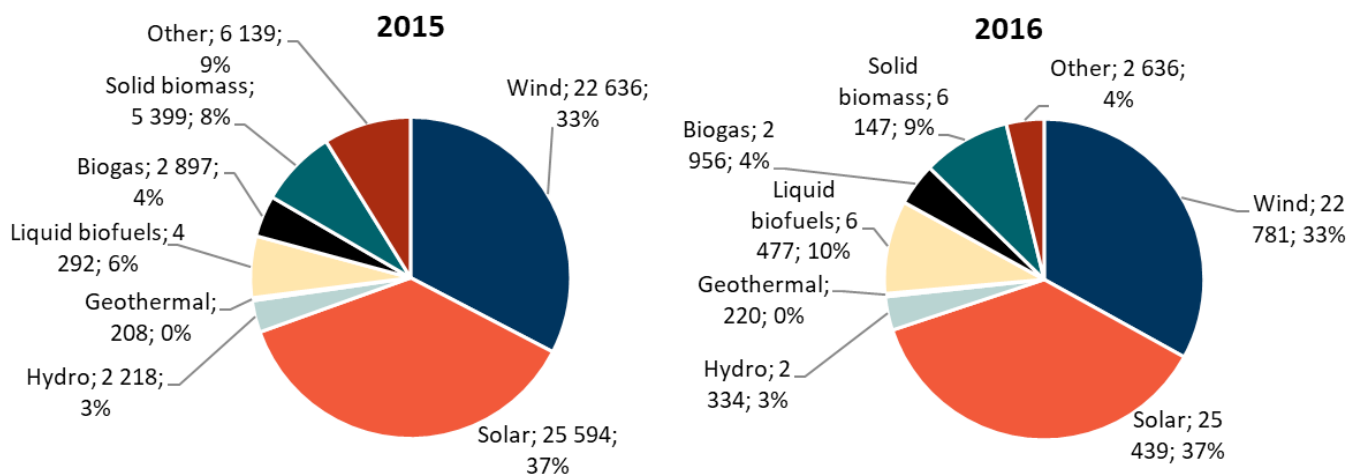
Bioenergy support in context

The previous chapter demonstrated that bioenergy subsidies are substantial in many of the examined countries. It is also important to understand how these fit within the overall structure of financial support to renewable energy. This chapter places the subsidies identified in the previous chapter in the context of all renewable energy subsidies in their respective countries.

Bioenergy subsidies as share of all renewable energy subsidies

Data gathered in the *Energy Costs and Prices in Europe*, 2018 study can be used to put bioenergy subsidies into the context of all subsidies to renewable energy.

Figure 3-1: Share of biomass energy in total renewable energy subsidies, for 15 selected countries, 2015 and 2016, million EUR and %



Source: Derived from figures presented in chapter 2 and totals provided in the annexes to the report *Energy Costs and Prices in Europe* (2018).
Note: Figures are for 15 EU member countries only and exclude R&D and transport subsidies.

Detailed results

In eight of the case study countries, subsidies for energy from solid biomass represent less than 10 percent of the total financial support given to renewables. In only four countries do these subsidies account for 15 percent or more of the total support given to renewables; these are Finland, Austria, Belgium, and the United Kingdom. There is generally a clear correlation between countries with a high share of renewables support going to biomass and the share of biomass electricity in gross electricity generation. For the use of solid biomass in final energy consumption, the relation with government subsidies seems to be less pronounced. It should be noted, though, that in many countries the use of biomass for heating is less heavily taxed than the use of other energy carriers, and in many cases no energy taxes apply at all.

Table 3-1: Overview of the share of biomass in total renewable energy subsidies in 2015 and 2016

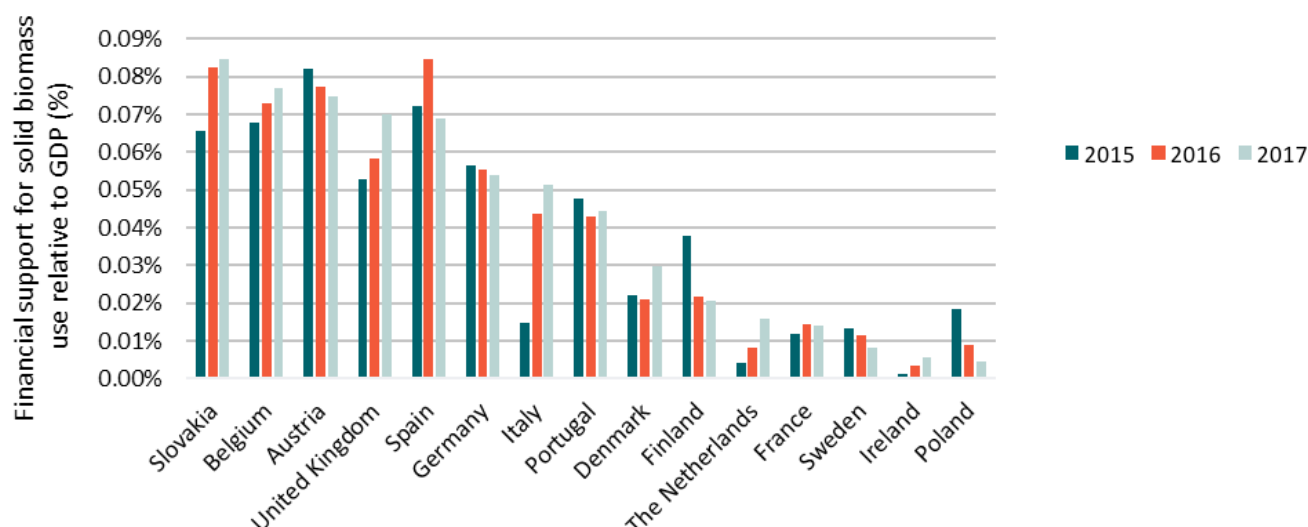
Country	Bioenergy subsidies (EUR million)		RES subsidies (EUR million)		Bioenergy as % of total	Bioenergy as % of total
	2015	2016	2015	2016	2015	2016
Finland	79	47	229	194	35%	24%
Austria	283	275	1,096	1,179	26%	23%
Belgium	279	309	1,395	1,378	20%	22%
United Kingdom	1,384	1,399	9,391	8,658	15%	16%
Sweden	60	53	381	368	16%	14%
Slovakia	52	67	474	464	11%	14%
Spain	781	948	9,261	8,179	8%	12%
Portugal	86	80	963	1,137	9%	7%
Germany	1,724	1,746	25,544	26,199	7%	7%
Italy	242	740	12,169	11,877	2%	6%
Poland	79	39	1,019	636	8%	6%
Ireland	4	9	97	160	4%	6%
Denmark	60	59	1,117	1,107	5%	5%
The Netherlands	29	57	863	1,159	3%	5%
France	256	319	5,544	6,497	5%	5%
Total	5,399	6,147	69,541	69,192	8%	9%

Comparison of relative subsidy levels

Apart from putting the total levels of financial support to biomass in the context of overall support levels for renewable energy, one can also relate biomass support levels to other general country characteristics like the size of the economy, the population, and the overall energy use.

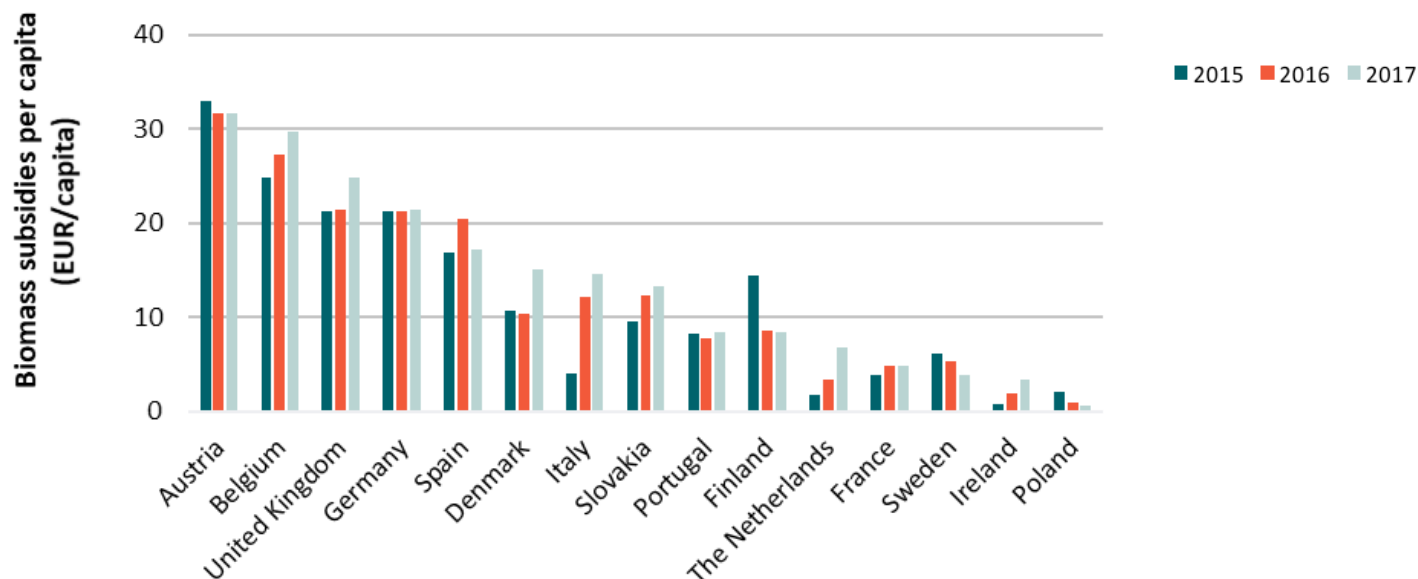
When looking at the subsidy levels in relation to GDP, we see that the case study countries spend between <0.005 percent and 0.085 percent of their GDP on support to solid biomass use (Figure 3-2). Slovakia spends the highest proportion of money as biomass subsidies in relation to GDP, with this support made up almost entirely of its OZE feed-in tariff for biomass. Belgium, Austria, the United Kingdom, and Spain spend the next most on biomass support relative to the size of their economy; Ireland and Poland spend the least.

Figure 3-2: Expenditures on financial support to solid biomass relative to GDP



One can also assess the expenditures on solid biomass relative to the total population size (Figure 3-3). In this comparison, Austria, Belgium, the United Kingdom, and Germany offer the largest per capita levels of support to biomass energy, whereas Poland, Ireland, Sweden, France, and the Netherlands offer the least. It is important to note that some of the financial support is provided via market actors or mechanisms (as in the case of green certificates, for instance), and some of the subsidies represent forgone government income rather than direct government expenditures.

Figure 3-3: Per capita financial support to solid biomass



It may be most relevant to compare the overall levels of financial support to the total level of energy consumption (Figure 3-4) or more specifically to the level of solid biomass consumption (Figure 3-5). Relative to total energy use, the highest subsidies are found in the United Kingdom, Austria, and Spain, reflecting either high shares of biomass use or high subsidies. As shown in Figure 3-5, the latter is the case in the United Kingdom. In Ireland, Sweden, and Poland, expenditures relative to total energy use are rather low. For Austria the reverse is true. However, while its costs of biomass subsidies relative to overall energy use are relatively high, in relation to total solid biomass use the support levels are quite low.

Figure 3-4: Financial support to solid biomass relative to overall energy use

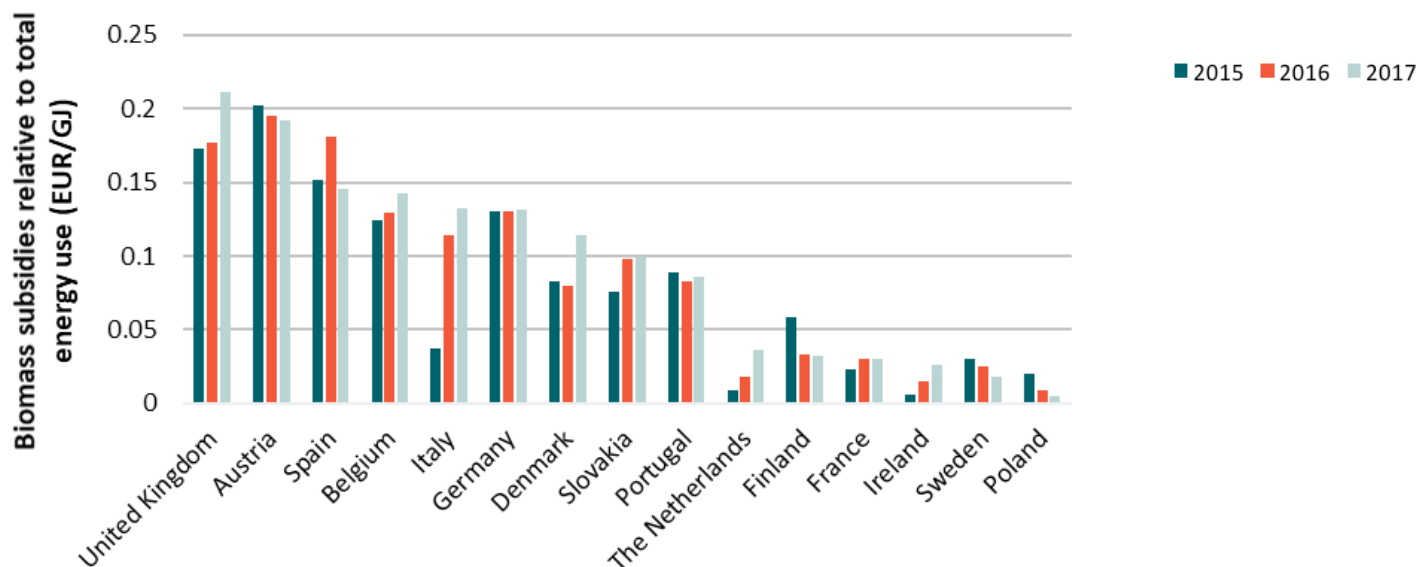
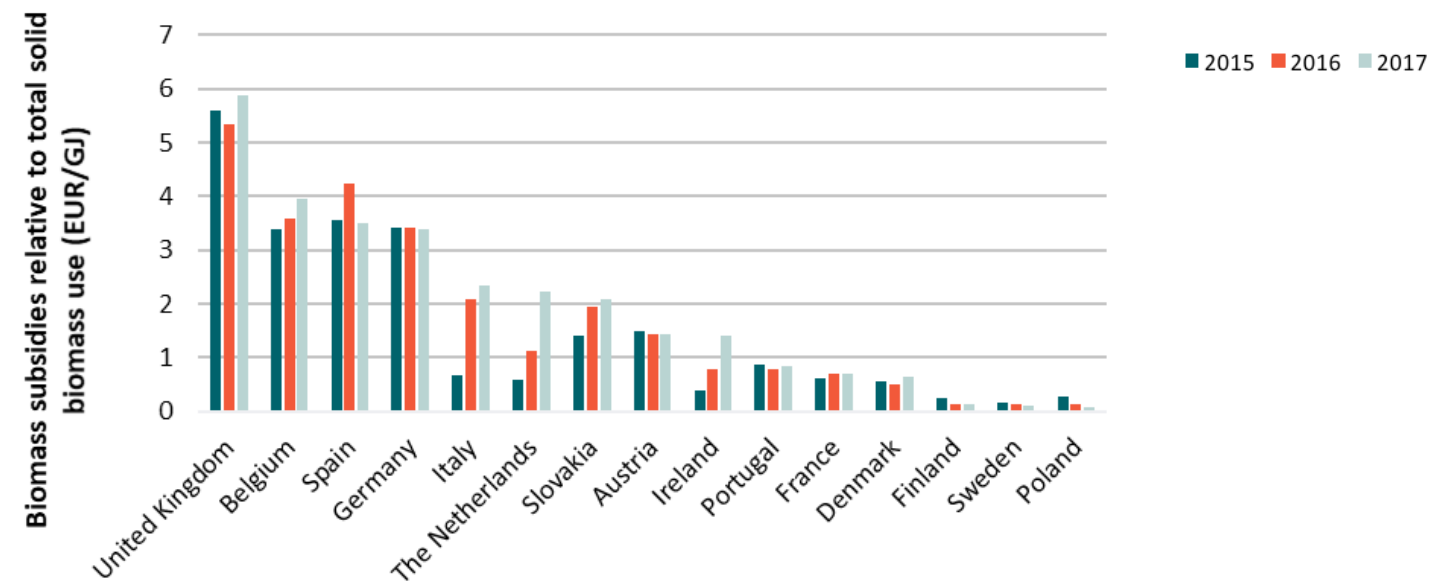


Figure 3-5: Financial support to solid biomass relative to gross primary energy consumption of solid biomass



Biomass use for bioenergy

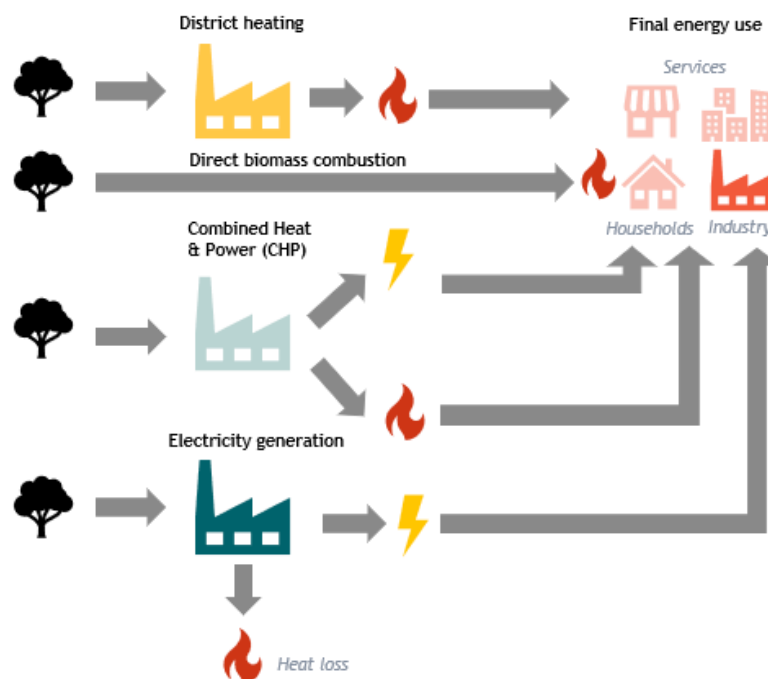
It is important not only to understand the level of support to bioenergy relevant for electricity and heat generation, but also to understand the impact this support is having on the type and size of biomass use. Understanding the type of use (co-firing with fossil fuels, dedicated biomass, other), the efficiency of use (CHP, other), and the specific fuels being used can help illuminate whether policy is encouraging sustainable and efficient uses of biomass sources.

Headline results

Overview of the uses of solid biomass for energy purposes

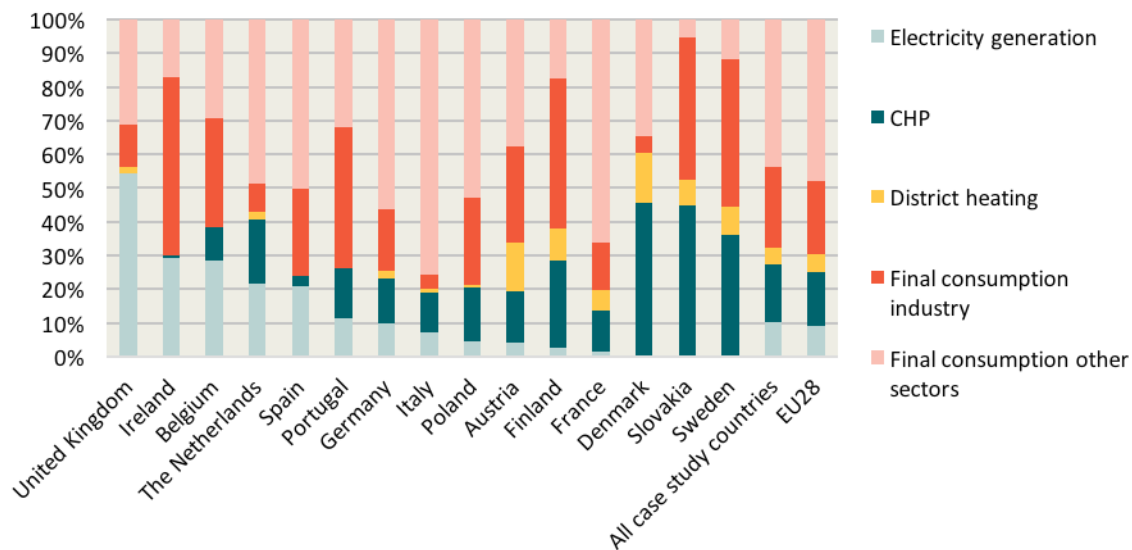
In our study of the energy uses of solid biomass, we looked at bioenergy that is used as a fuel in power plants, CHP plants, and district heating plants as well as the final consumption by end-use sectors such as industry, the residential sector, and the services sector. In power plants, biomass is used to generate electricity with an efficiency of 35 percent to 45 percent, and the remainder of the energy is lost as heat. CHP stations make more efficient use of the fuel, as both the generated electricity and the heat are utilized to serve final energy demand. In district heating plants, all the fuel is converted into heat, which is then fed into the heat distribution grid to heat buildings. Last, solid biomass such as firewood or wood pellets can be used directly in boilers to heat buildings or in industry for the generation of process heat. The different uses of solid biomass considered in this study are illustrated in Figure 4-1, below. The colors used in this illustration for the different end uses are repeated throughout the rest of this chapter.

Figure 4-1: The different energy uses of solid biomass considered in this study



In the European Union, the lion's share of solid biomass consumed for energy purposes is directly used by end-use sectors. This "final energy consumption" averaged around 70 percent in 2017. Of the remaining 30 percent, around 16 percent, on average, was used by CHP plants, 9 percent was used for electricity generation, and 5 percent for district heating. The picture is quite similar for the 15 countries investigated in this study (Figure 4-2), with final consumption by industry and other sectors averaging 67% in 2017. However, the energy uses of solid biomass vary strongly from country to country. The most striking deviations from the general picture are seen in the Scandinavian countries, where a significant share of the biomass is used in CHP plants, and in some West European countries, especially the United Kingdom, where a significant share of the solid biomass consumption is used for dedicated electricity generation.

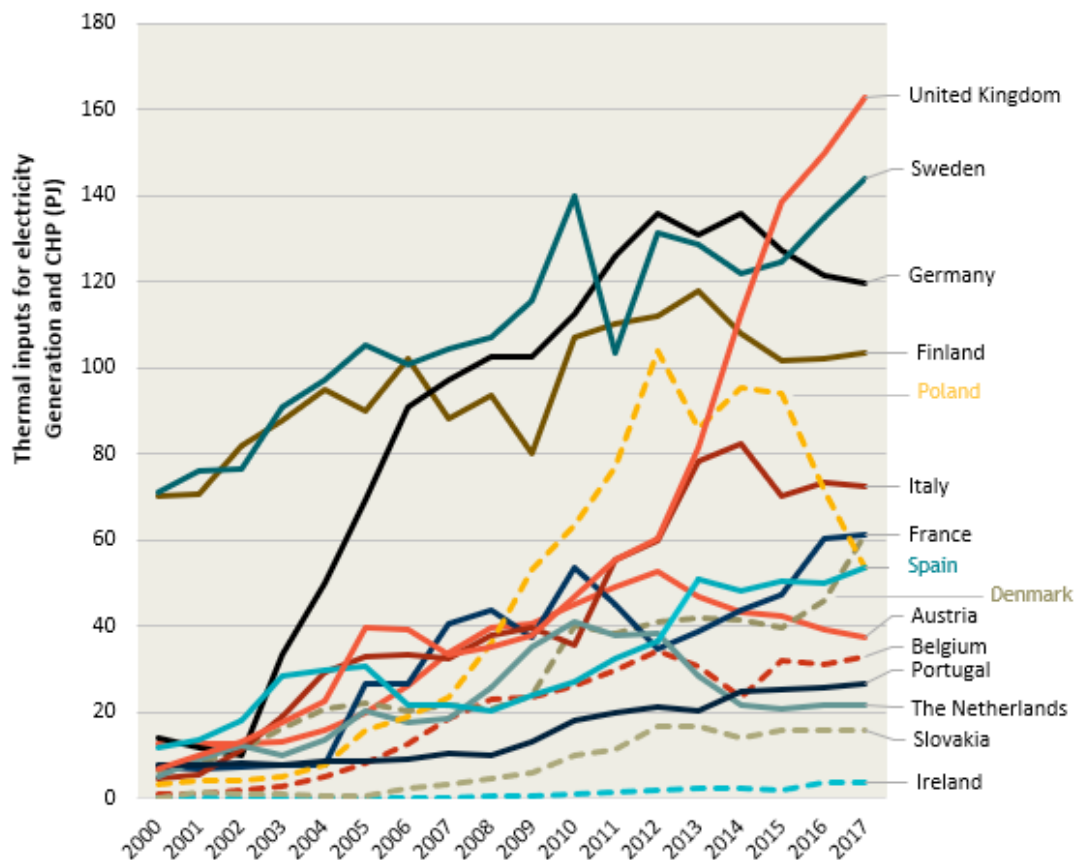
Figure 4-2: Overview of the uses of solid biomass by consumption type in 2017



Solid biomass use in electricity generation, district heating, and combined heat and power plants

When we look at the use of solid biomass for electricity generation and as a fuel for CHP plants, we see a clear increasing trend since the year 2000 for all case study countries (Figure 4-3). The countries with the highest consumption of solid biomass in CHP plants and power plants are the United Kingdom and Sweden, followed by Germany and Finland. The United Kingdom has shown a vast increase since 2010, and lately strong growth is visible in France as well.

Figure 4-3: Solid biomass inputs for electricity generation and combined heat and power for 2000-2017 (PJ).



Use of solid biomass in electricity generation

The share of electricity generated from solid biomass in the overall electricity generation mix per country is highest in the Scandinavian countries (Figure 4-4, left). However, if we look at all the electricity generated from solid biomass across the European Union (Figure 4-4, right), we see that nearly one-quarter is produced in the United Kingdom (22 percent), followed by Finland (12 percent), Germany (11 percent), and Sweden (11 percent). Overall, the 15 case study countries represent 93 percent of all the electricity generated from solid biomass in the EU28. The absolute levels of electricity generation from solid biomass from conventional power plants and CHP plants are shown in Figure 4-5.

Figure 4-4: Electricity generated from solid biomass as a share of total electricity generation in 2017 (left), and electricity generated from solid biomass in each case study country as a share of total electricity generation from solid biomass in 2017 in the EU28 (right)

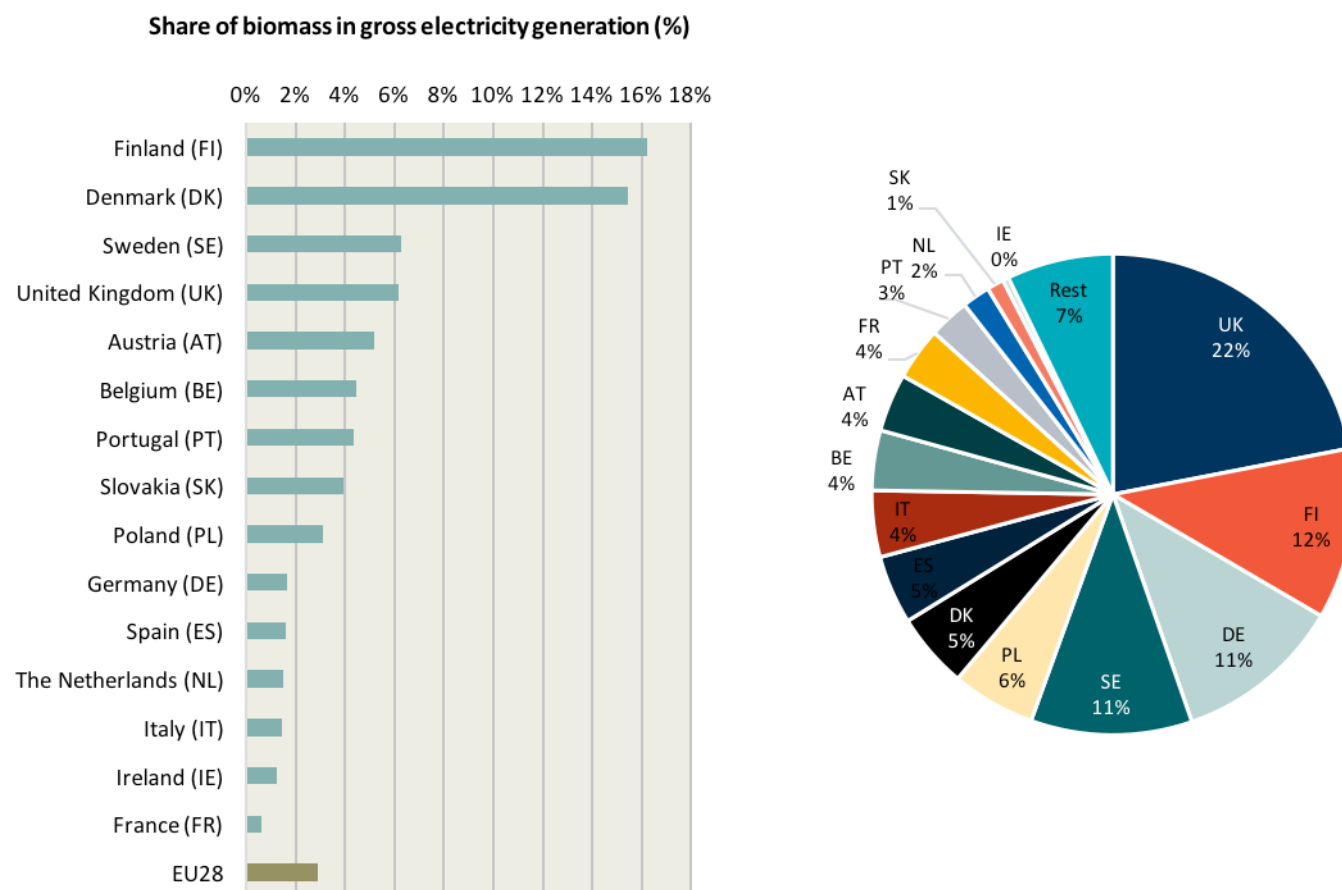
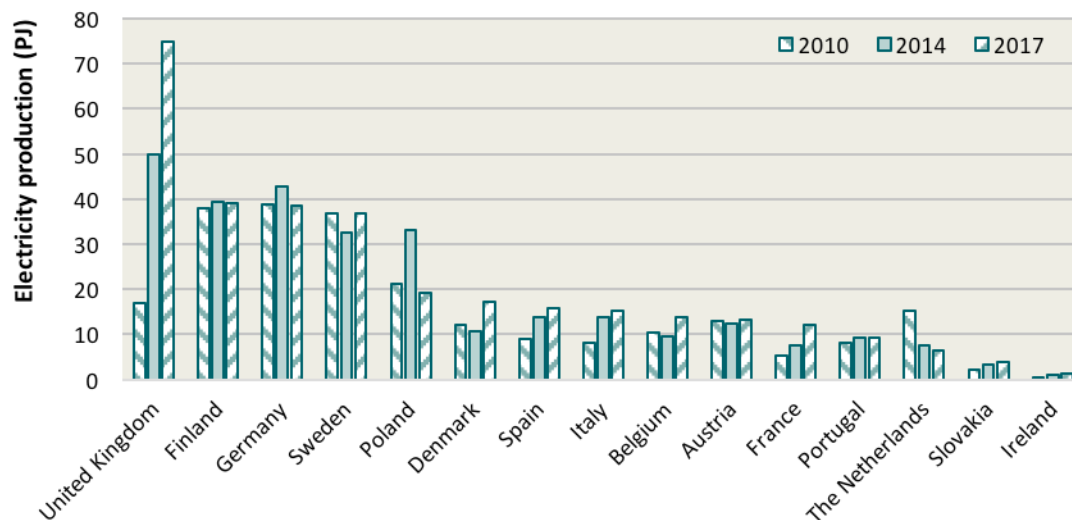
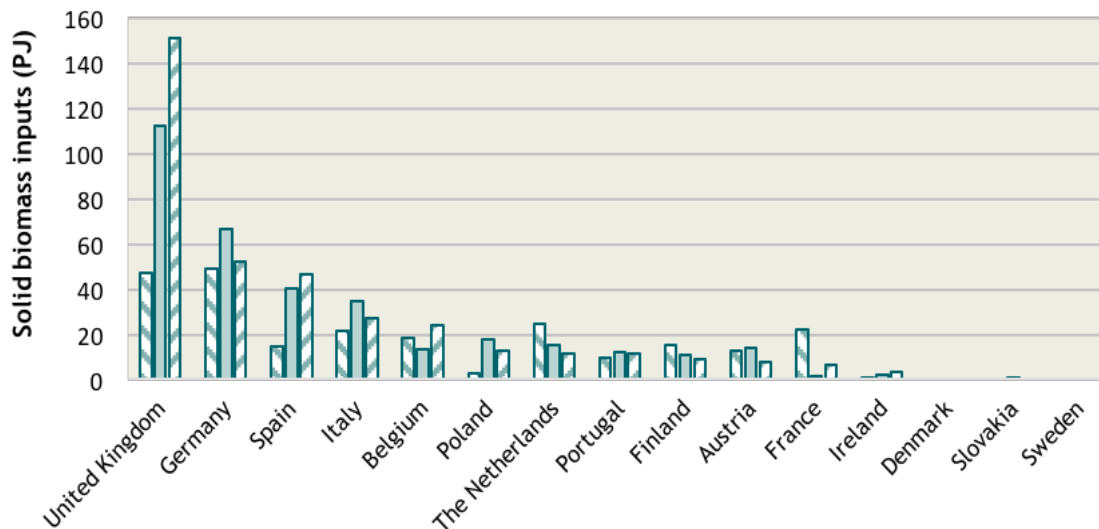


Figure 4-5: Electricity generation from solid biomass in 2010, 2014, and 2017 (PJ)



The use of biomass in power plants (excluding CHP) is highest in the United Kingdom, followed by Germany and Spain (Figure 4-6). When looking at all solid biomass inputs for power plants (excluding CHP), the United Kingdom accounts for 40 percent of the total fuel consumption in the EU28, Germany for 14 percent, and Spain for 12 percent.

Figure 4-6: Solid biomass burned to generate electricity in power plants (excluding CHP)

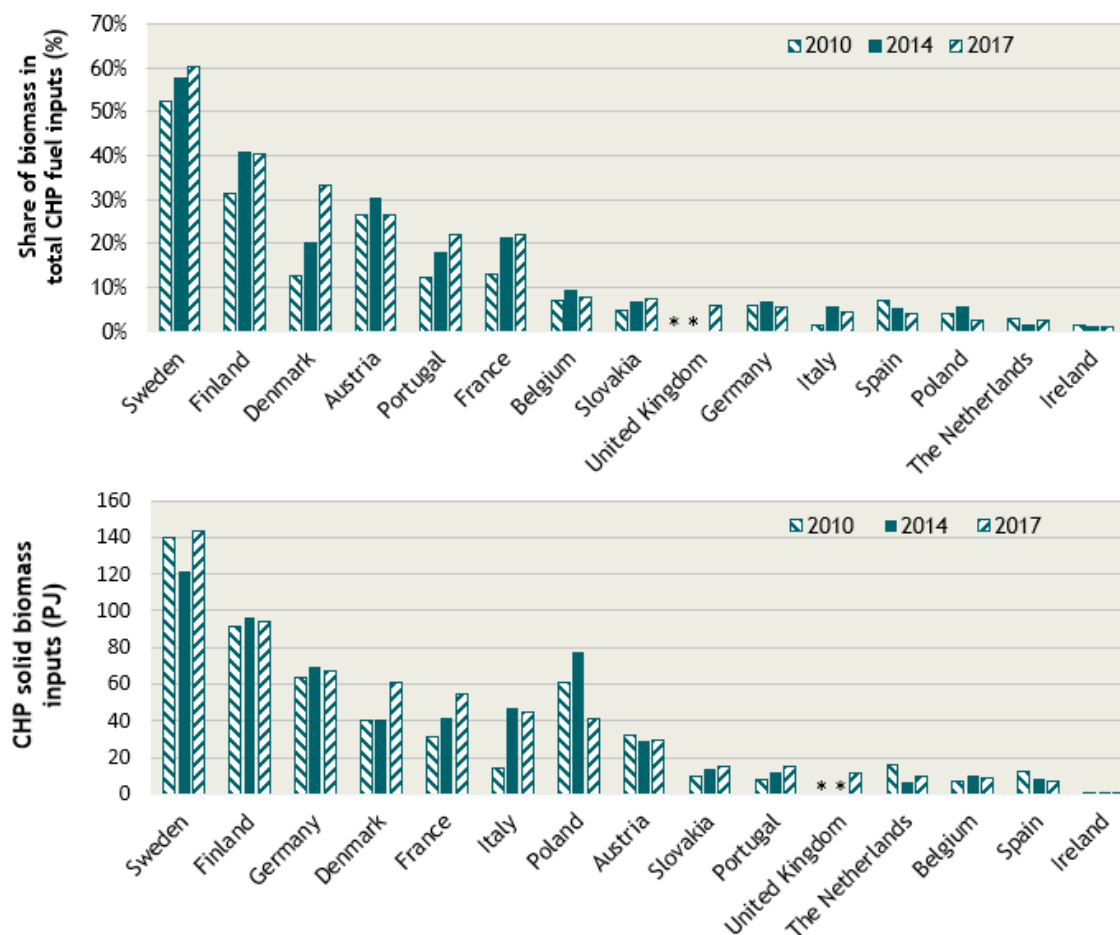


Use of solid biomass in combined heat and power plants

The use of solid biomass in CHP plants is common in Scandinavia and also in Austria (Figure 4-7). The front-runner is Sweden, where solid biomass accounted for more than 60 percent of the CHP fuel inputs in 2017, followed by Finland and Denmark. In Denmark, the use of solid biomass in CHP plants has grown substantially during the past decade, from around 13 percent in 2010 to 33 percent in 2017. Sweden and Finland also lead in terms of the absolute solid biomass use for combined heat and power generation, and Germany follows as the third-largest biomass consumer for CHP.

Figure 4-7: How much of a nations CHP runs on biomass?

Share of solid biomass in fuel inputs for CHP installations as percentage of total fuel inputs (top) and in absolute fuel input levels (bottom).



* The biomass fuel inputs for the United Kingdom were 0 in 2010 and 2014, according to Eurostat. According to the biofuel map of biofuelwatch.org, there are two operational CHP plants in the United Kingdom that currently use a total of 641 ktonnes of fuel wood and wood chips, which is equivalent to ± 11 PJ. No UK data were available for 2010 or 2014.

Annex A: Detailed subsidy list and sources

Note: Where calculation approach is listed as N/A, this means the data were available from the source.

Country	Instrument name	Instrument type	Use	2015	2016	2017	2018	Data source	Calculation approach
Austria	Einspeisetarif Biomasse	FIT	Electricity	270 400 000	262 700 000	263 200 000	260 400 000	Energie Control Austria: Annual amounts paid in FITs http://www.e-control.at/de/statistik/oeko-energie/oekostrommengen	N/A
Austria	Diversifizierung land- und forstwirtschaftlicher Betriebe durch Energie aus nachwachsenden Rohstoffen sowie Energiedienstleistungen - Bund	Investment support	Multiple		10 978			https://www.bmnt.gv.at/land/laendl_entwicklung/foerderinfo/sonderrichtlinien_auswahlkriterien/srl_le_2014-2020.html	N/A
Austria	Diversifizierung land- und forstwirtschaftlicher Betriebe durch Energie aus nachwachsenden Rohstoffen sowie Energiedienstleistungen - Bundesländer	Investment support	Multiple	329 701	7 318			https://www.bmnt.gv.at/land/laendl_entwicklung/foerderinfo/sonderrichtlinien_auswahlkriterien/srl_le_2014-2020.html	N/A
Austria	Reduced VAT tariff for wood pellets	Tax incentive	Any	12 321 239	12 585 442	13 925 664		National report	N/A
Belgium	Green electricity certificates (Flanders, Walloon, and Brussels region)	Green certificates	Electricity	227 670 500	252 647 000	282 158 100		ICEDD: Bilans des Energies renouvelables Région wallonne; CVAPE: Rapports spécifiques électricité verte; Bruxelles Environnement: Rapports techniques; VREG: Certificatemarkttrappen	N/A
Belgium	Grants for investment in bio-heating installations (Flemish region)	Investment subsidies	Heat	8 900 000	7 000 000	7 000 000		VITO: Inventaris Hernieuwbare energiebronnen in Vlaanderen	N/A
Belgium	Reduced VAT tariff for wood pellets	Tax incentive	Any	42 806 604	49 412 264	48 897 754		VITO: Inventaris Hernieuwbare energiebronnen in Vlaanderen	N/A
Denmark	Bekendtgørelse af lov om fremme af vedvarende energi, nr. 356 04/04/2019	FIP	Electricity	60 297 775	59 403 270	87 112 483	90 699 601	https://ens.dk/sites/ens.dk/files/Analyser/ve-stoettefremskrivning_ifm_basisfremskrivning_2019_.pdf https://www.skm.dk/media/1827200/Afgifts-og-tlksudsanalysen-delanalyse-2.pdf https://ens.dk/sites/ens.dk/files/Analyser/notat_-_pso-fremskrivning_pba_bf2017_-_20170608.pdf	N/A
Finland	Feed-in premium for renewable electricity—Biomass (Syöttötariffi, metsähäke)	FIP	Multiple	33 188 187	32 280 151	31 767 132	19 587 396	Data from the monitoring database SATU operated by the Energy Authority	N/A
Finland	Energy aid (investment aid) for solid biomass electricity (Energiatuki, kiinteä biomassa)	Investment subsidies	Electricity	27 880 000	-	-	-	Ministry of Economic Affairs and Employment, pekka.gronlund@tem.fi	N/A
Finland	Energy aid (investment aid) for solid biomass H&C (Energiatuki, kiinteä biomassa)	Investment subsidies	Heat	8 590 000	4 490 000	4 160 000	2 330 000	Ministry of Economic Affairs and Employment, pekka.gronlund@tem.fi	N/A
Finland	Energy aid (investment aid) for heating centers based on RE for farmers (Maatilojen lämpökeskusinvestoinnit)	Investment support (subsidy/loan)	Heat	1 530 000	3 820 000	5 280 000	5 990 000	Ministry of Agriculture and Forestry, Kjell Brännäs, kjell.brannas@mmm.fi	N/A

Country	Instrument name	Instrument type	Use	2015	2016	2017	2018	Data source	Calculation approach
Finland	Production support for biomass from forestry sector (Pienpuun korjuutuki (Kestävän metsätalouden määräraikainen rahoituslaski KEMERA))	Production support (wood chips)	Any	7 838 433	6 131 180	4 675 600	6 598 800	Ministry of Agriculture and Forestry, Marja Hilska-Aaltonen, marja.hilska-aaltonen@mmm.fi	N/A
France	Contribution au service public de l'électricité pour l'électricité (CSPE) – Contrats d'achat divers	FIT	Electricity	196 181 464	269 155 228	281 844 444		http://www.developpement-durable.gouv.fr/Presentation-generale,25.27.html	N/A
France	Fonds chaleur	Investment subsidies	Heat	60 000 000	50 000 000	40 000 000	40 000 000	http://www.developpement-durable.gouv.fr/Presentation-generale,25.27.html	N/A
Germany	Enerneuerbare Energien Gesetz 2017	FIT	Electricity	1 627 330 232	1 636 717 379	1 650 663 744	1 732 643 485	EEG in Zahlen: Vergütungen, Differenzkosten und EEG-Umlage 2000 bis 2019 (Stand: 15. Oktober 2018)	Solid biomass share of total bioenergy subsidy
Germany	KWK Umlage	FIT	CHP	36 906 589	59 451 187	60 902 729		https://www.netztransparenz.de/KWKG/ Jahresabrechnungen	Solid biomass share in CHP fuel inputs
Germany	Reduced VAT tariff for wood pellets	Tax incentive	Any	59 842 991	49 345 794	56 484 112		National report	N/A
Ireland	BioEnergy (Willow) Scheme (BioEnergy Establishment Scheme)	Biomass production support	Any	103000	5000			CSO—Environmental Subsidies	N/A
Ireland	Renewable Energy Feed-in Tariff (REFT)	FIT	CHP	3 563 012	9 025 393	16 236 482		https://www.seai.ie/resources/seai-statistics/energy-data/	Total subsidy * Proportion of biomass in total of eligible energy technologies
Italy	Feed-in premiums (Incentivi del DM 6 luglio 2012)	FIP	Electricity	14 000 000	26 000 000	47 000 000	48 000 000	Gestore Servizi Energetici, Energy & strategy group	N/A
Italy	Feed-in premiums (Incentivi del DM 23 giugno 2016)	FIP	Electricity		-	3 000 000	12 000 000	Gestore Servizi Energetici, Energy & strategy group	N/A
Italy	Renewables decree—All-inclusive rate—Solid biomass (D.M. 18 december 2008—Tariffa onnicomprensiva)	FIT	Electricity	95 000 000	90 000 000	89 000 000	100 000 000	Gestore Servizi Energetici, Energy & strategy group	N/A
Italy	Feed-in tariff (old) Biomass and biogas (CIP6)	FIT	Electricity	109 075 472	96 096 369	88 586 626	43 754 879	Gestore Servizi Energetici, Energy & strategy group, Eurostat [nrg_bal_c]	Total subsidy * proportion of biomass in energy balance with biogas
Italy	Green certificates for biomass (Certificati verdi)	Green certificates	Electricity		470 000 000	526 000 000	513 000 000	Gestore Servizi Energetici, Energy & strategy group, Eurostat [nrg_bal_c]	N/A

Country	Instrument name	Instrument type	Use	2015	2016	2017	2018	Data source	Calculation approach
Italy	White certificates—Titoli di Efficienza Energetica (cosiddetti Certificati Bianchi)—Biomassa	Investment subsidies	Heat	13 272 166	26 532 634	43 174 445	34 274 373	Gestore Servizi Energetici, Energy & strategy group; ARERA	Total certificates * Annual cost per unit
Italy	Investment support for biomass boilers (Conto Termico 2.0)	Investment subsidies	Heat	10 833 000	21 210 000	51 050 000	98 400 000	Gestore Servizi Energetici, Energy & strategy group	N/A
Italy	Ecobonus	Tax deduction for investments	Heat		10 500 000	39 500 000		ENEA—National Agency for New Technologies, Energy and Sustainable Economic Development	N/A
Poland	Soft loans for thermal power stations and biomass heating plants (GIS)	Investment subsidies and loans	CHP	233 804	190 157	194 952		Sprawozdanie z działalności Narodowego Funduszu Ochrony Środowiska i Gospodarki Wodnej w 2008-2016 roku (Report on the activities of the National Fund for Environmental Protection and Water Management in 2008-2016)	Total loan * (difference between market interest rate and loan interest rate)
Poland	Green certificates (Zielone Certyfikaty—PMOZE and PMOZE_A)	Green certificates	Electricity	79 037 222	38 333 542	21 542 953		Polish Power Exchange, Property Rights Market, Archive of trading sessions	Total certificate value * biomass share in RES generation
Poland	Investment support dispersed renewable energy sources (BOCIAN)	Investment loans	Multiple	105 347	87 223	89 423		Sprawozdanie z działalności Narodowego Funduszu Ochrony Środowiska i Gospodarki Wodnej w 2008-2016 roku (Report on the activities of the National Fund for Environmental Protection and Water Management in 2008-2016)	Support * (difference between market interest rate and loan interest rate)
Poland	Program for projects in the field of renewable energy sources and high-efficiency CHP plants.	Investment loans	Multiple	340 672	44 011			Sprawozdanie z działalności Narodowego Funduszu Ochrony Środowiska i Gospodarki Wodnej w 2008-2016 roku (Report on the activities of the National Fund for Environmental Protection and Water Management in 2008-2016)	N/A
Portugal	Produção em Regime Especial	FIT	Electricity	85 936 910	79 807 057	85 936 129	76 515 143	http://www.erse.pt/pt/desempenhoambiental/prodregesp/Paginas/default.aspx http://www.dgeg.gov.pt/default.aspx?cn=738680528054AAAAA http://www.dgeg.gov.pt/default.aspx?cn=636364478051AAAAA	N/A
Portugal	Portugal 2020—Quadro de Referência Estratégico Nacional (QREN) 2014-2020	Investment loan	Heat	8 514	91 090	152 101	128 553	https://www.portugal2020.pt/ https://poseur.portugal2020.pt/pt/candidaturas/candidaturas-aprovadas/	N/A
Slovakia	Podpora tarify za prevádzku systému obnoviteľných zdrojov (OZE)	FIT	Electricity	51 708 047	65 659 532	70 546 804	70 116 869	http://www.urso.gov.sk/?q=Informacny-servis/Zverejnenie-udajov-podla-%C2%A79-ods-5-zakona-309-2009	N/A
Slovakia	Zelená domácnostiam I & II—Kotly na biomasu	Investment subsidies	Heat	148 849	1 165 487	1 290 520	2 316 948	https://zelenadomacnostiam.sk/sk/	N/A
Spain	Special regime for electricity generation—biomass (energy crops) (Real Decreto 661/2007)	FIT	Electricity	451 168 082	412 887 872	499 433 933	521 058 518	RD 661/2007 of 25 May. Electricity Generated in Special Regime. Source: CNMC	N/A

Country	Instrument name	Instrument type	Use	2015	2016	2017	2018	Data source	Calculation approach
Spain	Special regime for electricity generation—Biomass (waste/residuos) (Real Decreto 661/2007)	FIT	Electricity	285 060 765	234 676 816	302 460 481	313 077 364	RD 661/2007 of 25 May. Electricity Generated in Special Regime. Source: CNMC	N/A
Spain	Plan de Energías Renovables (PER) 2011-2020	Investment subsidies	Multiple	45 000 000	300 000 000	-	30 000 000	Plan of Renewable Energies (PER) 2011-2020	N/A
Sweden	Electricity certificate system (Elcertifikatsystemet)	Green Certificate—biomass	Any	60 328 004	53 180 887	38 665 216	50 480 812	Swedish Energy Agency	N/A
Netherlands	Stimulation sustainable energy (SDE + regeling)	FIP	Electricity	22 200 000	42 200 000	84 900 000		Personal communication with RVO expert Aggregated data available at: https://www.rvo.nl/subsidies-regelingen/stimulerings-duurzame-energieproductie/feiten-en-cijfers/resultaten-2016 ; Jaarbericht SDE & MEP 2009; Jaarbericht SDE & MEP 2010; Jaarbericht SDE & MEP 2011	N/A
Netherlands	Investment subsidy sustainable energy (Investeringssubsidie duurzame energie—ISDE)	Investment subsidy	CHP		8 536 831	28 739 220	28 728 000	http://www.rijksbegroting.nl/2015/verantwoording/jaarverslag.kst221658.html ; Vaststelling van de begrotingsstaten van het Ministerie van Economische Zaken (XIII) en het Diergezondheidsfonds (F) voor het jaar 2017	N/A
Netherlands	Energy investment deduction (Energie Investeringsafrek—EIA)	Investment support (tax deduction)	Heat	6 487 217	6 497 041	3 643 845		http://www.rvo.nl/subsidies-regelingen/energie-investeringsafrek-eia EIA Jaarverslag 2015, https://www.rvomagazines.nl/eia/2016/01/gebruikte-energie-technieken EIA Jaarverslag 2016, https://www.rvomagazines.nl/eia/2017/01/gebruikte-energie-technieken EIA Jaarverslag 2017, https://www.rvomagazines.nl/eia/2018/01/gegevens-eia-2017	N/A
United Kingdom	Domestic Renewable Heat Incentive (RHI) payments—biomass	FIT	Heat	49 351 240	59 460 317	53 722 603	55 590 960	https://www.ofgem.gov.uk/data-portal/amount-domestic-rhi-payments-made-under-each-tariff	N/A
United Kingdom	Winter fuel payment—biomass	Tax incentive	Heat	180 834 586	163 468 678	156 787 189	-	https://www.gov.uk/government/publications/benefit-expenditure-and-caseload-tables-2017	Total subsidy * bioenergy share of heating demand
United Kingdom	Non-domestic renewable heat incentive	FIT	Heat	277 509 366	382 328 238	448 889 565	555 426 992	https://www.ofgem.gov.uk/environmental-programmes/non-domestic-rhi/contacts-guidance-and-resources/public-reports-and-data	Total subsidy * bioenergy share of total
United Kingdom	ROCs—Fuelled	Green certificates	Electricity	875 892 154	793 549 822	696 386 458		OFCEM annual reports and https://www.ofgem.gov.uk/environmental-programmes/ro/contacts-publications-and-data/public-reports-and-data-ro	ROCs issued * average value * (tax year split)
United Kingdom	Contracts for difference	FIP	Electricity			283 333 333	363 050 847	https://www.lowcarboncontracts.uk/sites/default/files/publications/11.7.18%20Final%20LCCC%20%2012%20Approved%20by%20NAO%20-proofs.pdf ; Drax power annual reports	N/A

Trinomics B.V.
Westersingel 34
3014 GS Rotterdam
The Netherlands

T +31 (0) 10 3414 592
www.trinomics.eu

