Biomass Energy in Hungary

REPORT

November 2022

CEEweb for Biodiversity

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False Promises of a Sustainable Future

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Date of publication: November 2022

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Funded by Stichting BirdLife Europe. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of Stichting BirdLife Europe.

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1. Introduction

The accelerating climate crisis makes a transition to renewable energy more important than ever. Adding to this pressure is the extraordinary increase in fossil fuel prices due to Russia's invasion of Ukraine. In light of this, the European Union (EU) has set out plans to increase targets of renewable energy production to enhance energy security under the REPowerEU plan. However, as in other parts of Europe, in Central and Eastern European (CEE) countries the majority of renewable energy is supplied by burning biomass and plans to expand renewable energy will likely involve expanding biomass energy even further. This is particularly an issue in domestic heating: with increasing energy prices, the already significant part of the population heating their homes with solid fuels is likely to grow further.

This occurs despite the fact that the scientific evidence is increasingly showing that biomass burning is not carbon neutral in the short to medium term, can lead to biodiversity destruction, harms people's health, and adds pressure to already vulnerable food systems.

This report sets out the current status of biomass energy production in Hungary, the science behind why it is unsustainable, and suggestions for a greener way forward.

2. Status of biomass energy in Hungary

2.1. Overview of energy systems in Hungary

In Hungary, the majority of household energy consumption is used for heating homes and water (Hungarian Central Statistical Office 2022). The energy sources for heating and cooling often differ from those used for electricity production. Therefore, both have to be considered when planning a transition to renewable energy.

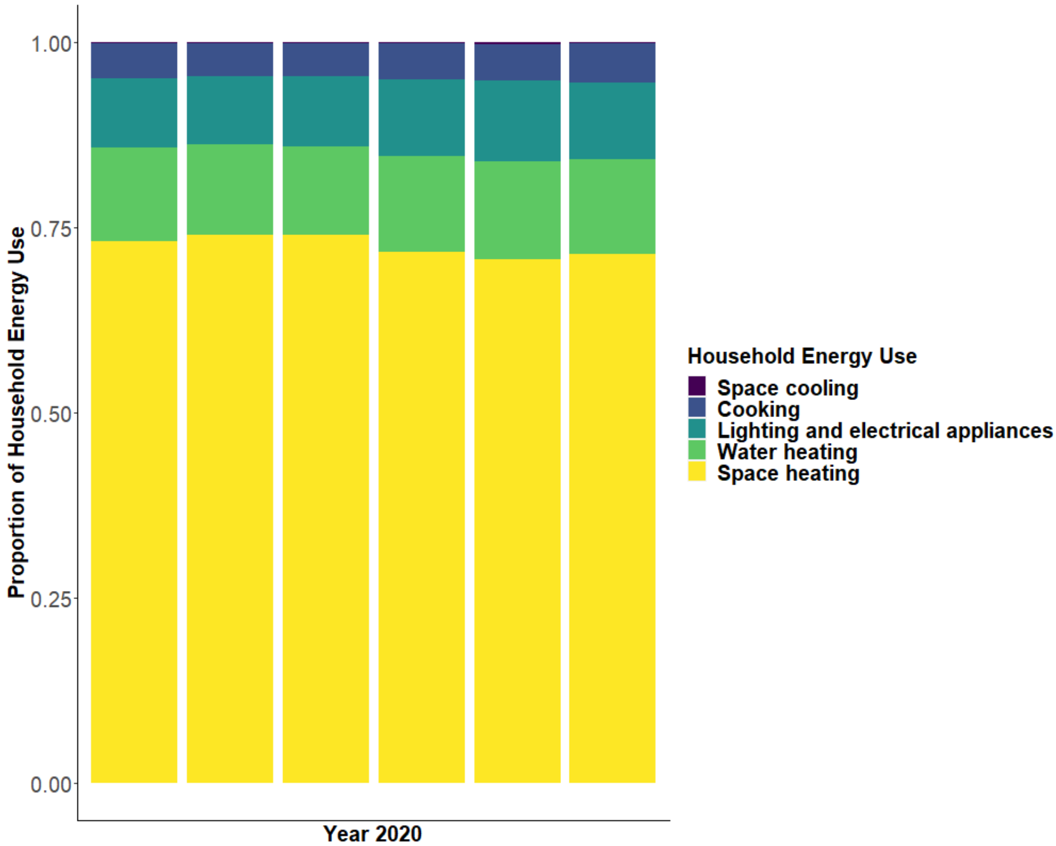

Figure 1. Proportion of household energy consumption by energy use in Hungary. *Source. Hungarian Central Statistical Office 2022.*

From 2000 to 2020, the amount of energy produced from renewable energy sources in Hungary increased more than threefold (see figure 2) (Hungarian Central Statistical Office 2022). It is important to highlight that the dramatic increase from 2004 to 2005 has been explained as a change in statistical methodology used in aggregating this data (WWF 2021). The majority of growth in renewable energy across this period was due to an increase in the use of biomass as an energy source which itself almost tripled across this time period. In 2020, biomass energy made up 66 % of all renewable energy produced in Hungary. In 2016, 73 % of total bioenergy consumption was consumed by households in Hungary (Hungarian Ministry of Innovation and Technology 2019).

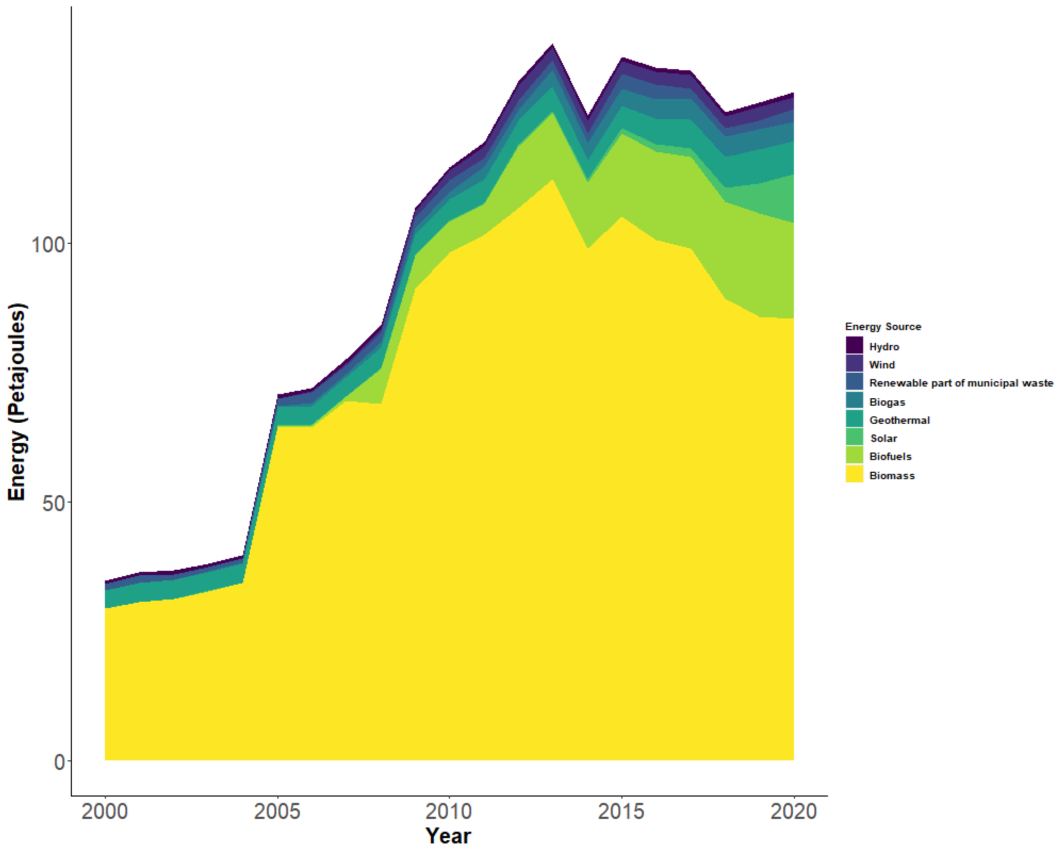

Figure 2. Share of renewable energy from different sources in Hungary. *Source: Hungarian Central Statistical Office 2022.*

Despite increasing, renewable energy still only contributed 11,9 % to the electricity produced in Hungary in 2020 — the second lowest proportion of all EU Member States (Eurostat 2022). Nuclear energy, supplied by the Paks Nuclear Power Plant, continues to dominate electricity production in Hungary. This means that biomass only supplies 3,69 % of electricity (see figure 3). However, renewables do play a larger role in heating and cooling in Hungary, making up 17,7 % of the energy used in this sector — a large part of this coming from biomass energy.

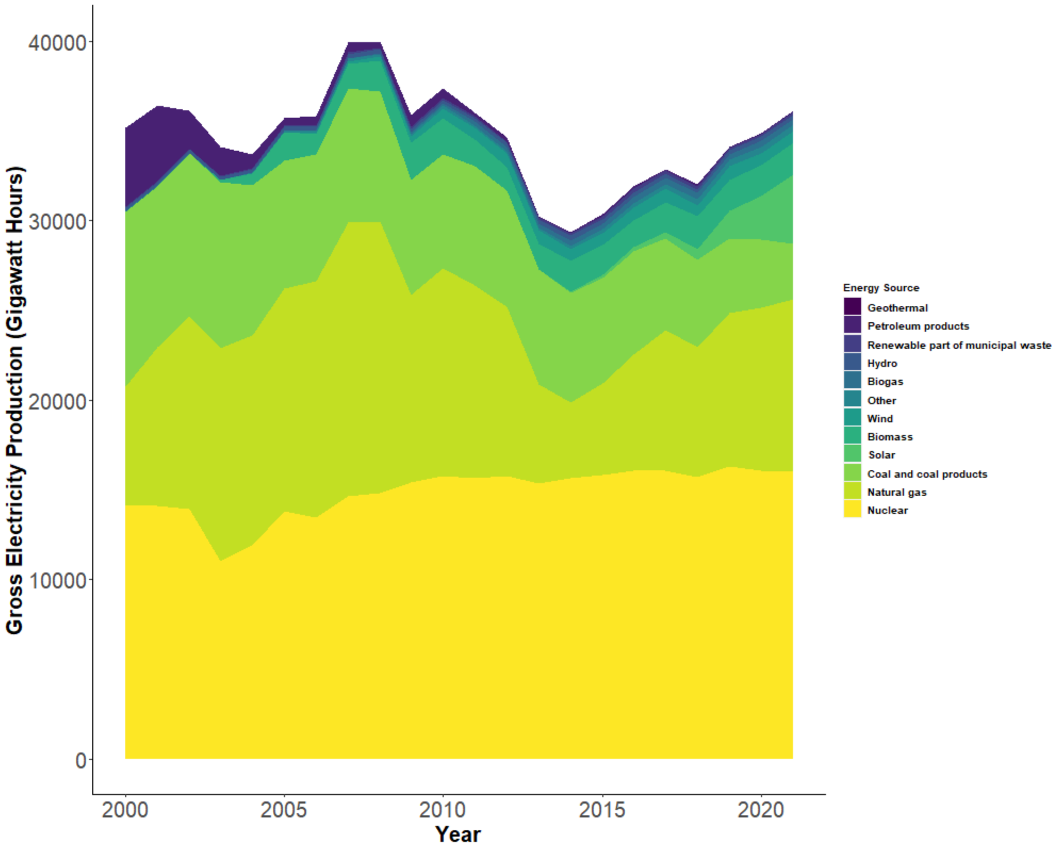

Figure 3. Share of gross electricity production in Hungary from different sources. *Source. Hungarian Central Statistical Office 2022.*

2.2. Targets

The increases in the share of biomass energy have been driven by efforts to meet EU and domestic targets for renewable energy use. The EU Parliament targets under Directive 2009/28/EC for renewable energy usage by 2020 were country specific and required Hungary to source 13 % of its gross final energy consumption from renewables. Hungary exceeded this target in 2020, achieving 13,9 % renewable energy consumption. However, this fell short of the domestic target of 14,65 % renewables (Republic of Hungary National Renewable Energy

Action Plan 2010–2020), and it is still in the bottom five of the EU27 countries in terms of renewable energy usage (European Environment Agency 2022).

2.3. How does biomass energy work in Hungary?

Two major sources of biomass energy are agriculture and forestry. Within agriculture, there is a distinction between biomass that is grown specifically for energy production and by-products that can be used to produce energy. An example of a specific bioenergy crop is *Miscanthus,* a tall grass perennial with low ash content that can be planted on former arable land or grassland (McCalmont and Hastings *et al.* 2015). Conversely, it is possible to use by-products of conventional crops grown for food. For instance, corn stover is the leftover stems of corn (*Zea mays*) which can be harvested for use in bioenergy (Fronning, Thelen and Min 2008).

In forestry, biomass can be taken from tree stem wood, by-products of forestry such as bark, or wood products that have reached the end of their intended use such as furniture. In 2006, 401 hectares of land in Hungary were used for dedicated short rotation tree fuel crops while 2122 hectares were used for other energy crops such as grasses (Renewable Energy Action Plan 2010).

Hungary sources 1 594 000 tonnes of dry matter from forestry for bioenergy production, according to the latest estimates from the BIOMASS project, European Commission. The vast majority of the supply of forestry matter in Hungary is derived from domestic roundwood. Only 77 000 tonnes of the forestry biomass used for energy is imported. This means that it is almost entirely Hungarian forests that supply Hungarian fuelwood. Wood pellet production does not play a significant role in Hungary and fell after 2010 (Thrän *et al.* 2017). The main driver of wood pellet production in Hungary is exports to other countries, such as Italy (Thrän *et al.* 2017). Of the pellets burned in Hungary, most are actually imported from Slovakia, the Czech Republic or Ukraine, making expansion of the internal market unfavourable (Thrän *et al.* 2017).

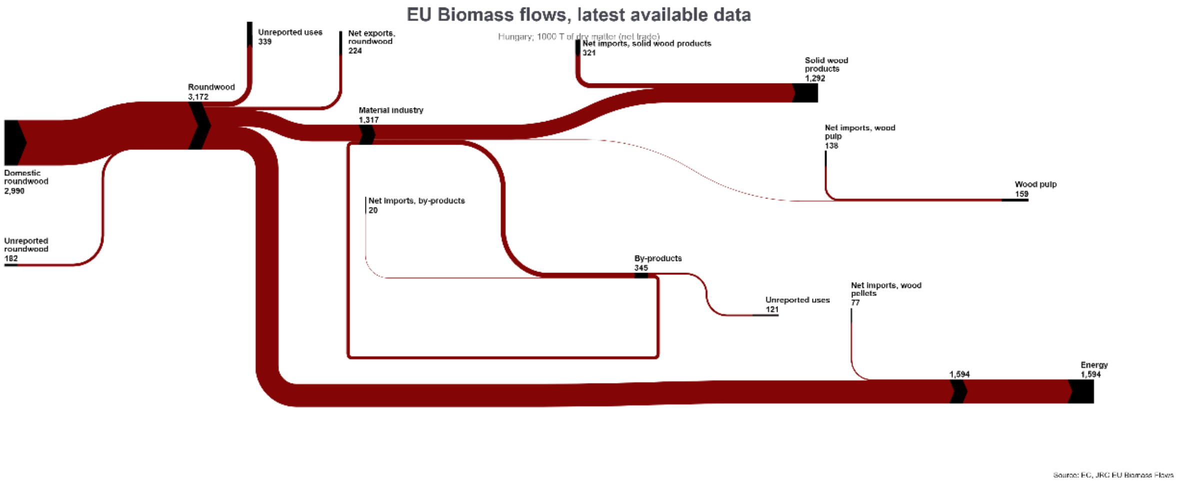

Figure 4. EU Biomass Flows. *Source: Figure and data from BIOMASS project, European Commission.*

Hungary is unusual in Europe for having such a high proportion of its bioenergy derived from crops. This is because there is a high rate of biofuel production — including energy for vehicles. A total 1 509 000 tonnes of dry matter are used in biofuel production in Hungary, according to latest estimates from the BIOMASS project, European Commission.

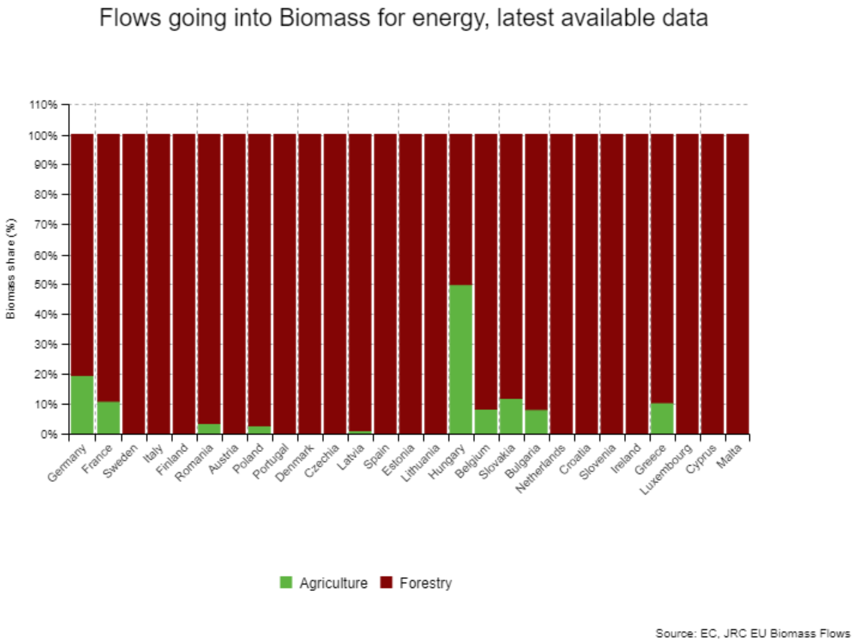

Figure 5. European Member States' biomass sources. Source: Data from BIOMASS project, European Commission.

2.4. Energy Poverty in Hungary

A legacy of years of energy subsidies suppressing household fuel bills and a lack of requirements for energy efficiency has left Hungary with a poorly insulated housing stock that needs high levels of energy consumption to keep warm (Ürge-Vorsatz *et al.* 2006). Over 23 percent of the population lives in houses with a leaking roof, damp walls, floors, or foundation, or rot in window frames or floor (HKÉF 2018). There seems to have been a preference, at least as far back as 2008, from Hungarian governments for allocating more money for direct price intervention over efficiency improvement programmes (Fülöp 2009). This means that despite absolute costs of energy for households being low compared to other EU states, Hungarian households spend a significantly higher proportion of their income to heat their homes than the EU average (European Commission 2020).

Although 91,2 % of settlements in Hungary are connected to the gas network, 21 % of households entirely heat their homes with solid fuels, such as wood, and 20 % partially use wood for heating (Csizmady *et al.* 2021; Bajomi *et al.* 2021). The poorest 20 percent of households are 4,4 times more likely to heat their homes entirely using solid fuels than the richest 20 percent. This goes some way to explaining that the root of this difference in energy consumption is due to energy poverty. Research has shown that in Hungary households falling into energy poverty typically have a monthly income below HUF 140 000 (approximately EUR 390). However, there is also a significant part of the population that is considered to be in a transitional group who is at risk of energy poverty with incomes between HUF 161 000 and HUF 200 000 (approximately, EUR 450 and 560, respectively) per month. It could be the case that, with increasing fuel prices, many more households already in energy poverty or vulnerable to energy poverty switch to burning solid fuels to heat their homes in the winter.

2.5. Regulations and subsidies

The current scheme of renewable energy subsidies in Hungary is known as METÁR (short for "*megújuló energiaforrásokból származó hő- és villamosenergia-átvételi támogatási rendszer*"). Under this system, energy producers apply for funding, known as a feed-in tariff, to meet the difference between the cost of energy production and the market price. The most recent tender round went entirely to solar energy projects as solar is by far the most competitively priced renewable energy source. However, in 2021 money was only available for the renovation of plants that had been commissioned at least 20 years earlier and, thus, three purely biomass fuelled power plants and a hydropower plant won the subsidy round — despite solar options being more cost-effective (Wattler 2022). There is another stream of funding for biomass energy in the form of so-called 'brown premiums' which are allocated to biomass power plants and pay for the difference between the cost of energy production and the cost that would have been achieved with fossil fuels for five years at a time (European Commission 2017). There is, therefore, clearly some support for biomass energy production on an industrial scale. However, the consistently falling price of solar installations means that subsidies are increasingly being captured by photovoltaic electricity producers.

For domestic consumers of biomass, the Hungarian government provides support through the social fuel allowance. Despite a relatively small budget, the social fuel subsidy support reached more than 193 000 households in 2021, which is still not even enough to meet the needs of half of the poorest fifth of households using solid fuels (Feldmár and Bajomi 2022). The support takes the form of direct provision of solid biomass for domestic burning. However, the scheme has been criticised for not targeting support specifically enough to those that face fuel poverty (Bajomi 2018). Furthermore, in some cases, municipalities simply do not have the funds to pay for the transportation of the wood to those in need (Bajomi 2018).

There are regulations governing the sourcing of the wood used for biomass electricity production in large installations. Government Decree 389/200737 requires that biomass be sourced from sustainable forestry — either verified by the forestry authority or, for imported wood, by a Forest Stewardship Council (FSC) certificate to be eligible for feed-in tariff support (Bódis *et al.* 2021). However, this stipulation was left out of the regulations governing the new METÁR scheme. There are further requirements stopping the burning of food, illegally sourced wood, or high-quality wood. However, there is no mention of non-forestry biomass, leaving agricultural biomass for energy production effectively unregulated.

The regulated nature of industrial biomass use starkly contrasts the completely unchecked sourcing of biomass for heating by households and district heating systems (Bódis *et al.* 2021). This is extremely significant as households are the largest consumer of firewood in Hungary. The lack of any legally enforceable criteria for biomass in the household and district heating sector means there are no checks on what is being burned.

3. Sustainability of the Hungarian response to the energy crisis and war in Ukraine

3.1. What is the current plan for the future of biomass in Hungary?

EU Member States were required to present their National Energy and Climate Plans (NECPs) in 2019. The plans set out two alternative scenarios: with existing measures (WEM) and with additional measures (WAM). The WAM plan and the response from the European Commission give the clearest idea of Hungary's plans for energy in the future (Hungarian Ministry of Innovation and Technology 2019; European Commission 2020).

Hungary aims to achieve greenhouse gas emissions 7 % lower than in 2005, which the Commission believes it is on track to achieve with its current plans. However, this assessment of progress on emissions excludes land use, land use change, and forestry (LULUCF), and Hungary has not provided any details about its targets in this area (European Commission 2020). This is vital to the discussion of bioenergy, which is a key part of the land use debate.

The share of renewable energy in Hungary is set to increase to at least 21 % by 2030, a figure considered "*unambitious*" by the Commission, as it is less than the 23 % target set out in Annex II to Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. To fulfil this target, bioenergy is planned to increase by 28 % from 2016 to 2030 under additional measures. The most significant role for bioenergy will continue to be in heating and cooling and this role is "*not expected to change in the longer term*" (Hungarian Ministry of Innovation and Technology 2019). However, the plan suggests that domestic biomass consumption will fall by 46 % by 2030 (Hungarian Ministry of Innovation and Technology 2019). Therefore, most of the increase in the use of biomass energy is expected to be driven by increases in use for electricity, district heat generation, the industrial and services sectors (Hungarian Ministry of Innovation and Technology 2019). The plan suggests that, under the Forest Act requirements, the forest owner replaces the cleared forest according to certain deadlines guaranteeing the sustainability of forests. However, there is no mention of how any of the climate policies might interact with the biodiversity crisis. This is concerning given the exaggerated impact of bioenergy on biodiversity through direct and indirect land use change when bioenergy forms such a central part of the plan. Another key criticism relating to bioenergy is that the plan does not analyse the impact that expanding bioenergy production would have on air quality. This is a serious omission given evidence for the impacts on mortality (Buonocore *et al.* 2021).

Other renewable energies are expected to increase in significance in Hungary under the National Energy and Climate Plan. The aim is to equip 200 000 households with roof-based photo-voltaic panels by 2030. Under the WAM scenario, total installed Photovoltaic (PV) capacity of over one gigawatt (GW) in 2020 will increase to 2,5 GW by 2025, to over six GW by 2030, and could approach 12 GW by the 2040s. However, despite these increases, biomass will still make up two-thirds of renewable energy in 2030 in the WAM scenario. Currently, regulations make it almost impossible to get a licence for wind farm construction in Hungary (Simon and Deák 2019). Wind energy capacity is "*expected to be maintained*" (Hungarian Ministry of Innovation and Technology 2019), suggesting that there are no official plans for expansion. The Commission suggests that Hungary "*might consider tapping into the potential of wind energy*" (European Commission 2020). However, there has recently been a change in tone from the Minister for Innovation and Technology, László Palkovics, who suggested in an interview with Anadolu that the policy on wind energy could change to enable expansion (Portfolio 2022).

Nuclear energy is expected to expand its role with the construction of two new 1200-megawatt (MW) power plants as part of the Paks 2 project (Hungarian Ministry of Innovation and Technology 2019). These are planned to come online by 2030 leading to a peak in nuclear energy production as the old and new units overlap. However, falling water levels in the Danube needed for reactor cooling, as highlighted by Greenpeace Hungary, and increasing tensions between the EU and Russia place some uncertainty on the expansion.

Energy efficiency targets are also considered to "*show a very low level of ambition,*" according to the Commission, leaving a "*scope for Hungary to intensify efforts to improve the energy performance of the building stock*" (European Commission 2020). The Hungarian plan suggests that the largest potential saving in energy is in the "*modernisation of buildings and heating systems*" (Hungarian Ministry of Innovation and Technology 2019). Currently, heating accounts for three quarters of energy consumption in Hungarian households — which suggests that savings in this area are not just significant at a national planning level but would also have consequences for individual household fuel poverty. The Commission notes that the plan does not give specific details for future action and does not set out any targets. The estimated rate of renovation based on external façade thermal insulation is currently approximately 1 % of the housing stock annually (Hungarian Ministry of Innovation and Technology). As the current residential dwelling stock in Hungary is 3,7 million, this means only 37 000 homes are being renovated per year.

3.2. REPowerEU strategy

REPowerEU is the EU's recent strategy to turn away from Russian gas as an energy source and become more energy self-sufficient. This, in many cases, involves the expansion of domestic renewable energy production above targets previously set out. However, the plan to increase the production of energy from renewable resources under the REPowerEU strategy has caused concern that it could undermine existing environmental protection (EEB 2022). The European Environmental Bureau (EEB) suggests that the:

> *"blanket exemption from the evaluations set in the Environmental Impact Assessment Directive and the Birds and Habitats Directives for renewable projects in 'go-to' areas […] risks severe harmful effects to nature as a result of bad planning."*

These concerns have arisen due to the removal of the requirement to conduct an Environmental Impact Assessment (EIA) when constructing new renewable energy infrastructure. As well as removing consultation with the environmental authorities and the public, this also removes the public's right to challenge decisions on energy developments in court. The EEB argues that renewable energy should not always be assumed to have a completely overriding public interest and should be judged on a case-by-case basis. In light of the issues set out in this report, this is particularly pressing not just for site-specific variations but also because the very status of bioenergy as a carbon neutral and biodiversity positive energy source is in question (Luick *et al.* 2022).

3.3. Hungarian forests in focus

On 4 August 2022, the Hungarian government published a decree (287/2022. VIII. 4.) which altered the rules on firewood collection. Key changes included:

- Enabling logging of native and invasive species in nature conservation areas.
- Empowering some forestry companies to cut roads through forests without consultation.
- New powers for the minister to authorise unplanned logging.

This change in policy was met with significant resistance from the public, as well as from civil society organisations. Reuters reported that there was a protest involving thousands of people on 12 August 2022 outside the Hungarian Parliament. Furthermore, an open letter written by the World Wide Fund (WWF) and other conservation organisations protesting the changes to the law gained over 110 000 signatures from the public and the support of 376 organisations.[1] A representative poll of people in Hungary conducted by Greenpeace showed that 63 % of people opposed the policy change, with only 22 % saying that they thought it would help solve the energy crisis (Greenpeace Hungary 2022).

The Hungarian government has since rolled back on the changes with a minister's order and suggested that logging would only be increased in the case of "a supply emergency" (Reuters 2022). The order, furthermore, upholds the prohibition of clear-cutting in state-owned protected or Natura 2000 forests (Magyar Közlöny 2022). Statements from the Board of the National Forest Association suggest that it is committed to not compromising the sustainability of forestry despite the recent policy announcements (OEE 2022). However, there is no clarity as to exactly what would constitute a "supply emergency," leaving open the possibility of future destruction of Hungarian forests.

[1] The petition can be found at https://peticio.wwf.hu/.

4. Problems with Bioenergy

4.1. Carbon neutrality

The claim that using wood for bioenergy is carbon neutral is coming under increasing scrutiny. Proponents of biomass energy production suggest that increasing its usage would lead to reductions in global CO_2 emissions due to tree growth and an increase in forested areas due to market incentives to increase production (Miner *et al.* 2014). They argue that it is renewable in comparison to fossil fuel energy as forests can regrow, while fossil fuel reserves cannot — at least not on a relevant timescale.

However, Luick *et al.* (2022) emphasise that there is a strong body of research that comes to the opposite conclusion (Agostini *et al.* 2014; Camia *et al.* 2021; EASAC 2017; EASAC 2018; NRDC 2015; Norton *et al.* 2019; Kun *et al.* 2020). In their view:

> *"the use of forest biomass for heating purposes emits significantly more CO_2 than fossil fuels over a timespan of a few decades and, depending on its origin, can have an immediately negative carbon footprint at the moment it is harvested."*

Burning wood from felled trees emits CO_2 into the atmosphere that would otherwise have been left locked up in the forest if left undisturbed. In the short to medium term, this means that using whole-tree biomass energy increases the concentration of CO_2 in the atmosphere, contributing to climate breakdown (see figure 6). These impacts are compounded by the inefficiency of wood as a fuel source. Due to high water content and low energy density, burning wood for energy can release two to three times more greenhouse gases than the equivalent fossil fuel baseline (Searchinger *et al.* 2018).

The impacts of using forestry by-products such as bark directly for energy are less serious, and in the short term emit CO_2 that would have been released through decomposition if left in the forest (Agostini *et al.* 2014). However, the long-term carbon neutrality of stem wood-based bioenergy rests on the assumption that these forests will be regrown. Trees burned for bioenergy today have taken on average between 70 and 120 years to grow. This means that we cannot expect CO_2 released by burning to be recaptured on a timescale shorter than decades or centuries (Luick *et al.* 2022). This is a serious issue as it means that any wood used for bioenergy today makes fulfilling the required CO_2 emissions reductions in the next few years even more difficult.

Table 1. Source: Agostini *et al.* 2014.

Biomass source	CO_2 emission reduction efficiency					
	Short term (10 years)		Medium term (50 years)		Long term (centuries)	
	coal	natural gas	coal	natural gas	coal	natural gas
Temperate stemwood energy dedicated harvest	---	---	+/-	-	++	+
Boreal stemwood energy dedicated harvest	---	---	-	- -	+	+
Harvest residues*	+/-	+/-	+	+	++	++
Thinning wood*	+/-	+/-	+	+	++	++
Landscape care wood*	+/-	+/-	+	+	++	++
Salvage logging wood*	+/-	+/-	+	+	++	++
New plantation on marginal agricultural land (if not causing iLUC)	+++	+++	+++	+++	+++	+++
Forest substitution with fast growth plantation	-	-	++	+	+++	+++
Indirect wood (industrial residues, waste wood etc)	+++	+++	+++	+++	+++	+++

+/-: the GHG emissions of bioenergy and fossil are comparable; which one is lower depends on specific pathways,

-; --; ---: the bioenergy system emits more CO_2eq than the reference fossil system

+; ++; +++-: the bioenergy system emits less CO_2eq than the reference fossil system

**For residues, thinning & salvage logging it depends on alternative use (roadside combustion) and decay rate*

This carbon debt can be partially addressed through a cascading use of biomass (Dammer *et al.* 2016). This means that biomass harvested from forests is first used in high-quality materials such as building materials or quality furniture.

When these products reach the end of their life they can then be recycled into paper and pulp products and used again. Each time the biomass is reused it means that fresh biomass does not have to be harvested for that instance of use. Through ensuring the long-life use of biomass materials, the pool of carbon sequestered in material objects increases. This can mitigate the impact of carbon dioxide emissions as the CO_2 is not immediately put into the atmosphere after the biomass harvest — as would be the case for biomass being used directly for energy (see Figure 7). At the end of this chain of cascading use, biomass waste can then be burned for bioenergy. However, the key aim here is not to produce energy; instead, it is to prolong the life of biomass material in use — energy production is only the final and last resort.

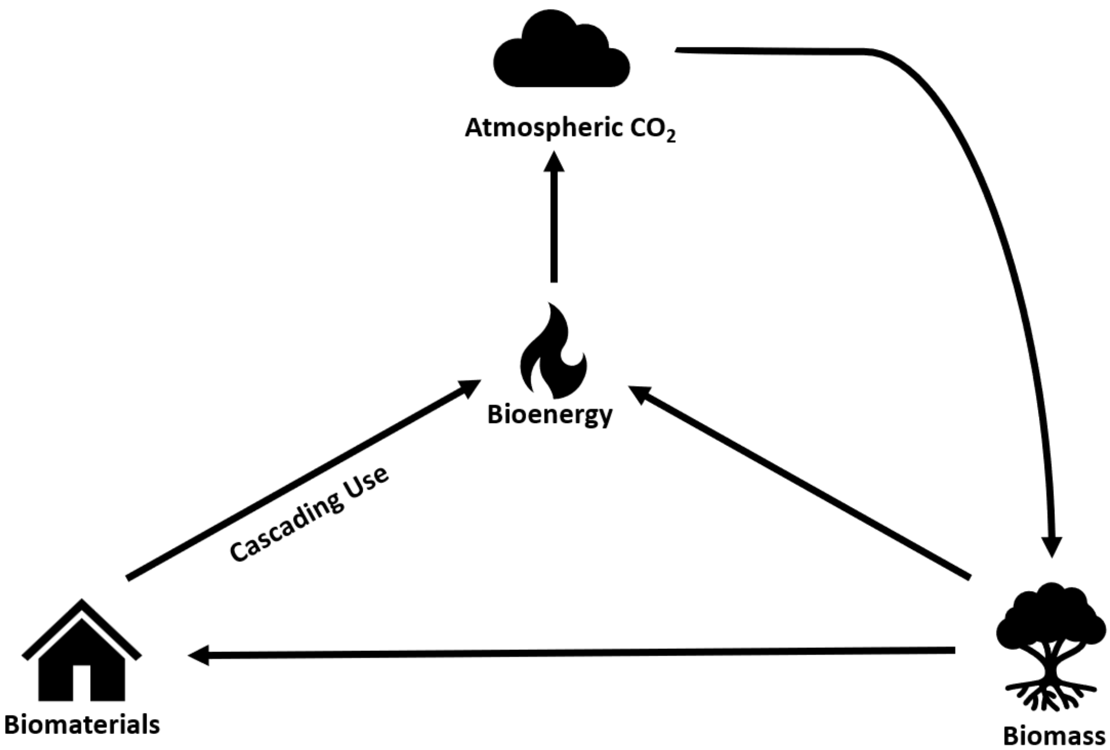

Figure 6. Carbon pools in cascading use and bioenergy.

4.1.1. Why timing matters

The argument that long-term absorption rates compensate for short-term CO_2 emissions in bioenergy systems is often put forward without any mention of the nonlinear nature of climate breakdown. In this context, non-linear means that the rate at which climate breakdown happens is not constant. This means that we can pass over tipping points that suddenly increase the rate of change and make it much harder for us to undo the damage. A good example of a tipping point is the destabilisation of ice sheets in West Antarctica due to global heating. The collapse of some sections of this ice sheet could cause a cascading positive feedback loop leading to a large enough discharge of ice to raise sea levels by three metres (Feldmann and Levermann 2015). Other tipping points can occur in ecosystems, such as the Amazon rainforest, which is predicted to switch to a savannah type ecosystem if 20-25 percent is deforested (Lovejoy and Nobre 2018). Recent evidence has shown that these tipping points are more likely than previously thought, often interconnected, and can have devastating consequences — leading Lenton *et al.* (2019) to describe them as "too risky to bet against." In this context, it is extremely important to reduce emissions as soon as possible to avoid going over these thresholds, which would prove difficult with expansions of bioenergy that increase the concentration of CO_2 in the atmosphere in the short term (Norton *et al.* 2021).

4.2. Biodiversity

The impact of bioenergy on biodiversity is often completely ignored when assessing its sustainability. There is evidence that bioenergy crops reduce biodiversity when they are planted to replace natural ecosystems (Núñez-Regueiro *et al.* 2019). While some studies find biomass energy crops can increase the diversity of animal species, this is mainly due to increases in non-native species (Núñez-Regueiro *et al.* 2019).

Central and Eastern European (CEE) forests in a near natural state are relatively poor in tree species but very rich in animals, fungi, and herbaceous plants (Luick *et al.* 2022). An investigative report by The New York Times in 2022 found that some forests cut down for bioenergy in Romania are not replanted as required, and in some cases, wood is illegally taken from supposedly protected areas. Cutting these biodiverse habitats down contributes to a global pattern of biodiversity loss driven directly by land use change, particularly if these forests are not replanted. This is the process by which changes in how we manage land (e.g. from converting near natural to managed forest) cause a decrease in biodiversity due to a loss of natural habitat.

The impacts of this biodiversity loss are greater than just the CO_2 released. Biodiverse habitats are generally more resilient and functional than less biodiverse ecosystems (Oliver *et al.* 2015). This is important for the organisms that live within them but also for humans because ecosystems provide lots of ecosystem services. These ecosystem services are functions that the ecosystem carries out and that happen to benefit people. These include regulating our atmosphere, cycling important nutrients, providing pollination, and slowing flood waters (Millennium Ecosystem Assessment 2005). Biomass energy production threatens to undermine the provision of these essential services.

4.3. Indirect land use change from crops

The issue of land use change is also present for biomass energy crops grown on agricultural land. In this case, the effect is indirect. This means that biomass crops compete with food crops for finite agricultural land. This can displace other forms of agriculture as it becomes more profitable to grow those crops on new land and increase the encroachment of agriculture into undisturbed ecosystems (Malins *et al.* 2014) (see figure 8). An impact of this change can be domestic deforestation or an increase in food imports that drives deforestation and other forms of land use change abroad. In both cases, biodiversity loss and CO_2 release are significant. When new land is cultivated, nearly all of the carbon in plant biomass and nearly a third of soil carbon is emitted as CO_2, and the future sequestration potential of the ecosystem is lost (Searle and Malins 2011).

Indirect land use change as a result of EU land use policy already causes issues abroad. From 1990 to 2014, European forest area grew 9 %, while outside of the EU around 11 000 000 ha were deforested to grow crops that were consumed within the EU (Fuchs, Brown and Rounsevell 2021). It is important that land used to grow biofuel crops does not exacerbate this trend of exporting deforestation and other forms of ecosystem destruction. Unfortunately, modelling the consequences of bioenergy on indirect land use change involves such a degree of uncertainty that many studies simply opt to not account for it. This, however, does not discount the enormous potential for indirect land use change alone to undermine all remaining environmentally friendly credentials of biomass energy production. The tentative designation of biomass energy grown on marginal land as carbon neutral in the table from (Agostini *et al.* 2014) rests on the assumption that there are no indirect land use change impacts, an assumption unlikely to hold. Furthermore, the mechanisms through which food systems are assumed to absorb the impact of biofuel demand can have social consequences (Malins *et al.* 2014). For example, a response to biofuel crops encroaching on food crop production can be a decrease in food consumption; this would mitigate indirect land use change. However, these food price increases do not fall evenly on the population and can negatively impact the welfare of tens of millions of people globally (Malins *et al.* 2014).

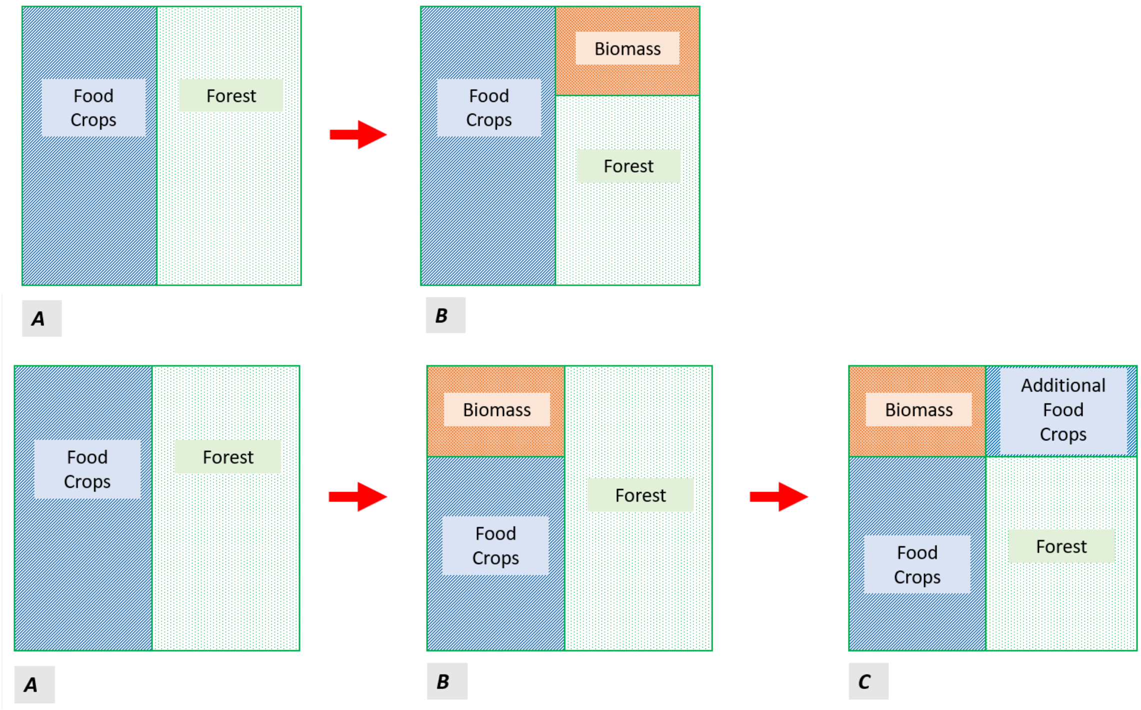

Figure 7. Upper panel: Direct Land Use Change. Lower Panel: Indirect Land Use Change.

4.4. Impact on soil

Soils have been called the "*most important part of the natural resources of Hungary*" (Stefanovits 1963). This is because soils are complex and vital parts of the landscape that we rely on for human survival as they underpin our crops and wild ecosystems. Unfortunately, human activity can reduce the fertility and resilience of soils if they are mismanaged — this process is called soil degradation (Várallyay 2015). One important component of soils is their soil organic carbon (SOC) content. This is the part of the soil made up of compounds containing carbon that have been made by living organisms. If SOC is lost, then it has to be replaced; this is usually supplied by decaying plant material. This poses a significant problem to plans to remove food crop residues and by-products from the land on which they are grown in order to use them to generate bioenergy. One potential source of biomass for energy is corn (*Zea mays*) stover — the stems and roots left in fields after harvest. Removal of this additional organic material without replacement with compost or manure can result in a drop in SOC in the soil of 3 % over the course of just three years (Fronning, Thelen and Min 2008). Consistent overextraction of these residues for biomass energy could result in reduced SOC stocks with serious consequences for the long-term fertility of soils. Instead of seeing the residues from crops as a waste product that can be removed from fields without consequence, we need to understand the importance of maintaining soil carbon stocks.

4.5. Human Health

Transitions towards biomass energy are already having measurable negative impacts on population health globally (Buonocore *et al.* 2021). This takes two forms: indoor pollution affecting the household burning the fuel, and outdoor pollution which affects anyone nearby. In 2017, particulate pollution from biomass combustion in the USA was a significant problem in both residential and commercial settings. In many US states, biomass and wood burning has replaced coal as the largest source of mortality impacts from fuel combustion. The World Health Organisation (WHO) estimated in 2015 that particulate pollution from wood- and coal-fuelled residential heating is responsible for 61 000 premature deaths per year in the EU. In Hungary, PM2.5 particulate pollution, often released by burning solid fuels, is responsible for 10 367 premature deaths each year (European Environment Agency 2019). In 2021, Hungary was found guilty by the European Court of Justice for exceeding particulate pollution levels repeatedly and failing to bring the pollution under control quickly enough (Court of Justice of the European Union 2021).

This increase in mortality is linked to a variety of health impacts. Particulate pollution from biomass combustion has been linked to cardiovascular issues

(Zhou *et al.* 2011), respiratory issues in children (Browning *et al.* 1990; Slaughter *et al.* 2003), and increased emergency room and hospital visits (Norris *et al.* 1999; Sheppard *et al.* 1999). We can quantify this health risk as associated deaths per unit of energy produced — in this case, measured in terawatt-hours. Per terawatt-hour of energy production biomass results in 4,63 deaths, which is significantly lower than 32,72 for brown coal but it is more than for gas at 2,82 (Ritchie 2020). However, biomass is more than 100 times less safe than renewables, such as solar and wind which have on average 0,02 and 0,04 deaths per terawatt-hour respectively (Ritchie 2020).

In the midst of the 2008 economic crisis, there was a 30 % increase in winter particulate pollution in Greece as communities switched to wood as a fuel source in response to fuel poverty (Saffari *et al.* 2013). With growing fuel poverty in 2022 and beyond, a movement toward household biomass combustion in a similar way would be unsurprising in many EU countries including Hungary. In light of all these factors, Buonocore *et al.* (2021) suggest that the health impacts of fuel sources should be factored into strategic decision-making alongside other factors such as greenhouse gas emissions. Swapping out coal for another health-damaging fuel source such as biomass is not a route towards sustainable energy and any infrastructure built today will lock in future negative health impacts for decades.

5. Alternative strategies for a better future

Given the downsides to biomass-sourced energy, you might be left with the question: why was biomass pursued in the first place? One explanation put forward in a report by Material Economics (2021) is that the aim of using bioenergy in a renewable transition is "*to keep as much as possible of the current industrial logic and capital equipment*." Biofuels can simply replace fossil fuels in power plants, home heating, and internal combustion engines in the transport sector. This scenario makes sure there is as little technological, infrastructural or capital expenditure as possible. From the perspective of forest owners and managers, bioenergy presents an opportunity to reassert the productive value of forests over the biodiversity value. Soritov and Storch (2018) suggest that the dominant coalition of product-oriented forestry interests, including private timber producers and state forest agencies in Europe, "*endorsed new bioenergy use and climate protection policies in order to (re-)integrate and stress timber production goals in forest policy and re-gain political influence.*" This reassertion was in reaction to the growing influence of biodiversity conservation over the last few decades.

However, as this report sets out, the current and future reliance of Hungary on biomass is not sustainable. In light of this, it is important to find alternative strategies to facilitate a fast and just green transition. To achieve this, we can draw on elements of the Hungarian National Energy and Climate Plan and increase the ambitions of its green elements.

The first priority of any emissions reduction plan should be to reduce consumption through efficiency gains. This has been a core part of the European Union's approach to energy since 1999 in the form of the "energy efficiency first principle" (the Regulation on Governance of the Energy Union and Climate Action 2018/1999). Nowhere is this more evident in a Hungarian context than in household insulation. Targets for household renovation could be much more ambitious than the current estimated rate of 1 % of the housing stock annually (Hungarian Ministry of Innovation and Technology).

There is also significant scope to expand the role of truly renewable energy. Analysis of Hungary's National Energy and Climate Plan from Visegrad+ for Renewable Energy suggests that the share of renewables in electricity could be more ambitious at 30-40 % by 2030. They suggest that the wind capacity potential of Hungary is 93 PJ per year — currently, wind only supplies 2,5 petajoules (PJ) (Energiaklub 2020). This is important as it means that Hungary does not have to turn to biomass energy production in order to increase its renewable energy share and makes renewable such as solar and wind extremely attractive prospects for a genuinely sustainable transition. Since 2009, the price of electricity from large solar voltaic installations has fallen by 89 % while the price of solar modules has fallen by 99,6 % (Ritchie and Roser 2021).

There is not only an economic argument to favour solar photovoltaic energy over biomass, but also their significantly lower climate impacts (van de Ven DJ. *et al.* 2021). Solar installations can provide at least ten times more energy per m^2 of land covered than biomass crops. Modelling shows that the amount of time taken to 'pay back' the carbon dioxide emissions associated with the land use change of installing solar energy through avoided fossil fuel emissions is only around eight months, compared to four years for biomass.

There has been a similar fall in the price of wind energy; for every doubling of global capacity, the price has declined by one quarter (Ritchie and Roser 2021). Furthermore, the land area case for wind energy is even stronger than for solar, although there is significant variability in how much land onshore wind installations use. If we just account for the turbine footprint, as little as 0,4 m^2 per MWh is needed, allowing for other land uses in and around the turbine (Ritchie

2022). The direction of travel for the cost of renewable energy is clear, and the advantage of solar and wind power is even starker when you consider that there is no cost for fuel — only for installation and maintenance. Greenpeace Hungary suggests that if Hungary had embraced a similar sixfold growth in wind power as Romania and Poland, there could be 2000 MW of wind capacity in Hungary today instead of the current 329 MW. This leaves a big opportunity for the expansion of wind as a renewable energy resource.

5.1. Opportunities in Hungary

There are some advantages that Hungary has in a transition towards renewable energy: district heating networks and geothermal energy. District heating is a system of delivering household heating where a central plant heats water that is then transported in insulated pipes to end users. A report from the European Commission highlights that district heating infrastructure can make renewable heating and cooling technologies more competitive (Gerard *et al.* 2021). This is particularly the case for energy sources, such as geothermal and solar thermal, which are much more cost-effective if operated at scale. In 2021, 653 877 dwellings in Hungary were connected to district heating systems, 240 315 of which are in Budapest (Hungarian Central Statistical Office 2022). This presents a large opportunity for efficient renewable energy-based heating systems. However, the National Energy and Climate Plan express that there is "major potential for the efficient use of biomass in both individual heating equipment and in district heating" (Hungarian Ministry of Innovation and Technology 2019). Given the issues set out in this report, it is critical that reforms of district heating and individual heating do not rely on biomass and instead move to truly renewable energy sources.

According to Hungary's own National Energy and Climate Plan, only 10-15 % of Hungary's geothermal potential is currently being used. This is expected to expand with the additional measures set out in the National Energy and Climate Plan with installed geothermal capacity expected to increase to 60 MW in 2030 and 104 MW in 2040. While this would still form only a small part of the renewable transition, it presents an avenue of energy diversification that is uniquely available to Hungary due to its geology.

5.2. Support for change

There is strong public support for renewables among the Hungarian population (Greenpeace Hungary 2021). A representative poll in March 2022 found that 86 % of respondents support the re-licensing of wind farms in Hungary. Furthermore, 87 % of people would like the Hungarian state to financially encourage extensive renovation of residential properties to save energy.

There is also a political appetite for a green transition at the representative level in Hungary. The LMP party suggests that they would lift the ban on wind energy (HIRADO 2020), raise the renewable share to 35 %, and insulate 100 000 apartments per year. This political appetite is also present in elected representatives, such as Sándor Rónai, the Demokratikus Koalíció MEP, who voted in favour with the majority on amendment CA9 to the revisions to the Renewable Energy Directive (RED). This recommended that primary woody biomass subsidies should stop and that this form of biomass energy should not be included in renewable energy targets.

This public support can be strengthened by ensuring that decision-making is participatory. Excluding local people due to fears of a "Not In My Backyard" (NIMBY) backlash against a renewable energy project can actually increase the likelihood of a backlash happening (Vela 2022). Support can be increased through efforts such as establishing renewable energy communities, in which both decision-making and material benefits are shared with local stakeholders.

There are examples from the Netherlands of community-owned wind farms that can power around 300 000 households that demonstrate this community engagement can happen at scale (Vela 2022).

5.3. Biomass energy policy

Given the weight of the evidence set out in this report and the strong public support for renewable energy, CEEweb endorses the set of biomass policy principles outlined by the European Environmental Bureau in its Nature-Positive Renewable Energy policy brief (2022). These are:

- Ensuring full compliance with the cascading principle of biomass;
- No public support for bioenergy plants using primary forest biomass;
- Ensuring proper accounting of emissions associated with the burning of biomass;
- Move from the risk-based approach to the precautionary approach;
- Phase out solid biomass for residential and tertiary heating by 2045;
- Do not use negative emission technologies (i.e. Carbon Capture Storage and Use) which do not make bioenergy sustainable; and
- Limit the production of biogas to sustainable waste streams only.

These policy proposals entail a shift in how we think about the role of biomass energy. Instead of considering it as another renewable energy technology to be exploited, we need to reframe biomass use for energy as the last use case for biomass waste at the end of a cascade of material uses. In other words, using biomass for energy should only be considered a small end-use solution to the material biomass value chain, and not an end goal.

Instead of pursuing bioenergy, we suggest that the following policy measures are taken:

- Substantially increase the rate of building renovation to raise the energy efficiency of buildings in Hungary through added investment, prioritising low-income households living in the worst-performing buildings;
- Relicense wind energy in Hungary and invest in its expansion;
- Convert district heating networks to renewable energy sources, not to biomass combustion;
- Further expand investment in solar energy; and
- Rural energy poverty investment to enable populations to move away from wood fuel for home heating.

From a national perspective, biomass presents Hungary with an energy, poverty, and climate policy problem. As this report sets out, the negative impacts of biomass use make it vital to reduce the role it plays in the energy sector. However, efforts to do so are complicated by the fact that a large part of unsustainable biomass combustion provides a vital lifeline for domestic heating in low-income households (Csizmady *et al.* 2021). In other words, the very energy source that needs to be phased out forms the basis of wellbeing for some of the most vulnerable people in Hungary, making the aim of phasing out solid biomass for residential and tertiary heating by 2045 complex. There have been suggestions from NGOs that schemes to replace and improve the efficiency of domestic stoves can help reduce the climate and health impacts of biomass combustion in these communities in an affordable way (Bajomi 2018). This would to some extent address the problems of serious air pollution and reduce the national rate of biomass consumption.

However, this could lock these households into using biomass for the foreseeable future and means a later transition to another energy source incurs an additional cost. The technologies and infrastructures suited to these rural communities' heating and cooling needs, namely heat pumps that use electricity generated by wind and solar installations, have expensive up-front costs (Gaur *et al.* 2021). As well as installation costs, heat pumps need to be accompanied by significant increases in energy efficiency through insulation to be cost-effective (Lingard 2020). Heat pumps extract heat from one place and transfer it to another using electrical energy, making them ideally suited to switching heating and cooling to draw energy from a renewable electricity grid (Gaur *et al.* 2021). This means that low-income communities are in a position where they are using damaging fuels because they simply cannot afford to transition away from them.

The question is how this transition could be facilitated in spite of these costs. It seems clear that if Hungary is going to take climate change seriously this will have to be addressed and it will probably involve some degree of up-front investment in tackling energy poverty with a long-term perspective. A "Clean Air" programme set out by the Polish government has allocated €22.5 billion between 2018-2029 to help poorer households insulate their homes and install new, more efficient heating systems (Wilczek 2022). However, it should be noted that 15 % of beneficiaries so far have opted for modern coal burners, and more than half chose gas-fuelled heating (Wilczek 2022). The exact details of such an intervention in Hungary and its financing fall outside the scope of this report and present a knowledge gap that deserves attention from both researchers and decision-makers.

6. Conclusion

The way we use land is perhaps the most important policy issue facing us today. This is because more than any other factor it directly influences climate, biodiversity, and human wellbeing. As the classic quote attributed to Mark Twain "*buy land, they're not making it anymore*" succinctly summarises, land is a finite resource. Therefore, when making decisions about land, we are constantly making trade-offs. This report sets out that the trade-offs entailed in biomass energy production are firmly unfavourable to biodiversity and climate breakdown, and human wellbeing. Central and Eastern Europe harbours some of the last fragments of European old-growth forests and so will be impacted more than most by forest destruction. Hungary should be pursuing an energy strategy that protects its natural assets, not one that sells them to be burned. It is for these reasons that CEEweb advocates alternative solutions to meet current energy needs without compromising the future, the very definition of sustainability.

However, there is another lens through which this is important: that of path dependency. When making the switch to renewable energy in light of climate and ecological breakdown, and energy security, it is important we get it right the first time. Bioenergy is a tantalisingly easy solution that avoids a significant shift in how we think about where energy comes from, namely that we can just keep on burning things. However, if we construct the infrastructure for bioenergy on a large scale now, shifting away from it towards cleaner and more efficient energy sources in the future only gets more difficult. Using biomass for energy is an unnecessary added pressure to land use that can be avoided through cleaner, more efficient energy sources and a reduction in consumption through efficiency gains.

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The accelerating climate crisis makes a transition to renewable energy more important than ever. Adding to this pressure is the extraordinary increase in fossil fuel prices due to Russia's invasion of Ukraine. In light of this, the European Union has set out plans to increase targets of renewable energy production to enhance energy security under the REPowerEU plan. However, in Central and Eastern European countries, the majority of renewable energy is supplied by burning biomass and plans to expand renewable energy will likely involve expanding biomass energy even further.

This report sets out the current status of biomass energy production in Hungary, the science behind why it is unsustainable, and suggestions for a greener way forward.

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