Sustainable Bioenergy for Georgia: A Roadmap

International Energy Agency

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Overview

Purpose

The International Energy Agency (IEA) has produced this *Sustainable Bioenergy for Georgia* roadmap as part of the EU4Energy programme, a five-year initiative funded by the European Union. EU4Energy's aim is to support the development of evidence-based energy policy design and data capabilities within the countries of the Eastern Partnership and Central Asia, including Georgia.

The central purpose of this document is to guide policymaking at all levels related to the supply and sustainable use of biomass for producing bioenergy in Georgia, and to act as a precursor for a national bioenergy strategy. The Government of Georgia is therefore invited to consider incorporating the actions needed to modernise the use of biomass resources, as outlined in this roadmap, into a dedicated bioenergy strategy.

Although bioenergy is a broad issue encompassing a wide range of fuels, technologies and end-use applications, this roadmap's primary focus is on increasing the sustainability of biomass-based heating in Georgia to mitigate the social and environmental impacts of inefficient firewood use.

This roadmap aims to help Georgia formulate its integrated National Energy and Climate Plan (NECP) for 2030 as part of the Ministry of Economy and Sustainable Development's wider State Energy Policy, in addition to other relevant strategies and plans across all levels of government. It is also intended to support and guide the activities of other key stakeholders, notably non-governmental organisations (NGOs), providers of development financing and the private sector.

Structure

An overview of the prevailing institutional framework related to bioenergy and associated policies opens this roadmap, followed by a description of the wider context of bioenergy supply and consumption in Georgia.

The body of the roadmap focuses on:

- Ensuring sustainable biomass supplies
- Modernising the consumption of biomass.

Current Georgian practices are summarised for these two areas, and examples of international best practices in bioenergy from IEA member countries are offered. The roadmap then outlines the policies, technologies and management practices needed for Georgia to harness its biomass potential securely and sustainably. These are presented as a set of overarching policy actions, underpinned by detailed biomass supply and consumption recommendations.

The recommended actions are compiled as a co-ordinated package of measures to be implemented during 2020-25 to modernise Georgia's bioenergy industry and make it sustainable by 2030. The social, economic and environmental benefits for the country are summarised as a vision of Georgia's modern bioenergy industry in 2030.

Key institutions and stakeholders

As bioenergy falls under the jurisdiction of multiple government ministries and departments, a co-ordinated approach to policymaking, governance and market development is required.

The Ministry of Economy and Sustainable Development (MoESD) has overall responsibility for renewable energy policy through its Energy Department. It is also responsible for implementing energy efficiency measures in the energy, industry and transport sectors, and it develops technical regulations for transport and implements overall transport policy.

The Georgian Energy Development Fund (GEDF) is a state-owned company under the jurisdiction of the MoESD. Created in 2010, the GEDF's key mission is to promote the development of commercially viable renewable energy projects. The GEDF supports project development by conducting preliminary research, project feasibility assessments and initial environmental impact assessments, and it facilitates contact between project developers and investors. It also participates in project development as an equity partner.

The Ministry of Environmental Protection and Agriculture (MEPA) is the highest executive body in charge of developing national forestry policies. MEPA has overall responsibility for strategic planning and policymaking regarding forestry and agricultural resource management. It also defines and implements Georgia's national climate change policy, issuing environmental permits for energy sector projects and defining and implementing air quality policy.

MEPA implements and enforces forestry policy through the structural units under its jurisdiction: the Department of Biodiversity and Forestry, the National Forestry Agency, the Agency of Protected Areas and the Department of Environmental Supervision. The Department of Biodiversity and Forestry's responsibilities include forest conservation, monitoring and reporting, and the National Forestry Agency is tasked with enforcing the Forest Code, which involves forest management and the supervision of biomass harvesting. The Autonomous Republic of Adjara has its own forestry agency.

The Public-Private Partnership (PPP) Agency is a new body created following adoption of the PPP Law in May 2018. The PPP Agency's mandate is to lead the development and implementation of public-private co-operation projects. PPP arrangements could prove effective in reducing the investment risks of early-stage bioenergy projects and could support modern bioenergy heating projects in public buildings.

The Ministry of Regional Development and Infrastructure is in charge of municipal capacity-building, which will be essential considering the new skills associated with modern heating solutions for public sector buildings. The **Municipal Governments** of Georgia are also important stakeholders since they are responsible for energy procurement for public buildings.

The National Statistics Office of Georgia (Geostat) compiles official energy statistics. It also conducts and analyses household energy consumption surveys, which are an invaluable source of quantified information on the final consumption of biomass. The first of these was conducted in 2017, and the next is scheduled for 2022.

International development programmes are currently the principal instigators of renewable heat project development in Georgia. Georgian institutions have benefitted from technical and financial support in the area of forestry and bioenergy from organisations such as the United Nations Development Programme (UNDP), the German Agency for International Cooperation (GIZ), the United States Agency for International Development (USAID), and NGOs such as the Caucasus Environmental NGO Network (CENN) and World Experience for Georgia. As these organisations proactively develop sustainable bioenergy policy proposals and project pilots, the modernisation of Georgia's bioenergy consumption will require their ongoing support.

Private sector activity in the biomass industry currently consists of fragmentary entrepreneurial initiatives. The **Biomass Association of Georgia** was established in 2017 with UNDP support. Its remit is to create a common and effective platform for co-operation as well as information- and knowledge-exchange in the area of biomass to accelerate biomass policy deployment and market development. There is scope to increase its membership and activity, however.

To integrate bioenergy into energy policy development and create the market conditions for growth of a modern bioenergy industry, the responsibilities of all relevant stakeholders must be clearly defined. This requires co-ordination among the public and private sectors and the various levels of government.

No single body currently has overall responsibility for a future bioenergy strategy. Considering the various cross-sectoral aspects of bioenergy, a co-ordinating body directly responsible for promoting biomass supply sustainability and efficient resource use is needed. Such an agency could be integrated into an organisation with a wider renewable energy remit.

Current policy landscape for bioenergy

Despite the widespread use of solid biomass for residential heating, bioenergy is not broadly incorporated into energy policy. Furthermore, no specific support measures are in place to facilitate renewable heat production, including by using modern biomass fuels and efficient technologies. International development programmes and development banks are currently the primary sources of financial support for renewable-heat initiatives.

Since Georgia's accession to the Energy Community Treaty, the country has begun to create a legal and regulatory framework to comply with the EU acquis. This includes introducing national legislation to harmonise its energy market with the EU Renewable Energy, Energy Efficiency and Energy Performance of Buildings directives.

Under the **Energy and Water Supply Law**, the MoESD is responsible for a comprehensive State Energy Policy that addresses all aspects of the energy sector. The law covers all forms of energy, including biomass.

Georgia's parliament passed a **Renewable Energy Law** in December 2019 that has provisions for setting renewable energy targets and monitoring progress in meeting them. It also provides a framework for introducing renewable energy support mechanisms; although these are in development, there are currently no details on whether bioenergy technologies will be included.

The several articles of the Renewable Energy Law that make specific reference to bioenergy:

- Outline that Georgia's National Renewable Energy Action Plan should implement policies to develop existing biomass resources and mobilise new ones.
- Ensure adequate certification of technologies, including biomass boilers and stoves.
- Consider the ability of renewables-based district heating to meet energy objectives by 2030, and to facilitate infrastructure development.
- Stipulate biannual reporting of renewable energy consumption, including the bioenergy portion, and any associated changes to consumer good prices and land use.

The **Law on the Energy Performance of Buildings (EPB)**, adopted in May 2020, aims to set buildings sector regulations to improve the energy efficiency of existing and new buildings, to introduce minimum energy performance standards and provisions, and to establish energy performance certification and the inspection of heating equipment. The Law on Energy Efficiency adopted alongside the EPB Law creates a framework for energy efficiency activities, including the introduction of support measures.

Secondary legislation still needs to be developed and passed to implement these laws, and ongoing technical and operational support are required to formulate new regulations and action plans.

Georgia is preparing its **NECP** for 2021-30 with an outlook to 2050 to ensure consistency with long-term EU, United Nations Framework Convention on Climate Change (UNFCCC) and Energy Community policy objectives. The NECP will provide a framework for 2030 sustainable bioenergy consumption targets and will outline support measures.

All of Georgia's forests are currently under state ownership and are administered according to the **Forest Code of Georgia**, a new version of which was adopted in 2020 under the authority of the Forestry Agency. The **National Forestry Programme (NFP)** facilitates stakeholder dialogue to support forestry sector reform through a working group on alternative energy sources and sustainable firewood use.

Georgia's parliament has adopted a **National Waste Management Code** and the government has approved a national waste management strategy and action plan to 2030. These prescribe less landfilling of biodegradable wastes, with waste sorting starting in 2020 and creating opportunities for energy-from-waste (EfW) project development. The code covers hazardous, municipal solid, urban green and industrial wastes, but not agricultural residues.

In its **Intended Nationally Determined Contribution (INDC)**, Georgia volunteered to reduce its greenhouse gas (GHG) emissions by 15% of the business-as-usual (BAU) level by 2030. As forestry management is a key means to reduce GHG emissions, the government has outlined three mitigation actions for the forestry sector: (1) establish sustainable forest management practices; (2) conduct afforestation/reforestation and assist natural regeneration; and (3) expand protected areas.

Georgia is also implementing **Nationally Appropriate Mitigation Action (NAMA)** projects, including:

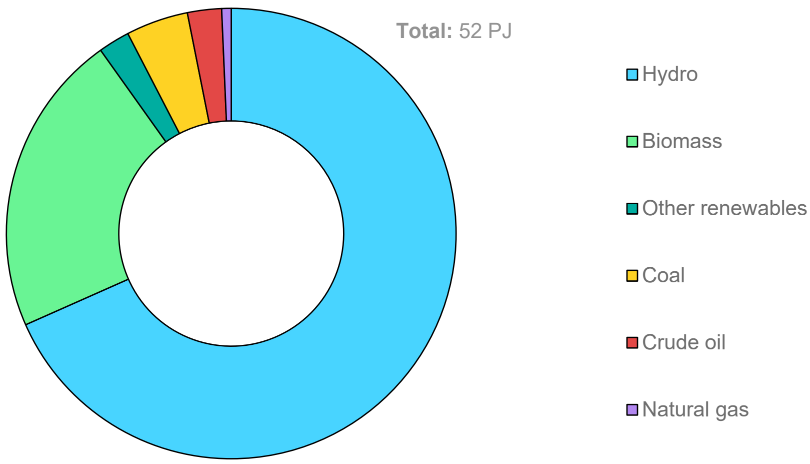
- Adaptive sustainable forest management in the Borjomi-Bakuriani Forest District (implemented).
- The efficient use of biomass for equitable, climate-proof and sustainable rural development (implemented on a small scale only due to lack of financial support).

Georgia's **Nationally Determined Contribution (NDC)** was at the draft stage at the time of writing. If adopted in its current form, it will commit the country to an unconditional target of reducing GHG emissions to 35% below the 1990 level by 2030. The draft NDC recognises the carbon-sink capacity of national forests and aims to maintain their climate change mitigation and adaptation capacities. Consequently, the draft NDC states Georgia's intention to increase the carbon capture capacity of its forests 10% by 2030 (compared with 2015). It also advocates the low-carbon development of the agriculture sector through climate-smart agricultural technologies and services.

Context for bioenergy in Georgia

Georgia's domestic energy production met less than 30% of its demand in 2018, and almost all the fossil fuels the country used were imported from neighbouring countries. Bioenergy accounted for 6% of total primary energy supply and provided one-fifth of all domestic energy production, making it the second-largest indigenous energy source after hydropower.

Figure 1 Georgia's domestic energy production, 2018



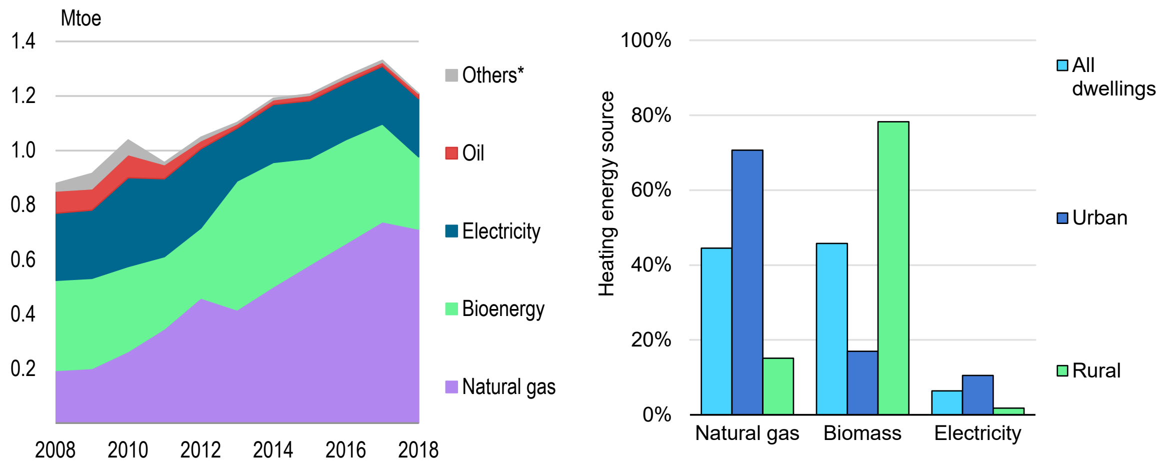
Notes: PJ= petajoule. "Other renewables" = geothermal, solar and wind.

Source: Geostat (2019), *Energy Balance of Georgia*.

Georgia's diverse climatic conditions and substandard building stock mean there is strong seasonal demand for building heat, with most heat consumed between October and March. The types of heating fuels used differ between urban and rural areas. Natural gas is a major source of heating for households in urban areas (accounting for just under 60% of the country's 3.7 million inhabitants), but access to natural gas is not widespread in rural areas, where energy poverty is most prevalent. Even where natural gas supplies are available, many rural households continue to use more affordable firewood for heating. Consequently, rural populations use natural gas mostly for cooking and heating water.

Of Georgia's 1.2 million households, almost half (around 500 000) use biomass as a fuel. It is consumed primarily as fuelwood for heating, and to a lesser extent for cooking. Around 80% of consumption is in the rural areas that are home to just over 40% of Georgia's population.

Figure 2 TFC in Georgia's residential sector (left) and heating fuel by location (right)



* Includes coal, solar thermal, geothermal and district heat; not visible at this scale.

Notes: TFC = total final consumption. Mtoe = million tonnes of oil equivalent (1 Mtoe = 41.9 PJ).

Sources: IEA (2020), *World Energy Balances 2020* (database), www.iea.org/statistics; Geostat (2017), *Energy Consumption in Households*.

Supply

Forests cover around 40% – some 3 million hectares (ha) – of Georgia's land area. They are more than 90% natural in origin and almost universally under state control. Georgia's rural population relies on forestry biomass for its energy needs due to both a lack of affordable alternatives and ingrained cultural practice. The Forestry Agency estimates consumption of 300 000 m^3 to 400 000 m^3 per year to be sustainable. Georgia currently has a "social cutting" policy that allows the population to source a designated volume of fuelwood from the forest. The 2019 social-cutting allocation was set at 392 000 m^3.

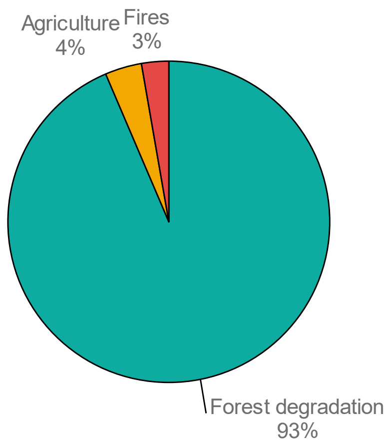
Fuelwood demand far exceeds the sustainable level of supply, however, as Georgia's 2018 energy balance indicates 1.4 million m^3 of consumption. Only 343 000 m^3 of the social-cutting allocation was consumed that year, indicating that around 75% of consumption was unaccounted for; a significant proportion is illegal and unsustainable. Social-cutting licences in remote areas are often underutilised, as illegal harvesting activity in the vicinity of settlements is favoured because it entails lower transport costs.

Given data uncertainties, the level of illegal consumption could be even higher. The 2018 energy balance indicates a 35% downward revision of fuelwood consumption from the previous year. Even accounting for the extension of natural gas access to some rural communities and the depletion of biomass availability around settlements due to forest degradation, this represents a significant year-on-year change. Monitoring illegal woodcutting is highly challenging, as the human resources of MEPA's environmental supervision department are insufficient to cover all of Georgia's extensive forested areas.

The long-term overexploitation of forest resources for firewood results in a range of environmental impacts. Increased soil erosion causes landslides and flash floods, and roughly 3 000 settlements are in danger of environmental disasters. According to a CENN personal communication of 23 January 2020, GEL 500 million (USD 143 million) has been allocated to disaster prevention measures.

Forest degradation in accessible areas (e.g. near roads and settlements) also results in biodiversity loss and lower CO_2 uptake. The estimated annual cost of deforestation in Georgia is between GEL 54 million and GEL 93 million (USD 17-29 million) (World Bank, 2015). From a social perspective, overreliance on firewood raises the risk of fuel poverty in areas where supply is degraded.

Figure 3 Georgian tree-cover loss by cause, 2000-18



Source: MEPA (2020), *Forest and Land Use Atlas*, https://atlas.mepa.gov.ge/?l=en.

National-level data on the state of forests is currently insufficient, hampering long-term forest management planning and the tracking of deforestation. The National Forestry Agency bases plans for long-term management on data gathered from regular forest inventories undertaken in 2013. As of 2020, only one-quarter of territories under National Forestry Agency management had updated their forest management plans for the next ten years.

A National Forest Inventory to monitor the state of the nation's forests has been launched, with fieldwork scheduled to finish by the end of 2021. Once completed, this inventory will enable political decision-making based on robust data and make it easier to evaluate the impact of policies on forests.

Georgia has the potential to utilise a wider range of biomass wastes and residues from forestry, agriculture, industrial and municipal sources for energy purposes. This would diversify domestic heating fuel supplies, both easing pressure on forestry resources and supporting the rural economy.

These resources are largely untapped at present, as the use of biomass wastes and residues is not subject to any formalised government policy or industrial strategy. It is therefore difficult to establish a co-ordinated supply chain between the resource base and the final demand site, and to mobilise the financing needed for the equipment to upgrade these resources to usable fuels. Consequently, only a small number of briquette producers have become established in Georgia, with varying levels of commercial success.

Consumption

Around 80% of Georgia's rural households consume wood for energy purposes. Basic and inefficient heating appliances fuelled by firewood are their main heating system, and almost one-quarter also use fuelwood for cooking. Furthermore, significant quantities of firewood are consumed in the public sector (e.g. in educational buildings, hospitals and offices) and the private sector (e.g. in restaurants and hotels). Unlike other independent states of the former Soviet Union, Georgia does not have district heating infrastructure, as it was dismantled in the 1990s.

The low energy efficiency of the building stock and of heating appliances heightens demand for fuelwood. Three-quarters of dwellings were constructed between 1951 and 1990, and findings from a recent World Bank study indicate that 85% of buildings surveyed had no roof or wall insulation, and almost one-third of the households consulted indicated their homes are cold and damp during the winter (EU, 2020).

Boiler in a kindergarten in the Marneuli region, © Energy Efficiency Center, Georgia

In most households, only a small area of the total building is heated. Underheating residential and public buildings has significant health, social and economic impacts. In 2018, 4% of Georgia's deaths were attributed to underheating, with the corresponding economic cost estimated at 3.5% of the country's GDP (EU, 2020).

Furthermore, Georgia's particulate matter (e.g. PM 2.5 and PM 10) concentrations are significantly above the recommended average in both urban and rural areas. Although there is a range of causes for this, household combustion of firewood (particularly wet wood) in inefficient appliances is a notable contributor.

While the World Health Organisation (WHO) has established an annual average ambient concentration limit for PM 2.5 of 10 microgrammes per cubic metre (μg/m^3) (WHO, 2018), Georgia has yet to set regulatory restrictions for ambient particulate matter. Households with high indoor air pollution may therefore have levels as high as 400 μg/m^3 (World Bank, 2015).

Indoor air pollution from inefficient combustion of solid biomass and poor ventilation also has serious human health consequences, causing 2.5 million premature deaths worldwide each year. The mortality rate attributed to air pollution (indoor and outdoor) in Georgia is around 100 people per 100 000, with the significant economic impact estimated at 2% of the country's GDP (World Bank, 2015). In 2016, the state budget allocated GEL 120 million (USD 34 million) to the treatment of diseases related to air pollution.

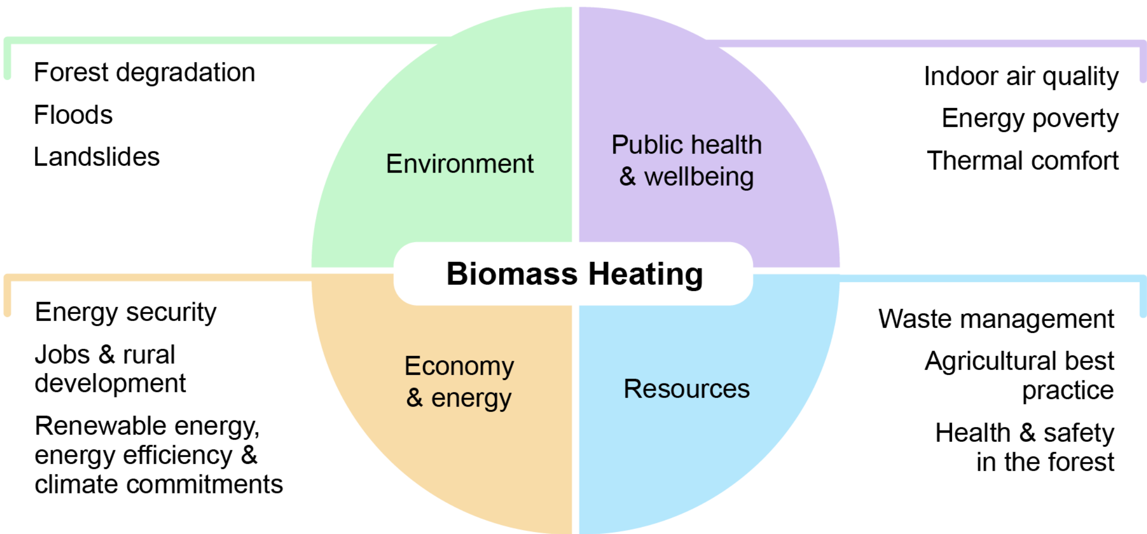
A bioenergy roadmap for Georgia

Biomass use in Georgia has implications not only for the energy sector, but far beyond. As the principal fuel used for household heating in rural areas, biomass is an important part of Georgia's energy system. There is considerable scope to improve biomass supply sustainability and the efficiency of its consumption through better heating and cooking appliances, and to develop a modern bioenergy industry based on upgraded biomass fuels produced from diverse waste and residue feedstocks and potentially energy crops.

These developments would help counteract the negative impacts of the current unsustainable use of Georgia's forestry resources, as well as facilitate modern bioenergy applications to support some of Georgia's economic, environmental and social goals. These include:

- Improving energy security by maximising consumption of domestic energy resources rather than increasing reliance on imported natural gas and other fossil fuels.
- Ensuring the sustainable use of natural forest resources and the integrity of the natural environment and reducing the risk of natural disasters such as floods and landslides.
- Expanding formalised employment in biomass fuel supply in rural areas.
- Reducing the health impacts of indoor air pollution.

Figure 4 Wider considerations associated with biomass heating in Georgia



Fundamentally changing current practices in biomass supply and consumption is complex and requires a co-ordinated effort across government ministries and departments, the private sector and international development agencies. A more comprehensive set of policies, support schemes and regulations will be required to establish a modern bioenergy industry. For this reason, the government of Georgia should consider packaging the range of actions needed to modernise the use of biomass resources into a dedicated bioenergy strategy.

To facilitate the development of such a strategy, this roadmap focuses on:

- Ensuring biomass supply sustainability
- Modernising the consumption of biomass fuels.

For each of these points, the following sections offer examples of international best practices and suggested polices for Georgia's current context.

However, while improvements in these two areas are important, these alone will not be sufficient to remedy the environmental issues associated with the management of Georgia's forestry resources, or social problems such as fuel poverty and indoor air pollution. This will also require comprehensive action in a number of areas outside the scope of this roadmap, such as raising the energy efficiency of the housing stock and supporting the installation of a wider range of sustainable heating systems such as solar thermal panels and heat pumps.

It may also be necessary to evaluate the extent to which public investments affect the achievement of sustainability goals. Other areas that warrant further assessment are fossil fuel subsidisation (e.g. related to natural gas infrastructure and consumption) and policies related to waste management.

Ensuring biomass supply sustainability

Employing best-practice forestry management can ensure biomass fuel supplies while avoiding deforestation and its associated environmental impacts. Furthermore, using waste and residues can diversify the types of biomass used as heating fuels and reduce pressure on Georgia's forestry resources, while also providing rural job creation opportunities and an avenue for managing municipal, agricultural and forestry wastes and residues. The principal objective of this section's recommendations is not necessarily to raise bioenergy use from the current level, but to replace firewood with a diverse set of other fuels from sustainable feedstocks.

Georgian context

This section provides an overview of the different biomass resources available in Georgia.

Forestry management and forest residues

There is considerable scope to improve the management of Georgia's forests, and the production of sustainable biomass fuels.

An update to Georgia's Forest Code was approved by parliament in May 2020 and will come into force in 2021. The updated code creates a legal basis for sustainable forestry management processes and will strengthen the state's capacity to supervise and detect illegal forest activity. Clearcutting of forests is prohibited in Georgia.

Georgia's current "social cutting" policy allows the population to source a designated volume of fuelwood from the forest. Under this policy, the Forestry Agency determines annual quotas and marks trees that can legally be cut. However, this policy and the wider issue of illegal firewood harvesting is problematic for many reasons:

- Unqualified people with inadequate equipment often carry out firewood sourcing. This damages the forest ecosystem, and a lack of supervision heightens the risk of accidents.
- Black market activity deprives the state of revenue and diverts timber suitable for higher-value uses (e.g. wood products) to lower-value energy production.
- Illegal firewood sourcing commonly overlooks trees in remote or difficult-access areas permitted for felling under the social-cutting quota, in favour of more accessible trees in already degraded areas around towns and villages that present lower logistical challenges and costs.
- Illegal fuelwood sourcing leaves a significant portion of forestry residues in the forest, which:
  - increases the risk of forest fires, to which 400 000 ha of Georgia's forested area is vulnerable, as well as insect infestations
  - prevents forestry residues from being upgraded to heating fuels such as woodchips, wood pellets or briquettes that are suitable for modern heating appliances.
- It hinders the market prospects of more sustainable fuels, as the extra collection and processing costs for wastes and residues cannot compete with low-cost unsustainably sourced logwood.

The updated Forest Code proposes abolishing the social-cutting system by 2023 – a key step to resolve some of the issues outlined above. Nevertheless, given citizens' reliance on fuelwood for residential heating and cooking, affordable alternative heating fuels must be made available to reduce fuel poverty and maintain social stability.

One solution is to maximise the use of available forestry residues, such as those that have accumulated in forests after illegal forest harvesting and those arising from environmental events, as well as biomass made available through forest management practices not currently being undertaken, e.g. from thinning and the removal of bush species to promote new forest growth.

Residue recuperation could provide around 8 PJ of material annually to produce upgraded biomass fuels (WEG, 2014) – more initially, as these unexploited resources have accumulated over time. However, as this assessment includes residues arising from illegal forest activities, their successful phaseout could reduce this energy potential by approximately half.

Challenges associated with using these forestry residues include collection costs given the difficult terrain in many areas, logistics because of limited road networks in some areas, and the lengthy time required for residues to dry to a suitable energy content for upgrading.

The revised Forest Code should reduce the supply of fuelwood and correspondingly increase its cost, thereby improving the relative economic case of more sustainable upgraded fuels. Nevertheless, supportive measures are still required to establish a forestry residue conversion business case that will be attractive to the private sector.

The updated Forest Code also proposes that the Forestry Agency provide biomass fuels at forest borders. The details of how this will be undertaken are still in development, with the creation of a public body to oversee these activities a potential option. Several business/supply yards have already been constructed for this purpose, and their number is planned to increase to over 50 by the end of 2021. Although this is encouraging, the scale of fuelwood consumption in the country may require even more facilities. These facilities could also serve as centres for forestry residue collection.

The price of residues is currently similar to the social-cutting licence fee, which is likely to make the use of forestry residues for fuel production uncompetitive. Selling forestry residues through an auction system is therefore under consideration.

Sawmills are a prime source of biomass supplies for the manufacture of upgraded fuels. They produce easily collectable sawdust, a feedstock that can be used for biomass briquettes and pellets. Sawdust from Georgia's sawmills is largely unused, and annual production potential has been assessed at 0.3 PJ (WEG, 2014).

Furthermore, sawdust has accumulated over the years due to a lack of legal disposal options for sawmills, although illegal burning and dumping into rivers has also occurred, causing negative environmental impacts to the air and water. Facilitating the use of sawdust will require the development of localised solutions for supply logistics, drying (as sawdust initially has a high moisture content) and upgrading.

Agricultural wastes and residues

Agriculture is a key sector of Georgia's economy and provides employment for more than half the population. Around 35% of the country's territory is agricultural land, of which 30% is for perennial crops and the rest is sown annually. The country practises mainly subsistence agriculture, and it is therefore fragmentary, with more than 90% of agricultural output from small-scale family-run farms and smallholdings.

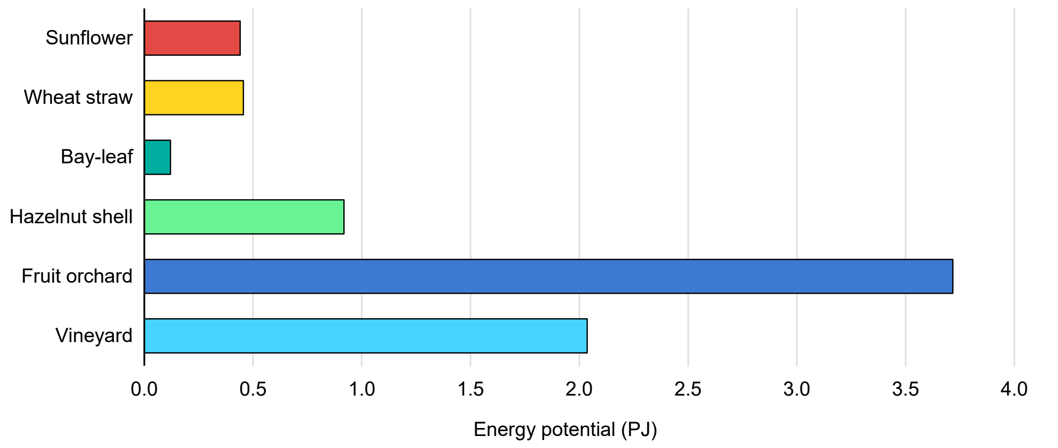
Crops produce biomass residues that can serve as feedstock for briquettes and pellets. Upgrading these residues to fuels is important: first, it increases the energy density of the material (i.e. energy per m^3) allowing for more economical transport over longer distances; and second, it makes the crop residues suitable for more efficient use in modern heating appliances.

Crop residues come from several sources:

- Perennial crops: vine pruning and pressing residues; fruit orchard pruning and pressing residues; hazelnut shells; walnut shells; and bay leaf residues.
- Annual crops: corn, wheat and barley straw; and sunflower residues.

Analysis indicates these residues have a theoretical energy content of 28 PJ, and an achievable energy content of roughly 7.7 PJ (WEG, 2014). Some of these residues are already used for non-energy purposes, however (e.g. straw for animal bedding).

Figure 5 Deliverable potential of agricultural residues in Georgia



Source: WEG (2014), Assessment of Wood and Agricultural Residue Biomass Energy Potential in Georgia, http://weg.ge/sites/default/files/final_report-weg_0.pdf

Although some agricultural residues are already used for energy, it is generally in isolated and informal cases. There are examples of bay leaf and vineyard residue use for agro-industrial heating and drying purposes, and in the Samegrelo and Guria regions it has been shown that with minimal adaptions, boilers and stoves can use hazelnut shells directly.

Overall, however, very little agricultural residue potential has been realised because of collection and logistics challenges that make it difficult to ensure reliable fuel supplies. Residues are produced seasonally: for example, waste biomass is available from spring to autumn while heating fuel demand is highest in the autumn and winter, requiring fuel storage and raising costs. In addition, the bulkiness of many agricultural residues means transport over distances of more than 50 km (and sometimes less) is uneconomical, making it more logical to favour local use or upgrade to increase fuel energy density.

Consequently, agricultural residues either remain uncollected or in some cases are burned in the field (e.g. wheat straw and vine trimmings). Not only does this not valorise their fuel potential, it produces particulate matter emissions that deteriorate air quality. Field burning can also unintentionally destroy windbreak trees, which is detrimental as the soil in many parts of Georgia is susceptible to wind erosion.

Wine production in Georgia is expanding rapidly. Vine trimmings are produced seasonally, usually during the three-month spring period, and there is no industry standard for their sustainable disposal. They are commonly burnt, as transportation and storage costs outweigh their value for fuel production in the current market context. If this dynamic were to change, vine-pruning residues could be converted to heating fuels through baling, drying and size-reduction processes (e.g. shredding). Following this they could also be upgraded to pellets.

There is potential for wine producers to either produce fuels or, to avoid the trimming, collection and disposal costs that would otherwise be borne by the winery, enter into a mutually beneficial relationship with fuel producers to take trimmings for fuel production. Costs can be around GEL 100/ha (USD 30/ha) for trimming and collection, with additional disposal costs. In 2020, a project was initiated in the Telavi municipality to test equipment for collecting and processing vine clippings, with the goal of providing heating fuel for two municipal kindergartens.

Aside from difficulties in establishing supply chains, further challenges need to be overcome to accelerate the development of agricultural residue-based fuels so that they can make a notable contribution to the biomass fuel market:

- Price escalation from suppliers once they realise there is a market for previously unused residues.
- Agricultural residues are not covered under waste management legislation, so producers are not obligated to collect and use them sustainably.
- A universal value-added tax (VAT) of 18% is applied to all fuels, with no distinction between fossil and renewable.
- High capital costs for small-scale producers to invest in the equipment necessary to upgrade residues to fuels.

Banks do not offer producers low-interest credit to purchase fuel upgrading equipment, leaving them with limited alternatives to taking out regular loans at high interest rates, commonly >10%.

Energy crop plantations

Energy crops can further diversify the supply of biomass fuels, and Georgia appears to have favourable climatic conditions for the cultivation of certain species, notably poplar, which grows well on poor-quality (e.g. high-moisture-content) land unsuitable for food crops, and alder species. A decline in Georgia's agricultural output has increased the share of unused agricultural land to roughly 130 000 ha (40% of all arable land) (World Bank, 2015).

Poplar plantations could provide feedstock for fuel briquette production (one has already been established in western Georgia). One plantation developer has indicated a calorific value for poplar of around 15 megajoules per kilogramme (MJ/kg), equal to fuel costs of around GEL 28 per gigajoule (/GJ) (USD 8.5/GJ). Poplar can offer a heating value of up to 20 MJ/kg, however, which would reduce fuel costs in energy terms.

Nevertheless, as other non-energy uses for poplar exist (e.g. for furniture and windbreaks[1]), plantation owners would need to assess which markets offer the highest returns, meaning that plantations may not always be used to produce fuel once established.

[1] Trees planted, usually in rows, to provide shelter from the wind and to protect soil from erosion.

Poplar trees (© Marani JSC)

Another potential benefit of energy crop plantations is rural job creation, as people are required for planting, maintenance and harvesting, as well as for fuel production. The number of jobs (e.g. jobs per hectare of land) will fluctuate over a plantation's lifetime, however, with most employment opportunities arising in the planting and harvesting phases.

International experience shows that developing markets for energy crop production can be difficult. From a production standpoint, securing investments to establish plantations is challenging because an initial investment is required to purchase and clear the land and plant the crop, and the subsequent delay before any revenues are realised is long (for poplar trees, the first harvest could be five years after planting). Some economic support from the government and offtake commitments for fuel are therefore likely to be needed to kick-start plantations. The GEDF has received one application for an energy crop plantation project.

Municipal waste

Georgia has over 60 registered landfills, around 30 unofficial ones in villages without formalised waste management services, and numerous illegal dumping areas. There is considerable scope to modernise waste management and reduce associated environmental impacts to land, water and air, and the release of methane[2] from waste disposal. With donor and international financial institution (IFI) support, old landfills are being closed and remediated, and new landfills compliant with EU requirements are being constructed.

A modernised waste management sector would also include EfW plants. There are currently no EfW plants in Georgia and no landfill gas production, and municipal waste is not segregated to produce refuse-derived fuel (RDF). Urban green waste also goes into landfills.

[2] According to the Intergovernmental Panel on Climate Change (IPCC), methane's global warming potential is 28 times that of CO2 over a 100-year timescale (UNFCCC, 2016).

The 2014 Waste Management Code:

- Stipulates that waste segregation should begin in 2020.
- Prohibits the burning of waste other than in permitted incinerators.
- Requires that municipalities prepare waste management plans.
- Calls for a strategy with concrete targets and measures to reduce the landfilling of biogenic waste.

Implementing these requirements has proved challenging so far. While many municipalities are integrating provisions from municipal waste management plans, actual progress (e.g. to improve waste separation) is currently limited. However, as successfully meeting these targets will enhance the quality of waste management and facilitate EfW project development, Georgia has adopted a National Waste Management Strategy for 2016-30 to guide implementation.

Unfortunately, Article 2 of the Waste Management Code specifically excludes non-municipal biomass materials, e.g. agricultural/forestry residues and sewage. This permits informal biomass residue utilisation and is not conducive to best-practice use of these resources.

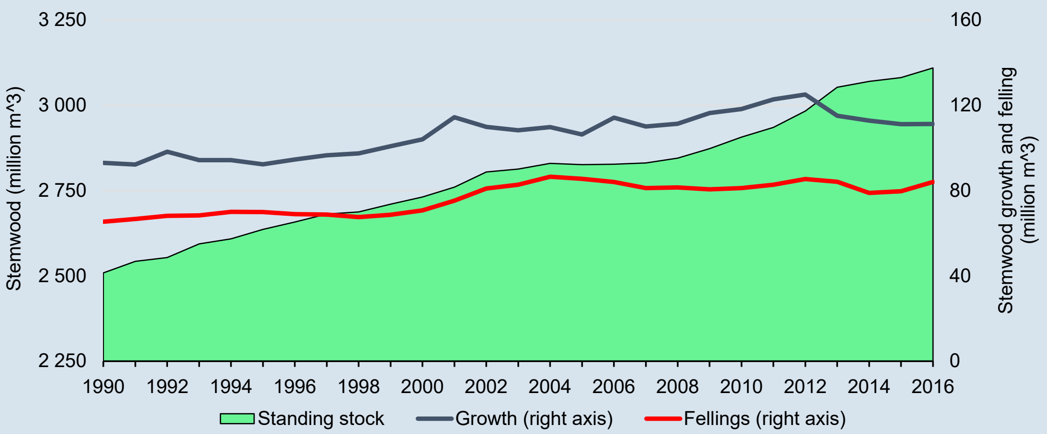
International best practice in biomass supply

Box 1 Sustainable forest management in Sweden

In Sweden, bioenergy plays a central role in all aspects of the energy system. Bioenergy accounted for one-fifth of the country's final energy consumption in 2017, and more than half of all space heating in the housing and services sectors (Svebio, 2020).

Sweden's solid biomass supply is highly sustainable: despite a near-doubling of solid biomass in primary energy supply since 1990, forest stock (i.e. the volume of living wood) has increased 23% through sustainable forestry management, with growth exceeding felling.

Forest standing stock, growth and felling in Sweden, 1990-2016



Sources: Swedish National Forest Inventory (2020), *Forest Statistics*, https://www.slu.se/foreststatistics, adapted from Svebio (2020), *Roadmap Bioenergy: Meeting the Demand for Bioenergy in a Fossil Free Sweden.*

Swedish forest law considers that all forests with a growth rate of more than one cubic metre per year are productively managed forests. Over 60% of productive forest land is certified, mostly through the Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) schemes.

Around 70% of forest wood growth is felled each year, and the remainder is untouched, providing ongoing carbon uptake. All elements of harvested trees are used, with the highest-value material used for lumber, pulp and paper products, and other wood products. Higher-value stemwood is generally not used for energy, with the exception of small trees removed from forest management operations (e.g. through clearing and thinning), or when it has been discarded and cannot be used for industrial purposes.

Biomass for energy use is integrated into the Swedish approach. Biomass fuels are produced from wood-processing residues from the abovementioned industries (e.g. bark, shavings and wood chips) and from felling residues (e.g. branches and tops) that are unsuitable for industrial use. Less than 10% of all harvested material (by energy content) is used for bioenergy production.

Harvested areas are replanted, with this form of active management leading to higher growth than in mature forests and therefore greater CO_2 uptake. Furthermore, sustainably managed forests are more resistant to forest fires and infestations, reducing the risk of significant CO_2 release that can result from such events.

Agricultural residues

Denmark is also a leader in bioenergy. Biomass makes up over one-fifth of primary energy supply, and over half of all fuel used for district heating. Since Denmark does not have notable forest resources, in addition to importing biomass fuels it has developed the technology to use domestic straw residues from agriculture.

Straw boiler plant (© AffaldVarme Aarhus)

Such modern systems can achieve efficiencies of over 90% but require specialised straw-bale feeding mechanisms and tightly controlled combustion temperatures to manage air pollutant emissions (e.g. from fly ash) and avoid technical problems such as slagging that arise when ash melts inside the boiler.

Europe possessed around 45% of global vineyard area in 2015 (Karampinis, 2020), with the majority in France, Italy and Spain. The production of biomass fuels from harvesting residues is not widespread, although there have been some trials and successful examples of small-scale commercial production from fuels used on-site or supplied locally.

Experience indicates that careful planning is required if vineyard residues are to be used for energy purposes. Initial assessments should comprise 1) an evaluation of local conditions (e.g. biomass productivity [tonnes/ha]) and identification of end uses; 2) a selection of appropriate harvesting methods and equipment; and 3) confirmation that combustion equipment is suitable (Karampinis, 2020).

Harvesting equipment also needs to be appropriate to ensure suitable characteristics (e.g. chip size) and – crucially – to avoid introducing contaminants such as soil and stones. For this reason, mechanical systems that avoid soil lifting are preferable. Where average landholdings are small, co-operative business models are likely to be most favoured. After harvest, a drying period will probably be required to reduce moisture content.

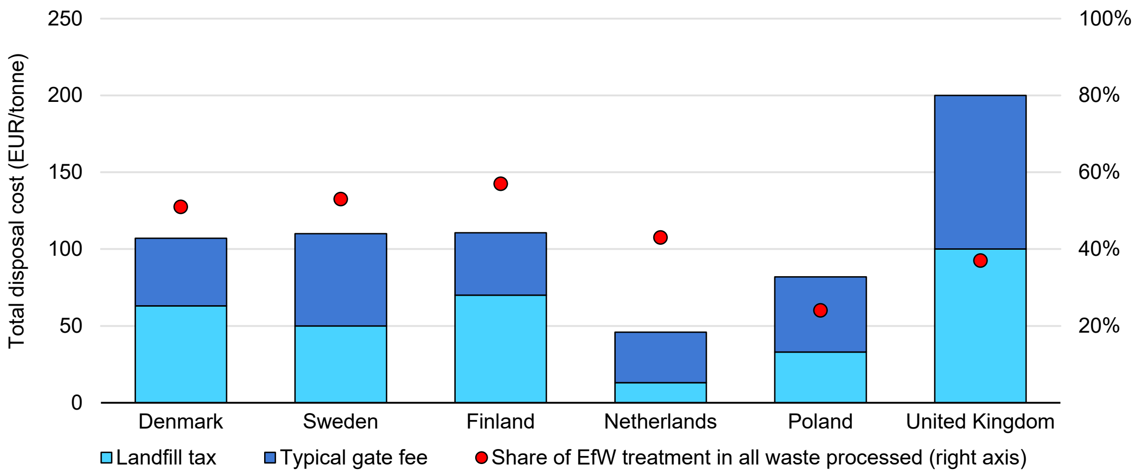
Because the low energy density and form of vine cuttings impede direct utilisation in small-scale combustion systems, initiatives in Europe have focused on energy densification through pelletisation. As vine prunings generally have a lower fuel quality than woody biomass, with higher ash, nitrogen and potassium content, sophisticated feeding and combustion systems and/or appropriate biomass cleaning are needed prior to pelletisation.

Energy from waste (EfW)

Energy recovery from municipal wastes offers multiple benefits compared with landfill disposal, as indicated by its higher position in the waste management hierarchy.[3] EfW facilities reduce waste volumes significantly and require less land area than landfill sites. From a sanitary and environmental perspective, compared with landfilling, energy recovery reduces odours, GHG emissions, and emissions to the groundwater and soil. EfW technology also offers electricity and heat close to the point of demand using locally available resources, which diversifies the local energy supply.

[3] EfW should be deployed according to its place in the wider waste management hierarchy of prevention, preparing for reuse, recycling, (energy) recovery and disposal.

Figure 6 Waste disposal costs and share of EfW in selected countries



Note: A "gate fee" is the payment treatment facilities charge waste disposers to accept their waste. As gate fees vary, the figure reflects the assessed average.

Source: Eurostat (2020b), *Municipal Waste Statistics* (database), https://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics; CEWEP (2017), "Landfill taxes and bans", https://www.cewep.eu/landfill-taxes-and-bans/.

In the European Union, almost 30% of waste (by volume) produced in 2017 was used to produce energy. However, several countries achieved higher shares, with four over 50%: Denmark, Sweden, Finland and Norway. There is a close correlation between waste disposal costs and EfW deployment, as all four countries have landfill taxes and certain forms of landfill bans, e.g. for organic material.

EfW projects can be highly sustainable. In the Netherlands, for example, the city of Utrecht has a 30-megawatt thermal (MW_{th}) biomass plant that provides heat to 50 000 households and businesses through a district heating system. The plant uses biomass fuels produced from green waste from the maintenance of parks, public gardens and forests in the region.

Key policies for biomass supply sustainability

Key overarching actions

- Actively implement the updated Forest Code drawn from best-practice sustainable forestry management principles (e.g. of the FSC and PFEC) adapted to the Georgian context.
- Promote an appropriate transition away from the social-cutting policy, with measures that ensure affordable and sustainable alternatives to fuelwood to avoid increasing fuel poverty.
- Establish a regulatory framework for the collection and disposal of commonly produced agricultural residues, which prohibits in-field burning and facilitates sustainable energy uses.
- Formally adopt a strategy for the production of upgraded biomass fuels such as pellets, woodchips and briquettes, identifying key steps to develop self-sustaining businesses. Such a strategy was produced with support from UNDP but is yet to be approved.

- With international donor support and using best-practice examples, enact replicable sustainable biomass fuel and waste management pilots to identify those with most promise.

Specific policies and actions for consideration

Forestry:

- Expand the number of Forestry Agency business yards (for forestry residue collection depots) and potentially as locations for fuel upgrading, with equipment purchased through PPPs or co-operatives.
- Consider transferring some current harvesting and fuelwood jobs in rural areas to a sustainable biomass industry.

Agricultural residues:

- Obtain international donor assistance to aid 'technology leapfrogging' to the most appropriate equipment and processes to combust straw and other agricultural residues.

Energy crop plantations:

- Support the establishment of a 'showcase' energy crop planation, with the aim of guaranteeing a future offtake of fuel produced for public sector heating demand.

Wastes:

- Adopt policies to increase the cost of (or prohibit) landfill waste disposal, such as banning the landfilling of certain materials or imposing landfill taxes, to encourage higher-value end uses, including EfW processing.
- Enact the collection of urban green wastes and source segregation of municipal solid waste (MSW) to improve waste management and boost supplies for fuel production.
- Assess the amount of waste and residue feedstock available for biogas production and determine the contribution biomethane could make to natural gas supplies.
- Develop a regulatory framework that covers biomass waste and residues and requires disposal routes in keeping with the waste management hierarchy (including energy recovery).

Modernising biomass consumption

The single most effective measure to improve the sustainability of biomass use in Georgia is to transition to more efficient heating appliances. Using more sophisticated biomass heating systems that combust upgraded fuels has multiple benefits. First, replacing the basic systems used for biomass combustion with improved heating appliances would offer more controlled and complete combustion, which, coupled with adequate ventilation (e.g. a flue), would reduce indoor air pollution and consequential health impacts. Thermal comfort and automation would also be improved.

Second, higher-efficiency modern systems using upgraded fuels means less fuel for the same heat output, reducing pressure on Georgia's fuel supply and forestry resources. Furthermore, programmes to install improved biomass heating systems and develop supply chains for upgraded fuels create skilled jobs, e.g. in system installation and maintenance, fuel upgrading and logistics.

Georgian context

This section outlines the heating appliances and types of biomass fuels used in Georgia.

Heating systems and appliances

Basic firewood heating stoves are commonly used. They generally have a low efficiency of 25-35% (GIZ, 2019), although stove efficiency is not verified through testing. Their design is simple, with no mechanism to control air inflow, and they are not airtight. Consequently, combustion is uncontrolled and occurs quickly at high temperatures, and the lifespan of basic stoves is relatively short at around five years. Open fires, which are even less efficient, are also commonplace.

Combustion efficiency is hindered by many households using wet firewood to slow the pace of combustion. In a residential context, it is advisable that solid biomass fuels not have a moisture content >25%, as higher moisture levels reduce the combustion temperature and result in greater smoke formation and health-damaging particulate matter emissions.

Table 1 Typical emissions factors for various biomass heating devices

Biomass heating device	PM (g/GJ)	% organic carbon
Open fireplace	322 - 1 610	40 - 75%
Simple log stove	140 - 225	50%
Modern log stove	46 - 90	20%
Pellet stove	3 - 43	10%
Pellet boiler	3 - 29	5%
Biomass boiler without emissions control	28 - 57	3%
Biomass boiler with emissions control	8 - 15	2%

Note: g/GJ = grammes per gigajoule.

Sources: Koppejan and de Bree (2018), *Kennisdocument Houtstook in Nederland* [*Knowledge Document in the Netherlands*]; Vincente and Alves (2018), "An overview of particulate emissions from residential biomass combustion".

In Georgia, fuelwood generally has moisture content well in excess of 25%, and up to twice as high. Drying wood from 40% to 25% moisture content can increase its energy content by around 40%,[4] but requires air-drying for several months in dry conditions. Drying equipment can reduce moisture content far more quickly but entails additional cost.

The single most effective measure to improve the sustainability of biomass use in Georgia is to transition to more efficient heating appliances. Changing to more modern heating stoves and boilers is required for two key reasons: first, to increase the efficiency of fuel combustion; and second, to facilitate the use of drier wood fuels and (preferably) upgraded fuels produced from a diverse set of biomass feedstocks. Both would reduce pressure on Georgia's forestry resources from residential heat demand.

Improved wood stoves with combustion chambers and air inlet controls are produced domestically on a small scale and in a nonstandard manner. They are likely to be more

[4] An approximate increase from 10 MJ/kg to 14 MJ/Kg.

efficient than basic stoves, but the extent of their efficiency has not been fully quantified due to a lack of testing programmes. Nevertheless, an improved Svanetian stove with 45% efficiency can reduce firewood consumption by around one-third compared with a 25%-efficient appliance, while a stove with 75% efficiency would cut firewood consumption by two-thirds compared with the basic alternative. In both cases, using a more efficient stove considerably reduces the cost of delivered heat for a household.

As the energy efficiency performance of stoves varies significantly from one model to another, standardisation, which in turn permits certification (e.g. of energy efficiency performance) is crucial to promote domestic stove manufacturing. In Akhmeta, GIZ is undertaking a programme to foster the development of alternative, energy-efficient and renewable energy sources, which will focus on testing, standardising and certifying energy-efficient stoves.

Domestically produced wood stoves cost GEL 300-550 (USD 95-175), equating to (at the upper limit of the price range) half of a rural Georgian household's average monthly income in 2019. Despite the higher purchase cost, an improved stove can pay for itself quickly (i.e. in less than one year) thanks to its higher efficiency.[5] However, the general population is largely unaware of the benefits of improved heating appliances.

Although better-quality imported household stoves are available on the market, their higher capital costs mean they are generally not an economically viable alternative for most households without innovative support measures or financing schemes. There is also a lack of suitably trained system specifiers, heating engineers, installers, etc., and turnkey solutions are uncommon.

Most current initiatives using improved heating systems are feasibility studies or one-off pilot projects. Some pilot projects in public buildings have used imported "best-in-class" biomass boilers that offer high levels of efficiency and automation, but their long-term use requires a reliable supply of suitable fuel and qualified maintenance engineers, which can be challenging to find in Georgia. The high quality of such systems also means elevated capital costs, so these projects are often not replicable without financial support. More widespread deployment would therefore require ongoing development financing.

Upgraded fuels

While the use of fuelwood is culturally ingrained, the consumption of other forms of biomass fuel is not. As awareness of biomass pellets, briquettes and other upgraded biofuels is low, their use remains very limited.

Briquettes have favourable combustion characteristics compared with fuelwood: higher calorific value owing to their lower moisture content, and higher density. Consequently, they burn for longer at more uniform temperatures and more efficiently, offering greater thermal comfort.

The market for briquettes is relatively undeveloped, but there are early signs of growth. In 2019, around 15 000 m^3 of firewood demand was replaced with briquettes. Domestic production is estimated in the range of 5 000 to 7 000 tonnes per year, equivalent to roughly 1% of all biomass fuel (by energy value) used in Georgia. Production is from small companies, and key supply-side market challenges are to mobilise feedstock supplies (e.g. sawdust or hazelnut shells) and to access capital to invest in production equipment. There

[5] Based on a purchase cost of GEL 60 of a basic stove (25% efficiency) compared with an improved stove (45% efficiency) at GEL 300 or an efficient stove (75% efficiency) at GEL 500.

have been instances in which production growth has been constrained by local feedstock availability or feedstock price escalation.

The main briquette consumers are public bodies (e.g. schools and municipal buildings), as general consumer awareness remains low, with most new customers learning of the fuel through word of mouth. In some case, briquettes have had to be provided free of charge for a period to demonstrate their additional value over fuelwood. Supplying end users over great distances is generally uneconomic, ruling out markets far from production sites that are located based on feedstock availability. Meeting household demand is also problematic due to low purchase volumes and the lack of retail outlet suppliers. The approximate cost of briquettes delivered to end users is around GEL 500/tonne.

Although public procurement could help boost supplies and support early-stage market development for upgraded fuels, procurement practices have instead hindered market access for some independent fuel suppliers. This has occurred where state procurement guidelines have specified that public buildings may purchase logwood only or must source the least costly (and not necessarily the best) fuel. Many tenders specifically request firewood or are based on volume rather than heat content, as municipal governments lack the heating expertise necessary to make informed fuel supply decisions. Furthermore, some public institutions do not pay for heat, so have no incentive to maximise efficiency.

General obstacles to market development for all types of upgraded biomass fuels include:

- Low and, in the case of illegal consumption, zero-cost unsustainable firewood supplies.
- A lack of consumer awareness regarding upgraded fuels, and unfamiliarity with the concept of purchasing fuels or heat energy in many areas.
- Challenges in establishing reliable supply chains for feedstocks and upgraded-fuel distribution.
- High interest rates for entrepreneurial fuel producers seeking the capital necessary to purchase equipment to expand operations.
- Absence of supportive policies and financial mechanisms for production and consumption.
- Incompatibility with the basic stove types commonly used in rural areas.

Other initiatives to produce modern biomass fuels and take advantage of the variety of untapped resources available in Georgia are not widespread. Only a limited number of cases use agricultural residues for energy, mostly linked to processing industries. A number of isolated biogas pilot projects have also been initiated; for example, the European Investment Bank has supported upgrading of Kutaisi's municipal water sector infrastructure, which will involve biogas production. Generating thermal energy from waste (e.g. through co-generation) is not utilised.

Stove and fuel economic analysis

An economic analysis of the cost of fuelwood and briquettes used in appliances of different efficiencies has been conducted to aid decision-making. Key findings are outlined below.

Table 2 Fuel and delivered heat costs

Fuel	Fuel cost range (GEL/GJ)	Stove type and combustion efficiency	Reference stove capital cost (GEL)	Delivered heat cost range (GEL/kWh)
Firewood	13-18	Basic, 25%	60	0.18 – 0.26
Firewood		Improved, 45%	300	0.10 – 0.15
Firewood		Efficient, 75%	500	0.06 – 0.09
Briquettes	23 - 32	Basic, 25%*	60	0.24 – 0.33
Briquettes		Improved, 45%	300	0.19 – 0.26
Briquettes		Efficient, 75%	500	0.11 – 0.16
Natural gas	16 - 17	Boiler, 90%	1 500 - 3 000	≈ 0.06

* Using briquettes in basic stoves is not recommended for safety reasons.

Notes: kWh = kilowatt hour. Moisture content of firewood: 40%; briquettes: 12%. Lower calorific value of firewood: 10 MJ/kg; briquettes: 17 MJ/kg. Natural gas boiler costs do not include the cost of internal heat distribution pipework and radiators.

Source: Eurostat (2020a), *Gas Prices for Household Consumers* (database), https://ec.europa.eu/eurostat/data/database.

Fuel costs for firewood are lower than for briquettes; however, the cost of delivered heat from briquettes used in an improved stove is broadly similar to firewood in a basic stove – plus they offer greater thermal comfort, lower air pollutant emissions and reduced pressure on forestry resources. The cost of delivered heat using briquettes in an efficient stove is lower than for firewood in a basic stove.

Using briquettes in basic stoves is not advisable due to the combination of their high combustion temperature and the thin lining of basic stoves, creating potential for injury. It should also be noted that using briquettes in simple stoves can shorten the appliance's lifespan due to their high burning temperature. Basic stoves are also not suitable for other upgraded fuels such as pellets or wood chips, creating a market barrier for these fuels.

Annual fuel costs for an average household with heat demand of 4 000 kWh per year (equivalent to 11 m^3 of firewood) would therefore be roughly the same for firewood in a basic stove and briquettes in an improved stove, with both in the range of GEL 750-1 050/year (USD 230-325/year). Annual fuel costs of using briquettes in an efficient stove would be lower, at GEL 450-620/year (USD 140-193/year).

Compared with the upper-limit cost of using firewood in a basic low-efficiency stove, the energy savings offered by using low-cost briquettes in an improved stove would easily pay for the additional cost of the appliance in less than one year. Assuming mid-range fuel costs for using firewood in a basic stove, the extra investment for an efficient stove using briquettes could be paid back in 12-18 months.

Georgia's household natural gas costs, which are subsidised, were the lowest in Europe in 2019, at around one-quarter the average EU residential gas price. Household gas prices were also one-third lower than commercial rates in 2019. These artificially low gas prices, combined with the high efficiency of modern gas boilers, offer more delivered heat per cost than unsubsidised briquettes and even fuelwood – even in the most efficient stoves. However, several factors must be considered:

- The prohibitive capital cost (for many households) of a modern natural gas boiler, as well as further heat distribution pipework and home radiator expenses
- The cost to the state of subsiding natural gas prices on a per-unit basis and the extension of natural gas transport infrastructure to rural areas
- Energy security implications, as natural gas is almost entirely imported.

The current very low gas prices as a result of the COVID-19 crisis offer the Georgian government an opportunity to reassess fossil fuel subsidies.

International best practice in biomass consumption

The following examples of good international practices can help guide the development of sustainable biomass consumption in Georgia.

Box 2 Residential wood pellet markets in Austria and Italy

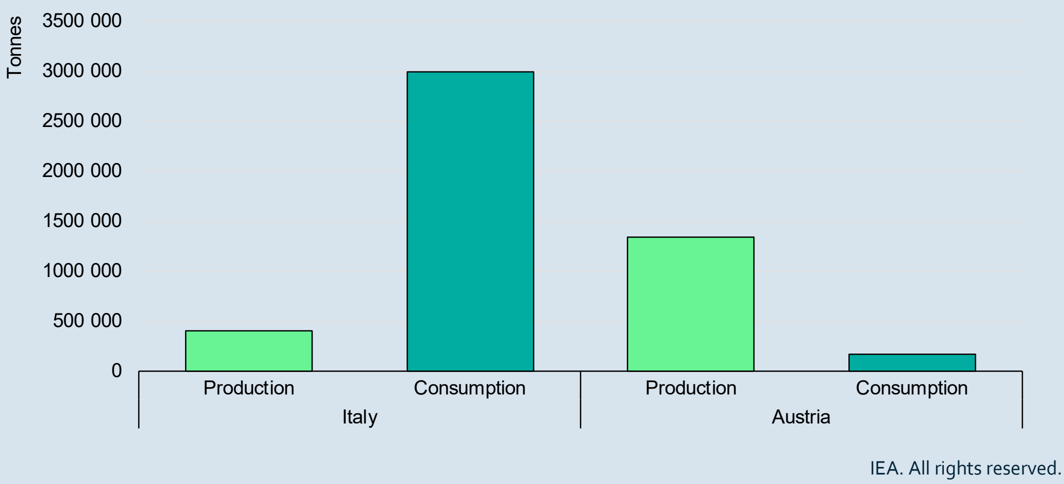
Residential and commercial heating accounts for over half of all wood pellet consumption in the European Union. Austria and Italy are two of the major residential wood pellet markets.

In Italy, biomass provided around one-fifth of residential heat demand in 2018. Around 9% of households have a pellet stove, equating to 2.4 million installations and 3 million tonnes (Mt) of wood pellet consumption in 2018, by far the largest domestic market globally.

In Austria, biomass met close to 30% of residential heating demand in 2018. Austria's pellet stove market is smaller at around 50 000 units (1% of households), but installations are on an upward trend, expanding by two-thirds over 2010-18. Large-capacity biomass heating systems are more common in Austria. Around 3% of households own biomass boilers, and biomass district heating is also used.

New installations are commonly modern automated systems that offer around 90% efficiency and comply with air pollution regulations, thanks to combustion control to ensure optimal combustion temperatures and air-to-fuel ratios. Plus, certification ensures appliance quality: for example, in Italy, AriaPulita certifies domestic appliances and provides a star rating based on efficiency and emissions. The pellets most commonly used in both countries meet the highest quality specifications (A1), having less ash content and therefore lower associated particulate matter emissions.

Wood pellet market overview in Austria and Italy, 2018



Source: Bioenergy Europe (2019), *Statistical Report 2019: Pellet Report.*

Around 80% of feedstocks for pellet production in Italy are secondary residues from wood processing. However, Italy also imports wood pellets because its demand exceeds national production capacity and feedstock availability. Additional supplies come mostly from neighbouring Austria, which has over three times Italy's production capacity. All of Austria's wood pellet production comes from secondary residues.

Policy has played a key role in promoting the use of residential biomass heating systems. In Italy, renewable heat installations are eligible for a tax reduction. Alternatively, the Conto Termico scheme provides two years of payments for households installing biomass systems of <35 kW capacity. Financial support is contingent on the heating system meeting prescribed limits for particulate matter emissions, and households cannot receive both support measures for the same system.

In Austria, the Environmental Assistance in Austria (UFI) programme provides purchase incentives for biomass and other renewable heating systems, of up to 35% of investment costs, but installations must meet certain quality standards to be eligible for support. Support levels are highest for the replacement of fossil-fuelled heating systems, with the next-highest support offered for replacing an old wood heating system (pre-2003) with a modern biomass heating system.

Austria also has a specialist training programme for installers of renewable heating technologies as well as guidelines for public buildings to set a good example, including by using renewable technologies as widely as possible.

Source: Bioenergy Europe (2019), *Statistical Report 2019: Pellet Report*.

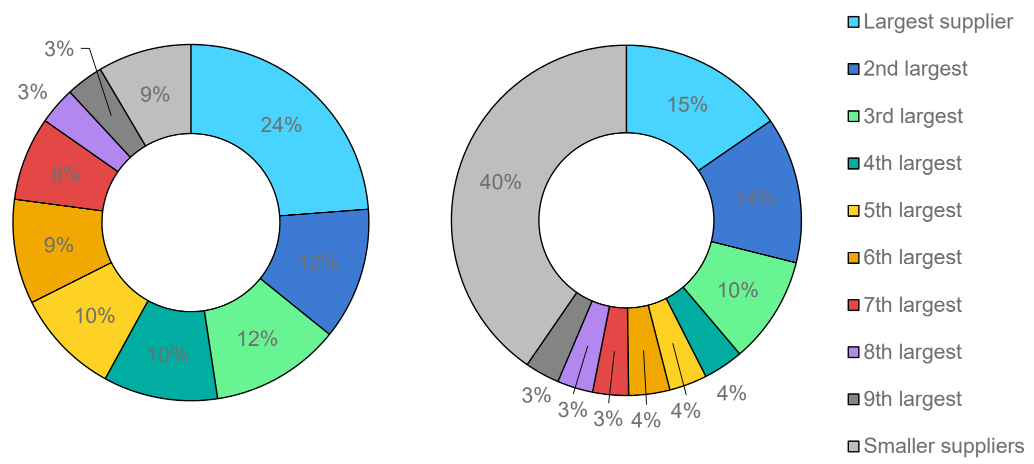
EN Plus Wood pellet certification

EN Plus is an independent third-party scheme for wood pellet certification, covering around 12 Mt of supply across 46 countries in 2020. In 2018, 85% of pellets produced in the European Union were from forestry residues. The scheme ensures consistent fuel quality by assessing the entire fuel supply chain, and pellets meet established technical specifications (calorific value, ash content, size, durability, moisture content, etc.) largely based on the international ISO 17225 standard. This ensures that poor-quality or inappropriate fuels do not needlessly shorten the lifespan of heating appliances.

The Baltpool biomass exchange

This exchange facilitates the trading of biomass fuels in Lithuania (e.g. wood pellets and wood chips) by providing a platform that connects suppliers and purchasers. In 2019, over 95% of all purchases by regulated heat producers took place over the exchange. Sellers submit offers and specify the distance over which they are prepared to deliver, and the exchange matches purchasers with the best suitable offer. The exchange has increased transparency and the number of suppliers in the marketplace.

Figure 7 Wood pellet supplier market shares in Lithuania, October 2014 (left) and October 2019 (right)



Source: Baltpool (2020), "Suppliers' market share", www.baltpool.eu/en/suppliers-market-share/.

This increase in supply liquidly has in turn reduced biomass fuel prices and delivered greater uniformity of pricing. Furthermore, suppliers are validated to ensure they are technically and financially able to fill orders and that fuels supplied meet the established technical specifications, thereby raising purchaser confidence. Timber and forestry residue trading has also been included since 2018.

Heat mapping

Many countries and regions throughout Europe have undertaken heat-mapping exercises to produce geographic information system (GIS) visualisation tools to guide public sector decision makers and industries in the best-practice deployment of low-carbon heating solutions. These show the density and source of heat demand (e.g. industry, residential, public sector) in a geographic area and allow comparison with the availability of local supply sources (renewable energy sources, waste heat, etc.). This initial data collection exercise can also be used to create a baseline to monitor and assess the impacts of policies and measures. In the Georgian context, heat mapping could match sustainable biomass resources with heat demand, as well as inform the deployment of district heating systems and projects to produce upgraded biomass fuels.

Adjusted VAT rates

Several European countries apply a lower VAT rate for biomass fuels to incentivise a switch from fossil heating fuels such as natural gas, heating oil or coal to sustainable biomass.

Table 3 General and biomass fuel VAT rates for selected countries, 2018

Country	VAT rate for wood pellets (%)	General VAT rate (%)
Austria	13%	20%
Belgium	6%	21%
Germany	7%	19%
France	10%	20%
Lithuania	9%	21%
United Kingdom	5%	20%

Note: The United Kingdom has reduced the VAT for all domestic heating fuels. In the other countries listed, the VAT on biomass fuels is lower that for fossil heating fuels.

Sources: Bioenergy Europe (2019), *Statistical Report 2019: Pellet Report*; EC (2019), *VAT Rates Applied in the Member States of the European Union*, https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf.

Key policies for modernising biomass consumption

Key overarching actions

- Harness donor funding and the capacity of the GEDF to support programmes (e.g. technical assistance to design projects, conduct feasibility assessments, secure grants or soft loans, purchase efficient stoves economically, and establish upgraded-fuel supply businesses).
- Use donors' technical assistance to improve national competences in: a) producing, installing and maintaining efficient stoves; and b) producing upgraded biomass fuels.
- Identify regional clusters of biomass supply and heat demand,[6] and launch focused initiatives to establish upgraded-fuel production businesses in these areas.
- Establish a strategic communication strategy to enhance public awareness of the benefits of higher-efficiency heating appliances and upgraded fuels, best-practice combustion practices, and the health impacts of poor air quality.

Box 3 Pilot project considerations

Using development funding to create biomass boiler and stove pilot projects is a means to highlight best practices and stimulate early-stage market development. However, while it may be tempting to use best-in-class technologies for pilot projects, these may ultimately be hard to sustain due to challenges in obtaining suitable fuels, maintenance expertise and parts. Furthermore, the high capital costs of the most sophisticated biomass boilers and stoves means that such projects are challenging to replicate.

Rather than conducting one-off projects, development funding for pilots would be more effectively used to install higher-efficiency stoves and boilers (e.g. with suitable air inlet controls), at capital costs that allow for the creation of local, self-sustaining business models. The production of these appliances should be standardised to permit performance and energy efficiency verification. Using part of the budget to offer co-funding of systems and institutional support for end users is also a means to ensure sustained success. As several pilot projects of this nature have already been undertaken, drawing on their experiences is a logical starting point for policy development.

[6] This assessment should build on existing end-use data collection on household energy consumption.

Specific policies and actions for consideration

Supporting fuel supply businesses:

- Support new fuel production businesses through financial de-risking measures (e.g. grants, soft loans or fiscal measures) to facilitate investment in equipment.
- Create capacity-building and training opportunities to offer technical support to biomass fuel producers from industry leaders in briquette and pellet production.
- Establish an active industry association to support the common interests of biomass fuel businesses though the dissemination of information and lobbying on their behalf.

Optimising fuel procurement:

- Reform procurement guidelines and processes to ensure that sustainability is a key criterion in sourcing biomass heating fuels.
- Use public sector demand to stimulate market development in upgraded fuels, with long-term public sector supply contracts strengthening the business case for fuel supply investments.[7]

Boosting upgraded-fuel competitiveness:

- Consider making the VAT for sustainable renewable fuels lower than for coal, fuel oil and natural gas.
- Ensure that forestry residue feedstocks for upgraded fuels (e.g. wood chips or pellets) are provided at a suitable price to make the fuels more cost-competitive.

Increasing combustion efficiency:

- Establish education and outreach programmes that offer guidance on best-practice combustion to ensure that households continuing to use firewood at least do so as efficiently as possible.
- Support new efficient-stove production businesses through financial de-risking measures (e.g. grants, soft loans or fiscal measures) to facilitate investment in equipment.

Cross-cutting:

- Introduce appropriate standards and certification measures (e.g. for stove efficiency or fuel characteristics[8]) to improve end-user confidence and facilitate market development.
- Develop replicable exemplar pilot projects in public buildings capable of long-term operations, bringing together appropriate technologies, upgraded-fuel supplies and operational competences.
- Assess the feasibility of PPP energy service company (ESCO) business models for the provision of heat as opposed to fuels.
- Create a publicly available online platform to map areas of sustainable biomass resource availability and heating demand.

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[7] This approach should also deliver spillover benefits for residential sector supplies.

[8] Fuel standardisation is becoming increasingly important with the introduction of more sophisticated heating appliances to the market.

Sustainable bioenergy in Georgia: A 2030 vision

This section envisions a modern bioenergy industry in Georgia in 2030. It outlines the economic, environmental and social benefits it could deliver, and offers a timeline to 2025 with key actions to achieve this concept by 2030.

The 2030 vision

In this vision, Georgia has fully integrated biomass into its national **energy policy** through formalised policies for the use of biomass wastes and residues. Robust implementation of the Forest Code means best-practice sustainable forestry management is widespread, and illegal forest activity is low. Responsibilities for all relevant stakeholders, as outlined in a government-approved national bioenergy strategy, are widely understood, and public procurement focuses on upgraded biomass fuels from sustainable origins.

The country's **modern bioenergy industry** produces diverse upgraded biomass fuels of uniform quality using sustainable feedstocks sourced from forestry, agriculture, energy crop plantations and wastes. Thriving national and local businesses produce and supply upgraded fuels such as pellets, wood chips and briquettes to the public and residential sectors, where they are consumed in economical biomass heating systems with verified high efficiency levels. The bioenergy sector supports a range of skilled jobs in fuel upgrading, heating appliance manufacturing, installation and maintenance, and logistics.

The **phaseout of basic firewood heating stoves is mostly complete**. Several exemplary projects using modern technologies such as biomethane and biomass district heating have been delivered successfully, giving direction to the next phase of bioenergy industry development.

Numerous **environmental benefits** have been realised. Sustainable forest management has greatly reduced pressure on national forestry resources and prevents deforestation. This in turn ensures the integrity of the natural environment and greatly reduces the risk of floods, forest fires and landslides. Waste management is now sustainable, avoiding environmental impacts on the air, land and water.

Positive **social benefits** are also in evidence. A far lower share of Georgia's rural population relies on firewood for their energy needs, and modern biomass stoves provide greater thermal comfort and reduce indoor air pollution, improving health. Upgraded biomass fuel production and supply operations create rural employment. Energy security is also higher, as the full range of domestically produced biomass resources is being maximised. The avoided costs of environmental and health impacts make investments in sustainable biomass supply and modern appliances programmes economically self-sustaining.

Attaining the vision: A timeline to 2030

To create the conditions necessary to achieve this scenario by 2030, key policies, programmes and initiatives need to be introduced during 2020-25.

ACTION	CATEGORY	2020	2021	2022	2023	2024	2025
POLICY AND STRATEGY							
Formally recognise the current use of biomass heating as an energy, social and environmental issue that must be addressed	Policy & Strategy	●					
Elaborate a national bioenergy strategy	Policy & Strategy		●				
Update and approve an upgraded-biomass fuel strategy	Policy & Strategy			●			
Develop and introduce appropriate regulations for the management of non-municipal biomass wastes and residues	Policy & Strategy		●	●			
Identify regional clusters of biomass supply and heat demand	Policy & Strategy			●			
Launch an online platform that maps clusters of biomass supply and heat demand	Policy & Strategy				●		
Reform public fuel procurement guidelines to incorporate fuel sustainability	Policy & Strategy		●				
SUSTAINABLE BIOMASS FUEL SUPPLY							
Actively implement new Forest Code nationwide	Forestry		●	●	●	●	●
Abolish the social-cutting system	Forestry				●		
Roll out Forestry Agency business yards for residue collection and fuel upgrading nationwide	Forestry	●	●	●	●		
Introduce regulations for the collection and sustainable use of agricultural residues	Agriculture				●		
Adopt the latest appropriate equipment to combust straw and other agricultural residues	Agriculture					●	●
Begin to produce fuel from showcase energy crop production	Agriculture		●				
Introduce programmes for urban green waste collection and source segregation of MSW	Waste Management			●	●	●	
Introduce measures to raise landfill disposal fees and require more sustainable end uses	Waste Management			●			

Launch international donor-funded pilot projects for sustainable biomass fuels and waste fuels	Technology
Offer capacity-building and training programmes for upgraded fuel producers	Technology
Introduce support measures for upgraded-biomass and waste-fuel supply businesses	Business Development
EFFICIENT AND SUSTAINABLE FUEL CONSUMPTION	
Improve national competencies in the production, maintenance and installation of efficient stoves	Heating Appliances
Initiate public sector building pilot projects with modern heating systems	Heating Appliances
Introduce support programmes for national production and economic purchase of efficient stoves	Business Development
Launch a communications strategy on efficient stoves and upgraded fuels	Business Development
Introduce a pricing structure for forestry residues that allows upgraded fuels to be produced at competitive costs	Business Development
Asses how lowering the VAT affects sustainable biomass heating fuels	Business Development
Introduce standards and certification for stove efficiency and upgraded fuels	Business Development

Conclusions

Biomass use in Georgia is a crosscutting issue that has implications both within and beyond the energy sector. As the principal fuel used for household heating in rural areas, bioenergy is an important part of Georgia's energy system. However, there is considerable scope to improve the sustainability of biomass consumption – first by modernising the fuel supply with a diverse set of upgraded biomass fuels from sustainable resources, and second by making all forms of biomass fuel consumption more efficient through the use of better heating and cooking appliances.

As biomass falls under the jurisdiction of multiple agencies, a co-ordinated approach to policymaking, governance and market development is required. Furthermore, to establish a modern bioenergy industry by 2030, biomass use needs to be integrated into wider energy policy at all levels of government. Achieving the vision outlined in this roadmap will therefore require more comprehensive and better-co-ordinated government, private sector and international development agency efforts. Ongoing data collection on household energy consumption is essential for policy development and monitoring.

The Government of Georgia could consider incorporating all the measures needed to modernise biomass resource use into a dedicated national bioenergy strategy. The primary objective of the strategy should not be to raise bioenergy consumption from the current level, but to transition to a modern and sustainable bioenergy industry.

The strategy should outline how to integrate bioenergy into energy policy development, explain how to create the market conditions necessary to modernise the bioenergy industry, and clearly define the responsibilities of all relevant stakeholders. Creating a co-ordinating body with overall responsibility for delivering the strategy could also be considered. This body could report to a supervisory agency that has overall responsibility for renewable energy and energy efficiency.

Programmes to scale up sustainable biomass fuel supply volumes and the use of higher-efficiency heating appliances cannot be delivered without an adequate budget. While the GEDF could provide funding, other financing sources may also be needed. International development donor funding will likely be available to support projects to increase biomass use sustainability and reduce indoor air pollution.

There are numerous examples of international best practice in the area of bioenergy that Georgia could replicate with in-kind support. The avoided costs of environmental and health impacts currently incurred from unsuitable biomass use for heating should be factored into equations that assess the cost of policy support to establish a modern bioenergy industry.

Other measures that can substantially facilitate growth of a sustainable bioenergy industry in Georgia can be undertaken at no cost. These include ensuring that biomass wastes and residues are adequately addressed in waste management regulations; refocusing public fuel procurement policies to take fuel sustainability into consideration; and providing forestry residues at a reasonable price to make upgraded fuels more cost-competitive.

As ensuring biomass supply sustainability is a key priority, robust implementation of the updated Forest Code to introduce best-practice sustainable forestry management is vital. The social-cutting policy should be phased out responsibly by 2023 with measures that ensure affordable and sustainable alternatives to fuelwood for the rural population.

Effectuating this transition in a manner that does not increase fuel poverty will be challenging, but it is a policy priority. Georgia's potential to produce sustainable fuels from wastes and residues should be exploited as a key means to shift away from using firewood in rural areas.

Modernising the consumption of biomass fuels is also fundamental. The single most effective method to improve the sustainability of biomass use in Georgia is to transition to more efficient heating appliances. This should be another key policy priority, and adequate attention should also be given to measures that strengthen the business case for the production of upgraded biomass fuels such as pellets, woodchips and briquettes made from sustainable resources.

It is crucial to capitalise on donor funding and the capacity of the GEDF to support programmes that make efficient heating appliances affordable and that establish upgraded-fuel supply businesses; support could take the form of soft loans or grant schemes. The fact that the household fuel cost savings that can be realised from switching to an efficient stove can pay for the appliance in less than a year means that government support schemes should be financially sustainable. A countrywide rollout of such devices would reduce pressure on Georgia's forestry resources considerably.

References

Baltpool (2020), “Suppliers’ market share”, Baltpool, www.baltpool.eu/en/suppliers-market-share/.

Bioenergy Europe (2019), *Statistical Report 2019: Pellet Report*, Bioenergy Europe, Brussels.

CEWEP (Confederation of European Waste-to-Energy Plants) (2017), “Landfill taxes and bans”, CEWEP, www.cewep.eu/landfill-taxes-and-bans/.

Geostat (National Statistics Office of Georgia) (2019), *Energy Balance of Georgia*, Geostat, Tbilisi.

Geostat (2017), *Energy Consumption in Households*, Geostat, Tbilisi.

EC (European Commission) (2019), *VAT Rates Applied in the Member States of the European Union*, EC, Brussels.

EU (European Union) (2019), “World Bank study supported by EU finds under-heating in Georgia leads to loss of 3.5% of GDP”, EU, https://eeas.europa.eu/delegations/georgia/65129/node/65129_zh-tw.

Eurostat (2020a), *Gas Prices for Household Consumers* (database), Eurostat, https://ec.europa.eu/eurostat/data/database (accessed June 2020).

Eurostat (2020b), *Municipal Waste Statistics* (database), Eurostat, https://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics (accessed June 2020).

GIZ (German Agency for International Cooperation) (2019), *Baseline data Collection-Energy Demand, Supply and Efficiency in Georgia*, GIZ, Bonn and Eschborn.

IEA (International Energy Agency) (2020), *World Energy Statistics and Balances 2019* (database), IEA, Paris, www.iea.org/statistics/ (accessed June 2020).

Koppejan, J. and F. de Bree (2018), *Kennisdocument Houtstook in Nederland* [*Knowledge Document in the Netherlands*], Proceed Biomass BV, Utrecht.

Karampinis, M. (2020), “Introduction to AgroBioHeat /European experiences on using vineyard prunings for heat production”, presentation at the Using Vineyard Prunings for Heat Workshop, Vilafranca del Penedès, Spain, 27 February 2020, https://agrobioheat.eu/wp-content/uploads/2020/03/AgroBioHeat_Workshop_Using-vineyard-prunings-for-heat_CERTH_FV.pdf.

MEPA (Ministry of Environmental Protection and Agriculture of Georgia) (2020), *Forest and Land Use Atlas*, MEPA, https://atlas.mepa.gov.ge/?l=en.

Swedish National Forest Inventory (2020), *Forest Statistics* (database), Swedish University of Agricultural Sciences, https://www.slu.se/foreststatistics (accessed June 2020).

Svebio (2020), *Roadmap Bioenergy: Meeting the Demand for Bioenergy in a Fossil Free Sweden*, Svebio, Stockholm.

UNFCCC (United Nations Framework Convention on Climate Change) (2016), *Global Warming Potentials*, UNFCCC, http://unfccc.int/ghg_data/items/3825.php.

Vincente, E.D. and C.A. Alves (2018), “An overview of particulate emissions from residential biomass combustion”, *Atmospheric Research*, Vol. 199, pp. 159-185.

WEG (World Experience for Georgia) (2014), *Assessment of Wood and Agricultural Residue Biomass Energy Potential in Georgia*, WEG, http://weg.ge/sites/default/files/final_report-weg_0.pdf.

WHO (World Health Organization) (2019), *World Health Statistics 2019: Monitoring Health for the SDGs*, WHO, Geneva.

WHO (2018), "Ambient (outdoor) air pollution", WHO, www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health (accessed May 2020).

World Bank (2015), Georgia: Country Environmental Analysis – Institutional, Economic and Poverty Aspects of Georgia's Road to Environmental Sustainability, World Bank, Washington, DC.

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