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“Pathways to sustainable biomass use in heat supply in Latvia”

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1. Introduction

Latvia's heat supply system consists of two main segments: the residential or individual heating (IH) and district heating (DH). DH is a regulated public service provided in numerous urban areas [1], whereas IH systems dominate in rural regions and low-density settlements [2]. In rural and peri-urban households, wood fuels remain the principal source of heat, reflecting both resource availability and long-standing self-sufficiency practices. Household heating based on manually loaded firewood appliances requires continuous supervision, reducing user convenience and strengthening demand for automated options, including DH connections, pellet boilers, and heat pumps. Public support schemes prioritize DH connections and heat pumps, signaling a shift toward more efficient and user-friendly technologies. [3]

Historically, Latvian heat supply has relied on woody biomass and imported natural gas. Since the 2022 energy crisis, natural gas consumption in heating has dropped substantially, while biomass use has expanded. At the same time, Latvia has ended imports of Russian natural gas, diversified supply structures and reinforcing the role of domestic renewables in the energy mix. The regulatory framework has been significantly reshaped by the EU Renewable Energy Directive (RED III), in force since November 2023. RED III strengthens sustainability criteria for biomass, introduces no-go areas for certain categories of forest biomass, and limits subsidies for electricity-only generation from forest biomass, except in narrowly defined cases. It also requires Member States to apply the cascading principle when allocating support to woody biomass – prioritizing higher value-added uses such as long-lived wood products, reuse, and recycling before energy utilization. While the directive does not explicitly promote "lower-quality biomass," its sustainability and support rules indirectly direct energy producers towards residual and by-product biomass streams and toward efficient CHP configurations rather than low-efficiency combustion.

Latvia's broader bioeconomy policy further encourages the valorization of residues and by-products, including agricultural residues, in higher value applications and, where appropriate, in energy production [4]. This aligns with the cascading approach and helps relieve pressure on high-quality wood resources. In the DH sector, large-scale infrastructure upgrades (particularly in Riga [5]) aim to reduce network losses and significantly increase the share of renewable heat supply through biomass modernization and related investments supported by international financial institutions. These projects are expected to strengthen energy efficiency, improve security of supply, and align DH development with national and EU climate objectives.

2. Biomass utilization approaches in heat supply

Biomass for heat can be regarded as one of the oldest technological solutions. Over a long development path, combustion technologies have matured, and today there is a wide range of thermochemical conversion options that can meet diverse consumer requirements and remain relevant, widely demanded solutions for heat supply.

Biomass technologies, including modern combustion systems, are being continuously improved to keep pace with global trends in the energy sector. One of the main near-term challenges is the shift away from high-quality roundwood toward residual feedstocks and other forms of alternative biomass, while maintaining high efficiency and low pollutant emissions.

Current approaches and future visions for the use of biomass in bioenergy differ substantially across the world. This chapter reviews the plans of selected EU Member States with particular attention to alternative biomass, choosing countries that are comparable to Latvia in three respects:

- the present importance of biomass in heat supply;
- broad availability of biomass resources, especially wood;
- pronounced seasonality with high space-heating demand.

The aim is to develop a clear country-by-country picture, compare approaches, and identify promising development directions for Latvia's heat supply. For each country, the analysis focuses on:

- the role of biomass in the National Energy and Climate Plan (NECP);
- existing bioenergy strategies and planning documents;
- best practices for integrating alternative biomass into heat supply, including residues and by-products, as well as non-wood feedstocks

2.1. Sweden

This subsection presents the bioenergy-related instruments and legal acts overview existing in Sweden that have a direct and current impact on heat supply. Table 2.1 contents summary about policies and programs.

Table 2.1. Most significant bioenergy-related instruments in Sweden

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
Climate Act & NECP Framework	Legal/strategic	Provides long-term mandate for decarbonisation and investment planning
Carbon Tax	Economic incentive	Makes biomass heat economically attractive vs. fossil fuels

Klimatklivet (Climate Leap)	Capital grants	Supports local biomass heat and CHP installations
Industriklivet (Industrial Leap)	Subsidies for industry	Stimulates bioenergy for industrial heat decarbonisation
Green Electricity Certificates	Market support	Encourages bioenergy in CHP
EU Funding Programmes	Financial support	R&D and deployment support for renewable heat technologies
EU R&I Partnerships / ERA-NETs	Research cooperation	Fosters innovation in bioenergy technologies
BECCS Support Auctions	Negative-emissions incentives	Future bioenergy system deployment including heat with carbon removal

2.1.1. National Energy and Climate Plan

Sweden's updated NECP sets the long-term trajectory to climate neutrality by 2045, with strengthened interim targets and continued reliance on high shares of renewables across heating, electricity, and transport. The plan submitted on June 27, 2024 integrates recent EU legislation and clarifies implementation timelines for RED III and related acts [6].

The existing situation shows that bioenergy has historically held a crucial position in Sweden's energy mix. Biomass constitutes the largest share of Sweden's renewable energy use and contributes across several sectors. In the heating sector, a substantial proportion of renewable heat used both in industry and district heating originates from biomass. The electricity sector benefits from biomass through numerous combined heat and power plants that supply both heat and electricity. The transport sector increasingly relies on biofuels derived from biomass as a means of reducing fossil oil consumption.

Forecasts indicate that bioenergy will continue to play a central role through 2030 and towards Sweden's long-term climate neutrality objectives. This includes the ongoing replacement of fossil fuels in heating and selected industrial applications, as well as the continued development of renewable liquid fuels for transport in segments where electrification remains technically challenging. Bioenergy is also expected to support system flexibility, including seasonal balancing, within a future decarbonized energy system.

Sustainability requirements remain a cornerstone of Swedish biomass policy. National frameworks emphasize that biomass used for energy should originate from sustainably managed forests and from residues of forestry and industrial processes. While opportunities

exist to mobilize additional biomass from residue streams, ecological constraints and sustainability principles determine the viable scale of increases.

Sweden does not primarily stimulate bioenergy through technology-specific subsidies. Instead, bioenergy deployment is indirectly supported through broader policy instruments. The carbon tax applied to fossil fuels remains one of the most influential mechanisms shifting competitiveness towards renewable energy sources, including biomass. This tax has been a key driver behind reductions in the use of fossil heating fuels.

Several investment-oriented support mechanisms complement this framework. The Climate Leap (Klimatklivet) [7] provides grants for local and regional projects that reduce greenhouse gas emissions, including bioenergy-based heating solutions. The program supports conversions from fossil oil to biomass boilers, renewable district heating connections, and other measures that deliver immediate emission reductions. Additional industrial support is available through the Industrial Leap (Industriklivet) [8], which funds decarbonization technologies, including those based on sustainable bioenergy and projects aimed at achieving negative emissions.

Renewable electricity generation, including biomass CHP, has also been supported through technology-neutral policy instruments. While the electricity certificate scheme no longer admits new installations, the framework has historically contributed to the expansion of renewable power generation.

Other heat-supply-oriented measures indirectly reinforce the role of biomass. These include investment support for district heating modernization, the introduction of renewable heating systems in industry, and targeted funding for advanced technologies such as bioenergy with carbon capture and storage. Sweden has introduced reverse-auction mechanisms to stimulate BECCS [9] deployment, recognizing its role in achieving long-term net-negative emissions. Research, development, and innovation in bioenergy are also supported through national programs and through European funding instruments.

Although Sweden's NECP does not explicitly prioritize "alternative biomass" or "residual biomass" as stand-alone categories, the plan stresses that biomass use must comply with bioeconomy and sustainability principles. This implicitly supports a continued shift toward forestry by-products and other low-value biomass streams as preferred feedstocks for energy production.

2.1.2. Existing bioenergy strategies and planning documents

Several strategic documents outline Sweden's long-term vision for the role of bioenergy. The Fossil Free Sweden [10] initiative has produced a comprehensive bio-strategy addressing how bio-based feedstocks can support the national transition to a fossil-free economy. This strategy highlights the need to balance bioenergy expansion with competing demand for

bio-based materials, emphasises the importance of resource efficiency, and underscores the relevance of forestry by-products and residues for future energy use.

Another key document is Roadmap Bioenergy – Meeting the Demand for Bioenergy [11] in a Fossil-Free Sweden, prepared by the Swedish Bioenergy Association. This roadmap analyses the long-term potential of bioenergy in Sweden and forecasts increased demand for biomass in a fossil-free future. It identifies opportunities in forestry, agriculture, waste streams, and marginal biomass resources, while also outlining strategic measures such as improved logistics, supportive policy instruments, and technical development in conversion technologies.

Together, these strategies emphasise the importance of sustainably sourced biomass, efficient use of by-products, and alignment of bioenergy deployment with the broader aims of the Swedish bioeconomy and circular-economy frameworks.

2.1.3. Best practices for alternative biomass utilization in heat supply

Sweden provides several practical examples of integrating alternative biomass into efficient and environmentally robust heat-supply systems.

One prominent case is the Dåva district heating complex in Umeå [12]. Operated by the municipal energy utility, the site comprises two units. The first plant primarily combusts sorted waste and residues from the forest industry. It combines high-efficiency energy recovery with advanced flue-gas cleaning, supplying substantial heat to the district heating network alongside electricity generation. The second unit, commissioned in 2010, operates on a mix of forest biomass, primarily logging residues, wood chips, bark, and sawdust. It employs fluidized-bed combustion with high boiler efficiency and achieves total energy recovery rates close to full utilization when including flue-gas condensation. The integration of forestry by-products demonstrates a mature system for mobilizing alternative biomass streams.

The Umeå region also benefits from collaboration between Holmen Skog and Umeå Energi, where harvesting residues such as branches and tree tops are collected, chipped, and used as fuel for the Dåva plants. This practice makes productive use of materials that would traditionally remain unused in forests, while also strengthening local supply chains and reducing reliance on imported fossil fuels.

Another example is the Trollhättan district heating system [13], which incorporates a biomass-fueled combined heat and power plant. The facility uses a blend of bark, sawdust, logging residues, and wood chips sourced within the surrounding region. The plant contributes significantly to the city's district heating demand and highlights the potential of smaller, modular CHP units to support local renewable heat supply. The approach reduces dependence on fossil oil and contributes to improved local air quality.

These Swedish examples illustrate how regional biomass resources, including harvesting residues and industrial by-products, can be effectively integrated into modern

district heating and CHP systems. They demonstrate practical pathways for utilizing alternative biomass feedstocks while maintaining high efficiency, low emissions, and strong local economic linkages.

2.2. Finland

This subsection presents the bioenergy-related instruments and legal acts overview existing in Finland that have a direct and current impact on heat supply. Table 2.2 contents summary about policies and programs.

Table 2.2. Most significant bioenergy-related instruments in Finland

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
Updated NECP 2021-2030	Legal/strategic	Identifies bioenergy as a near-term heating resource based on forest residues and industrial by-products, under EU sustainability rules and sectoral measures
Carbon Neutral Finland 2035	Legal/strategic	Frames bioenergy in heating as transitional while prioritising long-term electrification and efficiency, moderating future bioheat growth
Helen pellet boilers (Helsinki)	Capital investments	City-scale coal phase-out measure adding pellet heat for DH peak and transition, reducing CO_2 and maintaining supply reliability
Lahti Kymijarvi III bioheating plant	Capital investments	Heat-only plant using forest harvesting residues and wood-industry by-products to replace coal in DH, supported by international finance

2.2.1. National Energy and Climate Plan

Finland has an integrated NECP for period up to 2030, which serves as the main strategic framework for development of the national energy systems and climate policies. The overall objective of Finland's climate and energy policy is to achieve climate neutrality by 2030. Biomass use is a well established heat supply system in which biomass plays a central role, particularly in DH and CHP production. Biomass dominates as a renewable energy source in heating and cooling sector, largely based on forest residues, bark, sawdust, and other industrial by products from the pulp and paper industry [14]. This strong reliance on biomass is closely linked to Finland's extensive forest resources and a well-developed forest industry, which generates large volumes of residues and by products suitable for energy use. Biomass

based heat production is particularly important for ensuring security of supply during peak demand periods, especially in winter conditions, when a reliable baseload and flexible heat generation are required.

2.2.2. Existing bioenergy strategies and planning documents

Finland's NECP 2021-2030, sets binding targets for renewable energy deployment, greenhouse gas emission reduction, and energy efficiency improvements. Bioenergy is identified as dominant renewable energy source in heat sector to reduce dependence on fossil fuels.

Carbon neutral Finland 2035 defines Finland's legally binding goal of achieving climate neutrality by 2035. Strategy makes clear that bioenergy is not seen as long term solution, instead, biomass is described as a transitional and supporting energy source, mainly used in district heating for bas and mid load production. The strategy places strong emphasis on limiting biomass growth, protecting forest carbon stock, and shifting heat production towards electricity-based solutions. [15]

2.2.3. Best practices for alternative biomass utilization in heat supply

In Finland, alternative biomass is mainly used in large district heating systems as a practical replacement for fossil fuels, especially coal.

In Helsinki, transition from coal-based heat production has been one of the most viable examples for biomass use in urban district heating. As a part of coal phase out, energy company "Helen" introduced large scale wood pellet-based heat production. Pellet boilers were used as a temporary solution to secure heat supply during winter peak demand. As a result, carbon dioxide emissions from Helsinki heat production were reduced approximately 40 % compared to 2015 measurements, while maintaining reliable district heating for city's residents. [16], [17]

In Lahti, the Kymijärvi III bioenergy plant shows an example of alternative biomass utilization in heat supply. Plant operates a heat only boiler with a thermal capacity of about 190 MW and supplies district heating. Primary fuels are forest harvesting residues and industrial wood byproducts, such as bark and sawmill residues, sourced from local region. Plant replaced coal fired heat production and disabled Lathi from coal use in district heating. As a result, annual carbon dioxide emissions on local heat sector were reduced by 300 000 tons of CO_2 per year. [18], [19]

2.3. Austria

This subsection presents the bioenergy-related instruments and legal acts overview existing in Austria that have a direct and current impact on heat supply. Table 2.3 contents summary about policies and programs.

Table 2.3. Most significant bioenergy-related instruments in Austria

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
Renewable Energy Expansion Act (EAG)	Market support	Market premiums and tenders include biomass power and CHP, enabling renewable heat integration into DH and supporting investment signals
Eco-Social Tax Reform	Economic instrument	Introduces a national ETS for fuels in buildings and transport, creating a price signal that improves the competitiveness of renewable heat including bioenergy
Klima- und Energiefonds (KLIEN)	Capital grants	National grant lines for R&D, demonstration and deployment, widely used to modernise biomass heat and CHP assets and DH networks
Sanierungsoffensive 2026 and heating conversion schemes	Capital grants	Investment aid for heating conversion and DH connections, covering wood central heating alongside other renewables, maintaining bioheat utilisation in buildings and DH

2.3.1. National Energy and Climate Plan

Austria submitted its final updated NECP (2021–2030) in December 2024 [20], detailing targets and measures across all five Energy Union dimensions and integrating new EU requirements under the Green Deal, Fit-for-55, REPowerEU and RED III. The European Commission's October 18, 2024 assessment of Austria's draft updated NECP called for higher ambition on greenhouse gas reduction and energy efficiency while acknowledging that the country's planned renewables share aligns with the EU burden-sharing formula.

The Commission's EU-wide assessment published May 27, 2025 includes an Austria extract that summarizes final targets: a renewables contribution of at least 57 % in gross final energy consumption by 2030, ESR emissions reductions trajectory, and updated energy efficiency contributions; it notes Austria can meet ESR targets with flexibilities but should tighten primary energy consumption to better align with the Energy Efficiency Directive formula.

Austria's ministries also present NECP materials and Strategic Environmental Assessment documentation, confirming the 2024 update process and the national governance context. The IEA Policies database lists the Updated NECP in force, aligned with Austria's #mission2030 strategy [21] and Commission recommendations taken onboard since earlier iterations.

Two policy pillars underpin the heating transition described in and around the NECP: Eco-Social Tax Reform [22], which introduced a national fixed-price ETS for fuels in buildings and transport from 2022 to 2026, and Austria's Renewable Energy Expansion Act (EAG) [23] sets the expansion pathway to 100 % renewable electricity (national balance) by 2030, including 1 TWh additional biomass power and market-premium and investment-grant mechanisms for biomass and other technologies; the EAG has been amended repeatedly and is complemented by a 2025 draft acceleration act to speed permitting and implement RED III.

On district heating and renewable heat, Austria's energy statistics and bioenergy reporting show high bioenergy penetration. IEA Bioenergy's 2024 Austria country report [24] cites 34 % renewables in final energy consumption, high domestic bioenergy supply with strong roles in district heating and residential sectors, and rapid growth of renewable electricity shares to 87 % in 2023. Statistics Austria reports 2024 [25] energy balances and renewables share dashboards that policymakers use to track progress against NECP targets and heating-sector transitions.

Austria's federal funding architecture aligns with NECP implementation. The "Klima- und Energiefonds" (KLIEN) [26] issues annual calls for R&D, demonstration, and deployment with multi-year budgets to 2027, coordinated with BMK's transformation initiative. In 2025–2026 the national heating conversion schemes ("Raus aus Öl und Gas", "Sauberes Heizen für Alle") consolidate support for district heating connections, wood central heating, and heat pumps, with fixed annual budgets to 2030 and technology-specific grant levels, complementing provincial aids.

2.3.2. Existing bioenergy strategies and planning documents

Austria's bioenergy role is documented by national associations and research networks. The Austrian Biomass Association's (ABA) [27] notes that bioenergy use has doubled since 2000 and that residential space heating from bioenergy exceeded heating oil and natural gas for the first time in 2023–2024, excluding district heating; it also indicates district heating is ~55 % biomass-based, underscoring bioenergy's centrality in heat supply. Data highlights > 40 % of household space heat from biomass, ~2500 decentralized biomass heating plants and ~170 wood-CHP plants, and biogenic heat ~51 % of DH.

At policy level, the EAG is the cornerstone statute for renewable electricity and gas, with explicit biomass power targets and market premiums and tenders for PV/biomass, reinforced by continuous legal updates through 2025; legal commentaries and practice guides detail

tendering rules for biomass plants and renewable-energy communities. The Renewable Energy Laws and Regulations Austria 2026 [28] summarizes the multi-level permitting and support framework, critical for siting biomass CHP, waste-to-energy, geothermal, and heat-pump assets in DH.

Strategic studies examine optimal biomass deployment and future constraints. A national Biomass Strategy 2025–2040 outlines scenario-based flows for dry biomass use across DH, electricity, and industry, emphasizing residue mobilization and local value chains under sustainability constraints [29]. Research programs and projects such as BIOSTRAT [30] analyze least-cost, least-carbon allocation of biomass to heat vs transport vs electricity, using dynamic modelling to 2050.

2.3.3. Best practices for alternative biomass utilization in heat supply

Representative practices and programs (2024–2026):

- Municipal DH decarbonization roadmaps: City utilities are expanding waste-heat recovery and heat-pump integration while maintaining or upgrading biomass CHP. The IEA DHC projects involving Austrian entities cover peak load coverage with renewables and flexible pricing, indicating concrete operational solutions for low-temperature DH;
- Residue mobilization in rural DH: Rural heat networks continue to modernize feedstock logistics and combustion systems, as documented by ABA reports and the IEA Bioenergy country review, which show biogenic heat dominance in small networks and efficiency gains from modern boilers;
- Agricultural residues pathways: Research and demonstration explore agricultural residues for biofuels, with the BIOSTRAT project and thematic studies assessing techno-economic allocation under sustainability constraints. While straw-to-heat is case-dependent (fuel standards, ash management), the policy trend stresses cascading use and prioritization of residues where they deliver net carbon benefits and complement forestry streams;
- Funding triggers for heat conversion and networks: The “Sanierungsoffensive” [31] and national heating schemes fund district heating hook-ups and wood heating systems alongside heat pumps, acting as demand-side levers that keep biomass DH capacity utilized and expand renewable heat coverage, including in multi-family buildings.

2.4. Czechia

This subsection presents the bioenergy-related instruments and legal acts overview existing in Czechia that have a direct and current impact on heat supply. Table 2.4 contents summary about policies and programs.

Table 2.4. Most significant bioenergy-related instruments in Czechia

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
Final updated NECP 2024	Legal/strategic	Sets DH decarbonisation trajectory and sectoral measures, positioning biomass as part of the renewable heat mix
Modernisation Fund - HEAT programme	Capital grants	Large-scale investment support to replace coal with renewable heat sources and high-efficiency cogeneration, including biomass boilers and CHP for DH
Support scheme for heat in DH under the Modernisation Fund - budget increased to EUR 3.2 billion	Capital grants	State-aid decision expands funding envelope to accelerate DH modernisation, including projects switching to biomass where eligible
Green bonus for biomass heat in DH	Operational support	Per-gigajoule subsidy for heat from biomass supplied to DH, narrowing the cost gap versus coal and speeding biomass uptake
Act No. 165/2012 on Supported Energy Sources	Regulatory/ market design	Establishes support rules, guarantees and certificates of origin, auction mechanisms and over-compensation control applicable to biomass CHP and heat

2.4.1. National Energy and Climate Plan

Czechia approved its final updated NECP 2021–2030 on 18 December 2024 [32]; the European Commission published the submitted final text on 20 December 2024. The update integrates different EU's responses, sets contributions across all five EU's dimensions, and anchors an indicative ~30 % RES share in gross final energy consumption by 2030, with an accelerated coal phase-out trajectory and strengthened roles for nuclear and renewables.

The Commission's Recommendation (EU) 2024/603 on the draft updated NECP framed priority improvements (higher ambition for renewables and clearer sectoral measures) subsequently reflected in the 2024 final update. Independent system reviews underscore the plan's centrality to a rapid coal exit by ~2033 and to heating decarbonization, while cautioning against long-term lock-in to unabated natural gas and calling for timely updates of the State Energy Policy and Climate Protection Policy to ensure coherence with the NECP. [33]

To operationalize NECP goals in heat, Czechia deploys the Modernization Fund at scale to finance low-carbon heat and DH modernization; the national allocation is ≥ CZK 300 billion (price-dependent). In December 2022 the Commission approved a €1.2 billion scheme for "green DH," later amended in April 2025 to increase the budget ceiling to €3.2 billion, reflecting high demand and accelerated decarbonization. Parallel state-aid approval in March 2025 introduced a €103 million "green bonus" operational support for biomass heat supplied to DH, complementing the investment schemes and aligning with RED III targets for renewable heat uptake. [34], [35], [36]

2.4.2. Existing bioenergy strategies and planning documents

A dedicated bioenergy trajectories study evaluates sustainable supply potentials and constraints for forest and agricultural biomass, and the implications of EU sustainability criteria, LULUCF impacts, biodiversity safeguards, and air-quality limits, thereby informing fuel-switch decisions in DH. [37], [38]

On the legislative side, Act No. 165/2012 Coll. on Supported Energy Sources provides the framework for supporting electricity, heat and biomethane from renewables and for high-efficiency CHP, including rules for guarantees/certificates of origin and auction-based operational support; a 2020 government amendment introduced over-compensation control and auction mechanisms that extend to biomass and biogas, thereby aligning support with EU state-aid rules. The Modernization Fund program architecture finances renewable heat sources, DH network upgrades, and community energy, with successive calls through 2025; MPO also launched a targeted OP TAK "OZE–biomasa" call with CZK 500 million to co-finance biomass heat/CHP projects in firms, including agricultural entities. [39], [40]

2.4.3. Best practices for alternative biomass utilization in heat supply

There are few good examples of alternative biomass implementation in Czechia:

- The TTS energo system in Třebíč is a mature example of local alternative biomass integration into city-scale DH. Since the early 2000s the operator has consolidated legacy gas/coal heat sources into a multi-plant DH system where > 90–94 % of heat is produced from biomass boilers, notably wood chips and straw; project

materials document straw-bale combustion (VESKO-S) alongside wood-chip boilers (VESKO-B), flue-gas cleaning, and efficiency upgrades (incl. ORC). Reported outcomes include stable, comparatively low heat prices, regional feedstock procurement, and progressive displacement of fossil fuels; [41], [42]

- The Kněžice "energy-self-sufficient" model combines a biogas CHP (based on locally collected manures, silage and organic residues) with a biomass boiler house (wood chips and straw bales) feeding a small DH network. The arrangement supplies space heat and domestic hot water to most households; the biogas CHP recovers heat year-round, while the biomass boilers cover winter peaks. The project demonstrates agricultural-residue mobilization, nutrient return via digestate/ash, and municipal ownership/operation; [43], [44]
- Regional utility Veolia is replacing coal with a multi-fuel CHP concept that co-fires biomass with solid recovered fuel (TAP/RDF), supported by gas-fired peak/reserve units and accompanied by a local TAP production line. Environmental documentation and EIA decisions specify design capacities (up to 20–178 kt per year biomass in various scenarios) and compliance with BAT emission limits. Although TAP is not biomass, the scheme illustrates how biomass from local sources can be integrated into post-coal DH alongside other alternative fuels, with air-quality and logistics constraints explicitly addressed. [45], [46]

2.5. Estonia

This subsection presents the bioenergy-related instruments and legal acts overview existing in Estonia that have a direct and current impact on heat supply. Table 2.5 contents summary about policies and programs.

Table 2.5. Most significant bioenergy-related instruments in Estonia

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
National Energy and Climate Plan	Legal/strategic	Retains biomass CHP as a flexible DH component while raising ambition for renewables, framing DH decarbonisation measures
ENMAK 2035	Legal/strategic	Sets development priorities and reliability objectives, enabling dispatchable capacity alongside renewables and biomass-based DH
Green Reform	Legal/strategic	Cross-government framework that supports energy transition, including heating sector

		measures consistent with DH modernisation and renewable heat
Utilitas Väo biomass CHP upgrades	Capital investments	Adds flue-gas condensers, large heat pumps and an electric boiler to biomass CHP, increasing recovery and integrating low-temperature heat in Tallinn DH
Narva CHP operations with biomass co-firing	Operational practice	Transitional co-firing of biomass in CHP provides firm heat and power while enabling pragmatic bioheat shares subject to technical limits

2.5.1. National Energy and Climate Plan

Estonia's NECP is the central framework for energy and climate policy [47]; the Ministry of Climate's NECP page states that Estonia's long-term objective is an 80 % greenhouse-gas reduction by 2050, with an intermediate milestone of 70 % by 2030 against 1990 levels, and sets quantitative contributions for renewables, efficiency, security of supply, and the internal market. Estonia finalized an updated NECP and approved it in Government on 5 June 2025 (REKK update), with the update communicated under Article 14 of the Governance Regulation; the update retains higher ambition for renewables and clarifies measures across all five Energy Union dimensions. The European Commission's NECP process page confirms that final updates were assessed EU-wide in May 2025.

Renewables uptake has accelerated. Statistics Estonia reports a 41.0 % share of renewables in gross final energy consumption in 2023; renewables covered 31.9 % of final electricity consumption and 66.7 % of final heat consumption in 2023. Sector data for 2024 show that electricity generated from renewables reached 63 % of domestic power production, with wind and solar output both exceeding 1 TWh for the first time. As system planning advances, the Ministry has initiated reverse auctions for new onshore and offshore wind volumes (multi-year support with defined delivery dates), aiming to expand dispatchable-compatible renewables and lower average electricity prices by 2030. A January 2025 briefing reiterated that the 100 % renewable electricity by 2030 objective remains in force in Estonian law and planning. [48], [49], [50]

Within this transition, biomass-based CHP remains a flexible component supporting heat demand and providing firm electricity when needed in district-heating centers (co-generation role documented by the Narva and Utilitas operators) [51].

2.5.2. Existing bioenergy strategies and planning documents

The Government launched ENMAK 2035 [52] to update targets and measures for secure, affordable, cleaner energy across electricity, heat and fuels. The development plan aligns with EU and national long-term goals and addresses the need for sufficient controllable capacity alongside wind and solar. On 8 January 2026, the Government approved ENMAK 2035, emphasizing reliability, consumer price impacts, diversified generation portfolios, and market-based development with reserve measures for dispatchable capacity. Earlier ENMAK guidance (2030) had already prioritized preserving efficient district heating and raising the role of local renewable fuels in heat.

The Green Reform [53] sets cross-government objectives for a competitive, climate-neutral economy and knowledge-based decision-making by 2050, with an action plan approved for 2023–2025. It frames energy, heating and industry measures, and links directly to the Estonia 2035 strategy. The Commission's "Estonia 2035" material and Riigikogu documentation corroborate this long-term strategic backbone.

IRENA's profile for Estonia shows bioenergy accounting for roughly 70 % of renewable final energy consumption in 2022, underlining the structural role of wood fuels in heating and CHP that the planning documents assume [54].

2.5.3. Best practices for alternative biomass utilization in heat supply

There are few good examples of alternative biomass implementation in Estonia:

- At Narva, legacy oil-shale plants have been incrementally modernized with circulating fluidized-bed technology; Balti's CHP unit operates with oil shale mixed with biomass for district heat and power, and analysis by Tallinn University of Technology engineers assesses pathways to future low-carbon DH operation [55]. The Auvere unit with 300 MW capacity was designed to co-fire up to 50 % waste wood, with additional options for peat and shale gas. Operator information sets out the co-firing ranges and CHP usage in the Narva complex;
- Väo 1 and Väo 2 are biomass-fired CHP units supplying Tallinn's DH, with electrical capacities of 25 MW and 21.4 MW and thermal capacities of 49 MW and 76.5 MW respectively; both primarily use wood chips. In 2024, Utilitas added flue-gas condensers, heat pumps and an electric boiler to raise recovery, reduce gas use, and integrate more low-temperature heat into the DH network. A 2025 technical note describes large heat pumps at the Väo biomass CHP site to reuse waste heat and improve seasonal efficiency, illustrating how biomass CHP and power-to-heat are combined; [56], [57]
- The Pärnu CHP (Fortum) has 24 MW electricity and roughly 50 MW heat capacity, commissioned in 2010/2011, using wood chips, residues and some peat, and

covering much of the city heat demand. Case documentation reports typical annual outputs around 110 GWh electricity and 220 GWh heat, with design flexibility for mixed biomass fuels to optimize operation. [58], [59]

2.6. Poland

This subsection presents the bioenergy-related instruments and legal acts overview existing in Poland that have a direct and current impact on heat supply. Table 2.6 contents summary about policies and programs.

Table 2.6. Most significant bioenergy-related instruments in Poland

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
Updated NECP process 2024-2025	Legal/strategic	Raises 2030 renewables contributions and identifies DH decarbonisation needs, positioning biomass and biogas among fuels for CHP and DH
Energy Policy of Poland until 2040 (EPP2040)	Legal/strategic	Recognises biomass and biogas as key DH and CHP fuels under sustainability and cascading principles
URE reports on DH renewables share	Evidence and compliance	Low initial RES share in DH supports the need for operational and investment support to scale biomass heat within DH networks
Straw-fired boiler project (Grudziadz)	Capital investments	Replaces coal with straw combustion supplying existing turbine island and DH, demonstrating alternative agricultural biomass pathways

2.6.1. National Energy and Climate Plan

Poland's NECP [60] for 2021–2030 was first submitted in December 2019 and has since undergone an update process: an initial update was sent to the European Commission on 1 March 2024, a broader public consultation draft followed in October 2024, and an ambitious updated draft was approved by the Ministry of Climate and Environment on 28 July 2025 [61]. The European Commission published its EU-wide assessment of updated NECPs on 28 May 2025, placing Poland's update within the common governance cycle.

Recent official statistics show the share of energy from renewable sources in Poland's gross final energy consumption at 16.5 % in 2023 and 17.7 % in 2024. The updated NECP sets a national 2030 contribution of 32.6 % RES in gross final energy consumption in the

different scenarios, consistent with the government's executive summary and the IEA policies database. In electricity, the updated NECP targets more than half of generation from renewables by 2030, with the 2025 ministry draft specifying 51.8 % in 2030 and a trajectory toward nearly 80 % by 2040. Complementary coverage indicates the government plans to submit the final update in early 2026, with two development pathways and renewables plus nuclear as the backbone of the mix. District heating is identified as a priority for decarbonization. The energy regulator's market review shows the licensed district heating sector had less than 13 % renewables in its fuel mix in 2022, indicating a low base. The updated NECP's ambitious path aims to raise the district heating RES share to 36.7 % by 2030 and around 67.6 % by 2040, alongside phasing out coal in CHP during the 2030s. Transport remains the most fossil-dependent sector. Eurostat series (compiled in CEIC) put Poland's renewables in transport at about 6.0% in 2023, up slightly from 2022 but still far from long-term objectives. The government's policy framed a 14 % transport RES goal by 2030, and a draft amendment aligned with RED III signaled about 14.9 % by 2030 through advanced biofuels, renewable electricity, and biomethane, subject to legislative finalization. [62], [63], [64], [65], [66], [67]

2.6.2. Existing bioenergy strategies and planning documents

The Energy Policy of Poland until 2040 (EPP2040) [68] is the core national framework complementing the NECP and explicitly positions biomass and biogas as key fuels for district heating and CHP, while reserving more advanced fuels and electrification for transport in line with resource cascading principles.

From a system perspective, IRENA's country profile [69] shows that bioenergy accounts for roughly three-quarters of renewable final energy consumption in Poland, underlining the structural role of solid biomass in heating and CHP while wind and solar scale up in power.

2.6.3. Best practices for alternative biomass utilization in heat supply

There are few good examples of alternative biomass implementation in Poland:

- The Łąkowa Heat and Power Plant project replaces coal by installing a 12.5 MW straw-fired steam boiler that supplies the existing turbine island and district heating network, using locally sourced loose straw and advanced flue-gas cleaning to lower emissions. Construction and commissioning have been implemented by OPEC Grudziądz with SBB Energy and DP CleanTech, backed by the National Fund for Environmental Protection and the EEA/Norway mechanism; [70], [71]
- Ostrów Wielkopolski has integrated wood-biomass CHP with local electric bus charging, delivering electricity via a dedicated medium-voltage line to the charging

points and reducing both costs and local air pollution; the city continues to expand its e-bus fleet through 2025–2026 procurements. [72], [73], [74]

2.7. Latvia

This subsection presents the bioenergy-related instruments and legal acts overview existing in Latvia that have a direct and current impact on heat supply. Table 2.7 contents summary about policies and programs.

Table 2.7. Most significant bioenergy-related instruments in Latvia

Policy/Program	Type	Relevance to Bioenergy (Heat Focus)
Final updated NECP 2021-2030 (submitted 2024)	Legal/strategic	Near-term plan to 2030 defining sectoral measures for renewable heat, including development of biomethane and electrification of DH via industrial heat pumps and power-to-heat options
Latvian Bioeconomy Strategy 2030	Strategy	Cross-sector strategy promoting cascading use of biomass, with the energy sector identified as a major consumer; guides increased use of residues and low-grade biomass where appropriate
Energy Strategy Latvia 2050	Legal/strategic	Long-term framework setting energy affordability, self-sufficiency and efficient infrastructure as goals; recognises the role of biomass and biogas for base load and system flexibility in heat supply
Biomass sustainability certification recognition (RED BP scheme)	Market and compliance	Recognised in Latvia as suitable to demonstrate biomass sustainability, facilitating compliant fuel procurement for DH operators using solid biomass

2.7.1. National Energy and Climate Plan

Climate and Energetic Ministry of Latvia have enlisted a document of long-term planning guidelines called Energy Sector Strategy of Latvia until 2050. It includes 3 main goals for Latvia: The cheapest energy prices in the region, self-sufficiency in energy consumption and

energy infrastructure is being used effectively and sustainably. Locally produced and utilized biomass has the potential to impact all these goals. Which is also defined in the document, that stable base load and flexibility of the system is supported by biomass and biogas. Meanwhile biomass would stay as the cheapest energy resource until 2050 [75]. However, since biomass and biogas, both are mentioned in future energy consumption plans, mutual competition is naturally accruing, thus in document biogas and further biomethane are preferred fuels, since it directly reduces the fossil natural gas usage [75]. Thus, some types of biomass consumption would be reduced over time.

NECP of Latvia is document for near future, which is until 2030. However, in this document slightly different objectives are set: full energy independence for affordable prices for citizens, and promote decarbonization of economy, energetic sector, industrial and endorse electrification via investments and efficiency advancements; enforce energy security in Latvia. NECP shows that 66% of the DH is powered by biomass, but in future it is anticipated that industrial heat pumps and electricity would be heavily included in DH, thus reducing natural gas and biomass importance in DH. Natural gas distributors also will be influenced by planned obligatory supplement of biomethane in the natural gas grid. [76] Both of these documents are endorsing general changes in energy sector, which are directly related to fossil fuel reduction, GHG reduction and general decarbonization of all sectors in economy of Latvia. Besides decarbonization, documents both point on the biomass reduction in energy by partially replacing it with biomethane.

2.7.2. Existing bioenergy strategies and planning documents

Bioeconomy strategy 2030 of Latvia is endorsing to use biomass in whole economy according to the grade of the biomass including in construction, manufacturing industry (textile industry, chemical industry, etc.), as well as in energy industry [77]. In the bioeconomy strategy energy sector is also partly viewed as one of the largest biomass consumers. However, regarding biomass increase in other sectors, than energy sector, attractive entrepreneurial environment is set as an objective in the strategy. Also cascading principle is highlighted with biomass usage, thus allowing to use high quality according to the strategy and residues and low-quality in energy sector or other applications [77]. However, biomass reduction is not pinpointed in bioeconomy strategy, because other sectors increased usage in biomass is anticipated, thus sustainable gather of primary production of biomass should be ensured.

2.7.3. Best practices for alternative biomass utilization in heat supply

Situation in Latvia, regarding biomass consumption in energy sector has a positive tendency, since the natural gas price spikes during the Russia's invasion in Ukraine. Many

natural gas boilers and some CHP switched to biomass, thus becoming more independent from imported fossil energy resources. Some examples include:

- ”GREN Latvia” is enterprise based in northern Europe, which focuses on heat supply and district heating as well as cogeneration. One of the CHP plants are in Jelgava, which is biggest biomass CHP plant in Latvia, generating 23 MWe almost fully on biomass (92 %), while peak demands are satisfied with natural gas (8 %). Heat power is 45 MW and is supplied to the residents and industries. Calculated emission factor of the plant is 0.0176 tCO_2/MWh for heating. Also heat accumulation is in action, which allows to smooth out the production and shift production to peak demands; [78]
- “Salaspils Siltums” is another example of district heating supplier, however this power plant mostly generating heat from fossil fuel of natural gas (23 MW), while biomass is used for only 3 MW. However, this power plant is unique due to the high usage of solar collectors, which consists of 15 MW, thus fully supplying heat in summer and warmer months of heating season, thus fully substituting combustion-based heating for certain time of year; [79]
- ”Adven Latvia” is biomass-based boiler house operators all around Latvia, which is a great example for profitable businesses based on biomass combustion. Especially in Cēsis, where 85 % of local heat is produced based on locally gathered biomass. [80]

2.8. Comparison and summary

This section provides a comparative overview of the selected EU Member States to highlight the structural similarities and differences that influence the role of biomass in their heat supply systems. The comparison focuses on key parameters that shape national conditions for biomass utilization, including forest resource availability, the current share of renewables and biomass in the energy and heat sectors, as well as general economic indicators. Presenting these indicators side by side helps to contextualize each country's performance, identify common development patterns, and reveal constraints or opportunities that may be relevant for designing Latvia's own biomass pathway. Table 2.1 summarizes these parameters and serves as a basis for drawing cross-country conclusions in the subsequent analysis.

Table 2.8. Key structural indicators influencing biomass utilization

Parameters	**Sweden**	**Finland**	**Austria**	**Czechia**	**Estonia**	**Poland**	**Latvia**	**Source**
Share of forest in total area, %	62.4	66.5	48 [81]	37.3	45.1	30.2	53.4	[82]
RES share at energy sector, %	62.8	52.1	42.9	19.2	42.2	17.7	45.5	[83]
Biomass share at energy sector, %	48.1	42.7	41.1	15.3	30.3	15.2	39	[84]
RES share at heat production, %	67.8	62.6	42.2	29.1	67.8	21.2	61.8	[83]
Biomass share at heat production, %	> 20	> 20	31 [24]	~ 11	> 20	> 20	33.2	[85]
GDP per capita, Thousand EUR	52 600	49 100	52 760	29 280	28 740	22 560	21 610	[86]

Among the countries reviewed, Sweden applies the strictest and most price-driven mix, anchored in a high, long-standing carbon tax on heating fuels that has systematically pushed households and DH operators away from fossil inputs and toward bioenergy. This tax architecture is complemented by targeted tax exemptions for renewable heating fuels and broad investment grants via Klimatklivet, while a new reverse-auction scheme for Bio-CCS channels substantial state aid to biomass CHP with carbon capture. In combination, this produces the strongest economic signal to expand sustainable bioheat and simultaneously tighten lifecycle emissions control. Austria ranks next on policy stringency but is subsidy-led

rather than tax-led. Decarbonization of heating relies on market premiums and tenders under the Renewable Energy Expansion Act and persistent federal grants via KLIEN, while the Eco-Social Tax Reform introduces a national ETS covering fuels in buildings and transport, strengthening the price environment without a Sweden-style carbon tax centerpiece. Austria's bioheat penetration in DH and households is high, with public finance instruments doing the heavy lifting, making it strong on incentives but less punitive than Sweden's carbon price model. Czechia is strict on investment support and operational aid rather than taxation. DH decarbonization is driven by the Modernization Fund's HEAT program and related state-aid schemes, including approved budget increases and a green bonus for biomass heat paid per gigajoule, all nested under the updated NECP 2024 and legal architecture of Act No. 165/2012 with auctions and over-compensation control. The approach is hard on subsidies, soft on carbon pricing, yielding rapid fuel-switch options for DH operators while ensuring compliance through state-aid governance rather than fiscal penalties. Finland adopts the cautious and transitional stance for bioenergy in heating. The updated NECP and climate neutrality 2035 policy explicitly frame bioenergy as a near-term bridge under sustainability constraints, with strategic emphasis on electrification and heat pumps over long horizons. That makes Finland softer on expanding bioheat as an end-state, relying mainly on programmatic investment and planning rather than strong carbon-price escalation targeted at the heat sector. Estonia sits mid-range in strictness, keeping biomass CHP as a significant DH pillar but actively pairing it with large heat pumps, flue-gas condensers and efficiency retrofits, while national auctions scale wind and flexibility. The instrument set is pragmatic and investment-oriented, with limited use of carbon taxation, positioning Estonia as practical rather than punitive in steering bioheat. Poland is subsidy-heavy and implementation-focused. Strategy documents such as EPP2040 and the updated NECP process identify biomass and biogas as key DH fuels, with the Modernization Fund serving as the primary lever. Given the low renewables base in DH reported by the regulator, Poland's strictness lies in programmatic support and investment conditionality, not in price-based penalties, which places it mid-to-soft on the tax dimension. The Energy Strategy 2050 and updated NECP 2024 set a trajectory to retain a strong role for biomass in DH and develop biomethane, with the emphasis on sectoral action plans and EU-funded measures rather than heat-sector carbon taxation. Latvia's instrument mix is soft on price signals and harder on strategic planning and grants, reflecting the country's DH structure and long-term neutrality pathway.

3. Biomass pathway to sustainable heat supply

Sustainable use of biomass in heat supply requires a shift in focus with respect to the fuels used. Existing EU strategy documents and regulations send a clear signal that the use of high-quality wood fuel for heat production will be constrained and that resources will be redirected to industrial sectors to produce high value added biomass-based products. At the same time, available analyses indicate that both the EU as a whole and most of its member states consider biomass to have an important role in the decarbonization of heat supply. Bioenergy can successfully provide the sector's baseload because the production process is stable and independent of weather conditions, in contrast to many other renewable energy technologies, including solar and wind. The heat supply sector should focus on the use of biomass residues.

3.1. Identification of alternative biomass resources

Resource diversity can be viewed as an advantage because it offers choice. At the same time, it can also be a drawback. The properties of biomass residues differ markedly, so users may face large variations in moisture content, ash content, heating value, ash melting temperature, fuel particle size distribution, bulk density, and other parameters. The heterogeneity of biomass residues creates significant challenges for their efficient and sustainable use in energy production. It should be noted that biomass combustion technologies are typically a set of solutions that convert fuel into heat through coupled heat and mass transfer processes. Accordingly, the combustion chamber is only one element involved in fuel conversion. There are also multiple upstream elements that provide fuel preparation, feeding into the furnace, air supply, and removal of combustion products.

Differences in physicochemical properties affect fuel preparation and storage processes and also the stability and efficiency of combustion equipment. For example, elevated moisture content lowers the effective heating value and extends drying time, so larger grate or furnace surface area is needed to ensure effective moisture evaporation. High ash content and low ash melting temperature can promote slagging, fouling of combustion chambers, and accelerated equipment wear. It is therefore necessary to assess whether ash removal systems are suitable for fuels with high ash content.

Summary and recommendations. Knowledge is needed about biomass properties, particularly for new alternative biomass. Accumulating and transferring this knowledge to industry can be achieved by creating international databases that consolidate data and findings on different types of biomass and their properties.

3.2. Suitability of combustion technologies

There is a substantial difference between small-/large-scale combustion equipment and their suitability for using alternative biomass. Small scale equipment generally refers to pellet boilers, while large scale equipment refers to chip-fired boilers. The design elements of these combustion systems differ significantly. Pellet boilers operate on pre-processed biomass that is dried and densified into pellets. Most pellet boilers have strict pellet quality requirements with a narrow allowable range. Use of alternative and lower quality biomass in small scale pellet boilers is limited. Non-compliance with pellet quality criteria can cause combustion instability and increased slag and deposits, which lead to higher emissions and reduced efficiency.

Chip boilers also use biomass that has typically undergone pre-processing, mainly to prepare the required particle size distribution through chipping. By contrast, requirements for moisture, ash content, and heating value are usually less strict and allow variability. Large scale chip-fired systems, due to their design and process control with sensors and automation, are substantially more flexible regarding fuel quality. Such systems typically use moving grates or bubbling fluidized-bed technologies that improve fuel-air mixing and provide a more uniform temperature profile in the furnace. This enables a stable combustion process even when biomass properties fluctuate.

Summary and recommendations. Lower quality indicators of alternative biomass do not mean it cannot be used for heat supply. Combustion units that can efficiently fire alternative biomass already exist. Most combustion technologies, especially pellet boilers, should not be used for low quality biomass because emissions are high and efficiency is low. It is advisable to use modern combustion systems that are designed for low quality biomass or to retrofit existing technologies where technically feasible.

3.3. Appropriate policy framework

Use of biomass in heat supply is governed by a policy framework that includes regulations, taxes, subsidies, and other mechanisms that can both promote and limit biomass use. The policy framework should ensure sustainable, cost-effective, and climate-neutral heat production while maintaining biomass availability for other energy sectors and bioeconomy needs. The strategy should be based on a long-term view in which bioenergy is treated as a transitional and stabilizing energy resource that complements other renewables and supports the shift away from fossil fuels.

The policy framework may include various approaches and instruments. In the context of energy resources, it is important to balance instruments so that support for the desired resource does not distort markets or drive unwarranted price increases due to demand growth.

It is important to balance tax policy, subsidies and support schemes, and support for research and innovation.

Tax policy. Taxes should encourage a shift to more sustainable heating solutions while avoiding undue burdens on consumers and firms. This can be achieved by gradually increasing fossil fuel taxes to reflect external costs (CO_2 emissions, air pollution), providing relief or reduced rates for sustainably certified biomass, and avoiding broad tax holidays for bioenergy that could promote inefficient resource use.

Subsidies and support mechanisms should be targeted, time-limited, and technologically neutral. It is advisable to focus investment support on high-efficiency equipment, support the shift from individual fossil heating to integration of bioenergy technologies, and gradually reduce operational support for mature technologies to avoid market distortions. The main aim of subsidies is to lower biofuel prices by improving production efficiency.

Research, development, and innovation policy is essential for the long-term sustainability of bioenergy. Priorities include technologies for using low-quality and alternative biomass, emission reduction and ash management solutions, and integration of bioenergy into smart energy systems and sector coupling. Support should be stable and predictable to promote private sector engagement and knowledge transfer.

Summary and recommendations. An effective and coherent policy is needed, grounded in sustainable biomass criteria, heat supply planning, and close alignment with climate and bioeconomy strategies. This approach enables optimal use of bioenergy potential in heat supply while preserving flexibility for future energy system development.

3.4. Linkages across sectors

Strategy in energy aims to reduce fossil fuel consumption, enhance energy independence, and cut greenhouse gas emissions while ensuring secure and economically sound heat supply. Biomass resources are limited, so their use in heat supply cannot be considered in isolation from other energy sectors and bioeconomy development paths. Biomass is also a feedstock for power and combined heat and power, transport biofuels, and high value added products such as building materials, chemicals, and specialty products. There is therefore competition for the same resource, which requires a strategic and coordinated approach to biomass planning and use. From an energy system perspective, using biomass for heat is particularly rational when it is fired in high-efficiency combustion equipment. This approach maximizes the energy potential of biomass while avoiding environmental harm from air pollution. Consistency with bioeconomy principles is important, meaning prioritization based on the cascade principle, where higher value added products come first and energy use is mainly from residues, by-products, and low-quality biomass. This approach promotes efficient resource use, reduces pressure on primary natural resources, and

supports sustainable sector development while reducing risks related to overuse or inefficient allocation across sectors.

Summary and recommendations. Guidelines for biomass use in heat supply must be developed about the needs and goals of other energy and economic sectors for biomass. A coordinated national strategy for sustainable biomass use is needed. Such a coordinated approach enables optimal use of biomass potential while reducing risks linked to overuse or inefficient allocation across sectors.

3.5. Communication and cooperation

Effective use of biomass in heat supply depends not only on technology availability but also on effective cooperation among stakeholders. Participants include policymakers, national and municipal institutions, heat supply companies, biomass suppliers from forestry and other sectors, biofuel producers and other industry representatives, research institutions, and the public. Insufficient information exchange and fragmented action can lead to inconsistent decisions on biomass resource use, investment directions, and environmental requirement implementation.

At the national level, promoting biomass in heat supply requires a coordinated institutional approach. One effective solution is to establish a permanent cross-sector cooperation platform with representatives from the public to policymakers. The platform would ensure policy coherence, exchange data on biomass availability, and analyze the impacts of policy decisions on the heat supply sector.

At national level this can be organized through regular thematic working groups, public consultations, and industry forums. This approach helps to identify potential conflicts in time, such as between energy and material uses of biomass, and supports joint solution development.

A national knowledge and competence centre also has an important role. Such a centre can serve as an information hub, providing technical guidelines, good practice examples, methodologies for assessing biomass sustainability, and support to municipalities in heat planning. It would also facilitate practical uptake of research results and feedback to policymakers.

Public communication is an integral part of this effort. Clear, data-based, and understandable messages about the benefits, risks, and sustainability conditions of bioenergy help build public support and reduce misinformation risks. At the national level, this can be implemented through coordinated campaigns, educational materials, and open access to sector data.

Summary and recommendations. Promotion of biomass and bioenergy in heat supply requires purposeful and institutionally anchored cooperation among stakeholders. At national

level this means continuous cross-sector dialogue, development of competence centers, and structured stakeholder engagement. This approach ensures policy coherence, fosters trust, and enables more effective use of biomass potential in developing sustainable heat supply.

4. Discussion and conclusions

This study examined pathways toward sustainable biomass use in Latvia's heat supply, with particular attention to resource availability, regulatory frameworks, technological options, and system integration. The analysis confirms that biomass currently plays a critical role in meeting Latvia's renewable energy and climate objectives, especially in district heating systems, and will continue to do so in the medium term.

The results demonstrate that sustainability is no longer solely a resource availability issue, but increasingly a matter of compliance, efficiency, and system design. Strengthened sustainability criteria under EU energy policy require improved traceability, emissions accounting, and responsible forest management practices.

Diversification of biomass feedstocks and modernization of combustion technologies emerge as key strategies for reducing environmental pressure and improving efficiency. Biomass diversification and combustion technologies development and adaptation to the properties of alternative biomass should be carried out:

- in partnership with developed effective and coherent policy, grounded in sustainable biomass criteria, heat supply planning, and close alignment with climate and bioeconomy strategies;
- with coordinated national strategy for sustainable biomass use is needed;
- purposeful and institutionally anchored cooperation among stakeholders.

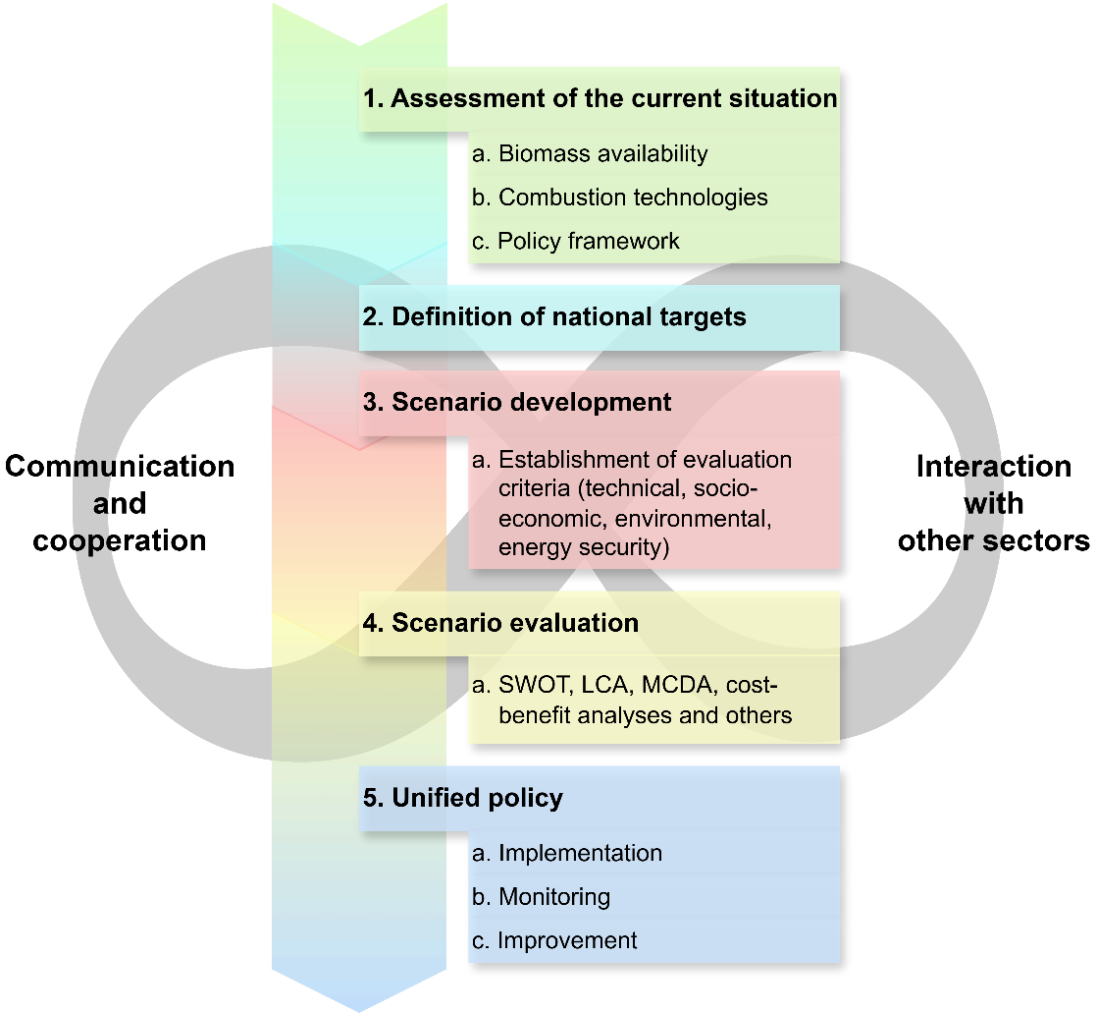

Figure 4.1. Roadmap for sustainable biomass heat supply

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