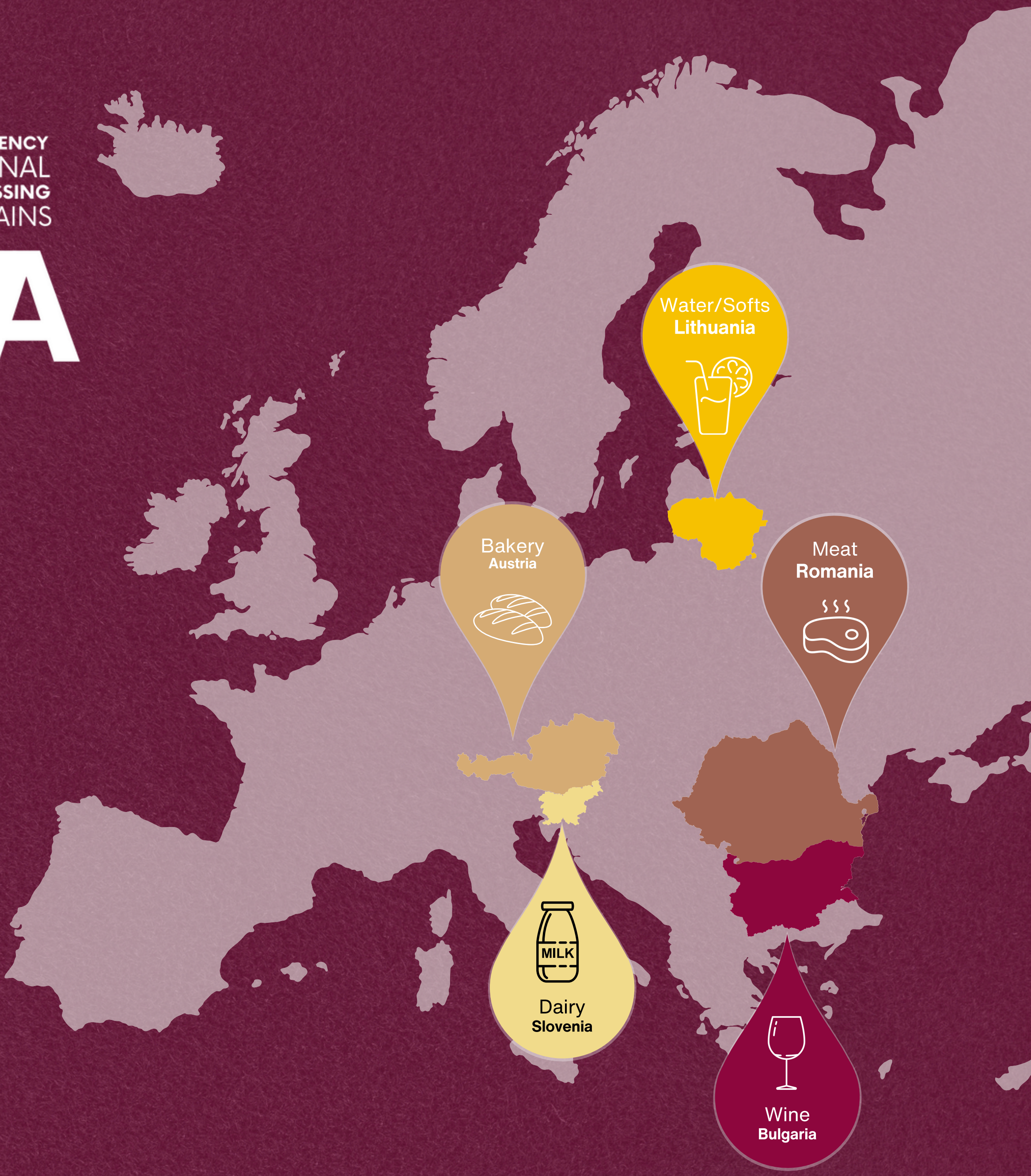
ENERGY EFFICIENCY IN REGIONAL FOOD PROCESSING VALUE CHAINS

EENOVA



DELIVERABLE 4.1

3rd Roundtable Regional Scenarios Report

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D4.1 - 3rd roundtable regional scenarios report

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Contents

Introduction

EENOVA is dedicated to addressing the key challenges associated with the food chain's heavy reliance on fossil fuels. Our primary objectives revolve around promoting energy- efficient solutions, evaluating and enhancing energy efficiency, increasing the use of renewable energy sources, and simultaneously reducing the carbon footprint within five regional value chains spanning five distinct food processing subsectors and countries. These value chains and their respective locations are as follows:

- Bakery - Austria (AT)
- Meat - Romania (RO)
- Water and soft drinks - Lithuania (LT)
- Winery - Bulgaria (BG)
- Dairy - Slovenia (SI)

EENOVA's goal is to guide businesses operating within these value chains towards the realization and implementation of tailored energy-related improvements.

This deliverable, D4.1 - 3rd Roundtable Regional Scenarios Report, is part of Work Package 4 (WP4), which focuses on the development and validation of regional energy transition scenarios. WP4 aims to engage stakeholders from each regional hub to explore future pathways for reducing fossil fuel dependency, enhancing energy efficiency, and accelerating the use of renewable energy sources within food processing. The third round of regional roundtables builds on previous findings, refining and validating key drivers, barriers, and opportunities identified across the five value chains.

The report provides a consolidated overview of the third roundtable discussions conducted in Austria, Romania, Lithuania, Bulgaria, and Slovenia. It summarizes the main challenges and opportunities identified by regional stakeholders, highlights the emerging trends in energy transition, and outlines the scenario-based insights that will inform the subsequent Deliverable D4.2, which focuses on validated scenarios and policy pathways.

Executive Summary on Regional Scenarios

The regional scenarios developed under EENOVA combine company-level audits, stakeholder dialogue and multi-dimensional assessment in five agri-food value chains: a bakery in Austria, a winery in Bulgaria, water and soft drinks in Lithuania, meat in Romania and dairy products in Slovenia. Each scenario reflects a balance between short-term feasibility and long-term ambition, while remaining anchored in the broader EU policy framework, including the European Green Deal, the Fit for 55 package, the NECP, CEAP and CSRD. The scenarios are not abstract visions, but approved frameworks developed together with businesses, policymakers and experts to help sectors achieve climate neutrality by 2050.

In Austria, the scenario for the bakery sector is based on a mature basis for energy efficiency and heat recovery, which has already been developed in large industrial bakeries and factories. Stakeholders have endorsed a trajectory that starts with comprehensive energy management systems, photovoltaic development, and compressed air optimization, and moves to high-temperature heat pumps and electrified logistics by mid-century. The scenario reflects both the technical preparedness of companies and the limitations of national legislation, in particular fire safety rules for PV installations. Its main message is that Austrian bakeries can move from gradual profits to systemic transformation if they are supported by predictable subsidy systems and infrastructure upgrades.

The Bulgarian winery scenario takes a different form, focusing on three pillars of activity: efficiency gains and digitalisation, the consumption of renewables with accumulation and gradual investment planning. The energy audit showed that irrigation, basement cooling, and logistics are the most energy-consuming points in the chain. Accordingly, the scenario emphasizes solar photovoltaic energy for irrigation pumps, adiabatic cooling in basements and optimization of compressors, supplemented by the gradual adoption of digital monitoring tools. Stakeholders confirmed that such a step-by-step approach is necessary as investment capacity varies widely across sectors and permitting photovoltaic products is limited by heritage rules. The scenario highlights not only the energy dimension but also the strong circular economy dimension, including the valorisation of by-products through cooperation between vineyards and wineries and the emerging practices of sustainable packaging.

In Lithuania, the water and soft drinks scenario, called "Clean Beverages 2050", combines efficiency, renewable energy and circular packaging in one way. The scenario envisages the rapid expansion of photovoltaic systems, the deployment of building management systems for real-time monitoring, and collaborative logistics to reduce transport costs and emissions. Policy alignment with the National Energy and Climate Plan and the Deposit Return Scheme make this scenario particularly important for export competitiveness, as European markets increasingly require demonstrable signs of sustainability. The scenario reflects both opportunities and barriers: while PV and monitoring are economically feasible in the short term, more ambitious measures such as battery storage and smart circular packaging depend on subsidies, joint procurement and supply chain stability. The narrative emphasizes the importance of naming Lithuanian beverages as "green exports", using sustainability as a competitive advantage.

Romania's meat value chain scenario presents a multi-layered approach, distinguishing between a baseline path to quick win, a compliance plan shaped by EU directives and a strategic transition path aligned with climate neutrality by 2050. In the baseline scenario, LEDs, reactive power compensation and small-scale PV are preferred, which pay for themselves quickly and are very popular with SMEs. The compliance scenario includes the obligations of the Energy Efficiency Directive and the CSRD, highlighting the importance of systematic energy management and reporting. The strategic transformation scenario envisages a full transition to renewable energy, the reduction of electrified processes and the decarbonization of logistics. However, the roundtable revealed that financing remains a crucial obstacle, especially for large companies not covered by support schemes. Therefore, while stakeholders supported the long-term vision, they insisted on gradual implementation and regulatory clarity to bridge the gap between ambition and economic reality.

The scenario for the Slovenian dairy sector illustrates the role of cooperative models and packaging transformation in enabling systemic change. Companies such as Planika and Mica are already engaged in increasing efficiency, installing photovoltaic power plants and recovering waste heat. The scenario confirms the further development of community energy models and explores the electrification of transport through pilot projects for electric trucks. Packaging remains a major challenge, as businesses are stuck between EU commitments on the use of rPET and consumers' reluctance to accept recycled plastics. Stakeholders stressed that subsidies and cooperation methods are essential to make packaging circularity possible and affordable. The scenario also envisages the valorisation of whey as a circular economy opportunity, although its practical implementation depends on overcoming cost and logistical constraints.

In all regions, the scenarios show both commonalities and differences. Common elements include prioritizing energy efficiency as the first step, renewables as the cornerstone of the medium-term transition, and circular packaging, and optimizing logistics as long-term measures. Austrian bakeries face the technical challenge of high-temperature heat; Bulgarian wineries emphasize irrigation and cellar cooling; Lithuanian beverage manufacturers emphasize packaging and branding; Romanian meat processors struggle with funding and compliance; Slovenian dairies are investigating the energy of collaboration and the use of circular by-products.

The scenarios together emphasize the importance of sequencing and adaptation. Short-term measures ensure credibility and momentum, medium-term investments include renewable and digital solutions, and long-term strategies ensure full circularity and neutrality. The scenarios also show that while EU policies are an overarching framework, national legislation, funding mechanisms and cultural factors determine the pace and nature of change. The EENOVA scenarios, combining comparability with regional specificities, are both a benchmark and an action plan to show how Europe's climate objectives can be achieved in the different realities of agri-food value chains.

3rd roundtable

Building on the findings of the first two roundtables, the 3rd roundtable in each partner country focuses on developing and validating scenarios for the regional value chains. Scenario is an action plan for each food and beverage sector (bakery, wine making, soft drinks, meat and milk) to reduce energy use, aligning with EU Green Deal guidelines. These scenarios integrate the measures identified at company and value chain level and extend them into structured pathways aligned with the European Green Deal, national energy and climate plans.

In this context, the scenarios are not individual company action plans but rather consolidated strategic roadmaps that synthesize the results of company-level audits and improvement measures into forward-looking, system-level visions. Each scenario describes how clusters of companies and stakeholders can collectively progress from isolated actions towards coordinated regional transition pathways.

The roundtables provide a space of trust and cooperation where companies, policymakers, and experts jointly assess the feasibility of the proposed scenarios. Stakeholders ensure that the scenarios reflect both operational realities of SMEs and policy ambitions at regional, national, and EU levels. Through this process, the 3rd roundtable supports the creation of actionable roadmaps that link company-level improvements with systemic policy recommendations, paving the way for replication and long-term impact.

Methodological Approach

Scenario development framework

The third round of national roundtables marked a decisive step in the EENOVA methodology, moving from the identification of measures and preliminary action plans towards the co-creation and validation of regional scenarios. Whereas the first two rounds concentrated on assessing the status quo of companies, conducting energy audits, and discussing priority measures, the third roundtables provided the setting in which these elements were synthesized into forward-looking pathways. The central aim was to ensure that scenarios were not designed in isolation by experts but rather built and endorsed by the companies and stakeholders who will ultimately shape and implement them.

This methodological progression ensured continuity within EENOVA's structure: WP2 and WP3 focused on empirical evidence and feasibility assessments (the "what" and "how"), while WP4 translated those outcomes into validated regional scenarios (the "what next"). Thus, scenarios act as collective implementation frameworks derived from the previously defined company action plans.

The methodological approach of the EENOVA project has been designed as an integrated and iterative process that combines technical analysis, stakeholder engagement, and multi-level validation. Its foundation lies in the recognition that energy transition in regional agri-food value chains cannot be achieved through isolated technological measures alone, but requires systemic thinking, cross-sectoral dialogue, and alignment with the European Union's overarching decarbonization and circular economy policies. The methodology thus operates at the interface between empirical evidence, in the form of company-level energy audits and action plans, and collective foresight, as developed through participatory scenario-building processes in the regional hubs.

By combining bottom-up data and top-down strategic foresight, WP4 effectively transforms localized measures into coherent regional transition pathways. This link between micro-evidence and macropolicy vision is what defines the EENOVA approach to scenario building.

At the core of the methodological design lies a participatory scenario development framework that builds directly on the results of company-level audits and assessments from WP2 and WP3. These earlier tasks established baselines for energy use, renewable uptake, and infrastructural bottlenecks, while identifying feasible measures and critical factors for improvement. Integrating these findings into WP4 ensured that scenarios were rooted in real company data rather than abstract assumptions. This continuity enabled WP4 to translate empirical evidence into forward-looking pathways linking company actions with systemic policy frameworks. As a result, the methodology effectively bridged micro-level audits and macro-level foresight, allowing company-level strategies to scale into coherent regional and sectoral transition pathways.

This approach also provided a shared analytical language among partners, enabling each regional hub to compare progress, identify common barriers, and propose harmonized policy responses.

Stakeholder involvement

Regional hubs served as practical co-creation spaces where companies, policymakers, and experts jointly refined scenario measures using real data and operational insights. Companies shared energy costs, barriers, and investment needs, while policymakers tested regulatory feasibility. This hands-on collaboration built trust, ensured scenarios reflected real business conditions, and validated them both through policy alignment and peer exchange across the value chain.

Each roundtable served as both a validation checkpoint and a mutual learning platform, ensuring that knowledge exchange occurred horizontally (among companies) and vertically (between business and policy actors).

Content included in the scenario

A central methodological feature was the multi-dimensional assessment lens applied to each scenario. This lens ensured that proposed measures were not evaluated solely in terms of technical efficiency but also in their economic viability, innovative potential, and policy alignment. Energy aspects were analysed in terms of expected savings, renewable integration, and carbon footprint reduction. Economic aspects were assessed through cost-benefit considerations, payback times, and the broader financial implications for SMEs operating under constrained resources. Innovation and digitalization were integrated as a third dimension, reflecting the project's ambition to go beyond incremental improvements and embrace transformative solutions such as digital monitoring, predictive maintenance, or circular resource valorisation. Finally, each measure and scenario was examined against the EU policy architecture, particularly the Fit for 55 package, the Energy Efficiency Directive, the Renewable Energy Directive, the Circular Economy Action Plan, and the Corporate Sustainability Reporting Directive. By systematically applying this lens, the methodology safeguarded coherence between company-level strategies and European-level targets.

This comprehensive assessment ensured that the scenarios could serve as credible evidence for both policy formulation and investment prioritization under EU and national programmes.

Basic sequence of steps and regional adaptation

Ensuring methodological consistency across five different countries and subsectors posed a challenge that the project addressed by combining a common analytical framework with flexible regional adaptation. While the basic sequence of steps **- data gathering, measure identification, scenario drafting, validation, and refinement** - remained constant across Austria, Bulgaria, Lithuania, Romania, and Slovenia, the content of each step was tailored to the specificities of the regional value chain. This meant that bakeries in Austria could focus on high-temperature heat and compressed air systems, while wineries in Bulgaria emphasized irrigation and cellar cooling. By maintaining a uniform structure but allowing substantive flexibility, the methodology produced outputs that are both comparable across regions and deeply grounded in local realities.

This adaptive approach also facilitates future replication, as other regions or sectors can follow the same logic while customizing technical content to their local context.

Data collection and validation

Data collection and validation formed another critical pillar of the methodology. Information flowed from several channels: energy audits conducted by specialized experts, internal company reports and investment plans, stakeholder interviews, policy document reviews, and roundtable discussions. Each data source was triangulated with others to ensure accuracy and robustness. Validation was not limited to technical checks but extended to stakeholder verification, whereby participants in the roundtables could challenge, refine, or endorse the scenario elements based on their lived experience and professional expertise. Additionally, the scenarios were verified within the partnership. These participatory validation loops enhanced the credibility of the scenarios and increased the likelihood of stakeholder buy-in during implementation.

This iterative validation ensured that scenarios evolved dynamically updated as new data, technologies, or policy directions emerged.

Benefits

Finally, the methodological approach highlights that the process is just as important as the product. The value of the scenarios lies not only in their written outputs but in the dialogue, trust, and shared understanding generated through the participatory process. The methodology has thus been both an analytical exercise and a capacity-building intervention. Companies gained exposure to new technologies and practices, policymakers obtained grounded insights into implementation barriers, and clusters developed the experience of facilitating multi-actor dialogue. This co-creation dimension is what enables the scenarios to serve as living documents, continuously adaptable as new opportunities and challenges emerge.

This participatory approach strengthens long-term collaboration among regional actors, positioning the hubs as innovation ecosystems capable of leading future energy transition projects beyond EENOVA.

In conclusion, the methodological approach of EENOVA represents a deliberate attempt to merge rigorous technical evidence with participatory foresight and multi-dimensional assessment. By grounding itself in company-level audits and the results of the action plans developed under WP3, convening stakeholders in regional hubs, and applying systematic lenses of energy, economics, innovation, and policy alignment, the methodology provides a robust foundation for scenario development.

Within this framework, the scenarios and their corresponding pathways are new analytical outputs generated under WP4. They build upon the WP3 action plans but go beyond individual company measures by translating them into collective, regional-level transition roadmaps. These pathways connect micro-level implementation realities with macro-level policy and investment frameworks, providing a bridge between business practice and systemic transformation.

The emphasis on consistency across regions combined with flexibility for local adaptation ensures that the resulting scenarios are both credible and relevant. Most importantly, by embedding the process within structures of trust and dialogue, the approach enhances the likelihood that the scenarios will not remain theoretical constructs but will translate into actionable pathways that guide the regional agri-food value chains toward energy efficiency, renewable integration, and climate neutrality by 2050.

Scenario Building

This scenario building process contributes to the construction of proof within the EENOVA project showing energy audit results (at the company level) implementation and energy efficiency exploitation in the regional context based on cooperation and synergies between individual companies being part of the food processing value chain.

In this sense, the scenarios act as evidence-based synthesis documents demonstrating how audit results can be operationalized through collaborative implementation rather than isolated company measures.

The scenario content relies on outcomes of the 1st and 2nd roundtables and the work done under WP2 and WP3: (1) the report of current status quo of single entities which is documented by an energy audit and is done for buildings, processes and logistics and (2) critical factors and action plan evaluating feasibility of the results from energy audits, identifying the critical factors and opportunities for improvement of energy efficiency and the use of renewables on both company and value chain levels.

However, it is important to distinguish that while action plans specify immediate company-level steps, scenarios represent an aggregated and forward-looking vision-linking those individual measures into collective, strategic pathways.

WP4 aims to develop conceptual roadmap to be followed by each regional hub with the aim of achieving climate neutrality by 2050 on the operational level as well as on policy (legislation and regulation) level.

These conceptual roadmaps also serve as blueprints for replication in other regions, ensuring that the lessons learned within EENOVA can support the broader EU transition toward climate neutrality.

Pre-defined Scenario Options

In order to ensure methodological consistency across all five regional centres, while allowing for sector-specific adaptation, the EENOVA consortium has developed a set of pre-defined scenario options. They served as reference templates to ensure that each regional scenario remained comparable across countries and based on local realities. The scenarios reflect plausible, structured ways to decarbonize agri-food value chains, reflecting a balance between ambition, feasibility and policy coordination.

Three main types of scenarios were used as reference points:

1. **Baseline 2030 (Incremental Improvement Pathway)**
    - The focus is on proven, low-cost efficiency measures with a short payback period, such as LED retrofitting, compressed air optimization, and heat recovery.
    - Includes photovoltaic (PV) systems for self-consumption, reactive power

compensation, and basic logistics optimization.
    - Serves as an entry-level path, creating immediate momentum and reducing financial and technical risks.
    - Aligned with the Fit for 55 measures and the short-term objectives of the National Energy and Climate Plans (NECPs).
2. **Compliance 2030 (Standards and Reporting Pathway)**
    - Reflects mandatory requirements stemming from the EU policy framework, including the Energy Efficiency Directive (EED), the Renewable Energy Directive (RED) and the Corporate Sustainability Reporting Directive (CSRD).
    - Highlights digitalisation, energy management systems and circular packaging measures needed to comply with reporting and sustainability obligations.
    - Helps companies prepare for changing market expectations and regulatory obligations, while ensuring competitiveness by increasing efficiency.
3. **Strategic Transformation 2050 (Long-term Climate Neutrality Pathway)**
    - Reflects each subsector's vision of full decarbonization and a circular economy.
    - Provides for the integration of 100% renewable energy (photovoltaic, biogas, hydrogen, storage), electrification of heat and logistics, and systematic adaptation of the valorisation of circular packaging and by-products.
    - Achieving climate neutrality by 2050 requires significant investment, cluster cooperation and support policy frameworks.
    - Companies are at the forefront of sustainable agri-food value chains, strengthening the competitiveness and resilience of regions.

Across all scenarios, common pillars were retained:

- **Energy efficiency and heat recovery** as first priorities.
- **Renewable energy deployment** through PV, energy communities, and storage.
- **Circular economy and packaging solutions** (rPET, returnable glass, whey valorisation).
- **Low-carbon logistics** include e-mobility and route optimization.
- **Policy alignment** with Fit for 55, CEAP, NECPs, and CSRD.

These pre-defined options provided a coherent framework for stakeholders to discuss the trade-offs between short-term feasibility and long-term ambition during the roundtable. They also ensured comparability of the results of Austria, Bulgaria, Lithuania, Romania and Slovenia, while leaving room for regional adaptation and company-specific plans in subsequent chapters.

Results from 3rd roundtables sessions

The roundtables took place across all five participating regions and subsectors. Each session brought together company representatives, policymakers, industry associations, consultants, and technical experts in a space of trust and dialogue. The discussions were guided by structured facilitation methods but remained open enough to allow local realities, sectoral challenges, and policy priorities to surface.

The results collected here provide a country-by-country account of the third roundtables, documenting the agendas, participants, and key outcomes of the sessions. They highlight the main topics that emerged, areas of disagreement and consensus, and the measures that were validated or refined through collective deliberation. In each case, the roundtables served not only as a validation exercise but also as a knowledge-sharing platform where companies could learn from one another and from external experts, while policymakers could test the feasibility of regulatory ambitions against business realities. The chapter is therefore not a mere record of events, but a reflection of how the methodological approach materialized in practice. It demonstrates the way in which the EENOVA project anchored its scenarios in real-world evidence and stakeholder perspectives, ensuring that the pathways developed are credible, context-sensitive, and aligned with both company strategies and EU policy frameworks. The following sections present the detailed outcomes of the third roundtables in each partner country, showing how the process of dialogue, negotiation, and validation produced actionable insights for the transition of regional agri-food value chains towards energy efficiency, renewable integration, and climate neutrality.

Roundtables took place on the following dates:

- 12 September 2025 / Austria
- 29 September 2025 / Bulgaria
- 26 September 2025 / Lithuania
- 19 September 2025 / Romania
- 25 August 2025 / Slovenia

On the following pages there is a summary of the results of each roundtable:

- Bakery value chain (Austria)
- Wine value chain (Bulgaria)
- Water and soft drinks value chain (Lithuania)
- Meat value chain (Romania)
- Dairy value chain (Slovenia)

Bakery value chain (Austria)

Objectives

Workshop concept relied on a How, Wow, Now, Ciao matrix[1]. The participants were assigned to different tables depending on their affiliation. One table was with Lukas Knoll representing Knoll Mühle and stakeholders and the other table consisted of Resch&Frisch representatives and stakeholders. First, the company and the stakeholders were asked to fill in the matrix. By filling in energy efficiency measures in the matrix the measures recommended in the energy efficiency audits were rated regarding the leverage of the measure and the easiness/feasibility of implementation. In the next step the matrix was discussed within the groups and on a common group matrix was agreed and presented to the other group. Afterwards, the groups discussed how the implementation of measures can be promoted and how these implementation incentives will affect the feasibility of measures. In the gallery walk the groups were asked to comment on the ideas of the other group. The roundtable and the workshop session were finished by an open discussion about what is needed by policy makers to accelerate the implementation of energy efficiency measures.

Agenda

- 09:30 - 10:00 Come together.
- 10:00 - 10:10 Opening speech by Heidrun Hochreiter, Cluster manager
- 10:10 - 10:30 Number, Data and Facts presented by CPU.
- 10:30 - 10:40 Introduction of Participants
- 10:40 - 10:55 Matrix of Measures
- 10:55 - 11 :20 Presentation of Group Matrix
- 11:20 - 11:50 Break
- 11:50 - 12:05 Measures to Promote Energy Efficiency Measures
- 12:05 - 12:15 Galary Walk
- 12:15 - 12:45 Open Discussion of Measures
- 12:45 - 13:00 Wrap-Up

Participants and Stakeholder Groups

17 stakeholders participated and came as representatives of the Upper Austrian state government, the chamber of commerce, two consulting agencies working in the field of energy efficiency and the food cluster, the clean tech cluster as well as a representative of an Upper Austrian start-up company working in the field of consulting and AI supported energy storage**.**

Summary of discussions

Main topics, disagreements, synergies

- Main topics include energy efficiency, PV systems, compressed air optimization, heat recovery, and e-mobility.
- Disagreements exist around the effectiveness of EMS (Energy Management Systems), with Resch & Frisch seeing it as foundational, while stakeholders rate it as low leverage.
- Synergies are found in shared views on infrastructure modernization, heat recovery, and the challenges of implementing E-trucks due to cost and range limitations.

[1] The "How, Wow, Now, Ciao" matrix is a tool for prioritizing ideas based on originality (How) and feasibility (Now). Ideas are categorized into four quadrants: Wow (original and feasible), Now (normal and feasible), How (original but not feasible), and Ciao (neither original nor feasible).

Relevance (sector priorities)

- Energy efficiency and heat recovery are top priorities across sectors.
- PV system expansion and compressed air optimization are seen as impactful measures.
- E-mobility is relevant but hindered by infrastructure and economic feasibility.

Feasibility (realism, economics)

- Heat recovery and LED implementation are feasible and already in place.
- PV systems face economic and regulatory hurdles, especially due to fire protection and funding mechanisms.
- E-trucks are currently not economically viable without subsidies.

Consistency (internal logic)

- Discussions show consistent logic in prioritizing measures with high leverage and
- short payback periods.
- There is alignment between technical feasibility and economic considerations.
- Awareness and behavioural change are consistently emphasized as prerequisites for successful implementation.

Stakeholder Fit (acceptability, buy-in)

- Stakeholders and companies agree on the need for infrastructure, modernization and heat recovery.
- There is buy-in for EMS from companies, though stakeholders are sceptical of its direct impact.
- Consensus exists on the need for subsidies and stable policy frameworks to support adoption.

Policy Alignment (Fit for 55, CEAP, NECPs, CSRD)

- Discussions align with Fit for 55 and CEAP goals through emphasis on decarbonization and energy efficiency.
- NECPs are reflected in the push for renewable energy and infrastructure development.
- CSRD relevance is seen in calls for transparency, planning security, and stakeholder engagement.

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- E-mobility is relevant but hindered by infrastructure and economic feasibility.

Photos from the 3rd roundtable


EE NOVA
Round Table 3 – Energieeffizienz in der Backwarenindustrie


4 gute Gründe,

Wine value chain (Bulgaria)

Objectives

The third roundtable in Bulgaria was held on 29 September at Black Sea Gold (Pomorie) and conducted in hybrid format to facilitate the participation of the energy auditor. Due to harvest-season constraints, BATA 2002 could not attend in person; their inputs were collected through follow-up online/phone consultations and fully integrated into the discussions and conclusions.
The session validated the three operational pillars (efficiency & digitalisation; renewable self-consumption with storage; phased investment planning).

The meeting began with an introduction and context, providing an overview of the objectives, background, and relevance of the discussion. This was followed by a roundtable introduction, where all participants briefly presented themselves and their roles, fostering collaboration and knowledge sharing. The presentation of the scenario outlined the key elements, assumptions, and operational pillars under consideration. Participants then engaged in a scenario refinement discussion to review and enhance the proposed scenario based on their expertise and practical insights. Afterward, breakout group discussions were organized to validate the scenario in smaller teams, allowing for focused dialogue on specific aspects. The session continued with a policy recommendations brainstorm, during which participants identified and suggested policy measures or actions needed to support scenario implementation. The meeting concluded with a summary of conclusions and next steps, outlining agreed actions and responsibilities, followed by closing remarks to wrap up the discussion and thank participants for their contributions.

Agenda

- 10:30-10:40 Introduction and context
- 10:40-10:50 Roundtable introduction
- 10:50-11:20 Presentation of the scenario
- 11:20-12:00 Scenario refinement discussion
- 12:00-12:30 Breakout groups discussion - scenario validation
- 12:30-12:45 Policy recommendations brainstorm
- 12:45-13:00 Conclusions and next steps
- 13:00-13:15 Closing remarks.

Participants and Stakeholder Groups

Representatives from Black Sea Gold and POPKOMERS participated on site; BATA 2002 contributed via online/phone consultations (harvest season). The senior energy auditor joined remotely. This ensured all three value-chain actors - viticulture/irrigation (BATA 2002), winemaking/cellar (Black Sea Gold), and logistics/distribution (POPKOMERS) - were represented in the validation process.

Summary of discussions

Main topics, disagreements, synergies

The Bulgarian scenario builds upon the insights gained from the first and second roundtables, as well as detailed energy audits of three key actors in the national agri-food value chain: BATA 2002 (viticulture and irrigation), Black Sea Gold (wine production and cellar operations), and POPKOMERS (logistics and distribution).

The scenario is structured around three operational pillars, reflecting both the audit findings and the consultations with the companies:

- Efficiency upgrading and digitalization.
- Renewable self-consumption with storage and organizational readiness
- Phased investment planning.

Relevance (sector priorities)
The scenario's design is highly relevant to the strategic transformation of Bulgaria's wine sector. It captures the intersection of technological innovation, sustainability, and economic pragmatism - three dimensions that define the sector's current policy and market agenda.

Improving efficiency and embracing digital technologies directly respond to the sector's need to modernize production, reduce energy costs, and enhance competitiveness in both domestic and export markets. The integration of renewable energy solutions reflects growing national and EU commitments to sustainability and energy independence, supporting producers in managing rising energy prices and reducing their environmental footprint. The phased investment approach ensures that transformation remains economically realistic and accessible, allowing companies of different sizes to progress at a manageable pace.

Feasibility (realism, economics)

Operational pillars	Realism	Economics
Efficiency Upgrading and Digitalisation	*Highly feasible* Most wineries already use basic digital tools for production monitoring, irrigation, and logistics. Upgrading to more advanced energy-efficient technologies or digital monitoring systems is a realistic next step	*Moderate to high feasibility* While initial investment costs for new equipment, sensors, or software can be significant, efficiency gains often translate into reduced energy consumption and operational costs over time. ROI can be achieved within a few years, particularly if supported by grants or incentives.
Renewable Self-Consumption with Storage and Organizational Readiness	*Feasible but with certain constraints* Installing solar panels, small-scale wind systems, or storage solutions is technically viable, especially for larger facilities. Organizational readiness: training staff and integrating energy management into daily operations may require operational adjustments	*Moderate feasibility* Capital costs for renewable generation and storage remain high, though falling technology costs and potential government incentives improve economic viability. Financial feasibility increases if energy self-consumption reduces reliance on grid electricity and avoids peak pricing. For smaller operators, phased adoption may be necessary to spread costs.
Phased Investment Planning	*Highly feasible*	*High feasibility*

	Implementing investments in stages allows companies to align capital expenditures with operational needs and cash flow, making adoption of energy efficiency and renewable technologies manageable. This approach also allows for testing and scaling solutions based on results and lessons learned.	Phasing investments mitigates financial risk and provides flexibility in capital allocation. Companies can prioritize measures with the fastest payback, gradually integrating more complex or costly technologies as resources allow.

Consistency (internal logic)
The three pillars are mutually reinforcing and logically coherent. Efficiency upgrades provide the operational basis for renewable energy adoption; renewable integration is optimized through data-driven management; and phased investment planning ensures the implementation of both efficiency and renewable initiatives is financially and operationally feasible.

Stakeholder Fit (acceptability, buy-in)
The scenario demonstrates a high level of acceptability and buy-in potential across the Bulgarian wine sector. The three pillars are compatible with stakeholders' operational realities and strategic priorities, balancing ambition with practicality. Efficiency and digitalisation offer immediate benefits, renewable energy adoption appeals to sustainability goals, and phased investment planning provides the flexibility and reassurance needed for broad engagement.

Strong stakeholder engagement throughout the roundtable process - including input from Black Sea Gold, BATA 2002, and POPKOMERS - reinforces the sense of ownership and confidence in the scenario's direction. Continued consultation, communication, and access to financial and technical support will be key to ensuring successful implementation.

Policy alignment of the wine sector with Fit for 55 objectives
The Bulgarian wine sector is gradually aligning with the EU's Fit for 55 objectives, though progress remains uneven and constrained by financial, technical, and organizational barriers. Efforts to improve energy efficiency are underway, most notably through the planned installation of photovoltaic systems in production workshops, which will reduce grid dependency, lower electricity costs, and cut emissions. However, the sector lacks systematic energy audits and ROI-based investment evaluations, and there are currently no structured monitoring systems in place to track energy performance.

Financial and technical barriers such as high upfront investment costs, limited access to capital, and outdated production infrastructure continue to limit deeper energy savings. Companies also face administrative burdens when applying for support under national and EU funding schemes. Targeted financial instruments, such as SME-focused grants, low-interest loans, and simplified permitting procedures, are needed to enable greater renewable energy adoption. The creation of energy communities could further support joint investment and cost-sharing, particularly since operational communities exist near major production areas like Burgas, only a short distance from Pomorie.

In line with the Renewable Energy Directive (RED), wineries have already achieved modest efficiency gains - such as through the installation of soft starters on compressors, reducing electricity use by about 10%. To scale up renewable integration, policy support should emphasize technical training, incentives for energy storage, and collaborative renewable projects among producers.

Regarding the Effort Sharing Regulation (ESR), the wine industry is encouraged to cut greenhouse gas emissions through renewable energy integration, efficient transport, and improved production management. The transport and logistics segment remains a key emissions source. Companies are exploring decarbonization through fleet modernization, electrification, and route optimization. BATA, for instance, plans a full replacement of its vehicle fleet, while future strategies aim for low-emission transport modes, digital logistics tools, and integration of renewable power in distribution operations.

Regarding waste heat and circular economy, opportunities exist to reuse thermal energy from fermentation, distillation, and cooling processes. The partnership between Black Sea Gold and BATA demonstrates an effective circular model: organic by-products (grape pomace) are mulched and reused as natural soil enhancers, replacing chemical fertilizers and reducing landfill waste. Such initiatives advance Fit for 55 goals while improving cost efficiency and soil health. To scale similar practices, SME-friendly funding mechanisms, tax credits, and investment leasing options for heat recovery and recycling systems are essential.

Overall, the Bulgarian wine sector demonstrates growing alignment with EU climate and energy goals. However, achieving full Fit for 55 compliance will require a coordinated policy effort - combining financial incentives, capacity building, digital monitoring, and cross-sector collaboration to unlock the sector's potential for sustainability, competitiveness, and circular growth.

CEAP Alignment in the Bulgarian Wine Sector

The Bulgarian wine sector is increasingly engaging with circular economy principles, though progress remains fragmented and primarily driven by individual company initiatives rather than coordinated policy or industry-wide frameworks. The sector demonstrates promising examples of by-product reuse, sustainable resource management, and emerging digitalization, but faces challenges in scaling these practices due to limited funding, data gaps, and low consumer demand for circular products.

Food Waste and By-Product Valorisation

Wineries are beginning to recognize the economic and environmental value of their by-products. Grape pomace, lees, and wastewater are among the most significant waste streams that can be transformed into useful resources such as animal feed, compost, fertilizers, or biogas. For instance, Black Sea Gold has invested in advanced mulching equipment that processes organic by-products, which are then reused by BATA 2002 in vineyards as natural soil enhancers. This cooperation exemplifies a circular model that reduces landfill waste, lowers input costs, and enhances soil quality. However, the sector needs stronger policy incentives and financial support including grants, subsidies, and pilot funding in order to adopt technologies such as anaerobic digestion, composting, and extraction systems for high-value compounds like tartaric acid or polyphenols.

Circular Material Flows and Data Management

While some companies, such as Black Sea Gold, have made progress in tracking material flows through automation and renewable energy integration, comprehensive input-output-waste accounting remains rare. Data on by-product reuse, packaging materials, and end-of-life management are often incomplete, especially among smaller wineries. Adoption of digital tools such as ERP systems, traceability software, and Life Cycle Assessment (LCA) platforms can improve data accuracy and help quantify environmental performance. However, the lack of standardized monitoring and limited technical expertise present barriers to wider implementation.

Extended Producer Responsibility (EPR) Compliance
Awareness and understanding of EPR obligations among wine producers remain low. Large wineries tend to work with licensed waste recovery organizations, but SMEs often lack clarity and administrative capacity to fully comply with packaging reporting and fee requirements. Simplified reporting templates, digital compliance tools, and training programs organized by the Ministry of Environment and Water and wine associations would help improve compliance and reduce environmental impact. Clear communication of EPR duties and practical guidance would enhance participation and transparency across the sector.

Business Models and Financial Barriers
Despite growing interest in sustainability, most wineries rely on internal financing for circular investments. High upfront costs for technologies such as solar panels, waste valorisation systems, and eco-packaging, combined with limited access to affordable credit or grants, pose significant barriers. Administrative complexity and co-financing requirements in EU and national funding programs further discourage smaller producers. Currently, there are no collaborative models in shared logistics or packaging, though such partnerships could reduce costs and increase resource efficiency.

Consumer and Market Perspective
Consumer awareness of sustainability in Bulgaria remains relatively low, particularly in the domestic market where price remains the dominant purchasing factor. However, export-oriented wineries face growing pressure from EU buyers and premium markets to demonstrate sustainable practices through eco-labelling, carbon footprint tracking, and circular production models. While specific customer demands for circular products have not yet materialized, this trend is expected to grow, offering long-term competitiveness for early adopters like Black Sea Gold and BATA 2002, which already demonstrate best practices in waste reuse and eco-friendly production.

Monitoring and Circularity Indicators
To effectively monitor circular progress, the sector should adopt measurable indicators related to resource efficiency, waste reduction, energy use, and innovation. These include metrics such as material input per litre of wine, share of renewable energy use, waste recycling rate, CO_2 intensity, and revenue from by-products. Currently, only a few companies track such data, and reporting remains inconsistent. Establishing standardized KPIs and encouraging annual sustainability reporting would improve sector-wide transparency and policy alignment.

Outputs
The scenario prioritises three operational pillars that reflect both the audits and the discussions with the companies. First, **efficiency upgrading and digitalisation**: automation and real-time monitoring of energy use, inverter controls and pumping optimization in irrigation, and process-level optimization in winery operations and warehouses. Second, **renewable self-consumption with storage:** deployment of PV systems coupled with battery storage for seasonal and daily load-matching (notably irrigation pumps at BATA 2002 and electrical loads in logistics), alongside adiabatic cooling in cellars to stabilize humidity and temperature while reducing chemical use and electricity demand at Black Sea Gold. Third, **organizational readiness and phased investment planning**: integrating energy management into routine decision-making, sequencing low-capex/high-impact measures first (e.g., fans for destratification, lighting and controls, basic BMS), and preparing larger capex items once permitting or site constraints are resolved. The companies share interest in joint procurement for PV and batteries to reduce unit costs, while acknowledging practical constraints such as archaeological-site procedures delaying PV deployment at the winery and wildlife-related risks that limit the feasibility of underground and unsupervised drip irrigation at the vineyard.

Validated elements (broad consensus, high support)
Participants confirmed the overall direction and practicality of the scenario's three pillars -efficiency and digitalisation, renewable self-consumption with storage, and phased investment planning. There was strong agreement that near-term actions should prioritize low-capex, high-impact measures already identified in the audits: adiabatic cooling and compressor optimization at Black Sea Gold; PV with batteries targeted to irrigation loads at BATA 2002; and quick operational fixes at Popkomers such as destratification fans, lighting controls, and solar DHW.

The group also endorsed setting up basic energy-monitoring routines to build a data baseline and track savings; keeping investment decisions sequenced to cash flow and permitting realities; and exploring joint procurement for PV and batteries to reduce unit costs. The circular collaboration already in place - mulched winery by-products reused in the vineyards - was recognized as a credible, scalable practice. Finally, the KPI frame proposed in the scenario (energy intensity, renewable share, leveraged investment, and verified GHG reductions) was considered fit-for-purpose, provided it remains simple and evidence-based.

However, Black Sea Gold reported a side effect of increased renewable-energy use - the occurrence of harmonic distortions in the internal grid due to the interaction between AC and DC systems, particularly from PV inverters and variable-speed drives. These harmonics can reduce energy quality, overload electrical components, and affect equipment performance. The company has therefore started assessing compensatory solutions such as active harmonic filters and power-factor correction systems to stabilize voltage and maintain grid compatibility. This challenge highlights the importance of technical system integration and power-quality management in renewable expansion.

Elements needing refinement (partial support, modifications suggested)
Several items require additional scoping before firming up commitments. PV deployment at the winery level depends on resolving cultural heritage permitting; timelines should remain indicative until approvals are secured. Underground/drip irrigation variants that looked promising on paper need site-specific constraints reflected in the plan (wildlife damage risk, young-vine root systems), with human monitoring retained as a control measure. Battery storage sizing and duty cycles should be recalculated against actual seasonal and daily load profiles to avoid overspecification. The idea of partial fleet electrification is directionally sound but should be reframed as trials limited to short-haul or yard operations until infrastructure, TCO, and duty-cycle evidence accumulates. Waste-to-energy was acknowledged as technically feasible but economically weak under seasonal operation; it should stay off the near-term slate unless grant conditions change. On the organizational side, the scenario should add a light governance element (responsible persons, simple RACI, quarterly review cadence) to ensure measures move from plan to implementation. Finally, two cross-cutting enablers - ROI/NPV templates for measure ranking and a minimal data model for energy/material flows and EPR-relevant packaging - should be developed so that savings, emissions, and compliance benefits are consistently quantified and comparable across companies.

While all stakeholders supported further deployment of renewables, Black Sea Gold noted technical constraints related to power quality. The coexistence of AC industrial loads and DC power from photovoltaic inverters has created harmonic disturbances that can impair sensitive equipment and increase maintenance costs.

Participants agreed that future feasibility studies should include power-quality assessments and, where necessary, integration of active harmonic filters or reactive-power compensators. These refinements will ensure that renewable self-consumption and energy-storage systems operate efficiently without disrupting production processes or compromising electrical safety.

New measures proposed (ideas not in original scenario, but recommended by stakeholders)

- Smart water management sensors and satellite-based vineyard monitoring (soil moisture, evapotranspiration) to fine-tune irrigation based on real-time climatic and plant stress data.
- AI-based predictive maintenance systems for compressors, pumps, and bottling lines to prevent breakdowns, reduce downtime, and optimize maintenance schedules.
- Integration of LCA (Life Cycle Assessment) and ERP systems for digital traceability of energy, water, and material flows across both companies.
- Digital twin models for winery and irrigation operations to simulate process improvements and energy-saving scenarios before implementation.
- Training and capacity-building workshops for staff on digital tools, energy efficiency, and environmental management.

Stakeholder Feedback and Validation

- Purchase of robotic equipment by Black Sea Gold that enables greater automation of production processes. These investments not only help to overcome the limitations caused by the lack of workforce but also improve efficiency, consistency, and productivity across operations.
- The relative share of manual labour has decreased as robotic systems have been introduced to handle transport and packaging operations. This automation has led to greater precision and consistency in production processes, reducing the likelihood of human error and significantly lowering the volume of defective or discarded products.
- The installation of soft starters on machine compressors has led to an estimated 10% reduction in energy consumption, contributing to improved efficiency and sustainability in production processes.
- All refrigeration units have been equipped with soft starters over the past year, marking a significant step toward improving the company's energy efficiency and equipment longevity.
- There has been a significant reduction in water consumption as a result of installing advanced water intake and monitoring systems connected to borehole water sources. In 2004, the company's monthly water consumption reached approximately 36,000 м3, whereas today it has been reduced dramatically to between 4,000 and 6,000 м3 per month.
- Purchase of a nitrogen generator, which eliminates the need to transport nitrogen from Serbia.
- Installation of rooftop photovoltaic (PV) systems has resulted in substantial energy savings for the company. In August alone, the amount of electricity generated from solar power reached 71,000 kWh, significantly reducing dependence on the grid and cutting operational costs.

Photos from 3rd roundtable


www.eenova-project.eu

Water and soft drinks value chain (Lithuania)

Objectives

The third Lithuanian roundtable was held on 26 September 2025 in Vilnius and focused on the water and soft drinks value chain, represented by Birštonas Mineral Water, Akvavita, and Švenčionių Vaistažolės. The session was built on findings from the previous two roundtables, where energy audits and action plans had identified efficiency opportunities, barriers, and investment needs.

The main objectives were to:

- Validate and refine the “Clean Drinks 2050” scenario for Lithuania, which outlines a pathway to climate neutrality by 2050.
- Align company-level measures (e.g. PV expansion, BMS systems, packaging circularity, shared logistics) with national and EU policy frameworks (NECP, Fit for 55, CSRD, CEAP).
- Provide a structured platform for companies, policymakers, and experts to discuss feasibility, synergies, and barriers to implementation.
- Identify policy recommendations and financing instruments needed to accelerate adoption of energy efficiency and renewable energy measures.

Agenda

- 09:30 - 09:45 Welcome and Opening Remarks
  - Introductory words by AgriFood Lithuania DIH and Lithuanian Energy Agency
  - Overview of the EENOVA project objectives and the role of the Lithuanian hub in driving energy transition within the beverage sector
- 09:45 - 10:15 Setting the Energy Transition Context
  - Presentation by the Lithuanian Energy Agency
  - Key topics: national energy efficiency targets, renewable integration in the food and beverage sector, and policy incentives under NECP 2030
- 10:15 - 10:40 Insights from the EENOVA Project
  - Presentation by AgriFood Lithuania DIH / EENOVA Team
  - Key topics: results of energy audits in the Lithuanian beverage value chain, identified efficiency measures, and preliminary "Clean Drinks 2050" scenarios
- 10:40 - 11:20 Open Discussion: Challenges and Opportunities
  - Moderated dialogue among companies, technology providers, and policymakers
  - Guiding questions: What are the most significant barriers to decarbonization? What synergies can be built along the value chain?
- 11:20 - 11:40 Coffee Break & Networking
- 11:40 - 12:20 Group Discussions - Co-Creating the Scenarios
  - Thematic working groups:
    - Energy Efficiency and Heat Recovery
    - Renewable Integration (PV, PPA, Energy Communities)
    - Circular Packaging and Resource Use
    - Digitalization and Data-Driven Efficiency
- 12:20 - 12:45 Policy Recommendations Brainstorm
  - Consolidation of key messages for national and EU policy frameworks
  - Drafting practical measures to support the "Clean Drinks 2050" pathway
- 12:45 - 13:00 Wrap-Up and Next Steps
  - Summary of main takeaways and consensus

The facilitation combined structured presentations with interactive group discussion and validation exercises. Stakeholders worked through scenario elements using guided questions and a participatory dialogue format, ensuring that both technical feasibility and organizational realities were captured in the final validated pathway.

Participants and Stakeholder Groups

The Lithuanian roundtable brought together 45 participants, representing the full water and soft drinks value chain alongside policymakers, energy experts, and cluster facilitators. This ensured that both company realities and regulatory perspectives were addressed in a balanced way.

Companies (value chain actors):

- Birštonas Mineral Water - production and bottling
- Akvavita - spirits and soft drinks producer
- Švenčionių Vaistažolės - herbal teas and functional beverages

Policy and institutional stakeholders:

- Lithuanian Energy Agency - national policy, energy efficiency obligations, audits
- Ministry of Energy of the Republic of Lithuania - policy context and regulatory framework
- Ministry of Economy and Innovation of Lithuania - financing instruments and SME support
- The Lithuanian Chamber of Agriculture - an influential farmer and rural society self-governance organization in Lithuania.

Cluster and facilitation:

- AgriFood Lithuania DIH - EENOVA partner and roundtable organizer/facilitator
- SMART FOOD cluster

Technical and consulting experts:

- Independent energy auditors and consultants specializing in PV, BMS, and energy monitoring systems.
- Circular economy and packaging experts
- Logistics and transport consultants

The mix of participants reflected the diversity of perspectives required for scenario validation. Companies provided direct insights into operational constraints and investment priorities, while policymakers contributed to the broader regulatory and strategic context. Experts added technical and financial knowledge, ensuring that the discussions were grounded both in practice and in alignment with EU and national climate and energy policy frameworks.

Summary of discussions

Main topics, disagreements, synergies

The Lithuanian roundtable discussions were related to the validation of the *Clean Drinks 2050* scenario and its alignment with both company-level realities and national energy policy. Key themes included the rapid deployment of solar PV, the integration of Building Management Systems (BMS), electrification of thermal processes, and the challenge of circular packaging. Participants highlighted the critical role of financing instruments and stable policy frameworks to overcome high upfront investment costs and ROI uncertainty.

The session opened with remarks from AgriFood Lithuania DIH and the Lithuanian Energy Agency, framing the discussion around Lithuania's NECP targets and the beverage sector's potential contribution to climate neutrality. Both institutions emphasized the dual goal of enhancing competitiveness and decarbonizing production in line with the Fit for 55 and Green Deal objectives.

While there was broad agreement on the direction of the transition, differing views emerged at the speed of implementation. Companies emphasized that although audits identified clear efficiency measures, the lack of real-time energy data and high bureaucratic hurdles (especially for PV permitting) slow down decision-making. Policymakers insisted on the need for stricter audit follow-up and monitoring, while firms urged for more flexibility and support in implementation timelines.

During the thematic group discussions, participants explored four focus areas-energy efficiency, renewables, circular packaging, and digitalization-identifying both sector-specific barriers and cross-cutting synergies.

Synergies were identified in joint logistics solutions, co-investment in renewable generation and storage, and collective energy monitoring platforms. The discussion also underlined the potential branding advantage of positioning Lithuanian beverages as a "green export sector."

In the policy recommendations brainstorming, stakeholders emphasized the importance of linking these collaborative initiatives with upcoming EU and national funding instruments to maintain momentum and ensure the scalability of successful pilot actions.

Relevance (sector priorities)
Energy costs were consistently flagged as a decisive factor for competitiveness. The beverage industry - highly reliant on electricity for cooling and bottling, and heat for sterilization - saw energy efficiency not as an environmental add-on, but as a business survival strategy. Packaging obligations under the Deposit Return System and EU Circular Economy Action Plan were also considered strategically important, especially in export markets.

As highlighted in the Lithuanian Energy Agency presentation, agrifood sector, including beverage producers account for a significant share of industrial electricity use, making energy efficiency directly linked to national energy security and resilience goals.

Feasibility (realism, economics)
Short-term measures such as PV expansion, BMS deployment, and basic energy monitoring were considered realistic, with payback periods of 3-5 years. More capital-intensive measures, such as heat pumps and large-scale storage, were seen as feasible only with subsidies or joint financing. Circular packaging redesign was recognized as a long-term priority, but cost and supply limitations of rPET remain barriers.

Participants agreed that collective approaches, such as shared PV parks, sectoral PPA models, or cluster-level financing schemes, could improve feasibility by reducing upfront costs and spreading investment risks.

Consistency (internal logic)
The validated scenario was perceived as logically coherent: starting with quick wins (PV, BMS, monitoring), moving towards systemic electrification and logistics optimization, and culminating in full circularity and climate neutrality by 2050. Participants agreed that sequencing measures is essential to balance ambition with financial and operational feasibility.

This sequencing approach was widely supported across all working groups, confirming the internal coherence and practical applicability of the *Clean Drinks 2050* scenario.

Stakeholders fit (acceptability, buy-in)
Companies confirmed buy-in for energy monitoring, PV roll-out, and shared logistics pilots, but expressed caution towards ambitious packaging targets without stable supply chains and financial incentives. Policymakers and experts emphasized that stable subsidies, simplified permitting, and access to advisory support are critical for broad engagement.

During the closing session, participants agreed to continue cooperation under the EENOVA platform and to explore pilot actions for renewable and digital integration in 2026, leveraging national and EU funding schemes.

Policy alignment (Fit for 55, CEAP, NECP, CSRD)
The discussions took into consideration Lithuania's National Energy and Climate Plan and Fit for 55 targets, particularly regarding renewable integration and efficiency improvements. The upcoming obligations under the Energy Efficiency Directive (audits, energy management systems) and CSRD were highlighted as both a pressure and an opportunity for companies to systematize their sustainability practices.

These policy insights and validation results contribute directly into Deliverable D4.2, supporting the refinement of Clean Drinks 2050 scenarios and the formulation of concrete policy pathways for Lithuania's beverage sector transition toward climate neutrality.

Outputs

Validated scenario elements (broad consensus, high support)
- Deployment of solar PV systems across all three companies, with joint procurement and cooperative models seen as a cost-reducing enabler.
- Introduction of Building Management Systems (BMS) for real-time monitoring and energy optimization, recognised as a high-impact, low-capex measure.
- Energy monitoring dashboards and KPI tracking (kWh/litre, CO_2/pallet-km, rPET share), ensuring alignment with CSRD and national reporting requirements.
- Shared logistics initiatives, such as co-loading herbal teas and bottled drinks, to reduce fuel costs and improve competitiveness.
- Engagement with the Deposit Return System (DRS) and progressive packaging circularity measures, supported by policy incentives.
- Participants also agreed on the importance of linking these measures with national sectoral financing programs ensuring continuity beyond the EENOVA project.

Elements needing refinement (partial support, modifications suggested)
- Waste heat recovery was acknowledged as technically feasible, but ROI was deemed weak in current operations; companies agreed it should remain an optional, long-term measure.
- Battery storage was discussed as desirable but not yet realistic without subsidies; participants recommended keeping it as a long-term (post-2040) option.
- Packaging redesign (increased use of rPET, lighter bottles) was supported in principle, but companies stressed the need for stable supply and lower raw material costs before committing.
- Energy management systems for companies with annual consumption >23.6 GWh were validated as mandatory, but companies expressed concerns about implementation capacity and financing.
- In addition, the need to strengthen supply-chain cooperation for sourcing recycled materials and to establish a national packaging innovation platform was emphasized as a medium-term

goal.

New measures proposed (ideas not in original scenario, but recommended by stakeholders)

- Establishment of a national SME voucher scheme for BMS and digital monitoring, to accelerate uptake and reduce administrative barriers.
- Creation of a joint “green Lithuanian drinks” branding initiative, leveraging energy transition and circularity as a market advantage in EU export markets.
- Pilot of renewable-powered logistics hubs (shared EV charging stations and refrigerated storage), coordinated through cluster-level initiatives.
- Development of technical guidelines and templates for energy audits, ensuring higher quality and practical usability of recommendations for SMEs.
- Introduction of training programs for in-house energy managers, reducing dependence on external consultants and building long-term capacity.
- Stakeholders also proposed integrating these initiatives within Lithuania’s Smart Specialisation Strategy and national circular economy roadmap to ensure institutional ownership and policy coherence.

The outputs of the Lithuanian roundtable therefore validated the overall direction of the Clean Drinks 2050 scenario, while refining its pace, sequencing, and support mechanisms. The discussions emphasized that success depends on stable financing, regulatory clarity, and cluster-level cooperation, ensuring that individual company actions can scale into a coherent national pathway towards climate neutrality by 2050.

Stakeholder Feedback and Validation

The Lithuanian roundtable provided a trust-based setting for companies, policymakers, and experts to validate the *Clean Drinks 2050* scenario. Feedback confirmed that the scenario is both technically feasible and strategically relevant, while also highlighting systemic barriers that need to be addressed through policy and financing support.

Participants particularly appreciated the transparent facilitation format and data-driven approach used during the roundtable, noting that it allowed constructive dialogue between business and policy perspectives.

Barriers identified

- High upfront CAPEX and unstable ROI: Companies expressed concern that although PV and BMS have acceptable payback periods, larger investments such as heat pumps and storage remain unaffordable without subsidies.
- Bureaucratic permitting: Lengthy and unpredictable approval processes for PV installation were cited as a critical bottleneck, discouraging investment and delaying implementation.
- Lack of real-time energy data: Firms reported that energy audits often remain static documents without actionable follow-up. Without digital monitoring, companies cannot optimize consumption or track savings effectively.
- Packaging supply constraints: The high cost and limited availability of recycled PET (rPET) undermine efforts to meet EU circular packaging requirements.
- Conservative decision-making: Smaller companies in particular highlighted internal resistance to adopting unfamiliar technologies without clear external incentives.
- Some companies also mentioned limited human resources and skills to implement digital and renewable projects, calling for targeted technical assistance and training.

Enablers identified

- National funding schemes: Participants welcomed the role of the Lithuanian National Energy Efficiency Fund and EU programs (LIFE, InvestEU, CAP eco-schemes) in lowering investment risk.
- Cluster-level cooperation: Stakeholders confirmed strong interest in co-loading exports, joint PV projects, and shared logistics hubs, which could reduce costs and strengthen competitiveness.
- SME-friendly templates and tools: Calls were made for simplified CSRD reporting models, ROI/NPV calculation templates, and sector-specific guidelines for packaging compliance.
- Policy incentives: Stakeholders emphasized that fast-tracking PV permitting and introducing SME vouchers for BMS and digital monitoring would significantly accelerate uptake.
- The Lithuanian Energy Agency and AgriFood Lithuania agreed to continue cooperation on developing a model pilot combining PV deployment, BMS installation, and logistics optimisation to demonstrate Clean Drinks 2050 in practice.

Evidence-based feedback (examples and insights)

- One company noted: “Audits tell us what to do, but without data and digital monitoring, it is difficult to know if we are really saving energy or not.”
- Another participant emphasized: “Circular packaging is a must for exports, but rPET is too expensive and unstable in supply - we need joint solutions or policy incentives.”
- A policymaker highlighted the financing gap: “We see companies ready to act, but without support mechanisms the ambition will not translate into implementation.”
- A logistics expert stressed cluster synergies: “If we can coordinate transport and co-load different beverages, fuel savings of 5-10% are realistic even in the short term.”
- Experts also highlighted the potential of data sharing across the value chain to enable sector-level energy benchmarking, which could improve competitiveness and transparency under CSRD reporting.

Overall, stakeholders validated the Clean Drinks 2050 scenario as a credible pathway for Lithuania’s beverage sector, provided that financing, permitting, and packaging supply barriers are addressed. The feedback reinforced the importance of combining company-level efficiency measures with policy clarity, cluster collaboration, and digitalisation to ensure practical implementation and long-term competitiveness.

Photos from 3rd roundtable


NACIONALINE ENERGETINES NEPRIKLAUSOMYBES STRATEGIJA –
ENERGETIKOS SEKTORIUS KLIMATUI NEUTRALUS 2050 M.

Meat value chain (Romania)

Objectives
The third roundtable focused on the development and discussion of scenarios for the Romanian meat value chain, building on the results of the energy audits (RT1) and the identification of critical factors (RT2). The objective of the session was to place the proposed efficiency measures in a broader policy and strategic context, and to examine how companies can realistically align with EU and national climate targets.

The session started with a short introduction to the EENOVA project and the objectives of the roundtable, followed by participant introductions to ensure a collaborative working atmosphere. A presentation of the European and national energy and climate policy framework was then delivered, highlighting the implications of the Green Deal, Fit- for-55 package, and Romanian Energy and Climate Strategy for agri-food companies.

Based on this context, the facilitator introduced three future scenarios for the meat value chain: a Baseline 2030 scenario focused on quick wins and moderate investments, a Compliance 2030 scenario emphasizing mandatory standards and reporting obligations, and a Strategic Transformation 2050 scenario integrating all measures identified in the audits with long-term decarbonization goals.

The methodology combined structured presentations with open discussion, encouraging companies, auditors, and institutional stakeholders to react to the scenarios, share their views on barriers, opportunities, and support measures, and identify possible synergies along the value chain. The session closed with a synthesis of key findings and a commitment to use the input for the next phase of WP4, namely the drafting of policy recommendations and validation scenarios.

Agenda:

- 13:00 - 13:10 Short introduction and context of the EENOVA project
- 13:10- 13:25 Roundtable introductions by participants
- 13:25 - 13:50 Presentation of European and national policy framework relevant for agri-food energy transition
- 13:50 - 14:20 Presentation of proposed scenarios for the meat value chain
    - Scenario 1 - Energy Transition Baseline 2030
    - Scenario 2 - Standard & Compliance 2030
    - Scenario 3 - Strategic Transformation Scenario 2050
- 14:20 - 14:50 Discussion and feedback from participants on scenarios
    - Which scenario is more realistic and applicable?
    - What are the main barriers and opportunities for implementation?
    - What support measures (policies, funding, training) are needed?
    - What value chain collaborations could enhance feasibility?
- 14:50 - 15:00 Conclusions and next steps - integration of results into WP4 report

Participants and Stakeholder Groups
The roundtable brought together a total of 14 participants, representing all key segments of the meat value chain alongside relevant institutional, research, and policy stakeholders. This ensured a multi-perspective dialogue that combined business realities with technical expertise and governance considerations.

Meat value chain companies:

- Agro Cosm Fan: 1 representative (primary production)
- Carna Carpatica: 1 representative (processing)
- Moldovan Carmangerie: 1 representative (processing and distribution)

Energy services and auditing:
- Servelect: 1 representative (energy audits provider)

Cluster organization:
- AgroTransilvania Cluster: 2 representatives (facilitation, coordination)

Academic and research institutions:
- Universities: 2 representatives
- Institute for Research in Circular Economy and Environment "Ernest Lupan": 3 representatives

Public authorities:
- Municipality of Cluj-Napoca: 1 representative
- Labor Inspectorate (ITM) Cluj: 1 representative
- Municipality of Cojocna: 1 representative

The stakeholder groups therefore included: SMEs and large enterprises from the meat value chain, an energy audit provider, a cluster organization, academic and research experts, and local/regional public authorities. This diverse mix allowed for balanced exchanges between companies seeking practical solutions, experts providing technical and analytical input, and policymakers highlighting regulatory and funding perspectives.

Summary of discussions

Main topics
The third roundtable highlighted several cross-cutting issues that shape the future of energy transition in the Romanian meat value chain. The central theme was the balance between ambition and feasibility: while all participants acknowledged the importance of aligning with the European Green Deal and the Romanian Energy and Climate Strategy, the pathway and speed of transformation are constrained by financing, regulatory clarity, and internal company capacity.

a) Financing barriers were repeatedly underlined, especially for large enterprises like Moldovan Carmangerie, which are legally obliged to perform audits and implement measures but cannot access public funding instruments. SMEs, in contrast, benefit from some support schemes, but often lack the knowledge and resources to apply effectively.
b) Regulatory uncertainty created confusion around prosumers legislation, permitting procedures for renewable energy installations, and the lack of methodologies to calculate the carbon footprint across entire value chains. This makes it difficult for companies to anticipate obligations and plan investments.
c) Skills and capacity gaps remain critical, none of the companies involved have dedicated energy managers. Companies expressed the need for training programs and accessible advisory services to strengthen internal capacity, particularly for complex requirements like DNSH (Do No Significant Harm) analysis.
d) Value chain collaboration was discussed as a promising approach, with synergies in shared logistics, cooperative models, and joint infrastructure investments. These could reduce individual costs and improve market competitiveness, particularly for smaller producers.
e) Circular economy and packaging issues, although not part of the audits, were flagged as an

emerging EU priority that will inevitably impact the sector, requiring early attention and innovation.

Disagreements

a) Companies expressed frustration that standards (energy efficiency, sustainability reporting) are seen primarily as additional costs with little immediate return, while auditors and academics emphasized that compliance is essential for long-term competitiveness and access to European markets.
b) SMEs tended to focus on measures with quick payback (LED replacement, reactive energy compensation), whereas researchers and policy experts argued for considering the strategic transformation scenario as the only viable pathway to climate neutrality.

Synergies

Despite disagreements, several synergy points were identified:

a) Companies agreed that joint efforts in logistics and energy investments could bring significant benefits.
b) Both companies and municipalities showed openness towards cooperative models where infrastructure (e.g., abattoirs, processing facilities, photovoltaic systems) could be shared.
c) Clusters and GALs (Local Action Groups) were recognized as potential facilitators, helping to coordinate investments, connect stakeholders, and advocate for improved funding mechanisms.

Relevance (sector priorities)

The discussion confirmed that energy efficiency and decarbonization are highly relevant for the meat value chain, primarily because of their impact on production costs. High energy costs directly affect the competitiveness of local meat products, which are already priced higher than mass-market alternatives. For companies, efficiency is not just an environmental issue but a business survival strategy. Moreover, compliance with ESG and CSRD requirements is becoming a prerequisite for accessing supply chains and retail markets, making sustainability a market access condition rather than a voluntary option.

Feasibility (realism, economics)

a) The Baseline scenario (2030, quick wins) was widely regarded as feasible and realistic, with immediate measures such as LED replacement, reactive energy compensation, and small-scale photovoltaics. These are affordable and deliver quick results.
b) The Compliance scenario (2030, standards) was seen as more demanding: companies acknowledged that compliance with EU directives and sustainability reporting standards is inevitable, but they stressed the need for policy support, funding, and simplified procedures to make it manageable.
c) The Strategic Transformation scenario (2050) was considered desirable but not realistic under current conditions. The large-scale investments required (especially at Moldovan Carmangerie) are out of reach without dedicated funding instruments for large enterprises. Participants agreed that this scenario should remain a long-term vision, contingent on policy and financial developments.

Consistency (internal logic)

The scenarios were seen as internally coherent, offering a progressive pathway from incremental measures to comprehensive transformation. Participants appreciated that the scenarios reflect different levels of ambition and investment, allowing companies to position themselves realistically while still aligning with long-term EU targets.

Stakeholder Fit (acceptability, buy-in)

a) SMEs were more receptive to incremental measures, aligning with their resource constraints and risk appetite.
b) Large companies emphasized financial barriers and a lack of adequate support, which undermines their willingness to engage beyond compliance.
c) Academia and research institutes were supportive of ambitious scenarios, stressing the importance of innovation, training, and data-based decision-making.
d) Local authorities were open to facilitating cooperative models and integrating energy efficiency into local development strategies.
e) Overall, the discussion revealed a moderate level of buy-in: stakeholders accept the need for transition, but their engagement is conditioned by financial and regulatory feasibility.

Policy Alignment

The scenarios and discussions were directly linked to EU and national policy frameworks:

a) Fit for 55 and the European Green Deal - overall alignment with the 55% emission reduction target by 2030 and neutrality by 2050.
b) Energy Efficiency Directive - obligation for large companies to perform audits and implement measures.
c) Renewable Energy Directive - relevance for prosumers, self-consumption, and renewable integration.
d) Circular Economy Action Plan (CEAP) - implications for packaging, waste, and resource efficiency in the meat value chain.
e) National Energy and Climate Plan (NECP) Romania - commitment to -85% GHG reduction by 2030 and neutrality by 2050.
f) Corporate Sustainability Reporting Directive (CSRD) - indirect but significant pressure on SMEs through reporting requests from large buyers and retailers.

The roundtable, therefore, succeeded in connecting company-level realities with EU and national policy objectives, highlighting the need for financial instruments, regulatory clarity, and capacity-building measures to make the transition both feasible and strategically valuable.

Outputs

The third roundtable generated a set of outputs that are directly relevant for shaping the scenarios under WP4. Discussions helped to identify which elements of the proposed scenarios enjoy broad consensus, which require refinement, and what additional measures should be considered to ensure policy alignment and practical feasibility.

Validated elements (broad consensus, high support).

Participants agreed that the baseline measures - such as LED replacement, reactive power compensation, and the installation of small-scale photovoltaic systems - are realistic and can deliver immediate benefits. These were seen as cost-effective, quick-win solutions that companies are both willing and able to implement. They offer measurable impacts in terms of reduced energy costs and lower CO_2 emissions, while also serving as an accessible entry point into the energy transition for SMEs.

Another element validated with strong support was the emphasis on collaboration across the value chain. Shared logistics, cooperative infrastructure, and coordinated investment were all perceived as mechanisms that could reduce individual risks and increase overall competitiveness. Stakeholders also confirmed the need for internal capacity building, particularly through the appointment or training of dedicated energy managers capable of monitoring compliance, implementing measures, and anticipating regulatory changes.

Elements needing refinement (partial support, modifications suggested)
While the Compliance scenario (2030) was accepted as inevitable, companies stressed that it is often experienced as a burden rather than a driver of competitiveness. Concerns were raised about bureaucratic complexity, costs of compliance, and unequal access to funding between SMEs and large enterprises. Stakeholders suggested that for this scenario to be realistic, it must be accompanied by simplified procedures, accessible financing instruments, and clearer guidance from national authorities.

The Strategic Transformation scenario (2050) was acknowledged as highly relevant in aligning with EU climate neutrality targets, yet stakeholders questioned its economic realism under current conditions. The scale of investment required, especially for large companies such as Moldovan Carmangerie, makes this scenario aspirational rather than actionable in the short term. Participants agreed that such a scenario remains necessary as a long-term vision, but it needs to be phased, financially supported, and politically underpinned to avoid remaining purely theoretical. Finally, issues related to packaging and circular economic requirements were acknowledged but identified as insufficiently addressed in the current scenarios, requiring more detailed integration in future iterations.

New measures proposed (ideas not in the original scenario but recommended by stakeholders).

Several new and forward-looking measures were put forward during the discussion. A major point was the integration of DNSH (Do No Significant Harm) analysis into company practice. Stakeholders emphasized that, while currently perceived as a bureaucratic obligation linked to EU funding, DNSH is in fact a strategic instrument that directly conditions eligibility for European financing. Building internal DNSH capacity instead of outsourcing the analysis to consultants - was seen as an important step to ensure that companies can access EU programs such as the Recovery and Resilience Facility, the Modernization Fund, or the Operational Program for Sustainable Development. Another new measure was the proposal to adjust regional funding rules so that companies which have already conducted energy audits or implemented efficiency measures would receive bonus points in evaluation, thereby rewarding early movers and encouraging broader adoption.

Additionally, stakeholders requested a clearer legislative framework for prosumers and energy communities, including explicit recognition of energy storage solutions and the ability to use generated electricity across multiple company sites. This was presented as a necessary step to unlock larger renewable energy investments in the agri-food sector. Participants also suggested that clusters and municipalities should play a more proactive role by embedding energy efficiency in local development strategies, serving as facilitators between companies, research institutions, and funding bodies.

In conclusion, the outputs of the roundtable reveal a multi-layered picture: there is strong consensus around the baseline scenario and the immediate measures it proposes; partial support but significant reservations about compliance and transformation pathways; and a set of innovative new measures - particularly related to DNSH, prosumers, and regional funding rules - that expand the scope of the scenarios. These insights will be directly integrated into Deliverables, ensuring that the project's recommendations are not only technically sound, but also politically relevant and aligned with EU policy frameworks.

Stakeholder Feedback and Validation

The third roundtable provided a valuable opportunity to validate scenario elements against real company experiences and to identify barriers and enablers that are directly relevant for EU and national policy frameworks. Stakeholders' feedback confirmed that while the proposed scenarios are internally coherent, their feasibility depends strongly on the design of funding instruments, regulatory clarity, and capacity building measures.

Systemic barriers

The most critical barrier highlighted by participants was access to financing. Large enterprises such as Moldovan Carmangerie, which are legally obliged under the Energy Efficiency Directive (EED) to carry out regular audits and implement part of the recommended measures, reported that they have no access to public support schemes. Their only options are private loans with restrictive eligibility conditions. As one participant explained, "we want to make progress, but without financing it remains only at the level of ideas." This mismatch between regulatory obligations and funding accessibility represents a systemic gap that undermines implementation. SMEs also face difficulties: while they are eligible for support, the administrative burden, slow approval processes and lack of tailored advisory discourage them from pursuing long-term energy investments.

A second systemic barrier relates to regulatory uncertainty, especially in the transposition of the Renewable Energy Directive (RED II/RED III). Companies investing in photovoltaics and storage reported that they could not fully use or sell their generated electricity because the definition of prosumer remains unclear in Romanian legislation. As one company representative noted, "we invested in photovoltaic panels and batteries, but the current legal definition prevented us from using or selling stored electricity." This illustrates the gap between EU-level ambition on renewable self-consumption and its national-level implementation.

Finally, the absence of methodologies for measuring carbon footprint across the entire value chain was identified as a major shortcoming. Current audits focus on individual facilities, but do not capture logistics and inter-company exchanges. This disconnect makes it difficult for companies to anticipate reporting obligations under the Corporate Sustainability Reporting Directive (CSRD) and for policymakers to monitor sectoral performance in line with the Circular Economy Action Plan (CEAP).

Operational enablers

Despite these systemic challenges, participants also pointed to factors that could facilitate change. Clusters and municipalities were seen as natural enablers: AgroTransilvania Cluster is already coordinating value chain discussions and could act as a bridge between companies and funding instruments, while local authorities such as the Municipality of Cojocna expressed openness to embedding energy efficiency and renewable into local development strategies.

Another enabling factor identified was value chain collaboration. Both Agro Cosm Fan and Moldovan Carmangerie confirmed that shared logistics and cooperative models could significantly reduce costs and improve competitiveness, particularly for smaller producers. This feedback strongly validates the EENOVA approach of working on value chains rather than isolated companies.

Finally, there was broad recognition that training and capacity building represent critical enablers. None of the companies currently have dedicated energy managers, making them dependent on consultants. Participants agreed that structured support for in-house skills development - including training on energy management and on the application of the DNSH principle (Do No Significant Harm) - is essential. As one academic participant observed, “if firms do not understand DNSH internally, they will remain locked out of future EU funding opportunities.”

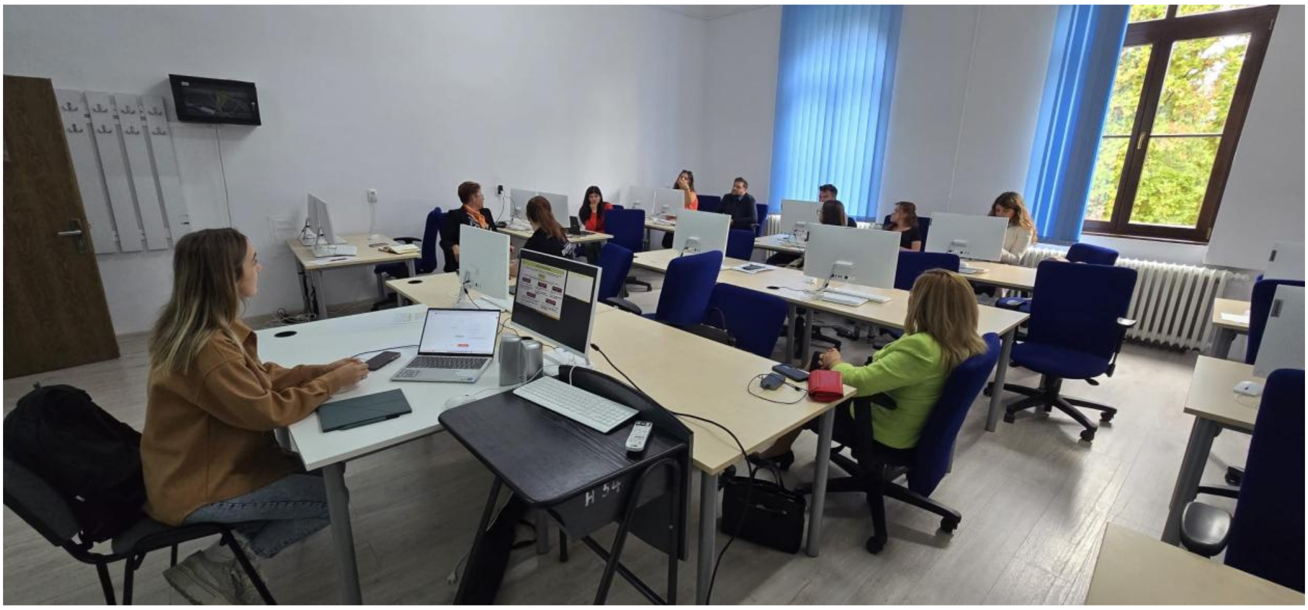
Validation of scenarios

Feedback confirmed that the Baseline scenario is realistic and enjoys strong support, as it is based on measures that are technically simple and financially accessible. The Compliance scenario (2030) was validated as inevitable, but stakeholders emphasized that it can only be effective if policy support mechanisms (simplified procedures, dedicated funding for both SMEs and large companies) are put in place. The Strategic Transformation scenario (2050) was recognized as the only one fully aligned with EU climate neutrality.

Policy implications

This feedback underscores that the scenarios cannot be seen in isolation. Their success depends on addressing systemic financing gaps, regulatory alignment with EU directives (EED, RED III, CSRD, CEAP), and the provision of capacity-building instruments. The roundtable thus validated both the internal coherence of the scenario framework and the need for multi-level policy interventions, confirming the added value of EENOVA as a project that links company-level realities with European climate and energy objectives.

Photo of the 3rd roundtable



Dairy value chain (Slovenia)

Objectives
The objectives of the 3rd Round Table (RT3) were to link the results from the 1st and 2nd round tables with the EU policy context, to engage companies (Planika and Mica) in a structured debate on Slovenian regulation using targeted questions from the WP4 scenario development questionnaire, and to jointly explore scenarios and policy recommendations. The session aimed to identify barriers, enablers, and potential synergies across companies in order to inform realistic pathways for energy transition, circular economy measures, and long-term alignment with Fit for 55, CEAP (Circular Economy Action Plan), NECP (National Energy and Climate Plan), and CSRD (Corporate Sustainability Reporting Directive).

The agenda was guided by the WP4 scenario development questionnaire, covering energy efficiency (machine upgrades, waste heat recovery, cooling, audits), renewable energy (PV deployment, community self-supply models, biogas, and biomass), circular economy and packaging (rPET, glass reuse, HDPE, whey valorisation), low-carbon logistics (daily transport, feasibility of e-trucks), policy alignment: EED, RED, ETS/ESR, CEAP, CSRD, NECP (Note: Scenario validation (feasibility, sector priorities, recommendations) will be carried out in the next phase.)

Facilitation methodology was semi-structured discussion based on WP4 questionnaire, a guided linking of company experiences to EU and national policy frameworks.

Agenda

- 11:30 - 11:45 Welcome and Introduction
  - Opening remarks by AgriFood Slovenia (facilitator).
  - Overview of EENOVA objectives and the purpose of the Slovenian hub within the project.
  - Presentation of the session goals: linking company measures to EU and national policy frameworks.
- 11:45 - 12:00 Presentation of Company Insights (Planika and Mica)
  - Key findings from energy audits and action plans (machine upgrades, cooling systems, heat recovery).
  - Current progress on renewable energy deployment (PV, cooperative models).
  - Packaging and circular economy updates (rPET, glass reuse, whey valorisation).
- 12:00 - 12:30 Guided Discussion - Scenario Elements and Validation
  - Structured dialogue based on the WP4 scenario development questionnaire:
  - Energy efficiency: machine modernization, insulation, waste heat recovery.
  - Renewable energy: PV, biogas, cooperative self-supply, biomass use.
  - Circular economy: packaging innovation (rPET, HDPE, glass reuse), whey valorisation.
  - Low-carbon logistics: transport optimisation, e-truck feasibility.
  - Policy alignment: Fit for 55, CEAP, NECP, CSRD, EED, RED, ETS/ESR.
- 12:30 - 12:45 Identification of Barriers and Enablers
  - Facilitated exchange on technical, financial, and behavioural barriers.
  - Discussion of enabling factors: subsidies, cooperative models, and regulatory incentives.
- 12:45 - 12:55 Policy and Investment Recommendations
  - Summary of key findings and recommendations to strengthen national and EU support mechanisms.
  - Validation of priority actions for energy transition and packaging circularity.

- 12:55 - 13:00 | Wrap-Up and Next Steps

Summary of agreements and takeaways for Deliverable D4.2.
Confirmation of continued engagement between companies and facilitators for follow-up activities (e.g., PV implementation and logistics pilots).

Participants and Stakeholder Groups
3 company representatives (2 from Planika, 1 from Mica) + 2 external experts/facilitators.
- Food and dairy processors (Planika).
- Packaging sector stakeholders (Mica).

Summary of discussions

Main topics:
- Machine modernization: Mica is replacing hydraulic with electric machines; Planika is considering frequency regulation of pumps, insulation, and heat recovery from condensate.
- Cooling and waste heat: Centralized cooling (Mica), compressor and steam recovery (Planika).
- Energy procurement: Mica contracts electricity 2-3 years ahead; Planika hedges ~6 months in advance.
- Renewable energy: Roof-mounted PV at two sites of Planika cooperative self-supply models explored, but roof/transformer bottlenecks remain. Mica is planning to set it up.
- Packaging: Increasing rPET use; migration tests and consumer acceptance challenges; glass vs PET economics contested.
- Transport: Planika's truck, which is parked overnight at the dairy and departs around 11 a.m. for daily deliveries to Ljubljana (~350 km), could in the future represent a strong pilot case for an e-truck. This is a different vehicle from Munih's milk collection truck. Mica, in contrast, relies on outsourced logistics.
- CSRD: Not yet binding for SMEs, but awareness of 2029 obligations rising.

Disagreements:
- None.

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Synergies:
- Shared interest in PV expansion, energy efficiency, and logistics decarbonization.
- Potential for joint community self-supply models.
- Common challenges in packaging compliance → scope for shared approaches.

Relevance (sector priorities):
- Energy cost reduction and security of supply.
- Meeting EU packaging and climate targets.
- Strengthening regional competitiveness and energy independence.

Feasibility:
- Machine replacement and upgrades are already in progress.
- PV expansion at Mica is feasible, but roof space is limited; a new warehouse is planned in the next few years.
- Adoption of an e-truck is technically possible, but it requires suitable charging solutions and collaboration with external partners.

Consistency:

- Measures align with EU climate neutrality goals.
- Financing and sequencing of measures require more planning.

Stakeholder Fit (acceptability, buy-in):

- High acceptance for efficiency measures and PV.
- Cautious stance on rPET due to technical and market risks.

Policy Alignment:

- Fit for 55: energy efficiency, PV, e-mobility.
- CEAP: packaging compliance, circular economic measures.
- NECP: national RES targets, efficiency, low-emission transport.
- CSRD: preparation needed, but not binding for SMEs until 2029.

Outputs

Validated scenario elements (broad consensus):

- Machine upgrades and cooling optimization (Mica).
- PV deployment of available roofs and new facilities (Planika & Mica).
- Waste heat recovery from compressors (both companies).
- Cooperative/community self-supply models (Agricultural Cooperative Tolmin, Planika, Mica).
- E-truck feasibility exploration for Planika.
- Digital monitoring and audits as enablers for CSRD readiness (both companies).

Elements needing refinement (partial support):

- rPET integration (concerns about migration safety, inconsistent quality of recycled feedstock, and uncertain cost-effectiveness compared to virgin PET).
- Glass reuse/recycling (contested economics due to high transport and washing costs; logistical complexity without national deposit-return support).
- Whey valorisation (barriers include small and dispersed volumes, filtration/processing costs, and transport bottlenecks; needs evaluation of most effective pathway (feed, biogas, or protein products).

New measures proposed (not in original scenario):

- None.

Stakeholder Feedback and Validation

Feedback collected:

- Positive momentum on energy efficiency and PV deployment, though infrastructural and regulatory barriers persist.
- Subsidies are seen as essential enablers of investment.
- Ongoing concerns about recyclate price volatility and consumer acceptance of recycled packaging. There was also discussion that the availability of material is gradually increasing due to the introduction of deposit return systems in countries such as Poland and Austria. At the same time, challenges remain, as some practices involve simply colouring virgin plastic to make it look like rPET, which highlights the lack of a clear system for ensuring quality.
- Transport decarbonization is viewed as a realistic next step, starting with pilot testing.

Barriers identified:

- Technical: limited roof space, transformer upgrades needed for self-supply.
- Economic: recyclate price volatility, food-grade migration challenges, high upfront costs for e-trucks.
- Social: consumers demand returnable packaging but often reject low-quality or visually unappealing recycled plastics.

Enablers identified:

- Subsidies and targeted financial incentives.
- Cooperative/community models (shared infrastructure, shared electricity).
- Alignment with EU and national policy frameworks.

Evidence-based notes (examples/quotes):

- “Every day 36 pallets go to Ljubljana - an e-truck could work if charging is solved in Planika and if the truck can do 350 km per day (hilly road to Ljubljana). The truck is parked at the dairy for most of the day (until around 11 a.m.), which could allow for charging during non-operational hours.”
- “Planika has conscious customers, but the look of packaging is decisive - if the plastic is not visually appealing, nobody buys it.”
- “KZ Tolmin has many metering points without PV - this is the biggest chance for community self-supply.”

Photos of the 3rd roundtable

Multi-dimensional Analysis (energy, financial, innovation)

A structured multi-dimensional analysis of the predefined scenarios was carried out to ensure that each approach was not only technically sound, but also economically viable, socially acceptable and aligned with innovation and policy frameworks. This approach ensured that the scenarios developed during the roundtable would go beyond the intended narratives and provide effective, evidence-based guidance for businesses and policymakers.

The analysis was conducted through a combination of cross-country comparison, quantitative indicators (energy savings, ROI, GHG reduction), and qualitative validation inputs collected during RT3 sessions, ensuring methodological consistency across all hubs.

1. **Energy Dimension**
   The energy dimension focused on the potential of each scenario to reduce consumption, increase renewable integration, and lower greenhouse gas (GHG) emissions across the five value chains.
   a. Efficiency gains: Measures such as LED retrofitting, compressed air optimization, insulation, and heat recovery were consistently evaluated for their energy-saving potential and ease of implementation.
   b. Renewable integration: Deployment of photovoltaic systems, biogas, and community energy models were assessed in terms of technical feasibility, grid compatibility, and capacity to reduce fossil fuel dependency.
   c. Systemic impacts: Electrification of thermal processes and logistics, combined with digital monitoring, were analysed for their contribution to long-term climate neutrality. Across all regions, the analysis confirmed that energy efficiency provides the fastest and most secure returns, while renewable deployment represents the cornerstone of long-term decarbonization.

The combined effect of validated measures across all five hubs amounts to an estimated reduction potential of 5-15% in total energy consumption by 2030 and up to 40-50% renewable energy share by 2040, illustrating the scalability of energy transition within regional food systems.

2. **Financial Dimension**
   The financial analysis assessed investment needs, cost-benefit ratios, and payback periods, with a particular focus on the realities faced by SMEs in the agri-food sector.
   a. Short-term feasibility: Low-capex measures (LEDs, control systems, destratification fans) show payback times of 1-3 years, making them attractive entry points for companies with limited capital.
   b. Medium-term measures: Investments in PV, heat pumps, and digital energy management systems typically yield payback within 5-8 years, contingent on subsidies and financing instruments.
   c. High-capex investments: Battery storage, e-trucks, and advanced circular packaging solutions remain financially challenging under current market conditions. Their feasibility is largely dependent on targeted incentives, grants, and cooperative models to spread risk.
   d. Cluster synergies: Joint procurement of PV systems, shared logistics platforms, and cooperative financing schemes emerged as critical enablers to improve affordability and reduce unit costs.

The financial lens underlined the importance of stable subsidy frameworks, SME-tailored financing instruments, and predictable regulatory conditions to ensure implementation.

The comparative financial assessment also revealed that cross-company and cluster led investments can reduce unit costs by 10-25%, while blended finance schemes (EU, national, private) significantly improve ROI stability for medium to high capex measures. This reinforces the strategic role of clusters and cooperatives as financing intermediaries within regional transition models.

3. **Innovation Dimension**

   The innovation analysis addressed the potential for digitalisation, new technologies, and circular economy practices to transform the regional value chains.

   a. Digital monitoring and management: Building Management Systems (BMS), energy dashboards, predictive maintenance, and digital twins were identified as high-impact innovations that enhance efficiency, transparency, and reporting readiness under CSRD.
   b. Circular economic practices: Valorisation of by-products (whey, pomace, herbal residues), adoption of rPET or glass reuse, and smart packaging solutions demonstrate potential to reduce waste and generate new value streams.
   c. Transport and logistics innovation: E-mobility pilots, renewable-powered logistics hubs, and route optimization software highlight how innovation can address one of the most energy-intensive stages of the value chain.
   d. Organizational innovation: Beyond technology, innovation was also recognized in governance models - such as community energy initiatives, cluster-led procurement, and joint branding of “green” regional products - which enable systemic change.

The innovation mapping confirmed that nearly 70% of identified measures integrate a digital component (monitoring, automation, traceability), directly supporting compliance with CSRD and ESRS standards. This positions the EENOVA scenarios as practical enablers of data driven sustainability transitions rather than purely technical interventions.

4. **Integrated Findings**

   By applying this multi-dimensional lens, the analysis confirmed that:

   a. Energy efficiency and renewable are technically feasible and strategically essential.
   b. Financial viability is uneven across measures, requiring phased sequencing, stable incentives, and cooperative approaches.
   c. Innovation, both technological and organizational, is a key enabler of long-term competitiveness, particularly when aligned with EU frameworks such as Fit for 55, CEAP, NECPs, and CSRD.
   d. Social and capacity-building effects are equally important: through multi-actor participation, companies have developed new competencies in digital energy management, policy awareness, and collaborative project design, strengthening local innovation ecosystems.

The result of this multifaceted assessment is scenarios that are not only technically sound, but also financially realistic and innovation based. They provide pathways for companies to gradually take steps, from low-capital efficiency measures to the transition to the integration and digitalisation of renewables, and finally to full circularity and climate neutrality by 2050.

These insights also serve as the analytical foundation for Deliverable D4.2, where scenario validation results are integrated into policy roadmaps and investment recommendations at EU and national levels.

Regional Adaptation and Customization

Although the EENOVA project operated according to a common scenario framework, each region had to adapt to specific technological, regulatory and market conditions. Austrian bakeries have focused on heat recovery, optimizing compressed air and replacing gas furnaces, but have faced challenges related to fire safety regulations and expensive electromobility. Bulgarian wineries have emphasized irrigation efficiency, cellar cooling, and renewable consumption, adapting investment plans to heritage constraints and high capital costs. In Lithuania, the water and soft drinks sector has prioritized the development of solar photovoltaic energy, digital monitoring and logistics cooperation, as well as the issue of packaging circularity through national deposit return system obligations. Romanian meat producers faced funding gaps and unclear consumer legislation, requiring a distinction between fast-benefit measures such as LED replacement and more ambitious long-term approaches. Slovenian dairies adapted their scenario to collaborative energy models, whey valorisation and packaging measures, balancing options and consumer scepticism towards recycled plastics.

In each case, regional adaptation translated the generic scenario framework into a context-sensitive roadmap, ensuring that company-level measures were feasible within national policy, market, and infrastructural realities.

Regional adaptation has also been driven by national policy frameworks, ranging from the objectives of the Austrian NECP for the heat transition to Lithuania's renewable electricity ambitions, as well as market realities such as export demand in Bulgaria and Slovenia or SME financing barriers in Romania. In Austria, adaptation was policy-driven (strict regulatory compliance and subsidy dependence), in Bulgaria, resource and infrastructure driven (heritage and irrigation constraints), in Lithuania, innovation driven (digitalisation and circularity focus), in Romania, finance driven (SME versus large company funding gap) and in Slovenia, cooperation driven (community energy and cluster-based logistics).

The process stressed that while the common structure ensures comparability between countries, real responsibility and feasibility only arise through adaptation.

This bottom-up contextualization is what allowes WP4 scenarios to move from theoretical design to operational reality, demonstrating that regional hubs can act as living laboratories for the twin transition combining green and digital innovation in practice.

In practice, this means sequencing measures to align local capacities, from short-term efficiency gains to medium term digitalization and logistics optimization, to large-scale renewables and long-term circular economy conversions.

Such sequencing has proven critical to ensure both technical realism and financial viability: measures with short payback periods (1-3 years) build confidence and cash flow for later, higher CAPEX investments in renewables, packaging circularity, and transport electrification.

Finally, regional adaptation has made the possibility pre-determined to take into account circumstances that reflect both European policy objectives and the realities of the companies that hope to achieve them.

This adaptive process also provides an analytical bridge to Deliverable D4.2, where regional lessons are aggregated into EU-level policy insights. The EENOVA methodology thus proves that a harmonised framework, when flexibly applied, can deliver both comparability across regions and relevance to local business ecosystems, paving the way for replication in other agri-food subsectors and EU regions.

Sustainable Bakery 2050 - Austria: Energy-Efficient, Renewable, and Circular Value Chains

Executive Summary

The Austrian bakery sector stands at a decisive moment in its transition towards climate neutrality, facing both strong opportunities for energy efficiency and persistent barriers to renewable integration and e-mobility. The scenario, which was developed through the cumulative results of energy audits, previous roundtables, and WP3 action plans, was validated during the 3rd Roundtable. It outlines a pathway in which bakeries and mills adopt comprehensive energy management systems, expand photovoltaic generation, optimize compressed air and logistics, and replace gas-based heat with renewable-powered high-temperature heat pumps by 2050.

The regional focus is on Upper Austria, where companies such as Resch&Frisch, Knoll Mühle, and Pfahnl represent different segments of the value chain. These firms already demonstrate strong maturity in implementing heat recovery and efficiency measures, while simultaneously confronting challenges linked to strict regulatory frameworks, volatile subsidy schemes, and high national energy prices. Stakeholder validation confirmed that while the technical feasibility of measures is high, economic viability depends heavily on stable funding mechanisms and supportive infrastructure policies.

The scenario contributes directly to the European Green Deal and Austria's National Energy and Climate Plan by promoting renewable energy adoption, circular economy practices, and decarbonization of transport fleets. By 2030, the sector aims to achieve substantial reductions in energy intensity and emissions through PV expansion, EMS deployment, and continued efficiency gains. By 2040-2050, the goal is to complete the shift towards fully renewable electricity, electrified logistics, and circular value chains, ensuring the bakery industry's competitiveness while meeting national and EU climate neutrality targets.

Contextual Foundation

The Austrian bakery sector operates within a dynamic energy and policy landscape shaped by the European Green Deal, the Fit for 55 package, and Austria's National Energy and Climate Plan (NECP). Companies such as Resch&Frisch, Knoll Mühle, and Pfahnl are representative of the regional agri-food value chain, facing both opportunities and challenges in their transition to climate neutrality by 2050.

Regional snapshot

- Market maturity
  - The bakery sector in Upper Austria is technologically advanced and internationally competitive, with established infrastructure for large-scale industrial baking and milling. Companies in this subsector already implement core energy efficiency measures, such as heat recovery and LED systems, while also exploring renewable integration. Market maturity is medium to high, as modern bakeries are equipped with automation and digital systems, yet remain highly dependent on fossil-based energy sources, especially natural gas for high-temperature processes.
- Infrastructure
  - Infrastructure modernization is seen as a key enabler of further decarbonization. While

heat recovery systems are fully integrated in leading bakeries, expansion of renewable electricity generation through photovoltaic (PV) systems is hindered by strict fire safety regulations, high upfront investment costs, and a funding system based on lowest-bidder principles. Compressed air systems and logistics infrastructure (particularly for e-trucks) represent additional areas where technical upgrades are needed but constrained by economic feasibility and limited charging infrastructure.

- Energy dependency
    - The sector is heavily dependent on electricity and process heat, traditionally supplied by natural gas. Resch&Frisch highlighted the challenge of high-temperature demand, which until recently could only be covered by gas but is now increasingly substitutable with high-temperature heat pumps powered by renewable electricity. Knoll Mühle reported an annual electricity demand of around 2 GWh, with significant potential for PV expansion and optimization of compressed air systems. Energy costs in Austria are significantly higher than in neighbouring countries, raising competitiveness concerns.
- Regulatory environment
    - Austria's NECP sets ambitious goals for climate neutrality by 2040, with 100% renewable electricity by 2030 and strong emphasis on energy efficiency. However, national regulations, particularly on PV installation (fire protection requirements, complex permitting), are viewed as barriers to rapid adoption. Companies also stressed the volatility of subsidies and the lack of long-term planning security, which undermines investment decisions. At the EU level, CSRD reporting obligations are expected to increase pressure for transparency and systematic energy management, while CEAP reinforces requirements for circular packaging and waste valorisation.

Subsector focus

The bakery subsector faces specific challenges linked to energy intensity, cold chain logistics, and packaging. Resch&Frisch has already implemented advanced waste heat recovery and digital route optimization for logistics, while Knoll Mühle continues to explore PV, compressed air optimization, and employee awareness campaigns. Bran valorisation and biogas integration are part of the mill value chain, linking food processing with circular economy practices. E-mobility is recognized as a long-term necessity, yet stakeholders emphasized that current costs and range limitations make e-trucks economically unviable without subsidies and infrastructure improvements.

Road map goals and objectives

- Achieve a progressive reduction in energy intensity by at least 25% by 2030 and full climate neutrality by 2050.
- Replace fossil-based process heat with renewable-powered high-temperature heat pumps.
- Expand photovoltaic and community renewable generation across bakery and milling sites.
- Implement comprehensive Energy Management Systems (EMS) to enable real-time monitoring and CSRD-compliant reporting.
- Modernize logistics through electrification, digital route optimization, and cooperative delivery models.
- Promote circular economy practices through waste valorisation and recyclable or reusable packaging solutions.

These objectives form the basis of the Austrian bakery roadmap, outlining a coherent pathway toward energy-efficient, renewable, and circular value chains. The following sections describe the concrete actions, investments, and organizational measures that operationalize these goals within the 2025-

2050 timeframe.

Operational Roadmap

The Austrian bakery subsector is at a crossroads where proven energy efficiency measures coexist with emerging renewable solutions and new mobility concepts. The roadmap below outlines concrete actions, investments, and organizational changes required to achieve climate neutrality by 2050.

Implementation of the roadmap requires coordinated engagement of company management (strategic planning and investment), technical staff (maintenance and digital monitoring), cluster facilitators (joint procurement, knowledge exchange), and public authorities (policy and funding support). Financial resources will derive primarily from company CAPEX budgets, complemented by national and EU subsidy schemes.

Scalable actions

- Heat Recovery Expansion: Maintain and replicate the already implemented heat recovery systems across bakeries and mills; ensure integration in all new production lines.
- Energy Management Systems (EMS): Scale up EMS adoption to enable real-time monitoring, Cross-Site benchmarking, and optimization of electricity and heat use.
- Compressed Air Optimization: Introduce monitoring tools, whistle sensors, and pressure adjustments in milling companies to reduce inefficiencies.
- PV Deployment: Expand rooftop, facade, and Agri-PV systems where technically feasible, supported by regulatory reforms and tailored subsidies.
- Cold Chain Optimization: Further improve freezing and refrigeration processes with waste heat utilization and efficient cooling technologies.
- E-Mobility Transition: Gradual introduction of EV cars and e-trucks, supported by charging infrastructure expansion and route optimization technologies.

Technologies and upgrades (e/g/ heat recovery, monitoring system, PV)

- High-temperature heat pumps to replace gas in baking processes.
- Digital assistance systems and AI-driven logistics optimization for transport.
- Battery storage for balancing PV generation and electricity demand.
- Modern compressors and sectional monitoring to reduce compressed air losses.
- LED retrofits and smart lighting systems for non-production areas.
- Digital energy dashboards for awareness-building among employees.

Investments required (CAPEX estimates, collaborative actions)

- CAPEX for PV and Storage: Medium-to-high upfront investments with payback periods dependent on subsidy reform.
- EMS Implementation: Initial costs for software, sensors, and training, offset by efficiency gains and compliance benefits.
- E-Mobility Fleet Renewal: High investment in e-trucks, requiring targeted subsidies and co-financing from EU/National programs.
- Infrastructure Modernization: Replacement of outdated systems at end-of-life, with focus on integrating energy-efficient machinery and smart controls.
- Collaborative Actions: Shared investment in regional charging stations, community energy projects, and cooperative heat networks.

Organizational changes (training, digitalization, logistic)

- Training and Capacity Building: Upskilling staff on EMS usage, compressed air maintenance, and energy-conscious behaviour.
- Digitalization: Full integration of monitoring systems, dashboards, and route optimization software.
- Logistics Restructuring: Shift towards cooperative delivery models and shared infrastructure to maximize fleet efficiency.
- Awareness Campaigns: Engagement of employees in energy-saving behaviour through visualization of energy consumption and efficiency gains.

Timeline:

- Short-term scenario (2025-2030)
    - Deploy EMS in all major companies.
    - Expand PV systems where roof/facade conditions allow.
    - Optimize compressed air systems in mills.
    - Extend waste heat recovery systems.
    - Begin transition to EV cars for fleets; pilot e-trucks with subsidies.
    - Launch employee training and awareness programs.
- Midterm (2030-2040)
    - Scale up high-temperature heat pumps for baking processes.
    - Achieve substantial penetration of PV with integrated storage.
    - Expand e-truck fleets as technology matures and infrastructure improves.
    - Strengthen cooperation in energy communities and shared logistics models.
    - Integrate circular packaging and material valorisation into mainstream operations.
- Long-term scenario 2050
    - Complete transition from gas to renewable-based heat.
    - Achieve near-100% renewable electricity in the bakery value chain.
    - Establish fully electrified transport fleets supported by smart charging networks.
    - Integrate Austrian bakeries into regional circular economy ecosystems.
    - Reach climate neutrality through continuous efficiency improvement, renewable integration, and policy-aligned innovation.

Implementation of the roadmap relies on coordinated action across multiple levels. Individual companies such as Resch&Frisch, Knoll Mühle, and Pfahnl are responsible for executing technical and organizational measures through internal investment plans and staff training. Regional clusters (Food Cluster Upper Austria, Cleantech Cluster) act as facilitators, organizing joint procurement, technology transfer, and knowledge-sharing to reduce costs and align investments. Public authorities and funding bodies provide the enabling framework through stable subsidy schemes and streamlined permitting for renewable installations. Financial resources combine company CAPEX with national and EU co-funding, while technical resources include supplier partnerships, engineering consultancies, and digital service providers. Human resources are strengthened through targeted training and capacity-building programmes supported by vocational institutions and cluster initiatives. This multi-actor approach ensures that responsibilities, expertise, and funding are shared efficiently, translating the roadmap from strategy into implementation.

Policy Framework

The Austrian bakery subsector operates within the framework of the European Green Deal, the Fit for 55 package, and Austria's National Energy and Climate Plan (NECP). While EU and national policies provide an overarching structure for the clean energy transition, companies in the sector identified several regulatory gaps and enablers that shape their ability to act.

- **Policy context**: Existing laws, directives (e.g., CSRD, CSDDD)
    - European Green Deal & Fit for 55: Establishes the overarching goal of 55% GHG reduction by 2030 and climate neutrality by 2050.
    - Energy Efficiency Directive (EED): Imposes binding energy efficiency targets, requiring industrial bakeries and mills to implement continuous efficiency measures.
    - Renewable Energy Directive (RED): Sets a target for renewable energy share in final consumption (Austria aims for 100% renewable electricity by 2030).
    - EU Emissions Trading System (ETS): Large bakeries are not directly included under current thresholds but face indirect exposure via energy costs.
    - Effort Sharing Regulation (ESR): Applies to non-ETS sectors, including bakery transport fleets, incentivizing electrification and alternative fuels.
    - Circular Economy Action Plan (CEAP): Reinforces sustainable packaging requirements and food waste prevention, directly relevant to bakery value chains.
    - Corporate Sustainability Reporting Directive (CSRD): Mandates large companies to disclose sustainability data, requiring systematic EMS and GHG reporting.

- **Barriers**: Bureaucracy, permitting, funding gaps
    - Permitting Complexity: Strict Austrian fire safety regulations make PV rooftop installation costly, often requiring full roof renovation.
    - Volatile Subsidies: Frequent changes in funding schemes undermine planning security, discouraging long-term investments in e-mobility and PV systems.
    - Economic Competitiveness: High Austrian energy prices relative to neighbouring countries create pressure on bakery competitiveness.
    - E-Mobility Infrastructure: Insufficient public charging points and lack of incentives for private charging infrastructure at customer sites limit e-truck feasibility.
    - Policy Scope: Current energy audits do not consider opportunities for cross-company energy sharing (e.g., waste heat exchange, energy communities).

- **Enablers**: National/EU grants, tax reliefs, infrastructure support
    - National & EU Funding Programs: Klima- und Energiefonds, InvestEU, and Horizon Europe provide financing for renewable energy, e-mobility, and efficiency upgrades.
    - Energy Communities Legislation: Recent Austrian reforms allow companies to join or establish renewable energy communities, reducing costs and enabling shared infrastructure.
    - Tax Incentives: Existing schemes have already accelerated EV adoption in company car fleets and could be expanded to trucks.
    - CSRD & Transparency Requirements: Push companies towards adopting EMS and systematic reporting, indirect driving efficiency and renewable integration.
    - Cluster Support: Regional clusters (Food Cluster, Cleantech Cluster, Energiesparverband) facilitate cooperation, joint infrastructure, and knowledge sharing.

- **Policy proposals**: What new or adjusted policies are needed.
    - Reform PV Funding Mechanisms: Replace lowest-bidder principle with schemes that ensure fair support for SMEs and food companies, while subsidizing compliance with strict fire protection rules.
    - Stabilize Subsidy Frameworks: Introduce long-term, predictable funding lines for e-mobility and EMS adoption, reducing investment risk.

- Support for E-Mobility Infrastructure: Co-finance private charging infrastructure at company and customer sites and accelerate nationwide charging network expansion.
- Expand Scope of Energy Audits: Require inclusion of cross-company synergies (heat sharing, joint PV, storage) to identify systemic efficiency potential.
- Circular Economy Incentives: Introduce financial or regulatory incentives for circular packaging and valorisation of by-products (bran, bakery waste).
- Awareness Campaigns: Support cultural change through public initiatives that promote energy efficiency as an economic and societal priority ("make saving sexy").

Impact Assessment

The implementation of the Austrian bakery sector scenario will have significant impacts on energy efficiency, greenhouse gas (GHG) reduction, innovation, and socioeconomic development. The assessment builds on validated measures from company energy audits (Resch&Frisch, Knoll Mühle, Pfahnl) and stakeholder discussions during the 3rd Roundtable.

- **Estimated energy savings (MWh)**
  - Heat Recovery Systems: Continued and expanded use of waste heat recovery is expected to reduce thermal energy demand by up to 20-25% in baking and cooling processes.
  - Compressed Air Optimization: Lowering system pressure and addressing leaks could reduce electricity consumption in milling operations by 5-10%, equivalent to several hundred MWh annually for medium-sized mills.
  - Energy Management Systems (EMS): Indirect savings of 5-8% across electricity and heat consumption, achieved through improved monitoring, control, and behavioural change.
  - Lighting and Auxiliary Systems: Replacement with LED and smart control systems leads to modest but cost-effective reductions of 1-3%.
  - Total Energy Savings Potential: Across the value chain, implementation of all measures could deliver 15-25% lower energy intensity by 2030, with incremental improvements towards 2050.

- **Estimated GHG reductions (tCO_2e)**
  - Renewable Electricity (PV, Energy Communities): Expansion of PV and participation in energy communities can replace fossil-based electricity, avoiding 1,000-2,000 tCO_2e annually a cross participating bakeries by 2030.
  - High-Temperature Heat Pumps: Replacement of gas-fired ovens and boilers with heat pumps powered by renewable electricity could reduce direct emissions by 30-40% in the mid-term (2030-2040).
  - E-Mobility Transition: Partial electrification of company fleets (cars and trucks) could avoid 100-200 tCO_2e annually by 2030, scaling as infrastructure and subsidies expand.
  - Overall Impact: Full roadmap implementation positions the sector to align with Austria's NECP and contribute to net-zero by 2040, with climate neutrality in bakery operations by 2050.

- **Innovation impact** (e.g., new technologies, digitalization)
  - Technology Uptake: Accelerated deployment of high-temperature heat pumps, smart compressors, AI-driven logistics, and EMS systems strengthens Austria's innovation profile.

- Circular Economy Practices: Valorisation of bran for animal feed and biogas, combined with recyclable packaging, demonstrates circularity as a competitive advantage.
    - Digitalization: Widespread adoption of monitoring, dashboards, and route optimization introduces a culture of data-driven decision-making across SMEs.

- **Socioeconomic benefits** (e.g., local jobs, export potential)
    - Local Jobs: Investments in PV, heat pumps, EMS, and logistics modernization stimulate local engineering, installation, and maintenance jobs.
    - Export Potential: Austrian bakeries adopting advanced energy practices can serve as reference cases for exporting "sustainable bakery" expertise and products across the EU.
    - Resilience and Competitiveness: Reduced dependence on volatile gas prices strengthens Austria's food sector competitiveness compared to neighbouring markets.
    - Community Value: Participation in renewable energy communities fosters regional cooperation and shared infrastructure investments.

- KPIs for monitoring:
    - Energy Intensity: kWh per ton of baked goods produced.
    - Renewable Share: % of electricity and heat demand covered by renewable sources.
    - Investment Leverage: € of private investment mobilized per € of public support.
    - Emission Reduction Progress: tCO_2e avoided compared to 2020 baseline.
    - Circularity Metrics: % of packaging recyclable/compostable; % of by-products valorised.

Feasibility & Validation

The Austrian bakery scenario was tested and validated during the 3rd roundtable through intensive dialogue between companies, stakeholders, and policymakers. Validation followed a semi-structured methodology based on the WP4 scenario questionnaire, enabling participants to assess technical feasibility, investment realism, and policy coherence through guided discussion and ranking exercises. The overall feedback confirmed that the scenario is both relevant and realistic, although several barriers to implementation remain.

From a technical perspective, the measures included in the scenario were assessed as highly feasible. Heat recovery, LED lighting, and compressed air optimization are already proven and, in many cases, fully implemented, providing clear evidence that energy efficiency can be achieved without excessive risk. The integration of energy management systems was discussed more critically: while companies such as Resch&Frisch see EMS as the foundation for all further improvements, some stakeholders questioned its direct value since it does not in itself save energy. Nevertheless, the consensus was that EMS is indispensable as an enabling technology, especially when linked to monitoring, reporting, and compliance with CSRD requirements.

Economic feasibility was a more contested issue. PV systems, for example, are widely recognized as a high-potential measure, yet strict fire safety regulations and the lowest-bidder funding principle in Austria significantly increase costs and complexity. Companies noted that without reform of the subsidy framework and simplification of permitting, PV expansion will remain limited despite its clear contribution to the NECP goals. Similar concerns were voiced regarding e-mobility: while the transition to electric cars is already underway, e-trucks remain economically unviable due to high upfront costs, short ranges, and lack of charging infrastructure. Participants stressed that without targeted subsidies and planning security, these technologies will not reach scale within the desired timeframe.

Validation also highlighted the importance of stakeholder fit. Companies expressed strong buy-in for infrastructure modernization, waste heat recovery, and incremental efficiency measures, while policymakers underlined the need for stable frameworks and subsidy continuity. Both sides agreed that behavioural change and awareness-building within companies are essential, as energy efficiency is not only a technical challenge but also a cultural one. The idea that “saving must become sexy,” voiced during the roundtable, reflects the shared understanding that employee engagement and social acceptance are just as critical as investments in technology.

Risks identified during the validation included regulatory volatility, high energy prices in Austria compared to neighbouring countries, and uncertainties around future subsidy schemes. These risks could slow down investments and undermine competitiveness if not addressed through stable and supportive policies. Mitigation strategies discussed include long-term subsidy frameworks, streamlined permitting for PV, and enhanced cooperation in energy communities to spread costs and benefits across multiple actors.

Overall, the validation process confirmed that the scenario is coherent, aligned with EU and national policy objectives, and supported by both companies and stakeholders. While technical feasibility is already high for many measures, economic and regulatory adjustments are essential to unlock the full potential. The readiness level of the scenario can therefore be rated as medium-to-high, with clear pathways for improvement once structural barriers are addressed.

In practical terms, this validation establishes a strong basis for Deliverable D4.2, where the Austrian roadmap feeds into cross-country comparison and policy synthesis. Stakeholders agreed to maintain engagement through the regional clusters and energy communities to monitor progress, support joint funding applications, and continue refining the scenario as new technologies and policy instruments emerge.

Sustainable Winery - Bulgaria

Executive Summary

The Bulgarian scenario under WP4 of the EENOVA project builds on the outcomes of the first and second roundtables and the detailed energy audits of three representative actors in the national agri-food value chain: BATA 2002 (viticulture and irrigation), Black Sea Gold (wine production and cellar operations), and POPKOMERS (logistics and distribution). It translates company-level energy efficiency and renewable energy measures into a forward-looking roadmap consistent with the EU "Fit for 55" package and Bulgaria's updated National Energy and Climate Plan (NECP 2021-2030, submitted 2025). In the NECP, Bulgaria sets a national renewable energy share of 34.96% in gross final energy consumption by 2030 (with indicative sub-sectoral split across electricity, heating/cooling and transport), targets reductions in primary and final energy consumption of 15.42% and 11.61% versus the 2020 reference scenario (corresponding to 13,190 ktoe primary and 8,819 ktoe final), and commits to a 10% reduction of greenhouse-gas emissions in non-ETS sectors by 2030 relative to 2005. These goals are underpinned by an Energy Efficiency Obligation Scheme and alternative measures delivering cumulative final-energy savings of 6,227.39 ktoe over 2021-2030, complemented by EU and national financing instruments (including the Modernization Fund and cohesion-backed programs).

Within this policy frame, the scenario prioritizes three operational pillars that reflect both the audits and the discussions with the companies. First, efficiency upgrading and digitalisation: automation and real-time monitoring of energy use, inverter controls and pumping optimization in irrigation, and process-level optimization in winery operations and warehouses. Second, renewable self-consumption with storage: deployment of PV systems coupled with battery storage for seasonal and daily load-matching (notably irrigation pumps at BATA 2002 and electrical loads in logistics), alongside adiabatic cooling in cellars to stabilize humidity and temperature while reducing chemical use and electricity demand at Black Sea Gold. Third, organizational readiness and phased investment planning: integrating energy management into routine decision-making, sequencing low-capex/high-impact measures first (e.g., fans for destratification, lighting and controls, basic BMS), and preparing larger capex items once permitting or site constraints are resolved. The companies share interest in joint procurement for PV and batteries to reduce unit costs, while acknowledging practical constraints such as archaeological-site procedures delaying PV deployment at the winery and wildlife-related risks that limit the feasibility of underground and unsupervised drip irrigation at the vineyard.

By 2030, the scenario foresees implementation of priority measures - PV with storage for irrigation and logistics, adiabatic cooling in cellars, and automated monitoring - followed by system optimization and equipment renewal in 2030-2040, and full renewable electrification and circular resource use approaching 2050. The expected effects are sustained reductions in specific energy use, a rising share of on-site renewables in consumption, measurable GHG reductions through displacement of grid electricity and diesel, improved resilience to energy-price volatility, and stronger coordination between production, processing, and distribution. In this way, the scenario provides a replicable pathway that connects micro-level audit actions with Bulgaria's NECP targets and the European Green Deal, supporting competitiveness today while contributing to climate neutrality by mid-century.

Contextual Foundation

Regional snapshot

Bulgaria's wine and agri-food industries are concentrated mainly in southern regions with well-developed transport corridors but varying access to modern energy infrastructure. The sector remains energy-intensive, heavily reliant on electricity for cooling, irrigation, and bottling, and on diesel for transport and field mechanization. Grid connections in rural zones is reliable but often limited by capacity constraints that complicate renewable self-consumption projects. Industrial consumers can now benefit from the liberalized electricity market and in future - on bilateral green-power contracts, yet permitting and administrative procedures remain among the slowest in the EU.

Energy audits conducted under EENOVA revealed that electricity accounts for more than 70 % of total energy use in the participating companies, followed by fuels for mechanization and logistics. The audits also identified substantial savings potential through digital monitoring, waste-heat recovery, and onsite renewable generation - measures fully aligned with NECP priorities.

Regulatory environment

The national framework transposing the Energy Efficiency Directive (EED) and Renewable Energy Directive (RED III) mandates regular energy audits for large enterprises and voluntary participation for SMEs. Since 2023, Bulgaria has introduced voluntary agreements for industrial SMEs that commit to quantified energy-saving targets in exchange for financial support. These schemes are particularly relevant for wine producers, cold-storage operators, and logistics firms, whose combined footprint places them within the scope of future obligations under the revised Effort Sharing Regulation (ESR).

Complementary policies - such as the National Decarbonization Fund, Green Industry Support Program, and Innovation Fund - create financial avenues for investments in solar, biomass, and electrification technologies. However, administrative fragmentation and limited advisory capacity often delay project implementation, a challenge highlighted repeatedly during the second roundtable.

Subsector focus

The Bulgarian EENOVA hub concentrates on the wine-production value chain, which integrates three key functional stages:

1. Viticulture and irrigation (BATA 2002) - characterized by high seasonal electricity use for water pumping and field machinery. Energy-saving priorities include automation of irrigation, moisture-sensing systems, and solar PV with battery storage.
2. Winemaking and cellar operations (Black Sea Gold) - dependent on stable temperature and humidity conditions. Priority measures comprise adiabatic cooling, waste-heat recovery from compressors, and real-time electricity monitoring.
3. Logistics and warehousing (POPKOMERS) - dominated by electricity use for lighting, HVAC, and internal transport. Efficiency gains can be achieved through solar-assisted heating of domestic water, ceiling fans for destratification, motion-sensing lighting, and eventual electrification of forklifts.

Collectively, these actors represent the vertical energy footprint of a typical Bulgarian wine value chain - from grape production through processing to distribution - offering a realistic testing ground for scalable efficiency and renewable measures.

While Bulgaria’s renewable-energy market is expanding rapidly - surpassing 3 GW of installed solar capacity by early 2025 - integration at SME level remains modest. Access to financing and technical expertise is improving, yet most agrifood SMEs still depend on internal funds. Grid-modernization plans under the NECP, including reinforcement of medium-voltage lines and digital metering, are expected to improve self-consumption conditions by 2027.
Overall, the contextual landscape combines favourable long-term policy direction with short-term implementation barriers, confirming the need for targeted scenarios that bridge company-level

initiatives with national decarbonization objectives.

Roadmap goals and objectives
Overall goal (2050): achieve climate-neutral wine production and logistics through full electrification where feasible, high renewable self-consumption, and circular resource use across viticulture, cellar operations, and distribution.

2030 targets (short term):
- Reduce energy intensity by 10-15% versus 2024 baselines across BATA 2002, Black Sea Gold, and POPKOMERS.
- Reach 20-25% renewable share in electricity consumption via PV self-consumption (with storage where feasible).
- Deploy digital monitoring/BMS at all sites for real-time control and audit follow-up (EED/CSRD readiness).
- Implement priority no/low-CAPEX measures: adiabatic cooling, compressor optimization/heat recovery, lighting controls, and operational fixes.

2040 milestones (mid term):
- Expand on-site renewables and storage to approach ≈40% self-consumption; electrify suitable thermal uses (e.g., DHW, process water).
- Scale precision irrigation and fertigation to cut pumping electricity and water use; integrate predictive maintenance in cellar and logistics.
- Pilot low-emission logistics (EV/alternative fuels) on short routes; consolidate circular by-product use (mulch, compost).

2050 outcomes (long term):
- Exceed 60% renewable share across the chain (on-site + green power contracts/energy communities).
- Maximize electrification of processes and local circular valorisation of organic residues; minimize diesel use in logistics.
- Sustain CSRD-grade data systems for transparent Scope 1-3 reporting and finance access.

Operational objectives (cross-cutting):
- Efficiency & digitalisation: Automate monitoring, close control gaps after audits, and lock in behavioural savings.
- Renewables & storage: Prioritise PV for irrigation/logistics loads; right-size batteries based on measured profiles.

- Circularity: Systematise pomace/mulch reuse; assess additional pathways case-by-case (e.g., heat recovery, process optimization).
- Financing & collaboration: Use joint procurement (PV/batteries), apply to Modernization Fund/OP CIE/LIFE; engage municipalities/clusters to de-risk permits and co-invest in shared assets.

Governance and responsibilities: Company management leads site actions, clusters/associations coordinate joint tenders and funding, municipalities support permitting and infrastructure, ministries align incentives (NECP, EED/RED) and simplify procedures.

Operational Roadmap
The operational roadmap for Bulgaria builds on the outcomes of the energy audits and the discussions held during the first and second roundtables. It translates individual company actions into a structured pathway toward energy efficiency, renewable integration, and value chain collaboration - in full alignment with the revised Bulgaria National Energy and Climate Plan (NECP, 2025) and the EU Fit for 55 package, including the Energy Efficiency Directive (EED) and the Renewable Energy Directive (RED III).
The roadmap covers three-time horizons - short term (2025-2030), midterm (2030-2040), and long term (to 2050) - and includes technical, organizational, and investment measures.

Scalable Actions (from WP3 Action Plans)
The companies have identified a coherent set of energy-saving measures (ESMs) based on audit results, each classified by priority and feasibility. These measures represent scalable actions that can be replicated across similar industrial and agricultural settings in Bulgaria's agri-food sector.

BATA 2002

ESM - I category (top priority)
ESM 01 Use of magnetic treatment of drilling water in order to reduce scale deposits in pumps and pipelines and reduce hydraulic resistances.
ESM 02 Reduction of water and electricity for irrigation by using moisture meters to measure soil moisture.
ESM 03 Automation of drip irrigation systems.

These measures reduce electricity demand for irrigation, improve water resource management, and serve as a model for precision agriculture in line with NECP 2025 priorities for irrigation modernization and energy efficiency in primary production.

BLACK SEA GOLD

ESM - I category (top priority)
ESM 01: Adiabatic (evaporative) cooling and air purification in wine cellars
ESM 02: Utilization of waste heat from a screw compressor for compressed air
ESM 03: Optimizing the operation of a screw compressor for compressed air by lowering the temperature of the intake air through adiabatic cooling

These measures align with RED III objectives for energy system flexibility and the EED provisions encouraging industrial process heat optimization.

POPKOMERS 1

ESM - I category (top priority)
ESM 01 Division of lighting systems into separate functional circuits and installation of movement/personnel presence sensors.
ESM 02 Solar installations for heating DHW (Domestic hot water).
ESM 03 Installation of ceiling slow-rotation fans in order to push the warmer air in the upper part of the heated halls to the lower part of the premises in order to set the heating devices (air conditioners) at a lower temperature and save electricity.

These operational measures are low-cost, high-impact interventions supporting the NECP's energy-efficiency obligations for industrial SMEs.

Technologies and Upgrades (e.g., heat recovery, monitoring system, PV)
The roadmap emphasizes integration of digital energy monitoring, process automation, and renewable energy technologies, supported by funding mechanisms under the Operational Program "Competitiveness and Innovations in Enterprises 2021-2027", the Modernization Fund, and the Energy Efficiency Obligation Scheme.

Core technology pathways include:

- Heat and cooling optimization: Adiabatic cooling, compressor heat recovery, improved radiator performance.
- Renewable energy systems: Solar PV and thermal systems for self-consumption, targeting a renewable share of 25 % by 2030 and 60 % by 2050.
- Automation and digitalisation: Smart metering and Building Management Systems (BMS) for real-time control.
- Electrification of irrigation and logistics: Substitution of diesel generators and vehicles with electric systems where feasible.

Planned investments by company
Beyond specific energy efficiency measures, companies have outlined additional investment plans that extend beyond direct energy savings, focusing on equipment modernization, automation, and operational efficiency improvements, such as ensuring reliable water supply for irrigation.

Planned investments by company

Company	Planned Investments
BATA 2002	Replacing old tractors with energy-efficient models (funding pending). Interested in joint tenders for PV panels and batteries.
Black Sea Gold	Secured funding for automation, installing 3 new robots. Considering adiabatic cooling for barrel storage. Expanding electricity monitoring.
POPKOMERS	Refining efficiency measures through internal audits. Plans to transition to solar heating for DHW and battery storage.

- Most measures are financed through internal company budgets, though Black Sea Gold has successfully obtained national grants and co-funding for several upgrades.
- Companies are exploring joint procurement for PV panels and battery systems to lower investment costs - an approach encouraged under NECP 2025 to stimulate decentralized energy generation.
- Investment planning generally follows a centralized decision model, with technical staff executing pre-approved plans. However, all three companies are integrating energy audits into annual investment cycles and remain open to co-financed opportunities under LIFE, Horizon Europe, and Modernization Fund schemes.
- Investment planning across the companies follows a centralized, top-down approach, where top management and owners are responsible for final decisions. The implementation process typically follows a structured, pre-approved sequence, with technical personnel carrying out assigned tasks.

Prioritized Investments identified:

- Battery storage for PV for e.g. powering irrigation systems
- Adiabatic cooling for wine storage (to maintain air humidity without chemical treatments)

Organizational changes (training, digitalization, logistics)

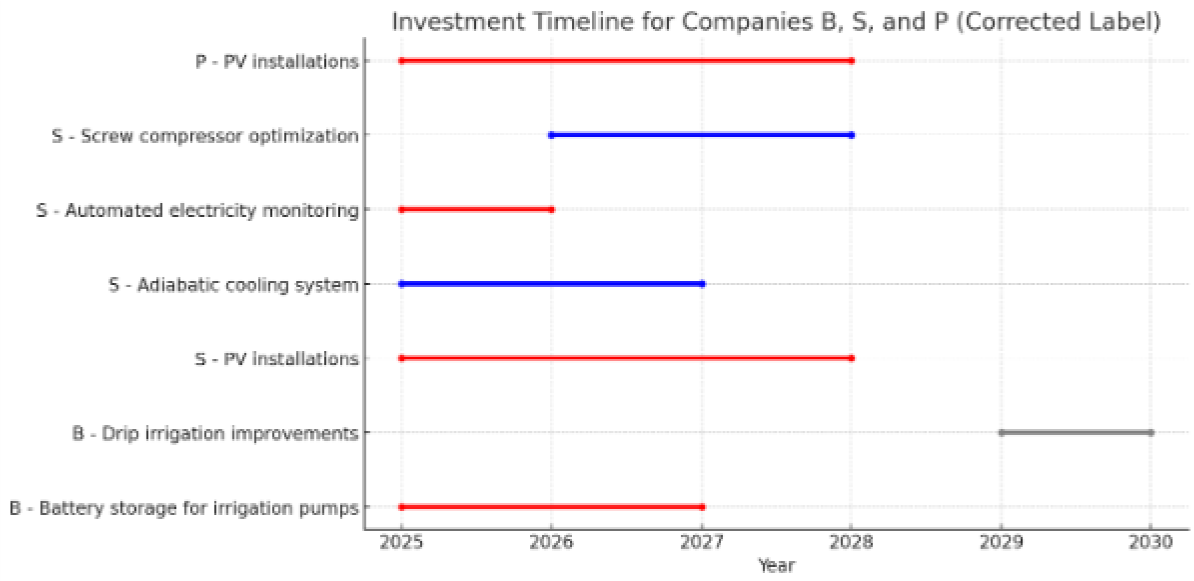
Black Sea Gold has been actively investing in modernization and automation, including robotic systems for improved efficiency and precision. Continuous training of engineering staff ensures effective operation and maintenance of new technologies.
Across the three companies:

- **Energy-responsible roles** are to be defined to track audit results and coordinate implementation.
- **Training** in energy monitoring and behavioural measures must be a priority.
- **Digitalisation** is expanding (for example, through smart meters).
- **Logistics optimization** at POPKOMERS includes route management and gradual fleet electrification (not including the truck fleet).

These initiatives contribute to compliance with the Energy Efficiency Directive's audit cycle and emerging CSRD reporting requirements on energy and emissions.

Timeline:
<u>Short-term scenario (2025-2030)</u>
<u>Readiness to implement measures.</u>

Investment measure	**Readiness level**	**Companies involved**	**Planned implementation**
Battery storage for irrigation pumps	High (priority identified)	BATA 2002 (B)	2025-2027
Use of batteries to accumulate electricity from solar photovoltaic systems and supply drilling irrigation pumps	High (priority identified)	BATA 2002 (B)	2025-2027
PV installations	Medium (awaiting regulatory clearance)	Black Sea Gold (S), POPKOMERS (P)	2025-2028
Adiabatic cooling system	Medium (low cost but lacking implementation capacity)	Black Sea Gold	2025-2027
Automated electricity monitoring	Medium (ongoing analysis)	Black Sea Gold	2025-2026
Screw compressor optimization	Low (initial analysis stage)	Black Sea Gold	2025+



Key short-term targets (aligned with NECP 2025):

- 10-15% energy-intensity reduction.
- 20-25% renewable share in electricity.
- Digital monitoring operational in all sites.

Key observations:

- Battery storage for irrigation pumps is a high-priority measure for BATA 2002, but implementation depends on financing.
- Solar PV expansion is hindered by regulatory delays, particularly due to cultural heritage site restrictions at Black Sea Gold.
- Adiabatic cooling was identified as a cost-effective opportunity at Black Sea Gold. While implementation is pending, the company is actively exploring timing and resource alignment for the measure.
- Automated electricity monitoring is under review, with Black Sea Gold actively analysing its feasibility.
- Screw compressor and irrigation system upgrades remain low priority, due to technical constraints and uncertain returns.
- Magnetic door control preventing energy loss from open warehouse doors (especially during smoking breaks).
- Behavioural soft measures interventions with ongoing staff training, remainders.

<u>Midterm (2030-2040)</u>

BATA 2002
Combining fertigation processes, underground irrigation, and drone-based crop management to reduce fuel use and optimize resource application.

BLACK SEA GOLD
Upgrading heating systems and introducing PV-powered process-water heating to further reduce fossil energy dependence.

POPKOMERS 1

Expanding automation (BMS), adiabatic cooling, static electricity-loss reduction, and solar water heating integration.

Long-term scenario 2050

BATA 2002
Full electrification of irrigation systems, new energy-efficient machinery, inverter-driven pumps, route optimization, and precision agriculture based on climate analysis.

BLACK SEA GOLD and POPKOMERS 1
Expansion of renewable generation to cover >60 % of consumption; integration of advanced heat-pump systems and electrified logistics.
Expected outcomes:

- 35-40 % total energy-efficiency improvement.
    - 60 % renewable share.
- Participation in regional **energy communities** and **bilateral green power agreements**.
- Fully circular use of organic residues through composting and mulching collaborations.

Actors & Responsibilities (companies, clusters, municipalities, ministries)
The Bulgarian wine sector involves several key actors with distinct but interconnected roles including:

- **Companies (Wine Producers)**: Wineries are the main drivers of the sector, responsible for grape cultivation, wine production, and market distribution. They invest in modern equipment, digitalization, and training to stay competitive while ensuring compliance with national and EU standards.
- **Clusters and Industry Associations**: These networks connect wineries, suppliers, and research institutions, supporting knowledge exchange and innovation. They also represent the industry's interests in policy discussions and help members access funding, export markets, and joint sustainability initiatives.
- **Municipalities:** Local authorities play a supportive role by providing infrastructure, facilitating permits, and assisting with seasonal workforce needs. They also encourage local sustainability efforts, such as renewable energy projects or circular economy practices, which benefit wine producers.
- **Ministries (National Government)**: Ministries of Agriculture, Economy, Environment, and Energy shape the regulatory framework for the sector. They manage grants and incentives, oversee compliance with EU directives, and develop long-term strategies to align wine production with sustainability and climate goals.

Synergies across the value chain (e.g., shared logistics, waste-to-energy)
The transport among the three companies is as follows: Grapes are collected from different BATA 2002 vineyards in the peak grape season (October - November (but no later than mid-December) and transported to Black Sea Gold. Wine from BSG makes its way to POPKOMERS 1 Warehouse in Burgas. Then, wine is distributed to businesses by the logistics company.

Black Sea has recently invested in advanced mulching equipment, enabling the company to process organic by-products from wine production more efficiently. Instead of being treated as waste, the mulched material is transported by BATA and reused in the vineyards as a natural soil enhancer. This collaboration creates a practical example of the circular economy in action: Black Sea significantly reduces its costs associated with waste disposal and avoids landfill contributions, while BATA benefits by producing an eco-friendly input for viticulture that substitutes chemical fertilizers. The approach not only lowers environmental impact but also promotes sustainable agriculture, improves soil health, and strengthens cooperation between companies within the wine sector. The described circular collaboration between Black Sea Gold and BATA 2002 exemplifies NECP-supported principles of resource efficiency and circular economy, demonstrating how sectoral waste reuse can contribute to national sustainability objectives.

Black Sea has evaluated the potential of waste-to-energy technologies but has decided not to pursue such investments at this stage. The main barrier is the high capital cost required for installation and operation, which cannot be justified given the company's seasonal production cycle. With peak activity concentrated between September and early December, the facility would remain underutilized for much of the year, making the project economically inefficient.

Financing Sources (EU funds, NECP, private investments)
Companies primarily rely on their own financial resources for investments. While Black Sea Gold has some experience in securing public funding, both BATA 2002 and Popkomers depend largely on internal financing. Although there is clear interest in accessing potential grant opportunities, the delays in national funding schemes and the complexity of application procedures create uncertainty and discourage broader participation. Instruments such as the Operational Programme for Innovation and Competitiveness (OPIC) and the State Agricultural Fund (SAF) provide relevant support mechanisms for modernization, energy efficiency, and agricultural development, yet the administrative burden and slow disbursement processes limit their effectiveness in addressing the immediate needs of wine producers.

Companies are exploring the possibilities to participate in joint procurement strategies for renewable energy installations (e.g., bulk purchasing of solar panels and batteries) to reduce investment costs. These investments align with Bulgaria's Energy Efficiency Obligation Scheme and are expected to be eligible for support under Operational Programme "Competitiveness and Innovations in Enterprises 2021-2027", the Modernization Fund, and EU calls supporting industrial decarbonization.

Policy Framework
Pursuant to the latest legislative developments in Bulgaria, the transposition of the Corporate Sustainability Reporting Directive (CSRD) is ongoing. The national draft law foresees its gradual application starting in 2026, following the European Commission's recent proposal to phase implementation and temporarily limit the scope to large undertakings with more than 1 000 employees and turnover exceeding EUR 50 million. As a result, only a small share of companies in Bulgaria's wine sector will fall directly under CSRD obligations in the initial phase.

Nevertheless, the reporting obligations under CSRD and the Corporate Sustainability Due Diligence Directive (CSDDD) will indirectly affect SMEs through value-chain requirements imposed by larger buyers and distributors. For the companies involved in EENOVA - BATA 2002, Black Sea Gold, and Popkomers - this means gradually adopting energy and environmental data collection systems and documenting decarbonization measures that can later support compliance.

At the same time, Bulgaria has transposed the Energy Efficiency Directive (EED 2023/1791) and Renewable Energy Directive (RED III 2023/2413) into national law through the Energy Efficiency Act (2023 amendments) and the Renewable Energy Act, which together introduce:

- mandatory energy audits for large enterprises and voluntary participation for SMEs,
- the establishment of energy efficiency obligation schemes,
- incentives for self-consumption and decentralized renewable generation, including solar PV, biomass, and biogas installations for agri-food producers.

Barriers*:*
The Bulgarian wine sector remains subject to significant administrative complexity, which affects both small and large producers. Delays in permitting and approval procedures, such as Black Sea Gold's experience with cultural-heritage assessments for its potential PV installation, exemplify persistent obstacles that can slow down renewable-energy deployment:

Licensing & Registration:
Licensing and registration requirements demand multiple interactions with the Ministry of Agriculture and the Executive Agency on Vine and Wine, covering vineyard registration, PDO/PGI certification, and production reporting. Compliance with EU quality-scheme and labelling rules adds another administrative layer.

Accessing Grants & Funding:
Accessing public funding (for instance through the State Fund Agriculture (SFA) or the Operational Programme "Innovation and Competitiveness" (OPIC) requires detailed applications, audits, and co-financing guarantees, which are challenging for SMEs without specialized administrative staff.

Sector Impact:
These bureaucratic demands slow innovation, raise transaction costs, and deter smaller companies from applying for grants. Digitalisation and one-stop-shop procedures for licensing and funding are therefore essential to accelerate sectoral modernization.

Enablers:
While Black Sea Gold has experience preparing and managing public-funded projects, BATA 2002 and Popkomers rely primarily on internal financing. All three companies are, however, open to EU and national funding opportunities under forthcoming Recovery and Resilience Plan (RRP) extensions, Horizon Europe, and LIFE calls.

The Modernization Fund and Innovation and Competitiveness Programme 2021-2027 explicitly support renewable-energy systems, electrification of production, digital energy monitoring, and circular-economy solutions - all relevant to the measures identified in EENOVA.

In terms of infrastructure, Black Sea Gold is investing at this moment in a Local Wastewater Treatment Plant (LWWTP), ensuring full compliance with both Bulgarian and EU environmental standards. BATA 2002 is exploring replacement of old agricultural machinery with high-efficiency models to reduce fuel consumption, while Popkomers is looking at installing solar thermal systems for domestic hot-water production and auxiliary battery storage.

At policy level, these actions align with NECP 2021-2030 priorities for industrial energy efficiency, renewable self-consumption, and agricultural decarbonization.

Policy proposals and gap analysis
Building on EENOVA findings, several targeted **policy improvements** are proposed to accelerate the energy transition of Bulgaria's wine and agri-food sector:

1. Climate-adaptation readiness
Extreme weather - droughts, heatwaves, and frosts - has increasingly affected grape yields, forcing some producers to import raw material.
Policy gap: No dedicated national programme for climate-resilient viticulture (e.g., irrigation modernization, drought-resistant varieties).

Recommendation: Introduce funding lines under the CAP Strategic Plan for climate-smart vineyards, advanced irrigation, and digital weather monitoring.

2. Market balance and resilience
Fluctuations in domestic supply led to dependence on imported grapes.
Policy gap: Absence of coordinated market mechanisms to balance production and demand.
Recommendation: Establish adaptive yield-management schemes and market-stabilization instruments consistent with CAP objectives.

3. Innovation and R&D support
Low investment in research and limited testing of energy-efficient or low-alcohol wine technologies.
Policy gap: Insufficient public incentives for applied R&D in sustainable neology.
Recommendation: Expand funding for pilot projects through different funding sources, including blended financing schemes.

4. Renewable-energy uptake
Adoption of PV, heat-pump, and waste-heat-recovery systems remains limited.
Policy gap: Investment costs and unclear permitting procedures for small producers.
Recommendation: Simplified connection rules for prosumers, and targeted support from the **Modernization Fund**.

5. Risk-management mechanisms.
Producers remain vulnerable to climate and market shocks.
Policy gap: Limited crop-insurance and emergency-support schemes.
Recommendation: Expand access to subsidized insurance and establish a **sectoral risk-management fund** for viticulture.

Impact Assessment
The key measures identified during the energy audits that have not yet been implemented include the following:

- **Estimated energy savings (MWh)**

BATA 2002

ESM - I category (top priority)	
ESM 01 Use of magnetic treatment of drilling water in order to reduce scale deposits in pumps and pipelines and reduce hydraulic resistances.	**122,812 kWh × 15% = 18,422 kWh/year** **Financial savings** 18,422 kWh/year × BGN 0.22/kWh = BGN 4,053
ESM 02 Reduction of water and electricity for irrigation by using moisture meters to measure soil moisture.	**122,812 kWh × 30% = 36,844 kWh/year** **Financial savings** 36,844 kWh/year × BGN 0.22/kWh = BGN 8,106
ESM 03 Automation of drip irrigation systems.	**730,705 kWh × 50% = 365,352 kWh/year** **Financial savings** 365,352 kWh/year × BGN 0.20/kWh (average fuel price) = BGN 73,070/year

BLACK SEA GOLD

ESM - I category (top priority)	
ESM 01: Adiabatic (evaporative) cooling and air purification in wine cellars	**Consumed electricity at a 0.5 operating coefficient of the chiller with a corresponding buffer tank for the cooled medium** 100 kWel × 4,600 hours/year × 0.5 = 230,000 kWh/year × 3 zones = = 690,000 kWh/year **Difference in electricity consumption (energy savings) when operating with adiabatic cooling versus the chiller:** Chillers 690,000 kWh/year - Adiabatic cooling 93,840 kWh/year = 596,160 kWh/year **Financial savings** 596,160 kWh/year × BGN 0.25/kWh = BGN 149,040/year
ESM 02: Utilization of waste heat from a screw compressor for compressed air	**Energy savings** Operating electric power of the compressor 22 kW × operating factor 0.6 × 10 hours/day × 22 days/month × 6 months = 17,424 kWh/year **Financial savings** 17,424 kWh/year × BGN 0.25/kWh = BGN 4,356/year
ESM 03: Optimizing the operation of a screw compressor for compressed air by lowering the temperature of the intake air through adiabatic cooling	**Difference in electricity consumption (energy savings) when operating with adiabatic cooling versus the chiller:** Chiller 230,000 kWh/year - Adiabatic cooling 31,280 kWh/year = 198,729 kWh/year **Financial savings** 198,720 kWh/year × BGN 0.25/kWh = BGN 49,680/year

POPKOMERS 1

ESM - I category (top priority)	
ESM 01 Division of lighting systems into separate functional circuits and installation of movement/personnel presence sensors.	**Energy savings** LED lighting fixtures 3.0 kW × 30% energy savings × 10 hours/day × 24 days/month × 12 months/year = 2,592 kWh/year **Financial savings** 2,592 kWh/year × BGN 0.30/kWh = BGN 778/year
ESM 02 Solar installations for heating DHW (Domestic hot water).	**Energy savings** 2 thermal solar systems × 3.0 kW × 0.7 utilization factor × 350 days/year = 1,470 kWh/year **Financial savings** 1,470 kWh/year × BGN 0.30/kWh = BGN 441/year
ESM 03 Installation of ceiling slow-rotation fans in order to push the warmer air in the upper part of the heated halls to the lower part of the premises in order to set the heating	**Energy savings** 9,216 kWh/year - 864 kWh/year = 8,352 kWh/year **Financial savings** 8,352 kWh/year × BGN 0.30/kWh = BGN 2,506/year

devices (air conditioners) at a lower temperature and save electricity.	

Throughout the implementation of EENOVA, the companies are actively implementing measures for which they secure co-financing through national programmes. These efforts primarily focus on replacing outdated equipment with more energy-efficient machinery. **One notable investment is the purchase of a nitrogen generator, which eliminates the need to transport nitrogen from Serbia.** This not only addresses logistical challenges but also makes the business more sustainable by reducing harmful emissions associated with long-distance transport, thereby contributing to a greener operational model. *(Quantification of the associated transport-related GHG reduction can only be assessed once annualized data are available)*.

Estimated GHG reductions (tCO_2e)
Applying Bulgaria's average grid emission factor of **0.31 tCO_2e/MWh**, derived from the 2023 EEA Greenhouse Gas Inventory and data in the updated **NECP 2021-2030 (Annex 1)**, the projected emission reductions are approximately:

- BATA 2002: 130 tCO_2e/year
- Black Sea Gold: 252 tCO_2e/year
- Popkomers: 4 tCO_2e/year

Together, these measures would avoid an estimated ~386 tCO_2e per year, contributing to Bulgaria's non-ETS emission-reduction commitments.

Innovation impact (e.g., new technologies, digitalization)
To address persistent labour shortages in the sector, companies are accelerating digitalisation and automation. *Black Sea Gold* is investing in advanced robotic systems to automate production and material handling, while *BATA 2002* is looking at digital irrigation monitoring systems. These innovations will reduce dependence on manual labour, enhance process consistency, and improve operational control. Over time, such digital solutions will allow remote energy monitoring and predictive maintenance - the key enablers of the smart, low-carbon winery of the future.

Socioeconomic benefits (e.g., local jobs, export potential)
Investments in modern, high-efficiency equipment will generate direct benefits for local employment, workforce upskilling, and rural economic stability. New machinery requires specialized training, leading to the professionalization of technical staff and fostering long-term retention. Increased process efficiency and sustainability also enhance the competitiveness of Bulgarian wines in export markets, supporting regional branding and value-chain resilience.

KPIs for monitoring:
The implementation and tracking of energy-efficiency measures will rely on the following indicators, aligned with Bulgaria's NECP (2025 update) and the Energy Efficiency Directive (2023/1791):

- Energy intensity (MWh per unit of output) - reduction by >5% over baseline.
- Renewable share in total consumption - target: >25 % by 2030 (consistent with NECP target of 27.09 %).
- Investment leverage ratio - private to public co-funding ≥ 2:1 (as per national grant schemes).
- Emission reduction progress - cumulative avoided emissions (tCO_2e/year, based on 0.31 tCO_2e/MWh).
- Cost-benefit efficiency - ≤ €250 per MWh saved or ≤ €100 per tCO_2 avoided (benchmark from EU funding criteria).

Together, these KPIs provide a robust framework for tracking progress towards both EENOVA objectives and Bulgaria's NECP targets.

Feasibility & Validation

Summary of stakeholder feedback from T4.3 workshops
During the third roundtable held under WP4, representatives of the three participating companies provided feedback on the feasibility of implementing the identified energy efficiency and renewable energy measures, as well as on broader operational challenges affecting their business continuity and competitiveness.

Across all three companies, the most prominent issue remains the **shortage of skilled and semi-skilled labour**.

- **Popkomers** faces a persistent lack of professional drivers with category C licenses, which has resulted in several transport vehicles remaining unused.
- **BATA 2002** must organize complex transport logistics to collect seasonal workers from neighbouring villages during harvest peaks.
- **Black Sea Gold** experiences increasing difficulty in retaining qualified technical personnel for production operations.

To address this, companies are exploring different mitigation strategies:

- Digitalisation and automation are seen as long-term solutions to optimize labour use.
- **Black Sea Gold** is actively assessing the integration of AI-assisted process control and robotic systems to reduce dependence on manual operations and enhance precision in bottling and cellar management.
- **BATA 2002** is investigating remote monitoring and precision-irrigation systems, while Popkomers is focusing on building-management systems (BMS) and automated lighting controls to reduce energy and labour demands.

Another recurring theme was the financial feasibility of the recommended measures. All companies expressed strong interest in co-financing opportunities from EU and national programmes (e.g. Modernization Fund, Innovation and Competitiveness OP 2021-2027, LIFE CET, and RRP calls), rather than relying solely on internal capital expenditures.

A concrete outcome already achieved concerns Popkomers, where the energy audit recommendations on solar-panel placement were implemented between the second and third roundtables. The company optimized its rooftop array configuration, leading to improved energy yield and reduced grid dependency.

Risks and mitigation strategies
During the third roundtable discussion, all three Bulgarian companies validated the practical feasibility of the proposed energy-efficiency and renewable-energy measures. As envisioned in the scenario, the main issues raised concerned workforce shortages, regulatory complexity, and access to financing.

Despite these constraints, all firms demonstrated clear commitment to modernization and confirmed that the measures identified through EENOVA's audits are realistic and aligned with their investment priorities.

Popkomers had already implemented one of the optimization measures from its energy audit (solar-panel repositioning), achieving improved system performance - a tangible example of scenario validation in practice.

Combined matrix below:

Risk / Challenge	Stakeholder Validation (Main Insights)	Mitigation Strategy	*Status* Black Sea Gold	*Status* Popkomers 1	*Status* BATA 2002	Overall scenario readiness
Sharp fluctuations in energy-resource prices	All three companies confirmed vulnerability to rising electricity and fuel costs.	Investment in high-efficiency equipment; exploring self-generation (PV, heat recovery, battery storage).	**Active**	**Planned**	**Planned**	**High**
Climate variability (droughts, heatwaves, frosts)	BATA 2002 and Black Sea Gold reported harvest losses; Popkomers less affected.	Adaptation through precision irrigation, fertigation, improved storage; occasional grape imports to secure continuity.	**Implemented**	-	**Planned**	**Medium-high**
Lack of qualified labour	Shortage of technicians and engineers across firms; automation is seen as critical.	Digitalisation, automation, and targeted upskilling programmes.	**Ongoing**	**Planned**	**Planned**	**Medium**
Lack of non-qualified / seasonal workforce	BATA 2002 and Popkomers struggle to recruit seasonal workers and drivers (C category).	Simplified mechanization and digitalisation of repetitive tasks; seasonal contracts; transport	-	**Ongoing**	**Implemented**	**Medium**

		support for workers.				
Limited access to external funding	All participants rely mainly on internal budgets; strong interest in EU and national schemes.	Use of external consultancy support for project applications; diversification of funding sources (Modernization Fund, Horizon Europe, LIFE).	**Active**	**Planned**	**Planned**	**Medium-high**
Seasonal nature of production	Production peaks reduce utilization of some RES systems.	Prioritizing scalable technologies (battery storage, shared PV, modular cooling).	**Planned**	**Planned**	**Planned**	**Medium**
Power-quality issues due to RES integration (harmonics, voltage fluctuations)		Installation of active harmonic filters, compensators, and power-quality monitoring systems to ensure stable operation of mixed AC/DC networks	Ongoing assessment (after PV expansion)	N/A	N/A	Medium

Scenario Visualization

Policy Maturity Map (policy support vs implementation readiness)

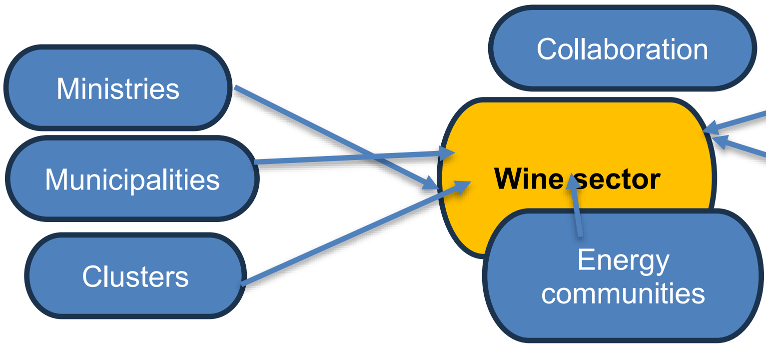
Policy Area	Maturity Level	Comments
Energy Efficiency and Renewable	**Developing / Emerging**	EU and national schemes provide solid funding potential, but administrative complexity and delayed

Energy Incentives		disbursements limit SME participation.
Labor and Workforce Development	**Ad hoc / Initial**	Persistent shortage of skilled technicians and seasonal labour; company-led automation and training initiatives are growing, but policy support for vocational upskilling in viticulture and food logistics remains limited.
Climate Adaptation and Resilience	**Developing / Emerging**	General adaptation strategies exist under the National Climate Adaptation Plan, yet there is no dedicated programme for climate-resilient vineyards; small wineries lack technical guidance and incentives for drought-resistant varieties or precision irrigation.
Infrastructure and Waste Management	**Developing / Emerging**	Local wastewater-treatment regulations are clear, but investment capacity is uneven. Circular-economy and waste-to-energy measures remain voluntary and under-incentivized.
Innovation and Digitalisation	**Ad hoc / Initial**	Early steps in automation (robotic equipment at Black Sea Gold) and digital irrigation control (BATA 2002) are promising; however, national policies for digital transition in agri-food industries are still fragmented.
Export and Market Development	**Mature / Consolidating**	Strong institutional support from the Executive Agency on Vine & Wine and the Ministry of Agriculture promotes export capacity and branding; these can serve as platforms to integrate sustainability performance metrics.

The map shows that Bulgaria's regulatory and financial framework is progressing, particularly in energy efficiency and export promotion. However, climate adaptation, labour capacity, and digital transformation require further policy maturation to ensure a resilient, low-carbon wine sector.

Synergy Map (visual collaborations across subsectors)
The synergy analysis identifies existing and potential cooperation between the three companies and complementary actors:

- **BATA 2002 → Black Sea Gold:** Supply of grapes and organic mulch material; potential joint procurement of PV and battery systems for shared use during harvest season.
- **Black Sea Gold → Popkomers 1:** Distribution of finished wine products via Popkomers' logistics network; potential joint procurement of PV and battery systems.
- **Cross-cutting synergies:**
    - Shared consultancy support for EU-funded project applications (Horizon Europe, LIFE).
    - Joint participation in regional circular-economy initiatives (reuse of by-products, wastewater valorisation).



Timeline milestones (2030, 2040, 2050)

Period	Key Milestones	Expected Outcomes
2025 - 2030 (Short-Term)	• Implementation of top-priority energy efficiency measures (PV systems, adiabatic cooling, automation of irrigation and monitoring). • Establishment of internal energy-management and monitoring systems across the three companies. • Launch of joint procurement discussions for renewable-energy equipment (PV panels, batteries). • Introduction of staff-training modules on energy management, safety, and digitalisation.	Tangible energy savings (>10% reduction in energy intensity) and approximately 386 tCO_2e/year avoided. Enhanced operational efficiency, cost control, and data readiness for future CSRD-aligned sustainability reporting.
2030 - 2040 (Mid-Term)	• Expansion of renewable-energy capacities, including battery storage and hybrid solar heating/cooling systems. • Gradual electrification of logistics, including pilot testing of electric vehicles for short-distance routes. • Broader uptake of precision agriculture (moisture sensors, fertigation) and AI-based process monitoring. • Integration of partial circular-economy measures (reuse of winery by-products for soil enhancement).	Renewable self-consumption reaching ≈40% of total electricity use, strengthened energy autonomy, and reduced grid dependency. Deeper emission cuts and improved resilience to climate and market variability.
2040 - 2050 (Long-Term)	• Strong decarbonization of on-site operations through renewable electricity and electrified transport where feasible. • Advanced circular valorisation of organic residues and by-products.	Integration into the regional circular economy, and complete alignment with Bulgaria's 2050 climate-neutrality objective and the EU Green Deal targets.

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	• Deployment of digital-twin systems and predictive maintenance for process and energy optimization.	

Clean Drinks 2050 - Net-Zero Water and Soft Drinks in Lithuania

Executive Summary

Lithuania's beverage value chain, represented by Birštonas Mineral Water, Akvavita, and Švenčionių Vaistažolės, faces rising energy prices, packaging circularity obligations, and export-related logistics challenges. This scenario sets a pathway to 2050 climate neutrality, anchored in the Lithuanian NECP (45% RES, -17% energy use, -21% ESR GHG by 2030). Short-term actions prioritize **solar PV roll-out** and **Building Management Systems (BMS)**. Mid-term measures focus on **heat electrification**, **circular packaging**, and **shared logistics**. By 2050, the sector will operate on **100% renewable electricity**, >70% renewable heat, closed-loop packaging, and decarbonized exports.

Contextual Foundation

Lithuania's beverage sector is a strategic part of the national agri-food value chain, producing water, soft drinks, and herbal beverages that supply both domestic and EU markets. The sector operates at the intersection of energy transition, packaging circularity, and export competitiveness, making it a critical testing ground for Lithuania's NECP and Green Deal objectives.

Market and value chain snapshot

- Subsector: Bottled water, soft drinks, and herbal teas an industry characterized by medium energy intensity, strong export orientation, and increasing sustainability requirements from EU retail chains.
- Exports: Mainly to Latvia, Poland, and Germany, representing more than one-third of total beverage output.
- Energy hotspots: Bottling and cooling (electricity), cleaning and sterilization (thermal energy), packaging production (PET/glass), and transport.
- Circularity context: Lithuania's Deposit Return System (DRS) already achieves >90% packaging collection, yet the limited supply and high price volatility of recycled PET (rPET) remain key barriers to achieving full circularity.
- Rising energy prices and tightening sustainability standards among export markets further pressure producers to modernize processes and strengthen energy management.

Company audit highlights and readiness (RT2)

Birštonas Mineral Water (BMW):

- BMS priority measure: ~67.9 MWh/yr savings; ROI ~ 3.4 years; CO_2 ↓ 28.5 t/yr.
- Boiler replacement: moderate priority; ROI ~ 3.3 years; CO_2 ↓ 3.7 t/yr.
- Waste-heat recovery: technically feasible but currently low ROI.

Akvavita:

- 415 kWp PV system underway, saving ~476 MWh/yr and 71.4 t CO_2/yr (ROI ~ 4.7 years).
- BMS: high priority; 67.7 MWh/yr savings (ROI ~ 1.9 years).
- Low priority for boiler replacement or WHR due to high CAPEX.

Švenčionių Vaistažolės:

- PV expansion (+70 kW) saves ~70 MWh/yr; ROI ~ 5.9 years; CO_2 ↓ 10.5 t/yr.
- Battery storage considered long-term, conditional on subsidies.

Collectively, the audits confirm that digitalisation and on-site renewables deliver the fastest returns, while heat electrification and packaging redesign remain medium- to long-term priorities.

Barriers and Enablers

- Barriers: High upfront CAPEX, ROI uncertainty due to energy-price volatility, complex permitting for PV systems, and lack of real-time energy data to validate savings. Cultural conservatism and limited in-house technical staff further slow adoption.
- Enablers: Established DRS infrastructure, government commitment to expand renewable capacity, and access to the Lithuanian National Energy Efficiency Fund, CAP eco-schemes, and EU programmes such as LIFE and InvestEU. AgriFood Lithuania DIH and sectoral clusters serve as intermediaries connecting companies with these instruments, providing both technical advice and coordination for collective investment.

Policy Alignment and Strategic Context

Lithuania's National Energy and Climate Plan (NECP 2030) targets 45 % renewable energy, -17 % final-energy consumption, and -21 % non-ETS GHG emissions by 2030. These goals are fully consistent with the EU Fit for 55 package and the Energy Efficiency Directive (EED 2023/1791), which mandates continuous efficiency improvement and auditing. The Renewable Energy Directive (RED III 2023/2413) provides a framework for renewable self-consumption and energy communities, while the Circular Economy Action Plan (CEAP) and CSRD/ESRS impose stronger requirements on packaging circularity and sustainability reporting.

Within this framework, the Lithuanian beverage industry is both a compliance sector and an innovation test bed-able to demonstrate how small and medium producers can align operational realities with EU-level decarbonisation, digitalisation, and circular-economy goals.

The contextual analysis shows a sector ready for transition: high motivation, proven technical feasibility, but persistent financing and administrative barriers. The combination of digital energy management, renewable self-consumption, and circular packaging measures provides a credible route to climate neutrality by 2050 while strengthening Lithuania's export competitiveness and branding as a "green beverage hub" in the Baltic region.

Roadmap goals and objectives

Overall goal (2050):

Achieve climate-neutral beverage production and logistics in Lithuania through 100 % renewable electricity, at least 60-70 % renewable heat, fully circular packaging within the national DRS system, and competitive low-carbon exports that strengthen Lithuania's reputation as a green beverage hub in the Baltic region.

2030 targets (short term):

- Reduce total energy intensity by 10-15 % versus 2024 baselines across Birštonas Mineral Water, Akvavita, and Švenčionių Vaistažolės.
- Reach 30-40 % renewable-electricity share through PV self-consumption and long-term green-power contracts.
- Deploy BMS/EMS and advanced metering at all sites to ensure real-time control, follow-up of audit results, and readiness for CSRD/ESRS-light reporting.
- Increase rPET content to ≥30 % (in line with EU packaging targets) and continue reducing

average bottle weight where technically feasible.
- Pilot shared logistics and joint PV procurement coordinated by AgriFood Lithuania DIH to demonstrate cost-effective collaboration.

2040 milestones (mid term):
- Achieve ≥80 % renewable electricity and ≈40 % renewable heat through wider uptake of heat pumps and renewable thermal networks.
- Digitalise operations end-to-end: predictive maintenance, sector-level KPI dashboards, and AI-supported logistics optimisation.
- Close the packaging loop: all PET bottles sourced from certified Lithuanian or regional rPET suppliers; integration of reusable or lightweight glass for premium lines.
- Convert ≥50 % of domestic distribution to low- or zero-emission transport (EV fleets or rail, depending on route economics).

2050 outcomes (long term):
- Full climate neutrality with 100 % renewable electricity and >60-70 % renewable heat, circular packaging, and near-zero-emission logistics.
- Automated Scope 1-3 data management enabling verified CSRD/ESRS reporting and continuous access to sustainable-finance instruments.
- A resilient beverage industry recognised for its digital efficiency, brand transparency, and export sustainability credentials.

Operational objectives:
- Efficiency and digitalisation: integrate BMS/EMS, track performance via KPI dashboards (kWh/litre, CO_2/pallet-km, rPET %), and link data to CSRD reporting.
- Renewables and storage: scale rooftop PV, explore shared storage through a Clean Drinks Energy Cooperative, and connect to green-power PPAs.
- Circularity: secure long-term rPET supply contracts, co-invest in local recycling capacity, and test reusable-packaging pilots through DRS partnerships.
- Logistics: expand co-loading between beverage and herbal-tea producers, introduce smart-routing tools and EV charging at key depots.
- Financing and collaboration: blend the National Energy Efficiency Fund, LIFE, InvestEU, and green loans, use cluster-level joint procurement to lower unit CAPEX by 10-20 %.
- Responsibilities: companies implement site level upgrades, AgriFood Lithuania DIH coordinates joint projects and data tools, the Lithuanian Energy Agency fast-tracks PV and BMS voucher schemes, ministries align incentives under NECP, CEAP, and CSRD to support long-term competitiveness.

Operational Roadmap

The Clean Drinks 2050 roadmap translates company level audit results and stakeholder feedback into an actionable sequence of measures designed to achieve climate neutrality by 2050.
It defines what needs to be done, who implements each step, and how these actions will be financed and coordinated across the beverage value chain.

Timeline:

Short-term actions (2025-2030) - Building the foundation

What:

- Deploy energy-monitoring and management systems (BMS/EMS) across all three companies to ensure real-time visibility of electricity and heat use.
- Commission rooftop PV systems for self-consumption (415 kWp at Akvavita, +70 kW at Švenčionių Vaistažolės, and expansion plans for BMW).
- Optimize existing boilers, install meters on thermal systems, and introduce smart sensors to monitor process water, cooling, and sterilization cycles.
- Pilot joint logistics between Akvavita and Švenčionių Vaistažolės by combining deliveries of bottled water and herbal teas, reducing fuel costs and CO_2 emissions.
- Launch a shared Clean Drinks KPI Dashboard (kWh/litre, CO_2/pallet-km, % rPET) for benchmarking and CSRD reporting preparation.

Who:

- Companies implement site-level measures and data collection.
- AgriFood Lithuania DIH provides digital templates, connects suppliers, and facilitates the KPI dashboard setup.
- Lithuanian Energy Agency administers BMS voucher and PV support schemes.
- Cluster partners (Smart Food, Packaging Cluster) coordinate joint logistics pilot and awareness training for SMEs.

How:

- Funded by internal CAPEX and National Energy Efficiency Fund co-financing.
- Supported by EU LIFE/InvestEU grants for digitalisation and small-scale renewable integration.
- Technical implementation through Lithuanian technology suppliers and ESCO partners.
- Skills developed via DIH-led training on digital tools, energy management, and sustainability reporting.

Expected results by 2030:

- 10-15% energy-intensity reduction.
- 30-40% renewable-electricity share.
- BMS installed at 100% of production sites.
- Common KPI and data baseline for CSRD/ESRS readiness.

Mid-term actions (2030-2040) - Scaling efficiency and circularity

What:

- Electrify thermal energy uses (hot water, washing, sterilisation) with industrial heat pumps where feasible.
- Expand PV installations and integrate shared storage or energy-sharing through a Clean Drinks Cooperative PPA**.**
- Implement process automation and predictive maintenance systems for compressors, cooling, and bottling lines.
- Redesign packaging to increase rPET share to ≥50% and reduce bottle weight; expand partnerships with DRS operators and recyclers.
- Digitalise logistics through route optimisation software and EV pilot fleets for local deliveries.

- Establish an industry-wide Energy and Circularity Data Platform, linking company dashboards into a national aggregation tool.

Who:
- Companies deploy heat pumps, manage automation upgrades, and redesign packaging with suppliers.
- AgriFood Lithuania DIH and clusters manage shared PPA and storage projects, connect recyclers and logistics innovators.
- Government agencies (Energy, Economy, Environment) integrate beverage-sector measures into NECP implementation and CSRD capacity-building programmes.
- Universities and R&D partners provide LCA modelling, packaging safety testing, and logistics optimisation analytics.

How:
- Blended finance combining EU Competitiveness Fund, other EU schemes and commercial green loans.
- Technical support from ESCOs for shared PV-storage projects and advisory funding under LIFE CET.
- Cluster-based procurement to reduce unit investment costs by 10-20%.
- DIH coordinated pilot projects to validate economic viability and collect standardised KPI data.

Expected results by 2040:
- ≥80% renewable electricity and ≈40% renewable heat across the value chain.
- Digital process control in all plants.
- Shared logistics models covering at least 50% of domestic transport.
- All bottles and packaging within verified circular loops through DRS integration.

Long-term actions (2040-2050) - Achieving full climate neutrality

What:
- Reach full electrification of energy use, covering 100% of electricity and 60-70% of process heat from renewable sources (PV, PPA, green grid supply).
- Expand renewable-powered logistics hubs, integrating EV and rail-based export routes to Poland and Germany.
- Fully automate sustainability data reporting, linking Scope 1-3 emissions, energy use, and circularity KPIs with national CSRD platforms.
- Establish local R&D partnerships for packaging innovation, including bio-based and reusable materials for niche product lines.
- Strengthen Lithuania's beverage industry branding as **"**Clean Drinks - Baltic Green Exporters**."**

Who:
- Companies sustain operations under full CSRD/ESRS compliance, run zero-emission fleets, and manage renewable infrastructure.
- AgriFood Lithuania DIH maintain the national Clean Drinks cooperative, provide digital data infrastructure, and coordinate export branding.
- National Ministries and Agencies ensure supportive regulation and maintain predictable long-term subsidy schemes for renewables and circular innovation.

- Private investors participate in green-finance instruments, supporting expansion of renewable capacity and logistics decarbonisation.

How:
- Long-term PPAs and joint storage networks ensure stable renewable energy costs.
- Continued access to green loans and sustainability-linked bonds for SMEs.
- Cluster and DIH act as institutional intermediaries for CSRD verification and ESG data assurance.
- Strong public-private cooperation guarantees consistency with NECP updates and EU Green Deal 2050 targets.

Expected results by 2050:
- Climate-neutral beverage sector: 100% renewable electricity, >60-70% renewable heat.
- Fully circular packaging within Lithuania's DRS and regional recycling systems.
- Near-zero-emission logistics with digital, transparent carbon accounting.
- Sector recognised as a benchmark for digitalised circular manufacturing in the Baltic region.

Policy Framework

Context: EU Fit for 55 (EED, RED, CEAP, CSRD), Lithuanian NECP targets (45% RES, -17% energy use, -21% ESR GHG by 2030).
This scenario operationalises those targets for beverages by prioritising on-site PV, digital energy management, heat electrification, circular packaging, and low-carbon logistics, with CSRD/ESRS light data readiness embedded from 2025.

Barriers: CAPEX costs, ROI uncertainty, grid limits for PV, bureaucratic permitting, lack of CSRD-readiness.
Additional pain points raised at RT sessions: uneven DSO interconnection timelines for rooftop PV, fragmented SME access to advisory for BMS/EMS and CSRD, rPET price/availability volatility impacting packaging targets, limited depot charging for EV logistics.

Enablers: Lithuanian National Energy Efficiency Fund, CAP eco-schemes, LIFE, InvestEU, DRS for packaging.
Practical enablers for this sector: AgriFood Lithuania DIH and clusters (Smart Food, packaging networks) to run joint procurement and shared data tools, Lithuanian Energy Agency to administer BMS vouchers and PV fast-track, potential cooperative PPAs for green power and shared storage hubs at logistics depots.

Policy Proposals (what / who / how):
- Fast-track PV permits and SME BMS vouchers.
  Who: Ministry of Energy, Lithuanian Energy Agency, DSOs.
  How: 30-day rooftop PV "light permit" for ≤500 kW; standardised interconnection queue; €5-10k BMS/EMS vouchers per site tied to audited KPI reporting (kWh/litre).
- SME-friendly CSRD templates & technical support.
  Who: Ministry of Economy and Innovation, DIH/EDIH network.
  How: sector-specific ESRS-light templates, helpdesk hours, and a shared Clean Drinks KPI Dashboard (kWh/litre, CO_2/pallet-km, rPET%).
- Incentives for logistics decarbonisation and packaging redesign.

Who: Ministries of Transport and Environment, DRS operator.
How: capex co-funding for depot chargers and route-optimisation software; rail-freight support on export corridors (PL/DE); eco-modulation of EPR fees rewarding ≥30% rPET and lightweighting; pilots for returnable glass on selected SKUs.

- Cluster level cascade financing for joint PV parks and shared storage.
  Who: AgriFood Lithuania DIH, clusters, municipalities.
  How: create a Clean Drinks Energy Cooperative to aggregate demand, use InvestEU/Modernisation Fund, green loans; DSCR-based facility where PPAs secure revenues; site shared BESS at logistics nodes.

2025-2030 priority actions: PV fast-track; BMS vouchers; CSRD templates/helpdesk; depot-charging pilots; rPET supply MOUs; cooperative PPA set-up.

2030-2040 scaling: heat-pump incentives for DHW/process heat; rail/EV logistics expansion; recyclable/reusable packaging schemes; sector data platform integration with national CSRD systems.

Governance and roles:

- Companies implement site upgrades and data reporting.
- AgriFood Lithuania DIH / clusters: joint tenders, shared data tools, pilot coordination.
- Lithuanian Energy Agency: vouchers, PV fast-track guidance, monitoring.
- Ministries (Energy, Economy/Innovation, Environment, Transport): funding windows, permitting simplification, DRS/EPR alignment, rail incentives.
- DSOs/municipalities: grid capacity planning, depot charging, siting for shared storage.

Monitoring (policy KPIs):

- Rooftop PV lead time ≤30 days;
- ≥90% BMS uptake by 2030;
- ≥30% rPET by 2030;
- ≥50% low-/zero-emission domestic deliveries by 2040;
- sector RES-electricity share ≥30-40% (2030) and ≥80% (2040).

Impact Assessment

Method & assumptions

- Impacts are calculated from RT2 audit figures and RT3 validations, focusing on BMS/EMS deployment, PV self-consumption, boiler/thermal optimization, and joint logistics pilots.
- For consolidated GHG estimates, a standard grid emission factor of ~0.21 tCO_2/MWh is applied for Lithuania to ensure consistent reporting across companies and years. Company-specific factors reported in audits may differ slightly; the consolidated figure is used for project reporting.

Short-term impacts (2025-2030)

Energy savings (electricity)

- Birštonas Mineral Water (BMW): ~68 MWh/yr (BMS + metering).
- Akvavita: ~544 MWh/yr (415 kWp PV + BMS).

- Švenčionių Vaistažolės: ~70 MWh/yr (PV expansion + EMS-lite).

Total electricity savings: ~680 MWh/yr**.**

GHG reductions (consolidated)
- Using 0.21 tCO_2/MWh to ~142 tCO_2/yr avoided across the three sites.

Operational and circular benefits
- BMS/EMS across all sites enables real-time control, stabilises baselines, and closes audit follow-up gaps.
- Packaging: rPET share increases toward ≥30% by 2030 with lightweighting of selected SKUs (exact % by SKU to be tracked); improves CEAP alignment and reduces virgin resin demand.
- Logistics**:** co-loading (herbal teas and bottled drinks) and route optimisation pilots target ~5-10% fuel savings on participating routes, depot-charging pilots prepared for 2030+.

Mid-term impacts (2030-2040)
- Renewables**:** ≥80% renewable electricity**,** ~40% renewable heat via heat pumps for DHW/process washing where feasible; wider PV and shared storage via a Clean Drinks cooperative PPA.
- Digitalisation**:** predictive maintenance and sector-level KPI dashboards reduce unplanned downtime, improve energy productivity, and support ESRS-light reporting.
- Circularity**:** rPET content ≥50% on core PET lines (subject to supply contracts); DRS integration and design-for-recycling reduce material losses.
- Logistics**:** ≥50% domestic distribution on low/zero-emission modes (EV/rail/biofuels depending on route economics).

Long-term impacts (2040-2050)
- Climate neutrality**:** 100% renewable electricity and >60-70% renewable heat, residual emissions offset only where technically unavoidable.
- Fully circular packaging**:** closed-loop rPET and selected returnable glass lines; traceable material flows with verified recyclate content.
- Near-zero-emission exports: EV/rail corridors toward PL/DE; renewable-powered logistics hubs at depots.

Innovation impact
- Data-driven operations (BMS/EMS, predictive maintenance, digital twins pilots) enable continuous optimisation and verifiable Scope 1-3 accounting.
- Process & product innovation: heat-electrification, low-temperature sanitation, lightweighting, label/cap standardisation for DRS performance.
- System innovation**:** cooperative PPAs, shared storage, and cluster-brokered logistics reduce unit costs and risk for SMEs.

Socioeconomic impact
- Cost competitiveness from lower energy intensity and self-generation; improved resilience to price volatility.
- Skills and jobs in digital energy management, maintenance, and circular packaging.
- Export branding as “Green Lithuanian Drinks**”** strengthens access to EU retail buyers with sustainability criteria.

Risks and sensitivities (and mitigations)

- CAPEX/ROI uncertainty: blended finance (National Energy Efficiency Fund, LIFE, InvestEU) and PPAs to stabilise cash flows.
- Grid/permits bottlenecks: PV fast-track and DSO queue standardisation, staged storage.
- rPET price/availability: supply MOUs, regional sourcing, and design-for-recycling standards.
- SME capacity for CSRD: sector templates, helpdesk hours, and a shared KPI dashboard.

Monitoring framework (KPIs & cadence)

- Energy intensity (kWh/litre) 10-15% by 2030 from 2024 baseline.
- RES-electricity share (%) 30-40% by 2030, ≥80% by 2040.
- Renewable heat share (%) ~40% by 2040, >60-70% by 2050.
- GHG (tCO_2e/yr) - consolidated reporting using standard factor; site-specific factors recorded in annex.
- Packaging circularity: rPET content (%), lightweighting (g/bottle), DRS return rate (%).
- Logistics: CO_2/pallet-km; % domestic km on low/zero-emission modes.
- Data maturity: % sites with BMS/EMS; % SKUs with verified recyclate content; CSRD readiness index.
- Monitoring: quarterly site dashboards, semi-annual cluster review; annual data consolidation for policy dialogue.

Feasibility & Validation

The Lithuanian beverage scenario was validated through a series of stakeholder consultations and the third roundtable, involving various stakeholders and external experts.

Validation followed a structured WP4 approach: companies reviewed the technical feasibility of proposed measures, while policymakers and experts assessed regulatory coherence, financing availability, and scalability within the NECP framework.

Key validation outcomes:

- PV and BMS implementation were confirmed as the most realistic and already funded short-term priorities. These measures offer clear payback, energy savings, and CSRD-readiness benefits.
- Boiler replacement and waste-heat recovery were recognised as technically feasible but only viable with dedicated subsidies or cooperative funding due to long payback periods.
- Logistics co-loading was seen as operationally possible and environmentally beneficial, but dependent on packaging redesign and coordinated scheduling among producers.

Risks identified:

- Energy price volatility affecting ROI calculations.
- Grid constraints limiting new PV interconnections and storage options.
- Weak SME access to long-term financing, especially for high-CAPEX measures like heat pumps or logistics electrification.
- Administrative bottlenecks related to PV permitting and limited advisory capacity for CSRD reporting.

Mitigation strategies:

- Adoption of blended finance instruments (EU grants, national green loans) to stabilise investment risk.

- Fast-tracking PV permitting and creating a clear, centralised interconnection queue for industrial sites.
- Targeted packaging support and rPET supply agreements through national DRS operators to ensure circularity goals remain achievable.
- Cluster brokered Power Purchase Agreements (PPAs) and shared PV/storage projects to reduce CAPEX and secure predictable renewable energy supply.

Overall conclusion:
The validation confirmed that the Clean Drinks 2050 scenario is both technically feasible and strategically relevant for Lithuania's beverage sector. Short-term measures (PV, BMS) are ready for immediate deployment, while medium-term actions (heat electrification, logistics optimisation, packaging circularity) require stronger financing and regulatory support. Stakeholders demonstrated high commitment to collaboration under the coordination of AgriFood Lithuania DIH, making the Lithuanian roadmap a credible and scalable model for achieving climate neutrality by 2050.

Energy Transition Baseline Scenario 2030 - Romanian Meat Sector

Executive Summary

This scenario represents the **baseline energy transition pathway for the Romanian meat value chain** (Agro Cosm Fan, Carna Carpatica, Moldovan Carmangerie) up to 2030. It is grounded in measures that companies themselves confirmed as **feasible and desirable** during the 2nd Roundtable and validated during the 3rd Roundtable.

The focus is on **practical, small and medium-scale interventions** with short payback times: installation of photovoltaic (PV) systems for self-consumption, modernization of lighting through LED technology, reactive power compensation, and basic logistics optimization. While modest compared to long-term decarbonisation ambitions, these measures form the **foundation of the transition**, delivering tangible cost savings, moderate CO_2 reductions, and early alignment with **EU and national climate and energy targets**.

Contextual Foundation

The Romanian meat value chain represented in the EENOVA project (Agro Cosm Fan, Carna Carpatica, Moldovan Carmangerie) is characterized by high energy consumption in processing facilities and significant fuel use in logistics.

- **Agro Cosm Fan** (livestock production & raw meat): already installed PV for self- consumption, identified opportunities for additional PV (85 kWp), heat pumps for space heating, and reactive power compensation.
- **Carna Carpatica** (processing): audit identified PV installations (12-164 kWp across multiple sites), LED modernization, heat pumps for hot water and space heating, and trigeneration potential. Company prioritized PV and LED measures, while larger CAPEX solutions remain long-term options.
- **Moldovan Carmangerie** (distribution & retail): energy consumption dominated by refrigeration and logistics. Audit identified PV potential, trigeneration, and heat pumps, while roundtable discussions highlighted willingness to adopt route optimization and gradual EV fleet renewal.

Common company priorities (from RT2 action plan):

- Immediate implementation of PV, LED modernization, reactive power compensation.
- Logistics efficiency measures (route optimization, load consolidation, pilot EV vans).
- Larger investments (biogas, trigeneration, BEMS) postponed due to cost and complexity.

Regional snapshot

Market maturity

The Romanian meat sector is among the most important agri-food subsectors, representing ~20% of national agricultural output and ~4% of GDP. It is a mature market in terms of production capacity and export volumes (~200,000 tons/year), but still in an early phase regarding energy transition and circular economy practices.

Infrastructure

Facilities are functional but energy-intensive, relying on conventional boilers, refrigeration, and fossil-based logistics fleets. Cold chain infrastructure is well established but not yet optimized for energy efficiency. PV adoption is emerging, with small-to-medium installations (<200 kWp) in planning.

Energy dependency
Strong reliance on **natural gas** for processing (abattoirs, cold rooms, hot water production) and **diesel** for logistics (annual consumption exceeding 200,000 litres across the value chain). Electricity demand is growing, especially due to refrigeration. Current renewable share in company consumption is below 5%.

Regulatory environment

- **EU Fit for 55 and national NECP targets**: Romania committed to 55.8% renewable electricity by 2030 and -12.7% reduction of non-ETS emissions.
- **Law 121/2014**: mandatory energy audits every 4 years for large enterprises.
- **Law 123/2012**: guarantees grid access for PV prosumers.
- **Funding mechanisms**: PNRR (€1.6 bn for RES & EE), Modernisation Fund, PODD, AFIR
- grants.
- **CSRD obligations**: Moldovan Carmangerie is likely to fall under scope in 2025-2026, indirectly impacting suppliers.

Subsector focus
While the food sector is diverse this scenario focuses on meat production, processing, and distribution, which are energy-intensive subsectors with high reliance on fossil fuels and cold chain logistics.

Roadmap goals and objectives

Overall goal:
To establish a practical and replicable foundation for Romania's meat-processing sector to begin its energy transition reducing costs, improving efficiency, and preparing companies for deeper decarbonisation after 2030 and in the long run until 2050.

Short-term objectives (2025-2030):

- Cut total energy consumption by 10-15 % through proven, low-capex measures (PV self-consumption, LED modernisation, reactive-power correction).
- Achieve 20-25 % renewable-electricity share across the value chain using small-scale PV (<200 kWp) and simplified prosumer schemes.
- Improve logistics efficiency by 5-10 % fuel savings through route optimisation, load consolidation, and pilot EV delivery vans.
- Strengthen internal energy-management capacity via cluster-led training and shared advisory services.
- Ensure compliance with EED audit obligations and prepare large firms for CSRD/ESG reporting.

Mid-term objectives (2030-2040):

- Scale renewable capacity and integrate heat pumps and energy-storage pilots.
- Introduce basic energy-management systems (BEMS/EMS) for continuous monitoring and reporting.
- Develop cluster-level procurement and joint-logistics hubs to lower costs and expand low-emission transport coverage.
- Pilot circular-economy measures, such as by-product valorisation and packaging optimisation.

Long-term objectives (2040-2050):

- Reach 70-80 % renewable-energy share (electricity, heat) through PV, biogas, and cooperative PPAs.
- Complete logistics electrification and expand rail or alternative-fuel transport.
- Implement full digital monitoring and verified CSRD/ESRS reporting.
- Achieve near-zero-emission meat-processing operations and recognised alignment with Romania's NECP and EU climate-neutrality targets.

Operational Roadmap

Measures prioritized by companies:

- Photovoltaics for self-consumption
  - Agro Cosm Fan: 85 kWp PV
  - Carna Carpatica: PV systems between 12-164 kWp across multiple sites
  - Moldovan Carmangerie: PV pilot under discussion
- LED modernization and reactive power compensation
- Logistics optimization: route optimization, load consolidation
- Pilot use of EV vans for urban deliveries (Moldovan Carmangerie)

Investment estimates and ROI:

- PV: €20,000-120,000/site (payback 3-4 years)
- LED & reactive power: €5,000-15,000/site (payback <2 years)
- Logistics improvements: organizational (software, training, low CAPEX)

Timeline:

Short-term (2025-2030)
Implement quick-win efficiency measures: install PV for self-consumption, modernise lighting (LED), apply reactive power compensation, and optimise logistics routes (5-10% fuel savings). Pilot EV vans for local deliveries and train staff in energy management.
Result: ~1,550 MWh/year energy saved, ~310 t CO_2 avoided, 20-25% renewable electricity share.

Mid-term (2030-2040)
Scale renewables and digitalisation: expand PV and introduce heat pumps, basic BEMS/EMS, and energy storage pilots. Strengthen cluster cooperation for joint procurement and low-emission logistics hubs.
Result: ≥40% renewable electricity, ~25% renewable heat, >500 t CO_2 reduction vs 2025.

Long-term (2040-2050)
Achieve circular, low-carbon operations: 70-80% renewable energy, electrified logistics, by-product valorisation (biogas/feed), and full digital monitoring under CSRD/ESRS.
Result: Near-zero-emission meat processing and logistics, full circularity, recognised national benchmark for sustainable agri-food transition.

Actors and Responsibilities
In the Baseline 2030 scenario, the responsibility for implementation lies primarily with the companies in the meat value chain - Agro Cosm Fan, Carna Carpatica and Moldovan Carmangerie - which act as the direct implementers of photovoltaic systems, LED modernisation, reactive power compensation and logistics optimisation. Their role is not only to reduce their own energy consumption but also to

provide evidence of feasibility for similar agri-food SMEs across Romania.

The AgroTransilvania Cluster plays a pivotal role as facilitator and coordinator. It can aggregate demand for equipment and services, organise training sessions for company staff, and act as an intermediary with funding bodies and national authorities. The cluster ensures that actions taken at company level are consistent with regional development strategies and can be replicated along the value chain.

Technical service providers, including auditors and ESCOs, provide expertise in designing, implementing and monitoring measures. Their responsibility is to ensure that investments deliver the expected savings and comply with the Energy Efficiency Directive (EED).

Local authorities contribute by enabling infrastructure and removing administrative barriers. They can simplify permitting for rooftop PV installations, support the integration of energy efficiency measures in local climate and energy plans, and facilitate the development of EV charging infrastructure that supports pilot electrification of logistics.

At national level, the Ministries of Energy and Agriculture are responsible for ensuring access to funding streams such as PNRR, the Modernisation Fund and PODD, while also clarifying the regulatory framework for prosumers and ensuring that company-level actions are recognised in Romania's NECP targets.

Synergies across the value chain

Although baseline measures are primarily implemented at company level, the roundtable confirmed several synergies that can amplify impact when coordinated across the value chain. Joint optimisation of logistics, for example, can reduce diesel consumption by consolidating routes and coordinating deliveries between processors and distributors. Similarly, joint procurement of PV systems and LED equipment through the cluster can lower investment costs and secure better service conditions for all companies.

Capacity building is another area where collaboration creates added value. Instead of each company hiring external consultants, the cluster can organise shared training sessions for energy managers, ensuring consistent expertise across the chain. Data sharing on energy consumption and logistics patterns also enables better synchronisation of production and distribution, reducing inefficiencies that currently increase both costs and emissions.

Such synergies reinforce the idea that efficiency gains are not limited to individual facilities but can be scaled up across the value chain, multiplying both economic and environmental benefits.

Financing Sources

The baseline measures are characterised by moderate CAPEX and short payback times, which makes them attractive for both public and private financing. Several funding sources are directly relevant:

- PNRR (National Recovery and Resilience Plan): grants for renewable energy and energy efficiency, particularly suitable for PV installations and pilot EV fleets.
- Modernisation Fund: financing for renewable energy integration and grid improvements, relevant for processors and distributors with higher consumption levels.
- PODD (Operational Programme for Sustainable Development): SME-focused support for LED

modernisation, reactive power compensation and small-scale renewables.

- AFIR (Rural Development Programme): tailored to primary producers such as Agro Cosm Fan, financing efficiency upgrades in livestock and farming operations.
- Private finance: commercial banks can provide loans or leasing schemes for short ROI measures. Access to green credit lines is facilitated when companies demonstrate compliance with EU efficiency directives.
- Cluster-supported aggregation: the cluster can act as a platform for joint applications, increasing the chances of approval and ensuring that SMEs with limited administrative capacity can still benefit from funding.

In this way, financing for the baseline scenario reflects a blend of EU structural funds, national programmes, and private investment, ensuring both accessibility and replicability.

Policy Framework

Relevant EU & national policies:

- EED (Energy Efficiency Directive): supports efficiency measures already identified through audits.
- RED III (Renewable Energy Directive): PV deployment contributes to the 42.5% EU.
- renewable target and Romania's 55.8% target.
- ESR (Effort Sharing Regulation): diesel reductions in logistics support Romania's -12.7% non-ETS target.

Barriers:

- Limited SME investment budgets
- Lack of in-house technical expertise
- Permitting delays for PV installations

Enablers and support mechanisms:

- National/EU grants: PNRR, Modernisation Fund, PODD
- Tax incentives for renewable energy investments.
- Subsidies for EV logistics
- Simplified permitting for rooftop PV under 200 kWp.

Impact Assessment

The baseline scenario delivers measurable improvements by focusing on photovoltaic systems, heat pumps, LED modernization, reactive power compensation, and logistics optimization.
Estimated energy savings by 2030:

- Photovoltaics (Agro Cosm Fan + Carna Carpatica): ~1,170 MWh/year
  - Agro Cosm Fan: ~240 MWh/year (85 kWp PV)
  - Carna Carpatica: ~930 MWh/year (PV systems across multiple sites: 164 + 40 + 60
  - + 32 + 15 + 12 + 12 kWp)
- Heat pumps (all companies): ~225 MWh/year.
  - Agro Cosm Fan: 25 MWh/year
  - Carna Carpatica: 100 MWh/year
  - Moldovan Carmangerie: 100 MWh/year

- LED modernization & reactive power compensation: ~50-70 MWh/year (based on AE estimates).

- Logistics optimization: ~100 MWh/year (fuel savings through route optimization and load consolidation).

Total energy savings: ~1,550 MWh/year. GHG reductions:
- Using standard emission factors (electricity 0.172 tCO_2/MWh, natural gas 0.205 tCO_2/MWh, diesel ~0.27 tCO_2/MWh), the cumulative effect corresponds to ~310 tCO_2/year avoided emissions.

Economic benefits:
- Energy cost savings are estimated at €200,000-220,000/year, depending on electricity and fuel price evolution.
- PV measures in particular show a payback of 3-4 years, while heat pumps average 6-7 years.

Socioeconomic benefits:
- Enhanced competitiveness by reducing operational costs.
- Stability for ~350 jobs across the three companies.
- A stronger sustainability image, useful for partnerships with retailers and for compliance with emerging EU standards.

KPIs for monitoring:
- Share of RES in electricity consumption: increase to 20-25% by 2030.
- Energy intensity reduction: -15% by 2030 compared to 2023 baseline.
- Logistics fuel efficiency: +5% improvement.

Feasibility & Validation

Risks and mitigation strategies

Risk Type	Description	Mitigation Strategy
Financial Risk	Large enterprises are excluded from many SME-focused grant schemes, limiting access to public support	Broaden eligibility under PNRR and Modernisation Fund; promote coordinated cluster applications and blended finance instruments
Regulatory Risk	Rooftop PV projects (>200 kWp) face permitting delays and inconsistent local procedures	Introduce a simplified national permitting protocol with clear timelines; pilot fast-track schemes in selected municipalities
Technical Risk	Lack of in-house energy management capacity increases reliance on external consultants	Develop cluster-led training programmes and voucher schemes to certify company staff as energy managers (ISO 50001 aligned)
Market Risk	Energy price volatility may affect ROI projections, especially for PV investments	Encourage PPAs and hedging strategies; promote ESCO/EPC arrangements where service providers assume part of the investment and performance risk

Stakeholder validation - main agreements and disagreements Agreements:

- Strong consensus that PV, LED and logistics optimisation are practical, cost-effective and appropriate initial measures.
- Confirmation that these measures align with company strategies and deliver near-term competitiveness gains.
- Recognition of the enabling role of clusters and municipalities for joint procurement, training and local facilitation.

Disagreements:

- Ambition of baseline actions: some stakeholders cautioned that baseline measures may risk becoming incremental "business as usual" rather than transformative.
- Funding coverage: industry representatives highlighted the funding gap for large processors, whereas policy actors noted that current EU and national programmes prioritise SMEs; resolving this tension requires targeted policy adjustments.

Readiness level

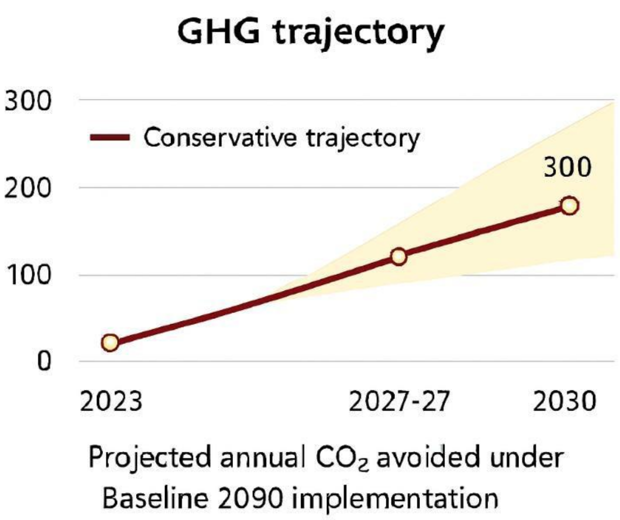
Baseline measures rely on established technologies, present short payback periods and are widely accepted by stakeholders. The principal barriers are regulatory and financial rather than technical. With targeted policy actions (expanded funding eligibility, streamlined permitting, and upskilling programmes), the Baseline 2030 scenario can be implemented at scale by 2030.

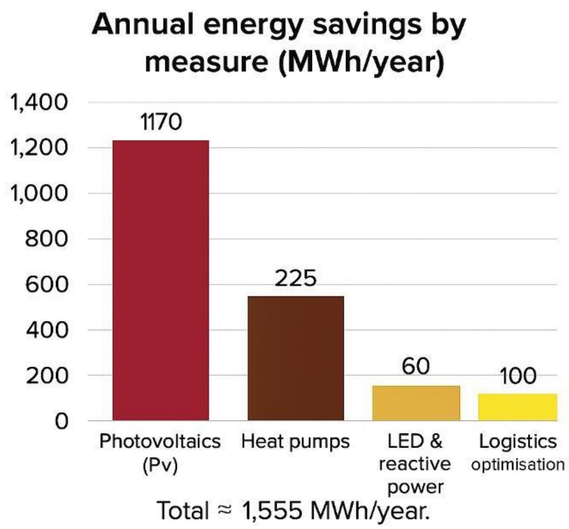
Scenario Visualisation

GHG and Energy Trajectory
The Baseline pathway shows a steady improvement in both energy efficiency and emission reductions from 2025 to 2030.

Companies implement short-term, proven measures: LED modernization, PV systems for self-consumption, reactive power correction, and logistics optimization.

By 2030, the combined effect reaches approximately **1,550 MWh/year of energy savings** and **310 tCO_2/year avoided emissions**, proving that low-cost interventions can generate measurable progress.

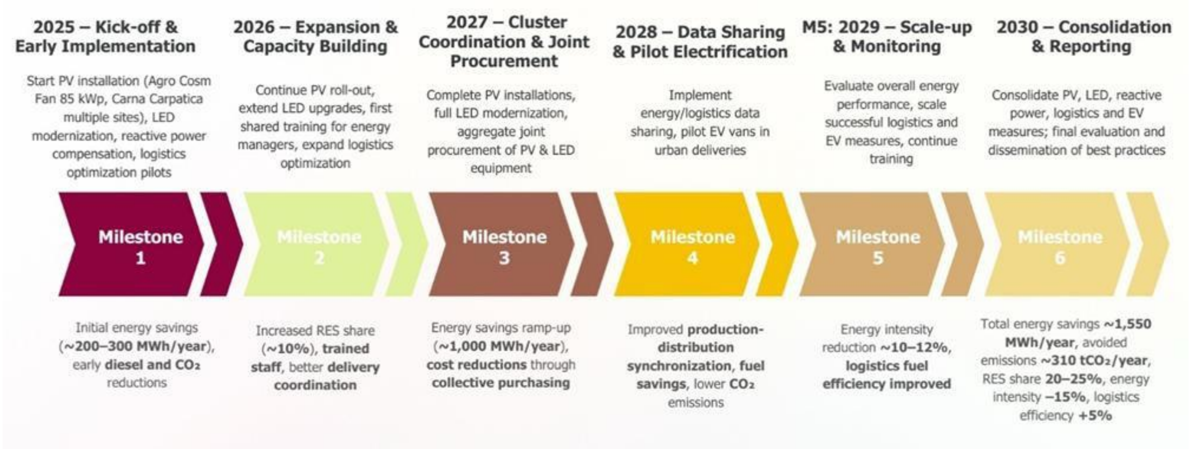


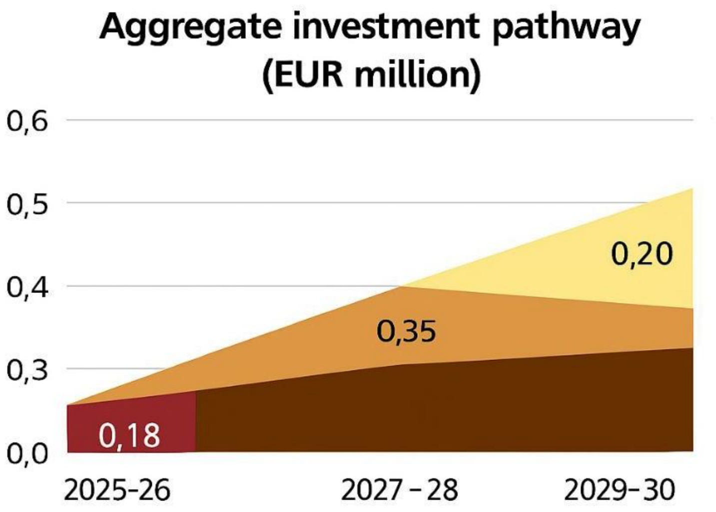


Investments in the Baseline scenario are **moderate and easily financeable**, with short payback periods.

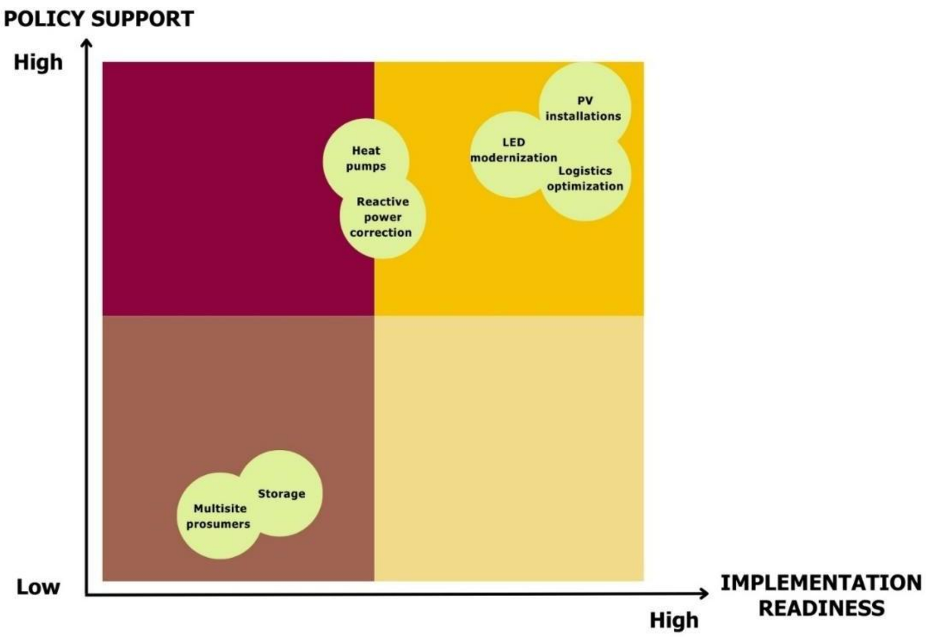
- **PV systems:** largest CAPEX (~€20,000-120,000/site), 3-4, year payback.
- **LED and reactive power compensation:** low CAPEX (~€5,000-15,000), <2-year payback.
- **Logistics optimization:** mostly organizational investments. This investment profile ensures both financial feasibility and scalability across SMEs and large enterprises.

Timeline milestones

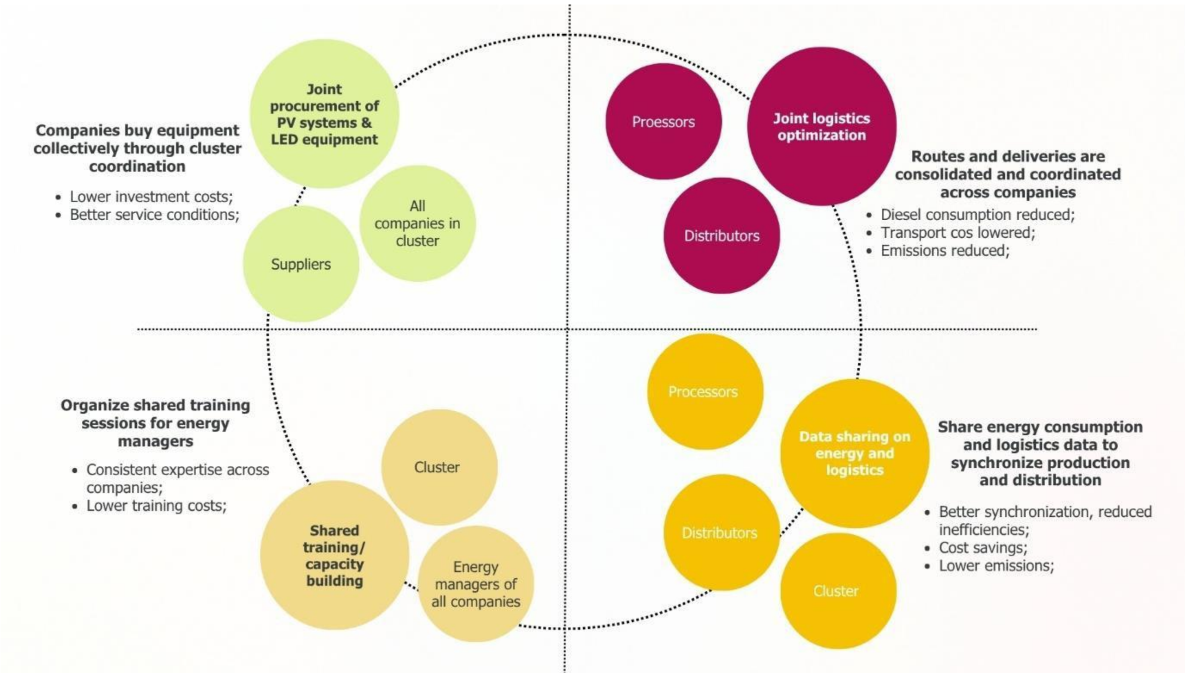




Policy Maturity Map (policy support vs implementation readiness)
Most measures in the Baseline scenario fall within **high policy support and high implementation readiness**, especially PV installations (<200 kWp), LED modernization, and logistics optimization. Measures such as heat pumps and reactive power correction are moderately mature but require capacity building, while storage and multisite prosumers still face unclear regulations.



Synergy Map (visual of collaborations across subsectors)


Companies buy equipment collectively through cluster coordination
• Lower investment costs;
• Better service conditions;
Joint procurement of PV systems & LED equipment
All companies in cluster
Suppliers
Proessors
Joint logistics optimization
Distributors
Routes and deliveries are consolidated and coordinated across companies
• Diesel consumption reduced;
• Transport cos lowered;
• Emissions reduced;
Organize shared training sessions for energy managers
• Consistent expertise across companies;
• Lower training costs;
Cluster
Shared training/ capacity building
Energy managers of all companies
Processors
Data sharing on energy and logistics
Distributors
Cluster
Share energy consumption and logistics data to synchronize production and distribution
• Better synchronization, reduced inefficiencies;
• Cost savings;
• Lower emissions;

Sustainable Dairy, Logistics & Packaging 2050 - Slovenia

Executive Summary

This scenario accelerates energy efficiency, renewable energy deployment and circularity in Slovenia's regional food-processing cluster, with a focus on SMEs **Mlekarna Planika** (dairy), **Mica** (packaging), and **Munih** (logistics). Through roundtables and company action plans, it addresses technical, financial, and regulatory barriers while leveraging community energy, shared logistics, and circular packaging. The long-term vision is to:

- **Achieve net-zero emissions** in dairy, packaging, and logistics through full electrification of processes, large-scale renewable integration (PV, biogas, hydrogen), and decarbonised transport fleets.
- **Close material loops** by valorising by-products such as whey (for biogas, feed, or high-value proteins) and ensuring packaging is fully circular and safe (rPET, deposit return system, returnable glass, or bio-based alternatives).
- **Strengthen regional clusters** (e.g., Agricultural Cooperative Tolmin, KZ Tolmin) and enhance coordination through GZS (Chamber of Commerce and Industry of Slovenia) and sectoral associations to facilitate joint investments in renewable energy hubs, waste valorisation plants, and shared logistics platforms.
- **Boost SME competitiveness** by reducing dependence on volatile fossil fuels and virgin materials while responding to consumer demand for sustainable products.
- **Ensure regulatory alignment** by building CSRD/ESRS compliance capacity, enabling transparent ESG reporting and access to green finance.

In short, by 2050 the scenario foresees a resilient, low-carbon, circular regional economy, where Slovenia's dairy value chain is recognised as a frontrunner in sustainable food production, logistics, and packaging, contributing to both local development and EU climate neutrality goals, and serving as a model for other value chains. The scenario targets climate neutrality, material circularity, and CSRD readiness to a climate-neutral, resource-efficient regional food sector fully aligned with the EU Green Deal and Fit for 55.

The regional focus is Slovenia, with an emphasis on the food-processing subsector, particularly the dairy industry and its related packaging and logistics value chain. The initiative concentrates on Mlekarna Planika, Mica, and Munih.

The value chain includes:

- Transport of raw milk from local farms to Planika dairy (Munih),
- Processing of milk, making butter, yogurt, and cheese (Planika),
- Packaging of products, particularly 500 ml PET bottles (Mica).

This northwestern Slovenian region is especially well-suited for piloting community energy systems, shared logistics, and circular economy models. The strong cooperative structure around KZ Tolmin (Agricultural Cooperative Tolmin) provides a trusted platform for collaboration and scaling.

Contextual Foundation

This scenario builds on findings from the 1st and 2nd regional roundtables and on company action plans developed under WP3. It reflects the current market maturity, infrastructure conditions, energy dependency, and regulatory environment in Slovenia, with a specific focus on the dairy-packaging-logistics value chain.

Planika (Dairy)
Planika has achieved steady progress in energy efficiency but continues to face some regulatory and infrastructural barriers. Completed or ongoing measures include electrification of selected machinery, optimisation of energy monitoring, and preparatory work for condensate heat recovery. Planned upgrades focus on replacing thermostatic valves, installing variable drives on motors, and replacement of butter plant and packaging. Discussions have also highlighted low-cost opportunities such as reactive power compensation, though these are not being prioritised in the short term.

On the renewable side, Planika operates PV systems at its main dairy and warehouse in Kobarid (115kW+90kW), as well as a 240 kW installation on its barn roof. The company also participates in the Bovec-Kobarid-Tolmin community self-supply project operated by the owner- cooperative Tolmin, which links eight metering points owned by the cooperative and achieves nearly 100% self-consumption. The initiative required transformer and cabling upgrades, illustrating the systemic infrastructure hurdles faced by SMEs setting up RES installations. With these bottlenecks now resolved, PV and community energy already supply close to half of Planika's electricity demand, with further expansion planned on new facilities (there is still available space for additional panels on some of the buildings at the farm).

Waste heat and by-product valorisation remain underdeveloped. Condensate heat recovery is in planning phase, while whey, produced in several cubic metres daily from ~10,000 L of processed milk, is partly used in whey-based food products and partly as animal feed. Other potential valorisation pathways, such as ultrafiltration, protein extraction, or biogas production, have not yet been implemented. Going forward, it will be important to evaluate which pathway is the most appropriate and effective: organised use as animal feed, processing into higher-value food products, or conversion to renewable energy.

In logistics, Planika organises daily deliveries of around 36 pallets to Ljubljana (approximately 350 km round trip). The company is evaluating the use of e-trucks for this route, which would be technically feasible in terms of distance; however, the uphill terrain towards Ljubljana raises concerns among Planika about range sufficiency, and the high investment costs of fleet renewal also remain a key worry. While charging infrastructure is already in place at the Kobarid site, scaling up to daily e-truck operations would still require additional capital investment and careful planning. In the longer term, collaboration with regional partners on shared logistics platforms and EV charging hubs could help reduce costs and improve feasibility. To achieve full decarbonisation, integrated and context-specific solutions will be needed.

Planika is owned by the Agricultural Cooperative Tolmin (KZ Tolmin). Decisions are made at the company level but verified by the cooperative's supervisory board. Planika makes investment decisions based on cost-benefit analysis and return on investment (ROI), with energy-related upgrades more likely to move forward when short payback periods are expected. The management follows a conservative financial approach: the director noted that the company prefers to invest only once sufficient funds have been saved, rather than relying on loans. Broader cooperative discussions underline the challenges of regulatory complexity, food-supply-chain risks, and the importance of joint initiatives in energy efficiency and renewable.

Mica (Packaging Producer)

Mica is steadily advancing in energy efficiency. It has replaced outdated HDPE production machines with modern, significantly more efficient units, insulated buildings, sealed windows, and installed reactive power compensation. Process water reconditioning and optimised machine cycles have further reduced consumption.

The current roof of main building cannot host sufficient solar panels due to structural limitations, but Mica plans a new warehouse within 3-5 years, designed PV-ready, which could increase renewable self-supply to around 40% of electricity demand.

Recyclable packaging is a strategic priority. Mica is increasing the rPET share in bottles, reducing bottle weight, improving cycle efficiency, and conducting food-contact migration tests. Collaboration with Planika is strong, particularly on packaging design, batch size and storage optimisation, and logistics. Both companies are also interested in shared EV charging and logistics solutions. They already optimize logistics for mutual good.

Supply chain risks remain raw materials for plastics are mainly imported from oil-producing regions. To reduce both CO_2 emissions and supply risks, Mica aims to shift sourcing toward regional recycled feedstocks (e.g., Austria, Netherlands), with future potential for pooled local rPET.

As a family-owned firm, Mica benefits from fast and flexible decision-making but maintains a strict focus on ROI and competitiveness. Investments are planned around two years in advance and must typically demonstrate short payback periods. While material and labour costs remain less flexible, energy savings and packaging innovations are key drivers of competitiveness. Organisational barriers are low, and earlier resistance to change has been largely overcome through communication and process improvements.
Key challenges include regulatory uncertainty (deposit-return scheme, SUP Directive) and market volatility, as plastics often undercut recycled plastics when oil prices fall.

Value Chain Insights

The regional dairy-packaging-logistics chain combines clear opportunities with systemic challenges:

- Raw materials: high dependency on imported plastics; potential for regional recycled feedstock sourcing and shared rPET/HDPE pools.
- By-products: whey remains a low-value side stream; joint valorisation (biogas, ultrafiltration, protein products) could unlock circular revenue streams.
- Shared infrastructure: opportunities for co-investment in EV fleets and charging hubs, regional glass washing facilities, and biogas plants.
- Precedents: the Bovec-Kobarid-Tolmin community energy project demonstrates the viability of cooperative renewable initiatives.
- Barriers: permitting delays, grid bottlenecks, and uncertain packaging regulation development constrain faster transitions.
- Market maturity: growing consumer and retailer demand for sustainable packaging creates both compliance risks and new competitive advantages.
- Governance/reporting: SMEs are not yet preparing for CSRD; early adoption of digital monitoring and cluster-based reporting could reduce compliance costs.

Regional Snapshot

- Market maturity: Developing but increasingly mature, with rising demand for sustainable dairy and packaging; SMEs still operate on thin margins and face exposure to global commodity price risks.

- Infrastructure: Logistics networks are functional, but grid bottlenecks delay PV deployment and charging infrastructure is missing. Recycling for cardboard and glass is established, but plastics and whey valorisation lack regional hubs.
- Energy dependency: Fossil fuels remain in use for heating and transport, but PV self-supply already covers ~50% of Planika's demand, with growth potential. Whey biogas offers a possible future diversification.
- Regulatory environment: EU and national policies (Fit for 55, SUP Directive, deposit-return scheme) are accelerating decarbonisation and circularity, but SMEs face complex permitting procedures and high compliance costs. Subsidies and cooperative models remain critical enablers.

Subsector Focus
The scenario focuses on the dairy industry, with emphasis on milk processing and packaging as critical elements of Slovenia's agri-food value chain.

- Dairy processing (Planika): Covers the collection of raw milk from local farms (Munih transport, KZ Tolmin cooperative), processing into fresh milk, butter, yogurt, and cheese, and national distribution. Planika's operations represent a traditional but flexible SME processor with strong potential for energy efficiency, renewable integration, and by-product valorisation (whey).
- Packaging (Mica): Specialises in producing different packaging materials, including HDPE and rPET plastic bottles, supplying Planika and other companies. Mica is advancing recyclable packaging solutions by increasing rPET content, optimising bottle design, and testing food-contact safety. Further weight reduction is limited, however, as the bottles must retain sufficient rigidity and other functional properties required for dairy packaging. The company works closely with Planika to align packaging requirements and optimise logistics.

Together, these SMEs (plus Munih logistics) represent complementary parts of the food-processing subsector, linking milk production with packaging and distribution. Their activities demonstrate the opportunities and challenges of achieving energy efficiency, renewable integration, and circular economy targets in small, regionally embedded companies.

The subsector focus also highlights the potential of regional clusters: linking dairies, packaging producers, logistics providers (e.g., Munih), and cooperatives (e.g., KZ Tolmin) to co-invest in shared infrastructure for renewable energy, waste valorisation, and low-carbon logistics.

Roadmap goals and objectives

Overall goal (2050)
Achieve a climate-neutral, fully circular regional value chain (dairy-packaging-logistics) through full electrification where feasible, high renewable self-supply (PV/biogas/PPAs), zero-emission transport, and verified CSRD/ESRS reporting-building on the cooperative backbone of KZ Tolmin and community energy models (Bovec-Kobarid-Tolmin).

2030 targets (short term)

- Energy & RES: ≥50% of Planika's electricity from PV/community self-supply; Mica PV-ready new warehouse (design completed, build started), shared transformer/cabling upgrades where needed.

- Efficiency & heat: Deploy variable drives, thermostatic valves, condensate heat recovery at Planika; expand compressor heat recovery at Mica.
- Packaging & circularity: Reach ≥25-30% rPET on main PET lines; complete food-contact migration testing; start feasibility for regional glass-return loop.
- Logistics: Pilot e-truck on Planika's daily Ljubljana route (charging at Kobarid depot); reduce empty runs via Planika-Munih route coordination.
- Data & compliance: Smart meters/IoT at both companies; basic ESG/LCA dashboards; CSRD readiness plan (governance, roles, data model).

2040 milestones (mid term)

- Energy & heat: ≥80% renewable electricity across sites; industrial heat pumps and expanded waste-heat recovery cover a substantial share of thermal loads; evaluate electric steam boiler + H_2 co-firing for peak flexibility.
- Circularity at scale: ≥50% rPET content on core SKUs; regional glass-washing hub operational for selected lines; decision on whey valorisation pathway (proteins/biogas/feed) with partners.
- Logistics: Majority of regional distribution electrified; cooperative charging hubs in the valley; digital route planning widely used.
- Data & finance: CSRD/ESRS reporting in place; access to green loans/Eko sklad and blended finance standardised for SMEs.

2050 outcomes (long term)

- Net-zero operations: 100% renewable electricity; very high renewable heat share, residuals offset only where unavoidable.
- Fully circular packaging: Closed-loop rPET; viable returnable glass for selected products; bio-based options in niche ranges.
- Zero-emission logistics: e-fleets + renewable hubs; rail where economical.
- Verified transparency: Automated Scope 1-3 data, third-party assurance, strong "Slovenian Alpine Dairy - Circular & Clean" market positioning.

Operational objectives

- Cooperative energy: Expand community self-supply (PV + storage), share grid upgrades; explore cluster PPAs.
- Process upgrades: Standardise VSDs, valves, compressor/condensate heat recovery; phase in industrial heat pumps.
- Circular packaging system: Lock long-term rPET supply; co-develop regional glass-return capacity with peers/municipalities; align specs (labels/caps) for high DRS performance.
- Shared logistics: Pool routes (Planika-Munih), build depot charging, and scale e-trucks on proven routes (Ljubljana).
- Data & CSRD: Deploy smart meters/IoT plant dashboards cluster ESG platform; train internal coordinators; keep reporting proportional for SMEs.
- Financing & governance: Use Eko sklad, SID, NEPN schemes LIFE/ERDF; KZ Tolmin/GZS convene joint tenders and skills programs; municipalities support permits and sites for shared assets.

Operational Roadmap

Scalable actions (from WP3 action plans):

- **Standardise energy efficiency upgrades:** roll out thermostatic valves, variable drives, and improved insulation; replace compressors and pumps; install an ice bank to optimise ice-water production; free cooling with ambient air during the warm season.
- **Expand renewable integration:** scale up rooftop PV and extend community self-supply models (e.g. Bovec/Kobarid/Tolmin).
- **Scale up waste heat recovery:** build on compressor heat recovery already implemented at Mica; add condensate recovery and industrial heat pumps at Planika.
- **Advance circular packaging:** increase rPET content, explore regional glass washing loops, and optimise batch/pallet logistics.
- **Pilot and expand EV trucks:** begin with Planika's daily Ljubljana deliveries, then transition toward cooperative fleets supported by shared charging hubs.
- **Introduce digital monitoring and reporting tools:** deploy smart meters, IoT sensors, and LCA dashboards to prepare SMEs for CSRD/ESRS compliance where feasible.
- **Promote cluster-based training and knowledge sharing:** create regional programmes to spread expertise, reduce compliance costs, and accelerate the uptake of best practices across SMEs - potentially implemented through the Chamber of Commerce and Industry of Slovenia (GZS).

These actions listed below are scalable, they are built on mature, low-risk measures already validated in WP3 audits and can be easily replicated by other SMEs using standard technologies and local expertise. Their short payback periods and cooperative implementation models (e.g., shared PV, logistics, and packaging systems) make them cost-effective and adaptable across the wider Slovenian agri-food sector.

Technologies and Upgrades

- **Energy efficiency & heat recovery:**
  - Compressor heat recovery (Mica, scalable to other SMEs).
  - Condensate heat recovery and industrial heat pumps (Planika, planned).
  - Variable drives for pumps and thermostatic valves in cooling/heating installations.
  - Replacement of hydraulic injection moulding machines with electric systems, reducing electricity, water, and chemical use while improving process precision.
- **Renewables:**
  - PV: Planika's 240 kW installation already covers ~50% of demand; Mica could reach ~40% once the new warehouse is built.
  - Community self-supply (Bovec/Kobarid/Tolmin) as a scalable cooperative model.
  - Future option: In the medium term, replacing LPG with an electric steam boiler during periods of low electricity prices, combined with hydrogen production for co-firing at higher price periods, represents a realistic pathway toward full decarbonisation. Over a 25-year horizon, such solutions are expected to become fully feasible - a necessary step if LPG is to be completely phased out.
- **Circular economy technologies:**
  - Ultrafiltration/membrane systems for whey valorisation.
  - Mechanical rPET recycling for food-grade packaging.
  - Glass washing systems for regional return loops.
- **Digital tools:**
  - Smart meters and IoT sensors for real-time energy and material flows monitoring

supplementing existing SCADA based systems.
  - Digital dashboards to integrate energy, waste, and logistics.
  - LCA software (e.g., OpenLCA, SimaPro, GaBi) to assess circularity and support CSRD/ESRS compliance.

Investments Required (CAPEX estimates, collaborative actions)

- **Energy Efficiency & Heat Recovery**
  - Compressor and condensate heat recovery systems: €50k-150k per installation depending on scale.
  - *Collaborative potential:* shared technical services across dairies could lower design and maintenance costs.
  - Variable dives & thermostatic valves: €5k-20k per site, with payback in ~2-3 years. Highly scalable across SMEs.
- **Renewable Energy**
  - Planika's 240 kW system cost approximately €200,000-250,000. Mica's planned installation on the new warehouse - expected to cover around 40% of electricity demand - is estimated at €300,000-400,000, corresponding to roughly 375-500 kW based on current market prices (~€800 /kW).
  - *Collaborative model:* community self-supply schemes (e.g. Bovec/Tolmin) help share transformer and grid upgrade costs.
  - Biogas from whey: a regional anaerobic digestion hub would require €1-2 million, but given the absence of large, continuous by-product streams, it may be more cost-effective to transport whey to existing AD plants rather than build a new facility locally.
- **Circular Packaging**
  - rPET migration testing & certification: €10k-50k per product line.
  - Returnable glass systems: €500k-1 million for regional washing and collection infrastructure. This is unlikely to be included in the first phase of the national deposit-return scheme, which initially targets PET bottles and aluminium cans. However, a later expansion could provide an opportunity to integrate returnable glass for dairy and other beverage sectors.
  - *Collaborative action:* shared facilities between dairies, beverage producers, and packaging firms could strengthen regional circular systems and reduce unit costs.
- **Transport & Logistics**
  - Electric trucks: €250k-400k per heavy-duty vehicle.
  - Charging infrastructure: €20k-50k per depot charging point. Planika already operates charging points at its Kobarid site, which can be scaled up for e-truck use and potentially shared with value chain partners. *Cluster approach:* pooled fleets and charging hubs reduce per-company CAPEX.
- **Digital Tools & Reporting**
  - LCA/ESG data management systems: typically require an initial setup cost of €10,000-30,000, often beyond the capacity of individual SMEs.
  - *Collaborative potential:* sectoral associations or cooperatives could take the lead in developing shared ESG platforms, allowing smaller firms to access standardised tools, reduce administrative burdens, and ensure comparable reporting across the value chain.

Organizational Changes

- **Training & Capacity Building**
  - Develop energy management skills for operating and maintaining various systems.
  - Raise sustainability awareness through workshops on circular economy, packaging compliance, and CSRD/ESRS requirements to build understanding of benefits from locally closed energy and material loops.
  - Build logistics decarbonisation skills by training drivers and managers in EV truck operation, charging, and route optimisation.
- **Digitalization**
  - Adopt smart meters and IoT sensors to monitor energy and material flows.
  - Meaningfully implement ESG data platforms for integrated tracking of energy, emissions, packaging, and by-products suitable for SMEs.
  - Use LCA and traceability software to assess packaging impacts and support sustainability reporting on the branch level.
  - Develop shared cluster platforms (Planika, Mica, Munih, KZ Tolmin) for collaborative reporting and resource sharing.
- **Logistics & Operations**
  - Plan fleet renewal to gradually integrate EV trucks into daily routes (e.g. Planika's Ljubljana deliveries and local collection).
  - Establish shared logistics models to reduce empty runs and distribute the costs of charging infrastructure.
  - Implement circular packaging workflows for collection, washing, and reuse of returnable glass bottles.
- **Governance & Strategy**
  - Appoint sustainability coordinators or teams within SMEs to prepare for CSRD.
  - Integrate ROI-based decision-making with long-term sustainability KPIs, ensuring alignment with EU climate and circular economy targets.

Timeline

- **Short-term (2025-2030):**
  - **Energy & Efficiency**
    - Consolidate ~50% PV coverage at Planika; expand further on new facilities.
    - Prepare Mica's new warehouse (2026-2027) with PV to reach ~40% self-supply.
    - Deploy variable dives, thermostatic valves, and condensate heat recovery systems at Planika (by 2025).
    - Evaluate reactive power compensation options at Planika.
    - Expand community self-supply projects (e.g. Bovec/Tolmin) to strengthen renewable access.
  - **Circular Economy & Packaging**
    - Achieve EU's 25% rPET mandate for PET bottles by 2025.
    - Continue migration testing to enable safe increases in recycled content (Mica: scaling recycled materials from 2027 onwards).
    - Broaden use of recycled cardboard and glass packaging.
    - Assess feasibility of whey valorisation (e.g. biogas, ultrafiltration, feed valorisation trials).
  - **Transport & Logistics**
    - Pilot e-truck use on Planika's daily Ljubljana route (~36 pallets, 350 km).

- Expand depot charging capacity at Planika (charging points already exist, scalable for e-trucks).
    - Begin developing shared logistics models among dairies and cooperatives to reduce empty runs.
    - Assess potential for EV charging points at Mica.
  - **Governance & Reporting**
    - Introduce digital monitoring tools for energy, packaging, and logistics flows.
    - Raise awareness and deliver training on CSRD/ESRS obligations (full compliance expected post-2029).
    - Establish cluster-based platforms for packaging and logistics innovation.
- **Midterm (2030-2040):**
  - **Energy & Efficiency**
    - Achieve full PV and renewable integration across company sites replacing imported fossil fuels with local RES and other energy carriers such as hydrogen.
    - Phase out LPG by introducing electric steam boilers powered by renewable electricity, combined with hydrogen co-firing to ensure operational flexibility.
    - Introduce regional renewable energy storage systems to balance supply and demand.
    - Deploy industrial heat pumps and advanced waste heat recovery across facilities.
    - Establish higher-value whey valorisation into protein products, feed, or renewable energy.
  - **Circular Economy & Packaging**
    - Transition toward 50%+ recycled content in PET bottles, supported by regional supply chains of recycled material.
    - Operate returnable glass systems backed by regional washing and logistics infrastructure.
    - Scale up bio-based and compostable packaging (PLA, PHA) for selected niche markets.
    - Achieve broad valorisation of whey into protein, feed, or renewable energy streams.
  - **Transport & Logistics**
    - Electrify most regional fleets; integrate charging infrastructure at production and distribution sites.
    - Implement shared logistics platforms among SMEs, enabling pooled vehicles and optimised routing.
    - Pilot alternative fuels (biofuel, hydrogen) for heavy-duty or long-haul routes.
  - **Governance & Reporting**
    - Achieve full CSRD/ESRS compliance with external audits.
    - Deploy digital ESG platforms to track Scope 1-3 emissions, waste, and circularity KPIs.
    - Gain EU recognition for regional clusters as sustainable food hubs, unlocking green finance opportunities.
- **Long-term (2050):**
  - **Energy & Efficiency**
    - Reach net-zero emissions across the regional dairy-packaging-logistics cluster.

- Operate on 100% renewable energy from PV, whey-based biogas, agricultural residues, and advanced storage of heat and hydrogen.
- Fully electrify all production processes, phasing out fossil fuels entirely.

- **Circular Economy & Packaging**
  - Close material loops with full valorisation of whey into proteins, feed, or renewable energy.
  - Ensure 100% circular packaging streams: rPET, returnable glass, and selected bio-based alternatives.
  - Achieve near-zero waste, supported by regional recycling hubs and continuous reuse systems.
- **Transport & Logistics**
  - Operate zero-emission logistics fleets powered by renewable electricity, biogas, or green hydrogen.
  - Run fully cooperative logistics networks with AI-driven routing and digital platforms.
  - Optimise last-mile delivery systems to minimise emissions and costs.

Governance & Reporting

- SMEs fully compliant with CSRD/ESRS, using advanced ESG platforms and third-party verification.
- Northwestern Slovenia recognised as a European frontrunner in sustainable food processing, packaging, and logistics.
- Stable access to green finance and EU innovation funds ensures long-term competitiveness.

Actors & Responsibilities

- **Companies (Planika, Mica & Munih in the value chain)**
  - **Planika (dairy):** Continue energy efficiency upgrades (variable dives, thermostatic valves, condensate heat recovery); expand PV through both on-site systems and community self-supply projects; explore whey valorisation pathways (ultrafiltration, biogas, protein extraction); strengthen digital monitoring of energy and logistics flows; and pilot electric trucks for daily Ljubljana deliveries, supported by existing depot charging points.
  - **Mica (packaging):** Replace outdated machinery with efficient alternatives; expand rPET use and optimise bottle weight/cycle efficiency while ensuring food-contact safety; prepare and implement a PV system on the new warehouse (planned in 3-4 years); collaborate with Planika on logistics optimisation (batch sizes, pallet loading, storage coordination); and remain open to shared investments in EV charging infrastructure.
  - **Munih (logistics):** Ensure efficient raw milk transport from farms to Planika; explore long-term options for low-emission fleets; and coordinate with cooperatives on shared logistics models and future charging solutions.
- **Regional Clusters & Cooperatives (e.g., KZ Tolmin, dairy and packaging networks)**
  - Coordinate community energy projects (Bovec/Kobarid/Tolmin self-supply) and expand them to renewable heat and logistics infrastructure.
  - Facilitate shared investments in glass washing plants, whey valorisation hubs, and EV charging stations.
  - Provide joint training, technical support, and ESG reporting platforms for SMEs.

- Represent local producers in national policy dialogues and EU project participation.

- **Municipalities & Regional Authorities**
    - Facilitate permitting processes and accelerate infrastructure upgrades (transformers, cabling, charging stations).
    - Support logistics decarbonisation by co-developing charging hubs and providing space for shared infrastructure.
    - Encourage local waste valorisation projects by linking municipal (food) waste streams with industrial needs.
    - Act as catalysts for regional cluster collaboration and communication with national ministries.
- **National Ministries (Energy, Environment, Economy, Agriculture)**
    - Provide targeted subsidies and green loans for PV, heat recovery, H_2, biogas, and logistics electrification.
    - Ensure regulatory clarity for SMEs, especially on EPR, ESR, SUP Directive, and deposit-return obligations.
    - Integrate food-processing clusters into Slovenia's NEPN and Fit for 55 strategies.
    - Develop SME-friendly reporting guidelines and training programmes to support CSRD/ESRS compliance.
    - Support blended finance models (EU + national + private) to enable shared infrastructure investments.

Synergies Across the Value Chain

- **Shared Logistics**
    - Coordinate Planika and Munih transport routes to reduce empty runs and optimise vehicle use.
    - Co-invest in electric trucks and depot charging infrastructure, lowering costs per company.
    - Implement cooperative route planning to increase efficiency and accelerate logistics decarbonisation.
- **Waste-to-Energy Valorisation**
    - Pool whey from Planika and local farms (via KZ Tolmin) for anaerobic digestion, producing renewable heat and power - or develop an organised system for animal feed use.
    - Integrate surplus heat (from compressors, condensate recovery) into municipal or cooperative heating networks aligning local energy planning and harnessing synergies via industrial symbiosis principles.
- **Circular Packaging Systems**
    - Develop shared washing and collection facilities to make returnable glass bottles viable at scale.
    - Coordinate joint sourcing and recycling of rPET and HDPE to improve quality, reduce costs, and ensure reliable supply.
- **Explore alternatives beyond plastics**: supporting innovation in reusable and bio-based materials to move toward truly circular packaging systems.
    - Strengthen alignment with retailers to support market acceptance and reduce compliance risks.
- **Digitalisation & Reporting**
    - Create cluster-wide ESG data platforms to lower compliance costs for SMEs through

shared resources.
  - Establish common traceability systems for transparent reporting of energy use, emissions, packaging flows, and by-products.
  - Note: Digitalisation and reporting systems should be proportionate to SME capacities, enhancing transparency without imposing unnecessary complexity or data burdens.
- **Community Energy Projects**
  - Expand the Bovec/Kobarid/Tolmin community self-supply model to other SMEs, integrating PV, storage, and renewable heat.
  - Share infrastructure investments (transformers, cabling) to overcome grid bottlenecks for renewable deployment.

Financing Sources

- **EU Funds**
  - **Horizon Europe:** Access mainly through consortia or clusters, supporting R&D and demonstration projects in circular packaging, biogas, renewable integration, and energy efficiency.
  - **LIFE Programme:** Targeted at climate action and environmental innovation, suitable for pilots such as whey-to-biogas valorisation or returnable glass systems.
  - **Innovation Fund:** Focused on large-scale decarbonisation technologies (industrial heat pumps, advanced recycling). SMEs would typically benefit indirectly through cluster projects or cooperative platforms.
  - **ERDF / Cohesion Policy:** Financing for regional infrastructure such as shared logistics hubs, renewable energy clusters, and waste valorisation plants.
  - **Common Agricultural Policy (CAP):** Support for sustainable farming practices and dairy by-product valorisation were linked to farm-level sustainability or bioeconomy measures.
- **National Funding (Slovenia)**
  - **NECP implementation schemes:** Grants and incentives for PV, heat recovery, biogas, and energy efficiency aligned with national climate targets.
  - **Spirit** subsidies for SMEs
  - **SID** loans for companies
  - **Eko sklad:** Soft loans and subsidies for SMEs investing in renewables, energy efficiency, or low-emission transport (including EV trucks and charging infrastructure).
  - **Packaging and waste schemes:** Support for compliance with EPR obligations, recycled-content targets, and packaging innovation.
  - **OPEX support** for hydrogen in the frame of feed in tariff (foreseen in some form).
- **Private Investments**
  - **Equity and cooperative capital:** Reinvested by Planika, Mica, and KZ Tolmin to drive core upgrades.
  - **Green loans from banks:** Increasingly linked to ESG performance and expected CSRD readiness, offering preferential financing conditions for SMEs preparing sustainability reporting.
  - **Public-private partnerships (PPPs):** Applicable to shared infrastructure such as biogas hubs, glass washing facilities, or EV charging networks.
  - **Retailer and buyer co-financing:** Corporate purchasers may co-invest in packaging and logistics pilots to secure reliable, sustainable supply chains.
- **Blended Finance Models**

- Combining EU grants, national subsidies, and private investment to reduce SME capital expenditure (CAPEX) burdens.
- Cluster-based financing approaches where SMEs jointly apply for funding, pool risks, and improve access to capital.
- Blended models can also streamline reporting obligations across funding streams, reducing administrative burden for SMEs.

Policy Framework

EU level

- **Fit for 55 package:** sets the overall climate-neutrality trajectory, driving energy efficiency, renewable deployment, and transport decarbonisation.
- **Corporate Sustainability Reporting Directive (CSRD):** introduces sustainability reporting obligations, with SMEs affected from 2029 onwards.
- **Corporate Sustainability Due Diligence Directive (CSDDD):** expected to shape supply chain responsibility and risk management.
- **Renewable Energy Directive (RED):** targets higher renewable shares and supports cooperative/community energy models.
- **Energy Efficiency Directive (EED):** obliges continuous improvements in efficiency, including audits and monitoring.
- **Single-Use Plastics (SUP) Directive** restricts disposable plastics and enforces tethered caps.
- **Circular Economy Action Plan (CEAP):** sets EU-wide direction for packaging reuse, recyclability, and by-product valorisation.

National level (Slovenia)

- **National Energy and Climate Plan (NEPN, 2024 update):** commits to at least 55% GHG reduction by 2033, a 33% renewable energy share by 2030, and energy use capped at 50.2 TWh.
- **Eko sklad subsidy schemes:** function as key financial instruments implemented through the Climate Fund, providing loans and grants for renewables, energy efficiency, and e-mobility, which are crucial for SMEs.
- **Common Agricultural Policy (CAP):** supports cooperatives and by-product valorisation when linked to sustainable farming practices.
- **Upcoming deposit-return scheme for beverage packaging:** expected to improve collection rates and closed-loop recycling.

Sector-specific

- **Effort Sharing Regulation (ESR):** the key driver of SME decarbonisation, covering transport, buildings, and smaller industrial sites outside the ETS.
- **Extended Producer Responsibility (EPR):** national packaging rules requiring companies to meet recycling and recycled-content targets.

Impact Assessment

Energy savings: 2.73 GWh primary energy (1.49 GWh final).

GHG reductions: ~421 tCO_{2eq} annually.

Innovation impact: pilots in whey valorisation, advanced rPET testing, shared logistics, digital monitoring systems.

Socioeconomic benefits: regional job creation in renewables and recycling; improved supply chain resilience; enhanced export competitiveness in sustainable dairy and packaging.

KPIs:
- Energy intensity (kWh/unit of product).
- Renewable share (% of total consumption).
- Investment leverage (public-private € ratio).
- Emission reduction progress (tCO_2/year).

Cost-benefit: Energy savings equivalent to ~108 €/MWh (based on 2023 energy prices); emission reductions correspond to ~383 €/t CO_2 avoided (indicative, not price-based).

Feasibility & Validation

Stakeholder feedback
- Only partly gathered at this stage. Planned consultations under T4.3 will validate and refine proposed scenarios, investment priorities, collaborative opportunities, and policy recommendations.

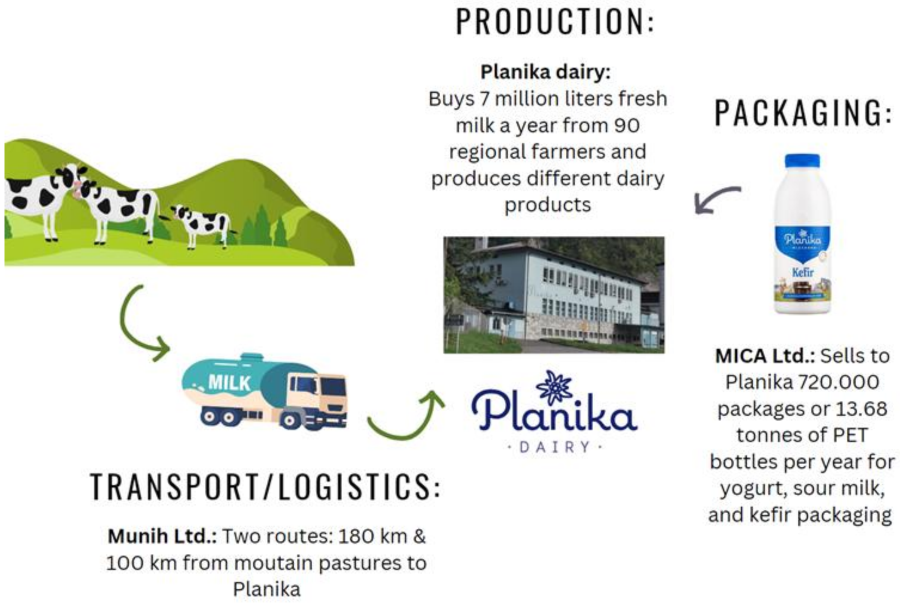
Risks and mitigation strategies
- **Regulatory delays:** Mitigation through early engagement with permitting authorities and cluster-level advocacy (building on the Ministry of Agriculture proposal success).
- **Financial barriers:** Maximise Eko sklad, Spirit, EU grants, and blended finance models; pursue cooperative co-investments.
- **Technical complexity:** Phase implementation, starting with low-cost, high-ROI measures (e.g. thermostatic valves, compensation and variable drives) while preparing for larger investments.
- **Organisational challenges:** Address through training and cluster-based capacity building; introduce digital tools gradually to ease CSRD/ESRS compliance.
- **Market risks (e.g. rPET price volatility):** Mitigation via supplier diversification and regional collaborative recycling hubs.

Stakeholder validation
- Not yet available. Agreements and disagreements will be documented following T4.3 workshops.

Readiness level
- **Current feasibility:** Medium - companies are committed and technically prepared, but progress is slowed by regulatory, financial, and organisational barriers.
- **Expected trajectory:** High - once permitting bottlenecks are addressed and financing instruments (national/EU) are fully leveraged.

Scenario Visualisation

Synergy Map (visual of collaborations across subsectors)


PRODUCTION:
Planika dairy:
Buys 7 million liters fresh milk a year from 90 regional farmers and produces different dairy products
PACKAGING:
Planika
Kefir
MILK
Planika
DAIRY
MICA Ltd.: Sells to Planika 720.000 packages or 13.68 tonnes of PET bottles per year for yogurt, sour milk, and kefir packaging
TRANSPORT/LOGISTICS:
Munih Ltd.: Two routes: 180 km & 100 km from moutain pastures to Planika

Conclusions and Next Steps

The third round of the EENOVA project roundtable showed that regional hubs can act as both knowledge platforms and decision-making places. In the five participating countries, the process confirmed that energy efficiency and the integration of renewable energy into agri-food value chains are not abstract ambitions, but concrete opportunities that are already being tested at company level. The 3rd roundtable endorsed a range of measures, from heat recovery and optimisation of compressed air to photovoltaic energy consumption and digital monitoring, as well as the policy, financial and infrastructure factors that need to accompany their wider deployment.

One of the clearest conclusions is that technical capabilities are rarely the main obstacle. Most companies already understand the technology and, in many cases, have implemented the first steps. Progress is driven by the economic and regulatory environment. High upfront investment costs, volatile energy prices and fragmented subsidy schemes remain major barriers for SMEs. Equally important is the need for stability and predictability of policy frameworks: without long-term financing and visibility into regulatory conditions, companies are reluctant to commit capital to a large-scale energy transition.

Another complex conclusion is the importance of multi-stakeholder dialogue. The methodology has proven that when companies, clusters, policymakers, and experts focus on a trusted space, a common understanding and shared responsibility for scenarios can emerge. This not only enhances the quality of the scenarios themselves but also lays the foundation for their implementation in the future. Stakeholders have repeatedly stressed that dialogue at different levels, linking local realities to European objectives, creates legitimacy and helps to bridge the gap between strategic ambition and feasibility.

The sessions also emphasized that behavioural and organizational change are just as important as technological updates. Several companies highlighted the cultural dimension of energy management, stressing that information campaigns, employee training, and digital transparency measures are essential to ensure that efficiency is maintained over time. In addition, organisational preparation, including clear accountability structures and systematic monitoring arrangements, has become a precondition for the successful implementation of more complex measures, such as the use of renewable energy with storage or the transition to a power park.

Key Conclusions

- Technical measures are well known and feasible, but their uptake is slowed by economic and regulatory constraints.
- Stable, predictable policy frameworks and subsidy schemes are indispensable to unlock investments.
- Multi-actor dialogue at the regional level creates ownership, legitimacy, and stronger scenarios.
- Organisational readiness and behavioural change are essential to ensure that technical solutions deliver lasting benefits.
- Cross-country comparison reveals shared challenges, such as infrastructure limitations and the high costs of e-mobility, which can be addressed through transnational learning.

Looking ahead, the next steps of the project are clear. The scenarios will be the basis for future results, linking practical measures to policy recommendations at both national and EU level. Secondly, the project will improve multi-dimensional analysis, quantifying the expected impacts in terms of energy savings, greenhouse gas reductions and financial consequences, as well as highlighting innovation and circularity aspects. This analytical deepening will provide the evidence base needed for both policy advocacy and business decision-making.

In conclusion, the third Roundtable confirmed that the transition to climate neutrality in regional agri-food value chains is necessary and achievable if technical measures are integrated into support policy frameworks, accompanied by cultural and organisational changes. Based on the EENOVA methodology partners successfully developed scenarios that are aligned with EU objectives.

The activities implemented under WP4 including the third roundtables, company consultations, and scenario validation have shown that the energy transition of regional agri-food value chains is both feasible and scalable when based on realistic, data-driven, and collaborative approaches.

Across all five participating regions (Austria, Bulgaria, Lithuania, Romania, and Slovenia), the EENOVA project successfully transformed the findings from WP2 audits and WP3 action plans into coherent regional scenarios that integrate technological solutions, financial mechanisms, and policy alignment.

The validated scenarios demonstrate that SMEs can play a leading role in achieving energy efficiency, renewable integration, and circular economy objectives when supported by cluster organisations, digital innovation hubs, and cooperative funding models. The third roundtables further confirmed that success depends not only on technical readiness, but also on stable policy frameworks, predictable financial instruments, and capacity-building for SMEs. The participatory approach applied in WP4 combining bottom-up engagement with policy dialogue proved essential for generating ownership and ensuring the long-term replicability of results.

Key lessons from WP4 highlight that:

- The most effective transition strategies start with low-CAPEX, high-impact measures (e.g., PV self-consumption, digital monitoring, heat recovery) that deliver early results and confidence for larger investments.
- Cluster cooperation and community-energy models significantly reduce costs and risks for SMEs, making advanced technologies such as storage, e-mobility, or circular packaging achievable.
- Policy coherence across local, national, and EU levels remains crucial to bridge the gap between ambition and implementation, particularly regarding permitting, financing access, and circular-economy regulation.
- Continuous capacity building and digitalisation are key enablers for sustainability reporting, investment readiness, and green-finance eligibility under the CSRD/ESRS framework.

Looking ahead, the results of WP4 serve as a foundation for Deliverable D4.2 Draft of policy recommendations where the findings from all five hubs are synthesised into national/EU-level recommendations and investment roadmaps**.** Through this work, EENOVA contributes to building a more resilient, energy-efficient, and climate-neutral agri-food ecosystem in Europe**.**