



Scenario-Based Assessment of Climate Neutrality Pathways in Cēsis Municipality, Latvia

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This document presents an assessment of future energy demand and CO₂ emissions in Cēsis municipality, Latvia, up to 2050, using a scenario-based modelling approach. The analysis covers major sectors, including buildings, transport, public infrastructure and waste management, and evaluates the impacts of selected policy measures on energy consumption, fuel structure, and emissions.

The analysed scenario assumes a modest economic development and a slight population increase (0,5 % per year), which leads to relatively stable or slowly increasing demand in several sectors. In this scenario, decarbonisation is primarily achieved through energy efficiency improvements, demand reduction, behavioural measures, and integrated sectoral policies. The document highlights the trade-offs between energy demand reduction and technology-led decarbonisation, and provides insights into how different policy choices can shape Cēsis's long-term energy system and climate outcomes.

NB! The simulations were conducted solely for exploratory and analytical purposes. They do not represent official projections, nor have they been adopted or endorsed by Cēsis municipality. Rather, these exercises serve as a basis for discussion and reflection among municipal stakeholders and may support future decision-making processes.

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1. PLANNING CONTEXT

Cēsis Municipality has an existing municipal climate and energy planning document: *Cēsu novada Integrētais Ilgtspējīgas Enerģētikas un Klimata Rīcības plāns līdz 2030. gadam* / Integrated Sustainable Energy and Climate Action Plan of Cēsis Municipality until 2030 (IEKRP2030).

The first Sustainable Energy Action Plan for Cēsis was developed and approved in 2016. In 2022, the plan was reviewed, updated and expanded to include short-, medium- and long-term objectives. Following the administrative territorial reform, the current IEKRP2030 covers the entire Cēsis Municipality, including the former Amata, Jaunpiebalga, Vecpiebalga, Pārgauja, Līgatne and Priekule municipalities.

The IEKRP2030 covers five main planning areas: municipal infrastructure, housing, transport and mobility, energy production, and climate change adaptation. It also defines the need for regular monitoring and review of the plan, including assessment of implementation progress, achieved results and the need for additional measures.

The CommitClimate simulation report does not replace or formally amend the Cēsis IEKRP2030. Instead, it provides an additional scenario-based analytical layer that can support the implementation, monitoring and future review of the existing municipal climate and energy planning framework.

2. SCOPE OF THE COMMITCLIMATE SIMULATION REPORT

The CommitClimate simulation report for Cēsis Municipality assesses future energy demand and CO₂ emissions up to 2050 using a scenario-based modelling approach. The report covers the main emission- and energy-related sectors, including municipal buildings, residential buildings, public infrastructure, transport, waste management and local energy production.

The modelling compares a baseline development pathway with selected policy measures and shows how different interventions may influence long-term energy demand, fuel structure and CO₂ emissions. The analysed policy package focuses primarily on energy efficiency improvements, demand reduction, behavioural and operational measures, renewable energy use and selected transport-related measures.

The simulations were carried out for exploratory and analytical purposes. They should be understood as a basis for discussion and reflection among municipal stakeholders and as a tool that may support future decision-making, rather than as official municipal projections.

3. MODELLING RESULTS

3.1. MUNICIPALITY BUILDINGS

Energy consumption in municipal buildings refers to the amount of energy used by public facilities owned or managed by local governments, including city halls, schools, libraries, police and fire stations, public works facilities, and recreational centers. These buildings often have diverse functions and require energy for lighting, heating, cooling, water heating, and running various equipment and systems.

Current situation

In Cēsis municipality, the total area of municipal buildings in the baseline year is 1 848 654 m². The largest share by area is made up of school, kindergarten and other building groups. The total energy consumption

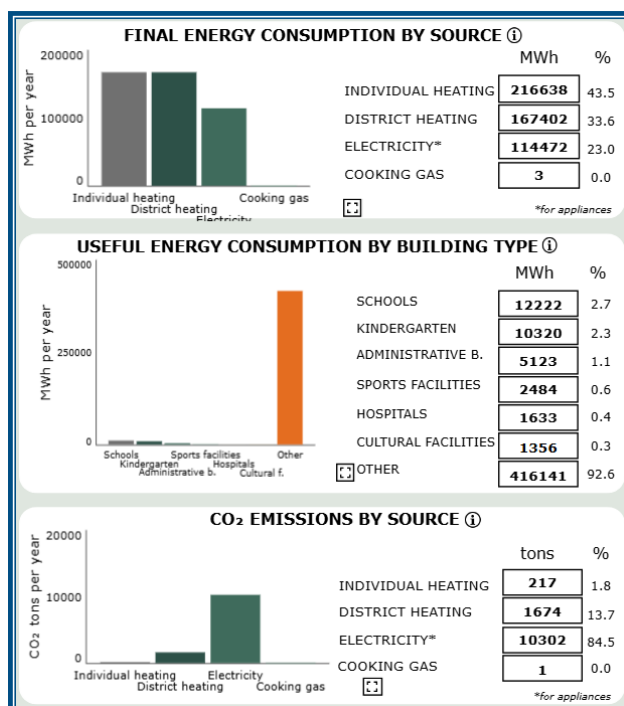
in municipal buildings in 2021 was 498 516 MWh, which accounted for 46.1 % of energy consumption in Cēsis municipality.

By 2050 an additional 7172 m² of administrative buildings is expected to be constructed, thus increasing energy consumption by 801 MWh (0.2 %).

In energy consumption, the largest share is individual heating with 43.5 % of the total energy consumption, followed by the district heating supply (33.6 %) and electricity consumption for appliances (23.0 %). It should be noted that electricity for appliances does not include electricity used for heating, rather it is included in individual heating.

The average specific heat energy consumption in municipal buildings is 181 kWh/m²/year and electricity consumption is 62 kWh/m²/year (weighted average across the entire building stock).

Total CO₂ emissions in municipal buildings related to energy use in the Baseline year were 12 194 tons of CO₂. The largest source of CO₂ emissions is electricity for appliances (84.5 %), followed by district heating (13.7 %) and individual heating (1.8 %). Due to the construction of administrative buildings, emissions are expected to rise by 21 tCO₂/year (0.2 %) by 2050. Overall, CO₂ emissions in municipal buildings make up 9.5 % of total CO₂ emissions in the municipality.



Policies

In the municipality buildings sector, several policy measures were proposed:

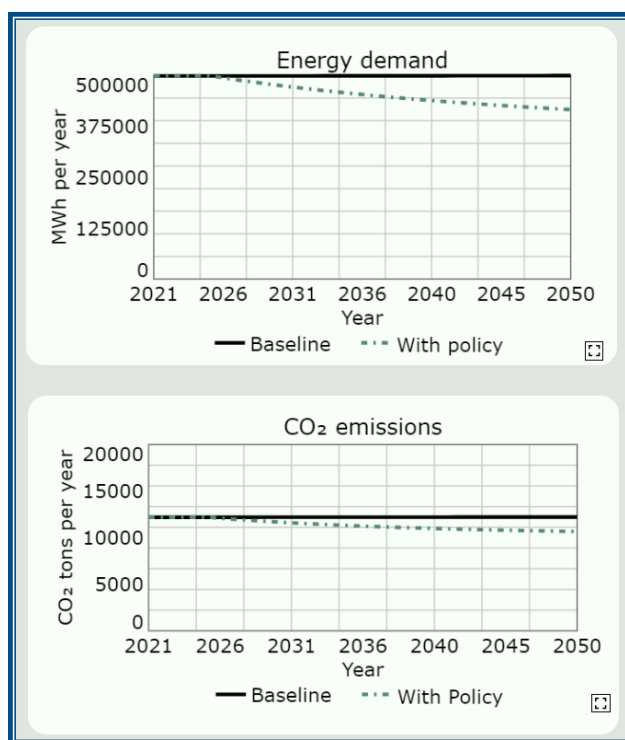
- **Replacement of windows** (Implementation speed (IS) 10 %/year, Expected savings (ES) 15 %)
- **Wall insulation** (IS 10 %/year, ES 40 %)
- **Replacement of light bulbs** (IS 10 %/year, ES 80 %)
- **Increased use of natural light** (IS 10 %/year, ES 5 %)

- **Ventilation optimization** (*IS 10 %/year, ES 10 %*)
- **Optimal use of appliances** (*IS 10 %/year, ES 10 %*)
- **RES-E generation** (*Solar photovoltaics installed capacity 10 kW, Heat pump air installed capacity 10 kW, Heat pump ground installed capacity 10 kW*)

For all policies the implementation start year was 2025, while implementation end year was 2050.

In total, the selected policies achieved 83 207 MWh in energy savings and 1549 tCO₂ in emission savings in 2050 compared to the baseline scenario (16.7 % and 12.7 % reductions respectively). Additionally, the RES-E policy introduced 289 MWh/year of renewable energy in the policy scenario.

After the policy implementation start year in 2025, both energy consumption and emissions continue to decrease in a relatively constant rate of around 3296,7 MWh/year (~0,7 %) and 61,2 tCO₂/year (~0,5 %) respectively.



3.2. RESIDENTIAL BUILDINGS

Energy consumption in residential buildings refers to the total amount of energy used for various activities, including heating, cooling, lighting, cooking, and powering appliances. All residential building stock is grouped according to four types – single family detached, single-family attached, large multi-family, and other.

Current situation

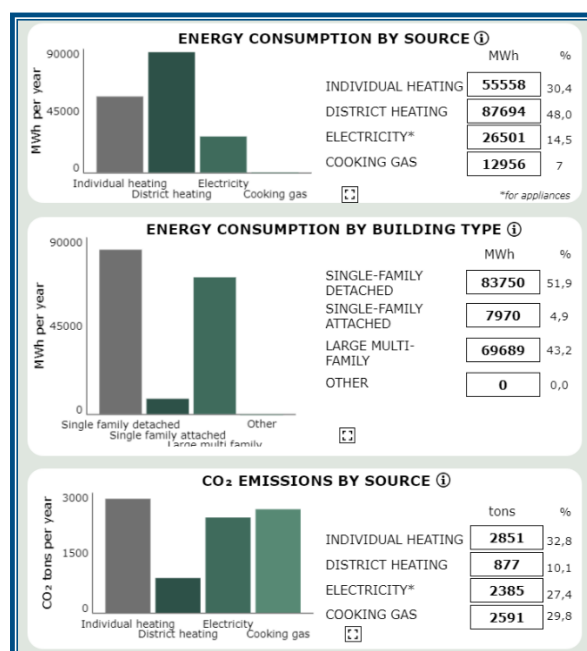
In Cēsis municipality, the total area of residential buildings accounted in calculation is 976 572 m². This area is made up of single-family detached, single-family attached and multi-family houses. In 2021, the total energy consumption in residential buildings was 182 709 MWh, accounting for 16.3 % of total energy consumption in Cēsis municipality.

Of the total energy consumption, district heating systems make up 48 % or 87 694 MWh and energy for individual heating – 30.4 % of total energy demand. Electricity consumption for appliances makes up 14.5 % or 26 501 MWh. It should be noted that electricity for appliances does not include electricity used for heating, rather it is included in individual heating.

Since the baseline scenario does not predict the construction of new residential buildings or the demolition of existing ones, the energy consumption of the baseline scenario is unchanged with the existing assumptions.

The average specific energy consumption for space heating and hot water preparation in the residential sector is 138 kWh/m²/year per year, and electricity consumption is 27 kWh/m²/year (weighted average across the entire building stock).

The amount of CO₂ generated in the household sector in the Baseline year were 8705 tons/year, which is 6.2 % of the municipality's CO₂ emissions. The largest source of CO₂ emissions in residential buildings is individual heat supply, which is responsible for 32.8 % of total CO₂ emissions.



Policies

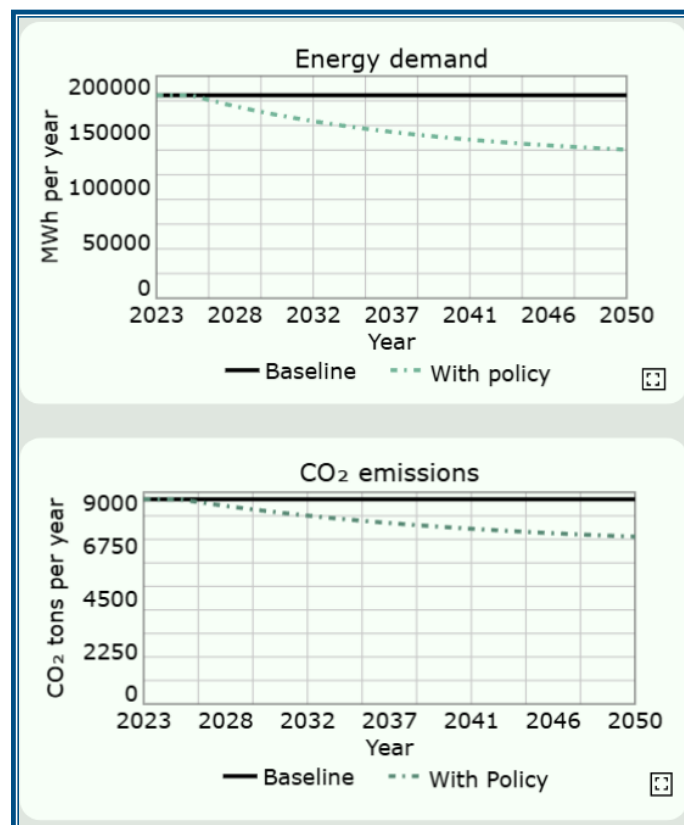
To reduce energy consumption and emissions, a comprehensive renovation and electrification strategy was tested, starting in 2025:

- **Renovation of single-family houses** (IS 5 %/year, ES 40 %)
- **Renovation of multi-family houses** (IS 10 %/year, ES 40 %)
- **Renovation of other houses** (IS 10 %/year, ES 40 %)
- **Electricity saving measures** (IS 5 %/year, ES 30 %/year)
- **Renewable and low carbon technologies** (Solar photovoltaics installed capacity 20 kW, Heat pump air installed capacity 20 kW, Heat pump ground installed capacity 20 kW)

For all policies the implementation start year was 2025, while implementation end year was 2050.

In total, the selected policies achieved 48 975 MWh in energy savings and 1 591 tCO₂ in emission savings in 2050 compared to the baseline scenario (26.8 % and 18.3 % reductions respectively). Additionally, the Renewable technologies policy introduced 577 MWh/year of renewable energy in the policy scenario.

After the policy implementation start year in 2025, both energy consumption and emissions continue to decrease in a relatively constant rate of around 1959 MWh/year (~1,1 %) and 64,4 tCO₂/year (~0,7 %) respectively.



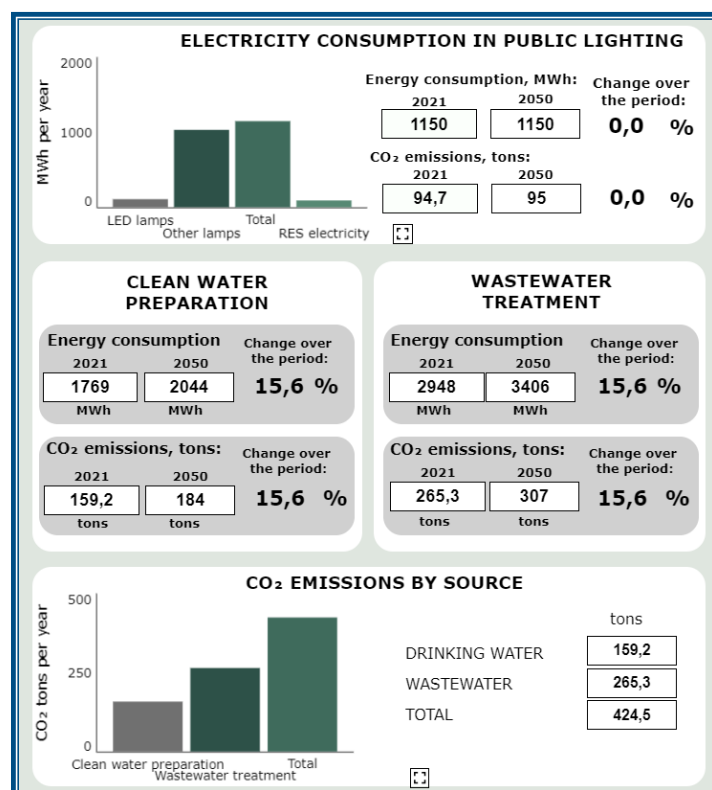
3.3. PUBLIC INFRASTRUCTURE

The Public Infrastructure sector encompasses essential services and systems that support communities and contribute to their quality of life. This sector includes electricity consumption related to public lighting, clean water preparation, and wastewater treatment, all of which are critical to maintaining public health, safety, and urban functionality.

Current situation

In Cēsis municipality, the expected total electricity consumption in the Public infrastructure sector in the baseline year is 5867 MWh/year, which is 0,6 % of the municipality's total energy consumption. Due to constant population growth, the amount energy used for clean water preparation and wastewater treatment is expected to increase by 15,6 %, bringing the total energy consumption of the sector to 6600 MWh per year in 2050; with wastewater treatment accounting for 51,6 %, drinking water preparation – 31 % – and public lighting – 17,4 % of the total energy consumption.

The amount of CO₂ generated in the Public Infrastructure sector in the baseline year is 519,2 tons/year and it is expected to increase to 586 tons/year (15,6 %) in 2050 due to population growth.



Policies

The following policy measures were implemented in the public infrastructure sector:

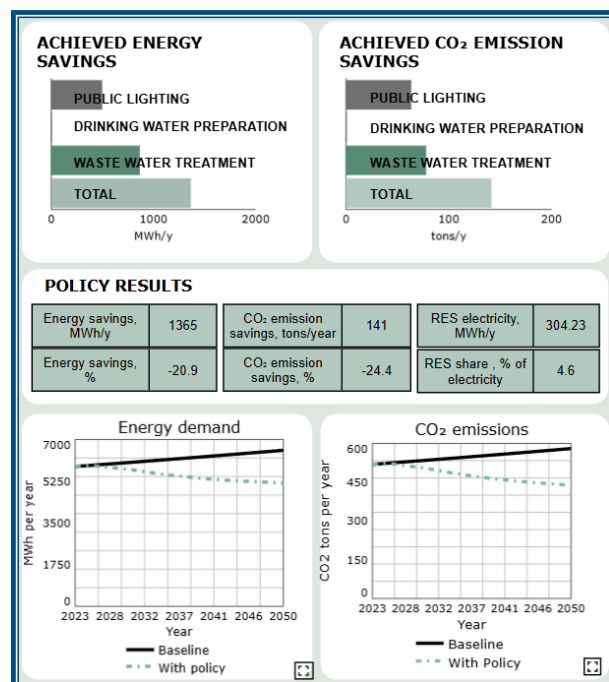
- **Replacement of inefficient light bulbs in public lighting** (IS 5 %/year)
- **RES usage in public lighting** (IS 5 %/year)
- **Wastewater treatment energy efficiency improvement** (IS 0,5 %/year)
- **Wastewater generation decrease** (IS 5 %/year)

For all policies the implementation start year was 2025, while implementation end year was 2050.

In total, the selected policies achieved 1365 MWh in energy savings in 2050 compared to the baseline scenario (20.9 % reduction). The largest reduction in energy consumption is achieved through improving wastewater treatment energy efficiency, resulting in a 13.2 % decrease. Replacement of inefficient light bulbs in the public lighting system result in a decreased energy demand by 6.1 %. The policy on RES usage in public lighting does not affect total energy consumption; instead, it increases the share of renewable electricity.

As after implementing policies, CO₂ emissions drop by 141 tCO₂, a (24.4 % decrease). The RES usage policy introduces 304.2 MWh/year of renewable energy, which comprises around 4.6 % of the sector's energy demand.

In the policy scenario both energy demand and CO₂ emissions initially are higher than in the baseline scenario, reaching peaks of 5914 MWh/year and 523 tCO₂/year in 2025, after which they start to decrease.



3.4. OTHER SECTORS

In Other sectors, energy consumption from four sub-sectors is considered: Commercial and Tertiary, Industry and Construction, Agriculture and Forestry, and Other. Only emissions related to energy consumption are considered in this sector. The calculations are based on aggregated statistical data on energy consumption in sectors and assumptions about future development trends.

Current situation

In Cēsis municipality, Other sectors energy consumption and GHG emissions are not included in the baseline inventory and projection.

Policies

In Cēsis municipality, Other sectors energy consumption and GHG emissions were not included in the baseline inventory and projection; thus, no policy analysis was conducted.

3.5. TRANSPORT

The transport sector in municipalities is a significant contributor to greenhouse gas (GHG) emissions, primarily due to reliance on fossil fuels. Sectors covered include: municipal vehicle fleet, public and private transportation. Only land transport and CO₂ emissions related to fuel combustion are considered. It should be noted that the results for the transport sector are obtained through calculations, not based on actual fuel invoices. Therefore, there may be data discrepancies.

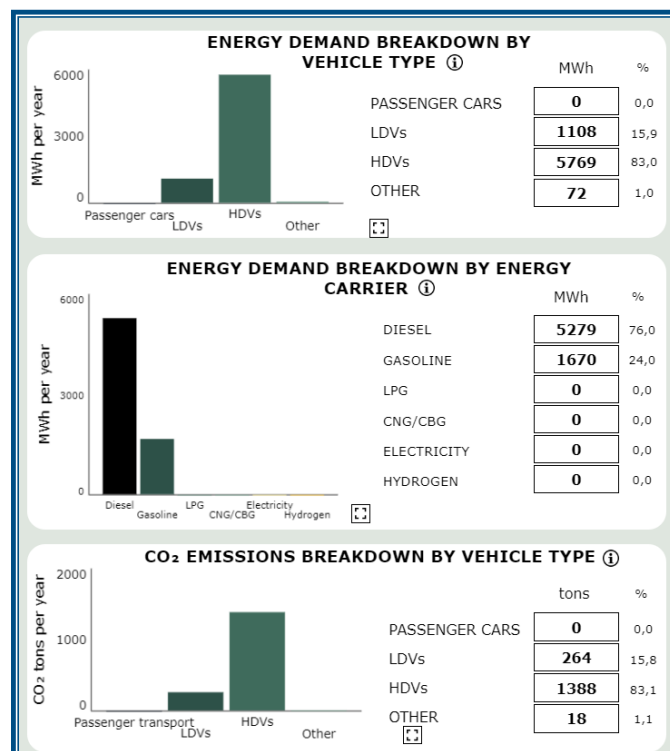
Current situation

Municipal vehicle fleet

The municipal vehicle fleet consists of 55 LDVs, 38 HDVs un 14 other vehicles. Assuming the average annual vehicle mileage, specific fuel consumption by fuel type and fuel type distribution, it was calculated that the energy consumption of the municipal vehicle fleet is 6949 MWh per year, which is equivalent to 0,6 % of the municipality's total energy consumption.

In terms of fuel consumption, diesel fuel accounts for the largest share (76 %), followed by gasoline (24 %). By vehicle type, the most significant energy consumer is HDVs (83.0 %), followed by LDVs (15.9 %) and other vehicles (1.0 %). Total CO₂ emissions related to the municipality's vehicle fleet amount to 1669 tons of CO₂ per year, or approximately 1.3 % of the municipality's total CO₂ emissions.

The baseline scenario does not assume any changes in the municipal vehicle fleet; thus energy consumption and emissions are assumed to remained unchanged from the base year.



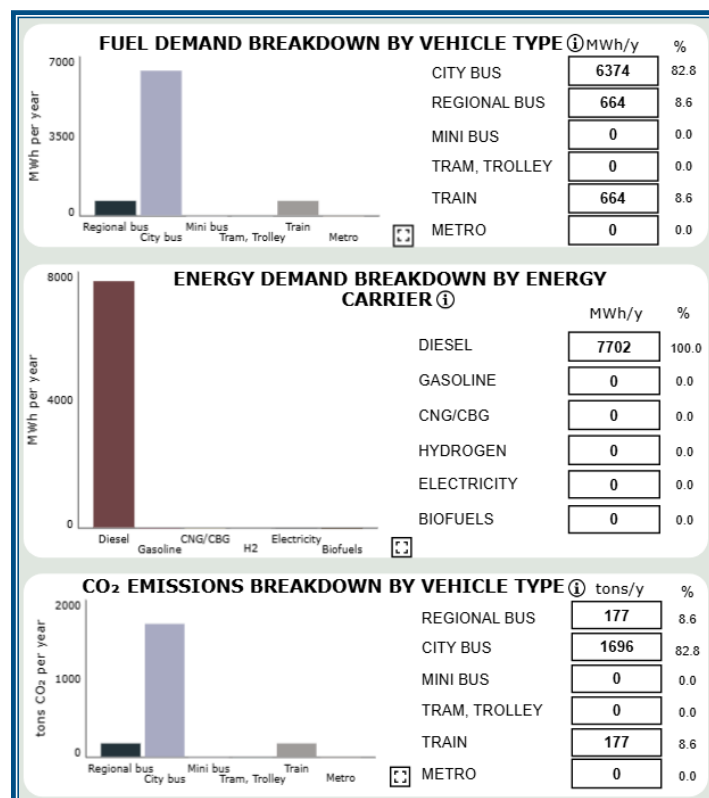
Public transport

According to existing data, 78.4 million passenger kilometres per year are performed by public transport and that number will reach 89.7 million by 2050. The largest share of this demand is made up of city public transport (90 %), followed by regional public transport (10 %).

Based on the assumptions made regarding the use of various public transport modes, average occupancy rates, average fuel consumption and type of fuel used, it has been calculated that the energy consumption of public transport is approximately 7702 MWh per year in 2021 or 0.7 % of the municipality's energy consumption. Of this, the largest share is made up of city bus (82.8 %), followed by train (8.6 %) and regional bus (8.6 %). Diesel dominates in terms of fuel consumption with 100 %. Total CO₂ emissions related to energy consumption in public transport amounted to 2049 tons of CO₂ in 2021 or approximately 1.6 % of the municipality's total CO₂ emissions.

The baseline scenario assumes no changes in the public transport vehicle fleet or usage patterns, and no policy measures are applied. Changes in energy consumption are driven solely by exogenous assumptions, including a gradual increase in population. As a result, public transport energy demand increases over time.

The projected energy consumption in 2050 is 8901 MWh, with associated CO₂ emissions of 2368 tons, corresponding to an increase of 15,6 % compared to the base year.

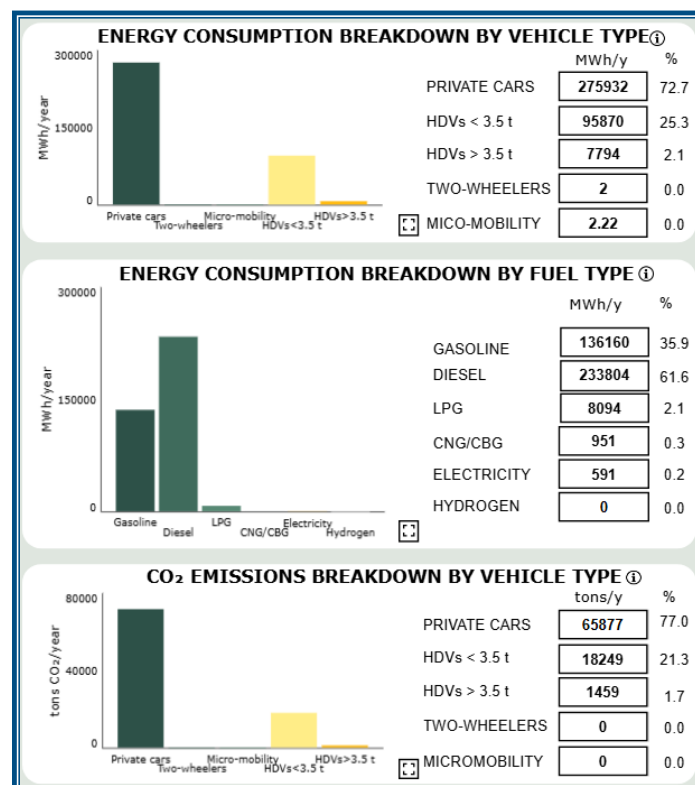


Private transport

According to existing input data, private transport demand in the municipality is approximately 574.9 million passenger kilometres per year. Based on the assumptions made regarding the use of private vehicles, average fuel consumption and type of fuel used, it has been calculated that the energy consumption in the private transport sector is 379600 MWh in the baseline year. Of this, the largest share is made by up private cars (72.7 %), followed by HDVs below 3,5 tons (25.3 %) and HDVs above 3,5 tons (2.1 %). Energy demand of other transportation modes, namely two-wheelers and micro-mobility tools, is negligible. Looking at the type of fuel, the two main types of fuel are diesel (61.6 %) and gasoline (35.9 %). Electricity accounts for a small proportion – 591 MWh per year or 0.2 % of total energy demand.

Total CO₂ emissions in the private transport sector amount 85 586 of CO₂ per year, or approximately 66.4 % of the municipality's total CO₂ emissions in baseline year.

Energy consumption is projected to reach 422 542 MWh per year by 2050, reaching 37,5 % of the municipality's total energy consumption. The baseline scenario assumes no changes in private transport usage patterns and no policy interventions. Changes in energy consumption and emissions are driven solely by exogenous assumptions, including a gradual increase in population. As a result, energy consumption increases by approximately 11,3 % and emissions by 12 % in 2050 compared to the base year.



Policies

Municipal vehicle fleet

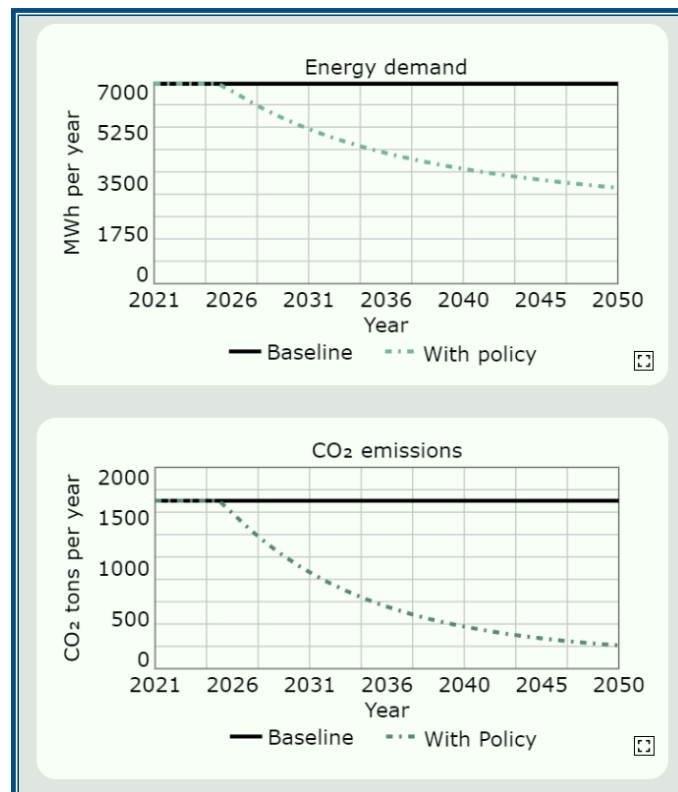
In this sector, several policy measures were proposed:

- **Other vehicle fleet decarbonization** (*Target technology choice Electric vehicles - 100 %*)
- **Fleet modernization and driver awareness training** (*IS 0,5 %/year*)
- **Fleet management improvement** (*IS 0,5 %/year*)

For the fleet decarbonization policy the start year was 2030. For fleet modernization and fleet management improvement policies the start year was 2025. For all policies the implementation end year was 2050.

In total, the selected policies achieved 3618 MWh in energy savings and 1437 tCO₂ in emission savings in 2050 compared to the baseline scenario (52,1 % and 86,1 % reductions respectively).

The biggest decrease in energy demand and emissions was achieved via vehicle decarbonization, which led to 52.1 % energy demand decrease and 86.1 % emission decrease due to a gradual replacement of all vehicles using internal combustion engines with electric vehicles.



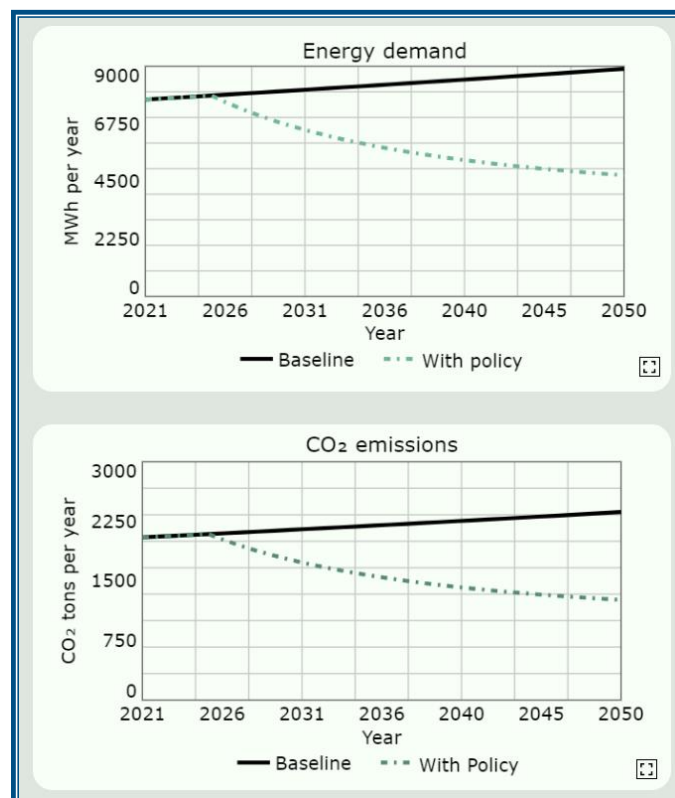
Public transport

In this sector, the following policy was tested:

- **Operational efficiency and route optimization** (*IS 2 %/year*)

The policy start year was 2025, while the end year was 2050.

In total, the selected policy achieved 4 118MWh in energy savings and 1 095 tCO₂ in emission savings in 2050 compared to the baseline scenario (46.7 % reductions).



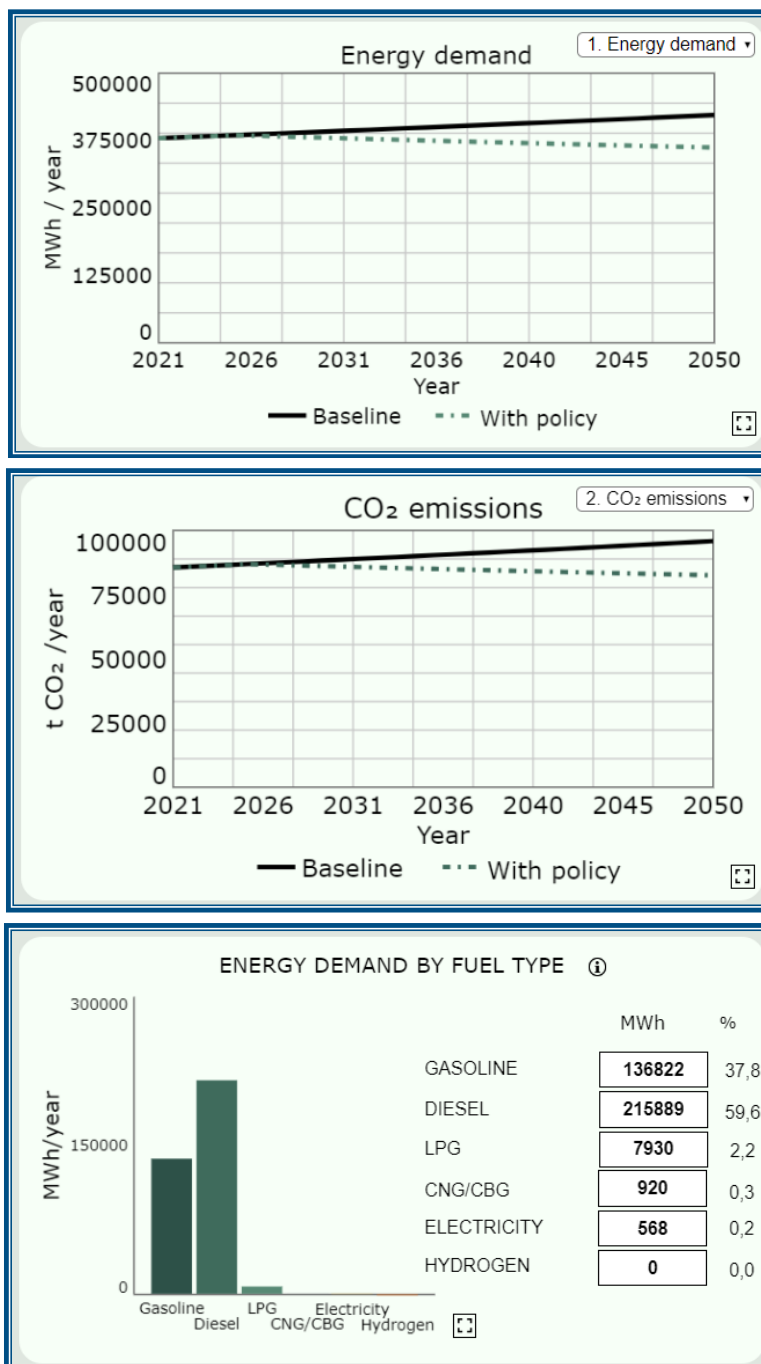
Private transport

In this sector, two key policies were implemented:

- **Car sharing** (*IS 0,5 %/year*)
- **Freight transport demand reduction** (*Daily distance reduction IS 0,5 %/year, Travel frequency reduction IS 0,5 %/year*)

For both policies the implementation start year was 2025 and the implementation end year was 2050.

In total, the selected policies result in a reduction of approximately 60 042 MWh in energy demand and 13 215 tons of CO₂ emissions by 2050 compared to the baseline scenario, corresponding to reductions by 14.3 % and 13.9 %, respectively. Because of freight transport (which mostly uses diesel fuel) demand reduction, the share of gasoline in energy demand has increased to 37.7 %, while diesel share has decreased to 59.7 % compared to the baseline scenario.



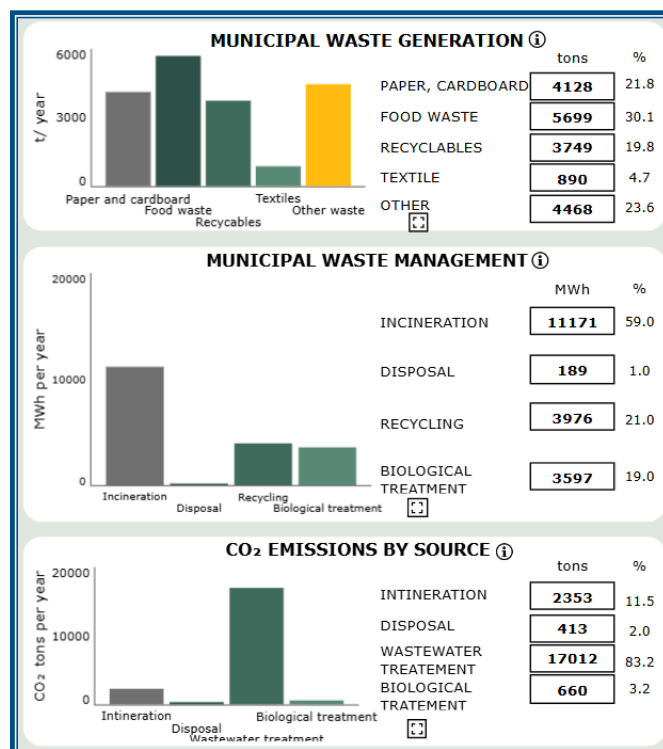
3.6. WASTE MANAGEMENT

In the waste management sector, GHG emissions related to waste management are considered. Effective waste management strategies, such as recycling, composting, and energy recovery, help reduce emissions by minimizing landfill waste and promoting circular economy practices. Municipalities can lower their carbon footprint by implementing sustainable waste policies, investing in waste-to-energy technologies, and encouraging community participation in waste reduction efforts.

Current situation

The calculations of the baseline scenario are based on assumptions about the number of inhabitants, the amount of waste generated per inhabitant (400 kg/capita/year) and the structure of municipal waste. Based on these assumptions, the amount of municipal waste generated in Cēsis municipality in the base year is 17 947 tons and the GHG emissions related to waste management constitute 18 116 tons CO₂eq. The waste management sector accounts for approximately 14.1% of the municipality's emissions

The baseline scenario assumes an annual 0,5 % increase in the municipality's population, however an annual 0,3 % decrease in waste generated per habitant is assumed. Consequently, by 2050, the total amount of waste generated is expected to increase by approximately 5.5 % and GHG emissions are expected to increase by approximately 12.88 % compared to the baseline year reaching 19 009 tons of generated waste or 20 438 tons CO₂eq, respectively.



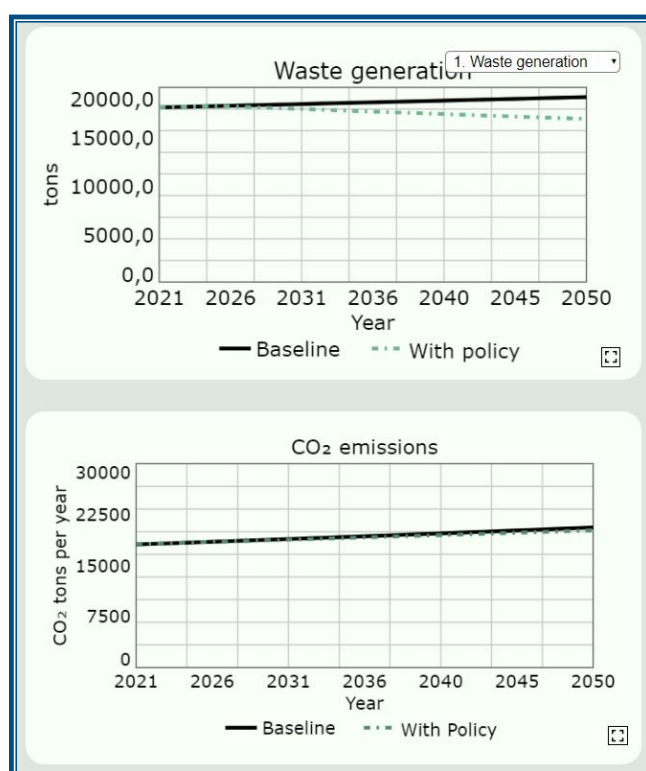
Policies

In this sector, the following policy was tested:

- **Reducing amount of waste generated** (15 0,5 %/year)

The policy start year was 2025, while the end year was 2050.

In total, the selected policy reduced the amount of waste generated by 1 249 tons and achieved 405 tCO₂eq in emission savings in 2050 compared to the baseline scenario (11.8 % and 2.0 % reductions respectively).



3.7. LOCAL ENERGY PRODUCTION

The Local Energy Production Sector encompasses energy production technologies and their associated environmental impact. This sector includes local electricity and heat generation parameters. The municipality can reduce CO₂ emissions in this sector by reducing heat losses in the system, recovering lost heat and decarbonizing various energy systems.

NB! The local energy production sector differs from other sectors in that it represents energy supply rather than energy demand. The 2050 scenario without energy-production-specific policies therefore reflects the energy demand generated by all other sectors after their respective policies are applied, but before any policies targeting local energy production are introduced.

Current situation

Electricity and district-heating demand and their associated emissions are included in the Cēsis simulation. However, no data on local electricity or heat generation were entered in the model. Local renewable electricity production, local heat production, combined heat and power production, energy-carrier inputs, energy imports and exports, and purchases of certified green electricity were therefore set to zero.

Consequently, the local electricity production and local heat production charts remain empty. This does not indicate that no electricity or district heat is consumed in Cēsis Municipality. Rather, it means that the current simulation represents electricity demand as being supplied primarily from the grid and district-heating demand as an aggregated heat-supply category, without modelling the underlying local generation technologies or fuel mix.

In 2050, the policy scenario shows electricity and district-heating demand of approximately 394,945 MWh/year, including distribution losses, and associated emissions of approximately 17,402 tonnes CO₂/year. The reductions shown in this sector result from lower energy demand in buildings, public infrastructure and transport following the implementation of policies in those sectors. They are not attributable to local-energy-production measures.

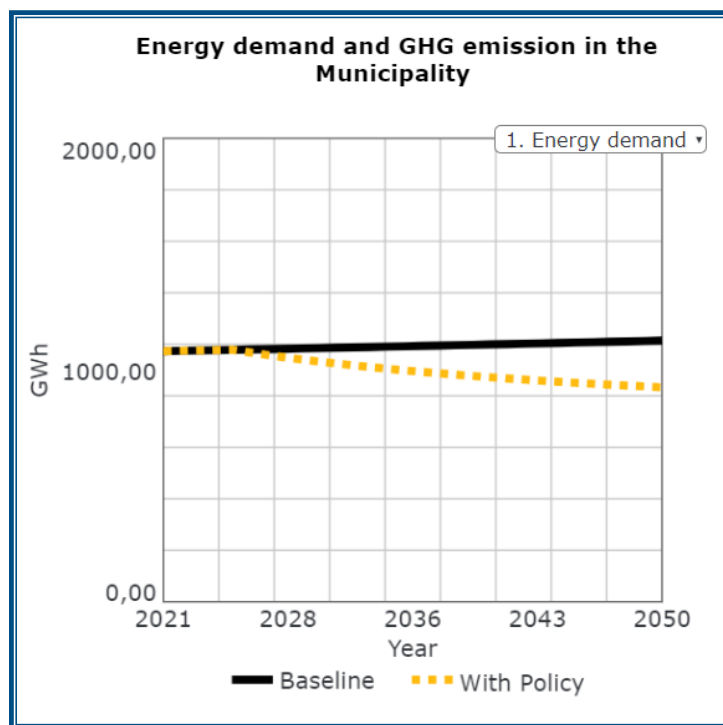
Policies

No policies targeting local electricity generation, district-heating production, fuel substitution, energy imports or exports, or certified green electricity purchases were tested in the Cēsis simulation.

The current results therefore do not assess the potential effects of local renewable-energy development, district-heating decarbonisation, changes in the heat-generation fuel mix, combined heat and power production or other energy-supply measures. Including local generation and fuel-input data would be necessary for a more complete assessment of the municipality's energy-supply system and its decarbonisation potential.

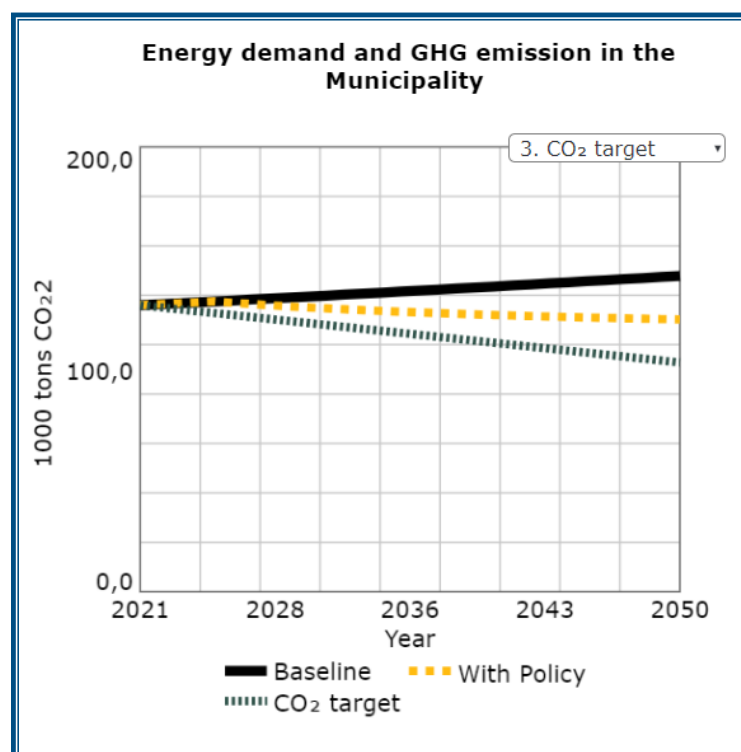
4. RESULT OVERVIEW

The results of the simulation show that in the baseline scenario energy demand in the municipality increases by approximately 0,15 %/year over time due to population increase and economic and activity growth assumptions. As illustrated in the figure below, total energy demand rises over time, reaching 11273.71 GWh in the baseline scenario by 2050. The implementation of the selected policy package causes a gradual energy demand decrease, resulting in an energy demand of 922.39 GWh by 2050. This corresponds to energy savings of 201 325 MWh, or 17,9 % compared to the baseline projection.



The selected policy package leads to moderate emission reductions. By 2050, GHG emissions decrease from approximately 141.0 thousand tonnes CO₂eq in the baseline scenario to approximately 121.6 thousand tonnes CO₂eq in the policy scenario. This corresponds to annual emission savings of 19,433.6 tonnes CO₂eq, or 13.8%, compared with the baseline projection.

As shown in the figure below, the policy scenario remains above the model's indicative long-term target trajectory, representing a 20% reduction by 2050. This comparison is illustrative and should not be interpreted as a formal assessment of IEKRP2030 target achievement. Nevertheless, it indicates that additional mitigation measures would be required to close the remaining modelled emission-reduction gap.



5. LINK WITH CĒSIS MUNICIPAL CLIMATE AND ENERGY PLANNING

5.1. Link between IEKRP2030 sectors and CommitClimate modelling

The table below summarises how the main IEKRP2030 planning areas correspond to the sectors and measures analysed in the CommitClimate simulation report.

IEKRP2030 planning area	CommitClimate modelled sector / measures	Link and added value
Municipal infrastructure and municipal buildings	Municipal buildings: window replacement, wall insulation, replacement of light bulbs, increased use of natural light, ventilation optimisation, optimal use of appliances and RES-E generation.	Strong link. The modelling supports assessment of energy efficiency and renewable energy measures in municipal buildings. It quantifies potential energy and CO ₂ savings and can support prioritisation of building-related measures.
Housing / residential buildings	Residential buildings: renovation of single-family houses, multi-family houses and other residential buildings; electricity-saving measures; renewable and low-carbon technologies.	Strong link. The modelling supports analysis of residential energy demand and the potential impact of renovation and energy efficiency measures. This is relevant for IEKRP2030 housing-sector actions, especially building renovation and household energy efficiency.
Public infrastructure	Public lighting, drinking water preparation and wastewater treatment: replacement of inefficient light bulbs, RES use in public lighting, wastewater treatment energy efficiency improvement and wastewater generation decrease.	Good link. The model can support evaluation of electricity-saving and renewable energy measures in public infrastructure and municipal service systems.
Transport and mobility	Municipal fleet, public transport and private transport: vehicle fleet decarbonisation, fleet modernisation, driver awareness, fleet management improvement, public transport route optimisation, car sharing and freight transport demand reduction.	Very strong link. Transport is one of the most important sectors for CO ₂ reduction in Cēsis Municipality. The model helps assess how different transport and mobility measures may influence energy demand and emissions over time.
Energy production and renewable energy	Local energy production is included as a sector in the model structure. However, local energy production energy demand and GHG emissions were not included in the Cēsis baseline inventory and projection; therefore, no detailed policy analysis was conducted for this sector.	Partial link. The sector is relevant for IEKRP2030, especially in relation to renewable energy, district heating and local energy supply. However, the current CommitClimate Cēsis simulation does not fully assess energy production or district heating decarbonisation measures.
Waste management and circular economy-related emissions	Waste generation and waste-management-related GHG emissions; reduction of waste generated.	Additional analytical value. Waste management is not one of the core IEKRP2030 energy-sector areas, but the results provide supplementary information on municipal emission sources and reduction potential.
Climate change adaptation	Not directly modelled.	Limited link. The CommitClimate CO ₂ simulation focuses on energy demand and emission

		mitigation. Climate risks, adaptation measures, green infrastructure and CO ₂ sequestration are outside the main scope of the model.
Monitoring and review of the IEKRP2030	Baseline and policy scenario results up to 2050; comparison of energy demand and CO ₂ emission trajectories.	Strong conceptual link. The model can support IEKRP2030 monitoring and review by helping the municipality compare baseline development, policy scenarios and remaining emission-reduction gaps.

5.2. Main modelling results relevant for IEKRP2030 monitoring

The CommitClimate simulation indicates that the selected policy package changes the municipality's long-term energy and emission trajectory, although it does not fully close the modelled emission-reduction gap.

By 2050, total energy demand decreases from 1 127.02 GWh in the baseline scenario to 925.37 GWh in the policy scenario. This corresponds to annual energy savings of 201 648.6 MWh, or 17.9%. CO₂ emissions decrease from approximately 142.0 thousand tonnes to 122.4 thousand tonnes, corresponding to annual savings of approximately 19 552.4 tonnes CO₂, or 13.8%.

From an IEKRP2030 monitoring perspective, the results highlight two main areas of importance. Building-related measures provide the largest contribution to energy-demand reduction, particularly through improvements in municipal and residential buildings. Transport measures, especially those affecting private-transport demand, provide the largest contribution to CO₂ emission reductions. These sectors should therefore remain central to monitoring because delays or lower-than-expected implementation rates could substantially affect the municipality's overall progress.

The results also reveal a difference between energy savings and emission reductions. Energy demand decreases more strongly than CO₂ emissions, indicating that demand-side and efficiency measures alone do not fully decarbonise the remaining energy supply. Further progress would therefore require not only additional energy-efficiency and transport measures but also stronger action related to fuel substitution, renewable energy and the decarbonisation of electricity and heat supply.

The policy scenario remains above the model's illustrative long-term CO₂ target trajectory. However, this should not be interpreted as a direct assessment of formal IEKRP2030 target achievement, because the CommitClimate simulation and IEKRP2030 differ in their baseline years, sectoral coverage and time horizons. The model results are more appropriately used to identify trends, compare alternative policy pathways and highlight sectors in which additional measures may be needed.

For future IEKRP2030 monitoring and review, the CommitClimate results can therefore support:

- comparison of actual developments with the modelled baseline and policy trajectories;
- identification of sectors in which implementation is progressing more slowly than expected;
- assessment of whether the current combination of measures remains sufficient;
- identification of sectors and energy sources requiring additional or more ambitious action;
- development of updated scenarios when new municipal data become available.

5.3. Link with the Cēsis feasibility study

The Cēsis feasibility study prepared within CommitClimate focuses on improving energy efficiency in historic brick public buildings while preserving cultural heritage.

This feasibility study complements the Cēsis simulation report by providing a more detailed assessment of one locally relevant priority area. It links directly to the IEKRP2030 municipal infrastructure and municipal buildings sector, where building renovation, energy efficiency and responsible management of municipal assets are important priorities.

The feasibility study adds practical value to the broader modelling exercise by showing how general energy efficiency objectives can be translated into a more specific local implementation context. This is particularly relevant for Cēsis Municipality, where historic buildings form an important part of the built environment and require renovation approaches that balance energy performance with heritage preservation.

5.4. Municipality feedback and practical relevance

Feedback from Cēsis Municipality confirms the relevance of the CommitClimate CO₂ simulator and simulation results for local planning.

The municipality noted that the model outputs effectively illustrate both the current energy situation and future goals. The results were considered to align closely with existing municipal planning documents and to support the visualisation and analysis of alternative development scenarios.

Cēsis Municipality also highlighted that the model supports structured, data-driven climate mitigation planning, investment prioritisation, stakeholder communication and alignment with national and EU-level reporting requirements. The flexibility to adjust assumptions and test different scenarios was considered particularly valuable for identifying effective local mitigation strategies.

At the same time, the municipality pointed out that further localisation of assumptions and policy parameters would improve practical use. In particular, more flexible annual implementation rates and more sector-specific policy options would help better reflect local conditions and implementation capacity.

5.5. Scope and limitations

The CommitClimate simulation report should be understood as a supporting analytical document. It does not by itself formally amend, replace or update the Cēsis IEKRP2030. Its results may nevertheless be used as analytical input for the implementation, monitoring and review of the existing plan, as well as for the preparation of future SECAP updates or new municipal climate and energy planning documents.

There are also differences in scope and time horizon. The IEKRP2030 focuses on actions and targets up to 2030, while the CommitClimate simulation report provides a longer-term scenario analysis up to 2050. Therefore, the model results should not be interpreted as a direct assessment of formal IEKRP2030 target achievement, but rather as an additional tool for long-term reflection, monitoring and future planning.

Some IEKRP2030 areas are only partly covered or not covered by the simulation. Climate change adaptation, climate risk management, green infrastructure and CO₂ sequestration are outside the main

scope of the CommitClimate CO₂ model. Local energy production is included in the model structure, but no detailed policy analysis was conducted for Cēsis due to the available baseline data.

The quantitative results of the CommitClimate simulation should not be directly compared with the formal IEKRP2030 target values without harmonising the baseline year, sectoral scope and time horizon.

These limitations should be considered when interpreting the results. However, they do not reduce the value of the model as a planning-support tool. Instead, they show where future data development, sectoral expansion and additional scenario work may be needed.

5.6. Use of CommitClimate results for future SECAP monitoring and review

The Cēsis IEKRP2030 includes a regular monitoring and review approach. The CommitClimate simulation results can support this process by providing an additional scenario-based perspective on energy demand, emission trends and the potential impact of selected measures.

The modelling approach may also support the preparation of new or updated SECAP/SEAP-type documents. It can contribute to the analytical stages of plan development by supporting baseline assessment, testing alternative policy packages, comparing development pathways and identifying sectors in which additional action may be required.

In practical terms, the model can be used to:

- develop and compare baseline and policy scenarios;
- assess the potential effects of proposed climate and energy measures;
- identify sectors with the largest energy- and emission-reduction potential;
- assess whether the selected combination of measures is sufficient to move towards long-term climate objectives;
- support the prioritisation of measures during SECAP preparation or revision;
- compare observed developments with modelled trajectories during monitoring;
- support discussions with municipal stakeholders on additional or more ambitious measures;
- provide visual and quantitative material for stakeholder communication;
- support future updates and reviews of existing municipal climate and energy plans.

Overall, the CommitClimate Cēsis simulation report is closely linked to the mitigation and energy-planning components of the Cēsis IEKRP2030, particularly in the sectors of municipal buildings, residential buildings, public infrastructure and transport. It provides a quantitative and scenario-based analytical layer that can complement the existing planning document and support its implementation, monitoring and future review. The same modelling approach may also provide analytical input for the development of new or updated SECAP/SEAP-type documents. However, the model remains a planning-support tool and does not replace the formal preparation, stakeholder consultation and political adoption of a municipal climate and energy plan.

6. CONCLUSIONS

The scenario analysis for Cēsis Municipality demonstrates that the selected policy package can deliver meaningful reductions in both energy demand and greenhouse gas emissions by 2050, despite the assumed gradual increase in population and activity levels.

Compared with the 2050 baseline scenario, total energy demand decreases by approximately 17.9%, corresponding to annual savings of 201,648.6 MWh. CO₂ emissions decrease by approximately 13.8%, corresponding to annual emission savings of 19,552.4 tonnes CO₂. The smaller relative reduction in emissions than in energy demand reflects the composition of the selected measures and the limited coverage of energy-supply decarbonisation.

Municipal buildings provide the largest quantified contribution to energy savings. Building-envelope improvements, operational measures, electricity-saving measures and renewable electricity generation reduce municipal-building energy demand by 83,207 MWh/year, or 16.7%, and CO₂ emissions by 1,549 tonnes CO₂/year, or 12.7%.

Private transport provides the second-largest contribution to energy savings and the largest contribution to emission reductions. The tested car-sharing and freight-demand-reduction measures reduce private-transport energy demand by 60,413 MWh/year, or 14.3%, and CO₂ emissions by 13,303 tonnes CO₂/year, or 13.9%. Private transport therefore accounts for approximately two-thirds of the total quantified emission reduction achieved by the policy package.

Residential-building measures also make a substantial contribution. The selected renovation, energy-efficiency and renewable-energy measures reduce residential energy demand by 48,975 MWh/year, or 26.8%, and CO₂ emissions by 1,617 tonnes CO₂/year, or 18.6%. These results demonstrate the importance of long-term renovation strategies for reducing energy demand in Cēsis Municipality.

The municipal vehicle fleet and **public transport** show particularly high relative reduction rates, although their absolute contributions are smaller because these sectors represent comparatively limited shares of total municipal energy consumption. Municipal-fleet measures reduce energy demand by 52.1% and emissions by 86.1%, while public-transport operational-efficiency and route-optimisation measures reduce both energy demand and emissions by approximately 46.7%.

Public-infrastructure measures provide smaller but clearly measurable savings, reducing energy demand by 1,276 MWh/year and CO₂ emissions by 133 tonnes CO₂/year. Renewable electricity use in public lighting reaches approximately 304.2 MWh/year.

The waste-generation measure reduces projected municipal waste generation by approximately 1,183 tonnes/year, or 6.2%, while waste-management emissions decrease by approximately 406 tonnes CO₂eq/year, or 2.0%. The relatively small emission reduction indicates that waste-prevention measures alone have a limited effect on total waste-sector emissions and could be complemented by additional measures addressing waste treatment and disposal.

The selected policy package is not sufficient to reach the model's illustrative long-term CO₂-reduction trajectory. The policy scenario achieves a 13.8% reduction compared with the 2050 baseline, while the modelled target trajectory represents a reduction of approximately 20%. This comparison is illustrative and should not be interpreted as a formal assessment of IEKRP2030 target achievement.

A significant limitation is that other economic sectors and local energy production were not included in the Cēsis baseline inventory and policy analysis. Consequently, the simulation does not quantify

potential reductions from commercial and industrial activities, local electricity generation, district-heating decarbonisation or other energy-supply measures. Climate adaptation, climate-risk management, green infrastructure and CO₂ sequestration are also outside the scope of the model.

The results should be interpreted as scenario-based estimates rather than official municipal projections. The calculations rely on aggregated data and modelling assumptions concerning population development, building stock, transport activity, vehicle use, fuel consumption, public services and waste generation. Further localisation and validation of these inputs would improve the reliability of future simulations.

Overall, the analysis shows that energy-efficiency improvements in municipal and residential buildings and demand-side measures in private transport provide the largest absolute contributions to the modelled reductions. Fleet decarbonisation, public-transport optimisation and public-infrastructure improvements provide additional measurable benefits. Achieving deeper long-term decarbonisation would require a broader and more integrated policy package, including measures in currently unaddressed sectors and stronger integration between energy-demand reduction, transport policy, waste management and energy-supply decarbonisation.

Table 1. Summary Table of Key Quantitative Results (2050)

Sector	Indicator	Results
Municipal buildings	Energy savings	83 207 MWh (16.7 %)
	Emission reduction	1 549 tCO ₂ (12.7 %)
	Renewable generation	289 MWh
Residential buildings	Energy savings	48 975 MWh (26.8 %)
	Emission reduction	1 591 tCO ₂ (18.3 %)
	Renewable generation	577 MWh
Public infrastructure	Energy savings	1 365 (20.9 %)
	Emission reduction	141 tCO ₂ (24.4 %)
	Renewable generation	304.2 MWh
Other sectors	Energy savings	–
	Emission reduction	–
Municipal fleet	Energy savings	3 618 MWh (52.1 %)
	Emission reduction	1 437 tCO ₂ (86.1 %)
Public transport	Energy savings	4 118 MWh (46.7 %)
	Emission reduction	1 095 tCO ₂ (46.7 %)
Private transport	Energy savings	60 042 MWh (14.3 %)
	Emission reduction	13 215 tCO ₂ (13.9 %)
Waste management	Waste generation reduction	2 235 (11.8 %)
	Emission reduction	405 tCO ₂ eq (2.0 %)
Local energy production	Energy savings	–
	Emission reduction	–