



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

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This document presents an assessment of future energy demand and CO₂ emissions in Rīga municipality 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 Rīga'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 Rīga 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

Rīga Municipality has an existing municipal energy and climate planning document: Rīgas pilsētas ilgtspējīgas enerģētikas un klimata rīcības plāns līdz 2030. gadam / Sustainable Energy and Climate Action Plan of the City of Rīga until 2030 (hereinafter: Rīga SECAP2030 / REK2030).

The Rīga SECAP2030 provides the strategic framework for municipal energy and climate action up to 2030. It addresses key areas of local climate mitigation and energy transition, including municipal infrastructure, buildings, transport and mobility, energy production, waste management, circular economy and climate adaptation.

The CommitClimate simulation report does not replace, formally amend or update the Rīga SECAP2030. 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.

The added value of the CommitClimate modelling is that it allows selected policy measures to be tested quantitatively and compared with a baseline development pathway. This helps assess whether selected actions are sufficient to reduce energy demand and CO₂ emissions, and where additional or more ambitious measures may be needed in future planning cycles.

2. Scope of the CommitClimate simulation report

The CommitClimate simulation report for Rīga 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, other sectors, 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 mainly on large-scale residential building renovation, public lighting improvements, municipal fleet electrification and reduction of private transport demand.

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

The total floor area of municipal buildings included in the Rīga simulation is 1 423 397 m². Schools account for 866 200 m², kindergartens for 319 311 m², administrative buildings for 102 000 m², sports facilities for 36 600 m², hospitals for 50 600 m² and cultural facilities for 48 686 m². No buildings are included in the “Other” category.

In 2021, the final energy consumption of municipal buildings amounted to 274 032 MWh/year, corresponding to approximately 2.5 % of the municipality’s total energy consumption. District heating was the largest energy source, accounting for 146 188 MWh/year or 53.3 % of the sector’s final energy consumption. Individual heating accounted for 80 471 MWh/year or 29.4 %, while electricity consumption for appliances amounted to 47 371 MWh/year or 17.3 %. Cooking gas consumption was negligible, at 2 MWh/year.

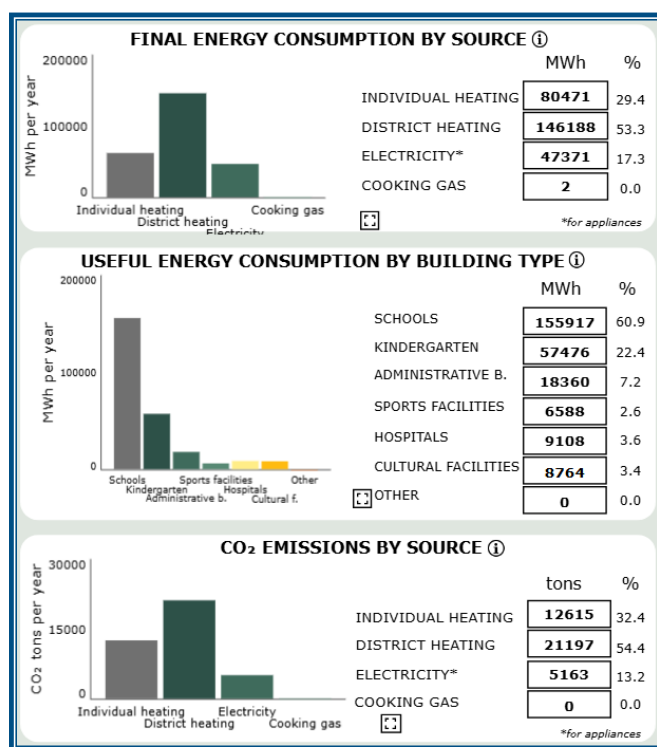
Electricity reported under the electricity category refers to electricity used for appliances. Electricity used for heating is included under individual heating.

The useful-energy results by building type show that schools are the largest consumer, with 155 917 MWh/year or 60.9 % of useful energy consumption. Kindergartens account for 57 476 MWh/year or 22.4 %, administrative buildings for 18 360 MWh/year or 7.2 %, hospitals for 9 108 MWh/year or 3.6 %, cultural facilities for 8 764 MWh/year or 3.4 %, and sports facilities for 6 588 MWh/year or 2.6 %. The “Other” category accounts for 0 MWh/year.

The weighted average specific heat consumption of the municipal building stock is 147 kWh/m²/year, while the weighted average specific electricity consumption is 33 kWh/m²/year.

CO₂ emissions associated with energy consumption in municipal buildings amount to 38 976 tonnes CO₂/year, corresponding to approximately 1.9 % of the municipality’s total CO₂ emissions. District heating is the largest emission source, generating 21 197 tonnes CO₂/year or 54.4 % of sectoral emissions. Individual heating generates 12 615 tonnes CO₂/year or 32.4 %, while electricity consumption for appliances generates 5 163 tonnes CO₂/year or 13.2 %. Emissions associated with cooking gas are negligible.

Under the baseline assumptions, no changes in the municipal building area, specific energy consumption or energy-source structure are modelled. Consequently, energy consumption and CO₂ emissions remain unchanged between 2021 and 2050.



Policies

No additional policy measures were proposed or tested for municipal buildings in this simulation. Consequently, the policy scenario remains identical to the baseline scenario, and no additional energy savings or CO₂ emission reductions are projected for this sector.

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

The total floor area of residential buildings included in the Rīga simulation is 20 100 000 m². Large multi-family buildings account for 18 615 000 m², while buildings classified under the “Other” category account for 1 485 000 m². No floor area is assigned to single-family detached or single-family attached houses in the model.

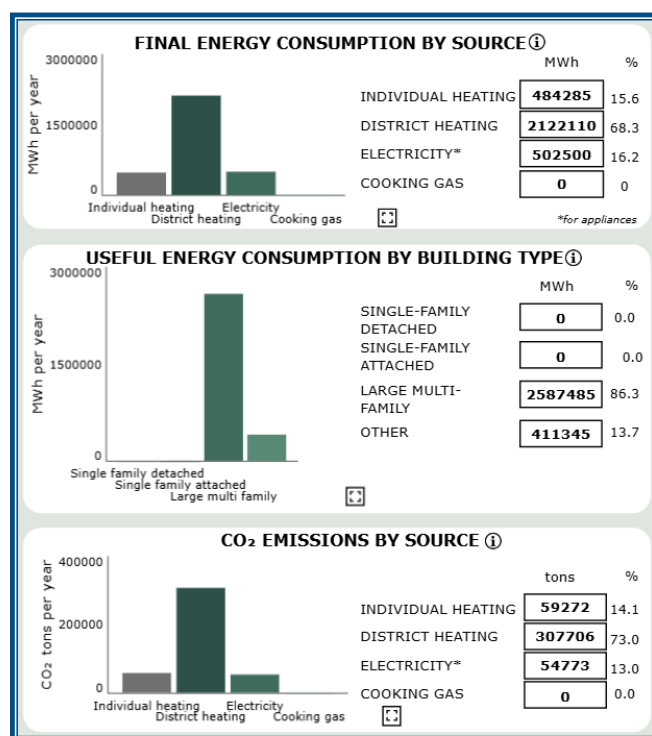
In 2021, final energy consumption in residential buildings amounted to 3 108 895 MWh/year, corresponding to approximately 28.6 % of the municipality’s total energy consumption. District heating was the dominant energy source, accounting for 2 122 110 MWh/year or 68.3 % of residential final energy consumption. Individual heating accounted for 484 285 MWh/year or 15.6 %, while electricity consumption for household appliances amounted to 502 500 MWh/year or 16.2 %. No cooking gas consumption was included.

Electricity reported under the electricity category refers to electricity used for household appliances. Electricity used for heating is included under individual heating.

The useful-energy results by building type show that large multi-family buildings account for 2 587 485 MWh/year or 86.3 % of useful energy consumption. Buildings in the “Other” category account for 411 345 MWh/year or 13.7 %. Single-family detached and single-family attached houses account for 0 MWh/year. The weighted average specific heat consumption of the residential building stock is 124 kWh/m²/year, while the weighted average specific electricity consumption is 25 kWh/m²/year.

CO₂ emissions associated with residential energy consumption amount to 421 750 tonnes CO₂/year, corresponding to approximately 18,9 % of the municipality’s total CO₂ emissions. District heating is the largest emission source, generating 307 706 tonnes CO₂/year or 73.0 % of residential emissions. Individual heating generates 59 272 tonnes CO₂/year or 14.1 %, while electricity consumption for household appliances generates 54 773 tonnes CO₂/year or 13.0 %. No emissions are associated with cooking gas.

Under the baseline assumptions, no changes in the residential building area or specific energy consumption are modelled. Consequently, residential energy consumption and CO₂ emissions remain unchanged between 2021 and 2050.



Policies

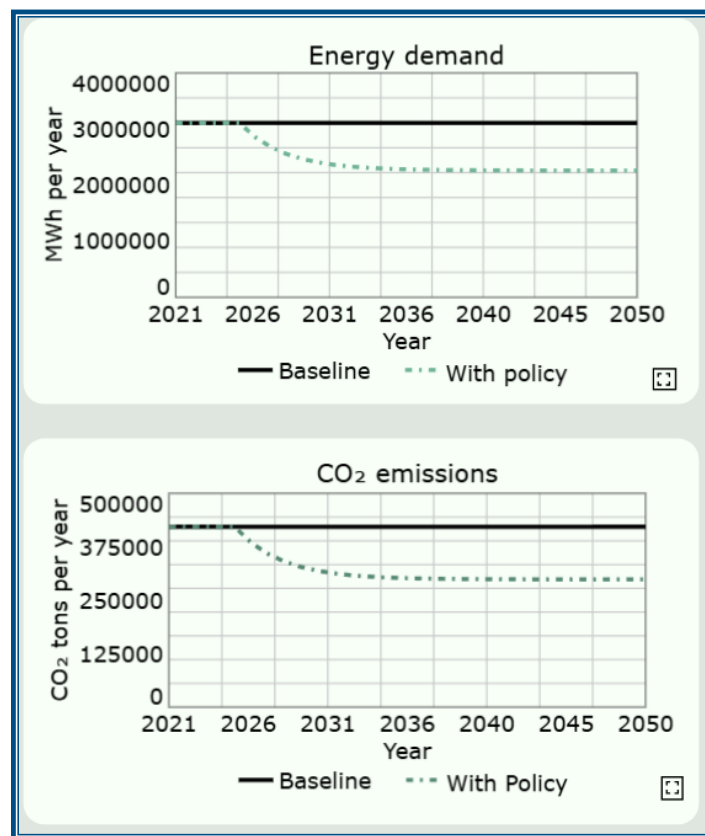
To reduce energy consumption and emissions, a comprehensive multi-family home renovation strategy was tested, starting in 2025.

- **Renovation of multi-family houses** (IS 30 %/year, ES 40 %)

The policy implementation period extends from 2025 to 2050.

Following the introduction of the policy in 2025, residential energy consumption and CO₂ emissions decrease rapidly during the first years of implementation. The rate of reduction gradually slows as the renovation potential is exhausted.

By 2050, the renovation policy reduces residential energy consumption by 848 730 MWh/year compared with the baseline scenario, corresponding to a reduction of 27.3 %. CO₂ emissions decrease by 123 068 tonnes CO₂/year, corresponding to a reduction of 29.2 %. No additional renewable energy production is introduced under this policy.



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 2021, total electricity consumption in the public infrastructure sector amounted to approximately 75 282 MWh/year. Public lighting was the largest consumer, accounting for 30 775 MWh/year. Wastewater treatment consumed 27 817 MWh/year, while clean water preparation consumed 16 690 MWh/year.

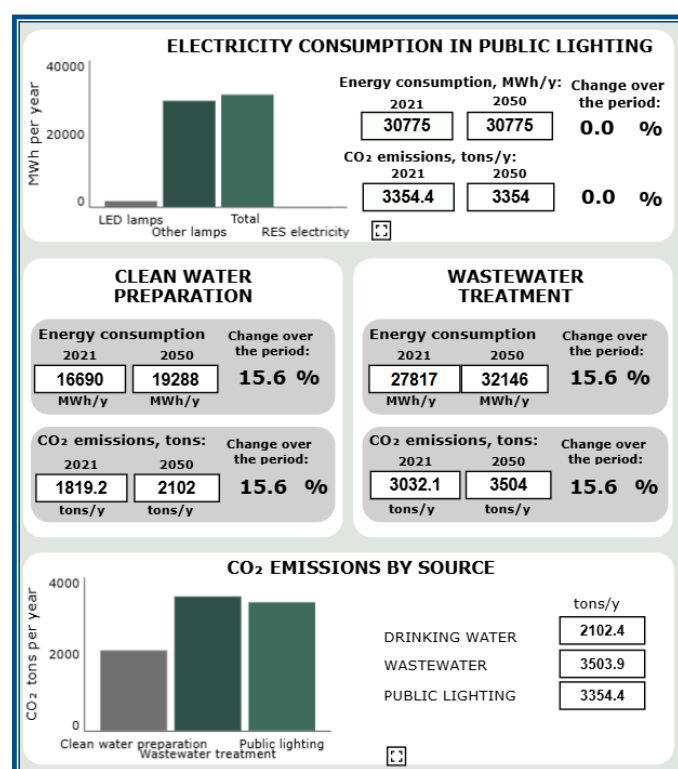
Electricity consumption for public lighting is assumed to remain constant at 30 775 MWh/year throughout the baseline scenario. By contrast, electricity consumption for clean water preparation and wastewater treatment increases in line with population growth. Between 2021 and 2050, electricity consumption for clean water preparation increases by 15.6 %, reaching 19 288 MWh/year. Electricity consumption for wastewater treatment also increases by 15.6 %, reaching 32 146 MWh/year.

Consequently, total electricity consumption in the public infrastructure sector increases to approximately 82 208 MWh/year by 2050. In 2050, public lighting accounts for 37.4 % of sectoral electricity consumption, wastewater treatment for 39.1 %, and clean water preparation for 23.5 %. The sector represents approximately 0.8 % of the municipality's total energy consumption in 2050.

The specific electricity consumption assumptions used in the model are 615 kWh per light bulb per year for public lighting, 0.41 kWh/m³ for clean water preparation and 0.41 kWh/m³ for wastewater treatment.

In 2021, CO₂ emissions associated with public infrastructure electricity consumption amount to approximately 8 206 tonnes CO₂/year. Public lighting generates 3 354.4 tonnes CO₂/year, wastewater treatment generates 3 032.1 tonnes CO₂/year, and clean water preparation generates 1 819.2 tonnes CO₂/year.

By 2050, emissions from clean water preparation increase to 2 102.4 tonnes CO₂/year, while emissions from wastewater treatment increase to 3 503.9 tonnes CO₂/year. Emissions from public lighting remain unchanged at 3 354.4 tonnes CO₂/year. Total sectoral emissions therefore increase to approximately 8 961 tonnes CO₂/year by 2050, corresponding to approximately 0.4 % of the municipality's total CO₂ emissions.



Policies

The following policy measure was implemented in the public infrastructure sector:

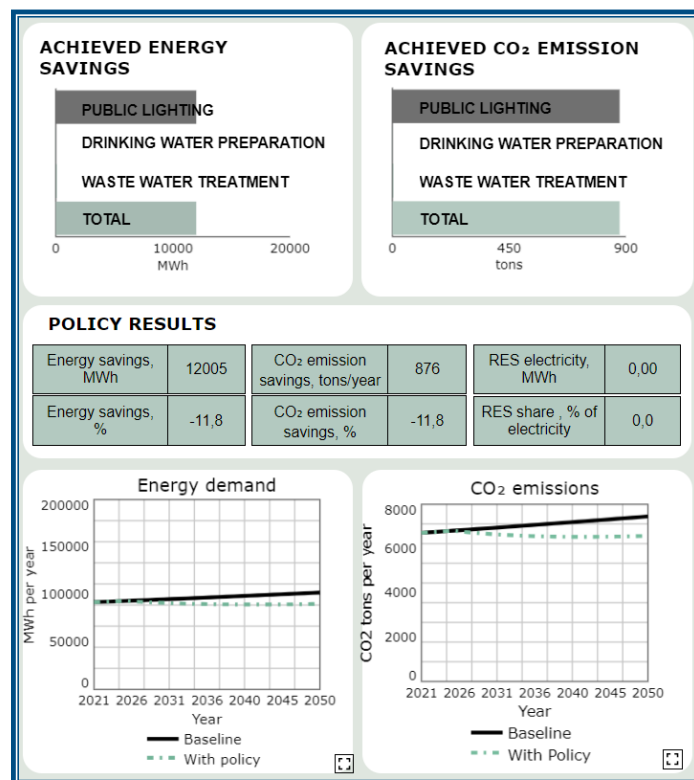
- **Replacement of inefficient light bulbs in public lighting (15 %/year)**

The policy implementation period extends from 2025 to 2050. No additional policies related to renewable electricity use, clean water preparation or wastewater treatment were activated in this scenario.

By 2050, the replacement of inefficient public lighting reduces electricity consumption by 15 006 MWh/year compared with the baseline scenario. This corresponds to an 18.3 % reduction in the total energy demand of the public infrastructure sector. Energy consumption in the policy scenario reaches 67 202 MWh/year in 2050, compared with 82 208 MWh/year in the baseline scenario.

CO₂ emissions decrease by 1 636 tonnes CO₂/year compared with the baseline scenario, also corresponding to an 18.3 % reduction. In 2050, sectoral CO₂ emissions amount to 7 325 tonnes CO₂/year under the policy scenario, compared with 8 961 tonnes CO₂/year in the baseline scenario.

The policy offsets the increase in electricity consumption and emissions caused by population-driven growth in clean water preparation and wastewater treatment. No renewable electricity production is introduced under this policy.



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 2021, total energy consumption in Other sectors amounted to 4 084 000 MWh/year, corresponding to approximately 37.6 % of the municipality's total energy consumption.

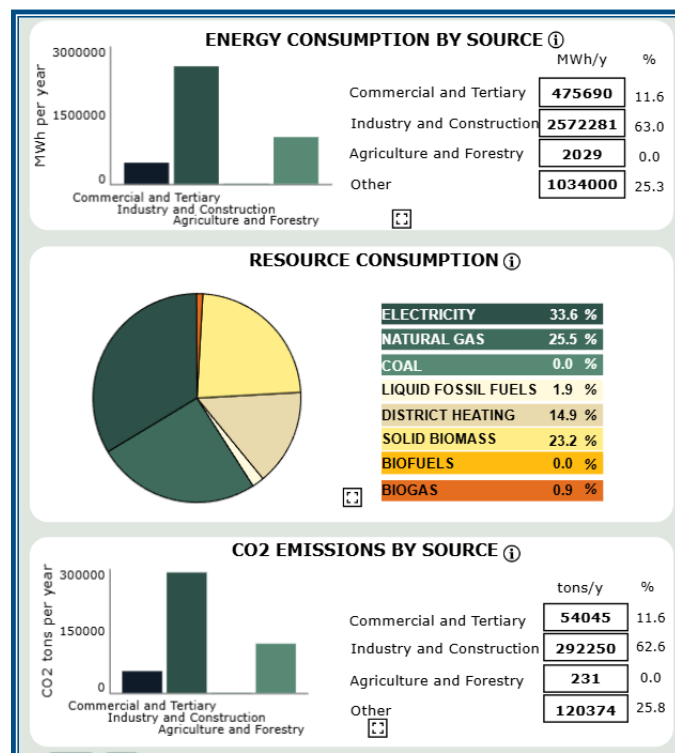
Industry and Construction is the largest sub-sector, consuming 2 572 281 MWh/year or 63.0 % of the sector's total energy demand. The "Other" sub-sector accounts for 1 034 000 MWh/year or 25.3 %, while Commercial and Tertiary activities consume 475 690 MWh/year or 11.6 %. Agriculture and Forestry accounts for 2 029 MWh/year and therefore represents less than 0.1 % of the sector's total energy consumption.

Electricity is the largest energy carrier, accounting for 33.6 % of total energy consumption in Other sectors. Natural gas accounts for 25.5 %, solid biomass for 23.2 %, district heating for 14.9 %, liquid fossil fuels for 1.9 %, and biogas for 0.9 %. Coal and biofuels are not included in the energy mix.

Total CO₂ emissions associated with energy consumption in Other sectors amount to 466 900 tonnes CO₂/year, corresponding to approximately 20.9 % of the municipality's total CO₂ emissions.

Industry and Construction is responsible for 292 250 tonnes CO₂/year or 62.6 % of sectoral emissions. The "Other" sub-sector generates 120 374 tonnes CO₂/year or 25.8 %, while Commercial and Tertiary activities generate 54 045 tonnes CO₂/year or 11.6 %. Agriculture and Forestry generates 231 tonnes CO₂/year and therefore accounts for less than 0.1 % of sectoral emissions.

No changes in the activity levels, energy demand or energy-source structure of these sub-sectors are assumed in the baseline scenario. Consequently, energy consumption and CO₂ emissions remain unchanged between 2021 and 2050.



Policies

No additional policy measures were proposed or tested for Other sectors in this simulation. Consequently, the policy scenario remains identical to the baseline scenario, and no additional energy savings or CO₂ emission reductions are projected for this sector.

3.5. TRANSPORT

The transport sector is a significant source of municipal energy consumption and greenhouse gas emissions, primarily because of its continued dependence on fossil fuels. The simulation covers the municipal vehicle fleet, public transport and private transport. Only land transport and CO₂ emissions associated with energy consumption are considered.

The transport-sector results are calculated using assumptions concerning transport demand, vehicle use, annual mileage, occupancy, fuel consumption and technology distribution. They are not derived directly from fuel invoices or a complete transport-energy inventory. Consequently, some differences between the calculated results and statistical or inventory data may occur.

Current situation

Municipal vehicle fleet

The municipal vehicle fleet consists of 1 444 vehicles: 697 passenger cars, 277 light-duty vehicles (LDVs), 162 heavy-duty vehicles (HDVs) and 308 vehicles classified as “Other”.

In 2021, the calculated energy consumption of the municipal vehicle fleet amounted to 13 447 MWh/year, corresponding to approximately 0.1% of the municipality’s total energy consumption.

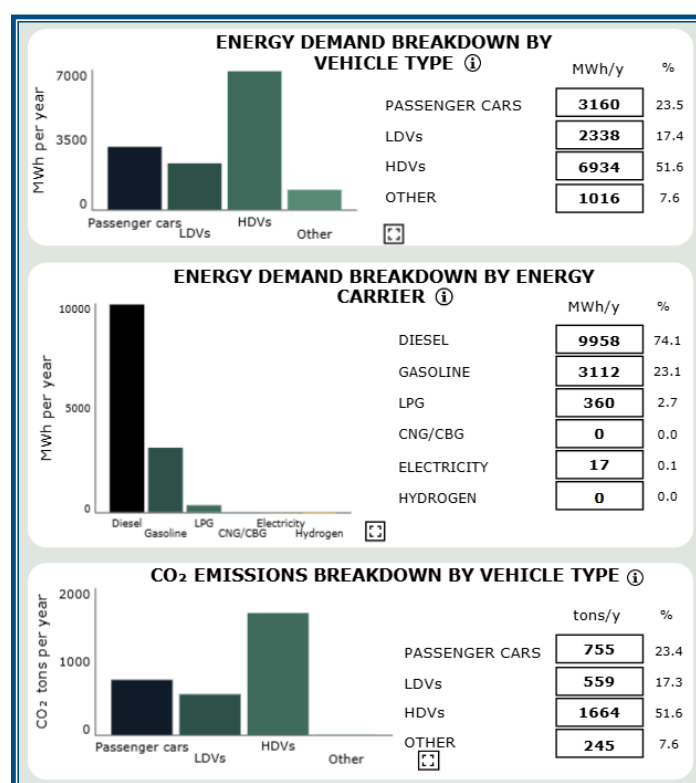
HDVs are the largest energy consumer, accounting for 6 934 MWh/year or 51.6% of the fleet’s energy demand. Passenger cars consume 3 160 MWh/year or 23.5%, LDVs consume 2 338 MWh/year or 17.4%, and other vehicles consume 1 016 MWh/year or 7.6%.

Diesel is the dominant energy carrier, accounting for 9 958 MWh/year or 74.1% of municipal fleet energy consumption. Gasoline accounts for 3 112 MWh/year or 23.1%, LPG for 360 MWh/year or 2.7%, and electricity for 17 MWh/year or 0.1%. No CNG/CBG or hydrogen consumption is included.

The weighted average fleet emission factor is 321 gCO₂/km. The vehicle-type emission factors are 174 gCO₂/km for passenger cars, 234 gCO₂/km for LDVs, 732 gCO₂/km for HDVs and 241 gCO₂/km for other vehicles.

Total CO₂ emissions from the municipal vehicle fleet amount to 3 223 tonnes CO₂/year, corresponding to approximately 0.1% of the municipality’s total CO₂ emissions. HDVs generate 1 664 tonnes CO₂/year or 51.6% of fleet emissions. Passenger cars generate 755 tonnes CO₂/year or 23.4%, LDVs generate 559 tonnes CO₂/year or 17.3%, and other vehicles generate 245 tonnes CO₂/year or 7.6%.

The baseline scenario assumes no changes in the municipal vehicle fleet, annual mileage, fuel consumption or technology distribution. Consequently, energy consumption and CO₂ emissions remain unchanged between 2021 and 2050.



Public transport

Annual public transport demand included in the simulation amounts to 940.6 million passenger-kilometres. All modelled demand is attributed to local residents, while demand from other commuters is set to zero. City public transport accounts for 752.5 million passenger-kilometres or 80% of total demand, while regional public transport accounts for 188.1 million passenger-kilometres or 20%.

Based on the assumptions concerning transport-mode allocation, vehicle occupancy, fuel economy and energy carriers, public transport energy consumption amounts to 187 783 MWh/year in 2021. Due to the assumed population increase, energy consumption rises by 15.6%, reaching 217 006 MWh/year in 2050. In 2050, public transport accounts for approximately 2.0% of the municipality's total energy consumption.

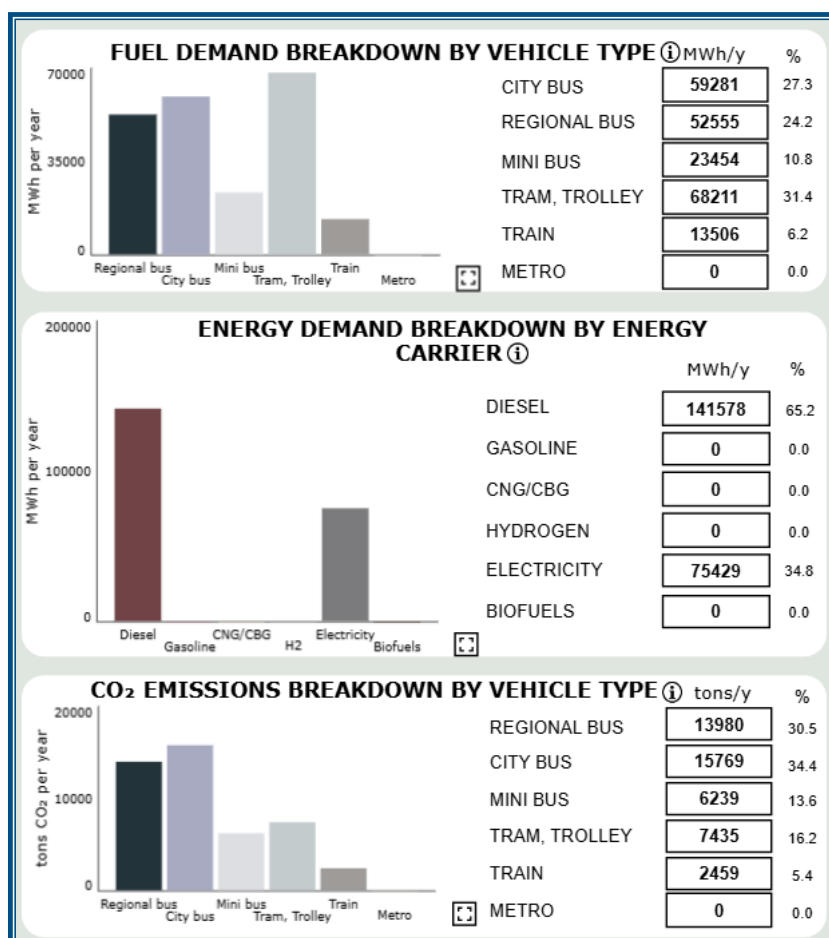
In 2050, trams and trolleybuses are the largest public transport energy consumers, accounting for 68 211 MWh/year or 31.4% of sectoral energy demand. City buses consume 59 281 MWh/year or 27.3%, regional buses consume 52 555 MWh/year or 24.2%, minibuses consume 23 454 MWh/year or 10.8%, and trains consume 13 506 MWh/year or 6.2%. No metro energy demand is included.

Diesel is the dominant public transport energy carrier, accounting for 141 578 MWh/year or 65.2% of total energy demand in 2050. Electricity accounts for 75 429 MWh/year or 34.8%. No gasoline, CNG/CBG, hydrogen or biofuel consumption is included.

Public transport CO₂ emissions amount to 39 703 tonnes CO₂/year in 2021 and increase by 15.6% to 45 881 tonnes CO₂/year in 2050. This corresponds to approximately 2.1% of the municipality's total CO₂ emissions in 2050.

In 2050, city buses generate 15 769 tonnes CO₂/year or 34.4% of public transport emissions. Regional buses generate 13 980 tonnes CO₂/year or 30.5%, trams and trolleybuses generate 7 435 tonnes CO₂/year

or 16.2%, minibuses generate 6 239 tonnes CO₂/year or 13.6%, and trains generate 2 459 tonnes CO₂/year or 5.4%.



Private transport

Annual private passenger transport demand included in the simulation amounts to 5 968.7 million passenger-kilometres. All modelled passenger demand is attributed to local residents, while demand from guests is set to zero.

Private transport energy consumption amounts to 2 786 496 MWh/year in 2021. Due to the assumed population increase, energy consumption rises by 9.8%, reaching 3 059 239 MWh/year in 2050. Private transport therefore accounts for approximately 28.2% of the municipality's total energy consumption in 2050.

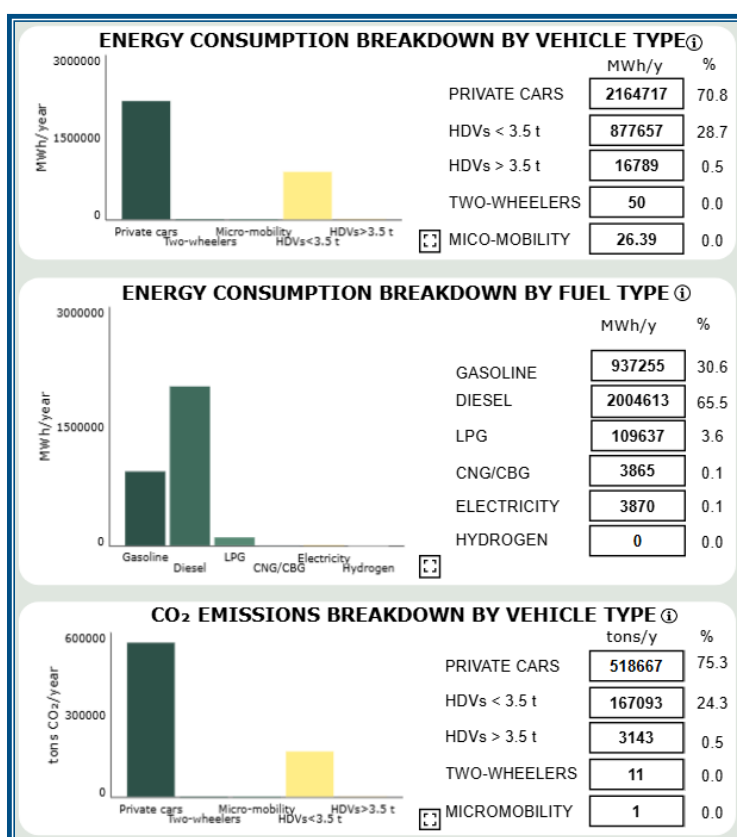
Private cars are the largest energy consumers, accounting for 2 164 717 MWh/year or 70.8% of private transport energy demand in 2050. Vehicles below 3.5 tonnes consume 877 657 MWh/year or 28.5%, while vehicles above 3.5 tonnes consume 16 789 MWh/year or 0.5%. Energy demand from two-wheelers and micro-mobility is negligible.

Diesel is the dominant fuel, accounting for 2 004 613 MWh/year or 65.5% of private transport energy demand in 2050. Gasoline accounts for 937 255 MWh/year or 30.7%, LPG for 109 637 MWh/year or 3.6%,

CNG/CBG for 3865 MWh/year or 0.1%, and electricity for 3 870 MWh/year or 0.1%. No hydrogen consumption is included.

Private transport CO₂ emissions amount to 623 567 tonnes CO₂/year in 2021 and increase by 10.5% to 688 916 tonnes CO₂/year in 2050. Private transport accounts for approximately 31.0% of the municipality's total CO₂ emissions in 2050.

Private cars generate 518 667 tonnes CO₂/year or 75.3% of private transport emissions. Vehicles below 3.5 tonnes generate 167 093 tonnes CO₂/year or 24.3%, while vehicles above 3.5 tonnes generate 3 143 tonnes CO₂/year or 0.5%. Emissions from two-wheelers and micro-mobility are negligible.



Policies

Municipal vehicle fleet

In this sector, a single policy measure was proposed:

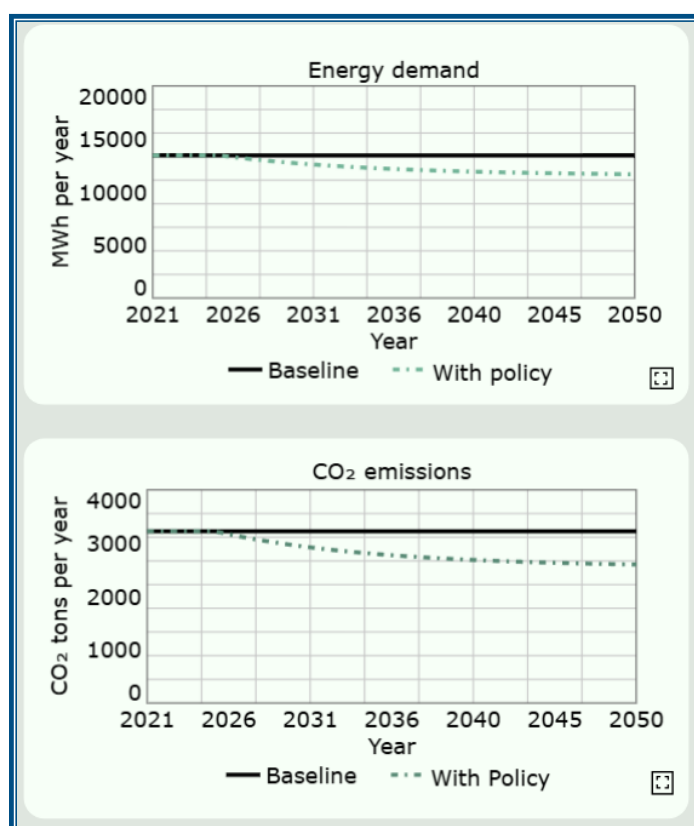
- **Passenger vehicle fleet decarbonization** (*Target technology choice Electric vehicles - 100 %*)

The policy start year was 2025 and the implementation end year was 2050.

The policy implementation period extends from 2025 to 2050. The measure applies to passenger cars. No additional decarbonisation measure for other municipal vehicles, fleet-management improvement, driver training, awareness raising or renewable-energy measure was activated.

By 2050, the policy reduces municipal fleet energy consumption by 1 777 MWh/year compared with the baseline scenario, corresponding to a reduction of 13.2%. Energy consumption decreases from 13 447 MWh/year in the baseline scenario to 11 670 MWh/year in the policy scenario.

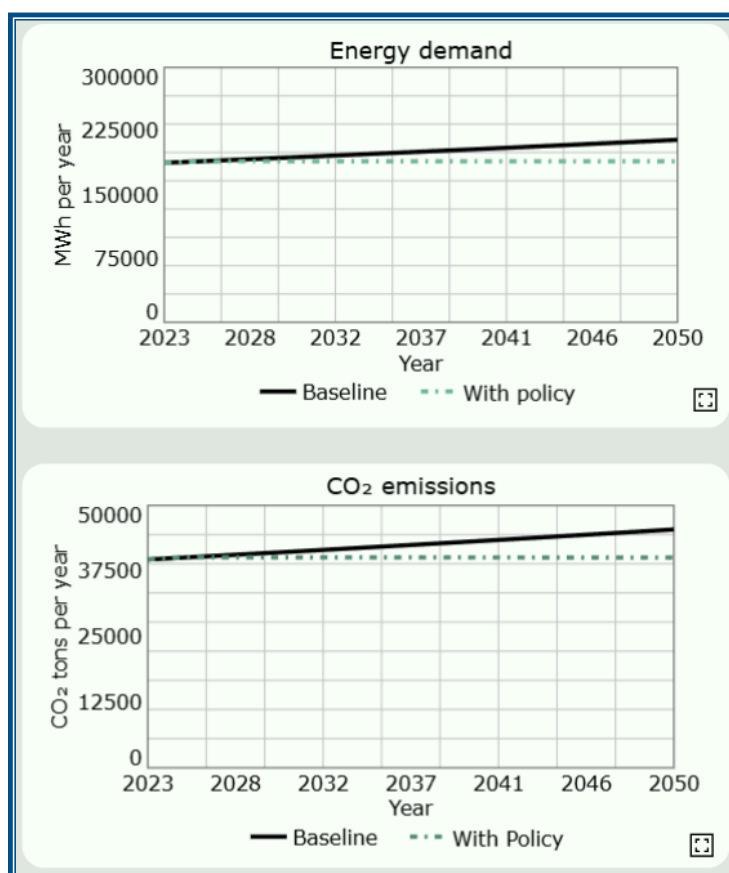
CO₂ emissions decrease by 623 tonnes CO₂/year or 19.3%, from 3 223 tonnes CO₂/year in the baseline scenario to approximately 2 600 tonnes CO₂/year in the policy scenario.



Public transport

Although no dedicated public transport policy was introduced, public transport demand is indirectly affected by the passenger travel demand-reduction measure applied within the private transport policy scenario. The measure reduces the general frequency of passenger travel and therefore affects total passenger-kilometres before travel demand is allocated between transport modes. Consequently, it reduces not only private transport activity but also the demand for public transport services.

By 2050, this indirect cross-sectoral effect reduces public transport energy consumption by 25,305 MWh/year and CO₂ emissions by 5,350 tonnes CO₂/year compared with the baseline scenario. Both energy consumption and emissions decrease by 11.8%. This effect accounts for most of the difference between the sum of the direct sectoral policy impacts and the overall energy and emission savings reported in the model.



Private transport

The following policy was implemented in the private transport sector:

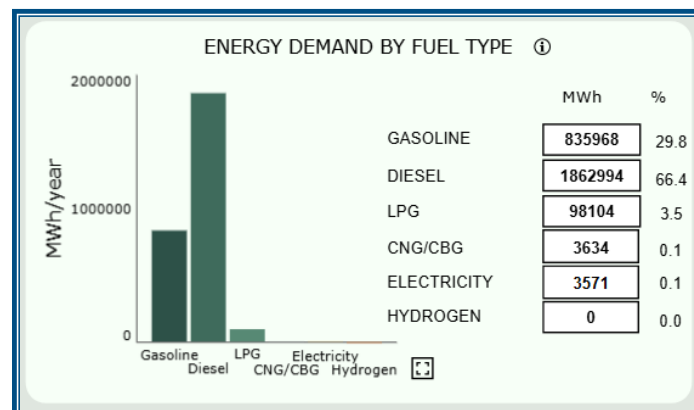
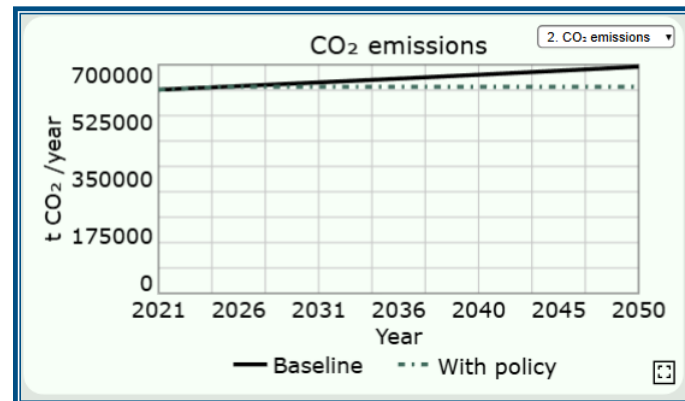
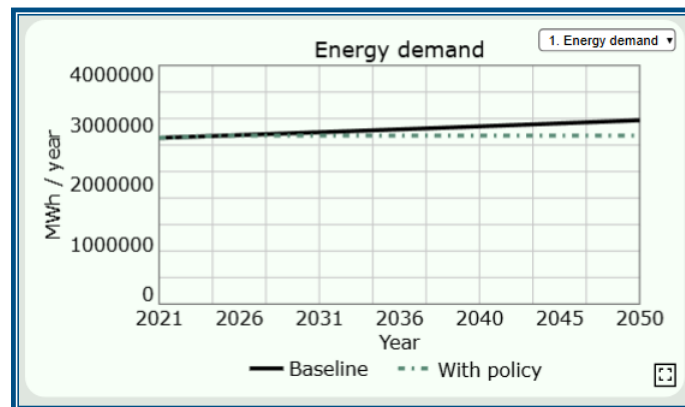
- **Reduction in passenger transport demand** (*Daily distance reduction IS 2 %/year, Travel frequency reduction IS 2 %/year*)

The policy implementation period extends from 2025 to 2050. No modal-shift, car-sharing, vehicle-technology transition or renewable-energy policies were activated.

By 2050, the demand-reduction policy reduces private transport energy consumption by 254 969 MWh/year compared with the baseline scenario, corresponding to a reduction of 8.3%. Energy consumption decreases from 3 059 239 MWh/year in the baseline scenario to 2 804 270 MWh/year in the policy scenario.

CO₂ emissions decrease by 61 090 tonnes CO₂/year or 8.9%, from 688 916 tonnes CO₂/year in the baseline scenario to approximately 627 826 tonnes CO₂/year in the policy scenario.

In the 2050 policy scenario, diesel consumption amounts to 1 873 628 MWh/year or 66.4% of private transport energy demand. Gasoline consumption amounts to 843 573 MWh/year or 29.9%, LPG to 98 970 MWh/year or 3.5%, CNG/CBG to 3 651 MWh/year or 0.1%, and electricity to 3 594 MWh/year or 0.1%.



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 baseline calculations are based on the projected population, the amount of municipal waste generated per inhabitant and the composition and treatment of municipal waste.

In 2021, municipal waste generation is assumed to be 478 kg per capita per year. With a population of approximately 621 120 inhabitants, this corresponds to a total of 296 895 tonnes of municipal waste.

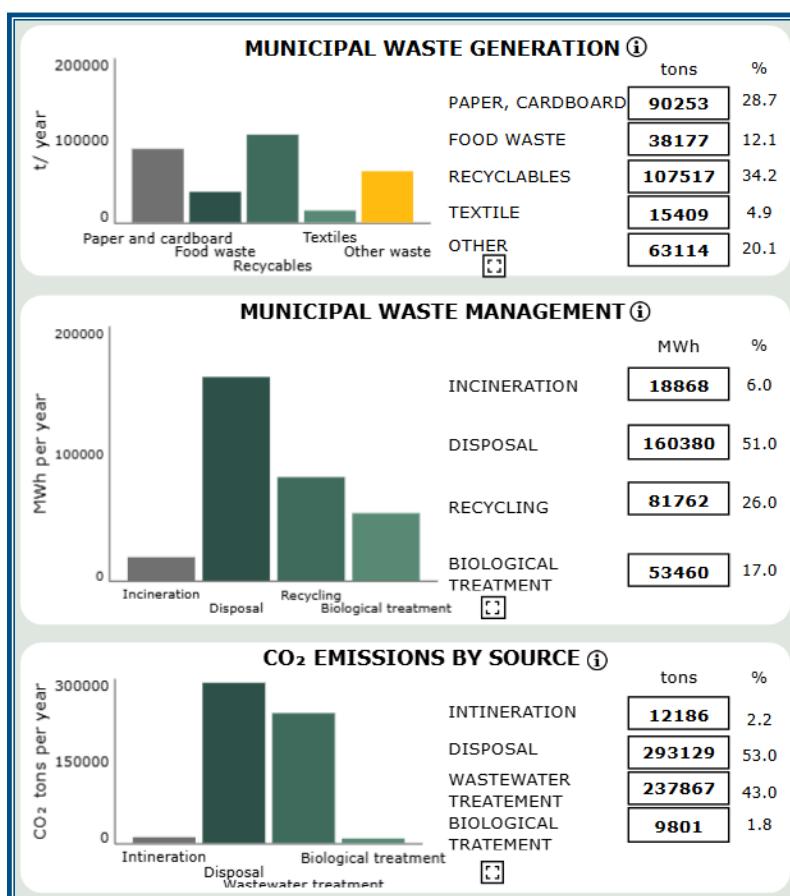
The baseline scenario assumes annual population growth of 0.5% and an annual reduction of 0.3% in waste generation per capita. Consequently, waste generation per capita decreases to approximately 438 kg per year by 2050. However, because the population increases, total municipal waste generation rises by 5.9%, reaching approximately 314 470 tonnes in 2050.

In 2050, recyclable materials constitute the largest waste category, accounting for 107 517 tonnes or 34.2% of total municipal waste. Paper and cardboard account for 90 253 tonnes or 28.7%, other waste for 63 114 tonnes or 20.1%, food waste for 38 177 tonnes or 12.1%, and textile waste for 15 409 tonnes or 4.9%.

According to the modelled waste-management distribution in 2050, 160 380 tonnes or 51.0% of municipal waste is sent for disposal. Recycling accounts for 81 762 tonnes or 26.0%, biological treatment for 53 460 tonnes or 17.0%, and incineration for 18 868 tonnes or 6.0%.

Greenhouse gas emissions associated with waste management amount to 503 339 tonnes CO₂-equivalent per year in 2021. By 2050, emissions increase by 9.9%, reaching approximately 552 982 tonnes CO₂-equivalent per year.

In 2050, waste disposal is the largest emission source, generating 293 129 tonnes CO₂-equivalent per year or 53.0% of sectoral emissions. Wastewater treatment generates 237 867 tonnes CO₂-equivalent per year or 43.0%, incineration generates 12 186 tonnes CO₂-equivalent per year or 2.2%, and biological treatment generates 9 801 tonnes CO₂-equivalent per year or 1.8%.



Policies

No additional policy measures were proposed or tested for waste management in this simulation. Consequently, the policy scenario remains identical to the baseline scenario, and no additional reductions in waste generation or greenhouse gas emissions are projected as a result of policy intervention.

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

In 2021, end-use district-heating demand amounts to 2 877 799 MWh/year. Residential buildings are the largest district-heating consumer, accounting for 2 122 110 MWh/year or 73.7% of total demand. Other sectors consume 609 501 MWh/year or 21.2%, while municipal buildings consume 146 188 MWh/year or 5.1%.

District-heating distribution losses amount to 431 670 MWh/year or 13.0% of the total heat supplied. Consequently, district-heat supply, including distribution losses, amounts to approximately 3 309 469 MWh/year in 2021.

End-use electricity demand amounts to 2 070 487 MWh/year in 2021. Other sectors account for 1 373 050 MWh/year or 66.3% of electricity demand, residential buildings for 502 500 MWh/year or 24.3%, public infrastructure for 75 282 MWh/year or 3.6%, transport for 68 838 MWh/year or 3.3%, and municipal buildings for 50 817 MWh/year or 2.5%.

Electricity-grid distribution losses increase the required grid supply to 2 153 307 MWh/year. Grid electricity accounts for 100% of the electricity supplied in the model. No local electricity production, electricity imports, exports or additional certified renewable electricity purchases are included.

Combined electricity and district-heat supply, including distribution losses, amounts to 5 462 776 MWh/year in 2021. Associated CO₂ emissions amount to 714 583 tonnes CO₂/year. District heating generates 479 873 tonnes CO₂/year or 67.2% of these emissions, while electricity generates 234 710 tonnes CO₂/year or 32.8%.

Policies

No policies specifically targeting local electricity production, local heat production, energy imports or exports were applied in the Rīga simulation. No local renewable electricity or heat-production technologies were introduced.

Nevertheless, the policies implemented in other sectors reduce the amount of electricity and district heat that must be supplied by the energy system.

By 2050, end-use district-heating demand decreases to 2 029 069 MWh/year. Residential buildings account for 1 273 380 MWh/year or 62.8%, Other sectors for 609 501 MWh/year or 30.0%, and municipal buildings for 146 188 MWh/year or 7.2%.

District-heating distribution losses amount to 304 360 MWh/year in 2050. Total district-heat supply, including distribution losses, therefore decreases to approximately 2 333 430 MWh/year.

End-use electricity demand amounts to 2 064 786 MWh/year in 2050. Other sectors account for 1 373 050 MWh/year or 66.5%, residential buildings for 502 500 MWh/year or 24.3%, transport for 71 217 MWh/year or 3.4%, public infrastructure for 67 202 MWh/year or 3.3%, and municipal buildings for 50 817 MWh/year or 2.5%.

After accounting for grid-distribution losses, electricity supply amounts to 2 147 378 MWh/year in 2050. No local production, electricity imports or exports are included.

The combined electricity and district-heat supply requirement decreases to 4 480 807 MWh/year in 2050. This represents an 18.0% reduction compared with 2021. The reduction is driven primarily by lower district-heating demand following the implementation of energy-efficiency measures in other sectors.

Associated CO₂ emissions decrease to 572 411 tonnes CO₂/year, representing a reduction of 19.9%. District heating generates 338 347 tonnes CO₂/year or 59.1% of total supply-related emissions, while electricity generates 234 064 tonnes CO₂/year or 40.9%.

These reductions result from policies implemented in the energy-consuming sectors and should not be interpreted as the outcome of policies targeting local energy production itself.

4. RESULT OVERVIEW

The baseline scenario projects a gradual increase in total municipal energy demand due to population growth and changes in activity levels. By 2050, total energy demand reaches 10 836 GWh/year in the baseline scenario.

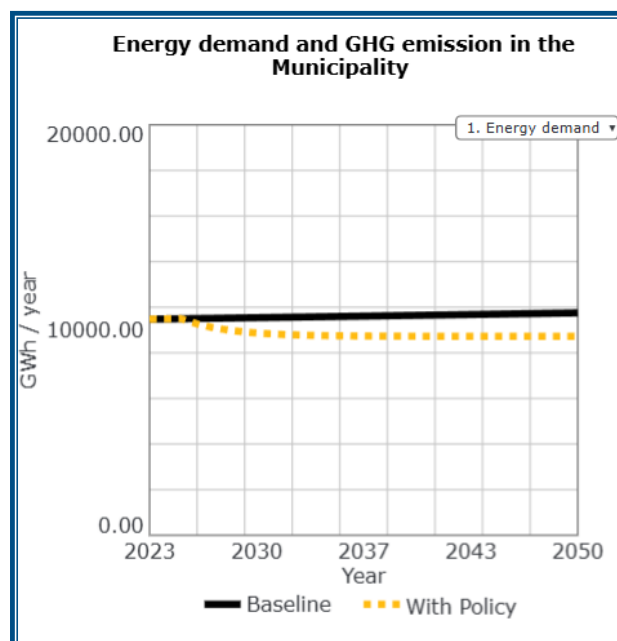
The tested policy package includes the renovation of multi-family residential buildings, the replacement of inefficient public-lighting equipment, electrification of the municipal passenger car fleet and a reduction in private passenger transport demand. No additional policies were applied to municipal buildings, Other sectors, waste management or local energy production. No dedicated public transport technology or fleet policy was applied; however, public transport demand is indirectly affected by the general passenger travel-frequency reduction measure.

Following the introduction of the selected measures in 2025, energy demand decreases during the initial policy-implementation period and subsequently stabilises. By 2050, total energy demand in the policy scenario amounts to 9 690 GWh/year.

Compared with the 2050 baseline scenario, the policy package reduces annual energy demand by 1 145 787.33 MWh, corresponding to an energy saving of 10.6%.

The largest quantified contribution to energy savings comes from the renovation of multi-family residential buildings. This measure reduces residential energy demand by 848 730 MWh/year or 27.3% compared with the residential baseline scenario. The reduction in private passenger transport demand provides the second-largest direct contribution, reducing energy consumption by 254 969 MWh/year or 8.3%.

The public-lighting policy reduces energy demand by 15 006 MWh/year, while the electrification of the municipal passenger car fleet reduces energy consumption by 1 777 MWh/year. Additional system-level differences arise from interactions between sectoral energy demand and electricity and district-heat supply, including distribution losses.



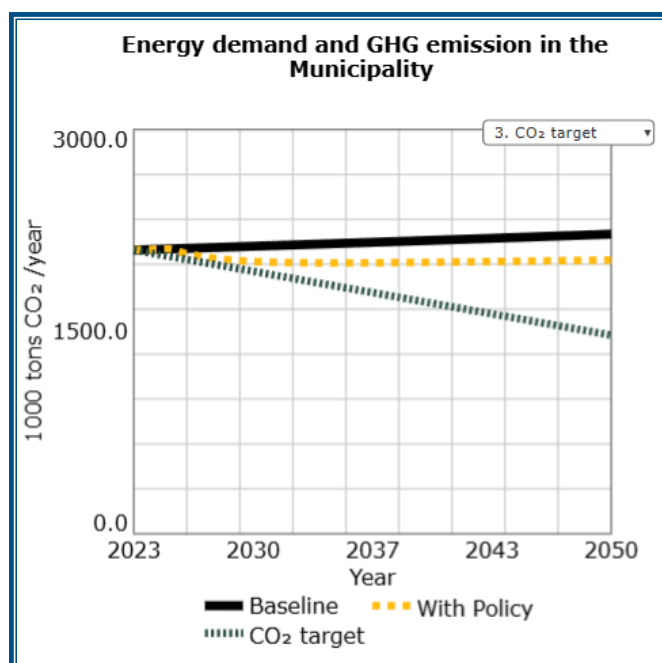
In the baseline scenario, total municipal CO₂ emissions reach approximately 2 223.5 thousand tonnes CO₂/year by 2050. With the selected policy package, emissions decrease to approximately 2 031.7 thousand tonnes CO₂/year.

The resulting annual emission saving is approximately 191 764.6 tonnes CO₂, corresponding to an 8.6% reduction compared with the 2050 baseline scenario.

Residential building renovation is the largest direct source of emission reductions, reducing emissions by 123 068 tonnes CO₂/year or 29.2% compared with the residential baseline. The private transport demand-reduction policy lowers emissions by 61 090 tonnes CO₂/year or 8.9%. Public-lighting improvements reduce emissions by 1 636 tonnes CO₂/year, while municipal passenger car electrification reduces emissions by 623 tonnes CO₂/year.

The results show that the tested policy package produces a clear reduction in both energy demand and CO₂ emissions. However, the policy scenario remains above the modelled long-term CO₂ target trajectory. The target represents an approximately 30% reduction by 2050, while the tested policy package achieves an 8.6% reduction relative to the 2050 baseline.

Additional and more ambitious measures would therefore be required to close the remaining emissions gap. In particular, further reduction potential may exist in sectors for which no additional measures were tested, including municipal buildings, public transport, Other sectors, waste management and local energy production.



5. LINK WITH RĪGA MUNICIPAL CLIMATE AND ENERGY PLANNING

5.1. Link between Rīga SECAP sectors and CommitClimate modelling

The table below summarises how the main Rīga SECAP2030 planning areas correspond to the sectors and measures analysed in the CommitClimate simulation report.

Rīga SECAP2030 planning area	CommitClimate modelled sector / measures	Link and added value
Municipal infrastructure and municipal buildings	Municipal buildings are included in the model baseline, but no additional policy measures were tested for this sector in the Rīga simulation.	Partial link. The sector is relevant for SECAP2030, but the current CommitClimate simulation does not quantify additional municipal-building energy efficiency or renovation measures. The baseline data can still support future analysis and monitoring if additional policies are introduced later.
Housing / residential buildings	Large-scale renovation of multi-family residential buildings was modelled, with an implementation period from 2025 to 2050.	Very strong link. Residential building renovation is one of the most important modelled measures in the Rīga case. The results quantify the potential impact of multi-family building renovation on energy demand and CO ₂ emissions and can support SECAP2030 implementation, housing-sector planning and future prioritisation of renovation measures.
Public infrastructure	Public infrastructure is represented through electricity consumption for public lighting, drinking water preparation and wastewater treatment. The tested policy focuses on replacement of inefficient light bulbs in public lighting.	Good but limited link. The simulation supports assessment of electricity-saving measures in public lighting but does not fully cover all public infrastructure measures that may be included in the SECAP2030.
Other sectors: commercial, tertiary, industry, construction, agriculture and forestry	Other sectors are included in the baseline structure, but no additional policy measures were tested.	Limited link. These sectors are relevant for the city's wider energy and climate transition, but the current simulation does not assess additional policy interventions in these areas.
Transport and mobility	Municipal fleet electrification and reduction of private passenger transport demand were modelled. Public transport is included in the baseline, but no additional public transport policy measures were tested.	Strong but partial link. Private transport demand reduction provides the second-largest quantified contribution to overall energy and emission savings, following residential building renovation, while municipal fleet electrification delivers a smaller but measurable reduction. Although no dedicated public transport technology or fleet policy was introduced, the sector is indirectly affected by the reduction in general passenger travel frequency. This cross-sectoral effect reduces public transport energy consumption and CO ₂ emissions.

Energy production, renewable energy and district heating	The module represents grid-electricity and district-heating supply requirements, including distribution losses. No local generation technologies, energy imports or exports, or dedicated energy-supply decarbonisation policies were modelled.	Partial link. This is an important SECAP2030 area, especially in relation to renewable energy, district heating and energy supply decarbonisation. However, the current simulation does not fully assess energy production or district heating decarbonisation measures.
Waste management and circular economy-related emissions	Waste management is included in the baseline, but no additional policy measures were tested.	Partial link. Waste management is relevant to the city's broader climate and circular economy objectives, but the Riga simulation does not quantify the effect of additional waste or circular economy measures.
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 climate resilience are outside the main scope of the model.
Monitoring and review of the SECAP2030 / REK2030	Baseline and policy scenario results up to 2050; comparison of energy demand and CO ₂ emission trajectories.	Strong conceptual link. The model can support SECAP2030 monitoring and review by helping the municipality compare baseline development, policy scenarios and remaining emission-reduction gaps.

5.2. Main modelling results relevant for SECAP2030 monitoring

The CommitClimate simulation results show that the selected policy package reduces both energy demand and CO₂ emissions compared with the baseline pathway. However, the results also demonstrate that the tested measures alone are insufficient to achieve the modelled long-term emission-reduction target.

By 2050, total energy demand reaches approximately 10,836 GWh in the baseline scenario. With the selected policy package, energy demand decreases to approximately 9,690 GWh. This corresponds to annual energy savings of 1,145,787.33 MWh, or 10.6%, compared with the 2050 baseline projection.

CO₂ emissions reach approximately 2,223.5 thousand tonnes in the 2050 baseline scenario and decrease to approximately 2,031.7 thousand tonnes in the policy scenario. This corresponds to annual emission savings of approximately 191,764.6 tonnes CO₂, or 8.6%, compared with the baseline projection.

At the sectoral level, the largest quantified contribution comes from the renovation of multi-family residential buildings. The measure reduces residential energy demand by 848,730 MWh/year, or 27.3%, and CO₂ emissions by 123,068 tonnes CO₂/year, or 29.2%, compared with the residential baseline scenario.

The reduction in private passenger transport demand provides the second-largest quantified contribution. This measure reduces private transport energy demand by 254,969 MWh/year, or 8.3%, and CO₂ emissions by 61,090 tonnes CO₂/year, or 8.9%, compared with the private transport baseline scenario.

The passenger travel demand-reduction measure also has an indirect cross-sectoral effect on public transport. Because general travel frequency is reduced before passenger demand is allocated between transport modes, public transport energy consumption decreases by 25,305 MWh/year and CO₂ emissions decrease by 5,350 tonnes CO₂/year by 2050. Both energy consumption and emissions decrease

by 11.8% compared with the public transport baseline scenario, although no dedicated public transport technology or fleet policy was introduced.

Smaller but measurable reductions are achieved through improvements in public lighting and the electrification of the municipal passenger car fleet. The public-lighting measure reduces energy demand by 15,006 MWh/year and CO₂ emissions by 1,636 tonnes CO₂/year. Municipal fleet electrification results in energy savings of 1,777 MWh/year and emission reductions of 623 tonnes CO₂/year.

The results indicate that the selected policy package contributes to reducing Rīga's future energy demand and emissions but is insufficient to achieve deeper long-term decarbonisation. No dedicated policy measures were tested for municipal buildings, other economic sectors, waste management or local energy production. Furthermore, although public transport is indirectly affected by the general reduction in passenger travel frequency, no dedicated public transport decarbonisation or efficiency measures were included. These findings are relevant for future SECAP2030 monitoring and review, as they identify sectors in which additional scenario analysis and more ambitious measures may be required.

In this sense, the CommitClimate modelling results can support the SECAP2030 monitoring and review process by helping to answer three practical questions:

- Are the existing and planned measures sufficient to reduce energy demand and emissions?
- Which sectors provide the largest reduction potential?
- Where are additional or more ambitious actions needed in future planning cycles?

5.3. Link with the Rīga feasibility study

Unlike some other municipal cases, the Rīga CommitClimate work did not result in a separate investment-focused feasibility study for one specific priority measure. Instead, the Rīga case focused primarily on the use of the CommitClimate CO₂ simulator and scenario-based analysis to assess how selected policy measures may contribute to long-term energy and emission reductions.

This modelling work is particularly relevant for Rīga because it provides a quantitative basis for comparing the relative importance of different sectors. The results clearly show that private transport demand reduction and residential building renovation are the two most important areas within the tested policy package.

Therefore, the Rīga simulation report can be understood as a planning-support output that complements the SECAP2030 by providing additional analytical evidence on policy prioritisation, sectoral reduction potential and the need for broader future measures.

5.4. Municipality feedback and practical relevance

Feedback from the Rīga municipal side confirmed the practical relevance of the CommitClimate CO₂ simulator and simulation results for local planning. The model was considered useful for visualising the current situation, comparing future scenarios and supporting discussions on municipal climate and energy policy options.

The Rīga case demonstrates that the simulator can be used as an analytical tool to support evidence-based planning, especially in a large urban municipality where energy demand and emission dynamics

differ significantly between sectors. The results provide a structured basis for discussing which measures may have the strongest impact and where further policy development is needed.

The strongest practical relevance of the Rīga simulation is linked to:

- assessment of private transport demand reduction;
- evaluation of multi-family residential building renovation impacts;
- comparison of baseline and policy emission trajectories;
- identification of sectors not yet sufficiently covered by policy measures;
- support for future SECAP2030 monitoring and review.

At the same time, the Rīga case also shows the importance of further localisation of assumptions, sectoral data and policy parameters. More detailed modelling of public transport, district heating, local energy production, municipal buildings, waste management and circular economy measures would improve the usefulness of future scenario analysis.

5.5. Scope and limitations

The CommitClimate simulation report should be understood as a supporting analytical document. It does not formally amend, replace or update the Rīga SECAP2030 / REK2030.

There are also differences in scope and time horizon. The Rīga SECAP2030 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 SECAP2030 target achievement, but rather as an additional tool for long-term reflection, monitoring and future planning.

The quantitative results of the CommitClimate simulation should not be directly compared with formal SECAP2030 target values without harmonising the baseline year, sectoral scope and time horizon.

Some SECAP2030 areas are only partly covered or not covered by the simulation. Climate change adaptation, climate risk management, green infrastructure and climate resilience 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 Rīga due to the available baseline data. In addition, no additional policy measures were tested for municipal buildings, public transport, other sectors or waste management.

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 Rīga SECAP2030 / REK2030 includes a strategic framework for municipal climate and energy action. The CommitClimate simulation results can support its future monitoring and review by providing an additional scenario-based perspective on energy demand, emission trends and the potential impact of selected measures.

In practical terms, the model can be used to:

- compare baseline development with policy scenarios;

- identify sectors with the largest emission-reduction potential;
- assess whether selected measures are sufficient to move towards long-term climate objectives;
- support discussions on additional or more ambitious measures;
- identify sectors where further modelling is needed;
- provide visual and quantitative material for stakeholder communication;
- support future updates or reviews of the SECAP2030 / REK2030.

Overall, the CommitClimate Rīga simulation report is strongly linked to the mitigation and energy-planning parts of the Rīga SECAP2030 / REK2030, especially in the sectors of residential buildings, private transport, municipal fleet and public infrastructure. It provides a quantitative and scenario-based analytical layer that can complement the existing planning document and support future municipal climate and energy planning.

At the same time, it should be clearly understood as a supporting tool, not as a formal SECAP/SEAP replacement or amendment. Its main value is to show the relative impact of selected measures, identify the strongest reduction potentials and highlight where additional sectoral measures would be needed for deeper long-term decarbonisation.

6. CONCLUSIONS

The scenario analysis demonstrates that the selected policy package reduces both energy demand and CO₂ emissions in Rīga municipality by 2050.

In the 2050 baseline scenario, total municipal energy demand reaches 10 836.2 GWh/year. With the selected policy package, energy demand decreases to 9 690.4 GWh/year. This corresponds to annual energy savings of 1 145 787.3 MWh or 10.6% compared with the baseline scenario.

Total CO₂ emissions reach approximately 2 223.5 thousand tonnes CO₂/year in the 2050 baseline scenario and decrease to approximately 2 031.7 thousand tonnes CO₂/year in the policy scenario. The policy package therefore achieves annual emission savings of approximately 191 764.6 tonnes CO₂, corresponding to an 8.6% reduction.

Residential building renovation is the most effective measure included in the simulation. The large-scale renovation of multi-family buildings reduces residential energy demand by 848 730 MWh/year, or 27.3%, and CO₂ emissions by 123 068 tonnes CO₂/year, or 29.2%, compared with the residential baseline scenario. These results demonstrate the importance of improving the energy performance of Rīga's multi-family building stock.

The reduction in private passenger transport demand provides the second-largest quantified contribution. The measure reduces private transport energy consumption by 254,969 MWh/year, or 8.3%, and CO₂ emissions by 61,090 tonnes CO₂/year, or 8.9%, compared with the private transport baseline scenario. The results demonstrate that changes in travel distance and frequency can make a meaningful contribution to municipal climate objectives.

The passenger travel demand-reduction measure also indirectly affects public transport. Because general travel frequency is reduced before passenger demand is allocated between transport modes, public transport energy consumption decreases by 25,305 MWh/year and CO₂ emissions decrease by 5,350 tonnes CO₂/year. Both energy consumption and emissions decrease by 11.8% compared with the public transport baseline scenario. Although no dedicated public transport technology or fleet policy was introduced, this cross-sectoral effect makes a measurable contribution to the overall reductions.

The public-lighting measure provides a smaller but clearly measurable contribution, reducing electricity consumption by 15,006 MWh/year and CO₂ emissions by 1,636 tonnes CO₂/year. Electrification of the municipal passenger car fleet reduces energy consumption by 1,777 MWh/year and CO₂ emissions by 623 tonnes CO₂/year. The relatively limited municipal-fleet impact reflects the small contribution of municipal vehicles to Rīga's total energy consumption and emissions.

The simulation also shows that the selected policy package is insufficient to achieve the modelled long-term CO₂ reduction target. The policy scenario achieves an 8.6% reduction compared with the 2050 baseline, while the model's illustrative target trajectory represents an approximately 30% reduction. This trajectory should not be interpreted as a formal assessment of Rīga SECAP2030 target achievement. The policy scenario remains above the target throughout the later simulation period.

A major limitation of the tested policy package is that no dedicated measures were applied to municipal buildings, other economic sectors, waste management or local energy production. Public transport is indirectly affected by the reduction in general passenger travel frequency, but no dedicated public transport decarbonisation or efficiency measures were tested. Several of these sectors account for

substantial shares of Rīga's energy consumption or emissions, and their limited coverage restricts the overall reduction achieved by the policy scenario.

Further reductions would require a broader and more integrated package of measures. Potential priorities include energy-efficiency improvements in municipal buildings, dedicated public transport decarbonisation and efficiency measures, stronger action in commercial and industrial sectors, waste prevention and diversion from disposal, and the decarbonisation of electricity and district-heat supply.

The results should be interpreted as scenario-based estimates rather than official municipal projections. Several calculations rely on aggregated data and modelling assumptions concerning building stock, population development, transport demand, vehicle use, fuel consumption and waste generation. Guest population and associated travel demand are not included, while transport energy consumption is calculated rather than derived directly from fuel invoices. Further localisation and validation of these assumptions would improve the reliability of future simulations.

Overall, the analysis confirms that residential building renovation is the strongest measure in the Rīga scenario, followed by private passenger transport demand reduction. The indirect reduction in public transport demand, public-lighting improvements and municipal fleet electrification provide additional but smaller contributions. Nevertheless, achieving deeper long-term decarbonisation will require additional measures across currently unaddressed or only partly addressed sectors and closer 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	–
	Emission reduction	–
Residential buildings	Energy savings	848 730 MWh (27.3 %)
	Emission reduction	123 068 tCO ₂ (29.2 %)
Public infrastructure	Energy savings	15 006 MWh (18.3 %)
	Emission reduction	1 636 tCO ₂ (18.3 %)
Other sectors	Energy savings	–
	Emission reduction	–
Municipal fleet	Energy savings	1 777 MWh (13.2 %)
	Emission reduction	623 tCO ₂ (19.3 %)
Public transport	Energy savings	25 305 MWh (11.8%)
	Emission reduction	5350 tCO ₂ (11.8%)
Private transport	Energy savings	254 969 MWh (8.3 %)
	Emission reduction	61 090 tCO ₂ (8.9 %)
Waste management	Waste generation reduction	–
	Emission reduction	–
Local energy production	Energy savings	–
	Emission reduction	–