Scenario-Based Assessment of Climate Neutrality Pathways in Jokkmokk Municipality, Sweden

Authors: RTU

This document presents an assessment of future energy demand and CO_2 emissions in Jokkmokk municipality, Sweden, 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 decrease (-0,6 % per year), which leads to relatively stable or slowly decrease 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 Jokkmokk's long-term energy system and climate outcomes.

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

This project receives financial support from Interreg program

Contents

1. PLANNING CONTEXT 3
2. SCOPE OF THE COMMITCLIMATE SIMULATION REPORT 3
3. MODELLING RESULTS 4
   3.1. MUNICIPALITY BUILDINGS 4
      Current situation 4
      Policies 5
   3.2. RESIDENTIAL BUILDINGS 7
      Current situation 7
      Policies 8
   3.3. PUBLIC INFRASTRUCTURE 9
      Current situation 9
      Policies 10
   3.4. OTHER SECTORS 11
      Current situation 11
      Policies 12
   3.5. TRANSPORT 13
      Current situation 13
      Policies 16
   3.6. WASTE MANAGEMENT 20
      Current situation 20
      Policies 21
   3.7. LOCAL ENERGY PRODUCTION 21
      Current situation 21
      Policies 21
4. RESULT OVERVIEW 23
5. LINK WITH JOKKMOKK MUNICIPAL ENERGY AND CLIMATE PLANNING 25
   5.1. Relationship between municipal planning areas and the CommitClimate modelling 25
   5.2. Main modelling results relevant for future energy and climate planning 26
   5.3. Experience from simulator testing and practical relevance 27
   5.4. Scope and limitations 28
   5.5. Use of CommitClimate results for future energy and climate planning and review 28
6. CONCLUSIONS 30

1. PLANNING CONTEXT

The principal planning framework relevant to the Jokkmokk simulation is the municipality's energy and climate planning process and its existing "*Energi- och klimatstrategi*". The strategy was adopted in 2009 and has not yet been replaced by a newer formally adopted document. There is a general political intention to review and update the municipality's energy and climate planning framework, although no specific timetable for adopting a revised strategy has been confirmed.

Under the Swedish Act on Municipal Energy Planning (*Lag 1977:439 om kommunal energiplanering*), each municipality is required to maintain an up-to-date plan addressing the supply, distribution and use of energy. The plan must consider environmental, health and resource impacts and must be adopted by the municipal council. The preparation or revision of such a plan normally requires data collection and analysis, stakeholder engagement, public consultation and political adoption.

The original intention of the CommitClimate activities in Sweden was to cooperate with Jokkmokk Municipality and explore how the CO_2 simulator could support an update of the existing municipal energy and climate strategy. However, due to delays in the simulator's development and technical and usability challenges encountered during the project period, it was not possible to apply the tool within a formal municipal planning process as originally envisaged.

Nevertheless, the scenario development, data collection and testing activities undertaken through CommitClimate generated relevant knowledge about Jokkmokk's energy demand, emissions, data availability and potential transition pathways. The results may therefore serve as supporting analytical material for future energy and climate planning, subject to further validation and updating of the underlying data.

2. SCOPE OF THE COMMITCLIMATE SIMULATION REPORT

This report presents an exploratory scenario-based assessment of possible developments in energy demand and greenhouse gas emissions in Jokkmokk Municipality up to 2050. The analysis covers municipal and residential buildings, public infrastructure, other economic sectors, municipal and private transport, public transport, waste management and local energy production.

The report compares a baseline scenario with a policy scenario in which selected energy-efficiency, renewable-energy, transport and decarbonisation measures are introduced. The modelling is intended to illustrate the possible direction and relative magnitude of change under the selected assumptions. It is not an official municipal forecast and does not constitute a formally adopted municipal energy and climate plan.

The simulations were prepared by Lapplands Kommunalförbund and Riga Technical university for exploratory, analytical and capacity-building purposes. They have not been formally adopted or endorsed by Jokkmokk Municipality. The results should therefore be interpreted as supporting evidence that may inform discussion, data development, priority setting and future scenario analysis.

A validated, reliable and maintained version of the CommitClimate simulator could support several analytical stages in the preparation or revision of a municipal energy and climate plan. Potential applications include compiling an energy and emissions baseline, comparing alternative development pathways, testing policy packages, identifying priority sectors and supporting future monitoring and review. However, the simulator would complement rather than replace the stakeholder dialogue, public

consultation, administrative assessment and political decision-making required for the adoption of a formal municipal plan.

Future practical use of the results will depend on the quality and regular updating of baseline data, the usability and maintenance of the modelling tool and the municipality's own assessment of its relevance for the planning process.

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.

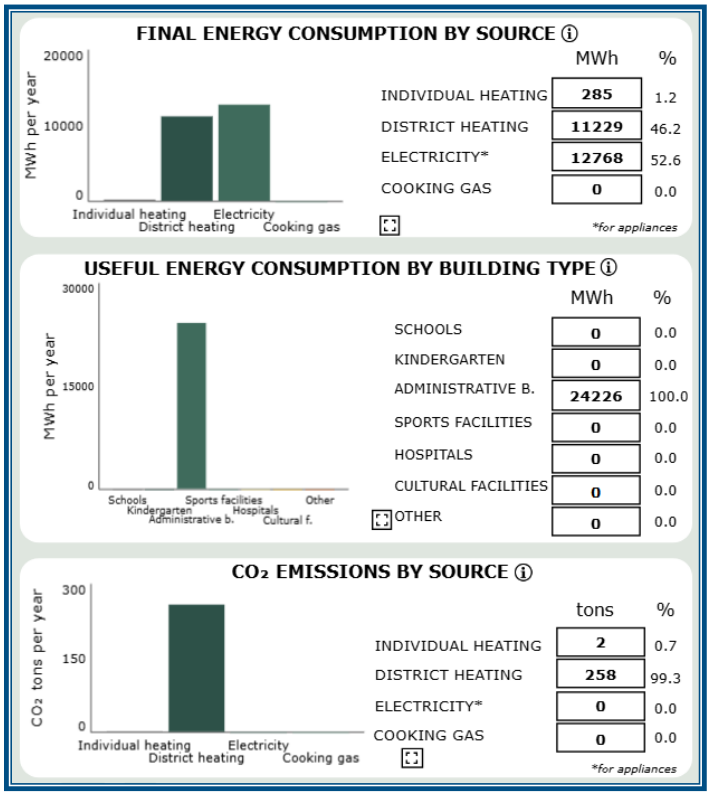
Current situation

In Jokkmokk municipality, the total area of municipal buildings in the baseline year is 81 843 m². The largest share by area is made up of administrative buildings. The total energy consumption in municipal buildings in 2023 was 24 281 MWh, which accounted for 9.1 % of energy consumption in Jokkmokk municipality.

In energy consumption, the largest share is electricity consumption for appliances with 52.6 % of the total energy consumption, followed by district heating (46.2 %). 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 140 kWh/m²/year and electricity consumption is 156 kWh/m²/year (weighted average across the entire building stock).

Total CO_2 emissions in municipal buildings related to energy use in the Baseline year were 260 tons of CO_2. The largest source of CO_2 emissions is district heating (99.3 %), followed by electricity consumption for appliances (0,7 %). Overall, CO_2 emissions in municipal buildings make up 1.6 % of total CO_2 emissions in the municipality.



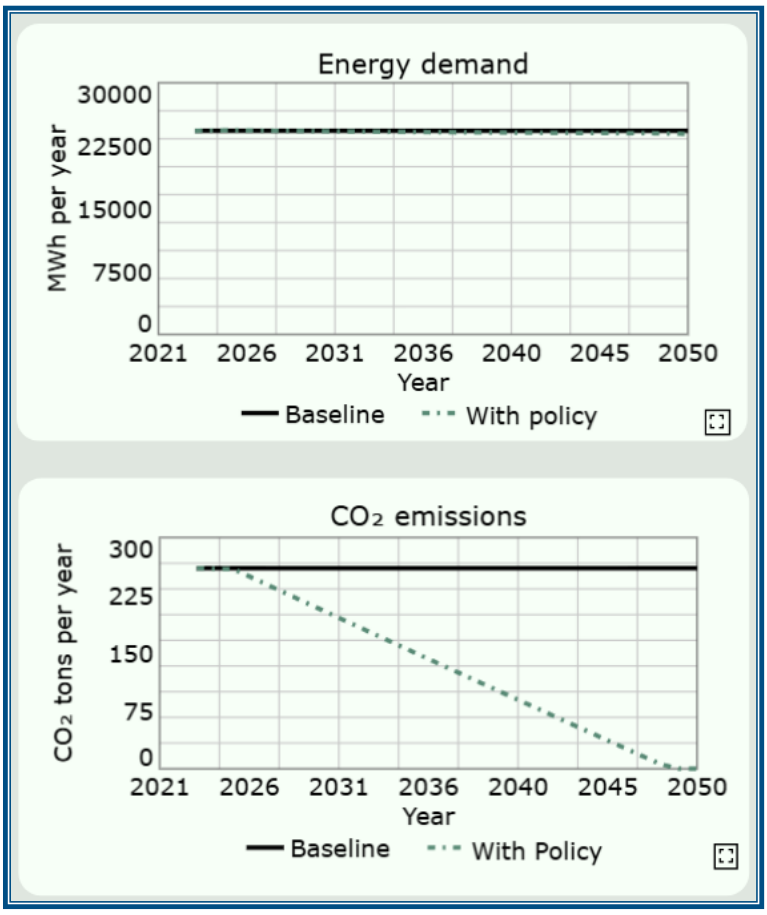
Policies

In the municipality buildings sector, a comprehensive energy efficiency strategy was proposed:

- **Replacement of windows** (*Implementation speed (IS)* 3 %/year, *Expected savings (ES)* 15 %)
- **Shading** (*IS* 3 %/year, *ES* 5 %)
- **Replacement of light bulbs** (*IS* 3 %/year, *ES* 80 %)
- **Lighting control** (*IS* 3 %/year, *ES* 5 %)
- **Use of natural light** (*IS* 3 %/year, *ES* 10 %)
- **Ventilation optimization** (*IS* 3 %/year, *ES* 10 %)
- **Energy efficient ventilation fans** (*IS* 5 %/year, *ES* 10 %)
- **Heat recovery** (*IS* 3 %/year, *ES* 10 %)
- **Heating optimization** (*IS* 3 %/year, *ES* 10 %)
- **Installation of thermostatic valves** (*IS* 3 %/year, *ES* 10 %)
- **Installation of new circulation pumps** (*IS* 3 %/year, *ES* 10 %)
- **Replacement of inefficient appliances** (*IS* 3 %/year, *ES* 20 %)
- **Optimal use of appliances** (*IS* 3 %/year, *ES* 10 %)
- **RES-E generation** (*Solar photovoltaics installed capacity* 500 kW, *Heat pump air installed capacity* 200 kW, *Energy storage installed capacity* 100 kW)

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

In total, the selected policies achieved 364 MWh in energy savings and 260 tCO_2 in emission savings in 2050 compared to the baseline scenario (1.5 % and 100 % reductions respectively). Additionally, the RES-E policy introduced 2854 MWh/year of renewable energy in the policy scenario.



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.

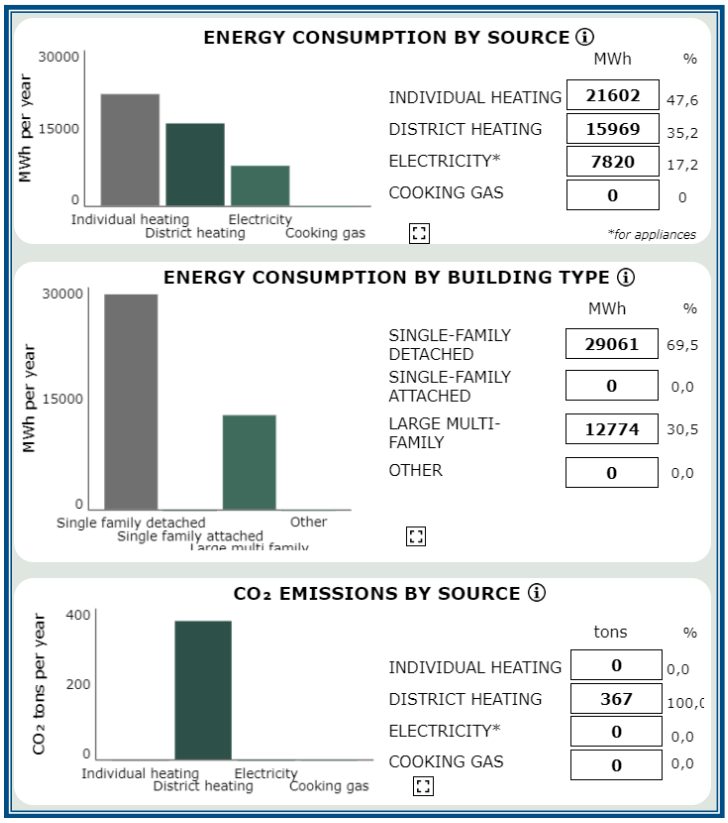
Current situation

In Jokkmokk municipality, the total area of residential buildings in the baseline year is 251 979 m². This area is made up of single-family detached and large multi-family houses. In 2023, the total energy consumption in residential buildings was 45 391 MWh, accounting for 17 % of total energy consumption in Jokkmokk municipality.

Of the total energy consumption, district heating systems make up 35.2 % or 15 969 MWh and energy for individual heating –21 602 MWh or 47.6 % of total energy demand. Electricity consumption for appliances makes up 17.2 % or 7820 MWh. 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 energy consumption for space heating and hot water preparation in the residential sector is 135 kWh/m²/year per year, and electricity consumption is 31 kWh/m²/year (weighted average across the entire building stock).

The amount of CO_2 generated in the household sector in the Baseline year were 367 tCO_2/year, which is 2.3 % of the municipality's CO_2 emissions. The only source of CO_2 emissions in residential buildings is district heating, which is responsible for 100 % of total CO_2 emissions.



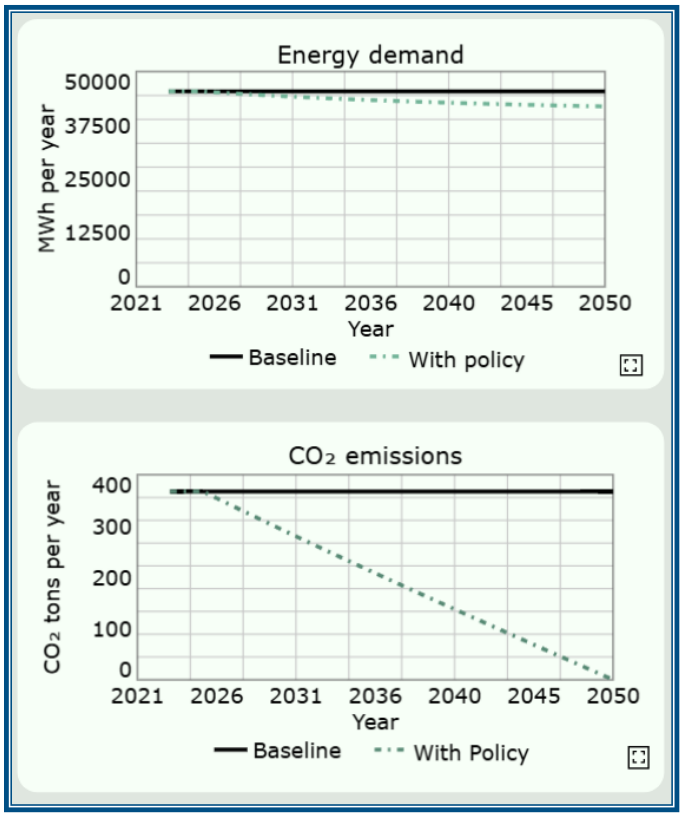
Policies

To reduce energy consumption and emissions in residential buildings, the following policies were tested:

- **Renovation of single-family houses** (*IS* 5 %/year, *ES* 10 %)
- **Renovation of multi-family houses** (*IS* 5 %/year, *ES* 10 %)
- **Electricity saving measures** (*IS* 5 %/year, *ES* 30 %)
- **Renewable and low-carbon technologies** (Solar photovoltaics installed capacity 1000 kW, *Heat pump air installed capacity* 700 kW, *Heat pump ground installed capacity* 700 kW, *Energy storage installed capacity* 900 kW)

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

In total, the selected policy achieved 3493 MWh in energy savings and 367 tCO_2 in emission savings in 2050 compared to the baseline scenario (7.7 % and 100 % reductions respectively). Additionally, the RES-E policy introduced 20 697 MWh/year of renewable energy in the policy scenario.



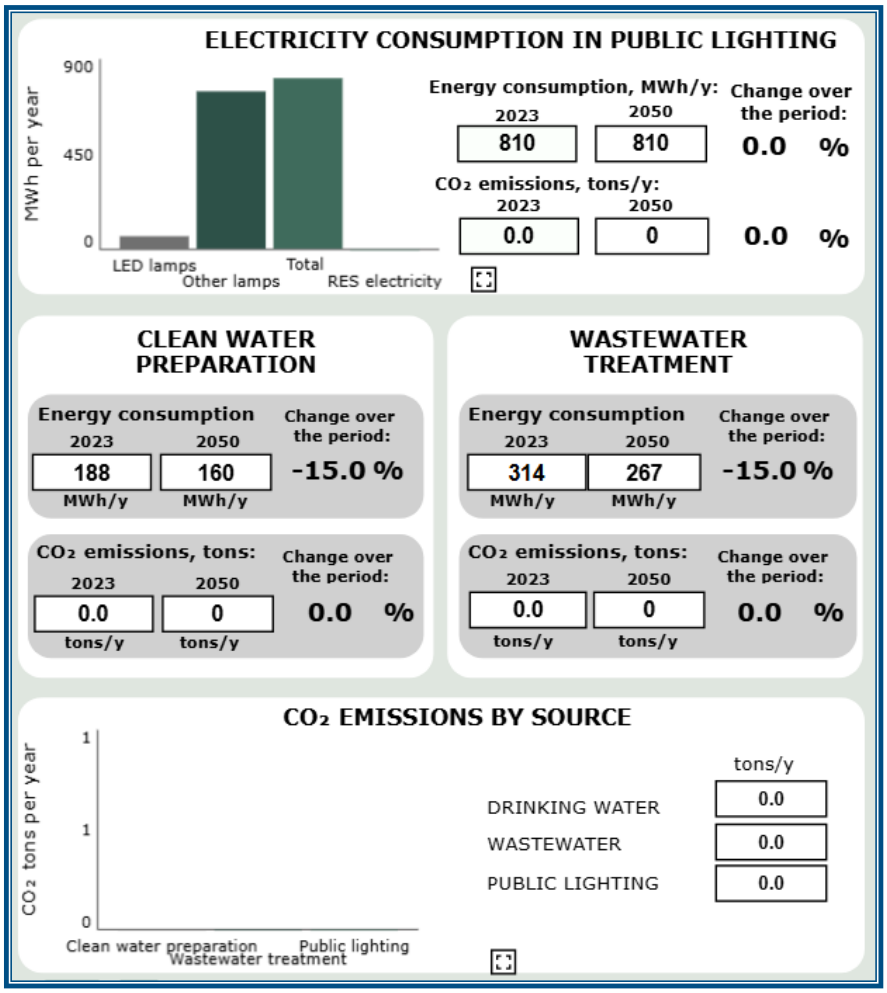
3.3. PUBLIC INFRASTRUCTURE

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 Jokkmokk municipality, the expected total electricity consumption in the Public infrastructure sector in the baseline year is 1313 MWh/year, which is 0.5 % of the municipality's total energy consumption. Due to constant population decrease, the amount energy used for clean water preparation and wastewater treatment is expected to decrease by 15 %, bringing the total energy consumption of the sector to 1237 MWh per year in 2050; with public lighting accounting for 65,5 %, wastewater treatment – 21,6 % – and drinking water preparation – 12,9 % of the total energy consumption.

Due to all of the electricity used in public infrastructure being produced by renewable resources, associated emissions are 0 tCO_2/year.



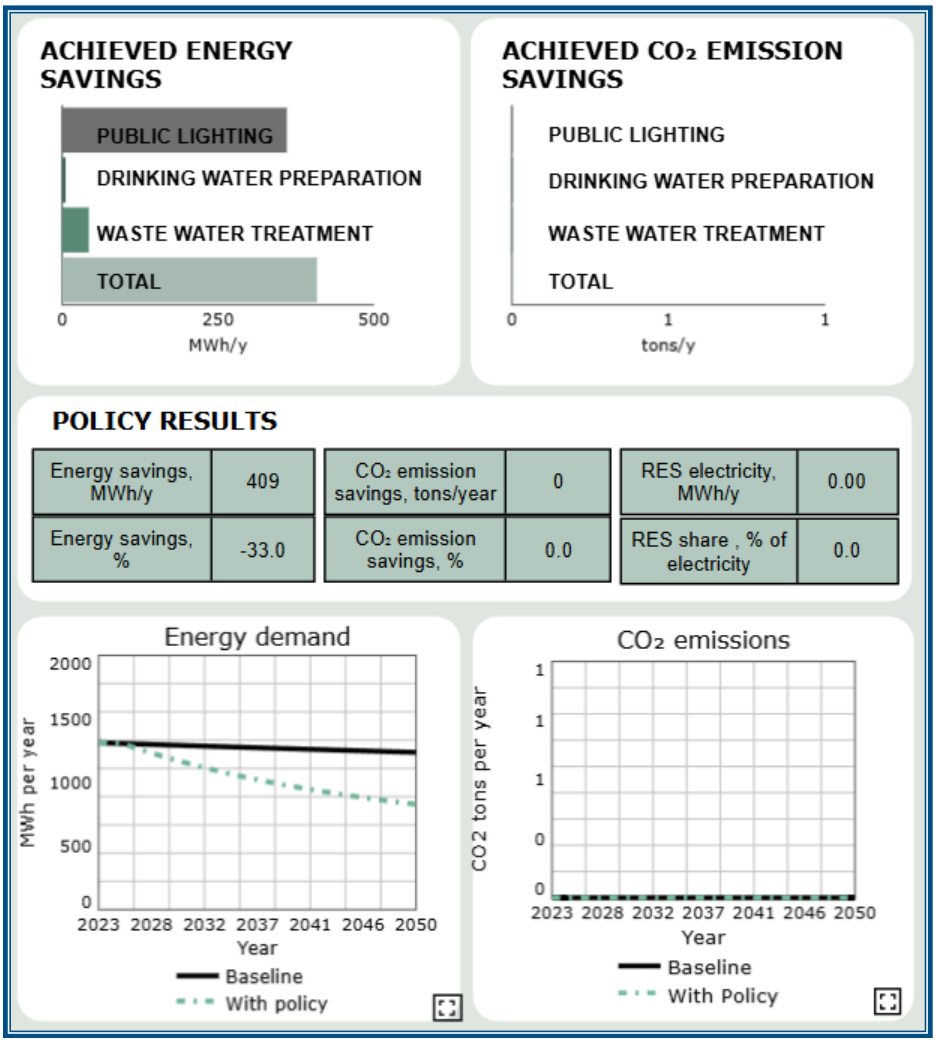
Policies

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

- **Replacement of inefficient light bulbs in public lighting** (*IS* 5 %/year)
- **Clean water preparation energy efficiency improvement** (*IS* 3 %/year)
- **Wastewater treatment energy efficiency improvement** (*IS* 0,5 %/year)

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

In total, the selected policies achieved 409 MWh in energy savings in 2050 compared to the baseline scenario (33.1 % reduction). The largest reduction in energy consumption is achieved through the replacement of inefficient light bulbs in the municipality's public lighting system, resulting in a 33 % decrease.



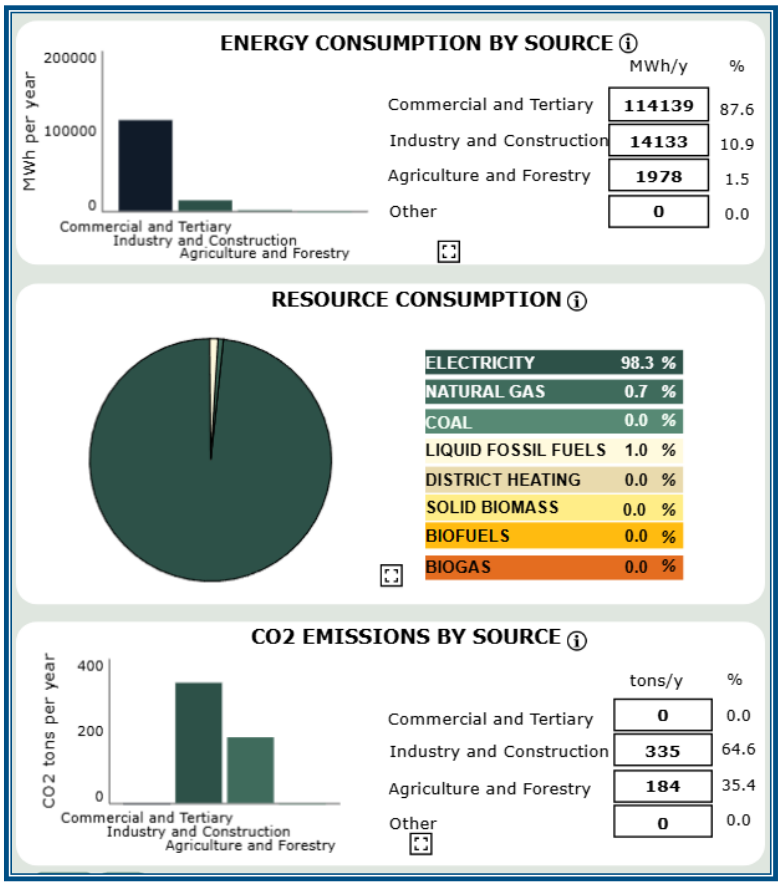
3.4. OTHER SECTORS

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 Jokkmokk municipality, Other sectors' Baseline energy consumption in 2023 is 130 250 MWh. As energy consumption required by the Industry and Construction sector increases at a rate of 1 %/year, the total energy consumption of other sectors will reach 134 242 MWh in 2050. Of this, the largest share in 2050 is made up of energy consumption in the Commercial and Tertiary sector (85 %), followed by Industry and Construction with 13,5 % and Agriculture and forestry (1,5 %). Electricity dominates the energy mix with 98,4 %, followed by liquid fossil fuels with 1 %. Values for the baseline year are provided in the figure.

Energy consumption in Other sectors accounts for 48.8 % of the municipality's total energy consumption. Total CO_2 emissions in Other sectors were approximately 519 tCO_2/year in 2023, accounting for 3.2% of the municipality's total emissions. Under the baseline scenario, emissions increase towards 2050 due to the assumed growth in energy consumption in Industry and Construction. Values for the baseline year are provided in the figure.



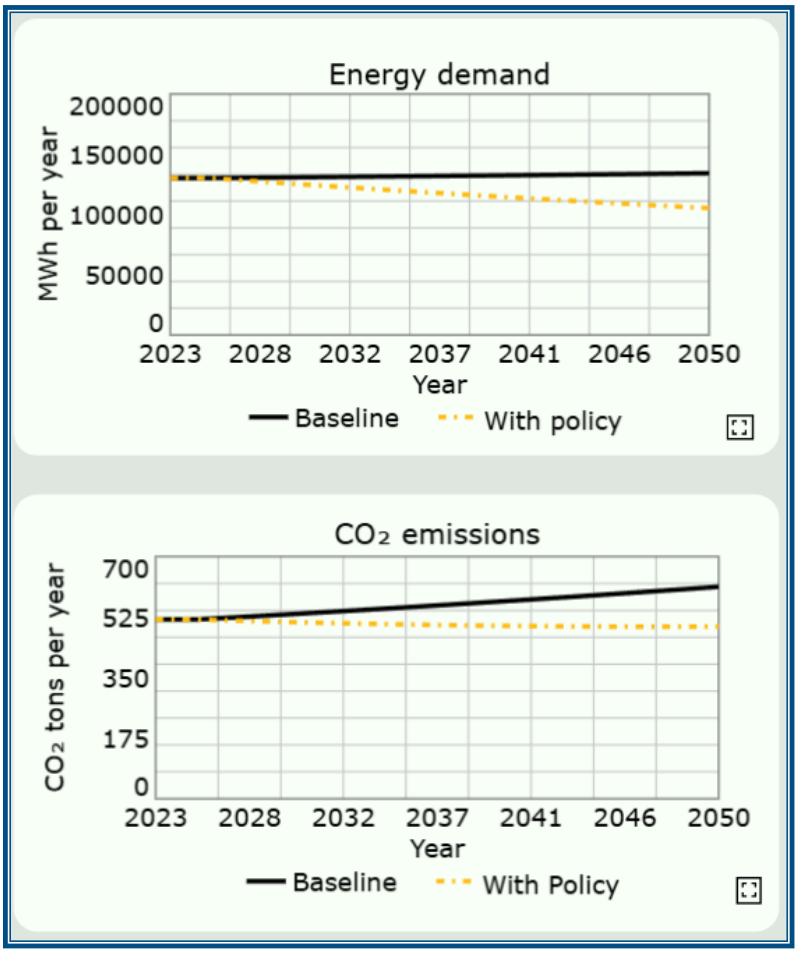
Policies

The following policies were proposed to reduce energy demand and emissions in other sectors:

- **EE measures in Commercial and Tertiary sector** (*IS* 1 %/year)
- **EE measures in Industry and Construction** (*IS* 1 %/year)
- **EE measures in Agriculture and Forestry** (*IS* 1 %/year)
- **EE measures in Other sectors** (*IS* 1 %/year)

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

In total, the selected policies achieved 28 939 MWh in energy savings in 2050 compared to the baseline scenario (21.6 % reduction). After implementing policies, CO_2 emissions drop by 115 tCO_2, which is a 18.8% reduction.



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 CO_2 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.

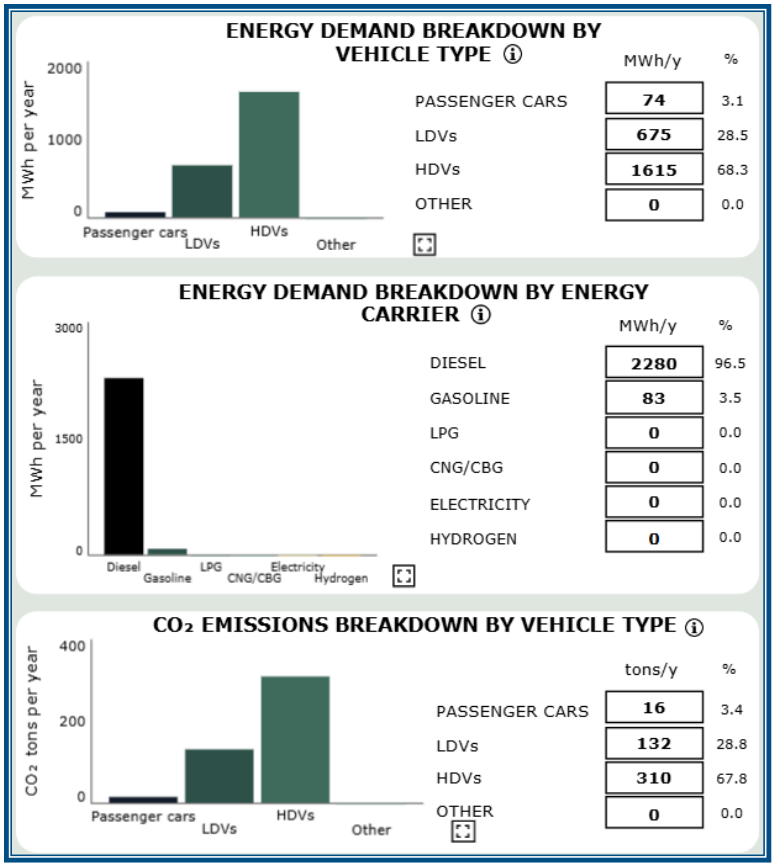
Current situation

Municipal vehicle fleet

The municipal vehicle fleet consists of 5 passenger cars, 35 LDVs and 10 HDVs. 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 2364 MWh per year, which is equivalent to 0.9 % of the municipality's total energy consumption.

In terms of fuel consumption, diesel accounts for the largest share (96,5 %), followed by gasoline (3,5 %). By vehicle type, the most significant energy consumer is HDVs (68,3 %), followed by LDVs (28,5 %) and passenger cars (3,1 %). Total CO_2 emissions related to the municipality's vehicle fleet amount to 457 tons of CO_2 per year, or approximately 2.8% of the municipality's total CO_2 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.



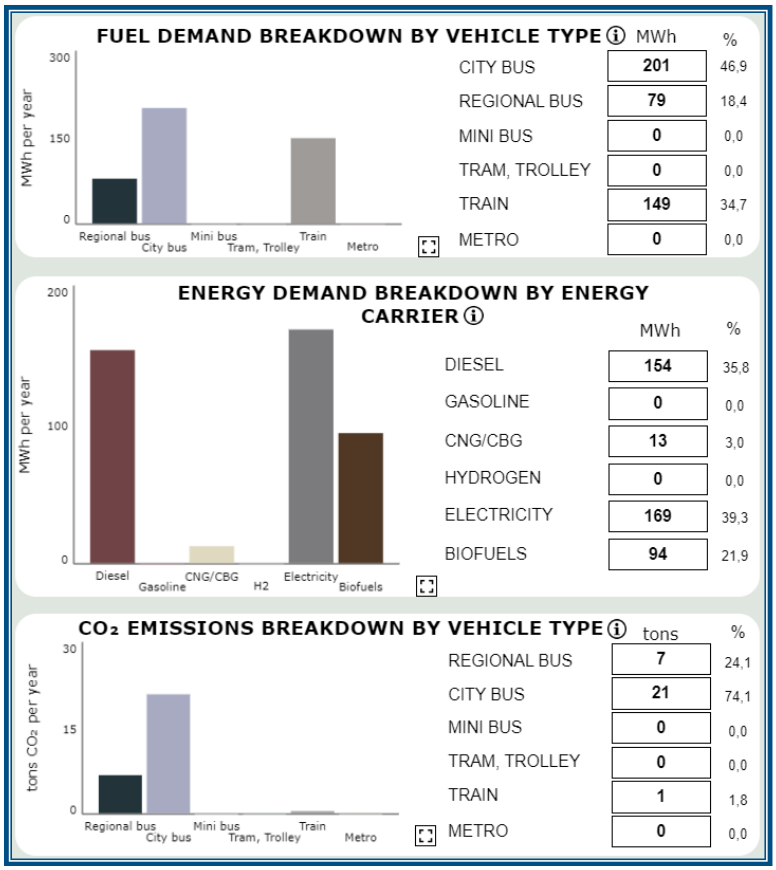
Public transport

According to existing data, 6.6 million passenger kilometres per year are performed by public transport in 2021. The largest share of this demand is made up of city public transport (70 %), followed by regional public transport (30 %).

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 498 MWh per year in 2023 or 0.2 % of the municipality's energy consumption. Of this, the largest share is made up of city bus (46.9 %), followed by train (34.7 %) and regional bus (18.4 %). Electricity dominates in terms of fuel consumption with 39.3 %, followed by diesel (35.8 %) and biofuels (21.9 %). Total CO_2 emissions related to energy consumption in public transport amounted to 33 tons of CO_2 in 2023 or approximately 0.2 % of the municipality's total CO_2 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 decrease in population. As a result, public transport energy demand decreases over time.

The projected energy consumption in 2050 is 429 MWh, with associated CO_2 emissions of 28 tons, corresponding to a decrease of 13.8 %.



Private transport

According to the available data, private transport demand in the municipality amounts to approximately 90.5 million passenger-kilometres per year. It is projected to decrease to 78.4 million passenger-kilometres per year by 2050.

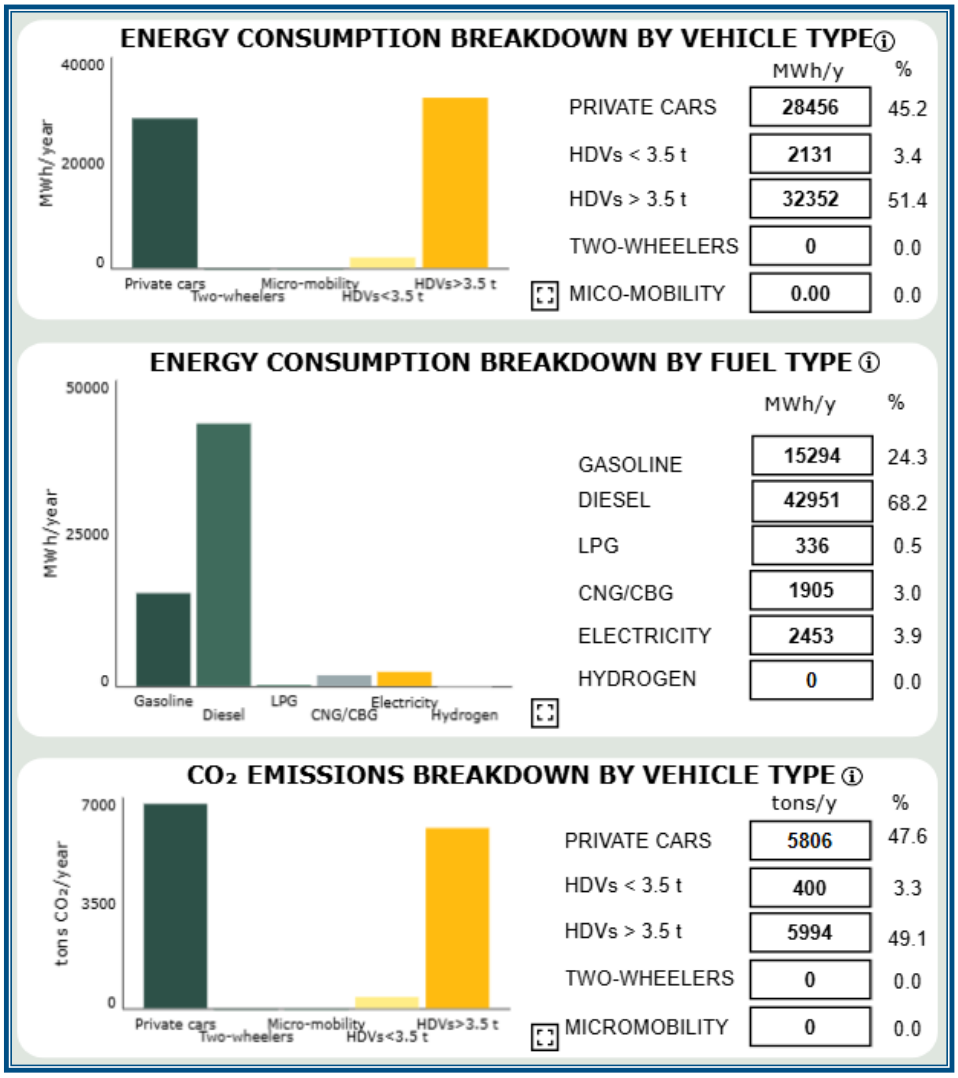
Based on assumptions regarding private vehicle usage, average fuel consumption, and fuel types, energy consumption in the private transport sector is estimated to decrease from 62 939 MWh per year in 2023 to 59 022 MWh per year by 2050. Consequently, the share of transport energy consumption in the municipality's total energy consumption is projected to decline from 23.6% in 2023 to 22.1% by 2050.

Energy demand is primarily attributable to HDVs above 3.5 tonnes, which account for 32 352 MWh/year (51.4%), followed by passenger cars with 28 456 MWh/year (45.2%) and HDVs below 3.5 tonnes with 2 131 MWh/year (3.4%). Energy consumption by other vehicle categories, including two-wheelers and micromobility devices, is negligible.

In terms of fuel type, diesel is the dominant fuel, accounting for 68.2% of total energy consumption, followed by gasoline (24.3%). Electricity represents a relatively small share, amounting to 2 453 MWh per year (3.9 %) of total energy demand. Compressed natural gas (CNG) accounts for 1 905 MWh per year (3%), while liquefied petroleum gas (LPG) contributes 336 MWh per year (0.5%).

Total CO_2 emissions from the private transport sector amount to 12 200 tonnes of CO_2 per year, representing approximately 75.3% of the municipality's total CO_2 emissions in the baseline year.

The baseline scenario assumes no significant changes in private transport usage patterns and no additional policy interventions. Changes in energy consumption and emissions are driven solely by exogenous factors, including a gradual decline in population. As a result, energy consumption and CO_2 emissions are projected to decrease by approximately 6.2% and 6.5%, respectively, by 2050 compared with the baseline year.



Policies

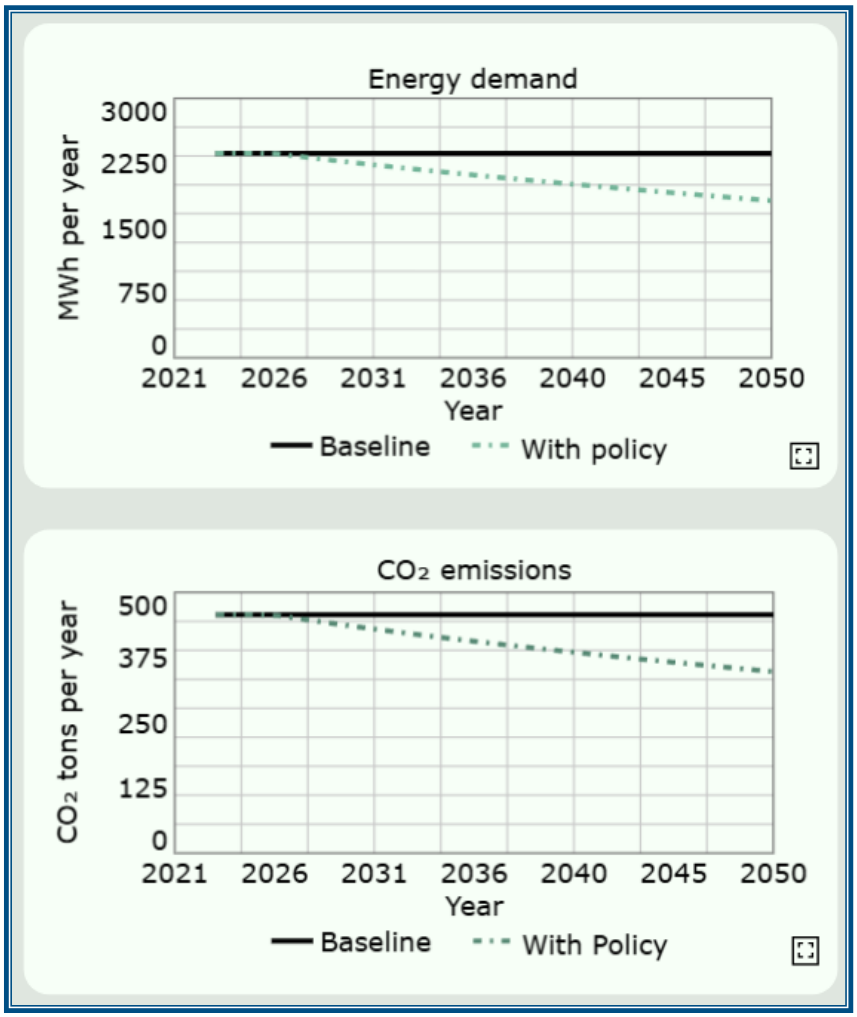
Municipal vehicle fleet

In this sector, the following policy measures were proposed:

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

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

In total, the selected policies achieved 547 MWh in energy savings and 109 tCO_2 in emission savings in 2050 compared to the baseline scenario (23.2 % and 23.9 % reductions respectively).



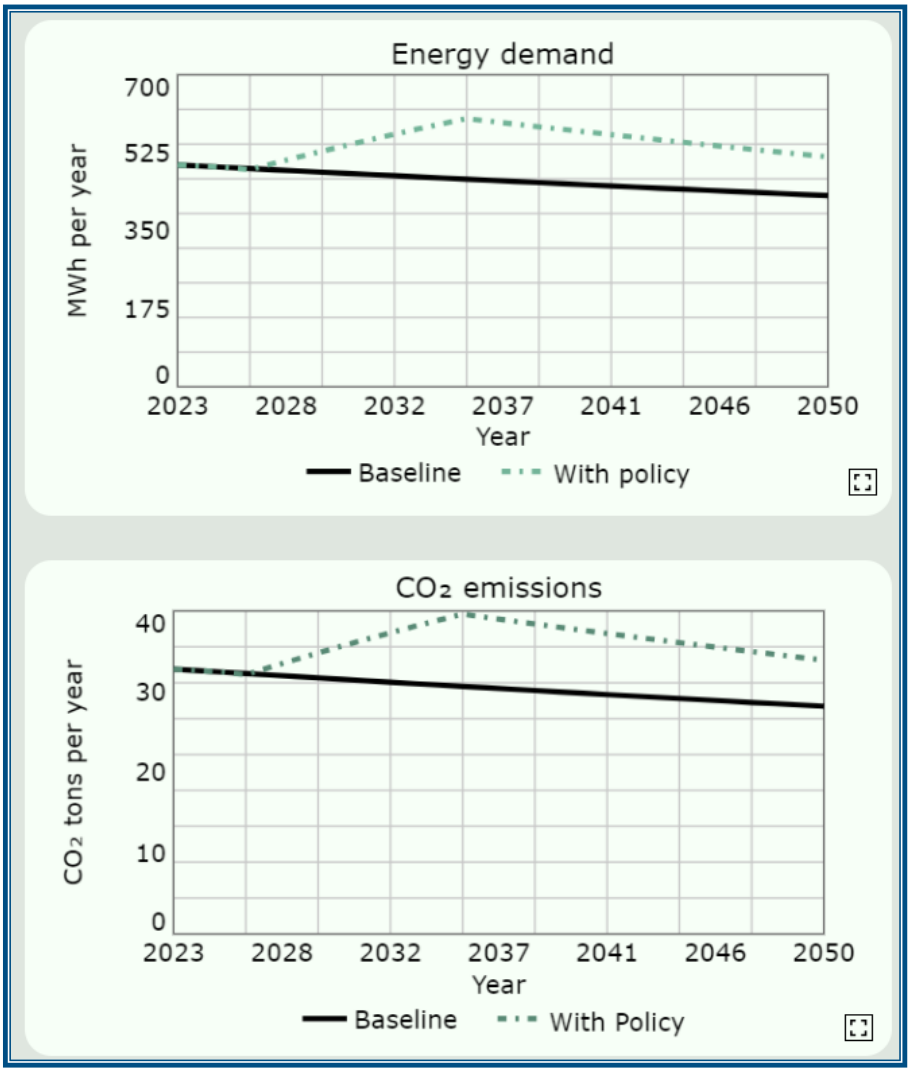
Public transport

In the public transport sector, the following policy was tested:

- **Mode shift to public transport** (*Target share – Public transport* 10 % (*+3 %*), *Bicycle* 3 %, *Walking* 5 %, *Car* 82 % (*-3 %*))

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

In total, the selected policy results in an increase of approximately 87 MWh in energy demand and 6 tons of CO_2 emissions by 2050 compared to the baseline scenario. With policy implementation in 2025, both energy demand and emissions continue rising until 2035, reaching peaks of 602 MWh and 40 tCO_2 respectively. After that, due to population decrease, energy demand and emissions start dropping at a relatively constant rate of ~0,95 % and 1 % respectively, while still remaining above the baseline scenario trendline.



Private transport

The following policies were implemented in the private transport sector:

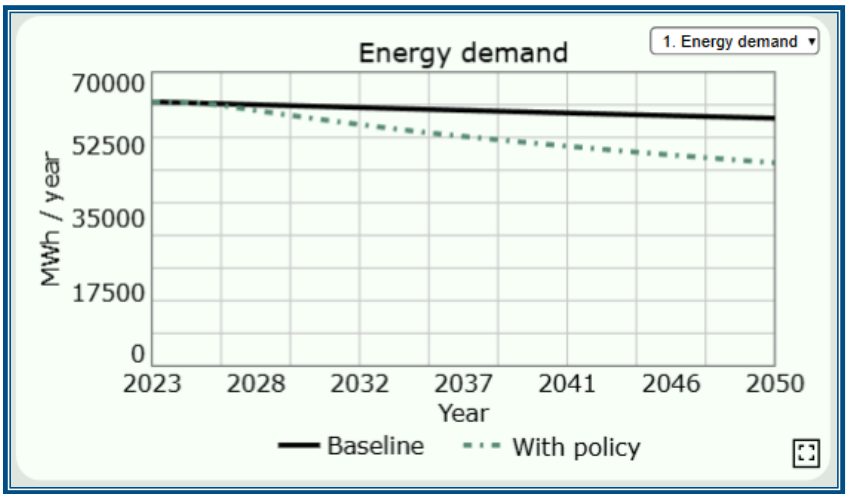
- **Reduction in passenger transport demand** (*Daily distance reduction IS* 0,5 %/year, *Travel frequency reduction IS* 0 %/year)
- C**ar sharing** (IS 1 %/year)
- **Transition to low and zero carbon technologies in passenger cars** (*Passenger cars Target share – Gasoline* 30 %, *Diesel* 24.6 %, *Electricity* 40.8 %, *Hydrogen* 4.6 % *HDVs < 3,5t Target share – Gasoline* 5 %, *Diesel* 10 %, *Electricity* 70 %, *Hydrogen* 15 % *HDVs > 3,5t Target share – Diesel* 20 %, *Electricity* 40 %, *Hydrogen* 40 %)
- **Apply selected passenger car policies to guest travellers**

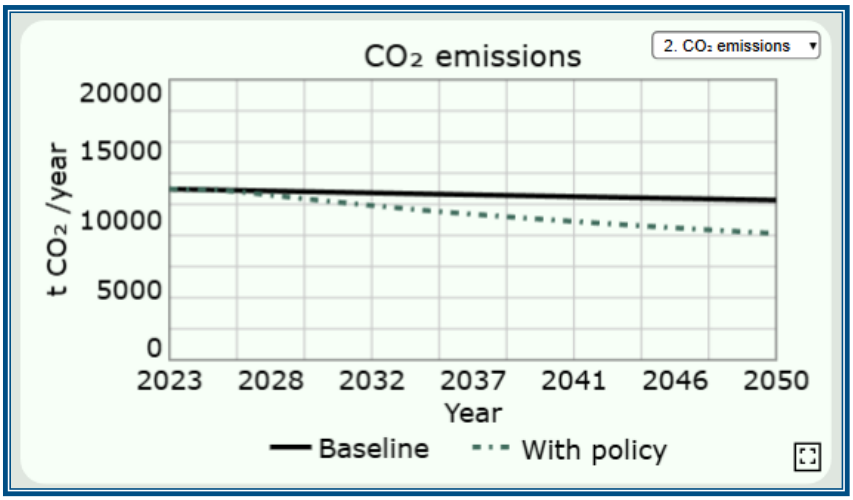
Additionally, the mode shift policy used in the public transport sector has an effect on the share of passenger cars in the private transport sector:

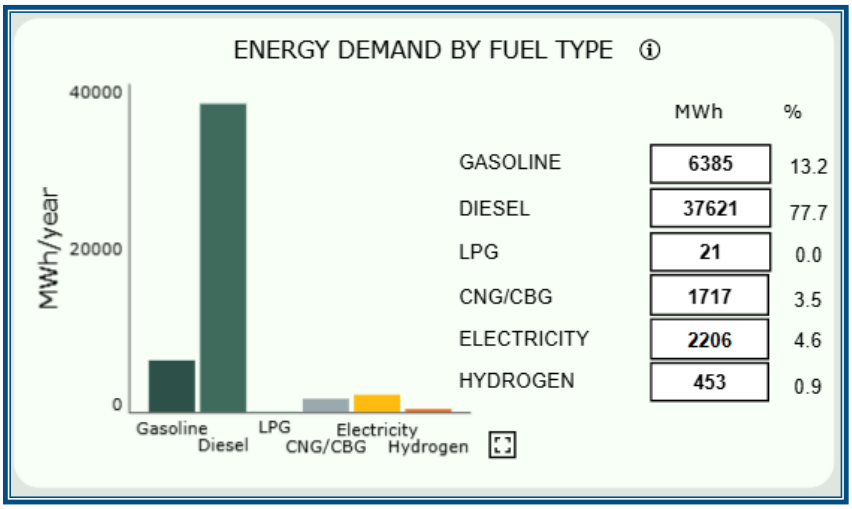
- **Modal change in passenger transport** (*Target share – Public transport* 10 % (*+3 %*), *Bicycle* 3 %, *Walking* 5 %, *Car* 82 % (*-3 %*))

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

In total, the selected policies result in a reduction of approximately 10 580 MWh in energy demand and 2 386 tons of CO_2 emissions by 2050 compared to the baseline scenario. Private transport achieves 17.9% energy savings and 20.9% emission reductions.







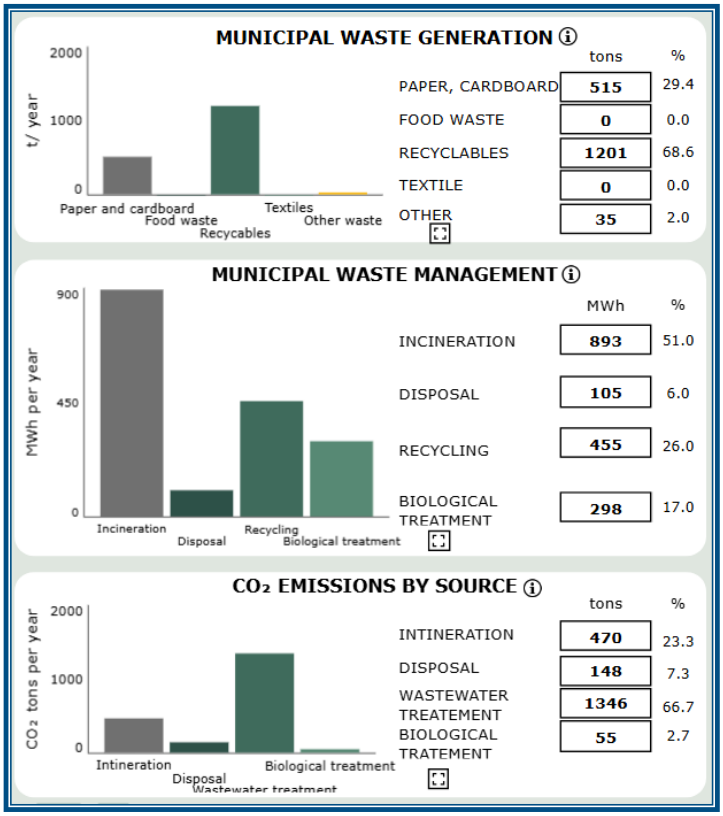
3.6. WASTE MANAGEMENT

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 (431 kg/capita/year) and the structure of municipal waste. Based on these assumptions, the amount of municipal waste generated in Jokkmokk municipality in the base year is 2060 tons and the GHG emissions related to waste management constitute 2376 tons CO_2eq. The waste management sector accounts for approximately 14.7 % of the municipality's emissions.

As the baseline scenario assumes an annual 0.6 % decrease in the municipality's population, by 2050, the total amount of waste generated and GHG emissions are expected to decrease by approximately 15 %, reaching 1751 tons of generated waste and 2020 tons CO_2eq, respectively.



Policies

In this sector, no policy measures were proposed or tested, as the municipality has currently no plans to implement additional interventions. Therefore, the baseline scenario remains unchanged, and no simulated energy or emission reductions are projected for this sector.

This decision may reflect limited municipal influence, lack of cost-effective measures, or prioritization of other sectors with higher reduction potential.

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 CO_2 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 the local energy production sector, district heating demand amounts to 27 198 MWh/year, with the largest share attributed to residential buildings (58.7 %), followed by municipal buildings (41.3 %). When distribution losses are considered, total heating demand increases to 31 278 MWh/year.

Total electricity demand is 152 777 MWh/year, with the largest share coming from other sectors (83.8%), followed by municipality buildings (8.5 %), residential buildings (5.1 %), transport (1.7 %) and public infrastructure (0.9 %). Including distribution losses, total electricity demand rises to 159 353 MWh/year.

Consequently, the total energy demand in the baseline year amounts to 190 166 MWh/year. CO_2 emissions from energy production in the baseline year are 719 tCO_2/year. Due to the diminishing population, energy demand from public infrastructure and transport sectors decreases over time throughout the baseline scenario, along with the associated emissions eventually reaching 159 044 MWh and 190 tCO_2 in 2050 (16.4 % and 73.6 % reductions respectively).

Policies

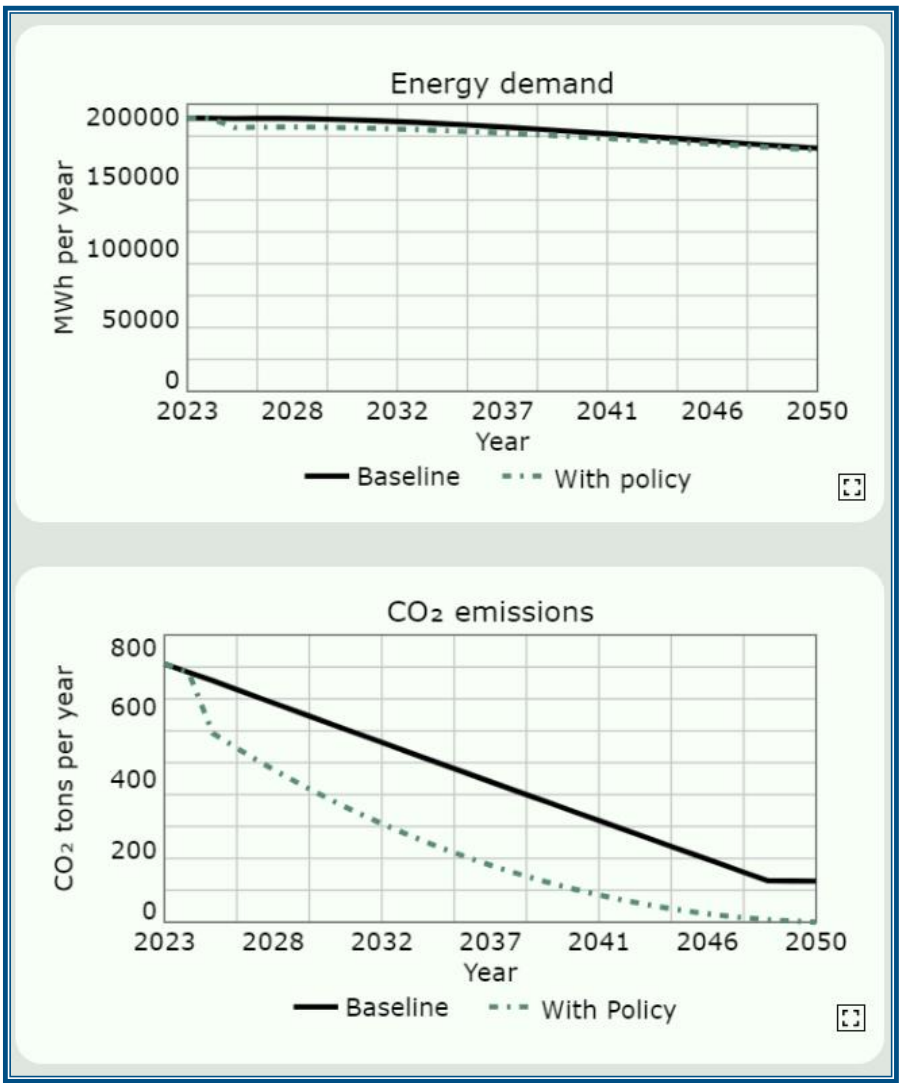
To further reduce CO_2 emissions from local energy production, the following policies were implemented:

- **Reduction of heat loss** (*Heat loss reduction limit* 7 %, *IS* 5 %/year)

- **Waste heat recovery** (*Savings potential* 25 %)
- **District heating decarbonization** (*Target emission factor* 0,000 tCO_2/MWh (*-0,023 tCO_2/MWh*))
- **Local electricity production decarbonization** (*Target emission factor* 0,000 tCO_2/MWh (*-0,000 tCO_2/MWh*))
- **Grid electricity production decarbonization** (*Target emission factor* 0,000 tCO_2/MWh (*-0,020 tCO_2/MWh*))

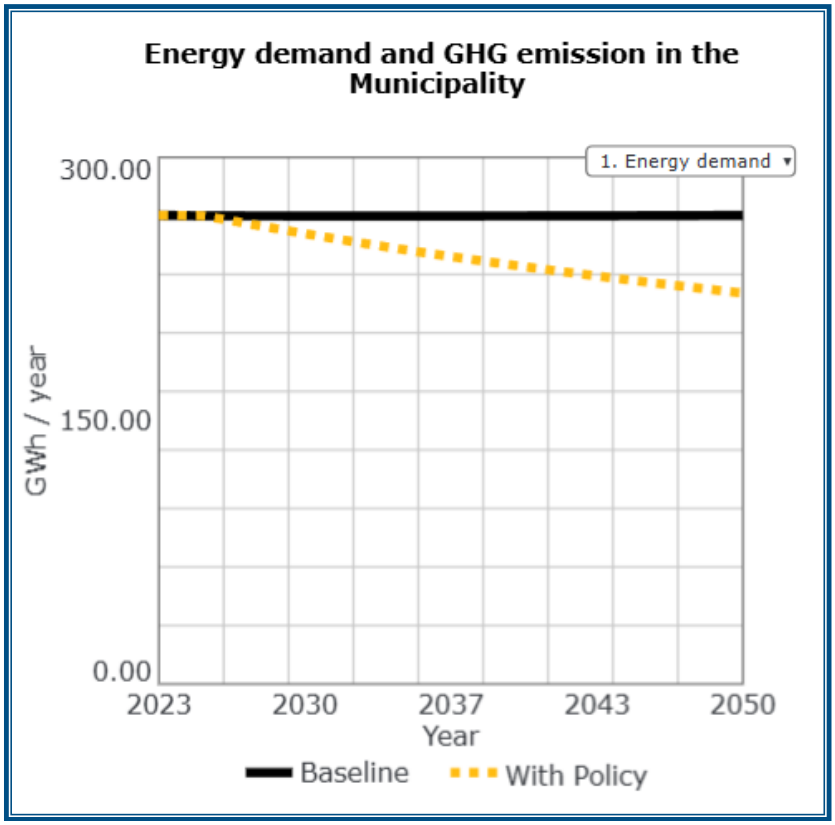
For all selected policies, the start year was 2025 and the end year was 2050.

In total, these policies achieved 8102 MWh (5.1 %) and 190 tCO_2 (100 %) in energy demand and emission reductions respectively.



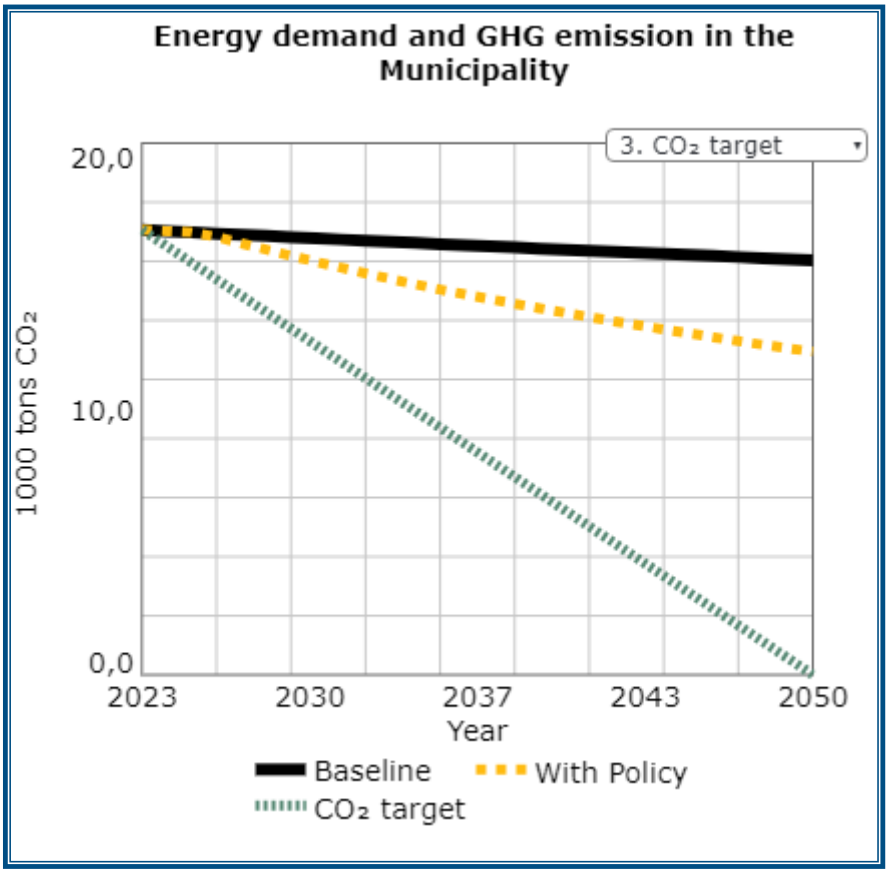
4. RESULT OVERVIEW

The results of the simulation show that in the baseline scenario energy demand in the municipality remains relatively stable, from 267.04 GWh in 2023 to 266.97 GWh by 2050. As illustrated in the figure below, the implementation of the selected policy package causes a gradual energy demand decrease, resulting in an energy demand of 222.68 GWh by 2050. This corresponds to energy savings of approximately 44 285 MWh, or 16.6 % compared to the baseline projection.



The selected policy package leads to a meaningful reduction in GHG emissions. Emissions decrease from approximately 16.2 thousand tonnes CO_2eq in the baseline year to approximately 15.2 thousand tonnes CO_2eq in the 2050 baseline scenario. With the selected policy package, emissions decrease further to approximately 11.9 thousand tonnes CO_2eq by 2050. This corresponds to an annual reduction of approximately 3.3 thousand tonnes CO_2eq, or 21.3%, compared with the 2050 baseline projection.

As shown in the figure below, the policy scenario remains above the model's indicative long-term target trajectory, which represents a 100% reduction by 2050. This comparison is illustrative and should not be interpreted as a formal assessment of municipal target achievement. Nevertheless, it demonstrates that additional and more ambitious mitigation measures would be required to close the remaining modelled emission-reduction gap.


Energy demand and GHG emission in the Municipality
3. CO₂ target
20,0
10,0
0,0
1000 tons CO₂
2023
2030
2037
2043
2050
Year
Baseline
With Policy
CO₂ target

5. LINK WITH JOKKMOKK MUNICIPAL ENERGY AND CLIMATE PLANNING

5.1. Relationship between municipal planning areas and the CommitClimate modelling

The table below presents the thematic relationship between the main areas relevant to Jokkmokk's municipal energy and climate planning and the sectors and measures included in the CommitClimate simulation. As the complete content of the municipality's 2009 Energy and Climate Strategy was not reassessed within the project, the table below presents a thematic relationship rather than a formal evaluation of strategy implementation.

Jokkmokk municipal energy and climate planning area	CommitClimate modelled sector / measures	Link and added value
Municipal buildings and operations	Municipal buildings: energy-efficiency improvements, renovation, heating-system changes and renewable-energy production.	Strong link. The modelling supports analysis of municipal building energy demand and the potential effects of efficiency improvements, heating-system changes and renewable-energy deployment. These results may help identify priorities for reducing energy use and operational emissions from the municipal building stock.
Housing / residential buildings	Residential buildings: renovation of single-family houses, multi-family houses and other residential buildings; electricity-saving measures; renewable and low-carbon heating technologies.	Strong link. The modelling supports analysis of residential energy demand and the potential impact of renovation, energy-efficiency measures and heating-system decarbonisation. This is relevant for future municipal work concerning building renovation and household energy efficiency.
Public infrastructure	Public lighting, drinking-water preparation and wastewater treatment: replacement of inefficient light bulbs and energy-efficiency improvements in municipal infrastructure.	Good link. The model can support evaluation of electricity-saving measures in public infrastructure and municipal service systems. The results indicate a considerable relative reduction in public-infrastructure electricity demand, although the sector represents a small share of total municipal energy consumption.
Commercial, tertiary and other economic sectors	Other sectors: energy-efficiency improvements and changes in energy consumption across commercial, tertiary, industrial and agricultural activities.	Strong link. This sector provides the largest quantified contribution to energy savings in the Jokkmokk policy scenario. The modelling can help identify the importance of engaging actors outside direct municipal control in future energy and climate planning.
Transport and mobility	Municipal fleet, public transport and private transport: fleet decarbonisation, fleet	Very strong link. Transport is a major source of energy demand and CO_2 emissions in the Jokkmokk

	modernisation, driver training and awareness, improved fleet management, modal shift, reduced passenger-transport demand, car sharing and transition to low- and zero-emission vehicles.	simulation. The modelling supports comparison of behavioural, modal and technological measures and shows that private transport provides the largest quantified contribution to emission reductions in the tested policy package.
Energy production and renewable energy	Local energy production: reduction of district-heating distribution losses, waste-heat recovery, district-heating decarbonisation, local electricity-production decarbonisation and grid-electricity decarbonisation.	Strong link. The modelling addresses several areas relevant to Jokkmokk's energy and climate planning, including district-heating efficiency, waste-heat recovery, renewable energy and the decarbonisation of local heat and electricity supply. It supports assessment of how changes in the local energy system may contribute to reducing energy demand and CO_2 emissions and can provide useful analytical input for future energy and climate strategy development.
Waste management and circular economy-related emissions	Municipal waste generation, waste composition and waste-treatment pathways were included in the baseline assessment. No additional waste-management policy measures were tested.	Partial link. Waste-related emissions are represented in the model, but the simulation does not assess the effects of additional waste prevention, recycling or treatment measures. This limits its current contribution to identifying future waste-sector mitigation pathways.
Long-term planning, monitoring and strategy revision	Municipality-wide baseline and policy scenarios up to 2050, including sectoral energy demand, emissions and estimated policy effects.	Strong conceptual link. The modelling framework can support the future preparation or revision of Jokkmokk's Energy and Climate Strategy or another comparable municipal energy and climate planning document, including a SECAP-type document, by helping to compare alternative pathways, identify priority sectors and assess the potential effects of different policy packages. It complements the formal municipal planning, stakeholder consultation and political adoption process without replacing it.

The modelling framework therefore addresses many of the technical sectors normally considered in municipal energy and climate planning. However, the simulation does not reproduce the complete content, governance process or legally required elements of a formal municipal energy plan.

5.2. Main modelling results relevant for future energy and climate planning

The CommitClimate simulation shows that the selected policy package reduces Jokkmokk's 2050 energy demand by approximately 44 285 MWh, or 16.6%, and GHG emissions by approximately 3 232 tCO_2eq, or 21.3%, compared with the baseline scenario. The larger relative reduction in emissions than in energy demand indicates that the policy package combines demand reduction with fuel switching, renewable-energy deployment and energy-supply decarbonisation.

The results are strongly concentrated in two areas. Energy-efficiency measures in commercial, tertiary and other economic sectors account for almost two-thirds of total modelled energy savings, while private transport accounts for almost three-quarters of total emission reductions. This concentration has an important planning implication: the largest potential benefits depend not only on measures directly

implemented by the municipality but also on cooperation with businesses, residents, transport users and regional and national authorities.

The building results illustrate a different mitigation pathway. Municipal and residential buildings provide comparatively moderate energy savings, but the modelled transition in heating technologies and renewable-energy use eliminates their reported operational emissions by 2050. This demonstrates that energy-efficiency improvements and heating-system decarbonisation should be considered together rather than treated as separate planning priorities.

The increase in public transport energy demand and emissions should be interpreted in the context of the wider transport system. It results from a shift of passenger activity from private cars to public transport and is substantially outweighed by the reductions achieved in private transport. For planning purposes, the combined effect across transport modes is therefore more relevant than the isolated result for public transport.

The local energy-production results further demonstrate the importance of combining end-use measures with improvements in district-heating efficiency, waste-heat recovery and the decarbonisation of heat and electricity supply. The scenario therefore supports an integrated approach linking energy demand, mobility, buildings and local energy supply.

Despite the quantified reductions, the policy scenario remains above the model's indicative climate-neutrality trajectory. No additional waste-management measures were tested, and the results suggest that deeper long-term decarbonisation would require a broader policy package. Future planning should therefore combine measures under direct municipal control with coordinated action in private transport, other economic sectors, residential buildings, waste management and energy supply.

5.3. Experience from simulator testing and practical relevance

The original intention of the Swedish CommitClimate activities was to cooperate with Jokkmokk Municipality and explore how the simulator could support the revision of the existing municipal Energy and Climate Strategy.

In Sweden, municipal energy and climate plans are formal planning documents. Their preparation or revision normally involves data collection and analysis, stakeholder dialogue, public consultation and political adoption by the municipal council. Consequently, the practical integration of a new modelling tool into this process requires the tool to be available and operational at an early stage of the municipal planning cycle. Due to delays in the development of the simulator and the technical and usability challenges encountered during the project period, it was not possible to apply the tool within a formal update of Jokkmokk's Energy and Climate Strategy as originally envisaged.

Nevertheless, the CommitClimate activities generated important practical value. More than two years of data collection, scenario development, testing and cooperation with municipalities increased understanding of the data, assumptions and methodologies required for local energy and climate planning in small municipalities.

The work helped identify gaps between nationally available statistics and the more detailed local data required for municipal modelling. It also strengthened the project partners' capacity to compile, interpret and assess energy and emissions data and provided practical experience in developing long-term transition scenarios.

These lessons were shared with member municipalities, follower municipalities and regional stakeholders through workshops, coaching activities, guidance materials and other energy-planning support. The project therefore strengthened institutional knowledge, built cooperation networks and created a useful foundation for future municipal energy and climate planning activities.

The developed CommitClimate scenario report and modelling results may be considered relevant background material for future energy and climate planning. Their practical use would depend on the quality and regular updating of baseline data, the municipality's assessment of the tool's usability and the continued development and maintenance of the simulator.

5.4. Scope and limitations

The CommitClimate simulation report should be understood as a supporting analytical document. It does not formally amend, replace or update Jokkmokk's existing Energy and Climate Strategy.

The modelling was undertaken for exploratory, analytical and capacity-building purposes and has not been formally adopted or endorsed by Jokkmokk Municipality. The results should therefore be interpreted as scenario-based estimates rather than official municipal projections.

The quantitative results depend on the available baseline information and on assumptions concerning population development, building stock, economic activity, transport demand, vehicle use, fuel consumption, waste generation, emission factors and technology development.

Several input datasets are aggregated, and some energy and emission values are calculated from modelling assumptions rather than derived directly from municipal consumption records or fuel invoices. This is particularly relevant for transport, where energy demand and emissions are estimated using assumptions about travel activity, vehicle use, occupancy, annual mileage, fuel consumption and technology shares.

The tested policy package does not represent Jokkmokk's full emission-reduction potential. No additional waste-management measures were tested, while some other sectors are represented through aggregated data and assumptions. Climate-risk assessment, adaptation measures, green infrastructure and climate resilience are outside the main scope of the CO_2 simulator.

The model's indicative 2050 climate-neutrality trajectory is used to illustrate the remaining modelled emission-reduction gap. It should not be interpreted as a formal assessment of compliance with an adopted municipal target.

The formal preparation or revision of a municipal Energy and Climate Strategy would require additional steps outside the modelling process, including stakeholder dialogue, public consultation, administrative assessment and political adoption by the municipal council.

These limitations do not prevent the results from being used as supporting analytical material. Instead, they identify the areas in which updated data, additional policy scenarios and further local assessment could strengthen future planning exercises.

5.5. Use of CommitClimate results for future energy and climate planning and review

Provided that the baseline data are kept up to date and the simulator is further developed and maintained, the CommitClimate results may serve as relevant background material for the future preparation, revision, implementation or monitoring of Jokkmokk's municipal energy and climate plan.

The modelling could support future work by:

- providing a structured starting point for updating the municipal energy and emissions baseline;
- illustrating the effects of alternative assumptions and policy packages;
- identifying sectors with the largest energy-saving or emission-reduction potential;
- highlighting gaps in local data and existing policy coverage;
- supporting discussion with municipal departments, energy companies, businesses, residents and other stakeholders;
- comparing progress with a baseline pathway during future monitoring and review;
- supporting the analytical preparation of a new or updated municipal energy and climate plan.

The CommitClimate report should therefore be regarded as complementary analytical material. It does not replace the formal municipal planning, consultation and political adoption process. However, the modelling approach, scenario results and experience gained during the project may support the evidence base required for the future preparation or revision of Jokkmokk's Energy and Climate Strategy.

6. CONCLUSIONS

The results of the scenario analysis for Jokkmokk municipality show that the implementation of the selected policy package leads to moderate reductions in both energy demand and greenhouse gas emissions by 2050, in the context of a gradually declining population and relatively stable economic development.

Overall, total energy demand decreases by approximately 16.6 % (44 285 MWh) compared to the baseline scenario, indicating that energy efficiency improvements and demand-side measures are effective in reducing energy consumption even under conditions of already declining demand. At the same time, GHG emissions decrease by 21.3% (3 232 tCO_2eq), indicating that the policy package achieves a stronger relative reduction in emissions than in energy deman

The results highlight that **the building sector** plays a significant role in emission reduction, particularly due to the complete decarbonisation of heating systems. In both **municipal** and **residential** buildings, emissions are reduced by 100 %, despite relatively modest energy savings (1.5 % and 7.7 % respectively). This indicates that fuel switching and renewable energy integration are the dominant drivers of emission reduction in this sector, rather than large reductions in energy demand.

The other sectors also contribute substantially to overall energy savings, achieving 28 939 MWh reductions (21.6 %) and significant emission reductions. This demonstrates the importance of continuous energy efficiency improvements across commercial and tertiary activities, even in municipalities with relatively low industrial intensity.

In **the transport sector**, the results show more moderate impacts compared to other case studies. Private transport achieves 18 % energy savings and 21 % emission reductions, while municipal fleet improvements contribute additional reductions. However, the introduction of modal shift policies in public transport results in an increase in energy demand and emissions (+20.3%), reflecting the trade-off between shifting travel behaviour and overall system efficiency in a low-demand context. Overall, policy measures reduce the energy required for private transport by over 10.5 GWh and emissions are projected to decrease by 2 380 tCO2 in 2050.

The public infrastructure sector achieves notable energy savings of 33.1 % (409 MWh), mainly through lighting improvements, although emissions remain unchanged due to the already renewable electricity supply. Similarly, in the waste management sector, no additional emission reductions are achieved, as no policy measures were implemented.

The local energy production sector demonstrates a complete elimination of emissions (100 % reduction) through decarbonisation measures, although the impact on total energy demand remains limited (5.1 % reduction).

Despite these improvements, the results indicate that the overall policy package leads to only moderate emission reductions at the municipal level, and emissions remain significantly above the long-term climate neutrality target. This suggests that additional and more ambitious measures—particularly in the transport sector and demand reduction policies—would be required to achieve deeper decarbonisation.

Overall, the analysis shows that in municipalities with declining population and relatively low growth, decarbonisation is driven more by fuel switching and energy system transformation than by large reductions in energy demand. A broader policy mix, including stronger behavioural measures and deeper

transport interventions, would be necessary to further increase emission reduction potential in Jokkmokk municipality. The CommitClimate modelling framework also demonstrates its potential to provide useful analytical support for the preparation or revision of Jokkmokk's Energy and Climate Strategy or another comparable municipal energy and climate planning document, including a SECAP-type document. By supporting baseline analysis, comparison of alternative development pathways, identification of priority sectors and assessment of different policy packages, the tool may complement the formal municipal planning, stakeholder consultation and political adoption process. Its future application would depend on the availability of reliable and up-to-date local data and on the further development and maintenance of the simulator.

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

Sector	Indicator	Results
Municipal buildings	Energy savings	364 MWh (1.5 %)
	Emission reduction	260 tCO_2 (100 %)
	Renewable generation	2854 MWh
Residential buildings	Energy savings	3493 MWh (7.7 %)
	Emission reduction	367 tCO_2 (100 %)
	Renewable generation	20 697 MWh
Public infrastructure	Energy savings	409 MWh (33.1 %)
	Emission reduction	0 tCO_2 (0 %)
	Renewable generation	–
Other sectors	Energy savings	28 939 MWh (21.6 %)
	Emission reduction	115 tCO_2 (18.8 %)
Municipal fleet	Energy savings	547 MWh (23.2 %)
	Emission reduction	109 tCO_2 (23.9 %)
Public transport	Energy savings	-87 MWh (-20.3 %)
	Emission reduction	-6 tCO_2 (-20.3 %)
Private transport	Energy savings	10 620 MWh (18.0 %)
	Emission reduction	2386 tCO_2 (20.9 %)
Waste management	Waste generation reduction	–
	Emission reduction	–
Local energy production	Energy savings	8102 MWh (5.1 %)
	Emission reduction	190 tCO_2 (100 %)
	Renewable generation	–