Sustainable Energy and Climate Action Plan (SECAP)

Khachmaz City

Project: EU4ClimateResilience – European Union Climate Resilience Programme

Partner: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Sustainable Energy and Climate Action Plan (SECAP)

City: Khachmaz

Project: Within the framework of the EU4ClimateResilience Programme (with support from the European Union, the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, and GIZ)

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LIST OF ABBREVIATIONS AND TERMS

Abbreviation	English full form	Meaning / equivalent term
Action Plan	—	Action Plan
Adaptation	—	Adaptation to climate change
AEEF	Azerbaijan Energy Efficiency Fund	Azerbaijan Energy Efficiency Fund
AERA	Azerbaijan Energy Regulatory Agency	Azerbaijan Energy Regulatory Agency
AREA	Azerbaijan Renewable Energy Agency	
AzerEnergy OJSC	—	AzerEnergy OJSC
Azerigaz PU	—	Azerigaz Production Union
Azerishiq OJSC	—	Azerishiq OJSC
AzStat	State Statistical Committee of Azerbaijan	State Statistical Committee of the Republic of Azerbaijan
Baseline Year	—	Baseline year / reporting year
BEER	Baseline Energy and Emission Register	Baseline Energy and Emission Register
BEI	Baseline Emission Inventory	Baseline Emission Inventory
BUR	Biennial Update Report	Biennial Update Report
CCDR	Country Climate and Development Report	Country Climate and Development Report
Climate Resilience	—	Climate resilience
CO_2-eq	Carbon Dioxide Equivalent	Carbon dioxide equivalent
CoM	Covenant of Mayors for Climate and Energy	Covenant of Mayors for Climate and Energy
COP	Conference of the Parties	Conference of the Parties
CSO	Civil Society Organisation	Non-governmental / civil society organisation
CSR	Corporate Social Responsibility	Corporate social responsibility
DST	Data Standard Template	Standard data format
EE	Energy Efficiency	Energy efficiency
Energy Poverty	—	Energy poverty

EPBD	Energy Performance of Buildings Directive	Energy Performance of Buildings Directive
EPOV	European Energy Poverty Observatory	European Energy Poverty Observatory
EPAH	Energy Poverty Advisory Hub	
ESCO	Energy Service Company	Energy service company
ESCO Contract	Energy Performance Contract	Energy performance contract
MENR	Ministry of Ecology and Natural Resources	Ministry of Ecology and Natural Resources
EU ETS	European Union Emissions Trading System	European Union Emissions Trading System
EU4ClimateResilience	European Union Programme for Climate Resilience	European Union Climate Resilience Programme
FAO	Food and Agriculture Organization	Food and Agriculture Organization of the United Nations
GHG	Greenhouse Gas	Greenhouse gas
GIS	Geographic Information System	Geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Green Transition	—	Green transition (decarbonisation of energy and the economy)
HVAC	Heating, Ventilation and Air Conditioning	Heating, ventilation and air-conditioning system
ICLEI	Local Governments for Sustainability	Local Governments for Sustainability Network
IEA	International Energy Agency	International Energy Agency
IFIs	International Financial Institutions	International financial institutions
IPCC	Intergovernmental Panel on Climate Change	Intergovernmental Panel on Climate Change
ISO 50001	International Standard for Energy Management Systems	International standard for energy management systems
IZIA	Economic Zones Development Agency	Economic Zones Development Agency
JRC	Joint Research Centre (European Commission)	Joint Research Centre of the European Commission

JRC142148 / 2025	—	JRC 2025 guidance: How to develop a SECAP
KPI	Key Performance Indicator	Key performance indicator
LED	Light Emitting Diode	Light-emitting diode (LED lighting)
LEDS	Low Emission Development Strategy	Low-emission development strategy
MEI	Municipal Energy Inventory	Municipal energy inventory
Mitigation	—	Climate change mitigation / emission reduction
MoE	Ministry of Economy	Ministry of Economy
MinEnergy	Ministry of Energy of the Republic of Azerbaijan	Ministry of Energy
Monitoring & Evaluation (M&E)	—	Monitoring and evaluation
MSW	Municipal Solid Waste	Municipal solid waste
MyCovenant Portal	—	Covenant of Mayors information platform
NAP	National Adaptation Plan	National Adaptation Plan
NC	National Communication	National Communication
NDC	Nationally Determined Contribution	Nationally Determined Contribution / national climate commitment
OECD	Organisation for Economic Co-operation and Development	Organisation for Economic Co-operation and Development
Paris Agreement	Paris Agreement	International climate change treaty adopted in 2015 and signed in 2016
PPP	Public–Private Partnership	Public–private partnership
PV	Photovoltaic	Photovoltaic / solar PV system
RE	Renewable Energy	Renewable energy
Digital Ecology System	Digital Ecology Information System	Integrated environmental information system
RES	Renewable Energy Sources	Renewable energy sources
RVA	Risk and Vulnerability Assessment	Risk and Vulnerability Assessment
SCADA	Supervisory Control and Data Acquisition	Supervisory control and data acquisition system
SCC	State Committee for Urban Planning and Architecture	State Committee for Urban Planning and Architecture

SDG	Sustainable Development Goals	Sustainable Development Goals
SECAP	Sustainable Energy and Climate Action Plan	Sustainable Energy and Climate Action Plan
UNDP	United Nations Development Programme	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change	United Nations Framework Convention on Climate Change
WB	World Bank	World Bank

Additional statements

EPOV	Energy poverty	A socio-economic situation caused by limited access to adequate energy services (heating, cooling, electricity and hot water), a high energy cost burden and low income.
MRV	Monitoring, Reporting and Verification	Tracking the implementation and impacts of actions through indicators, submitting periodic reports, and verifying methodological and data quality through internal or independent review.
NZEB	*Nearly Zero-Energy Building*	A building with high energy performance whose remaining energy demand is supplied mainly from renewable sources.
ESCO	*Energy Services Company*	A business that provides energy solutions, including the design and implementation of energy-saving projects and the management of energy infrastructure.
BEI	Baseline Emission Inventory	Calculation of GHG emissions by sector for the SECAP baseline year.
RVA	Risk and Vulnerability Assessment	Analysis of the impacts of climate hazards (heatwaves, floods, droughts, etc.) and the vulnerability of exposed sectors and population groups.

1. Analysis of energy-climate policies and frameworks

1.1 Energy-climate policies

1.1.1 Overview

This document summarises the results of the development of the Sustainable Energy and Climate Action Plan (SECAP) for the city of Khachmaz. Objective: to analyse national, regional and local legislation and policies related to energy, climate, urban planning and sustainable development, and to identify alignment with the SECAP, gaps and recommendations. The plan targets 2030 and 2050 and is based on the CoM Europe 2025 methodology.

1.1.2 Methodology

- More than 160 normative and strategic documents have been collected and classified.
- Normative-institutional analyses were conducted on energy, the environment, and municipal competences.
- Alignments and gaps between SECAP and national/local policies have been identified.
- Initial data requirements for the BEI (Baseline Emission Inventory) and RVA (Risk & Vulnerability Assessment) have been developed.

Stakeholders: municipality, executive authority, ministries, SMEs, NGOs, academic institutions.

Public participation: hearings, digital portal.

Priority areas: emissions reduction, adaptation and energy poverty.

1.1.3 BEI boundaries and base year

Sectors: buildings, urban transport, public lighting, waste; base year: 2023. Emissions calculated in accordance with the CoM 2025, IPCC 2006 methodology.

1.1.4 Source hierarchy and QA/QC

Official legislation, government programmes, statistical reports and municipal documents were used, and journals and a double-checking principle were applied for quality assurance.

1.1.5 Final results

Azerbaijan has ratified its international climate commitments through its NDC/NAP; domestic implementation and monitoring still need to be strengthened.

Khachmaz's geographical location increases climate risks, but the city has potential for solar, hydro and bioenergy.

The potential for energy efficiency is high in buildings, tourism and public lighting.

Sectoral findings:

- *Buildings*: energy audits and labelling are limited.
- *Public lighting:* LED and energy service company mechanisms are suitable.
- *Transport:* incentives for low-emission transport, charging infrastructure for electric vehicles is required.
- *Waste:* sorting and landfill gas to biogas opportunities exist.
- *Renewable energy*: regulations should be developed for PV roofs and community energy initiatives.
- *Energy poverty:* a baseline of indicators could be established, and confidentiality must be ensured.

1.1.6 Strategic pillars and priorities

SECAP: Mitigation, Adaptation, Energy poverty (EPOV).

Mitigation: thermal retrofitting, LED lighting, low-emission transport, waste sorting.

Adaptation: drainage and coastal erosion, water loss reduction, green infrastructure.

EPOV: insulation in social housing, subsidies for A++ appliances, awareness-raising.

Indicative targets for 2030: GHG emissions –35%, energy saving 20–25 GWh/year, RE ≥15–20%, ≥20% reduction in energy poverty, ≥25% reduction in adaptation risks.

1.1.7 Policy coherence and governance

National alignment: NDC/NAP, sector strategies support SECAP targets; local mechanisms need to be expanded.

Governance: Energy and Climate Secretariat, Energy and Climate Council, thematic working groups.

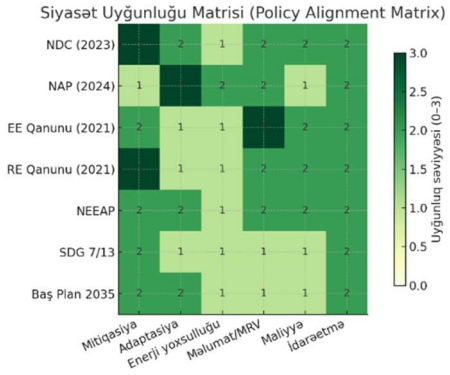
Monitoring: annual reports, MyCovenant platform, KPI matrix.

Digital information: integration of the local inventory and the national SECAP portal.

1.1.8 Roles and coordination (RACI)

Council: municipal leadership, experts, utilities, NGOs, academics.

RACI (R – Responsible: individuals directly responsible for carrying out the work; A – Accountable: the individual with ultimate responsibility for the work; C – Consulted: individuals whose input is sought during the work; I – Informed: individuals who are to be kept informed of the work's results) clarifies responsibilities by stage.



1.1.9 Financial and economic justification

2026–2035 budget: ~13.2 mln € (mitigation 7.5; adaptation 4.2; social 1.1; M&E 0.4). Sources: municipal, state, donor grants, IFI loans, ESCO/PPP models.

Benefits: reduction in energy costs, quality of service, social and economic impacts.

1.1.10 Summary of recommendations

National level: energy audits, Green Fund, ESCO/PPP, EPBD and ISO 50001, National SECAP Portal.

Local level: Secretariat establishment, BEI/RVA completion, PV roofs, LED and thermal retrofitting, adaptation projects, implementation of EPOV indicators.

1.1.11 Strategic outcome and key results

An Action Plan will be implemented on the outcomes of the BEI and RVA.

Azerbaijan has confirmed its climate targets through the NDC 3.0 (2025) and NAP (2024); local implementation and monitoring are not yet complete.

Khachmaz has high solar and wind potential and energy efficiency potential; climate risks: flooding, erosion, drought.

Key challenges: data gaps, lack of a monitoring mechanism, limited municipal coordination, energy poverty and social inequality.

1.2 Introduction and methodology

1.2.1 Context and justification

Climate change and energy security are the main global challenges of the 21st century. The UNFCCC and the Paris Agreement establish the commitment of countries to reduce GHG emissions and increase climate resilience.

Azerbaijan has joined these agreements and, with NDC 3.0, has set a target of reducing emissions by 40% by 2035. The National Adaptation Plan (NAP 2024) systematises resilience measures against climate risks.

National legislation (the Energy, Electricity, Renewable Energy and Energy Efficiency laws) creates the legal framework for the transformation of the energy sector. The protection of the environment and natural resources is regulated by the relevant Codes and laws.

The SECAP has been developed at a local level to transfer national and international commitments to the city, and to define a package of measures and implementation mechanisms. The plan is of strategic importance, as the city of Khachmaz has ageing energy infrastructure, weak waste management, and is vulnerable to climate risks.

1.2.2 Aims and objectives

The document has been prepared in accordance with the CoM/JRC 2025 methodology and aligned with NDC 3 (2025), the NAP (2024), and the National Strategy (2022–2026). Objective: To ensure the SECAP for Khachmaz is aligned with national, regional, and international policy frameworks.

Key tasks:

- Analysis of national legislation and policies;
- Assessment of compliance with international commitments (Paris Agreement, UNFCCC, SDG, Sendai Framework);
- Review of regional and local programmes;
- Analysis of the Khachmaz Master Plan and its demographic and economic indicators;
- Identification of normative and institutional gaps;
- Preparation of recommendations.

1.2.3 International methodological framework

- How to develop a SECAP (JRC, 2025) – Methodological guidance for BEI and RVA;
- JRC Guidance 2025 – energy poverty and social equity;
- CoM Reporting Template 2025 – reporting format;
- EU4ClimateResilience – alignment of national and local policies.

1.2.4 Analysis methodology and stages

Report stages:

- Collection and classification of documents – laws, international agreements, regional programmes, local plans;
- Analytical framework – defining alignment and gap criteria;
- Policy compliance matrix – comparison with SECAP objectives;
- Expert assessment – synthesis of approaches on energy, climate, urban planning and law;
- Consolidation of findings – summarisation of national, regional and local coordination opportunities and recommendations.

Note: This document presents only the policy-legal-institutional framework within the scope of the Analysis of Energy and Climate Policies and Frameworks. BEI, RVA and quantitative targets have been developed during the Stakeholder Engagement and Coordination Mechanism and the Data Collection and Verification for BEI-RVA phases; the "indicative" indicators in this document are for guidance only.

QA/QC procedure: Sources are cited with version and date; a single conversion protocol is applied; a source log and a change log are maintained; indicators are verified with a minimum of two sources; discrepancies are rectified within 7 days.

1.3 Analysis of national-level policies and frameworks

1.3.1 National policy and legal framework alignment matrix (Policy Alignment Matrix)

This section shows the degree of alignment of the national legislation, strategies and programmes in the field of energy and climate in the Republic of Azerbaijan with the SECAP objectives. The analysis was conducted based on the methodology of the Covenant of Mayors Europe and the Joint Research Centre (JRC, 2025).

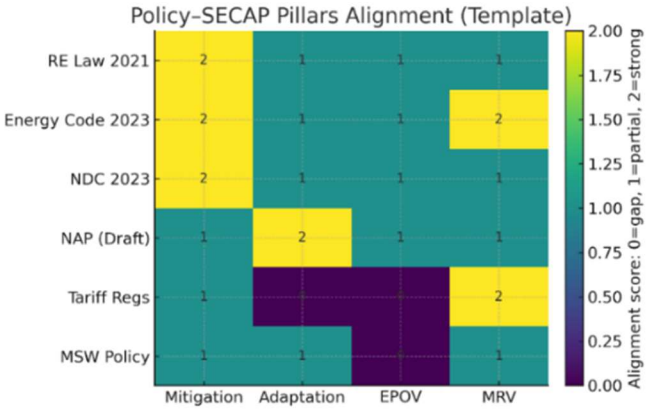
Table 1. SECAP compatibility matrix of Azerbaijan's climate and energy policy documents

Document / Law	Year of adoption	Scope	SECAP alignment	Note
Nationally Determined Contribution on Climate Change (NDC 3.0 2025)	2025	Greenhouse gas emissions by 2035 to 40%	Fully compliant	A key national commitment to a transition to carbon neutrality by 2050.
National Adaptation Plan (NAP 2024)	2024	Adaptation of water resources, agriculture, coastal and mountain ecosystems to climate change	Fully aligned	Measures have been identified for priority sectors in the run-up to COP29.
Law on the Rational Use of Energy Resources and Energy Efficiency	2021	Energy audit, energy conservation standards, responsibility of the public and private sectors	Partially applicable	Sub-legislative acts (e.g., regulations on energy audits) are in the drafting stage.
Law on the Use of Renewable Energy Sources	2021	Solar, wind, bioenergy, hydro and geothermal energy; investment incentives	Fully compliant	"AREA" (Azerbaijan Renewable Energy Agency) is the main implementing body.
Socio-Economic Development Strategy of the Republic of Azerbaijan for 2022–2026	2022	Green economy, digitalisation, environmental protection and energy reforms	Fully compatible	The strategy's 'green growth' priority is fully aligned with the SECAP objectives.
National Strategy on the Management of Solid Domestic Waste in the Republic of Azerbaijan (2018–2022)	2018	Waste sorting, recycling, modernisation of landfill sites	Fully compatible	Provides the legal basis for the circular economy and waste reduction measures.
National Strategy for the Efficient Use of Water Resources	2024	Reducing water losses, water management, climate adaptation	Fully compliant	Implemented jointly with the NAP; the lead responsible body is the AR State Water Resources Agency.

National Climate Change Strategy (in draft stage) Once adopted, the overlap with the SECAP indicators will be updated.		Carbon Neutrality 2040, the 'Green Energy' transition and the national emissions plan	In preparation	Developed by MENR

1.3.2 Overall approach

Azerbaijan's national legislation, state programmes and international commitments provide the main legal and institutional basis for the Sustainable Energy and Climate Action Plan (SECAP) developed for the city of Khachmaz. This section organises these documents, demonstrates their relationship with the SECAP, and analyses the alignments and gaps.



1.3.3 Energy sector legislation

Azerbaijan's energy legislation establishes the normative and institutional framework in the areas of energy security, renewable energy, energy efficiency, and heat supply, and serves the goals of climate neutrality through the 'green transition'.

Table 2. Key energy laws

Law	Key provisions	Significance for SECAP	Gaps
Republic of Azerbaijan Law on Energy, 2023 (Energy Act, 1998)	Public regulation of the energy sector	General legal basis for energy policy	The role of municipalities is not specified
RA Law on Electricity, 2023 (Law on Electricity, 1999)	Electricity generation and distribution	A basis for the modernisation of networks	No smart grid integration
Law of the Republic of Azerbaijan on the Use of Renewable Energy Sources in Electricity Production, 2021	Solar, wind, bioenergy, hydropower	A foundation for renewable energy projects in Khachmaz	Local incentives are limited
RA Law on the Efficient Use of Energy Resources and Energy Efficiency, 2021	Energy audit, management systems	Energy saving measures in public buildings	Local implementation capacity is weak

Law of the Republic of Azerbaijan on Heat Supply, 2003 (amendment 2021)	Production and distribution of thermal energy	Modernisation of heating systems	Obsolete infrastructure
AR Law on Gas Supply, 1998	Production and use of gas	Stability of gas supply	Efficiency is poorly considered
Draft Law on State Energy Supervision (in preparation)	Establishment of monitoring and audit mechanisms for energy security		

Table 3. Decrees, Orders of the President of the Republic of Azerbaijan, and Decisions of the Cabinet of Ministers

No.	Document	Content / Scope
1	Decree on the Expansion of the Use of Renewable Energy Sources in the Republic of Azerbaijan (5 May 2021)	Creation of 'Green Energy Zones' in line with the Energy Charter, selection of pilot projects (Shusha, Zengilan, Garadagh, Nakhchivan).
2	Decree on additional measures to increase energy efficiency (5 April 2022)	Energy audit and implementation of the ISO 50001 management system in state-owned enterprises.
3	Energy Security Strategy for the Republic of Azerbaijan for 2022-2030 (Approved by Decree, 2022)	Diversification of energy supply, management of energy reserves, increasing the share of renewable energy.
4	Decree on the Creation of Green Energy Zones (4 June 2021)	Implementation of 'smart city' and 'smart village' energy models in the Qarabağ and Eastern Zəngəzur economic regions.
5	Cabinet Decision No. 302 (2022)	Approval of statistical reporting forms for energy production and consumption.
6	Cabinet Decision No. 398 (2023)	Determination of the implementation mechanisms of the Law on Energy Efficiency.

Table 4. State Programmes, Strategies and Roadmaps

No.	Document	Main direction
1	Concept of 'Green Growth' and National Priorities for 2030 in the Republic of Azerbaijan (2021)	Decarbonisation of the economy, energy transition, sustainable cities.
2	"National Energy Efficiency Action Plan (NEEAP)" (2022)	Energy audits, efficiency measures in public buildings, fuel savings in transport.
3	"National Climate Change Strategy" (2024, under development)	Low-emission economy objectives by 2050, adaptation and mitigation directions.
4	"National Adaptation Plan (NAP)" (2022)	Measures against climate risks in the sectors of water resources, agriculture, infrastructure and public health.
5	"Nationally Determined Contribution (NDC 3.0, updated 2025)"	Target of a 40% reduction in 2035 and 40% in 2050 (conditional).

6	"Azerbaijan 2030: National Priorities for Socio-Economic Development" (2021)	National objective titled "Green growth and a clean environment".
7	State Programme on the Development of Alternative and Renewable Energy Sources in the Republic of Azerbaijan (2004, updated in 2015)	Initial legal basis for RES projects.
8	"Roadmap for the Development of the Energy Sector in the Republic of Azerbaijan" (2017)	Institutional reforms, privatisation and investment mechanisms in the electricity and gas sectors.
9	"Reform Programme for the Energy Sector for 2022–2026" (Ministry of Economy, 2022)	Liberalisation of the energy market and expansion of AERA's powers.

1.3.4 Regulatory and institutional framework

The management and regulation of the energy sector in the Republic of Azerbaijan is carried out on the basis of a multi-level institutional framework. The main state bodies and their functions are as follows:

- The Ministry of Energy – formulation of energy policy, preparation of state programmes and the energy balance, and coordination of international cooperation and investment projects;
- Azerbaijan Energy Regulatory Agency (AERA – Azerbaijan Energy Regulatory Agency) – regulation of the energy market, licensing, tariff policy and ensuring market transparency;
- Azerbaijan Energy Efficiency Fund (AEEF – Azerbaijan Energy Efficiency Fund) – a fund established on the basis of the Law on Energy Efficiency, adopted in 2023, which provides financial support for energy-saving initiatives in the public and private sectors;
- SOCAR, Azerishiq JSC, Azerigaz Production Union, Azəristiliktəchizat OJSC – production, transmission and distribution operators in their respective sectors;
- The Ministry of Economy of the Republic of Azerbaijan – coordination in the areas of energy efficiency, the green economy and investment promotion;
- Ministry of Ecology and Natural Resources of the Republic of Azerbaijan (MENR) – climate change, emissions reduction and adaptation policy development, coordination of the NDC and NAP processes.

1.3.5 Environmental and ecological legislation

In the Republic of Azerbaijan, the legal framework for environmental protection, combating climate change and ensuring ecological security has been developed consistently and is one of the main reference points for the SECAP process. This system is based on the general principles established by the Law of the Republic of Azerbaijan on Environmental Protection (8 June 1999) and the risk management approaches set out in the Law of the Republic of Azerbaijan on Ecological Safety (8 June 1999).

The state policy in the field of the environment and natural resources is implemented by the Ministry of Ecology and Natural Resources (MENR). The Ministry is responsible for the development of national strategies on climate change, the reduction of greenhouse gas emissions, the protection of biodiversity, and the sustainable management of natural resources.

The environmental legislative framework serves as the primary reference point for the Risk and Vulnerability Assessment (RVA) and adaptation planning stages, which have been developed at the urban level, and provides the legal basis for shaping both the mitigation and adaptation pillars of the SECAP document.

Table 5. Key national legislative acts

No.	Official title of the law / document	Key provisions	Significance for SECAP	Gaps and limitations
1	Law of the Republic of Azerbaijan on Environmental Protection (8 June 1999)	Key principles of environmental protection, ecological requirements, state control and accountability mechanisms.	Provides the legal basis for SECAP's adaptation and mitigation measures; refers to mechanisms for ecological risk assessment and monitoring.	The Law does not include a specific section on climate change and indicators for greenhouse gas (GHG) emissions.
2	Law of the Republic of Azerbaijan on Ecological Safety (8 June 1999)	Ensuring the ecological safety of the population and economic activities; prevention of natural and technogenic disasters.	Provides the legal basis for the Risk and Vulnerability Assessment (RVA) phase of the SECAP.	The linkage of ecological risks with climate and the mechanism for its application at the urban level are not specified.
3	Law of the Republic of Azerbaijan on Ecological Expertise (12 June 1999)	Environmental Impact Assessment (EIA) and approval procedures for new projects.	Allows for the assessment of the environmental compatibility of SECAP measures; can be integrated into the EIA process.	Applies at the project scale; provisions for urban-level planning are weak.
4	Law of the Republic of Azerbaijan on the Protection of the Atmosphere (3 March 2001)	Air quality protection, registration of emission sources and setting of standards.	Creates the legal basis for the preparation of the SECAP Emission Inventory (BEI); provides normative data for the industrial and transport sectors.	There is no mechanism for open scientific reporting of emission data and its distribution at the urban level.
5	Law of the Republic of Azerbaijan on the Subsoil, (13 February 1998)	Regulations on the protection of the subsoil, exploration and exploitation of mineral deposits, and environmental safety requirements in mining activities.	It is a key legal reference document for SECAP in terms of subsurface resource management, mitigating environmental impacts and assessing risks associated with energy production.	The law is not directly linked to energy and climate planning; local-level oversight and restoration mechanisms are weak.
6	Law of the Republic of Azerbaijan on Wastes (30 June 1998, as amended in 2020)	Rules for the management, sorting, disposal and recycling of waste.	It is a reference source for planning waste reduction and circular economy measures in SECAP.	Provisions regarding energy recovery (waste-to-energy) and the management of biological waste are limited.
7	Law of the Republic of Azerbaijan on Industrial and Domestic Waste, (24 June 2023)	Regulations on the management, sorting, disposal, recycling of industrial and	It establishes the main legal basis for waste reduction, the development of 'circular economy' and 'waste-to-energy'	As the law is new, the enforcement mechanisms and monitoring system are not yet fully established;

		household waste, and the management of landfill sites.	approaches within the SECAP framework.	the implementation regulations at the municipal level have not been finalised.
8	Law on Specially Protected Natural Areas and Objects (24 March 2000)	Legal status and management of reserves, national parks and nature monuments.	SECAP underpins adaptation measures from a landscape and biodiversity perspective.	There is no regulation regarding the management of urban greenery and urban ecosystems at the city level.
9	"Water Code" (26 December 1997, as amended in 2021)	Regulations for the management, protection and use of water resources.	It is the main reference document in the climate adaptation section of the SECAP (water management and risk analysis).	City-level implementation mechanisms for water losses and sustainable use are weak.
10	"Land Code" (25 June 1999)	Principles of land relations and sustainable land use.	Allows for the coordination of SECAP with urban planning, green spaces and land-use policy.	Climate risks are not integrated into land use.
11	AR Forest Code, 30 (December, 1997)	Rules for the protection, restoration and use of the forest fund; principles of afforestation for the purpose of reducing soil erosion and climate risks.	The legal basis for the amortisation role of forests and greenery against climate change and their carbon sequestration potential is established in the adaptation pillar of the SECAP.	Provisions for the management of the urban green fund and the valuation of forest ecosystem services are not provided.
12	Draft Law of the Republic of Azerbaijan on Climate Change (in preparation)	Legal framework for national climate policy, emission inventories and the establishment of a reporting system.	Once the law is adopted, it will allow for the full alignment of SECAP documents with the national climate strategy.	The law has not yet been adopted; practical implementation mechanisms are not in place.

1.3.6 International legal-framework documents

International climate, energy and sustainable development frameworks provide the main reference basis for national policies and local SECAP processes. These include the SDGs, the Covenant of Mayors (CoM) and the Sendai Framework, targeting energy security, climate adaptation and socio-economic resilience.

The Paris Agreement and the UNFCCC support Azerbaijan's international commitments, and these principles are reflected in national strategies such as the NDC, NAP, and NEEAP. Through SECAPs, these approaches are implemented at the local level, ensuring the integration of international and national policies and guiding the BEI, RVA, EPOV, and Action Plan phases.

Table 6. International legal framework for local-level climate and energy planning

No.	Convention / Agreement	Key provisions	Relevance for SECAP	Gaps and limitations
1	United Nations Framework Convention on Climate Change UNFCCC United Nations Framework Convention on Climate Change	Protecting global climate stability, emission reduction and adaptation commitments.	The international legal context of SECAP; the basis for NDCs and national inventory systems.	At the local level, implementation and financial mechanisms are limited.
2	Kyoto Protocol	Climate commitments managed through quotas and market mechanisms.	Alignment of BEI data with international reporting standards.	As Azerbaijan is not an Annex I country, its commitments are voluntary in nature.
3	Paris Agreement	Submission of Nationally Determined Contributions (NDCs) to achieve the 1.5–2 °C target.	Allows SECAP objectives to be aligned with national climate targets.	Specific implementation mechanisms at city level have not been defined.
4	The UN Sustainable Development Goals (SDGs)	A global agenda of 17 goals; it sets out objectives related to energy, climate, the environment, social equity and economic sustainability. Key goals: SDG 7 (affordable and clean energy), SDG 11 (sustainable cities), SDG 13 (climate action).	A strategic reference framework for aligning SECAPs' objectives and indicators with the global sustainability system; directly linked to the objectives of energy, adaptation, gender equality and social inclusivity.	At the municipal level, mechanisms for monitoring and reporting on SDG indicators have not yet been established; there are challenges with data collection.
5	The Covenant of Mayors' Climate and Energy Agreement Covenant of Mayors (CoM)	It entails the commitment of cities to reduce greenhouse gas emissions, increase energy efficiency, and achieve climate adaptation goals by 2030; the three pillars of the: mitigation, adaptation, and energy poverty.	SECAP is the main methodological basis; all stages (BEI, RVA, EPOV, action plan, monitoring) are carried out in accordance with the CoM methodology.	The agreement is implemented on a voluntary basis; at the municipal level, implementation mechanisms and financing systems have not yet been fully integrated into national legislation.

6	The Sendai Framework for Disaster Risk Reduction 2015-2030	It is a global mechanism for reducing natural and human-induced disaster risks; it identifies four main priorities: understanding risks, strengthening management capacities, directing investments towards risk resilience, and effective recovery.	An international reference document for the Risk and Vulnerability Assessment (RVA) phase of SECAP; it is applied in the planning of climate risk management and adaptation measures.	Local-level coordination bodies for disaster risk reduction (e.g., DRR structures at the municipal level) are not fully established; the database is limited.
7	Convention on Biological Diversity (CBD)	Conservation of biodiversity, sustainable use of genetic resources.	A key reference for landscape adaptation and greening policy within SECAP.	The integration between biodiversity and climate planning is weak.
8	Convention to Combat Desertification and Land Degradation (UNCCD)	Prevention of desertification and land degradation.	Legal basis for SECAP adaptation measures (soil, water, agriculture).	There is no section on urban ecosystems.
9	Aarhus Convention	Right of access to environmental information, public participation and justice.	Supports the SECAP principles of stakeholder engagement and gender equality.	The openness of information and the practical level of local participation are limited.
10	Espoo Convention	EIA and consultation procedures in cross-border projects.	Provides a framework for environmental impact assessment in regional-scale SECAPs.	Applies only to cross-border projects.
11	Helsinki Convention	Protection and joint management of transboundary water resources.	Legal basis for climate adaptation and water management measures.	A national coordination mechanism is still being established.

1.3.7 National strategies and state programmes

The strategic documents adopted in the Republic of Azerbaijan on ecological security, combating climate change and sustainable development constitute the main reference points at the national level for the SECAP (Sustainable Energy and Climate Action Plan) process. These documents ensure the interlinkages between the country's energy, water, agriculture, land, biodiversity, and environmental protection policies, and provide the conceptual basis for climate action to be implemented at the local level.

National strategies and programmes — "Azerbaijan 2030: National Priorities for Socio-Economic Development", "National Climate Change Strategy", "National Adaptation Plan (NAP)", the "Nationally Determined Contribution (NDC)", as well as documents such as the "National Strategy and Action Plan for Biodiversity Conservation". The aim of these documents is to ensure the country's long-term ecological sustainability by reducing climate risks, managing natural resources efficiently, and protecting ecosystem services.

These framework documents have been developed in line with the Covenant of Mayors (CoM) and the UN's Sustainable Development Goals (SDGs), ensuring methodological alignment in the development of local

climate action plans (SECAPs). The table below presents the objectives of the main national strategies and state programmes, their relevance to the city of Khachmaz, and the existing institutional gaps.

Table 7. Relevance and alignment of national strategies and programmes in the context of the SECAP for Khachmaz City

No.	Strategy / Programme	Key objectives	Significance for Khachmaz	Alignment and gaps
1	"Azerbaijan 2030: National Priorities for Socio-Economic Development" (Presidential Decree of 2 February 2021)	The 'Green growth and clean environment' priority; goals of clean energy, waste reduction and adaptation to climate risks.	A 'green transition', resource efficiency and ecological production opportunities in the agricultural and tourism sectors in Khachmaz.	Monitoring and enforcement mechanisms at the municipal level are unclear.
2	"National Climate Change Strategy" (in preparation, MENR)	Long-term climate resilience, low-emission development target by 2050; national strategy in line with the Paris Agreement.	Will create a framework for climate adaptation and disaster risk reduction for Khachmaz.	Not adopted; specific measures and local indicators have not been defined.
3	"National Adaptation Plan (NAP)" (MENR, UNDP, 2022)	Climate risk reduction and adaptation measures in the sectors of water, agriculture, infrastructure and health.	It is the main planning document for managing the risks of floods, inundation and water scarcity in Khachmaz.	The local monitoring system and financial mechanisms are weak.
4	"Nationally Determined Contribution (NDC 3.0)" (2025)	40% reduction of GHG emissions by 2035	The SECAP for Khachmaz sets out the direction for emission reduction and renewable energy measures.	There is no city-level data collection and reporting system.
5	"National Energy Efficiency Action Plan (NEEAP)" (Ministry of Energy, 2022)	Energy audit, efficiency in public buildings, fuel savings in transport, and awareness-raising measures.	It is a reference document for energy saving and modernisation in public buildings in Khachmaz.	Mechanisms for energy management at the municipal level have not been established.
6	"Strategy on Energy Security in the Republic of Azerbaijan" (Presidential Decree, 29 December 2022)	Diversification of energy sources, green energy zones, regional energy security.	This is significant for Khachmaz in terms of energy supply sustainability and the promotion of renewable energy projects.	Local implementation mechanisms and the climate adaptation component are weak.

7	"State Programme on the Development of Alternative and Renewable Energy Sources in the Republic of Azerbaijan (2004–2015)"	Application of alternative and renewable energy technologies, legal and institutional framework.	A preliminary reference document for the solar and wind energy potential in Khachmaz.	The programme period has expired; it should be replaced by new strategies.
8	"National Strategy and Action Plan for Biodiversity Conservation (NBSAP)" (MENR, 2017)	Conservation of biological diversity, protection of natural areas, promotion of ecosystem services.	Provides a framework for the protection and afforestation of Khachmaz's forest and water ecosystems.	Mechanisms for implementation and ecosystem indicators at the urban level have not been identified.

1.3.8 Table of alignment and integration (coordination with the NDC, NAP and other strategic documents)

During the development of the Sustainable Energy and Climate Action Plan (SECAP) for the city of Khachmaz, the objectives and lines of action are intended to be closely aligned with both national and international strategic documents. This alignment will be based on the principles set out in the methodological documents developed by the European Commission's Joint Research Centre (JRC): How to develop a Sustainable Energy and Climate Action Plan (Main Document, 2025) + and its five complementary documents.

The SECAP document prepared will be based on Azerbaijan's National Climate Change Policy, It is based on the principle of alignment with the Paris Agreement, the Nationally Determined Contribution (NDC), the National Adaptation Plan (NAP), the National Energy Efficiency Action Plan (NEEAP), and the UN Sustainable Development Goals (SDGs). The table below presents the initial integration directions for these strategic documents with the SECAP for Khachmaz city.

Table 8. Integration of the national strategy and international framework documents into the SECAP for Khachmaz City

No.	Document and Strategy	Key objectives and priority areas	Alignment and Integration Reflected in the Khachmaz SECAP
1	Nationally Determined Contribution (NDC 3.0, 2025)	40% GHG emissions reduction by 2035 compared to 1990 levels	The sectoral indicators, identified based on the results of the Analysis of Energy and Climate Policies and Frameworks, will be aligned with the 35% target in this SECAP; long-term measures will be integrated into the 2050 climate neutrality goal.
2	National Adaptation Plan (NAP, 2022)	Enhancing resilience in climate risk management, water resources, agriculture and infrastructure.	The results of the RVA analyses conducted under the Analysis of Energy and Climate Policies and Frameworks will be used as a basis for planning adaptation measures in this SECAP.
3	National Energy Efficiency Action Plan (NEEAP, 2022)	Improvement of energy management systems, energy savings in public buildings, fuel efficiency in transport.	The monitoring and management mechanisms for energy efficiency indicators in the adopted SECAP will be aligned with the requirements of the NEEAP.

4	Energy Security Strategy of the Republic of Azerbaijan (Energy Security Strategy, 2022–2030)	Ensuring energy security, diversification of energy sources, development of 'green energy zones'.	The energy supply resilience and renewable energy initiatives in Khachmaz will be coordinated with this strategy, based on the Analysis of Energy and Climate Policies and Frameworks.
5	State Programme on Green Energy Zones (2024)	Development of renewable energy infrastructure, energy integration, and the utilisation of local potential in Karabakh and other regions.	Khachmaz city's energy potential and pilot project areas will be integrated with 'green city' initiatives in this SECAP.
6	National Climate Change Strategy (in preparation, 2024)	Long-term climate neutrality objective, coordination of national adaptation and mitigation measures.	Once the Strategy is adopted, the framework developed in the Analysis of Energy and Climate Policies and Frameworks will form the basis for updating future SECAP indicators.
7	The United Nations Sustainable Development Goals (UN SDG 5, SDG 7 and SDG 13)	SDG 5: Gender equality and the empowerment of women; SDG 7: Clean and affordable energy; SDG 13: Global action on climate change.	The objectives of the SECAP developed will be aligned with SDG 5, 7 and 13; the principles of gender equality, energy justice and social inclusivity will be considered at all stages (BEI, RVA, EPOV, action plan); the local indicator system will be integrated into these international frameworks.

1.3.9 Institutional framework and inter-institutional coordination scheme

In the Khachmaz SECAP, cooperation between state, municipal and private entities plays a key role in climate and energy governance. Key actors:

- MENR – coordinator of climate policy, NDC and NAP;
- Ministry of Energy (MinEnergy) – energy security and efficiency;
- AREA – "green energy zones", investment promotion;
- AERA – energy market regulation;
- AzStat – information source for the BEI and RVA;
- State Water Resources Agency of Azerbaijan (ADSEA) and Ministry of Agriculture – water resources and adaptation;
- Ministry of Economy, SMEBA, Entrepreneurship Development Fund – green economy, SME support;
- Municipalities and local executive authorities – local implementation of SECAP measures;
- NGOs and universities – public participation, awareness-raising and research support.

1.3.10 Levels of coordination

At the national level, coordination involves MENR, the Ministry of Energy, the Ministry of Economy, SMBDA, AERA, AEEF and AzStat, and is carried out through strategic decisions, inter-ministerial working groups and programme commissions.

At the regional level, coordination involves the district executive authority bodies, the State Water Resources Agency, the Ministry of Agriculture, IZIA and SMBDA regional representations, and is aimed at implementing national strategies regionally while ensuring vertical and horizontal information flow.

At the local level, coordination involves Khachmaz city municipality, municipal services, SMEs, NGOs and communities, which implement activities, monitor progress and report on outcomes; this coordination is strengthened through local inter-municipal working groups.

1.4 Analysis of policies and programmes at the regional level

1.4.1 Regional development programmes and government initiatives

Regional development programmes adopted since 2004 have had a significant impact on the improvement of socio-economic infrastructure in Khachmaz. The last two key documents – the "State Programme on the Socio-Economic Development of the Regions of the Republic of Azerbaijan in 2019–2023" and the "Strategy for the Socio-Economic Development of the Republic of Azerbaijan for 2022–2026" - strengthens the 'green growth', energy efficiency and digital services strand. Within the framework of the Analysis of Energy and Climate Policies and Frameworks, the tangible content of these documents that can be transferred to SECAP (energy savings, renewable sources, waste and water management, climate risk management) is mapped separately.

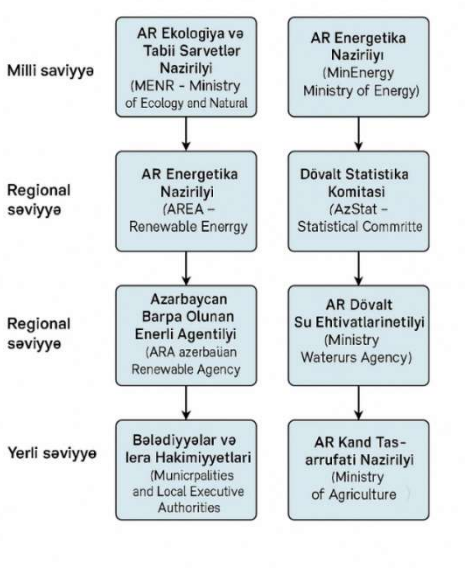


Table 9. Impact of state programmes and strategies for socio-economic development on Khachmaz city and indicators for 2026–2030

No.	Document	Date and decision No.	Main directions	Impact on Khachmaz City	Indicators for 2025–2030 (indicative)
1	State Programme on the Socio-Economic Development of the Regions of the Republic of Azerbaijan for 2019–2023	29.01.2019, Decree No. 500	Infrastructure, agricultural sector, social services	Modernisation of road, water-sewerage and municipal infrastructure	Switch to LED for ≥80% of street lighting; ≥10% reduction in water losses
2	"The Socio-Economic Development Strategy of the Republic of Azerbaijan for 2022–2026"	22.07.2022, Decree No. 3378	Green growth, digital services, energy efficiency	Alternative energy initiatives, support for ecotourism	Energy audit of ≥40% of public buildings

1.4.2 Khachmaz City Master Plan (until 2035)

The Khachmaz Master Plan (2035) was approved by the Cabinet of Ministers of Azerbaijan with Resolution No. 139 of 2023 and integrates the city's social, economic, and ecological development. The aim is to strike a balance between population growth, economic strengthening, and climate resilience.

Population and Infrastructure: By 2035, the population is expected to grow from 45,000 to 65–70,000. The plan includes two new residential estates, five schools, three nurseries, and other public facilities, which will increase energy demand.

- **Functional zoning**: The city is regulated by 8 zones: residential, public/administrative, industrial, green/recreational, transport/infrastructure, agricultural, protected, and tourism.

Within the SECAP framework:

- **Industrial:** energy efficiency, waste reduction;
- **Residential/public:** energy audits, insulation, rooftop PV;
- **Green spaces/conservation**: carbon sequestration, reduction of the heat island effect;
- **Tourism:** ecotourism, zero-waste services.
- **Energy and utility systems:** Within the SECAP framework, modernisation of networks, LED street lighting and solar/wind pilot projects are planned.
- **Transport**: The share of public transport will be increased, electric/hybrid vehicles will be promoted, and pedestrian and cycling infrastructure will be developed. In the future, a 'Low Emission Zone' and an electric bus fleet will be implemented.
- **Green spaces:** The green space, currently at 12%, will be increased to 18–20%. Mechanisms: green corridors, park and courtyard greenery, and forest restoration in peripheral zones.
- **Coastal and climate risks**: The Yalama and Nabran coasts are at risk of erosion and flooding. Within the SECAP framework, soft engineering measures such as vegetation restoration, drainage, etc., will be implemented.

Table 10. Coordination of the Khachmaz Master Plan with the SECAP

No.	Master Plan Direction	Date and document no.	Relevance to the SECAP	2030 targets
1	Transport system	NK Decision of 30.03.2023, No. 139	Low-emission transport, pedestrian and cycle network	Electric bus fleet ≥20%, 10–12 km of new cycle routes
2	Residential and construction zones		Energy-efficient construction and insulation standards	Energy audit in 50% of new buildings, 'A-class' energy rating
3	Green spaces and park system		Reduction of the heat island effect, carbon sequestration	Green cover to be increased to 20%, 2 new parks to be created
4	Energy supply		Integration of RE projects	10 MWp PV capacity, 80% LED lighting
5	Coastal zone		Erosion and flood risk management	3 km of coastal protection measures, drainage system restoration

KPIs (indicative) - Alignment with the 2035 Master Plan

- Share of LED (street lighting) **-** ≥80% (2030) *(unit of measurement: %; source: municipal lighting enterprise; annual monitoring for CoM reporting)*
- Installed capacity of solar *photovoltaic* (PV) systems – ≥10 MWp (2030) *(unit of measurement: MWp; source: municipal facilities + private/public partnership installations; annual aggregation)*
- Share of green cover (in urban area) – ≥20% (2035) *(unit of measurement: %; source: master plan and landscape inventories; five-year verification, annual update)*

Note: These indicators will be calibrated after the BEI/RVA is completed; annual internal monitoring is carried out for the **biennial** submission in accordance with CoM reporting (MyCovenant).

Analytical outcome

The 2035 Master Plan defines the city's spatial, social and economic development, but the energy, climate and environmental transformation has not yet been fully integrated. The 'green growth' principles are the starting point for the SECAP, but it is important that they are supported by KPIs and translated into sectoral actions (transport, buildings, green spaces).

Through the SECAP:

- Energy and climate objectives will be linked to concrete measures,
- Emissions will be reduced and adaptation to risks will be ensured,
- Renewable energy, energy efficiency and adaptation measures will be planned to meet the growing energy demand,
- Green spaces will be supported by their carbon sequestration potential, and ecosystem service indicators will be established.

The Master Plan and SECAP together:

- Master Plan – a framework for physical and social development,
- SECAP – the implementation mechanism for energy and climate.
- This approach strengthens Khachmaz's climate resilience and ensures the city's transition to a 'green transition' model.

1.4.3 Demographic and economic profile of Khachmaz City

The demographic and economic dynamics of Khachmaz city indicate that it is one of the regions where the demand for energy is growing rapidly, urbanisation processes are intensive, but energy efficiency is still weak.

The diversification of economic activities and the growth of the tourism and service sector, while enhancing social welfare, also increases the energy and resource burden.

The SECAP, developed under these conditions, will aim to manage the city's growing energy demand through smart, renewable, and socially equitable mechanisms. The integration of energy efficiency and climate adaptation measures with the city's economic structure, as well as the reduction of energy poverty, will ensure Khachmaz's transition to a 'green economy' model.

1.4.4 Environmental and climate risks

Flooding: Risk of flooding from the Gudyalchay River and other watercourses; drainage and rainwater management measures.

- Heat island effect: Temperatures in the city centre are 2–3°C higher; 'green/white roofs', afforestation and shading are recommended.
- Temperature rise and drought: Additional load on irrigation and drinking water; drip irrigation and rainwater harvesting measures.
- Air pollution and waste: Transport and household waste; low-emission transport and waste sorting.
- Coastal erosion and sea level: Yalama–Nabran coast; bio-engineering, sand nourishment and climate-resilient design.

1.4.5 Role and integration of the SECAP

- Socio-economic and energy data provide the basis for the SECAP.
- SECAP links energy efficiency, renewable energy and adaptation measures to specific sectoral activities.
- Increasing green spaces and carbon sequestration potential will be measured.
- "Green transition" measures will be planned for the transport, buildings and tourism sectors.

Table 11. Climate and ecological risks for Khachmaz city

No.	Risk	Area of impact	Significance for SECAP	Initial adaptation and management measures
1	Flooding	Roads, housing, drainage systems	High priority in RVA	Drainage and stormwater management, green infrastructure
2	Heat island effect	City centre	Medium priority, impact on energy efficiency	Increasing greenery, cooling surfaces
3	Temperature rise and drought	Water, agriculture	High priority	Water management, irrigation efficiency, SCADA
4	Air pollution	Transport, domestic sector	Mitigation priority	Limiting waste incineration, EV promotion
5	Sea level and erosion	Coastal zone	Critical risk	Coastal protection, ecological restoration and drainage

1.5 Regional regulatory and legal framework

The social, economic and ecological development of Khachmaz city is regulated by a number of national laws and regulatory documents. These documents establish the legal framework for urban planning, municipal governance, environmental protection, and the efficient use of resources. However, the weakness of implementation mechanisms, financial resources, and accountability systems at the local level reduces the practical impact of these laws.

The main regulatory legal documents and their importance for the SECAP are presented in the table below.

Table 12. Key regulatory legal documents and their importance for SECAP

No.	Official name of the law / document	Date of adoption	Key provisions	Significance for SECAP	Gaps and limitations
1	"Urban Planning and Construction Code"	29.06.2012, No. 392-IVQ	Urban planning, building regulations, infrastructure design	Creates a legal basis for energy-efficient construction and planning	Energy efficiency indicators are not yet applied at a normative level
2	Law of the Republic of Azerbaijan on the Status of Municipalities	02.07.1999, No. 698-IQ	Principles of local self-government and municipal powers	Legal basis for the preparation and approval of SECAP at the local level	Energy and climate governance powers are unclear
3	Law on Municipal Water Management	22.10.2021, No. 422-VIQ	Management of water supply and sewerage systems	A reference document for reducing water leaks and energy losses	Municipalities have limited financial instruments
4	Law of the Republic of Azerbaijan on Environmental Protection	08.06.1999, No. 678-IQ	Ecological principles and state control mechanisms	Legal basis for RVA (Risk and Vulnerability Assessment)	Enforcement at the local level is weak

5	Law of the Republic of Azerbaijan on Ecological Safety	08.06.1999, No. 678-IQ	Prevention of natural disasters and ecological risks	Lays the groundwork for climate adaptation measures	Mechanisms are not provided for at the municipal level
6	Law of the Republic of Azerbaijan on Industrial and Domestic Waste (with amendments as of 24.06.2023)	30.06.1998, No. 514-IQ	Waste management and sorting	A basic framework for the circular economy and energy recovery from waste	Clarity is lacking on the role of municipalities
7	Law of the Republic of Azerbaijan on the Subsoil	13.02.1998, No. 439-IQ	Protection and use of underground resources	Reference for the assessment of ecological risks and land degradation	No link with energy and climate policy

Additional institutional references:

- Ministry of Emergency Situations of the Republic of Azerbaijan (MES) – management of flood, inundation and coastal risks;
- SMBDA and the Entrepreneurship Development Fund – support for "green energy" and energy efficiency initiatives for municipalities and SMEs;
- Azerbaijan Energy Efficiency Fund (AEEF) – financing of energy efficiency projects;
- State Water Resources Agency – protection of the water balance and energy-oriented adaptation measures.

Analytical conclusion:

Although the legislative framework generally ensures the city's development and ecological security, the implementation mechanisms at the local level are still institutionally weak.

The SECAP developed will play a key role in translating the principles set out in these documents into practical tools and integrating energy and climate governance at the municipal level into the legal system.

1.5.1 Broad conclusion

An analysis of the regional and institutional environment of Khachmaz city shows that the existing policy and regulatory framework provides a favourable starting point for sustainable development. However, local mechanisms and a coordination system for the effective implementation of measures on energy efficiency, renewable energy, and climate adaptation have not yet been fully established

Strengths

- The Master Plan until 2035 provides a legal basis for the city's spatial and social development;
- Government programmes (2019–2023, 2022–2026) have promoted the renewal of infrastructure and the development of the service sector;
- Legislation contains modern provisions concerning environmental security, resource management and water management;
- At the national level, strategies for 'green energy zones' and 'energy efficiency' have already been adopted.

Gaps and weaknesses

- At the urban level, specific energy and climate targets have not yet been established;
- Although regional programmes prioritise economic growth, the emission reduction and adaptation components are poorly integrated;
- Municipalities have limited financial resources and human capacity;
- There is no local-level data collection, monitoring and reporting system;

- A coordination mechanism for managing climate risks (flooding, heat island effect, coastal erosion) has not yet been established.

Strategic outcomes and prospects

The SECAP for the city of Khachmaz will fill gaps not addressed in national and regional documents and will prioritise the following areas:

1. Energy efficiency – audit of public buildings and the housing stock, energy-efficient lighting and thermal insulation;
2. Renewable energy – solar panels, small-scale wind and bioenergy projects;
3. Waste management – sorting, waste-to-energy recovery and reduction of methane emissions;
4. RVA measures – adaptation to flooding, coastal erosion, the heat island effect and drought;
5. Information and monitoring – collection of climate indicators at the local level and reporting on the CoM platform.

SECAP will also strengthen the role of municipalities and public participation, applying the principles of gender and social justice by ensuring the involvement of women, young people, and vulnerable social groups.

Consequently, the SECAP for Khachmaz city will act as a bridge between strategies adopted at regional and national levels — that is, it will translate the principles set out in legislation into a measurable, fundable, and accountable action plan.

1.6 Strategic alignment of SECAP with national and regional frameworks

1.6.1 General approach

The Sustainable Energy and Climate Action Plan (SECAP) has been developed at the municipal level, but it is essentially a multi-level governance tool. According to the Covenant of Mayors (CoM) methodology, the local plan must be aligned with national legislation, regional programmes and international commitments.

This 'alignment' approach serves two purposes:

- Top-down transfer: to ensure the local implementation of Azerbaijan's commitments under its Nationally Determined Contributions (NDC 3.0, 2025), the National Adaptation Plan (NAP, 2024), and the Sustainable Development Goals (SDGs, 2015). The Khachmaz SECAP developed will serve as the local implementation mechanism for these commitments.
- Bottom-up integration: While national programmes provide a broad framework, practical mechanisms at the urban level are often lacking. The SECAP will fill this gap through measurable targets, actions, and monitoring.

Note: All alignments in this section will be calibrated with figures after the BEI (Baseline Emission Inventory) and RVA (Risk and Vulnerability Assessment) are finalised.

Table 13. Compliance with national legislation

No.	Official name of the law	Date of adoption and number	Key provisions	Compatibility with the SECAP
1	"Law of the Republic of Azerbaijan on Energy"	30 November 1998, No. 541-IQ	Principles of state regulation of the energy sector and energy security	Organisation of local energy governance, legal framework for energy efficiency measures
2	"Law of the Republic of Azerbaijan on Electricity"	24 November 1999, No. 582-IQ	Rules for the generation, transmission and distribution of electricity	Modernisation of urban electricity networks and reduction of losses

3	"Law of the Republic of Azerbaijan on the Use of Renewable Energy Sources"	31 May 2021, No. 339-VIQ	Promotion of solar, wind, bioenergy and other sources	Creating a foundation for the realisation of solar and wind potential in Khachmaz
4	"Law of the Republic of Azerbaijan on Energy Efficiency"	30 December 2021, No. 483-VIQ	Energy audit, management systems and performance indicators	Compliance with energy audit and LED lighting measures in public buildings
5	"Law of the Republic of Azerbaijan on Environmental Protection"	8 June 1999, No. 678-IQ	Principles of environmental policy and protection of natural resources	Waste management and expansion of green spaces in SECAP
6	"Law of the Republic of Azerbaijan on Municipal Water Management"	22 October 2021, No. 422-VIQ	Water resource management and the powers of municipalities	Compatibility with adaptation measures and projects for leak reduction

Table 14. Consistency with national programmes and strategies

No.	Full name of the Programme / Strategy	Date of adoption and document no.	Key objectives	Alignment with the SECAP
1	"State Programme on the Socio-Economic Development of the Regions of the Republic of Azerbaijan for 2019–2023"	29 January 2019, Presidential Decree No. 500	Modernisation of regional infrastructure and expansion of social services	Improvement of energy efficiency and heating and lighting systems in public utilities
2	"The Socio-Economic Development Strategy of the Republic of Azerbaijan for 2022–2026"	22 July 2022, Presidential Decree No. 3378	Green growth, digital economy, alternative energy	Alignment with renewable energy, digital energy management and 'green city' measures in SECAP
3	National Adaptation Plan (NAP) of the Republic of Azerbaijan	2024, Cabinet approval	Adapting water, agriculture and infrastructure to climate risks	Overlaps with adaptation measures based on the RVA results
4	"Roadmap for Energy Efficiency in Azerbaijan"	2019 and 2024	Energy saving and improving energy performance in buildings	Energy audits, thermal insulation and LED retrofitting measures in public buildings
5	"The Republic of Azerbaijan's Nationally Determined Contributions (NDC-3.0)"	2025	40% emissions reduction by 2035 (conditional)	Local actions in line with the 2030 and 2050 targets through SECAP

Table 15. Consistency with regional plans

No.	Name of the regional / local document	Date of adoption and document no.	Key provisions	Compatibility with the to-be-prepared SECAP
1	"Master Plan of Khachmaz City until 2035"	30 March 2023, Cabinet Decision No. 139	Urbanisation, transport network, increasing greenery and alternative energy	SECAP: low-emission transport, a 20% increase in green spaces and the integration of RE projects
2	"State Programme on the Socio-Economic Development of the Regions of the Republic of Azerbaijan for 2019–2023"	29 January 2019, Decree No. 500	Regional economic growth, improvement of infrastructure	Energy efficiency and resource optimisation in public utilities
3	"Socio-Economic Development Strategy of the Republic of Azerbaijan for 2022–2026" (regional implementation)	22 July 2022, Decree No. 3378	Development of the green economy and ecological services	"Green SME" initiatives, PPP/ESCO models, local energy monitoring

Table 16. Consistency with international commitments

No.	Official title of the international document	Commitments for Azerbaijan	Compatibility with the to-be-prepared SECAP
1	United Nations Framework Convention on Climate Change (UNFCCC), 1995	Submission of National Communications (NCs, BURs) and Emission Inventories	Consistent with the methodology for preparing the BEI and RVA
2	Paris Agreement, 2015	Implementation of NDC 3.0 sets an economy-wide target to reduce GHG emissions by 40% by 2035 compared with 1990 levels, subject to specified conditionalities.	SECAP: a system of domestic emission reduction targets and measures
3	UN Sustainable Development Goals (SDGs), 2015	SDG 7 'Clean and affordable energy', SDG 11 'Sustainable cities', SDG 13 'Climate action'	Alignment of SECAP with energy efficiency, RE and adaptation measures
4	Sendai Framework for Disaster Risk Reduction (2015–2030)	Disaster risk management and resilience measures	Assessment of flood, heat island and erosion risks in the RVA section
5	The European Union's Covenant of Mayors on Climate and Energy (Covenant of Mayors – CoM)	Development of local energy-climate plans and biennial reporting	SECAP will register and report directly on the CoM platform

Analytical outcome

The SECAP developed for the city of Khachmaz will act as a bridge between national legislation, regional planning, and international commitments. This will ensure a sustainable link at both the regulatory and practical levels of governance, investment, and monitoring.

1.6.2 Regulatory and legal compliance

The 'Energy Efficiency', 'Renewable Energy', and 'Environmental Protection' laws provide the legal basis for the SECAP.

Gaps exist at the local level; the SECAP will ensure implementation through energy audits in buildings, pilot RE projects, and technical/financial incentives.

1.6.3 Strategic and programme compatibility

National programmes (2022–2026 socio-economic strategy, Roadmap) provide macro-level objectives, but local implementation mechanisms are weak.

- SECAP will translate this into measurable actions:
- The share of RE in electricity consumption will be increased;
- Energy audit of 50% of public buildings;
- 100% conversion of street lighting to LED;
- Reduction of water leakage losses from 25% to 15%.

1.6.4 Regional/spatial compatibility

- The spatial components of the Master Plan will be translated into environmental and climate outcomes through SECAP:
- Transport: low-emission routes, electric transport, cycle paths;
- Housing: energy-efficient construction, promotion of "green roofs" and "white surfaces";
- Greening: reduction of the heat island effect and carbon sequestration.

1.6.5 International commitments

- UNFCCC, Paris Agreement, SDGs, Sendai Framework, Covenant of Mayors: SECAP will be the local operational tool.
- Mitigation: emission reduction in the energy, transport and waste sectors;
- Adaptation: water resources, coastal protection, heat island;
- Social justice: EPOV component, gender equality and support for vulnerable groups.

1.6.6 Governance and finance

- A 'Climate and Energy Secretariat' will be established at the municipal level;
- Finance: AEEF, KOBIA, donor resources (EU, GCF, UNDP, GIZ);
- Public participation, gender balance, youth involvement;
- A biennial "monitor–evaluate–report" system will be tracked on the MyCovenant platform.
- Strategic outcome:
- SECAP will translate national and international policies into local implementation;
- Will translate the Master Plan's energy and environmental goals into concrete actions;
- Will address gaps in regional and national programmes;
- It will transform Khachmaz to an energy-efficient, environmentally safe, and socially equitable city.

1.7 Compliance gaps and institutional barriers

1.7.1 Compliance gaps

Thus, the SECAP will not only identify compliance gaps but will also become the practical mechanism managing the transition from national policy to the local level.

Although current legislation and programme documents provide a common basis for Khachmaz, gaps in energy and climate governance exist:

Regulatory gaps

- The Energy Efficiency and Renewable Energy laws do not specify municipal implementation mechanisms;
- The 'Environmental Protection' law does not provide for local monitoring;
- The legal authority of municipalities for energy management is not regulated by law.

Strategic gaps

- The Master Plan and national strategies do not specify emission reduction and adaptation measures at the local level;
- There is no system for measurable indicators and monitoring in the transport, waste, and industrial sectors;
- Sanitary protection zones are insufficient for some industrial establishments.

Data and technological gaps

- Information on energy, waste and climate risks is not collected in a single database;
- Initial data mechanisms for BEI and RVA have not been established;
- There is no local annual monitoring and reporting system.

1.7.2 Institutional barriers

Central level

- Coordination between ministries is weak; the division of responsibilities is unclear; the role of municipalities is limited.

Regional level

- The Khachmaz District Executive Authority lacks sufficient structural and human capacity for energy and climate issues, and there are few local initiatives.

Local level

- The municipality's financial and human resources are limited;
- There is no technical basis and no specialist for energy audit, BEI and RVA;
- Public participation and gender balance are not systematically organised.

1.7.3 Recommendations

A. Legislation and policy

- The powers of municipalities should be specified;
- Climate adaptation and emission reduction should be added to the Master Plan and State Programmes;
- BEI and RVA should be conducted at the local level.

B. Institutional level

- An 'Energy and Climate Council' and coordination platforms should be established;
- A Regional Coordination Office (Climate Focal Point) should be established;
- Gender balance and youth participation must be ensured.

C. Technical and financial level

- A unified energy and climate database (Data Hub) should be created;
- A municipal energy fund and financial incentives should be established;
- Human capacity should be built and certification implemented;
- Accountability must be ensured through the MyCovenant platform.

1.7.4 Analytical conclusion

SECAP will address these gaps:

- Institutional strengthening – the role of municipalities will be legally recognised;
- Technical transformation – data and monitoring systems will be established on a digital basis;
- Social and financial integration – public participation, gender balance and financial instruments will be systematised.
- Thus, in addition to identifying compliance gaps, SECAP will also function as a practical mechanism ensuring the transition from national policy to the local level.

1.8 Recommended institutional mechanisms and governance model

1.8.1 Governance principles

SECAP governance will be based on the recommendations of the CoM and JRC:

- Multi-level integration: 'Top-down' and 'bottom-up' alignment will be ensured between national, regional and local plans.
- Stakeholder engagement: The Municipality, the Executive Authority, utility companies, businesses, NGOs, and academic institutions will be involved in the process for the annual plan.
- Subsidiarity: Decisions will be made at the local level (public buildings, lighting, waste).
- Data-driven decision-making: BEI and RVA data, and energy, water, waste, and green infrastructure databases will be utilised.
- Gender and social inclusivity: The participation of women, young people, the elderly and vulnerable groups will be ensured; energy poverty will be monitored.
- Transparency and accountability: All decisions will be publicly available; data will be shared on the CoM platform and the municipality's website.
- Financial sustainability: A combination of government programmes, municipal revenues, private investments, and international grants will be used.
- Example KPIs: female/male ratio, number of vulnerable households participating, share of income spent on energy, energy improvements in female-headed households.

1.8.2 Institutional structure and responsibilities

The Energy and Climate Council (ECC) will bring together the municipality, district and central bodies, NGOs, the private sector and universities, and will oversee the annual action plan, budget and accountability.

The Executive Secretariat, a five-person team, will be responsible for project management, data collection, monitoring, procurement and reporting.

Thematic working groups will operate in the areas of energy efficiency, renewable energy, adaptation, waste and transport.

Roles:

- Municipality – pilot projects, data and public awareness;
- District Executive Authority – regional coordination;
- Ministry of Energy – energy efficiency and renewable energy;
- MENR – climate and risk monitoring;
- Urban Planning Committee – building standards and environmental oversight;
- SMBDA and the Ministry of Economy – green business and PPP;
- NGOs and academic institutions – public participation and technical support.

1.8.3 Coordination mechanism and decision-making cycle

- An annual action plan will be developed, defining priorities and a financial framework; BEI and RVA data will be updated.
- Technical specifications for projects will be prepared; risks will be assessed in advance.
- The Secretariat will collect quarterly reports and submit them to the CoM.
- The annual final report will be presented to both the public and the CoM platform.
- Open hearings, focus groups and public participation will be provided every six months.

1.9 Data gaps and research needs

1.9.1 Overview

A reliable and systematised database is essential for SECAP. BEI and RVA can only reflect reality based on local, accurate and verified indicators. Currently, data for Khachmaz is held by various institutions but is insufficient for a concrete energy balance, emissions and risk calculations at the city level.

1.9.2 Data gaps

- ***Energy:*** There is no monthly energy consumption and audit for public buildings and households; no local monitoring for solar/wind energy.
- ***Transport:*** No reliable baseline for urban vehicles, fuel consumption and CO_2 emissions.
- ***Waste:*** Household waste, sorting rate, and landfill methane emissions are not measured.
- ***Water:*** Energy consumption of supply and sewerage systems is not recorded.
- ***Climate and ecology:*** Local meteorological data, and flood, drought and coastal erosion risks are not mapped.
- ***Demographic/Socio-economic:*** Population growth, urbanisation and energy poverty indicators are not available at the urban level.
- ***EPOV:*** Local data on household income and energy expenditure for measuring energy poverty is limited.
- ***The main limitation*** is the lack of local-level data, its non-systematisation in a unified format, and its failure to be regularly updated.

1.9.3 Research and priority needs

- ***Energy audits:*** Assess energy consumption, heating systems and insulation in public buildings; issue energy performance certificates.
- ***Household surveys:*** To determine energy habits, thermal insulation and the share of costs in the household budget.
- ***Transport inventory:*** Collect data on urban park, fuel types, annual mileage and emissions.
- ***Climate risks:*** Map flooding, drought, storms and coastal erosion, and model water resources.
- ***Socio-economic analysis:*** Assess urbanisation, jobs, energy poverty and social impact.
- ***Digital Energy and Climate Information System (REİMS):*** Ensure data is stored on a single platform and can be exported in line with the CoM reporting format.

1.9.4 International experience

In Poland and the Czech Republic, energy and emission data are integrated in real time at the urban level with the 'Urban Data Platform'.

The examples of Georgia (Kutaisi) and Croatia (Split) have assessed energy poverty and transport emissions through social surveys and mobile tracking.

These practices can be adapted to Khachmaz's digital platform and social survey components.

In the next phase:

- Local inventories for energy, transport, waste and water should be developed;
- Climate risks should be mapped and modelled;
- Socio-economic and energy poverty surveys should be conducted;
- All data must be integrated into a single digital platform.
- These measures will make the SECAP a sustainable document that is measurable, based on real-world conditions, and compliant with international reporting systems.

1.10 Strategic directions and priorities for the SECAP

Khachmaz city aims to become a carbon-neutral, climate-resilient, and energy-resilient city by 2050. Within this vision, the city plans to enhance community well-being by significantly reducing greenhouse gas emissions, increasing resilience to climate risks, and minimising energy poverty by 2030.

1.10.1 General approach

The Khachmaz SECAP will elevate local energy and climate governance to a strategic level. The plan will ensure the local implementation of national and international commitments. The approach is based on three pillars:

- Mitigation – reduction of greenhouse gas emissions;
- Adaptation – increasing resilience to climate risks;
- Reducing energy poverty – social justice and inclusion.

It combines top-down (localisation from national documents) and bottom-up (local needs) approaches. The Analysis of Energy and Climate Policies and Frameworks provides the analytical basis, and SMART targets are defined based on BEI/RVA results.

1.10.2 Mitigation priorities

- Buildings: Energy audits in public and residential buildings, insulation, ISO 50001 energy management system, LED lighting.
- Renewable energy: Solar panels, wind energy measurements, biomass production.
- Transport: Electric/hybrid buses, cycling/pedestrian infrastructure, incentive scrappage for high-emission vehicles.
- Waste: Sorting, recycling, landfill methane capture.

Initial estimates suggest that emissions can be reduced by 35% by 2030.

1.10.3 Adaptation priorities

- Water management: Rainwater harvesting and reuse, drip irrigation.
- Flooding and erosion: Monitoring of Gudyalchay River flow, drainage restoration, riparian green zones.
- Agriculture and urban environment: Drought-resistant varieties, tree-forest belts, increasing parks and greenery, cool roofs and shading technologies.

The RVA results will determine the sequence and scale of the measures.

1.10.4 Reducing energy poverty

Key EPOV indicators include the energy cost-to-income ratio, difficulty maintaining a comfortable indoor temperature, energy supply interruptions and poor insulation.

- Social measures: subsidies for low-income households, tariff concessions;
- Technical measures: insulation of social housing, energy saving in public buildings;
- Awareness-raising: school and community training, 'green energy' campaigns.
- Gender and inclusivity: the indicators 'gender-balanced participation rate', 'energy burden (low-income)', and 're-furnishing of women-led households' will be monitored in the annual report.

1.10.5 Strategic outcome and phasing

In the 2026–2030 period, the SECAP will prioritise rapidly implementable, high-impact measures, including building modernisation, LED lighting, rooftop solar panels, and drainage and greening projects.

Beyond 2030, the plan envisages a transition towards full carbon neutrality, supported by expanded renewable energy capacity, energy storage systems, electric transport and circular-economy principles.

The BEI and RVA results will be converted into formal commitments on the Covenant of Mayors platform, and the monitoring and reporting system will be aligned with these commitments.

Conclusion: The SECAP is the strategic roadmap for Khachmaz, ensuring an energy, climate, socio-economic and ecological transformation.

1.11 Proposed package of measures and action plan

1.11.1 Overall approach

The Khachmaz SECAP identifies priority measures across three strategic pillars, based on the Analysis of Energy and Climate Policies and Frameworks stage:

- Mitigation – reduction of greenhouse gas emissions;
- Adaptation – increasing resilience to climate risks;
- Energy poverty alleviation (EPOV) – social equity and inclusivity.

The measures are aligned with both national commitments (NDC 3.0 2025, NAP 2024, 2022–2026 Strategy) and the Khachmaz Master Plan 2035. Implementation will be phased: first pilot and municipal facilities, then a city-wide expansion.

1.11.2 Action categories and priorities

A) Energy efficiency and buildings

- Energy audits and thermal insulation in public buildings;
- Phased insulation of residential buildings and renewal of window and roof systems;
- 100% transition to LED for street lighting;
- Implementation of ISO 50001 energy management systems.

B) Renewable energy and energy infrastructure

- Roof-mounted solar panels (PV) on municipal and public buildings;
- Wind energy pilot plants (Yalama–Nabran);
- Bioenergy from agricultural and household waste;
- Modernisation of the electricity grid and reduction of losses.

C) Transport and urban logistics

- Implementation of electric and hybrid buses;
- Creation of cycle and pedestrian paths (10 km in the first phase);
- Incentives for scrapping high-emission vehicles;
- "Green parking" and charging points for electric vehicles.

D) Adaptation and ecological measures

- Flood and coastal protection along the Gudyalchay River basin;
- Green belts and tree planting in and around the city;
- Rainwater harvesting and reuse;
- "Cool roofs" and energy-efficient architectural solutions.

E) Energy poverty and social inclusion

- Subsidisation of energy-efficient appliances for low-income households;
- Thermal insulation and LED lighting in social housing;
- Energy modernisation programme for female-headed households;
- Awareness campaigns and educational projects.

Table 17. Initial action plan

No.	Action Area	Short description	Expected impact	Responsible body	Implementation phase
1	Energy audit and insulation of public buildings	Increasing energy efficiency, controlling heat loss	15–20% energy saving	Khachmaz Municipality, MENR	2026–2028
2	Roof-mounted solar panels	Pilot installations up to 10 MW of PV power	Reduction of 8–10 thousand tonnes of CO_2	Ministry of Energy, AREA	2026–2030
3	Electric buses and cycling infrastructure	Low-emission transport network	5–7 thousand t CO_2 reduction	Khachmaz district executive authority, Council, Transport Agency	2026–2030
4	Restoration of green areas and coastal protection	Reduction of erosion and heat islands	+20% green space	MENR, Khachmaz district executive authority	2026–2035
5	Social support programme against energy poverty	Energy modernisation support for vulnerable families	1000 families will be covered	Municipality, Ministry of Labour	2026–2030

(An expanded version is presented in 'Appendix 1')

Table 18. Action pillars, objectives and levels of implementation within the SECAP

No.	Column	Types of action	Main objective	Level of implementation
1	Mitigation	Energy efficiency, renewable energy, transport modernisation	Emission reduction	City and municipal level
2	Adaptation	Water management, green infrastructure, flood risk reduction	Climate risk resilience	Regional and local
3	Energy poverty	Social enterprise projects, gender and inclusivity measures	Equal energy access and social justice	Household level

Conclusion

The proposed package of measures constitutes the first strategic framework of action for the city of Khachmaz. These measures will be updated in line with the results of the BEI – Baseline Emission Inventory and the RVA – Risk and Vulnerability Assessment, and will be complemented with specific financial and monitoring parameters.

Thus, this plan ensures the transition to the operational phase of the SECAP and provides the initial roadmap for the transformation of Khachmaz city into a low-emission, climate-resilient, and energy-just city model by 2030.

2. Stakeholder engagement and coordination mechanism

2.1 Objective

The aim of this stage is to ensure the active participation of all relevant stakeholders in the process of developing the SECAP (Sustainable Energy and Climate Action Plan) for Khachmaz Municipality. This involves identifying key actors, establishing a coordination mechanism, organising consultations, and keeping stakeholders regularly informed about the process.

2.2 Identification of stakeholders

1. Municipal authorities
   - The Mayor and members of the municipal council
   - Departments for urban planning, environment, energy, transport and utilities
2. Representatives of the public
   - Representatives of township and village communities
   - Youth and senior groups
   - Local volunteers and community leaders
3. Utility companies
   - Electricity and gas supply companies
   - Water and sewerage authorities
   - Heat supply companies (if any)
4. Civil society organisations (CSOs)
   - Environmental NGOs
   - Local initiatives and advocacy groups
   - Community-based organisations
5. Business representatives
   - Chambers of Commerce
   - Local SMEs and industry representatives
   - Key economic actors influencing energy consumption in the municipality

2.3 Initial consultation workshops

Initial consultation workshops were organised with the following objectives:

- To inform stakeholders about the objectives and process of the SECAP
- To gather initial ideas and suggestions from stakeholders
- To build support for and interest in the process
- To identify local priorities, challenges and opportunities

Outcomes of the workshops:

- A report reflecting stakeholder feedback and suggestions
- Identification of priority actions and areas for SECAP
- Documented recommendations for a future action plan

3. Data collection and verification for the preparation of the BEI and RVA

This task involves the systematic collection and verification of data necessary for the preparation of the BEI (Baseline Emission Inventory) and RVA (Risk and Vulnerability Assessment) documents. Data was collected across key sectors including buildings, transport, street lighting, waste, energy generation and green spaces (Table 19). To ensure data reliability, official statistics, municipal records, and utility sources were prioritised. Existing gaps were filled using standard coefficients in accordance with CoM and IPCC methodologies. The collected and verified data form a reliable basis for the BEI calculations and RVA analysis.

Table 19. Sectors, key indicators and sources for data collection for BEI and RVA

Sector	Key data collected
1. Buildings	Number and area of buildings (m^2) energy consumption (gas, electricity) heating systems energy efficiency indicators
2. Transport	Number of vehicles (public, private, freight) fuel consumption (petrol, diesel, LPG, CNG) length of roads, traffic flow
3. Street lighting	Number of lamps type of technology (LED, sodium, etc.) annual electricity consumption
4. Waste	Volume of solid waste (tonnes/year) condition of waste landfills Recycling rates sewage system
5. Energy generation and supply	Local energy producers renewable energy facilities production volumes
6. Green spaces and parks	Area of green spaces energy consumption of parks carbon sequestration potential

3.1 Description of the municipality and vision for the future

3.1.1 Municipal objectives

The Khachmaz city administration has joined the CoM-Europe initiative, declaring its commitment to the 2030 and 2050 climate targets. Khachmaz Municipality has set a target of reducing emissions by 35% by 2030, within the framework of the Mayors' Agreement of the Eastern Partnership and the Global Mayors' Agreement. To achieve this goal, the municipality plans to monitor and assess emissions in the residential, service, transport, and waste sectors. The collected data will inform the municipality's strategic decisions and sustainable development projects.

The municipality will also implement a systematic approach to ensure the accuracy and reliability of the data. By verifying BEI and RVA data, identifying gaps, and applying appropriate assessment methods, the city will set an exemplary standard in both environmental policy and public accountability. This approach supports emission reduction at the local level and contributes to the city's sustainable development goals.

3.2 Municipality overview

3.2.1 Geographical location

Khachmaz city is the administrative centre of the eponymous district. The city and district are located in the north-eastern part of Azerbaijan (Figure 1). The current boundary of Khachmaz city covers

an area of 1,287.4 ha. The lands immediately adjacent to the city are primarily arable land, where vegetables are grown. The city's territory is bordered to the north by the Gudyalchay, to the west by the Baku-Yalama motorway, to the south by the main water pipeline, and to the east by the landfill site. The main part of Khachmaz city is situated between the Baku-Rostov railway and the Baku-Yalama motorway.

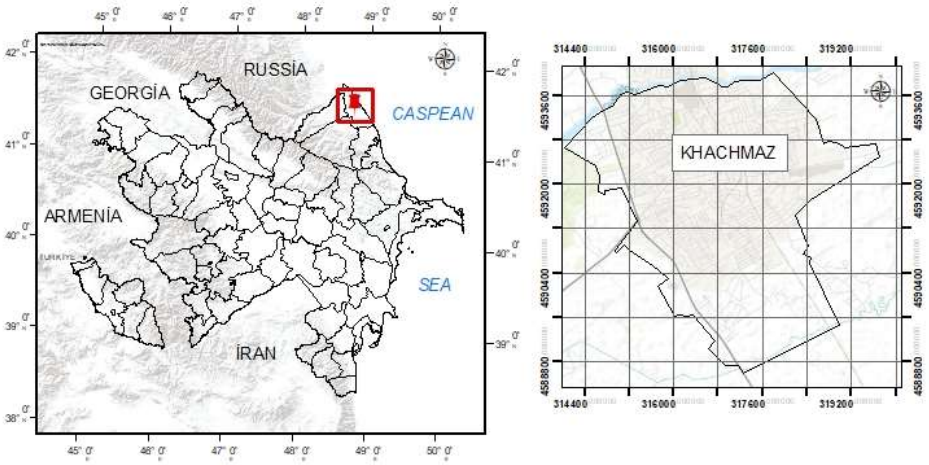


Figure 1. Location of Khachmaz city

Part of the Samur-Devechi Plain is located within the district. The main motorway and the Baku-Moscow railway line pass through the district. Forests cover 20,800 hectares of the district. Khachmaz District is one of Azerbaijan's ancient settlement areas and was established as an administrative district in 1930. Khachmaz was a town-type settlement in 1936-1937. In 1963, Khachmaz District was abolished and its territory was transferred to Quba and Qusar districts. In 1965, the district was re-established. It borders the Russian Federation to the north-west and the Caspian Sea to the north-east and east. The district's coastline is 70 km, and its border with the Russian Federation is 14 km.

3.2.2 Historical overview

The name Khachmaz originates from the name of the khachmataka (khechmatek) tribe, which once lived in this area and was part of the confederation of the Huns. Subsequently, the name underwent a transformation. Beginning from the mid-7th century, it appears in sources in the form of Khachmaz. Interestingly, in the second half of the 7th century, a part of this tribe migrated to the area of the present-day Oghuz district and there built a village and a fortress, both named Khachmaz.

Various theories are put forward regarding Khachmaz's history as a settlement. Some suggest it does not have a very ancient history, while others note that it has been known since 1718.

Khachmaz has a history of at least 1,200 years. Indeed, Ibn Khordadbeh, one of the most renowned Arab historians of the Middle Ages, mentions Khachmaz by name in his work 'Book of Countries and Routes', which he completed in 885. He wrote that the caravan route, which ran along the Caspian coast as far as Derbent, passed through a settlement called 'Khachmaz'. It is highly likely that he had been to these parts.

Beginning in early centuries AD, nomadic Turkic tribes came to Azerbaijan through Derbent, the northern gateway to the Caspian, and intermingled with the native population of the country.

Sources state that the Maskut principality, established by the Huns in the lands along the Caspian Sea, existed until the 6th century AD. Later, these territories formed part of the Qola province of the Alanian feudal state. In the 12th–14th centuries, these territories were conquered by Mongol armies, and the settlements were laid waste.

In the 17th century, the Russians raided the Caspian provinces via the Volga-Caspian waterway. For instance, in 1668, Stepan Razin's pirate bands reached the shores of the Caspian Sea by this route and engaged in piracy and looting in the area. In the early 17th century, these territories were incorporated into the Kuban

Khanate.

In the early 19th century, the Russian army occupied the Khanates of Ganja, Shirvan and Baku. On 22 February 1828, the Treaty of Turkmenchay was signed. According to this treaty, North Azerbaijan was incorporated into Russia. Like the other khanates, the Khanate of Quba was also abolished and became one of Russia's provinces. Thus, the Khachmaz uezd was established in this area and was subordinated to the Baku Governorate. In 1900, the Khachmaz station was established on the Baku–Petrovsk (Makhachkala) railway, whose construction was completed that year.

In connection with the 1930s districtisation in Azerbaijan, on 8 August 1930, the Khachmaz administrative district was created with the village of Khachmaz as its centre, and Khachmaz's name was entered on the republic's map as the district centre. In 1935, Khachmaz was granted settlement status, and in 1938, it was granted city status.

3.2.3 Climate conditions

The climate of Khachmaz city is of the dry subtropical type: mild and warm, with hot and dry summers and mild winters. Specifically, the city experiences a mild winter, a spring with low rainfall, a dry and hot summer, and a mild and rainy autumn. In studying the individual elements of Khachmaz's climate, multi-year observational data from the meteorological station located in the city and internet resources were used. Some indicators related to the city's climate are provided in Table 20.

Table 20. Some climate indicators

Geographic longitude	48.8020626
Geographic latitude	41.4591168
Elevation	49.69 m
Annual high temperature	16.75 °C
Annual minimum temperature	11.42 °C
Average annual precipitation	16.32 mm
Warmest month	July (28.89 °C)
Coldest month	February (1.78 °C)
Wettest month	November (32.74 mm)
The driest month	August (7.03 mm)
Number of days with rainfall (≥ 1.0 mm)	44.73 days (12.25%)
Days without rain	320.27 days (87.75%)
Humidity	68.84%

The average annual temperature in Khachmaz is 12.2 °C. The coldest month of the year is January. The average monthly temperature for this month is 1.2 °C. The lowest temperature recorded in this month was –29 °C. The hottest months of the year are July-August. The average monthly temperature during these months is 24.0 °C. A maximum temperature of 43 °C has been recorded during these months. Autumn is 3 °C warmer than spring (Table 21).

Table 21. Mean monthly and annual temperature indicators for the city: mean monthly and annual, mean minimum and mean maximum temperatures, °C

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Temperature	1.2	1.8	4.3	9.9	16.5	21.2	24.0	23.4	19.1	13.6	8.0	3.8	12.2
Minimum	-8	-8	-4	0	6	9	15	15	10	5	-2	-6	-11
Maximum	12	12	19	24	29	34	35	35	32	26	19	15	37

Source: Compiled based on data from the Khachmaz district meteorological station.

The average annual rainfall in the city of Khachmaz is 330 mm, with a total of 92 rainy days. Rainfall peaks mainly in the autumn months (IX–XI), with the highest figure recorded in October (46 mm). In the summer months (July–August), however, the amount of precipitation and the number of rainy days are at a minimum (12–13 mm and 4 days), which indicates an increased risk of seasonal drought (Table 22).

Table 22. Mean monthly and annual rainfall and number of rainy days in the city, mm

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Precipitation, (mm)	28	24	27	23	21	22	12	13	34	46	44	36	330
Number of rainy days, days	11	10	9	6	6	6	4	4	7	9	9	11	92

Source: Compiled based on data from the Khachmaz District Meteorological Station.

The hottest month is July (27.05°C), and the coldest month is February (4.24°C). The summer months (June–August) are hot, while the winter months (December–February) are cold. In the spring and autumn months, the temperature is moderate (Figure 2).

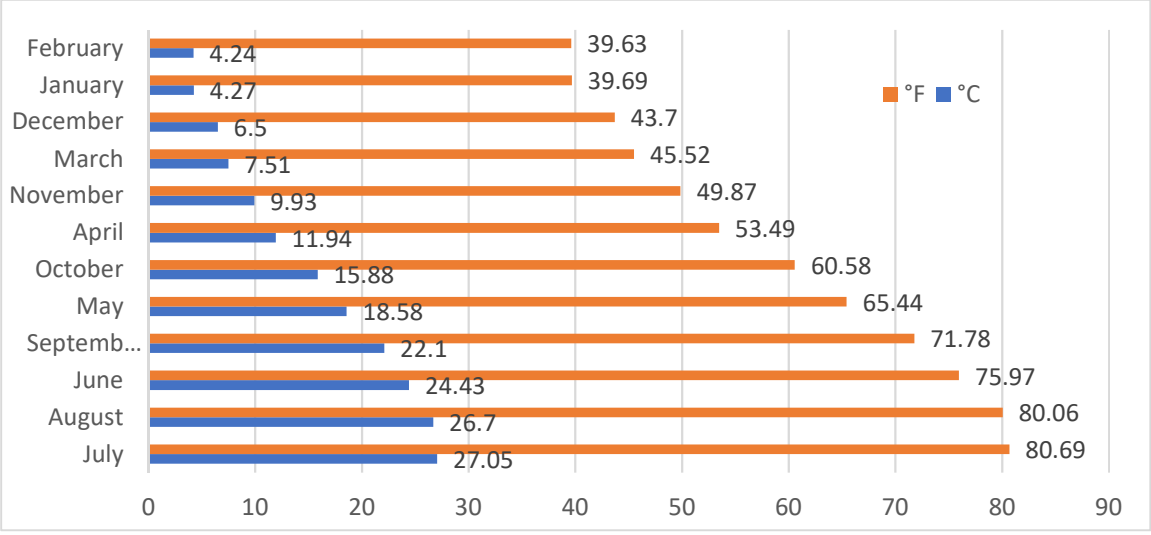


Figure 2. Change of mean monthly temperature throughout the year

The city's main precipitation peak is observed during the autumn-winter seasons. The maximum precipitation during this period is observed in October and November, at 46-44 mm. The minimum precipitation is observed in the summer season, from July to August. In these months, rainfall is observed to be 12-13 mm.

The annual number of rainy days is 92. During the autumn-winter season, there are 9-11 rainy days per month, while in summer, this figure is 4-5 days per month.

During the winter season, when the city's air temperature is low, precipitation falls as snow. The snow cover is mainly transient and melts quickly. The snow cover depth was 1–2 cm, with a maximum depth of 10 cm. The snow cover is observed for an average of 13 days per year (Table 23).

Table 23. Other climatic indicators

Indicator	January	February	March	April	May	June	July	August	September	October	November	December	annual
Record high temperature, °C (°F)	16.0(60.8)	16.0(60.8)	22.0(71.6)	24.0(75.2)	30.0(86.0)	36.0(96.8)	37.0(98.6)	36.0(96.8)	35.0(95.0)	29.0(84.2)	21.0(69.8)	19.0(66.2)	37.0 (98.6)
Mean high temperature, °C (°F)	5.72(42.3)	5.85(42.53)	9.51(49.12)	13.98(57.16)	20.48(68.86)	26.27(79.29)	28.89(84.0)	28.8(83.84)	24.27(75.69)	17.75(63.95)	11.48(52.66)	7.96(46.33)	16.75 (62.15)
Daily mean temperature, °C (°F)	4.27(39.69)	4.24(39.63)	7.51(45.52)	11.94(53.49)	18.58(65.44)	24.43(75.97)	27.05(80.69)	26.7(80.06)	22.1(71.78)	15.88(60.58)	9.93(49.87)	6.5(43.7)	14.93 (58.87)
Average low temperature, °C (°F)	2.1(35.78)	1.78(35.2)	4.5(40.1)	8.13(46.63)	13.86(56.95)	19.18(66.52)	22.15(71.87)	22.31(72.16)	18.42(65.16)	12.88(55.18)	7.48(45.46)	4.28(39.7)	11.42 (52.56)
Record low temperature, °C (°F)	-8.0(17.6)	-10.0(14.0)	-4.0(24.8)	-1.0(30.2)	4.0(39.2)	12.0(53.6)	15.0(59.0)	13.0(55.4)	10.0(50.0)	2.0(35.6)	-4.0(24.8)	-7.0(19.4)	-10.0 (14.0)
Average precipitation, mm (inches)	22.3(0.88)	16.35(0.64)	17.29(0.68)	11.77(0.46)	15.82(0.62)	10.03(0.39)	9.19(0.36)	7.03(0.28)	12.79(0.5)	17.84(0.7)	32.74(1.29)	22.72(0.89)	16.32 (0.64)
Average days with precipitation (≥ 1.0 mm)	5.64	4.27	4.36	2.64	3.18	3.09	2.45	1.73	2.73	4.73	4.82	5.09	3.73
Average relative humidity (%)	77.22	78.06	74.32	69.21	67.75	58.61	56.45	56.15	64.81	72.84	74.77	75.89	68.84
Average monthly hours of sunshine	6.87	9.03	9.94	11.83	13.95	14.25	14.27	13.06	10.91	9.02	7.13	7.3	10.63

a) Air humidity

The city's average annual absolute humidity is 12.1 mb. Absolute humidity depends on temperature

variations throughout the year. Thus, the maximum absolute humidity is observed in the summer months (July-August) and is 20.1 mb, while the minimum absolute humidity is observed in the winter months (January-February), with a value of 6.0 mb. The city's average annual relative humidity is 78%.

During the winter months, the relative humidity increases to 84-85%. When spring begins, the relative humidity gradually starts to decrease. In summer, the relative humidity decreases to 67-70%. In the summer months (July-August), the relative humidity can drop to as low as 30%. The main reason for this is the blowing of the Karayel, a dry wind, during this period. In this case, the air temperature rises and the relative humidity falls. The relative humidity is lowest in the afternoon and highest in the morning and evening (Table 24).

Table 24. Average monthly and annual relative humidity in the city, %

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Relative humidity	85	84	83	76	73	68	67	70	76	84	86	85	78

Source: Compiled based on data from the Khachmaz district meteorological station.

b) Evaporation

The average annual amount of potential evaporation in the city is 800 mm, which is 2.4 times greater than the amount of precipitation. In the city, during the cold months of the year, evaporation is 1-2 times greater than precipitation, and in the summer months, it is 5-12 times greater. This leads to the widespread use of irrigation in agriculture.

Note: Tables 20 and 23 are based on a secondary climate dataset, whereas Tables 21, 22 and 24 are based on observations from the Khachmaz District Meteorological Station. Differences arise from different observation periods and data-processing methods.

3.2.4 Demographic overview and employment

The Khachmaz district has an area of 1,063 square kilometres and a population of 175,000. The population of Khachmaz city is 45,000. The district comprises 2 cities, 2 urban-type settlements, and 147 villages. Overall, 22 nationalities and ethnic groups live in Khachmaz District. In the city, Azerbaijanis are the majority, while among representatives of other peoples, Russians and Ukrainians are predominant (Table 25).

Table 25. National composition of the population of Khachmaz city

Ethnic group	Number, 1970	Proportion, 1970
Total	**22,313**	**100%**
Azerbaijani	13,170	59%
Russians and Ukrainians	5,301	23.8%
Lazghi	1,726	7.7%
Jews	892	4%
Armenians	507	2.3%
Tatars	244	1.1%
Georgians	21	0.1%
Avar	5	0.1%
Tat	3	0.1%
Other	444	1.8%

The city's population has increased more than 35-fold in just over a century since 1926 (Figure 3). The fastest rate of growth occurred after the Second World War.

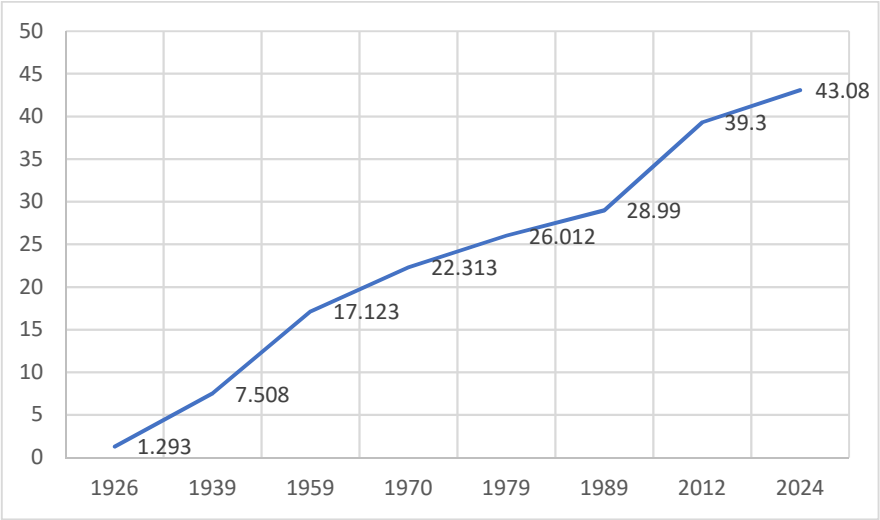


Figure 3. Dynamics of the city's population, thousands of people

3.2.5 Economic and social situation

Many enterprises operate in the city area, which means new job opportunities. These enterprises include the following.

The Caucasus Canning Factory commenced operations in Khachmaz district on 12 September 2003. The facility's total area is approximately 40 hectares. With an annual production capacity of 20-25 thousand tonnes (13-15 thousand tonnes actually produced) of fruit and vegetable preserves and 9 thousand tonnes (6 thousand tonnes actually produced) of meat preserves, the Qafqaz Canning Factory serves as the main buyer of agricultural products in the Northern Region of the Republic of Azerbaijan. The enterprise employs over 350 people, which is one of the factors in the development of the Khachmaz region.

The State Seed Fund, under the Ministry of Agriculture, operates a factory built in the city of Khachmaz. The facility has the capacity to process 5 tonnes of seed per hour. Covering a total area of 1.1 hectares, the facility comprises an administrative building, a seed cleaning centre, and a dedicated warehouse area.

The plant's main advantage is its ability to process seeds with minimal loss. The Khachmaz seed processing plant plays an important role in supplying the region's seed producers with high-reproduction seeds. Seeds resistant to the local climatic conditions and diseases are processed here, and the cleaning, packaging, and certification of seeds supplied from individual seed farms are carried out (Table 26).

Table 26. Statistical indicators of industrial enterprises

No.	Name of industrial enterprises	1995 — Actual number of employees	2010 — Actual number of employees
1	Canning plant	458	**366**
2	Condenser factory	297	**551**
3	Packaging market	-	**-**
4	Bakery	83	**70**
5	Flour, flour products and bakery complex	-	**-**
6	Dairy plant	-	**-**
7	Beer and soft drink factory	-	**52**

8	Carpet factory	120	-
9	Gravel plant	-	-
10	"Azirit" factory	-	-
11	Aluminium Structures Factory	-	-
12	Wood processing plant	-	-
13	Precision engineering workshop	-	-
14	Factory for the production of specialised machinery for viticulture, fruit growing and horticulture	-	-
15	Sewing factory	-	-
16	Brickworks	-	-
Total:		**958**	**1,039**

Source: The table has been compiled based on data obtained from the Khachmaz District Statistics Office and on calculations.

3.3 The building sector

As shown in Table 27, in the urban area, 375.0 ha (29.1%) of the land is state-owned, 404.0 ha (31.4%) are municipal and 508.4 ha (39.5%) are private land.

Table 27. Distribution of land in the urban area by land ownership type

No.	Types of ownership	Area, ha	%
1	State	375.0	**29.1**
2	Municipality	404.0	**31.4**
3	Private	508.4	**39.5**
	Total:	1287.4	100.0

Source: City's Master Plan

The total housing stock of Khachmaz city is approximately 806,200 m². Of this amount, approximately 769,700 m², or 95.5%, is privately owned, while approximately 36,500 m², or 4.5%, belongs to the public/state housing stock.

The city's industrial and municipal enterprises are concentrated in separate pockets in the north, central, southern, and south-western parts of the city. In addition, the condensator factory is located in the western part of the city, near the Baku-Yalama motorway. The existing communal and warehouse areas are located in the eastern part of the city along Kh. Shukurov Street.

The industrial zone in the northern part of the city includes a cannery, a cardboard factory, the railway goods yard and garages. The industrial zone in the city's eastern residential area consists of enterprises such as the Khachmaz tar factory, an oil depot, a bakery complex, etc. These enterprises are located close to residential houses, and no sanitary protection zone has been maintained between them and the residential area.

The industrial zones in the city's western residential district are home to Pak-Nur LLC, Regional TV, PTB LLC, warehouses, the Caucasus Canning Factory, Hado LLC, and others.

The building density in the area of low-rise private housing is 500 m^2 of total area per hectare. This is due to the presence of buildings with a very low density, characteristic of rural areas, which is 300 m^2 of residential area per hectare.

The density of 2-, 5- and 9-storey sectional buildings is accepted in accordance with normative data: for 2-storey buildings – 3000 m^2 of total area per hectare, for 5-storey buildings – 4300 m^2 of total area per hectare, and for 9-storey buildings – 6300 m^2 of total area per hectare. All sports facilities are designed as a single complex located in the sports centre in the western part of the city.

As shown in the table, 95.5% of the city's existing housing stock is privately owned, and 4.5% is stated (Table

28).

Table 28. Distribution of the city's existing housing stock by storey

No.	Houses	Number		Area	
		number	**%**	**m²**	%
1	Single storey	8620	98.82	736407	**91.3**
2	2-storey	76	0.87	5842	**0.7**
3	3 storeys	3	0.035	2450	**0.3**
4	4 storeys	3	0.035	4208	**0.5**
5	5 storeys	19	0.22	39188	**4.9**
6	9 storeys	1	0.01	10795	**1.4**
7	12 storeys	1	0.01	7310	**0.9**
Total:		8723	100	806200	100

Source: Explanation of the City's Master Plan

According to the Khachmaz City Master Plan, the future development of the housing stock is envisaged as follows (Table 29).

Table 29. The city's housing stock: previous and current situation, future development

No.	Indicators	Unit of measurement	01.01.2015	2020-2035	
				2020	2035
1	Population	people	40984	43750	**50000**
2	Housing stock	m^2	806200.0	962500.0	**1300000.0**
3	Total area per person	m²	19.7	22.0	**26.0**
4	Wear and tear of the housing stock	m^2	-	200.0	**3000.0**
5	**New residential development**	**m²**	**-**	**156500.0**	**340500.0**

Source: Explanation of the City's Master Plan

According to the classification of urban areas, a portion of it is residential. The allocation of these areas provides for the future construction of relatively high-rise buildings (Table 30).

Table 30. Changes in planned area, land ownership and housing stock indicators by year (2015–2035)

No.	Name of the indicator	Unit of measurement	01.01.2015	01.01.2020	01.01.2035
1	Area of the planned area – total,	ha(%)	1287.4 (100.0)	1727.4 (100.0)	**1727.4 (100.0)**
2	including area zones for:				

2.1	Residential (high-rise and multi-unit residential buildings, mid-rise and multi-unit residential buildings, low-rise and multi-unit residential buildings, block-built residential buildings with attached land plots, detached houses with attached land plots dwelling houses)	ha (%)	933.4 (72.5)	1221.2 (70.7)	**1298.3 (*75.2*)**
2.2	public-business	ha (%)	105.6(8.2)	123.5(7.2)	**140.6(8.1)**
2.3	recreation	ha (%)	25.7(2.0)	25.7(1.5)	**34.5(2.0)**
2.4	production (industrial, scientific-manufacturing, utilities-warehousing)	ha (%)	78.5(6.1)	78.5(4.5)	**89.5(5.2)**
2.5	transport infrastructure	ha (%)	28.3(2.2)	32.6(1.9)	**32.6(1.9)**
2.6	Engineering and Communications provision	ha (%)	55.4(4.3)	60.3(3.5)	**65.6(3.8)**
2.7	agriculture	ha (%)	-	125.1(7.2)	**-**
2.8	special purpose	ha (%)	20.6(1.6)	20.6(1.2)	**26.4(1.5)**
2.9	military and other regimes	ha (%	-	-	**-**
2.10	special-purpose areas	ha (%)	18.0(1.4)	18.0(1.0)	**18.0(1.0)**
2.11	specially protected areas	ha (%)	21.9(1.7)	21.9(1.3)	**21.9(1.3)**
3	Land ownership distribution by type:				
3.1	state	ha (%)	375.0(29. 1)	375.0(21. 7)	**375.0(21.7)**
3.2	municipality	ha (%)	404.0(31. 4)	688.6(39. 9)	**688.6(39.9)**
3.3	privately owned	ha (%)	508.4(39. 5)	663.8(38. 4)	**663.8(38.4)**
3.4	Total area per person	m^2	314	395	**346**
Housing stock					
1	Total housing stock total area,	m^2 (min flats, houses)	806.2	962.5	**1300.0**
	including:				
1	Residential buildings of six or more storeys and with multiple flats	m^2 (thousand flats)	18.105	18.105	**121.255**
1.2	4-5 storey and multi-unit residential buildings	thousand m^2 (thousand flats)	43.396	45.846	**45.846**
1.3	Residential buildings of 1-3 storeys and multi-unit dwellings	m^2 (thousand flats.)	8.292	8.292	**8.292**
1.4	blocked residential buildings with adjoining plots of land	m^2 (thousand flats)	2.447	2.447	**2.200**
1.5	garden plots single-family homes	thousand m^2 (min.	733.960	887.810	**1,122.397**

		house)			
2	Dilapidated housing stock (over 70%)	thousand m²	-	0.2	**3.0**
3	New housing stock - total,	thousand m² (thousand flats)	-	156.5	**340.5**
	including:				
3.1	in vacant plots	m2 (thousand flats)	-	138.2	**237.9**
3.2	in renewable areas	m² (thousand flats)		18.3	**102.6**
3.4	**Population's housing provision**	**m² / per person**	**19.7**	**22.0**	**26.0**

Source: Explanation to the City's Master Plan

In the buildings sector, the annual electricity consumption in 2023 was 11.73 million kWh (11,730 MWh), while natural gas consumption was 20.244 million m³, which is equivalent to 215,194 MWh. These figures indicate that the buildings sector holds a significant position in the urban energy balance (Table 31).

Municipal buildings

Electricity consumption in municipal buildings is 10,000 kWh (10 MWh), accounting for only 0.1% of the total consumption. Natural gas consumption was 4,000 m³ (43.04 MWh), accounting for 0.02% of total gas consumption. This indicates that municipal buildings are limited in number and size, and also place a low energy burden compared to other sectors.

Residential buildings

The largest energy consumption is attributable to residential buildings. In terms of electricity, this sector accounts for 29.7% of the total consumption, with a consumption of 3.48 million kWh (3,480 MWh).

Natural gas consumption was 15.58 million m³ (165,613 MWh), accounting for 76.96% of total gas consumption. This indicates that gas is widely used in residential buildings mainly for heating and domestic purposes, and that the sector plays a crucial role in terms of energy.

Service sector buildings, facilities and installations

The service sector makes extensive use of electricity. In this sector, electricity consumption of 3.84 million kWh (3,840 MWh) accounts for 32.7% of the total electricity consumption.

Natural gas consumption was 4.28 million m³ (45,492 MWh), accounting for 21.14% of total gas consumption. These figures indicate that the service sector – including offices, commercial premises, and public facilities – makes balanced use of both electricity and gas.

Industrial buildings

Electricity consumption in industrial buildings was 3.96 million kWh (3,960 MWh), accounting for 33.8% of total electricity consumption, which is the highest share among sectors.

In addition, natural gas consumption was only 95,000 m³ (1,011 MWh), accounting for 0.47% of total gas consumption. This indicates that processes in industrial buildings are mainly powered by electricity.

Other buildings

In the Other Buildings category, electricity consumption is 440,000 kWh (440 MWh), which is equivalent to 3.8% of the total electricity.

Natural gas consumption, at 285 thousand m³ (3,034 MWh), accounts for 1.41% of total gas consumption. This sector has a relatively small share in the total energy balance.

It can be concluded from Table 31 that:

- Electricity consumption is distributed relatively evenly among industrial buildings, the service sector, and residential buildings.
- In natural gas consumption, however, residential buildings have a clear advantage.
- In terms of energy efficiency and emissions reduction, the main focus should be on residential buildings and the service sector.

Table 31. Amount of energy and natural gas consumed by different buildings (base year 2023)

Sectors	Electricity			Natural gas		
	kWh kWh	**(MWh) MWh**	**%**	**cubic m m³**	**(MWh·hour) MWh**	**%**
Municipal buildings	10000	10	0.1	4000	43.04	0.02
Residential buildings	3480000	3,480	29.7	15580000	165,613.30	76.96
Service sector buildings, facilities and structures	3,840,000	3840	32.7	4280000	45,492.01	21.14
Industrial buildings	3960000	3960	33.8	95000	1,011.41	0.47
Other buildings	440000	440	3.8	285000	3,034.24	1.41
Total	11,730,000	11730	100.0	20244000	215194	100

3.4 Transport sector

3.4.1 Length of roads and traffic flow volume

The existing transport system in Khachmaz city is represented by road and rail transport.

Currently, two road transport organisations operate in the city. They play a key role in the welfare of the city's population.

" *SAA-Trans" LLC*. This company is located at 20A Baku Avenue and has been operating since 2010. This is the city's bus station complex. Here, the district's residents connect with the city of Baku and other cities in the country by bus and private car.

"Khachmaz Avtonəqliyyat" ASC is located at 5 Müşkür Street and has been operating since 1996. The company's main activity is the delivery of agricultural products, manufactured industrial goods and other cargo grown or produced in the region to consumers, as well as the delivery of goods sent to the region.

Currently, the city of Khachmaz has a well-developed road and street network. In terms of traffic, the city's streets are two-way. Within the urban built-up area, the street-road network density is satisfactory (4.3 km/km^2), but the majority of these are inconsistent with the rapidly increasing number of motor vehicles and traffic intensity (Table 32).

Table 32. Statistical indicators of transport infrastructure

No.	Transport infrastructure	Unit of measurement	01.01.2015	01.01.2020	01.01.2035
1	Main streets and roads length	km	55.754	74.5	**98.0**
2	Main street-road density of the arterial road network	km/km^2	4.3	4.1	**5.3**
3	Public transport network total length – total,	km	10.0	18.0	**26.0**
	including:				
3.1	electrified (electric train, metro, tram and trolleybus)	km	-	-	**-**
3.2	Bus	km	10.0	18.0	**26.0**
4	**Bridges, flyovers, tunnels and underground pedestrian passages**	**number**	**4**	**4**	**5**

During the collection of statistical data from the 9 petrol stations in the city, for the purpose of analysing the average daily sales of petrol, diesel and gas, we determined that they can be classified into 4 types according to their size and sales volume: small, medium and large -type petrol and diesel filling stations, and LPG filling stations.

2 small fuel stations, each with an average of 1.2 tonnes of petrol and 1.5 tonnes of diesel per day, and 2 medium-sized fuel stations, each with an average of 10 tonnes of petrol and 10 tonnes of diesel per day, 3 large-scale filling stations sell an average of 20 tonnes of petrol and 20 tonnes of diesel per day each, while 2 LPG stations sell an average of 30,000 litres of fuel per month each, with 30,000 litres in winter and 40,000 litres in summer.

The city's railway transport is represented by the Khachmaz railway station, located on the Baku–Moscow railway line that passes through the eastern part of the city. This station is located at 2 Vagzal Street and has been in operation since 1900. The station covers an area of 45.8 ha. A major trunk road passes through the western part of the city (Figure 4).

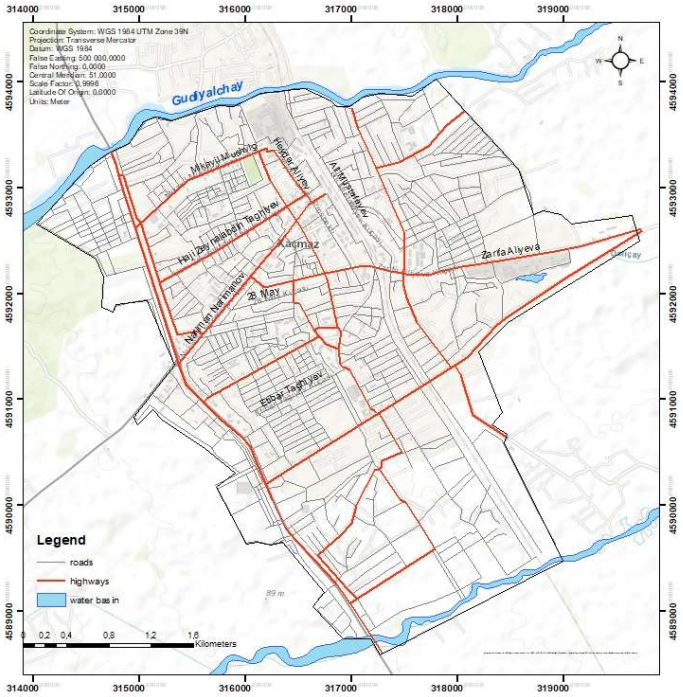


Figure 4. The transport network of Khachmaz city

The city's street and main road network has been developed taking into account the existing layout of connections between existing and prospective construction, new residential districts, and the industrial and surrounding settlements with their production and cultural-domestic facilities. Information on the city's main streets is provided in the table below. There are approximately 80 streets in the city with a total length of 55,754 m (Table 33).

Table 33. Length of streets, m

No.	Street name	Length, m.
1	Ziya Bunyadov Street	**4390**
2	Nariman Narimanov Avenue	**1980**
3	Baku Avenue	**5473**
4	Heydar Aliyev Avenue	**1396**
5	Zeynalabdin Tagiyev	**1620**
6	Atatürk	**4121**
7	28 May	**534**
8	Məmməd Əmin Rəsulzadə	**2800**
9	R. Behbudov	**1200**
10	N. Alasgarov	**403**
11	Suvorov Street	**722**
12	Khurushid Banu Natavan	**124**
13	H. Aslanov	**457**
14	Khagani Street	**822**
15	Gudyalchay	**461**
16	Rasulbayov	**432**

No.	Street name	Length, m.
17	Nesimi	**405**
18	S. Sultanov	**498**
19	Ali Bayramov	**950**
20	Mirza Fatali Akhundov	**390**
21	G. Garayev	**230**
22	I. Qayibov	**135**
23	Shahriyar	**523**
24	Shirazi	**515**
25	V. Seyidov	**515**
26	H.Huseynov	**793**
27	Shirvanshahs	**807**
28	E. Tagiyev	**443**
29	Sara Xatun	**735**
30	Shaykh Shamil	**998**
31	H. Farzaliyev	**718**
32	Sadikov	**1700**
33	Mehmed Hadi	**1448**
34	Chingiz Mustafayev	**406**
35	E. Guliyev	**398**
36	E. Karimizadeh	**422**
37	Aliaga Shikhlinski	**191**
38	Bünyadzade	**319**
39	Javad Khan	**312**
40	Xətai	**416**
41	S.M. Efendiyev	**233**
42	G. Nabi	**227**
43	M.A. Sabir	**554**
44	Youth	**234**
45	Nizami Ganjavi	**503**
46	B.M. Rasulov	**330**
47	Mehdi Huseynzadeh	**903**
48	X. Shukurov	**453**
49	N.Rafibəyli	**409**
50	General Mehmandarov	**458**
51	R.S. Imanverdiyev	**349**
52	Üzeyir Hacıbəyov	**800**
53	Topchubashov	**318**
54	Q.Mammadov	**454**
55	T.Ismayilov	**241**
56	C.Abdullayev	**263**
57	Mushkuri	**175**

No.	Street name	Length, m.
58	Tahirov	**278**
59	Commander	**274**
60	Ali Bayramov	**260**
61	R. Akhundov	**820**
62	Vidadi	**350**
63	S.Əsgərova	**592**
64	F. Raziyev	**742**
65	Koroğlu	**347**
66	1 May	**266**
67	R. Akhundov	**820**
68	Dede Korkut	**385**
69	Atabeks	**641**
70	Musabəyov	**277**
71	S. Bahivzadeh	**197**
72	S. Vurgun	**400**
73	Nizami	**296**
74	Friendship	**218**
75	State Farm	**485**
	Total	**55754**

Source: Compiled based on information received from the city executive representative of the Local Executive Authority

The total length of Khachmaz city's existing street and road network is 55.7 km. Future development of the city's street and road network, improvement of transport conditions for vehicles and pedestrians,...measures to protect the population from traffic noise and the effects of harmful gases, to bring the cross-sections of the streets up to standard, and also to provide comprehensive transport services for the public.

The city's street and road network has been developed with regard to existing and prospective construction, the placement of new residential neighbourhoods, and the existing directions of links to surrounding settlements, industrial and cultural-domestic service areas.

The streets of Khachmaz city are divided into the following classes:

1. City-wide main thoroughfares link the main residential areas with the city centre and other population-attracting districts. The carriageway width of these streets is 15–18 m, and the pavement width is 2–3 m.

2. District-level arterial roads link residential districts with the city's main arterial roads. These roads have a carriageway width of 9-10 m and pavements 1.5-2 m wide.

3. The carriageway width of local streets is 6 m, and the pavement width is 1.5 m.

3.4.2 Operating performance indicators of public transport (bus, minibus)

Currently, 2 passenger routes were operating. One of these has 7 minibuses operating on the route. It currently serves 50% of the city's population. The operating time for buses on the route is 6-8 hours. In addition, taxi services are also widely used for urban public transport. Currently, 95 people are employed in the taxi service in the city. Residential neighbourhoods are connected to the production zone, city-wide centres and sub-centres by passenger transport (bus). Bus stops are located within a walking radius of 500 m.

Parking for private cars is provided through the construction of box-type garages in open spaces within the

neighbourhood. In 2020, three new city-centre bus routes were added to meet the population's demand (Figure 5).

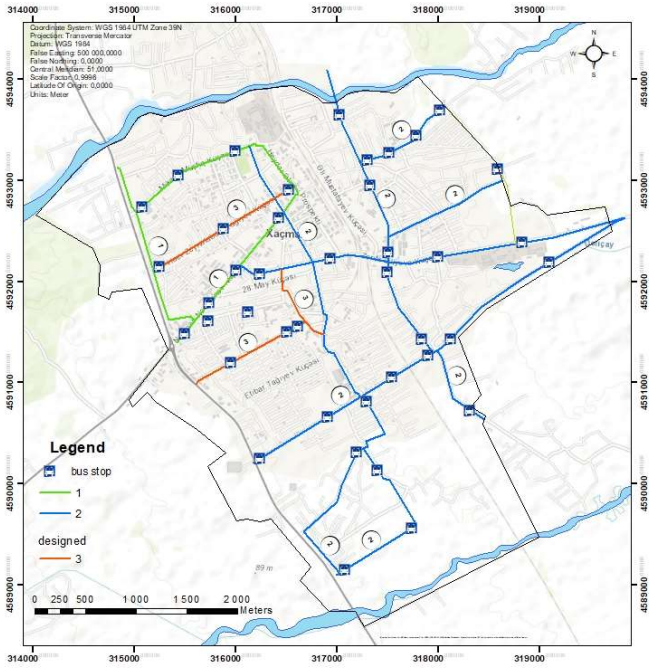


Figure 5. Urban route line

The number of buses on the No. 1 bus route is 12, with a turnover time of 50 minutes, comprising 6 stops and a length of 10 km. It primarily serves the route demand of employees, with a small number of residents using it to access cultural and household service facilities. Based on the information we have gathered in the area, 7 buses are actually operating. Each one uses diesel fuel and consumes an average of 35-40 litres of fuel per day. The route operates from 06:50 to 20:00.

Bus route number 2 consists of 6 stops and is 8 km long. The number of buses is 4, with a circulation time of 44 minutes. Based on the information we have gathered in the area, 3 buses are actually in operation. Each uses diesel fuel and consumes an average of 35-40 litres per day. The route operates from 7:00 to 19:00.

Route 3 (planned) will serve the city's central streets of Nariman Narimanov, Zeynalabdin Tagiyev and, providing access to Baku Avenue. It will serve the population using the cultural and social service facilities located in the centre. The No. 3 bus route consists of 10 stops and has a length of 12 km. The number of buses is 6, with a planned operating cycle of 30 minutes (Table 34).

Table 34. Technical and economic indicators for transport organisations operating in the city

No.	Name of transport organisations	01.01.2015		2020	
		Value of services rendered, thousand manats	Number of employees, people	Value of services rendered, thousand manat	**Number of employees, people**
1	"SAA-Trans" LLC	115.9	9	125.0	**11**
2	"Khachmaz Motor Transport" JSC	26.8	8	35.0	**10**
3	Khachmaz railway station	2053.0	32	2200.0	**35**
Total:		2195.7	49	2360.0	56

Source: Explanation of the City's Master Plan

3.4.3 Number of vehicles (public and private cars)

The total number of registered vehicles in the Khachmaz district is 24,640 (as of 2023). This is the total figure for the entire district (urban and rural areas combined). To calculate the number of vehicles in the city, we have used internationally accepted calculations.

Ratio of district to city population

Population share:

- Total population of Khachmaz district (2023): approximately 175,000 people
- Population of Khachmaz city: approximately 45,000 people

Calculation:

Urban share = 45,000 + 175,000 ≈ 0.25714 (25.7%)

The calculations determined that the number of passenger cars is 3,466, lorries 467, and buses 76 (Table 35).

Table 35. Number of vehicles by type and fuel, units

Type of vehicle	Total number	Petrol	Diesel	Gas	Electric	Hybrid	Plug-in hybrid
Passenger car	3,470	2,943	450	17	1	52	7
Lorry	467	152	308	7	–	–	–
Bus	76	24	51	1	–	–	–

3.5 Street lighting

Lighting systems are already in place on various streets in the city. These streets are particularly located in the business district. The inventory of street lighting covers the city's main arterial roads and important internal streets. Table 36 provides detailed information on the number of lighting fixtures per street, the average distance between poles, the orientation of the road, and the type of lighting used. Based on the current situation, the spacing between street lighting columns on the majority of streets is approximately 25 metres, which is considered a typical planning parameter ensuring continuity of lighting and road safety. The number of lighting fixtures varies according to the length and orientation of the road, with a higher lighting intensity on two-way streets (Figure 6).

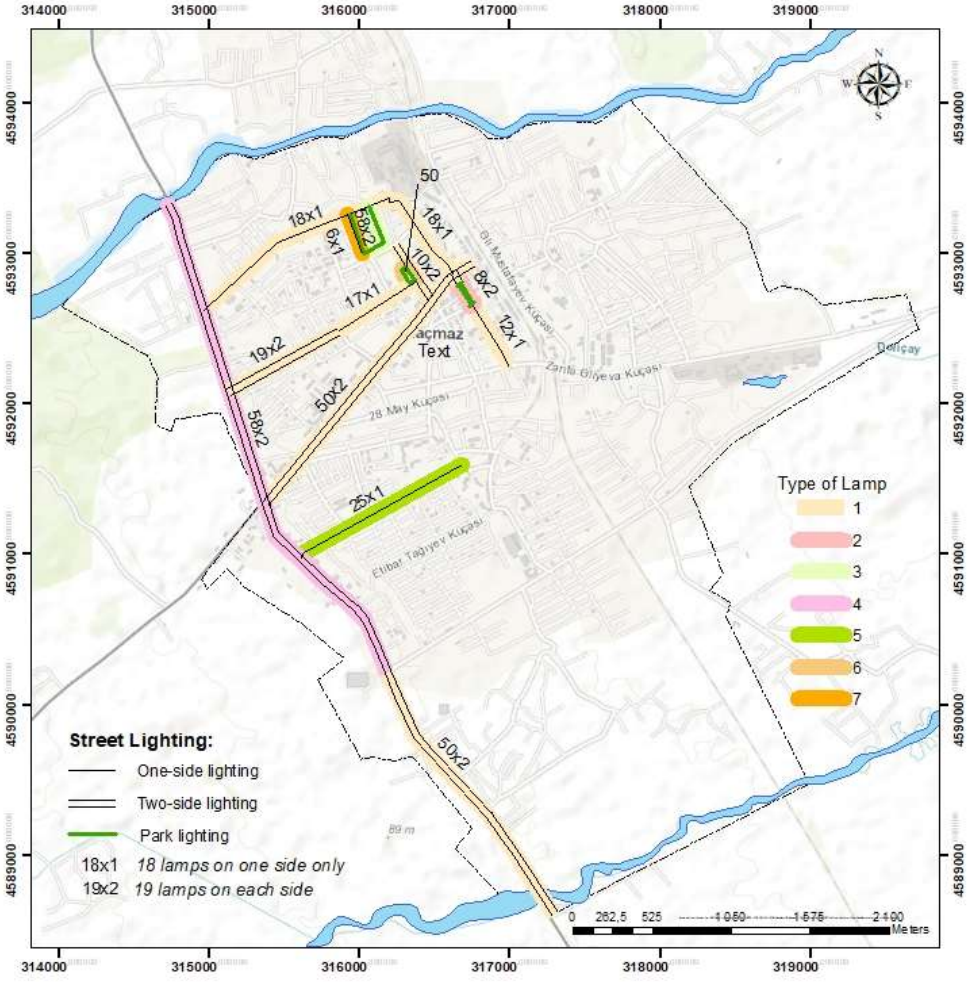


Figure 6. Street lighting system

Table 36. Street lighting

No.	Street name	Number of lights	Distance between lights	Type of lighting	Number of sides
1	N. Narimanov	100	Approximately 25 m		2
2	H.Z. Tagiyev (from Bakı Road to the intersection with Z. Aiyeva Street)	38	Approximately 25 m		2
3	H.Z. Tagiyev (from the intersection with Z. Aiyeva Street to the intersection with H. Aliyev Street)	17	Approximately 25 m		1

4	H. Aliyev (to the intersection with M. Mushvig Street)	19	Approximately 25 m		1
5	H. Aliyev (parallel to the railway line, to the intersection with N. Narimanov Street)	16	Approximately 25 m		1
6	H. Aliyev (parallel to the railway line, from the intersection with N. Narimanov Street to the intersection with Z. Aliyeva Street)	13	Approximately 25 m		1
7	R. Behbudov	25	Approximately 25 m		1
8	Baku Road	116	Approximately 25 m		2

The collected data were compiled based on the technical inventory records of municipal utilities and field observations. These indicators are used as the primary basis for calculating the annual electricity consumption of street lighting and its associated CO_2 emissions within the BEI framework. At the same time, the technological state of the existing lighting systems is of significant importance for assessing opportunities to increase energy efficiency, particularly a transition to LED technology. The results contribute to the prioritisation of energy efficiency measures within the SECAP framework.

The inventory of park lighting has covered the city's main public green spaces. Table 37 provides a detailed breakdown of the number of lighting fixtures per park, the average distance between poles, and the types of lighting installed. Victory Park has a total of 131 lighting fixtures, comprising 60 poles 2.5 m high, 60 light fixtures 1 m high, and 11 poles 2.5 m high with 4 lamps each. In this park, the spacing between lighting fixtures ranges mainly from 10 to 15 metres, which ensures even illumination of the park's large area (Table 37).

Table 37. Park Lighting

No.	Park name	Number of lights	Distance between lights	Type of lighting
1	Victory Park	60 units, height 2.5m; 60 units, height 1m; 11 units with 4 lamps and a height of 2.5m	Approximately 10-15 m	
2	Park of personalities	16	Approximately 15 m	
3	Animal park	50 items	Approximately 8-15 m	

In the personality park, 16 lighting fixtures have been installed, and the average distance between poles is approximately 15 metres. In the animal park, however, the lighting is more intensive, with 50 lighting elements and distances between fixtures ranging from 8 to 15 metres. The collected data serves as a baseline for assessing the electricity consumption and energy efficiency potential of public green spaces within the BEI framework, as well as for ensuring the parks' night-time security. The existing lighting systems have been identified as priority areas for replacement with more efficient technologies in the future.

3.6 The waste sector

3.6.1 Number and condition of landfills

The city has no functional zoning of the territory. This primarily concerns the siting of transport, industrial, warehousing and other facilities. Many of these facilities are located close to or within the residential area and are not separated from it by any sanitary-protection zone. This applies to the Khachmaz Canning Factory, the Caucasus Canning Factory, the brewery, the Khachmaz Power Junction, the Khachmaz Packaging Factory, the oil depot, the railway station, the bus station, etc. (Table 38). The location of these facilities within the residential zone deteriorates the population's living conditions.

Table 38. Classification of industrial enterprises in Khachmaz city by hazard level

No.	Name of the enterprise	Hazard level	Required sanitary protection zone, m
1	Solid household waste landfill	I	**1000**
2	Oil depot	II	**500**
3	Khachmaz Energy Hub	V	**50**
4	"Modern Youth" Brewery	IV	**100**
5	Cemetery	IV	**100**
6	Condensator factory	IV	**100**
7	Bread factory	IV	**100**
8	Bread factory	IV	**100**
9	Coach station	IV	**100**
10	Railway freight yard	IV	**100**
11	Railway station	IV	**100**

No.	Name of the enterprise	Hazard level	Required sanitary protection zone, m
12	Pak-Nur LLC	IV	**100**
13	Hado LLC	IV	**100**
14	Carpet weaving production	V	**50**
15	Cardboard workshop	V	**50**
16	**Warehouse**	**V**	**50**

Source: City's master plan

Currently, neither the railway nor the Baku-Yalama motorway has a sanitary protection zone within the city. In the western part of the city, private residential construction has been built in the immediate vicinity of the road.

The landfill site is located outside of the city boundary, within the Tikhli municipality. By Order No. 48 of the Head of the District Executive Authority dated 30.12.2002, a land plot of 1.0 ha was allocated. The actual area is 4.3 ha. The volume of waste delivered is 55 m³ per day (Figure 7).

The solid domestic waste landfill is located 500 m from the city centre, in an area bordering a residential settlement. The site is not fenced, there is no gate, no warning signs are installed, and there is no control over access. The waste is partially sorted, collected in an unsystematic manner, and is piled up and burnt. The waste is not recycled; it is sorted by local residents.

Figure 7. Waste landfill site in Khachmaz city

To the east of the city, there is a landfill site located outside the city limits but close to the city. This landfill is located very close to the city, and no sanitary protection zone has been considered. Food waste predominates in terms of the volume of waste disposed of (Table 39).

Table 39. Composition of waste, %

Other organic waste (vegetation, livestock, etc.)	11%
Metals	0.8%
Plastic/polyethylene	1.2%

Paper/cardboard	12.5%
Construction and demolition inert waste	10%
Glass	1%
Rubber, leather, textiles, etc.	2.5%
Electronic waste	1.5%
Other	8.5%

Between 2015 and 2017, the amount of waste generated in the country showed a rising trend. In 2015, the volume of waste was approximately 16,000 cubic metres (m^3). The following year, in 2016, this figure reached 18,000 m^3, representing an increase of 2,000 m^3 compared to the previous year. In 2017, the volume of waste increased further to 20,000 m^3. Thus, over the three-year period, the volume of waste increased steadily, with an annual increase of approximately 2,000 m^3. This increase can be attributed to both the population growth and the expansion of industrial and consumer activities.

The city's management of household waste is unsatisfactory. The landfill is operated at a low standard. Household waste collected within the city is transported to a designated site (the landfill). This solid municipal waste landfill site, located in the northern part of Khachmaz and close to residential areas, pollutes the land, groundwater and the atmosphere, thereby negatively affecting public health.

3.6.2 Urban engineering infrastructure

The city's engineering infrastructure provision is at a low level. This primarily concerns the water and sewerage networks. The partial construction of the sewerage system in Khachmaz leads to sewage being discharged into specially dug wells and from there emptied onto designated plots of land, which results in the pollution of soil and groundwater and causes significant damage to the environment. The city has no stormwater drainage (Table 40, Figure 8).

Table 40. Dynamics of water consumption and sewage volume in 2015–2020

No.	Name of the indicator	Unit of measurement	01.01.2015	01.01.2020
1	Water discharge – total,	thousand m^3/day	11.474	**16.677**
	including:			
1.1	drinking water	thousand m^3/day	7.685	**12.579**
1.2	technical	thousand m^3/day	3.789	**4.098**
2	Volume of wastewater – total,		9.554	**14.617**
	including:			
2.1	domestic-sewerage	thousand m^3/day	7.685	**12.579**
2.2	**industrial sewage**	**thousand m^3/day**	**1.869**	**2.038**

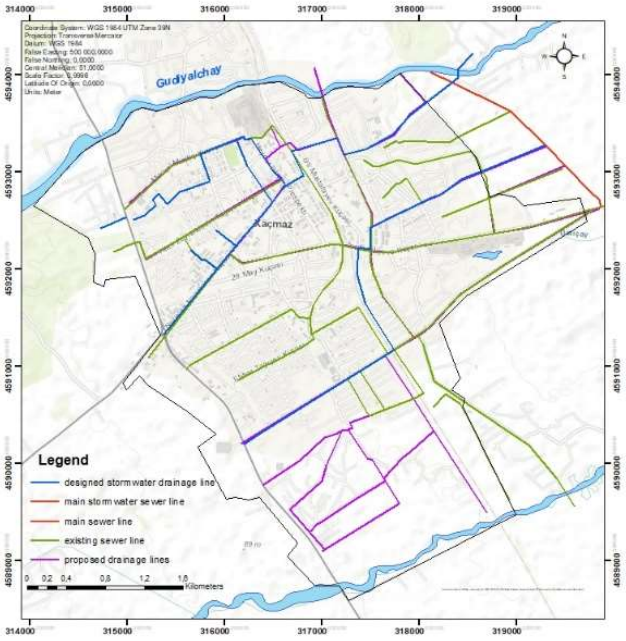


Figure 8. Schematic of the water supply and sewerage (wastewater and stormwater) network of Khachmaz city

In 2015, drainage measures were implemented over an area of 32.4 hectares to lower the groundwater level within the territory's boundaries. Additionally, the length of structures for diverting surface water from the area, including stormwater sewers, amounted to 3 km. By 2020, this work had been expanded, with drainage measures covering 45 hectares and the length of facilities for surface water management reaching 8 km. These indicators show that significant steps have been taken towards improving irrigation and water management systems in the area (Table 41).

Table 41. Dynamics of indicators for engineering preparation, environmental protection and greening of the area for the period 2015–2035

No.	Name of the indicator	Unit of measurement	01.01.2015	01.01.2020	01.01.2035
1	Measures for lowering the groundwater level within the territory's boundaries (drainage)	ha	32.4	45.0	**70.0**
2	**Length of facilities for the diversion of surface water from the area (stormwater drainage)**	**km**	**3.0**	**8.0**	**14.0**

3.7 Energy production and supply

In 2020, the heat loads in the residential and communal sector of Khachmaz city increased compared to previous years. The city's population was 43,750, and its housing stock was approximately 962,500 m². This increase has led to a rise in heat consumption in individual and 1–2 storey communal houses, as well as in buildings of 5 and more storeys.

- Heat consumption in individual and 1–2 storey houses was 114.701 $\times 10^6$ kcal/h in 2020.

- Heat consumption in residential buildings of 5 and more storeys reached 3.405 ×10^6 kcal/h.
- In public buildings, the consumption for heating and ventilation systems was 29.668 ×10^6 kcal/h and 17.801 ×10^6 kcal/h, respectively.
- The maximum hourly consumption for hot water supply was 1.939 ×10^6 kcal/h in 2020.

Overall, in 2020, the annual heat consumption of the residential and communal sector was 100.848 thousand Gcal/year (117.286 thousand MWh/year). These indicators form the primary basis for energy planning and for increasing the efficiency of heating systems, and allow for the identification of priority areas in the city's future climate change adaptation strategies (Table 42).

Table 42. Report on heat loads by periods

Names	2015	2020	2035
Residential sector:			
Population (persons)	40984	43750	**50000**
Housing stock: m²			
(private and communal housing, including 2-storey blocks) total area, m²	721296 + 5842 = 727,138	727,138-189+16,000+153,150 = 896,099	**896,099-3,000+238,350 = 1,131,449**
(3 and 4-storey houses) total area m²	2450 + 4208 = 6658	6658	**6658**
(5-storey and > flats) total area, m²	39188 + 10795 + 7310 = 57293	57293 + 2450 = 59743	**59743 + 102150 = 161893**
Total area: m²	791089	962500	**1300000**
Heat consumption for the heating system of residential buildings: kcal/h			
Individual and 1-2-storey residential buildings, kcal/h	Q_{heat} for 1–2-storey residential buildings = 130.0 × 727,138 = 94.528 × 10^6 kcal/h	Q_{heat} for 1–2-storey residential buildings = 128.0 × 896,099 = 114.701 × 10^6 kcal/h	**Qheat, 1-2 = 128.0 × 1,131,449 = 144.825 × 10^6 kcal/h**
3–4-storey residential buildings, kcal/h	Q_{heat},3–4 = 85.0 × 6,658 = 0.566 × 10^6 kcal/h	Q_{heat},3–4 = 85.0 × 6,658 = 0.566 × 10^6 kcal/h	**Q_{heat},3–4 = 85.0 × 6,658 = 0.566 × 10^6 kcal/h**
Residential buildings of 5 or more storeys, kcal/h	Q_{heat}, 5+ = 57.0 × 57,293 = 3.266 × 10^6 kcal/h	Q_{heat}, 5+ = 57.0 × 59,743 = 3.405 × 10^6 kcal/h	**Q_{heat}, 5+ = 57.0 × 161,893 = 9.228 × 10^6 kcal/h**
Average hourly hot-water demand for residential buildings of 5 or more storeys, kcal/h	Q_{hw}, avg, res, 5+ = 1.2 × 2,969 × 105 × (55 − 5) ÷ 24 = 0.779 × 10^6 kcal/h	Q_{hw}, avg,res,5+ = 1.2 × 3,080 × 105 × (55 − 5) ÷ 24 = 0.808 × 10^6 kcal/h	**Q_{hw}, avg, res,5+ = 1.2 × 7,009 × 105 × (55 − 5) ÷ 24 = 1.840 × 10^6 kcal/h**
Maximum hourly hot water consumption for residential buildings, kcal/h	Q_{hw}, max, res, 5+ = 0.779 × 10^6 × 2.4 = 1.870 × 10^6 kcal/h	Q_{hw}, max, res, 5+ = 0.808 × 10^6 × 2.4 = 1.939 × 10^6 kcal/h	**Q_{hw}, max, res, 5+ = 1.840 × 10^6 × 2.4 = 4.416 × 10^6 kcal/h**

Names	2015	2020	2035
Heat consumption for the heating system of public buildings, kcal/h	Q_{heat}, pub = $98.36 \times 10^6 \times 0.25 = 24.59 \times 10^6$ kcal/h	Q_{heat}, pub = $118.672 \times 10^6 \times 0.25 = 29.668 \times 10^6$ kcal/h	**Q_{heat}, pub = $154.619 \times 10^6 \times 0.25 = 38.655 \times 10^6$ kcal/h**
Heat consumption for the ventilation system of public buildings, kcal/h	Q_{vent}, pub = $24.59 \times 10^6 \times 0.6 = 14.754 \times 10^6$ kcal/h	Q_{vent}, pub = $29.668 \times 10^6 \times 0.6 = 17.801 \times 10^6$ kcal/h	**Q_{vent}, pub = $38.655 \times 10^6 \times 0.6 = 23.193 \times 10^6$ kcal/h**
Average hourly hot water consumption for public buildings, kcal/h	Q_{hw}, avg, pub = $1.2 \times 19{,}959 \times 25 \times (55 - 5) \div 24 = 1.247 \times 10^6$ kcal/h	Q_{hw}, avg, pub = $1.2 \times 21{,}788 \times 25 \times (55 - 5) \div 24 = 1.362 \times 10^6$ kcal/h	**Q_{hw}, avg, pub = $1.2 \times 26{,}000 \times 25 \times (55 - 5) \div 24 = 1.625 \times 10^6$ kcal/h**
Maximum hourly hot water consumption for public buildings, kcal/h	Q_{hw}, max, pub = $1.247 \times 10^6 \times 2.4 = 2.993 \times 10^6$ kcal/h	Q_{hw}, max, pub = $1.362 \times 10^6 \times 2.4 = 3.269 \times 10^6$ kcal/h	**Q_{hw}, max, pub = $1.625 \times 10^6 \times 2.4 = 3.900 \times 10^6$ kcal/h**
Heat supply to individual and 1–2-storey residential buildings, Gcal/h (communal sector)	94.528	114.701	**144.825**
Centralised heat supply to residential buildings of 3 or more storeys and public buildings, Gcal/h (MW)	48.039 (55.869)	56.648 (65.882)	**79.958 (92.991)**
Residential - communal sector annual heat consumption:			
Thousand Gcal/year for heating of private residential and 1–2-storey (communal sector) houses	179.610	217.942	**275.177**
For heating of residential buildings of 3-5 and > storeys, thousand Gcal/year	7.280	7.544	**18.607**
For hot water supply for houses of 5 and > storeys, thousand Gcal/year	5.164	5.356	**12.197**
Heating of public buildings, thousand Gcal/year	46.722	56.372	**73.449**
For ventilation of public buildings, thousand Gcal/year	18.690	22.548	**29.378**

Names	2015	2020	2035
For hot water supply of public buildings, thousand Gcal/yr	8.266	9.028	**10.772**
Total: thousand Gcal/yr (thousand MWh/yr)	**86.122 (100.160)**	**100.848 (117.286)**	144.**403** (167.941)

3.7.1 Electricity supply system

The city's engineering infrastructure is at a low level. The city receives its electricity from the 110/35/10 kV substation (Table 43). Since its commissioning, the Khachmaz Power Plant has generated a total of 5.4 billion kilowatt-hours of electricity. The modular Khachmaz Power Plant was commissioned on 7 December 2006. The station has a total installed capacity of 87 megawatts, comprising 10 gas-piston units of 8.7 megawatts each. The Khachmaz Power Station is located to the south of the city. The facility is engaged in the generation and distribution of electricity.

Table 43. Energy consumption indicators for engineering and communications infrastructure for 2015–2035

No.	Name of indicator	Unit of measurement	01.01.2015	01.01.2020	01.01.2035
1	Electricity consumption	kWh/year	15858	18017	**24892**
2	Heat energy consumption	MWt/year	100160	117286	**167941**
3	**Natural gas consumption**	**thousand m³/year**	**41657.702**	**49425.968**	**64785.256**

3.7.2 Heat supply

The city has no centralised heating supply. Individual boilers are not equipped with gas and flue-gas treatment systems, which results in the release of sulphide gas, hydrogen sulphide, smoke, carbon monoxide, etc. into the air. The increase in the motor fleet also affects air quality.

Carbon monoxide, nitrogen oxides, lead compounds, hydrocarbons, smoke and dichlorethane vapours poison the environment. The aforementioned substances affect the physical and chemical structure of the atmosphere. Nevertheless, the air quality is not hazardous to human life.

It has been established that urban and industrial noise has a negative effect on human health. Noise exceeding 75 dB causes changes in a person's physiological state. The main sources of noise in the city are transport, industrial enterprises, the communal and household sector, and also construction organisations.

Currently, there is no centralised heating system in the city of Khachmaz (according to information from Azəristiliktəchizat JSC).

Private residential houses are heated by gas-fired "Combi" units. According to "Azəristiliktəchizat" JSC, the heating for some residential and public buildings in Khachmaz city is provided by local boilers (Table 44) .

Table 44. Name of the buildings supplied with heat

No.	Name of the buildings supplied with heat.	Type of boilers and productivity.	Location of the boilers address.	Current situation.
1	Executive Authority, music school, cultural centre. Boiler room No. 27/2.	Q=0.70 Gcal/h	M.E. Räsulzadeh Street.	**Operational (gas fuel)**
2	Second Secondary School. Boiler Room No. 27/4.	--	M.E. Räsulzade Street	**Not in service (conservation)**
3	Conserve Plant, Boiler Room No. 27/5	--	A. Mammadov St.	**Not in operation (canning)**
4	Khachmaz Vocational School No. 92. No. 27/6 boiler room.	--	N. Narimanov St.	**Not in operation (conservation)**
5	Boiler room No. 27/9.	--	H. Aliyev St.	**Out of service (conservation)**
6	Home for the disabled. Boiler room No. 27/16.	Q=0.12 Gcal/h	N. Narimanov St.	**Operational (gas fuel)**
7	Home for the disabled. Boiler house No. 27/16.	Q=0.40 Gcal/h	Baku Avenue.	**Operational (gas fuel)**
8	Secondary School No. 1. Boiler room No. 27-M34/1.	Q=0.20 Gcal/h	Z. Tagiyev St. 9	**Operational. (diesel fuel)**
9	Secondary School No. 3. Boiler house No. 27-M7/3.	Q=0.50 Gcal/h	H. Aliyev St. 38a	**Operational. (diesel fuel)**
10	**Olympic Sports Complex.**	**Q=2.10 Gcal/h**	**Baku Prospect**	**Operational. (gas fuel)**

Source: Prepared on the basis of information from Azəristiliktəchizat JSC

According to information from Khachmaz District Heating Service, the existing boilers run on gas and diesel fuel. In accordance with the action plan of the "State Programme for the Socio-Economic Development of the Regions of the Republic of Azerbaijan", adopted in various years, the main task is to ensure the heating of residential houses and buildings, educational and healthcare institutions, and other social facilities in the city of Khachmaz. Industrial facilities are supplied with heat from their own independent heat sources.

3.8 Renewable energy potential

a. Wind energy

In the area under study, westerly and north-westerly winds predominate. Specifically, westerly winds account for 29% of the year, while north-westerly winds account for 22% of the year. The frequency of easterly and southerly winds accounts for 11% and 6% of the year, respectively. The average annual wind speed in the city is 2.3 m/s.

In the spring and summer months, the average annual wind speed increases to 2.4-2.5 m/s, whereas in the autumn and winter months it decreases to 2.0-2.1 m/s. The average monthly and annual wind speeds in the city are given in the following table (Table 45).

Table 45. Average monthly and annual wind speed

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Average speed, m/s	**2.1**	**2.3**	**2.4**	**2.5**	**2.4**	**2.5**	**2.3**	**2.4**	**2.3**	**2.1**	**2.0**	**2.0**	**2.3**

Source: Compiled based on data from the Khachmaz district meteorological station.

Strong winds are very rarely observed in the city. For instance, winds with a speed of 15 m/s are observed for 13 days a year. In the colder months of the year, the city experiences dry foehn winds, whilst in the warmer months, it experiences karaels, which are dry and hot winds. This leads to an increase in temperature and a decrease in relative humidity (Table 46).

Table 46. Wind speed

Wind	Maximum	Average	Minimum
Constant wind	23.0kmh (14.29mph)	12.5kmh (7.77mph)	6.0kmh (3.73mph)
Occasionally observed	39.0kmh (24.23mph)	20.2 km/h (12.55 mph)	10.0kmh (6.21mph)

b. Solar energy

Currently, there are no CSP plants operating in the city. However, there is potential for this. To determine this potential, maps of the area's topography and solar radiation have been prepared (Figure 9).

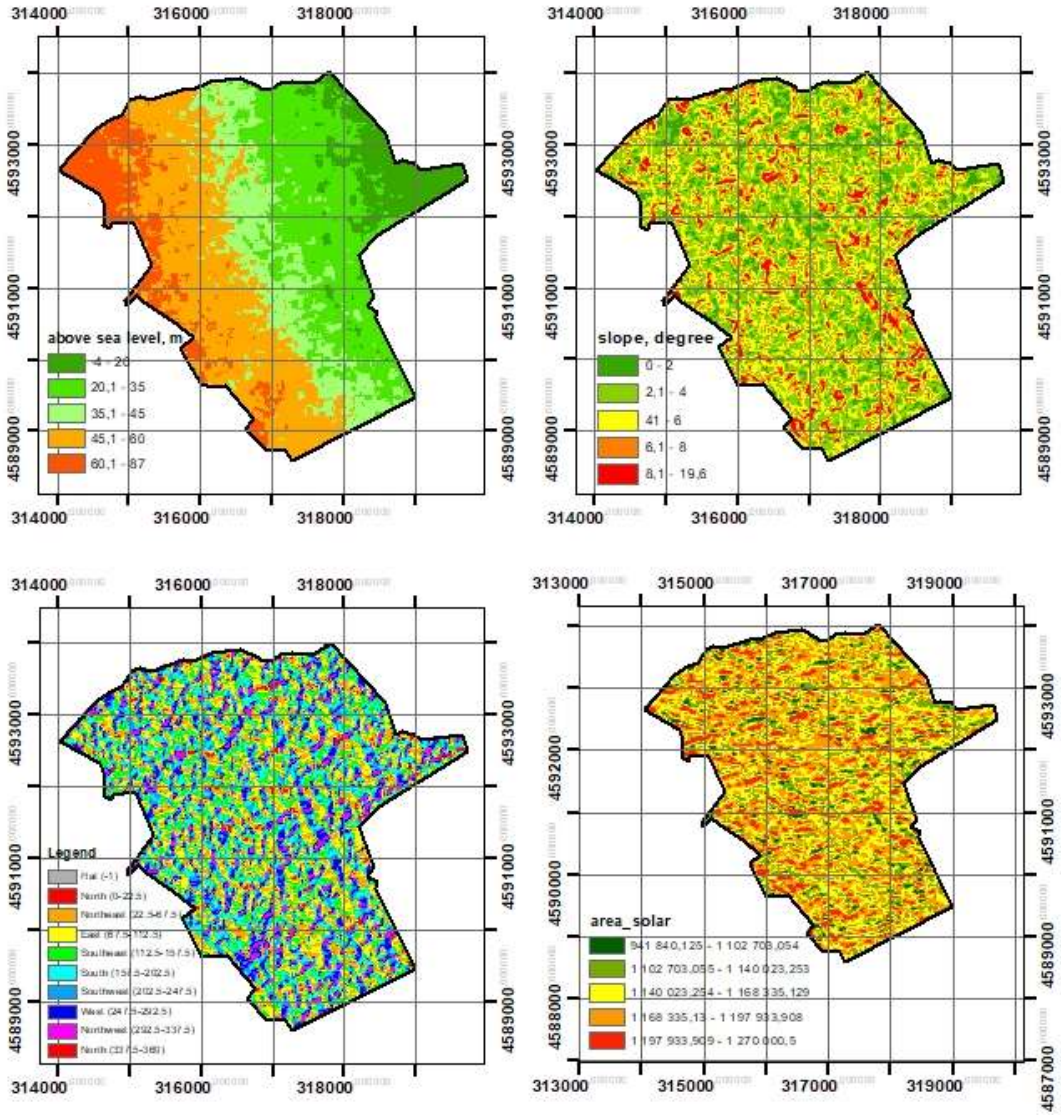


Figure 9. Terrain elevation, slope, aspect and solar radiation

c. Hydropower stations

There are no hydroelectric power stations in the city of Khachmaz. The study area is represented hydrographically by the Gudyalchay. The Gudyalchay River originates in the Greater Caucasus mountains near the Salavat pass, at an altitude of 3000 m, and flows into the Caspian Sea.

The total length of the river is 101 km, of which 56 km is upstream of the city of Quba and 87 km is upstream of the city of Khachmaz. The river's catchment area is 799 km². The average elevation of the catchment area is 1,820 m and its average slope is 28%. The river's average gradient is 85.7% in its upper course and 2.5% in its lower course. Due to its water-regime characteristics, the Gudyalchay belongs to the group of rivers with spring-summer floods.

d. Bioenergy

Bioenergy is not used in the city of Khachmaz.

3.9 Land use and green spaces (parks, forest belts, etc.)

3.9.1 Total area of parks and green spaces. Share of urban greenery

Despite the favourable conditions in the district, the city of Khachmaz currently lacks public green spaces. The state of street greenery is generally not subject to any particular system.

The surrounding areas are very poorly landscaped. These mainly consist of fruit trees and ornamental plants. Overall, the city's green cover does not meet modern standards. There are 6 cultural and recreational parks in the city. The characteristics of these parks are given in the table below (Figure 10).

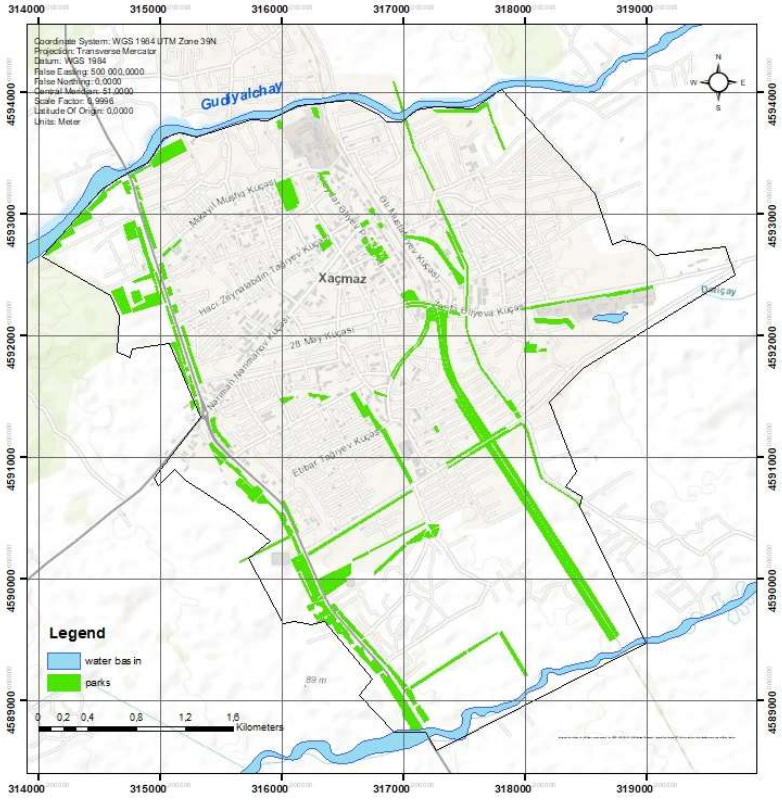


Figure 10. The city's green spaces

The existing green space system, covering an area of 7.1 ha, does not meet the needs of a city with a population of 45,000. Taking into account the climatic conditions (a hot, dry summer), the city area should be greened to the maximum extent.

The city's six existing parks have a total area of 16.9 ha. These parks have been comprehensively renovated and landscaped. In addition to these parks, the city also has numerous small gardens and avenues.

The master plan envisages increasing the total area of public green spaces to 35 ha by 2035, which amounts to approximately 7 m^2 per person. The greening initiative influences the city's planning structure and its future architectural appearance (Table 47).

Table 47. Characteristics of the city's parks

No.	Name	Address	Area, ha
1	Fountains Park	M.A.Ras Street, 12	**1.8**
2	"Çənlibel" park	Baku Avenue	**5.0**
3	H. Aliyev Promenade	Baku Avenue	**5.0**
4	"Personalities" Park	H. Aliyev Street	**1.0**
5	H. Aliyev Park	N. Narimanov Street	**2.1**
6	Flags Square	Baku Avenue	**2.0**
	Total:		16.9

Source: Compiled based on the explanation of the city's master plan

The green space ratio for the main functional zones is distributed as follows.

- *In residential areas – 55-60%*
- *In the industrial zone – 20%.*

In the future, the city's planned park will allocate over 70% of its total area to greenery, up to 25% to squares, roads and avenues, and up to 10% to the areas of buildings and structures.

Green plants play a major role in the landscaping of sanitary and anti-noise protection zones. In the sanitary protection zones of industrial facilities, the width of green plantings should not be less than 50-100 m. Evergreen species should be used here. Wide green belts are established to protect against street noise, dust and toxic car exhaust fumes. To this end, it is recommended to use trees and shrubs of various sizes along the sides of roads (Table 48).

Table 48. Recommended tree species for roadside planting

No.	Tree size	Tree species
1	Large trees over 20 m in height	common elm, boxelder, Canadian sycamore, maple-leaved sycamore
2	Secondary trees, 10-20 m in height	Wild cherry, Horse chestnut, Oriental plane
3	Tertiary trees, 5-10 m tall	Tatar linden, Common bird cherry
4	Four trees of class, with a height of 2-5 m	Pine, Western yew, Hawthorn
5	Tall shrubs, 4-9 m in height	Acacia, Larch, Dogwood, Lilac
6	Medium-sized shrubs, 1-3 m tall	Common elder, Lemoine lilac, Blackcurrant

4. Preparation of baseline emission inventories (BEI)

4.1 Purpose and scope

4.1.1 Purpose of the BEI

Baseline Emission Inventory (Baseline Emission Inventory – BEI) is one of the documents that forms the basis of the city's climate policy, and its purpose is to determine the quantity of greenhouse gas (GHG) emissions, to assess the sectoral breakdown, and to establish baseline figures for the calculation of future emission reduction targets.

The BEI for Khachmaz city is being prepared under the European Covenant of Mayors (CoM) and provides the scientific basis for planning climate change measures at the local level. This inventory provides a systematic assessment of the city's energy balance and emission sources.

The main objectives of the BEI are as follows:

- To determine the breakdown of greenhouse gas emissions across the city by sector (buildings, transport, street lighting, waste, etc.);
- To analyse the main sources of energy consumption and emissions;
- To identify priority areas and potential measures for future emissions reduction;
- To establish baseline indicators for the development of the 'Sustainable Energy and Climate Action Plan' (SECAP) for Khachmaz City;
- To meet the CoM standards in accordance with the principles of emissions monitoring, reporting, and transparency.

This document also aims to enhance the city's climate resilience, improve energy efficiency, and support the 'green transition' of the local economy. The BEI results will serve as a reference point for the development of emission reduction measures and adaptation plans in the coming years.

4.1.2 Scope of the report

This BEI report covers the administrative area of Khachmaz city and considers activities within the remit of local government (municipal services, public services, transport, buildings, etc.).

The main sectors included in the scope are:

- The Buildings sector: energy consumption in residential, commercial and public buildings (electricity, natural gas);
- Transport sector: emissions from urban vehicles (petrol, diesel and other fuels);
- Street lighting: electricity consumption for which the municipality is responsible;
- Waste sector: management of solid household waste and methane emissions from landfills.

The geographical boundary of the BEI is limited to the administrative limits of Khachmaz city and does not include the rural administrative areas of the district. This approach is in line with the 'administrative boundaries-based inventory' principle recommended in the CoM guidance.

The scope was selected taking into account both the availability of data and the actual regulatory powers of local government. Consequently, the BEI covers only the CO_2 and other greenhouse gas emissions (CH_4-methane, N_2O-nitrous oxide, etc.) resulting from the city's direct and indirect energy consumption.

4.1.3 Base year (2023)

The base year for this inventory has been selected as 2023. The selection is based on the following criteria:

- Availability and reliability of energy and emissions data for 2023;

- The availability of data from local and national statistical sources (energy companies, AzerEnergy, Azerigaz, municipal structures);
- 2023 reflects the city's normal operating conditions (absence of a pandemic or exceptional economic changes).

The base year serves as the starting point for future emissions comparisons. In other words, the reduction targets to be set for 2030 will be based on the figures from this base year.

The report has compiled the actual 2023 consumption data for all energy types, applied the corresponding emission factors, and the results are expressed in tonnes of CO_2 equivalent (tCO_2e).

4.1.4 Key reference documents and methodological basis

This BEI document has been prepared in reference to the following international and national methodological bases:

1. Covenant of Mayors (CoM) Reporting Guidelines (2025)
    - A key methodological document for preparing emission inventories for municipalities;
    - Provides standard approaches for data collection by sector, unit conversions and emission calculations.
2. IPCC 2006 Guidelines for National Greenhouse Gas Inventories
    - Provides the scientific basis for greenhouse gas calculations across the energy, transport, waste and other sectors;
    - Emission factors and conversion factors have been selected based on the guidelines in this document.
3. The National Communications and National Emission Inventories of the Republic of Azerbaijan
    - The national emission factors and methodological adjustments applied by sector at the national level have been taken from these documents.

All calculations are based on the principles of transparency, replication and consistency.

4.2 Methodology

The primary objective of the Initial Emission Inventory phase is to calculate greenhouse gas (GHG) emissions for the city of Khachmaz with an accurate, transparent, and reproducible methodology. To this end, the CoM 2025, the IPCC (2006) methodology, and the relevant national reports of the Republic of Azerbaijan have been taken as a basis.

The methodology covers the following stages:

1. Identification and collection of data sources
2. Processing and categorisation of activity data
3. Selection and adaptation of emission factors
4. Emission calculations
5. Quality Assurance (QA/QC) and data validation

4.2.1 Data sources

For the emissions inventory of Khachmaz city, data were collected from various sources at both local and national levels. The reliability, consistency, and availability of the data were assessed. The main sources are as follows:

a) Municipal and local executive authority structures

- Street lighting systems for the city (electricity consumption)

- Energy consumption of municipally-owned public buildings
- Data from municipal utilities and administrative buildings

b) Energy supply companies

- Azerishiq JSC – electricity consumption in Khachmaz city (by buildings, street lighting and industrial sectors)
- Azerigaz Production Union – natural gas consumption in residential and public buildings (annual volumes in m^3)
- Fuel retail outlets – estimation of data for the transport sector based on diesel and petrol sales volumes

c) State Statistics Committee and other open data sources

- Population, building categories and number of vehicles for the city of Khachmaz
- Annual volume of solid household waste (in tonnes)

d) Additional sources

- Ministry of Ecology and Natural Resources (data on waste management and CH_4 emissions)
- Local waste management operator
- Field observations and local expert assessments collected within the framework of the project

The collected data cover the annual figures for 2023 and, where possible, have been verified with actual consumption invoices.

4.2.2 Calculation approach

The calculation process is based on the activity data × emission factor principle. That is, for each sector, the energy consumption or activity volume (e.g., MWh, m^3, tonnes, etc.) is determined and multiplied by the corresponding emission factor to calculate the greenhouse gas emissions.

The basic calculations are carried out according to the following formula:

$$E_{CO2e} = A \times EF$$

where:

- E_{CO_2e}– the volume of emissions, in tonnes of CO_2 equivalent (tCO_2e);
- A – activity data (e.g., electricity consumption, m^3 of gas, tonnes of fuel);
- EF – emission factor (tCO_2e / unit of activity).

This approach is accepted in both the CoM and IPCC methodologies for simple, yet robust, calculations at Tier 1 level.

4.2.3 Collection of activity data

The activity data for Khachmaz city covers four main sectors. These include buildings, transport, street lighting, and waste (Table 49).

Table 49. Activity data sector for Khachmaz city

Sector	Key performance indicators	Source of data
Buildings (residential and public)	Electricity (MWh), natural gas (m^3)	Azerishiq, Azerigaz, municipalities
Transport	Diesel and petrol consumption (tonnes or litres)	Fuel stations, DSMF, local transport statistics
Street lighting	Electricity consumption (MWh)	Municipality and Azerishiq
Waste	Quantity of waste collected (tonnes), landfill data	Municipality and MENR

Wherever possible, actual consumption data is preferred during data collection. However, in some cases, for example in the transport sector, estimates are made using indirect methods (e.g. based on the number of vehicles).

4.2.4 Selection of emission factors

Emission factors are based on the international standards indicated in the CoM and IPCC 2006 guidance, but national adjustments for Azerbaijan are applied where possible.

The table below shows the representative factors used for the city of Khachmaz (Table 50).

Table 50. Greenhouse gas emission factors by fuel type and energy source

Fuel type / energy source	Unit of measurement	Emission factor (tCO_2e/ **MWh**)	Source
Electricity	MWh	0.597	CoM / IPCC 2006 (Azerbaijan average)
Natural gas	MWh	0.202	IPCC, 2006; based on local conversion
Diesel	MWh	0.267	IPCC
Petrol	MWh	0.249	IPCC
Household waste	MWh	0.5	Based on the CoM / simplified CH_4 model

Should the national emission factors for Azerbaijan be officially updated in the future, these figures will be adjusted accordingly in subsequent versions of the BEI.

4.2.5 Methodology for emissions calculation (with formulas)

Emissions have been calculated based on the following simple formulas:

(a) For the buildings sector:

$$E_{buildings} = (\text{Electricity consumption, MWh} \times 0.597) + (\text{Natural gas consumption, MWh} \times 0.202)$$

(b) For the transport sector:

$$E_{transport} = (\text{Diesel consumption, MWh} \times 0.267) + (\text{Petrol consumption, MWh} \times 0.249)$$

(c) For street lighting:

$$E_{lighting} = Elec_{MWh} \times 0.597$$

(d) For the waste sector:

$$E_{waste} = \text{Waste}_{\text{tonnes}} \times 0.5$$

The resulting emissions calculated for all sectors are then aggregated to obtain the total greenhouse gas emission for Khachmaz city (in tCO_2e).

4.2.6 Quality assurance and quality control (QA/QC process)

Data quality control is a key stage in ensuring the reliability of the BEI. To this end, the following steps have been implemented:

1. Internal check:

   The activity data entered for each sector were cross-checked with source documents (invoices, reports, energy balances).

2. Verification of discrepancies:

   Consumption figures for electricity and gas were compared with previous years to identify any discrepancies.

3. Cross-checking:

   For example, electricity consumption for street lighting was checked for consistency between data from Azerishiq and municipal records.

4. Repeatability and transparency:

   All calculations are stored in open spreadsheets and can be recalculated in subsequent years using the same methodology.

4.3 Sectoral emission calculations

The emissions inventory for Khachmaz city covers four main sectors: buildings, transport, street lighting, and waste. Activity data for each sector were collected, appropriate emission factors were applied, and annual emissions in tCO_2 equivalent were calculated.

4.3.1 Buildings sector (residential and public)

Activity data

The buildings sector uses electricity and natural gas as fuels.

Data sources:

- Data obtained from the municipality
- Electricity: 2023 invoices provided by Azerishiq JSC;
- Natural gas: Annual consumption data from Azerigaz Production Union;

Emission calculation

Emission factors have been selected based on IPCC and CoM standards. Emissions for the buildings sector are calculated as follows:

$$E_{building} = (Elec_{MWh} \times 0.5970) + (\text{Gas consumption (MWh)} \times 0.202)$$

The quantities of electricity and gas consumed from 2015 to 2024 are shown in the table (Table 51).

Table 51. Statistical data on energy and gas consumption

consumption	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Gas consumed by the population (million cubic metres)	25	27	25	23	23	24	25	23	20	22
electricity consumption by the population (million kWh)	12	13	13	13	15	17	19	15	12	14

Between 2015 and 2024, total CO_2 emissions varied between 50 and 66 thousand tonnes. Natural gas accounts for the main share of these emissions, while emissions from electricity generation, being relatively low, exhibit a variable trend (Figure 11-13).

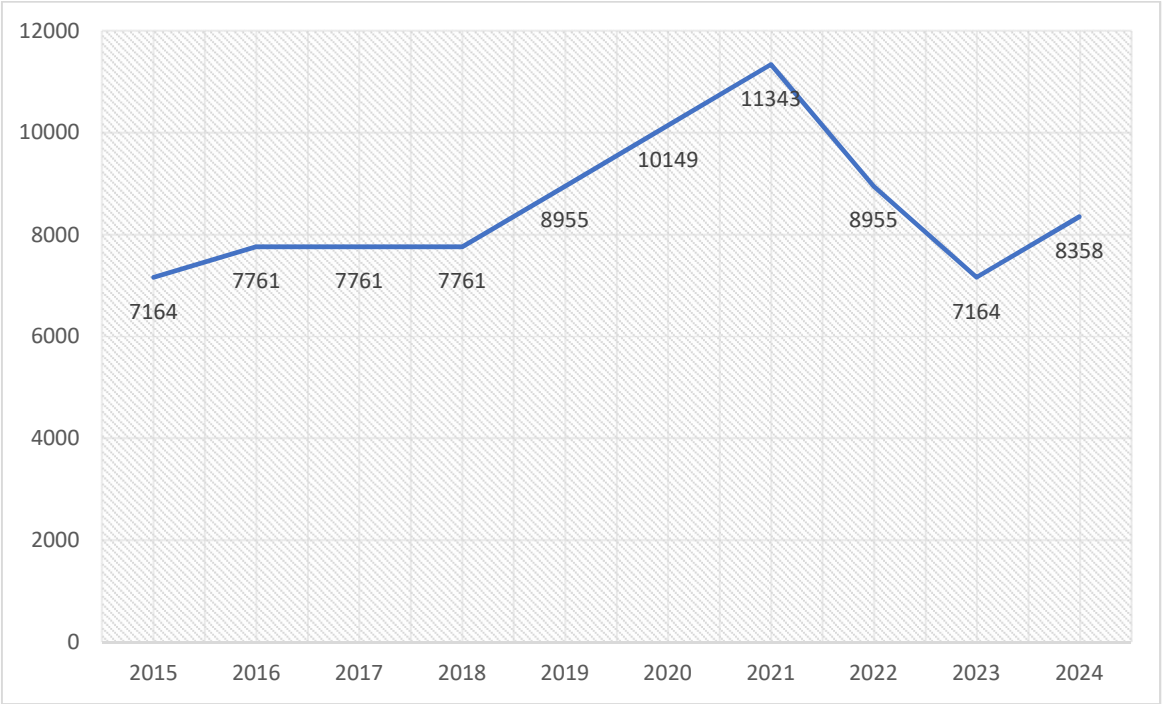


Figure 11. Dynamics of the statistical indicators of emissions from energy consumption (tonnes of CO_2)

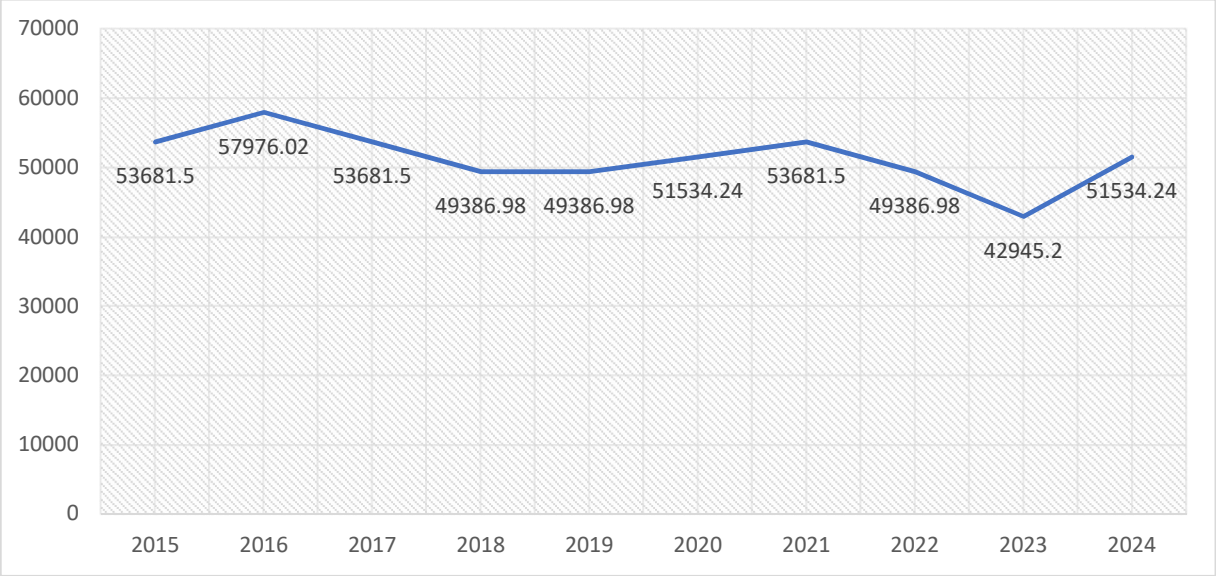


Figure 12. Dynamics of the statistical indicators of gas consumption emissions (tonnes of CO_2)

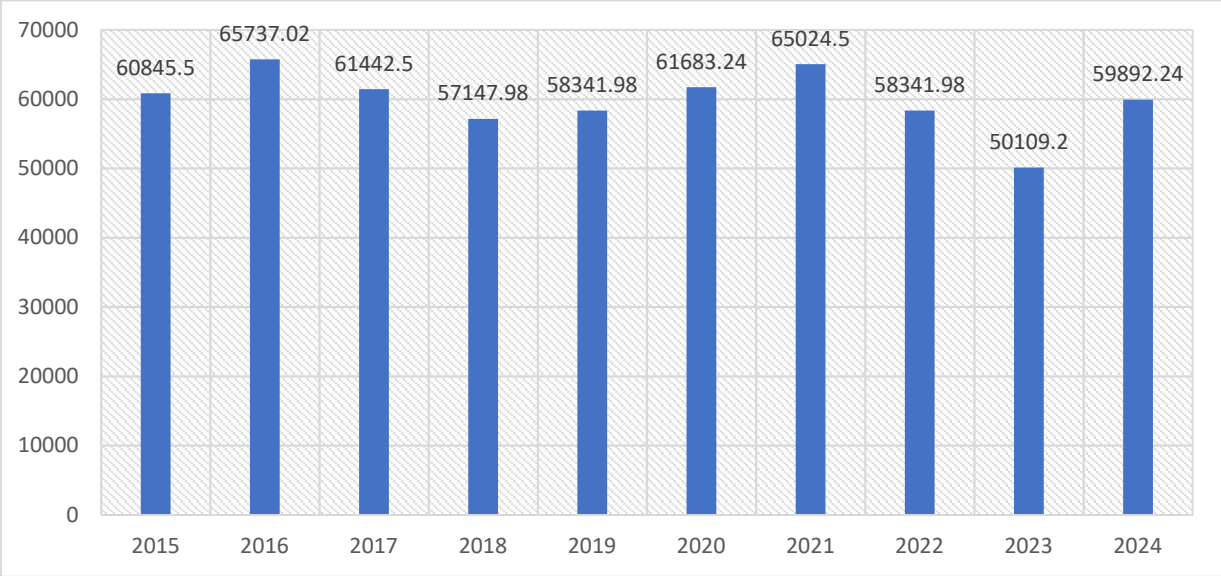


Figure 13. Dynamics of the statistical indicators of emissions from total energy and gas consumption (tonnes of CO_2)

2015–2016

In 2015, the total emissions amounted to 60,845.5 tonnes of CO_2. Of this, 7,164 tonnes were from electricity and 53,681.5 tonnes from natural gas.

In 2016, an increase was observed in emissions from both electricity (7,761 tonnes) and natural gas (57,976.02 tonnes), resulting in a total emission of 65,737.02 tonnes of CO_2. This period can be considered one of the first peak phases in terms of emissions.

2017–2018 years

In 2017, electricity emissions remained stable at 7,761 tonnes, while gas emissions were 53,681.5 tonnes. The total emissions amounted to 61,442.5 tonnes.

In 2018, there was a significant decrease in gas emissions (to 49,386.98 tonnes), while electricity emissions remained unchanged. As a result, total emissions fell to 57,147.98 tonnes of CO_2. This phase can be characterised as a period of relative emissions reduction.

2019–2020 years

In 2019, electricity emissions increased to 8,955 tonnes, while gas emissions remained at 2018 levels. The total emissions were 58,341.98 tonnes.

In 2020, the increase in electricity emissions continued, reaching 10,149 tonnes, while gas emissions stood at 51,534.24 tonnes. The total emissions for the year were 61,683.24 tonnes of CO_2. The increase in the share of electricity has led to a change in the composition of total emissions.

2021 – the peak phase

In 2021, electricity emissions reached the highest level of the entire period at 11,343 tonnes. Gas emissions, meanwhile, rose again to 53,681.5 tonnes. As a result, the total emissions amounted to 65,024.5 tonnes of CO_2, which is the maximum total emissions level shown in the table.

2022–2023 years

In 2022, a decrease was observed in both electricity (8,955 tonnes) and gas emissions (49,386.98 tonnes), and the total emissions amounted to 58,341.98 tonnes.

In 2023, emissions fell to a minimum for the period: electricity emissions of 7,164 tonnes, gas emissions of 42,945.2 tonnes, and total emissions of 50,109.2 tonnes of CO_2. This reduction can be attributed to a change in energy consumption or in the structure of energy sources.

2024

In 2024, electricity-related emissions amounted to 8,358 tCO_2e, while natural-gas-related emissions were approximately 47,239.72 tCO_2e. Total emissions were therefore approximately 55,597.72 tCO_2e.

Analysis of emissions in the buildings sector (Table 52):

Electricity consumption – 11,730 MWh,

resulting in emissions of 7,002.81 tonnes of CO_2 equivalent.

Natural gas consumption – 215,194 MWh,

resulting in an emission of 43,469.19 tonnes of CO_2 equivalent.

Thus, the majority of the total emissions (approximately 86%) are attributable to natural gas, while the emissions share of electricity is considerably lower.

Table 52. Emissions from various buildings (base year 2023)

Sectors	Electricity			Natural gas		
	(MWh) MWh	CO_2eq (tonnes)	%	(MWh·hour) MWh	CO_2eq (tonnes)	%
Municipal buildings	10	5.97	0.1	43.04	8.69408	0.02
Residential buildings	3480	2077.56	29.7	165,613.30	33,453.8866	76.96
Service sector buildings, facilities and installations	3840	2,292.48	32.7	45,492.01	9,189.38602	21.14
Industrial buildings	3960	2,364.12	33.8	1,011.41	204.30482	0.47
Other buildings	440	262,68	3.8	3,034.24	612.91648	1.41
Total	**11,730**	**7,002.81**	**100.0**	**215,194**	**43,469.188**	**100**

Municipal buildings

Electricity consumption in the municipal buildings amounts to 10 MWh, which results in emissions of 5.97 tonnes of CO_2 equivalent. This represents a share of just 0.1% of total electricity emissions.

Natural gas consumption is 43.04 MWh, with emissions of 8.69 tonnes of CO_2 equivalent, accounting for 0.02% of total gas emissions. The role of this sector in the overall emissions balance is very small.

Residential buildings

The highest emissions burden falls on residential buildings.

Consumption of electricity is 3,480 MWh, with emissions of 2,077.56 tonnes of CO_2 equivalent, accounting for 29.7% of total electricity emissions.

Natural gas consumption was 165,613.3 MWh, with emissions of 33,453.89 tonnes of CO_2 equivalent, accounting for 76.96% of total gas emissions. These figures indicate that the residential sector is the main source of emissions, particularly due to its use of gas for heating.

Service sector buildings, facilities and installations

In this sector, electricity consumption is 3,840 MWh, with emissions of 2,292.48 tonnes of CO_2 equivalent, which represents 32.7% of total electricity emissions.

Natural gas consumption was 45,492.01 MWh, with emissions of 9,189.39 tonnes of CO_2 equivalent, accounting for 21.14% of total gas emissions. The service sector is the second-largest source of emissions for both electricity and gas.

Industrial buildings

In industrial buildings, electricity consumption is 3,960 MWh, generating 2,364.12 tonnes of CO_2 equivalent emissions, and holds the highest share in electricity emissions at 33.8%.

In contrast, natural gas consumption was only 1,011.41 MWh, with emissions of 204.30 tonnes of CO_2 equivalent, accounting for 0.47% of total gas emissions. This indicates the dominant role of electricity in energy supply for industrial buildings.

Other buildings

For other buildings, electricity consumption was 440 MWh, with emissions of 262.68 tonnes of CO_2 equivalent (3.8%).

Natural gas consumption was 3,034.24 MWh, with emissions of 612.92 tonnes of CO_2 equivalent, representing 1.41% of total gas emissions. The sector's share in the total emissions balance is relatively low.

The largest share of electricity emissions is attributed to service sector buildings, facilities, and residential buildings, accounting for 32.7% and 29.7% respectively (Figures 14-15).

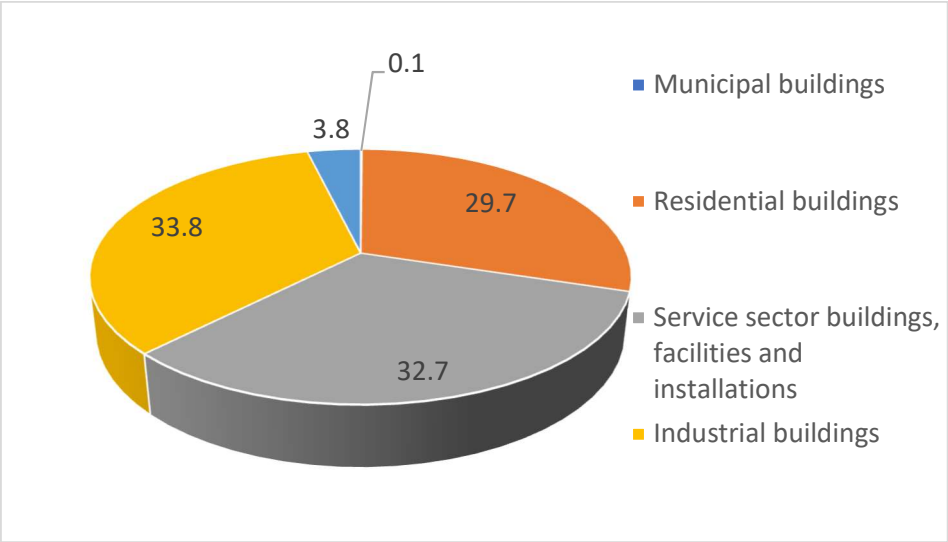


Figure 14. Emissions from energy consumed by different buildings, %

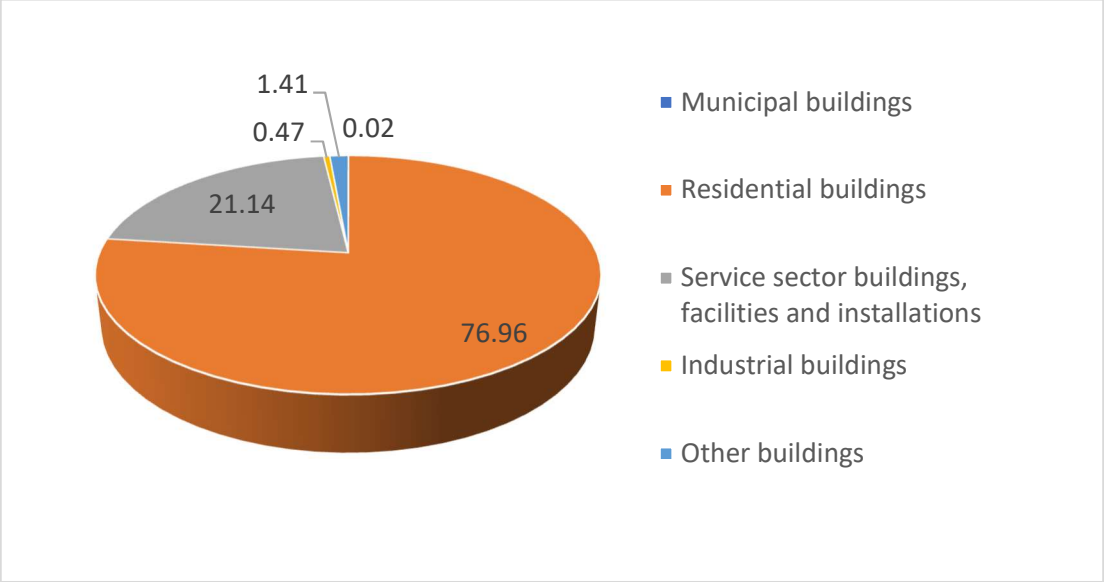


Figure 15. Emissions from gas consumed by different buildings, %

The total emissions in the buildings sector amount to 50,472 tCO_2e.

Analysis

The buildings sector is the largest source of emissions in the city of Khachmaz. The use of electricity and natural gas is linked to the population's standard of living and the energy efficiency of public buildings. These findings indicate that energy efficiency measures in buildings should be a priority.

- The main source of CO_2 emissions is natural gas, particularly in residential buildings.
- Emissions from electricity are mainly concentrated in the industrial and service sector buildings.
- Priority measures for reducing emissions should focus on optimising gas consumption in residential buildings and increasing the efficiency of electricity use in the industrial and services sector.

4.3.2 Transport sector

Activity data

The transport sector includes urban vehicles and public transport. Activity data:

- Fuel consumption (petrol and diesel) was estimated based on data from fuel stations and statistical information;
- The number and type of vehicles have been confirmed based on data from the State Statistics Committee.

The total emissions amount to approximately 43,170 tonnes per year.

Emission calculation

Private vehicles

Data (for the 2023 base year)

Petrol (motor petrol, Transport and warehousing column): 68,795.5 TJ

Diesel (diesel fuel, Transport and warehousing column): 58 754.5 TJ

Population of Azerbaijan (2023): 10,127,100 people

Conversion: 1 TJ = 277.78 MWh

Terajoule → MWh

Total national energy consumption:

Petrol = 68795.5 × 277.78 ≈ 19109860 MWh

Diesel = 58754.5 × 277.78 ≈ 16320680 MWh

Per capita (Table 53):

Petrol:

19109860/10127100 ≈ 1.887 MWh / person

Diesel:

16320680/10127100 ≈ 1.612 MWh / person

Table 53. National Energy Balance for 2023

National Energy Balance for 2023	MWh per capita
Petrol for transport, MWh	1.887
Diesel for transport, MWh	1.612

The fuel consumption of private vehicles in Khachmaz and the resulting CO_2 emissions have been estimated as follows (Table 54).

Petrol-powered private vehicles consume 84,915 MWh of energy over the course of the year. This results in the release of approximately 21,134 tonnes of CO_2 equivalent into the atmosphere.

Diesel-powered private vehicles, on the other hand, consumed 72,540 MWh of energy and generated 19,373 tonnes of CO_2 equivalent.

Thus, the total fuel consumption of all private vehicles, both petrol and diesel, is 157,455 MWh, and the resulting total CO_2 emissions amount to 40,507 tonnes.

Public transport

Number of routes: 16

- Each route per day: an average of 35 litres of diesel
- 1 litre of diesel = 0.011 MVt·h
- 1 MWh = 0.267 tonnes of CO_2
- 1 litre of petrol = 0.0097 MWh
- 1 MWh = 0.249 tonnes of CO_2

The fuel consumption and CO_2 emissions of public transport in the city of Khachmaz are as follows. For urban transport, 16 buses run on diesel fuel. These buses use 204,400 litres of diesel per year, which is equivalent to 2,248.4 MWh of energy and results in approximately 600 tonnes of CO_2 equivalent (Table 55).

Among the buses running from the city to the villages, there are 35 diesel and 25 petrol-powered buses. The diesel buses consume 447,125 litres of diesel per year, while the petrol buses consume 319,375 litres of petrol. This consumption is equivalent to 4,918.375 MWh for diesel and 3,084.77 MWh for petrol. Consequently, this results in CO_2 emissions of 1,313 tonnes from diesel buses and 750 tonnes from petrol buses.

Thus, the annual energy consumption of all public transport vehicles amounts to 10,251.545 MWh, resulting in approximately 2,663 tonnes of CO_2 being released into the atmosphere.

Table 54. Summary of energy consumption and greenhouse gas emissions in the transport sector (base year 2023)

Transport category	Energy consumption	Approved emissions estimate
Private and commercial transport	157,455 MWh/year40,507 tCO_2e/year	157,455 MWh/year40,507 tCO_2e/year
Public transportapproximately 10,252 MWh/yearapproximately 2,663 tCO_2e/year	Public transportapproximately 10,252 MWh/yearapproximately 2,663 tCO_2e/year	Public transportapproximately 10,252 MWh/yearapproximately 2,663 tCO_2e/year
Total transport sector—43,170 tCO_2e/year	Total transport sector—43,170 tCO_2e/year	Total transport sector—43,170 tCO_2e/year

Note: Transport emissions are based on the estimates approved in the municipal BEI. Minor differences may arise from fuel-conversion assumptions and rounding of the underlying activity data.

Analysis

The transport sector is the second-largest source of emissions in Khachmaz city. To reduce emissions, promoting public transport, implementing fuel-efficient technologies, and developing electric transport are important.

4.3.3 Street lighting

Performance data

To analyse the electricity consumption of the street lighting systems under the municipality's responsibility, we used data obtained from the municipality and data collected from the area. LED lamps are used for the lighting.

For street lights, the power is typically 80–150 W. For example, if a 100 W LED light is on for 12 hours a night:

$$E = (100 \times 12)/1000 = 1.2 \text{ kWh/day}$$

There are 541 streetlights in the city area. The annual energy consumption is approximately 200,000 kWh (200 MWh).

Emission calculation

$$E_{lighting} = Elec_{MWh} \times 0.597$$

The calculations have shown that the emission amount is equivalent to 119.4 t (Table 56).

Table 55. Emissions from street lighting

Activity data	Emission factor (tCO_2e/MWh)	Calculated emissions (tCO_2e)
200 MWh	0.597	119.4

Analysis

Street lighting accounts for a relatively small share of a city's total energy consumption, and the implementation of smart management systems can provide additional energy and emissions reductions.

4.3.4 Waste sector

Operational data

- The annual volume of solid household waste in Khachmaz city is 20,100 m^3;
- The waste is transported to municipal landfills, where CH_4 emissions are generated;
- Data source: municipality and local waste management operators.

Emission calculation

Step 1: Waste mass

Waste mass = 20100 m^3 × 0.3 t/m^3 = 6030 t

Step 2: Organic waste

Organic waste = 51% + 11% = 62%

Organic waste = 6030 × 0.62 ≈ 3738.6 t

Step 3: Organic carbon (DOC)

DOC = 3738.6 × 0.15 ≈ 560.8tC

Step 4: Anaerobically degradable carbon (DOCf)

DOCf = 560.8 × 0.5 ≈ 280.4tC

Step 5: Methane (CH_4)

CH_4 = 280.4 × 0.5 × 1.333 ≈ 186.8tCH_4

Step 6: CO_2 equivalent

CO_2-eq = 186.8 × 28 ≈ 5230 $_{tCO_2}$-eq

2023 emissions from the waste sector for Khachmaz city:

CH_4: ~187 t

CO_2 equivalent: ~5,230 tCO_2-eq

Based on the calculations, the emission amount was determined to be 5,230 tonnes of CO_2 equivalent (Table 57).

Table 56. Emissions from waste

Waste quantity	Calculated emissions (tCO_2e)
20100 m^3	5,230

Analysis

The waste sector accounts for approximately 5.28% of total emissions. The implementation of methane capture systems, waste sorting and recovery opportunities could contribute to reducing emissions.

4.3.5 Overall results by sector

Calculations based on the regulations have determined the amount of emissions generated by the various sectors (Table 58).

Table 57. Emissions by sector

Sector	Emissions (tCO_2e)	Share (%)
Buildings	50,472	50.99
Transport	43,170	43.61
Waste	5,230	5.28

Street lighting	119.4	0.12
Total	**98,991.4**	**100.00**

The highest figures across the various sectors are for buildings at 50.99% and transport at 43.61% (Figure 16).

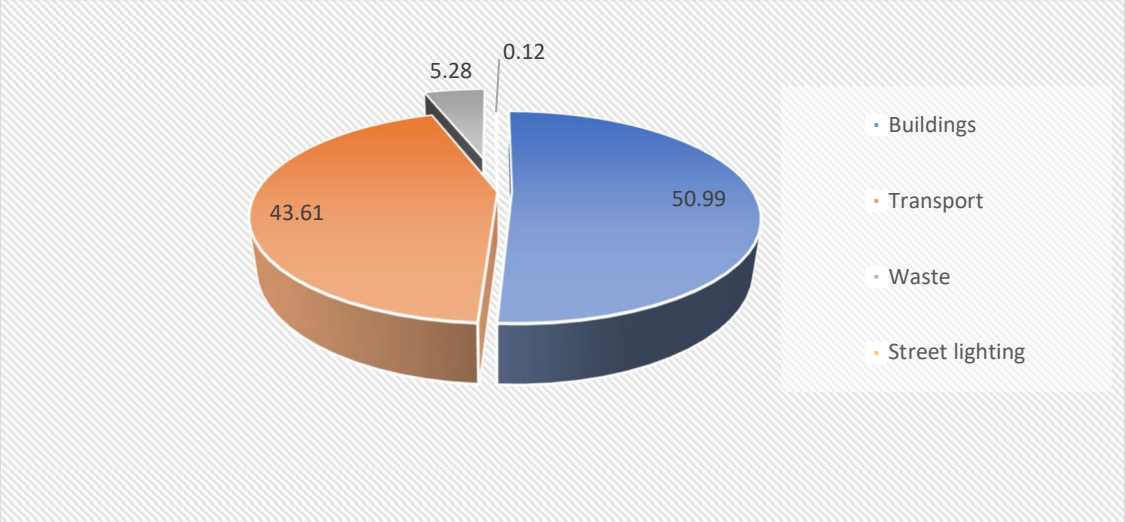


Figure 16. Percentage breakdown of emissions by sector

Analysis

- The buildings sector – the largest share (≈50.99%)
- The transport sector – in second place (≈43.61%)
- Waste – 5.28%
- Street lighting – 0.12%

This information provides the primary basis for establishing the energy efficiency and emission reduction priorities for Khachmaz city. These shares will be considered when developing the sectoral action plan in the future.

4.4 Overall conclusions and analysis

The BEI calculations for the city of Khachmaz show that in 2023, the city's total greenhouse gas emissions amounted to approximately 98,991.4 tCO_2e.

4.4.1 Sectoral analysis

1. The Buildings Sector
   - The buildings sector accounts for the largest share of the city's total emissions (≈50.99%).
   - The main reasons are the high consumption of electricity and natural gas in residential and public buildings.
   - The analysis shows that energy efficiency measures, improving thermal insulation in buildings, and the application of energy-efficient technologies should be prioritised.
2. Transport sector
   - The transport sector is the city's second-largest source of emissions (≈43.61%).

- To reduce emissions, it is advisable to promote public transport, introduce electric buses and cars, as well as expand fuel-efficient technologies.

3. The waste sector

- The waste sector accounts for approximately 5.28% of total emissions.
- The degradation of solid municipal waste in landfills generates CH_4 emissions.
- Analysis shows that implementing waste sorting, recovery and composting systems, and establishing methane capture technologies can ensure emission reductions in this sector.

4. Street lighting

- Street lighting accounts for only 0.12% of total emissions.
- Additional energy and emission savings can be achieved if smart control systems are also implemented alongside LED lamps.

4.4.2 Final analysis

- The majority of emissions in the city of Khachmaz are related to energy consumption, mainly observed in the buildings and transport sectors.
- Identifying the highest emission sources is essential for the development of a future reduction strategy.
- The sectoral analysis provides a basis for planning priority measures in accordance with CoM and SECAP (Sustainable Energy and Climate Action Plan) standards.

4.5 Future steps

4.5.1 Future steps

1. **Development of the sectoral action plan:**

- *Buildings:* energy efficiency programmes, thermal insulation, implementation of energy-efficient technologies.
- *Transport:* promotion of public transport, introduction of electric and hybrid vehicles, optimisation of road infrastructure.
- *Waste:* implementation of sorting, recovery and composting systems, establishment of CH_4 capture technologies.
- *Street lighting:* transition to LED lamps, implementation of smart management systems.

2. **Data update and monitoring:**

- The BEI must be updated annually and compared with new operational data.

3. **Future targets and integration into SECAP:**

- This inventory will be integrated into the SECAP document and will be used as the primary basis for setting emission reduction targets for 2030.
- Priority measures, financial resources and technological capabilities will be assessed and implemented by sector.

5. Climate Risk and Vulnerability Assessment (RVA)

5.1 Purpose and scope

The objective of this stage is to assess the climate-related risks and vulnerability of Khachmaz city. Consequently, adaptation measures will be identified to enhance the city's resilience to the adverse impacts of climate change.

- *The assessment is based on the following climate hazards:*

- Heatwaves
- Strong winds
- Heavy rainfall and floods
- Drought
- Hail
- Climate-related fires

5.2 Methodology

The assessment during the risk and vulnerability analysis is based on three main components (Table 59). These criteria have been identified based on long-term analyses within the urban area.

Table 58. Assessment criteria

Component	Description
Hazard	Probability and intensity of the climate event (e.g., heatwaves, floods, drought)
Exposure	Population, infrastructure, and economic activities exposed to the risk
Sensitivity	The resilience and adaptive capacity of these elements

Key data sources for assessment:

- Data from the National Hydrometeorological Service of Azerbaijan
- State Statistics Committee (population, infrastructure distribution)
- BEI results (by energy and emissions sectors)
- Data from local municipalities and service departments
- Information from meetings with stakeholders (Task 2 results)

Various institutions and stakeholders participated in the preparation of the RVA (Risk and Vulnerability Assessment for Climate Change). The assessment was carried out based on a working group, feedback from local experts, and community meetings.

5.3 Current climatic characteristics of Khachmaz city

Khachmaz city is located on a predominantly flat terrain, close to the coast of the Caspian Sea, and this geographical location directly influences its climatic characteristics. The city's climate is characterised as mild-warm, semi-humid, and continental. Observations in recent years indicate an increase in summer temperatures, with heatwaves lasting 2–3 days, uneven distribution of precipitation during the winter season, and stronger, particularly north-easterly winds occurring more frequently. Increase in summer temperatures (heatwaves last for 2–3 days).

5.4 Main climate risks affecting Khachmaz city

According to climate scenarios, a significant rise in average temperature (approximately +2 to +2.5°C) is expected in the Khachmaz region by 2050. This could lead to more frequent and prolonged extreme heatwaves in summer. Seasonal changes in precipitation distribution are also expected (a portion of the spring and autumn rainfall may fall as more intense downpours over a shorter period, which increases the risk of flooding in the city). An intensification of extreme weather events (e.g., strong storms) related to climate change is also possible along the Caspian Sea coast. These projections indicate that in the future, the city of Khachmaz may face more severe climate impacts than it does now, and this prospect must be considered when planning adaptation measures.

The city of Khachmaz is one of the areas affected by various climate hazards, and these threats directly impact the city's social, economic, and ecological systems. Heatwaves in the summer months pose a risk to public health, particularly for the elderly, whilst also leading to increased energy demand and a strengthening of the urban heat island effect. Flooding from short-lived but intense rainfall causes severe damage to the city's infrastructure, road network, and sewerage systems.

Strong winds along the Caspian Sea coast can cause power lines to be damaged, trees to be uprooted, and damage to buildings. During drought periods, the condition of green spaces deteriorates and water supply systems are placed under additional pressure (Table 60, Figure 17).

Table 59. Main climate hazards affecting the city of Khachmaz and their areas of impact

Hazard	Main areas of impact	Brief description
Heatwaves	Health, energy demand, elderly population	Heatwaves and the urban heat island effect in summer
Floods	Infrastructure, roads, sewerage	Street flooding from short but intense rainfall
Strong winds	Power lines, trees, buildings	Strong winds along the Caspian coast
Drought	Green belts, water supply	Reduction of water reserves during drought periods
Hailstorms	Windows, vehicles	Short-term, but causes serious physical damage
Climate-related fires	Urban fringe and grassland areas	Drought-related fire risk increases

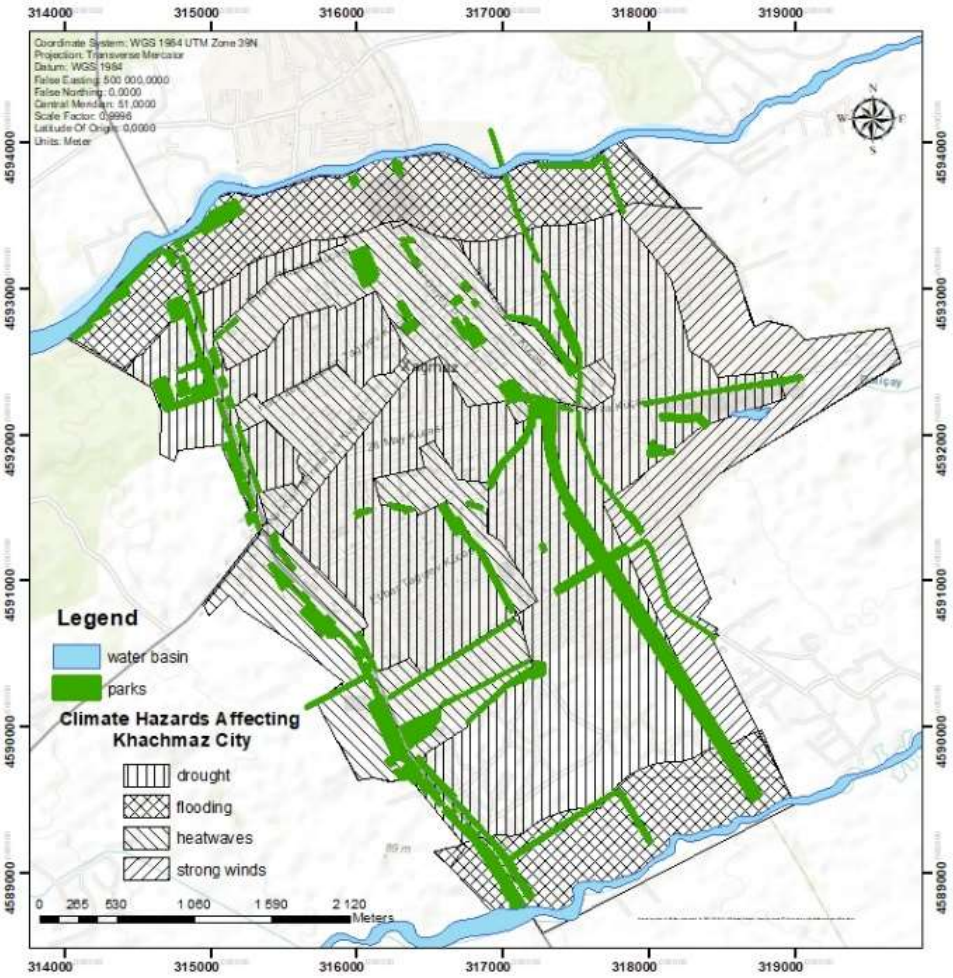


Figure 17. Main climate hazards affecting Khachmaz city

5.5 Sectoral risk and vulnerability

This section provides a risk analysis for each major urban sector. In Khachmaz city, different sectors are affected by climate change to varying degrees and have different levels of vulnerability. The water supply and sanitation system is highly affected by drought and floods. The energy infrastructure is moderately affected by strong winds and heatwaves; power cuts are regularly observed in this sector.

The healthcare sector is highly vulnerable to heatwaves, with the elderly and children being particularly at risk. Public transport and the road network are moderately affected by events such as floods and hail, and the inadequacy of the sewerage system in some areas further exacerbates these risks. Residential buildings have a medium-to-high vulnerability to wind and heat effects, with older structures at risk of damage. Green spaces and parks show high vulnerability due to drought, as irrigation systems and shading measures are not sufficiently effective.

This analysis shows that different mitigation and adaptation measures are required in various sectors against climate change (Table 61).

Table 60. Risk and vulnerability by sector

Sector	Key risks	Level of vulnerability	Note
Water supply and sanitation	Drought, floods	High	Water pressure is low in some parts of the city
Energy infrastructure	Strong winds, heatwaves	Moderate	Power cuts are being experienced
Health sector	Heatwaves	High	The elderly and children are at risk
Public transport and roads	Floods, hail	Medium	The sewerage system is inadequate in many places
Residential buildings	Wind and heat effect	Medium-High	Old buildings may be damaged
Green spaces and parks	Drought, fires	High	Irrigation and shading are poor

5.6 Public awareness and preparedness

In the city of Khachmaz, the level of public awareness of climate risks is still limited, which is particularly evident in the understanding of the impacts of extreme climate events such as heatwaves and droughts. This situation indicates that public awareness-raising measures should be strengthened, and climate and environmental education should also be enhanced at the school level. Increasing the population's level of awareness will not only be sufficient for protection against hazards but will also enable the more effective implementation of adaptation and preparedness measures at both community and individual levels. To this end, awareness-raising campaigns, public seminars and the implementation of modern warning systems are considered a priority area for the city.

5.7 Prioritisation of risks

Based on the Hazard–Exposure–Vulnerability matrix, the highest priority risks are as follows.

1. floods
2. heatwaves
3. winds

These three risks will be the primary focus when planning adaptation measures. The selection of these priority risks is based on both their impact on public health and on the city's infrastructure and services. Flooding is a high priority, as the inadequacy of the sewerage system in some areas and short-term, intense rainfall lead to an increase in street flooding. Heatwaves pose a serious risk, particularly to the elderly and children, and are therefore a key focus of adaptation measures. Strong winds play a significant role in risk management, as they affect power lines, buildings, and the city's green spaces. Adaptation plans should cover both short-term emergency preparedness measures and long-term measures to strengthen infrastructure and increase green spaces.

5.8 Recommended climate adaptation and emission reduction measures

A number of measures are proposed to mitigate the negative impacts of climate change in Khachmaz city and to enhance the community's adaptive capacity. Improving the city's drainage system is considered a key measure for reducing flood risk, while the upgrading of sewerage and stormwater collection systems will

help to prevent flooding. Increasing greenery and shade is essential for reducing the impact of heatwaves during the summer months and alleviating the urban heat island effect.

Energy efficiency measures are aimed at reducing the energy required for heating and cooling, which serves both environmental protection and cost optimisation. Water-saving systems and the reuse of water allow for a sustainable water supply during drought periods. At the same time, public awareness campaigns and educational initiatives enhance citizens' awareness of the risks and improve emergency preparedness. These measures strengthen the city's resilience by combining both adaptation and mitigation approaches (Table 62).

Table 61. Proposed adaptation and mitigation measures for climate risks in the city of Khachmaz

Measures	Type	Description
Improvement of the urban drainage system	Adaptation	Upgrading sewerage and stormwater drainage systems to prevent flooding
Increasing greenery and shade	Adaptation	Reducing the impact of heatwaves
Energy efficiency measures	Mitigation	Reducing energy demand for heating and cooling
Water conservation systems and reuse	Adaptation	Sustainable supply during drought periods
Public awareness campaigns	Adaptation	Increasing preparedness for risks

In the city of Khachmaz, the probability of occurrence and the main seasonal periods for various climate hazards differ. The most likely hazard is extreme heat, which is mainly observed during the summer months (June–August). Intensive rainfall and heavy downpours are moderately probable, occurring mainly in the spring (March–April) and autumn (September).

Flooding, river floods and forest (land) fires are low-probability hazards and are often restricted to specific seasons. Groundwater seepage and permanent flooding are not observed in the city. Drought and water scarcity pose a threat mainly during the summer months (July–August). Tornadoes, lightning and storms, however, occur rarely. This analysis is used as a key indicator in conducting the city's risk assessment and planning adaptation measures (Table 63).

Table 62. Probability and recurrence periods of climate hazards in Khachmaz city

Climate Hazard	Probability and return periods of climate hazards in the city of Khachmaz	Occurrence seasons / periods
Extreme heat	High	Summer – June-August
Heavy rainfall	Medium	Spring – March-April
Heavy rain	Medium	Spring – March, Autumn – September
Heavy snow	Moderate	Winter – December-February
Flooding	Low	Spring – March
Surface flooding due to heavy rainfall	Low	Rarely – mainly Spring
River floods	Low	Autumn – September-October
Flooding from groundwater discharge	No	–
Persistent subsidence	No	–
Forest/ground fires	Lower	Summer – July
Drought and water scarcity	Medium	July – August
Hurricane	Low	Occasionally – September
Strong wind / dust storm	Medium	In every season of the year
Lightning / storm	Low	Spring-Autumn – April-September

The assessment of climate hazards in the city of Khachmaz shows that extreme heatwaves are the most likely and high-impact hazard, and are expected to increase in the future in terms of both intensity and frequency. Severe cold, however, occurs with low probability and has a moderate impact, and is projected to decrease in both intensity and frequency.

Heavy precipitation, intense rainfall, floods, wildfires, drought and water scarcity, hurricanes and severe winds, and dust storms are threats with a medium to high impact that are expected to increase in both intensity and frequency in the future. Heavy snow, lightning and hail, however, have a low impact and probability and are projected to decrease in both intensity and frequency.

Groundwater emergence and permanent subsidence are risks that do not exist in the city and will not pose a threat in the future. This analysis is identified as a key indicator for the management of climate risks and the development of adaptation strategies (Table 64).

Table 63. Probability of occurrence, impact and future change projections for climate hazards in Khachmaz city

Climate hazards	Hazard Occurrence Probability	Hazard impact	Expected change in intensity	Change in frequency expected
Extreme heat	High	High	Will increase	Will increase
Strong cold	Low	Average	Will decrease	Will decrease
Intensive rain	Moderate	Medium	Will increase	Will increase
Heavy rain	Medium	High	Will increase	Will increase
Heavy snow	Low	Low	Will decrease	Will decrease
Flooding	Medium	Medium	Will increase	Will increase
Surface flooding due to heavy rainfall	Low	Low	Will increase	Will increase
River floods	Down	Down	Will increase	Will increase
Flooding resulting from groundwater discharge	No	No	No	No
Persistent flooding	No	No	No	No
Forest/land fires	Lower	Medium	Will increase	Will increase
Drought and water shortage	Middle	Average	Will increase	Will increase
Hurricane	Lower	Medium	Will increase	Increase
Strong wind / dust storm	Medium	Moderate	Will increase	Increasing
Lightning / storm	Down	Lower	Will decrease	Will decrease

In Khachmaz, long-term heatwaves show high vulnerability, particularly for the agricultural, drinking water and water supply sectors, while other sectors are affected to a moderate degree. Extreme cold waves also pose a high risk, mainly to the agricultural sector and water supply, while other sectors are moderately affected and the tourism and hospitality sector is less vulnerable. Short-term intense rainfall and severe downpours are highly sensitive for a number of sectors, including agriculture, energy production, ecology, and emergency services.

Risks such as heavy snowfall and frost, groundwater level rise, drought and water scarcity, and forest and open-area fires have a predominantly low to medium impact. Hurricanes, lightning and storms present a high vulnerability for all key sectors, meaning that when these events occur, all areas can be severely affected. Strong winds and dust storms, however, are assessed as having a medium vulnerability level for most areas.

This analysis is used as a key information source for prioritising climate risks by sector, and for the development of adaptation and emergency preparedness plans (Table 65).

Table 64. Level of vulnerability of climate hazards across various sectors in Khachmaz city

Climate Hazard	Sector	Level of vulnerability
1. Long-term heatwaves	Health and medical services	Medium
	Education and training institutions	Medium
	Urban transport	Medium
	Agricultural sector	High
	Drinking water and water supply	High
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	Medium
	Energy production and supply	Medium
	Emergency situations and civil defence	Medium
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	Low
2. Severe cold weather waves	Health and medical services	Medium
	Education and training institutions	Medium
	Urban transport	Medium
	Agriculture	High
	Drinking water and water supply	Medium
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergency situations and civil defence	High
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	High
3. Short-term intense rainfall	Health and medical services	Medium
	Education and training institutions	Medium
	Urban transport	Medium
	Agriculture	High

Climate Hazard	Sector	Level of vulnerability
	Drinking water and water supply	Medium
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergency situations and civil defence	High
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	High
4. Heavy downpours	Health and medical services	Medium
	Education and training institutions	Medium
	Urban transport	Medium
	Agriculture	High
	Drinking water and water supply	High
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergency situations and civil defence	High
	Digital technologies and ICT	High
	Tourism and hospitality sector	High
5. Heavy snow and frost	Health and medical services	Medium
	Education and training institutions	Medium
	Urban transport	Medium
	Agriculture	Medium
	Drinking water and water supply	Medium
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	Medium
	Energy production and supply	Medium

Climate Hazard	Sector	Level of vulnerability
	Emergency situations and civil defence	Medium
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	Medium
6. Localised flooding (after rainfall)	Health and medical services	Low
	Education and training institutions	Lower
	Urban transport	Lower
	Agricultural sector	High
	Drinking water and water supply	High
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergency situations and civil defence	High
	Digital technologies and ICT	High
	Tourism and hospitality sector	High
7. Flooding from surface runoff	Health and medical services	Low
	Education and training institutions	Low
	Urban transport	Low
	Agriculture	High
	Drinking water and water supply	High
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergency situations and civil defence	High
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	Medium
8. River floods	All sectors	-

Climate Hazard	Sector	Level of vulnerability
9. Groundwater rise	Health and medical services	Low
	Education and training institutions	Low
	Urban transport	Low
	Agriculture	Low
	Drinking water and water supply	Low
	Residential and commercial buildings	Low
	Technical installations and infrastructure	Low
	Ecogy and biodiversity	Low
	Energy generation and supply	Low
	Emergency situations and civil defence	Low
	Digital technologies and ICT	Low
	Tourism and hospitality sector	Low
10. Persistent subsidence	All sectors	-
11. Forest and wildfires	Health and medical services	Low
	Education and training institutions	Low
	Urban transport	Low
	Agriculture	Low
	Drinking water and water supply	Low
	Residential and commercial buildings	Low
	Technical installations and infrastructure	Low
	Ecology and biodiversity	Medium
	Energy generation and supply	Medium
	Emergency situations and civil defence	Medium
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	Medium
12. Drought and water scarcity	Health and medical services	Low
	Education and training institutions	Low
	Urban transport	Low
	Agriculture	Low

Climate Hazard	Sector	Level of vulnerability
	Drinking water and water supply	Low
	Residential and commercial buildings	Low
	Technical installations and infrastructure	Low
	Ecology and biodiversity	Low
	Energy generation and supply	Low
	Emergency situations and civil defence	Low
	Digital technologies and ICT	Medium
	Tourism and hospitality	Low
13. Cyclone	Health and medical services	High
	Education and training institutions	High
	Urban transport	High
	Agricultural sector	High
	Drinking water and water supply	High
	Residential and commercial buildings	High
	Technical installations and infrastructure	High
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergency situations and civil defence	High
	Digital technologies and ICT	High
	Tourism and hospitality sector	High
14. Strong wind, dust storm	Health and medical services	Medium
	Education and training institutions	Medium
	Urban transport	Medium
	Agriculture	Medium
	Drinking water and water supply	Medium
	Residential and commercial buildings	Medium
	Technical installations and infrastructure	Medium
	Ecology and biodiversity	Medium
	Energy production and supply	Medium

Climate Hazard	Sector	Level of vulnerability
	Emergency situations and civil defence	Medium
	Digital technologies and ICT	Medium
	Tourism and hospitality sector	Medium
15. Lightning, storm	Health and medical services	High
	Education and training institutions	High
	Urban transport	High
	Agricultural sector	High
	Drinking water and water supply	High
	Residential and commercial buildings	High
	Technical and infrastructure	High
	Ecology and biodiversity	High
	Energy production and supply	High
	Emergencies and Civil Defence	High
	Digital technologies and ICT	High
	Tourism and hospitality sector	High

The city of Khachmaz is moderately vulnerable to the negative impacts of climate change, and highly vulnerable in some sectors. The greatest risks are associated with heatwave events. It is necessary to integrate adaptation measures into urban planning, public utility, and public awareness plans.

6. Identification of mitigation and adaptation measures

6.1 Introduction

This section identifies specific activities to mitigate the impacts of climate change and implement adaptation measures for the city of Khachmaz. The measures are based on the results of the Baseline Emission Inventories (BEI) and the Risk and Vulnerability Assessment (RVA).

Key objectives:

- Reduction of greenhouse gas (GHG) emissions in the residential, energy, transport and waste sectors;
- Increasing resilience to climate-related risks;
- Aligning the measures with local development priorities and national climate strategies.

The proposed measures focus on both areas critical in terms of emissions (buildings, public lighting, transport, waste management) and areas vulnerable to climate risk (water management, heat stress, urban infrastructure).

6.2 Methodology for selecting measures

Mitigation and adaptation measures were selected based on the following principles:

- *BEI and RVA data:* energy consumption, emission sources and climate risks;
- *Stakeholder engagement:* the municipality, utilities, NGOs and local communities;
- *Technical, financial and institutional* feasibility;
- *Assessment of additional benefits:* social, economic and environmental advantages.

Each measure has been assessed in terms of its potential impact, cost-effectiveness, implementation timeframe, and alignment with national priorities.

6.3 Rationale and expected impacts of mitigation and adaptation measures

It is important to implement the key mitigation and adaptation measures identified to reduce the negative impacts of climate change in Khachmaz city and ensure the city's long-term sustainability. The proposed measures in priority areas such as energy efficiency, agriculture, transport, water management, public services, healthcare, green spaces, waste management, coastal and riverbank zones, as well as economic development, are aimed at making the city's development more sustainable, both ecologically and socio-economically.

Mitigation measures primarily aim to reduce energy consumption, implement renewable energy sources, and minimise greenhouse gas emissions. Adaptation measures, on the other hand, serve to increase the resilience of the population, infrastructure, and natural resources to climate risks such as drought, heatwaves, water scarcity, floods, and erosion.

The implementation of the proposed measures is expected to lead to more efficient use of energy and water resources, improved air quality, reduced public health risks, enhanced resilience of agricultural and economic activities, and an overall improvement in the quality of the urban environment. This approach, implemented through cooperation between local executive bodies, the municipality, government agencies, and international partners, is intended to contribute to the development of Khachmaz city as a more resilient and liveable city in the face of climate change (Table 66).

Table 65. Climate Change Mitigation and Adaptation Measures Plan for Khachmaz City (within the SECAP framework)

Public buildings and services	Water management	Transport	Agriculture	Energy efficiency and buildings	Sector
Rising electricity costs	Decrease in groundwater level and water shortage in summer	Intra-city traffic congestion and high fuel consumption	Drought and reduction in soil fertility	Increasing energy consumption, old heating systems	Hazard / Problem
Installation of solar panels in schools and administrative buildings	Reduction of water losses and a smart water management system	Purchase of electric buses and optimisation of bus routes	Drip irrigation and measures to increase soil water retention	Application of LED lighting and thermal insulation in buildings	Description of the measure
Mitigation	Adaptation	Mitigation	Adaptation	Mitigation	Type (Mitigation / Adaptation)
Local renewable energy generation, reduction of emissions	Resilience and sustainability of water resources	Reduction in fuel consumption, reduction in GHG emissions	Water resilience, stable productivity	Reduction in energy consumption, reduction in CO_2 emissions	Expected effect (GHG / Sustainability)
Average	Average	High	Medium	Average	Estimated cost
Green Energy Fund, public-private partnership	State Water Management, donor projects	Green Energy Funds, government programmes	Ministry of Agriculture projects, IFAD	Municipality, EU/GEF, private sector	Potential funding sources
Short-term	Medium term (2–3 years)	Medium term (2–5 years)	Medium term (2–4 years)	Short-term (1–2 years)	Implementation period
Municipality, Education Department	Azerbaijan State Water Resources Agency, Municipality	Transport Agency, Municipality	Khachmaz Agricultural Department	Khachmaz Municipality, Housing and Communal Services	Responsible bodies
Reduction in energy costs	Improved service quality	Improved air quality	Water conservation, income increase	Improved living conditions	Co-benefits

Economic development and business	Coastal and riverside areas	Waste management	Green spaces and urban area	Health and social care
Increase in production costs due to outdated, energy-inefficient technologies	Beach erosion and river flood risks	Volume of waste sent to landfill and methane emissions	Increase in temperature on urban islands	Increased health risks due to heatwaves
Energy audit and low-energy equipment support for small businesses	Coastal defence and flood channel improvements	Expansion of the separate collection system and composting of organic waste	Creation of new green belts in the city centre	"Cooling centres" and an early warning system
Mitigation	Adaptation	Mitigation	Adaptation	Adaptation
Energy savings, emission reduction	Reduced hazard risk, protection of infrastructure	Reduction of methane emissions, waste reduction	Reduction in temperature, improvement of the microclimate	Increased public health resilience
Low	High	Low-Medium	Average	Low
Small Business Development Agency	State Fund, World Bank	Municipal, private sector, donor projects	Ecology Fund, municipality	Municipality, donors' social projects
Short-term	Long term (4–7 years)	Short-term	Short-term (1–2 years)	Short-term
SME Agency, Municipality	Ministry of Emergency Situations, Municipality	Municipality, "Clean City"	Ministry of Ecology, Municipality	Khachmaz Social Protection Centre
Reduced business costs	Tourism development	Acquisition of beneficial compost for land	Aesthetics, improvement of air quality	Reduction in the risk of death from extreme heat

6.4 Mitigation measures (emission reduction)

The measures cover the city's main emission-generating sectors, such as buildings, public lighting, renewable energy, transport and waste management, and have been prioritised taking into account realistic implementation possibilities.

For each measure, the annual GHG reduction potential, estimated financial costs, possible funding sources, implementation period, and responsible bodies are indicated. This approach ensures that the measures are both technically and institutionally feasible and that they generate measurable climate benefits. The implementation of the measures is expected to lead to increased energy efficiency, increased renewable energy production, a reduction in emissions from transport and waste, as well as an improvement in the quality of life for the urban environment and its population.

Furthermore, the references shown in the table (CoM BEI Tool, IPCC emission factors, IEA and other international and national sources) indicate that the calculations have been conducted in accordance with scientific principles and international methodologies. Overall, this package of measures aims to make a

significant contribution to the fulfilment of Khachmaz city's climate commitments, the achievement of its SECAP objectives, and its transition to a low-carbon development pathway (Table 67).

Table 66. Priority activities for mitigation measures in Khachmaz city and greenhouse gas emission reduction potential

No.	Sector	Measure	Feasibility	Expected GHG Reduction	Cost (AZN)	Source of Funding	Implementation period	Responsible Body	Additional Benefits	Reference
M1	Buildings	Insulation for public buildings, energy-efficient windows and LED lighting	High	200 tCO_2 /year	350,000	Government Programmes, EU funds	2026–2028	Municipality, Ministry of Energy	Energy savings, increased comfort	CoM BEI Tool, IPCC Emission Factors, State Statistics Committee of Azerbaijan 2023
M2	Public Lighting	Replacement of street lights with LED systems	High	150 tCO_2 /year	180,000	Municipal budget, UNDP GEF	2026–2028	Municipality	Reduction in electricity consumption, safer streets	CoM BEI Tool, EBRD Urban LED Project Data
M3	Renewable Energy	Installation of solar panels on public and school buildings (500 kWp)	Medium	300 tCO_2 /year	500,000	EU/IKI fund, private partnership	2026–2030	Municipality, AZERENERGY	Job creation, clean energy	IPCC Emission Factors, CoM PV Calculator
M4	Transport	Implementation of electric minibuses on city routes and installation of 3 charging stations	Medium	400 tCO_2 /year	650,000	GCF, Ministry of Transport	2026–2030	Municipality, Department of Transport	Reduction of air pollution, noise reduction	CoM Transport Module, IEA Transport Data
M5	Waste Management	Expansion of waste collection and recycling	Average	250 tCO_2 /year	220,000	Municipal budget, EU support	2026–2029	Municipality, Waste Agency	Clean environment, public awareness	IPCC Waste Emission Factors, CoM BEI Tool

In the city of Khachmaz, activities have been selected that reflect the current greenhouse gas emissions from the residential, transport, and waste sectors, the main measures planned to reduce these emissions, and their potential impacts. The measures presented have been formulated in accordance with the SECAP methodology and IPCC emission factors, and prioritised considering realistic implementation times and responsible actors.

In the residential sector, improving building insulation and increasing thermal efficiency, as well as installing solar panels, reduces energy consumption and allows for the supply of electricity from renewable sources. These measures contribute both to a reduction in direct CO_2 emissions and to lower energy costs for the population.

In the transport sector, promoting the transition to electric, and hybrid vehicles, as well as expanding public transport, facilitates a reduction in emissions from urban traffic, improves air quality, and reduces traffic congestion.

The implementation of composting and the recycling of organic waste in the waste sector, as well as the improvement of landfill management, contributes to reducing methane emissions and minimising environmental and public health risks.

Overall, this package of measures supports the Khachmaz city's low-carbon development strategy, contributes to meeting climate commitments, and ensures the achievement of social and economic co-benefits alongside environmental benefits (Table 68).

Table 67. Sectoral greenhouse gas emission reduction potential and priority mitigation measures for Khachmaz city

Sector	Measure / Activity	Current emissions (t CO_2-eq)	Potential reduction (%)	Potential reduction (t CO_2-eq)	Term	Responsible actors	Costs / Financing	Potential co-benefits	Notes
Housing	Insulation and improving the thermal efficiency of buildings	50472	15%	7570	Medium (3–7 years)	Local Authority, Property Owners	Government subsidies, international donations	Energy savings, comfortable heating	In accordance with SECAP and IPCC indicators
Housing	Installation of solar panels (public and private)	50472	10%	5047	Long (7+ years)	Local Authorities, Electricity Companies, Citizens	Government support, private investment	Reduction in electricity costs, green energy	In line with SECAP and IPCC indicators
Transport	A 20% shift from petrol/diesel passenger cars to electric/hybrid	43170	15%	6476	Medium (3–7 years)	Local Government, Transport Company with	State incentives, subsidies	Improvement in air quality, reduction in fuel costs	Current transport activity data and CO_2 emissions have been taken into
Transport	Expansion and promotion of public transport	43170	10%	4317	Short-to-Medium (1–7 years)	Local Authority, Bus Operators	Government investment, EU funds	Reduced congestion, fuel savings	Includes bus and freight transport
Waste	Composting and biological waste recycling	5230	20%	1046	Medium (3–7 years)	Local Authority, Landfill Operator	Government programmes, NGO support	Soil quality, odour reduction	Reduction of CH_4 emissions in accordance with
Waste	Improvement of landfill management	5230	15%	785	Short-to-Medium (1–7 years)	Local Executive Authority, Landfill Management	Government and international funds	Environmental protection, health benefit	Modernisation of existing landfills

Table 67 presents a limited set of pilot actions. Table 68 presents broader theoretical sectoral reduction potential. The four quantified key actions reported in MyCovenant account for an estimated reduction of 18,891.36 tCO_2e/year. These values represent different scopes and should not be added together. Further measures and detailed quantification are required to demonstrate achievement of the approved 35% municipal target.

6.5 Adaptation measures (climate resilience)

Adaptive activities mainly cover high-risk areas such as water management, urban green spaces, agriculture, healthcare and awareness-raising, as well as the protection of coastal and riverbank zones.

In water management, the reconstruction of drainage systems serves to reduce the risks of floods and inundation, protecting urban infrastructure and residential areas. Expanding urban greenery and creating green corridors contributes to mitigating the heat island effect, improving air quality and public health indicators, whilst also protecting biodiversity.

In agriculture, the promotion of drought-resistant crops and the application of efficient irrigation methods enable the economical use of water resources, the stable maintenance of productivity, and the strengthening of food security. In healthcare and education, early warning systems and awareness campaigns minimise health risks by increasing public preparedness for heatwaves. Preventing erosion in coastal and riverbank areas, in turn, facilitates a reduction in soil loss and the preservation of natural landscapes and recreational potential.

Overall, these adaptation measures not only reduce the vulnerability of Khachmaz city to climate risks but also enhance the quality of the living environment, reflecting a comprehensive approach aimed at ensuring the city's long-term sustainable development (Table 69).

Table 68. Priority activities for adaptation measures and resilience impacts for the city of Khachmaz

No.	Sector	Measure	Sustainability Impact	Cost (AZN)	Implementation Period	Responsible Body	Additional Benefits
A1	Water Management	Reconstruction and maintenance of drainage systems	High	300,000	2026–2029	Municipality, Ministry of Ecology	Flood risk reduction, protection of infrastructure
A2	Urban Greening	Creation of new green corridors and parks	High	250,000	2026–2030	Municipality	Health, increasing biodiversity
A3	Agriculture	Promotion of drought-tolerant plants and efficient irrigation	Medium	200,000	2026–2028	Agricultural Department, Farmers' Union	Food security, water conservation
A4	Health & Awareness	Early warning system and awareness campaigns for heatwaves	High	100,000	2028–2029	Local Health Department; Ministry of Emergency Situations of the Republic of Azerbaijan	Increasing preparedness, protecting health
A5	Coastal and River Reserve	Measures to prevent erosion on riverbanks	Medium	150,000	2026–2028	Ministry of Ecology, Municipality	Reduction of soil loss, landscape protection

6.6 Prioritisation of measures

- Based on a multi-criteria assessment:
  - Potential for impact (GHG and sustainability);
  - Technical and institutional implementation capabilities;
  - Cost-benefit ratio;
  - Additional social and environmental benefits.

Four high-priority measures are:

1. Energy efficiency measures for public buildings (M1)
2. Strengthening of drainage and flood management systems (A1)
3. Implementation of LED street lighting (M2)
4. Urban greening and reduction of heat stress (A2)

6.7 Financing and implementation mechanism

- Sources of funding:
  - Municipal budget and local development programmes
  - Government support (Green Development Strategy, Energy Efficiency programmes)
  - International funds (EU Green Deal, GCF, IKI)
  - Private sector partnership (especially solar energy and waste projects)
- Implementation and monitoring:
  - The relevant specialised council of the municipality will be responsible
  - Stakeholder meetings will be continued
  - Monitoring will be carried out in accordance with the SECAP through annual reports

6.8 Expected outcomes and additional benefits

- *Emission reduction:* approximately 11,000–13,000 tCO_2/year by 2030
- *Increased climate resilience:* reduced impact of floods, droughts and heatwaves
- *Social and economic benefits:* improved air quality, new jobs, reduced energy costs
- *Environmental benefits:* increased green cover and biodiversity, a cleaner urban environment

These measures will contribute to the low-carbon, climate-resilient development of Khachmaz city and will be fully aligned with both local and national climate strategies.

6.9 Mitigation measures and financial analyses

6.9.1 The buildings sector

General information

In Khachmaz city, existing buildings are divided into three main categories: municipal buildings, residential buildings, and service sector buildings (commercial, office, social services). Most buildings are characterised by old energy systems and poor insulation, which leads to both high energy consumption and increased CO_2 emissions. Energy costs are high in the service sector, while comfort and heating efficiency are low in residential buildings.

Activity description

The measures across all categories are mainly aimed at increasing energy efficiency and reducing CO_2 emissions:

- Application of thermal insulation, energy-efficient windows and LED lighting in existing buildings;
- Promoting renewable energy production through solar panels;

- , installation of smart management systems and optimisation of energy consumption;
- Modernisation of lighting and heating systems in the service sector.

General objectives

- Increasing energy efficiency and reducing CO_2 emissions;
- Improving comfort and thermal conditions in buildings;
- Optimisation of energy costs in the service sector and public buildings;
- Promotion of renewable energy use;

Ensuring financial and environmental sustainability

Measures to reduce long-term maintenance costs and extend the service life of buildings cover three main areas: enhancing the thermal insulation of buildings and installing energy-efficient windows, increasing electricity generation through solar panels, and implementing smart energy management systems in buildings.

The measures to improve building thermal insulation and install energy-efficient windows are expected to save approximately 25% on annual gas consumption.

The measures are primarily funded through the municipal budget, government programmes, and international support. These activities directly contribute to increasing energy efficiency in the city, reducing greenhouse gas emissions, and optimising citizens' energy costs. At the same time, the measures also provide co-benefits such as increased comfort and enhanced local energy independence (Table 70).

Table 69. Priority measures for energy efficiency and renewable energy for Khachmaz city

Action	Estimated investment (AZN)	Annual energy consumption (MWh)	Expected savings (%)	Coverage (%)	Annual saving (MWh)	CO_2 reduction (tCO_2e/year)	Funding sources
Thermal insulation + energy-efficient windows	1,200,000	200450	25	10	5011	2991	Municipal budget, government programmes
Solar panels (electricity generation)	500,000	22000	10	3	66	39.4	International support, government programmes
Smart management system	150,000	22450	12	5	134.7	80.4	Government programmes, international support

6.9.2 Urban (public) lighting

General information

The street and park lighting systems under the municipality's responsibility are equipped with LED lamps. The street lights consist of LEDs with a power of 80–150 W, and the average distance between the lights is approximately 25 m. The park lights use LED lamps of various heights and numbers. There are 541 streetlights in the city, consuming approximately 200 MWh of electricity per year.

Project Description

The modernisation of the street and park lighting systems in the city of Khachmaz is one of the municipality's priority projects. Currently, the majority of the lights used in the city are based on LED technology. The street

lamps typically have a power rating of 80–150 W, and with each lamp operating for 12 hours per night, the daily energy consumption is approximately 1 kWh. In total, there are 541 street lamps in the city, and the annual energy consumption is approximately 200 MWh. Based on this consumption, the CO_2 emissions are 119.4 tCO_2e per year.

As part of the project, the street lights will be replaced with systems based on LED technology, and the wattage, placement, and operating hours of the lamps will be optimised to reduce energy consumption and emissions. The use of LED lamps not only saves energy but also reduces maintenance and replacement costs by extending the lifespan of the lamps.

In the parks, the lighting is provided by lamps at various heights and orientations. In Victory Park, there are lamps with heights of 2.5 m and 1 m, as well as 4-lamp systems with a height of 2.5 m. The Heroes' Park and the Animal Park, on the other hand, are equipped with smaller lighting systems with a spacing of 8–15 m. This measure ensures even illumination of the entire park area and also optimises energy consumption.

In our proposed model, the street and park lights are controlled by a system of smart sensors and a timer. Motion sensors and a timer programme reduce the light intensity on streets with low movement at night, while ensuring maximum illumination in high-traffic and frequently used areas. This approach significantly reduces energy consumption and reduces municipal expenditure.

The modern lighting system also meets public safety and aesthetic requirements. The positioning of the lamps ensures night-time safety in the city centre, streets, and parks, while the design is harmonised with the city's visual aesthetics. At the same time, well-lit public spaces create a pleasant environment for residents and tourists to relax.

The activities carried out under the project are aimed at increasing energy savings, reducing CO_2 emissions, and enhancing the social quality of the urban environment. The monitoring and maintenance of the lamps are carried out continuously to ensure that energy consumption and lighting quality are kept at an optimal level. This approach ensures both public comfort and sustainable, environmentally friendly lighting systems.

General objectives

The modernisation of Khachmaz city's street and park lighting systems serves several key objectives. The primary goal is to increase energy efficiency and reduce CO_2 emissions. By switching to LED technology and implementing smart control systems, the city uses electricity more effectively and reduces its annual energy consumption. This not only saves money for the municipal budget but also contributes to climate change mitigation.

The second objective is to ensure public safety and night-time comfort. The installation of street and park lights in accordance with modern standards, and the intensity and direction of the lamps, optimally illuminates areas where people move. This increases road safety at night, helps to prevent criminal incidents, and creates a safer environment for leisure in public spaces.

The third objective is to enhance the city's aesthetics and the visual quality of public spaces. The modern design of LED lamps and evenly distributed lighting improve the city's visual appearance, increase the appeal of public spaces, and support tourism opportunities.

The fourth objective is the implementation of sustainable and long-term lighting systems. The use of modern lamps and sensor systems reduces maintenance costs, extends lamp life and ensures sustained energy efficiency. Centralised management of the systems simplifies the monitoring and control of the lights, optimising operational costs.

The fifth objective is to ensure environmental and social benefits. The reduction in energy consumption, minimisation of CO_2 emissions, improved public safety, and the comfortable use of parks enhance residents' quality of life and strengthen the ecological sustainability of the urban environment. At the same time, the project provides long-term economic benefits for the municipality and ensures compliance with international climate standards.

Financial analysis

The proposed activities are planned to increase the energy efficiency of public lighting in Khachmaz city and reduce greenhouse gas emissions. Three main lines of activity are outlined:

- *Street lighting optimisation* – with the application of dimming functionality and sensor technologies, energy consumption will be reduced by 12% annually, resulting in savings of 24 MWh and a reduction in emissions of 14.33 tCO_2e.
- *Park lighting* – through the use of sensors and smart management systems, energy consumption is reduced by 35%, creating a potential saving of 17.5 MWh and a reduction in emissions of 10.45 tCO_2e.
- *A smart management and centralised sensor system* provides an additional 12% savings and a 3.58 tCO_2e emission reduction by centrally managing all public lighting.

These measures are funded through the municipal budget, government programmes, donor support, and international financial sources. As a result, not only are CO_2 emissions reduced, but electricity costs are also optimised, the safety of public spaces is increased, and the comfort level of the urban environment is enhanced. These additional benefits (co-benefits) provide a more sustainable and liveable environment for the city's residents.

Table 70. Smart and energy-efficient public lighting measures in Khachmaz city

Action	Estimated investment (AZN)	Annual energy consumption (MWh)	Expected savings (%)	Annual saving (MWh)	CO_2 reduction (tCO_2e/year)	Funding sources
Optimisation of street lighting (sensors, etc.)	200,000	200	12	24	14.33	Municipal budget, government programmes
Park lighting (sensors + smart control)	120,000	50	35	17.5	10.45	Municipal budget, donor support
Smart management and centralised sensor system	200,000	–	12	6	3.58	Government programmes, international support

Estimated investment (AZN) – B'

a) B’ = =

As the street lamps are LED, there is no investment in the lamps. Material, labour and installation costs for the park and sensor systems are added.

Source for the formula: SECAP Guidelines – Investment Cost Estimation for Street Lighting.

b) Annual energy consumption (MWh) – E_n

$E_{(annual)}$ =Number of lamps × Lamp power (kW) × Operating hours/day × 365 / 1000

- Street lighting: 541 lamps × 0.0844 kW × 12 hours × 365 / 1000 ≈ 200 MWh/year
- Park: approximately 50 MWh/year based on the number and power of the lamps.

c) Expected savings (%) – Q

The energy saving percentage recommended for sensors and optimisation in Q%=SECAP is as follows.

- Street lights: additional savings with sensors = 12%

- Park lamps: sensor + smart control = 35%

d) Annual saving (MWh) – Q_{annual}

$$Q_{annual} = E_{annual} \times Q\%$$

$$200 \quad h \times 12\% = 24 \text{ MWh/year}$$

e) CO_2 reduction (tCO_2e/year) – CO_{2a}

$$CO_{2reduced} = Q_{annual} \times EF$$

- Emission factor: 0.597 tCO_2e/MWh (for the Azerbaijani electricity grid).
- Street lamps: 24 × 0.597 ≈ 14.33 tCO_2e/year

6.9.3 Transport

General Information

In Khachmaz, the transport sector includes urban cars, public and commercial transport. The total number of vehicles is 4,009:

- Passenger cars: 3,466 units (2,943 petrol, 450 diesel, 17 gas, 1 electric, 52 hybrid, 7 plug-in hybrid)
- Lorries: 467 units (152 petrol, 308 diesel, 7 gas)
- Buses: 76 units (24 petrol, 51 diesel, 1 gas)

Description of activities

In Khachmaz, the transport sector includes urban cars, public transport, and commercial vehicles. The sector generates a high level of CO_2 emissions as a result of daily population movement and economic activity.

The total emissions amount to approximately 43.17 thousand tonnes per year, which constitutes the second-largest source of emissions for the city of Khachmaz.

Key measures to reduce emissions include promoting public transport, implementing fuel-efficient technologies, developing electric transport, and optimising traffic flows. These activities can significantly reduce CO_2 emissions, whilst also increasing the sustainability of transport in the city.

General objectives

- *Emission reduction:* Increasing fuel efficiency and promoting electrified transport.
- *Promotion of public transport:* Reducing the use of private cars by increasing the use of buses and minibuses.
- *Optimisation in freight and service transport:* More efficient logistics and the use of alternative fuels.
- *Sustainable urban planning:* Optimising traffic flows, reducing congestion and minimising CO_2 emissions.

Financial analysis

The measures presented are planned to reduce greenhouse gas emissions and increase energy efficiency in the transport sector of Khachmaz city. The measures are aimed at both public and private transport and are being implemented through various financial sources.

- *Promotion of public transport* – the acquisition of new buses and minibuses encourages intra-city travel. This measure has the potential to reduce emissions by 5,000 tCO_2e annually and is financed through the municipal budget, government programmes, and donor support.
- *Electric transport and charging stations* – electric buses and charging infrastructure enable a reduction of 3,500 tCO_2e in annual CO_2 emissions. Funding is provided by international funds and state support.
- *Implementation of fuel-efficient technologies* – fuel optimisation in diesel and petrol vehicles results in an annual reduction of 2,000 tCO_2e. This measure is implemented with municipal budget and donor support.

- *Optimisation of traffic flows* – operational efficiency is increased through training programmes and IT systems, reducing annual emissions by 1,000 tCO_2e. Funding is provided by the municipal budget.

As a result of these measures, the city's CO_2 emissions are not only reduced, but air quality also improves, fuel costs are optimised, and the resilience of the public transport system is strengthened. The measures also generate additional benefits (co-benefits), such as reduced noise and congestion, providing a more comfortable and environmentally friendly transport environment for city residents.

Table 71. Mitigation measures in the transport sector in Khachmaz city

Activity	Estimated investment (AZN)	CO_2 reduction (tCO_2e/year)	Financial sources
Promotion of public transport (new buses, minibuses)	1,200,000	5,000	Municipal budget, government programmes, donor support
Electric transport and charging stations	800,000	3,500	International funds, government support
Implementation of fuel-efficient technologies (diesel/petrol optimisation)	400,000	2,000	Municipal budget, donor support
Optimisation of transport flows (training, IT systems)	150,000	1,000	Municipal budget

Estimated investment (AZN)

B'=∑ (Investment per unit× Number of units to be implemented) + management and installation costs

- Investment per unit – for example, the price of one unit for a new bus, an electric car, or a fuel-efficient technology
- Number of units to be implemented – the number of units to be procured or optimised within the project
- Management and installation costs – costs for training, IT systems, installation and monitoring
- New electric buses: 20 units × AZN 50,000 + installation/management AZN 200,000 → AZN 1,200,000

CO_2 reduction (tCO_2e/year)

$$CO_{2\,reduced(tCO_2e/year)} = Q_{(fuel,\ saved)\ tonnes/year} \times EF_{fuel(tCO_2e/tonne)}$$

1. Q_n = Annual energy or fuel saved (MWh or tonnes of fuel equivalent nti)
    - Fuel or energy savings in the application of public transport or electrified transport
    - For example: 1 electric bus can save 10 tonnes of diesel in 1 year
2. EF = Emission Factor (tCO_2e/MWh or tCO_2e/tonne of fuel)
    - Assumed emission factor by fuel type
    - Diesel: 2.67 tCO_2e/tonne
    - Petrol: 2.31 tCO_2e/tonne
3. Calculation:

    Diesel saving 2,000 tonnes → CO_2 reduction: 2,000 × 2.67 = 5,340 tCO_2e/year

6.9.4 Waste management

General information

There are serious structural and organisational problems in the management of solid domestic waste in the city of Khachmaz. As a result of the lack of functional zoning in the city, industrial, transport, warehouse and other commercial facilities are located alongside or directly within residential areas. This leads to both violations of sanitary protection requirements and adverse effects on public health.

Many of the industrial enterprises in the city lack the required sanitary protection zones. In particular, the Khachmaz canneries, brewery, power junction, packaging factory, oil depot, railway station and bus station are located close to residential areas. The degree of hazard and the required sanitary zones for these facilities are indicated in the city's master plan.

The municipal solid waste landfill, the main facility for waste collection and disposal, does not currently meet sanitary standards. The landfill:

- It is located just 500 metres from the city centre;
- It is in direct contact with residential neighbourhoods;
- The site is not fenced and there is no control over access;
- Warning signs have not been installed;
- Only a small portion of the waste is sorted, while the majority is piled up unsystematically and burnt;
- Recycling activity is minimal (only 28 tonnes of cardboard were collected in 9 months).

The other landfill, located outside the city limits, is also situated too close to the city, and no sanitary protection zone has been considered. Food waste constitutes the majority of the waste, at 51%. Recently, an increase in the volume of waste has been observed (16 → 18 → 20 thousand m³ in 2015–2017).

This situation is consequently leading to the pollution of land, groundwater and atmospheric air, as well as posing a direct threat to public health.

Description of the activity

The solid household waste management initiative in the city of Khachmaz aims to address the shortcomings of the current system and to ensure that waste is managed safely and in an environmentally sustainable manner. The annual volume of waste generated in the city is approximately 20,100 m³, and most of this waste is transported to the municipal landfill. As the existing landfill does not meet sanitary and technical requirements, waste decomposition generates CH_4 emissions and other pollutants, adversely affecting the environment and public health. The risk of pollution is further increased as the site is unfenced, there is no control over access, and waste is haphazardly piled up and burnt.

The project entails a comprehensive improvement of the waste collection, transport, sorting, and disposal processes. Firstly, the landfill must be brought up to modern standards, the site fenced, access electronically controlled, warning signs installed, and the waste managed in a phased manner. The high proportion of food and other organic waste in the waste streams necessitates the establishment of a composting system. At the same time, sorting points are planned to be established for the separate collection of paper/cardboard, plastic, metal and glass waste, and for their transfer to recycling facilities.

This activity also aims to prevent waste incineration, minimise illegal dumping, and reduce the volume of waste sent to landfill. Optimising waste management logistics, deploying new containers and modernising the fleet are essential steps. Furthermore, public awareness campaigns will be conducted to promote source-separated waste collection.

As a result of the implementation of the activities, the efficiency of waste management will be increased, CH_4 emissions will be significantly reduced, the environmental situation in the city will improve, and non-compliance with sanitary protection standards will be gradually eliminated. This process will also make a significant contribution to increasing the city's overall sustainability and reducing health risks for the population.

General objectives

The primary objective of the activity to improve solid household waste management in Khachmaz city is to ensure that waste is managed safely, sustainably, and in accordance with regulatory requirements. An analysis of the existing waste infrastructure indicates that the processes of waste collection, transportation, and disposal do not meet modern technical, sanitary, and environmental standards. Therefore, the implementation of this activity encompasses broader objectives related to improving the city's overall ecological situation, reducing health risks for the population, and minimising the environmental impact of waste.

One of the main objectives is to increase the efficiency of the management system at all stages, from waste generation to final disposal. Implementing processes such as waste sorting, recycling, and composting will both reduce the volume of waste sent to landfill and allow for economic and environmental benefits from recycled resources. Furthermore, reducing methane emissions from decomposing waste, as well as strengthening safety measures at landfills, will ensure compliance with global climate objectives.

Another key objective is the creation or restoration of sanitary protection zones for industrial and household facilities. This step will protect residential areas from pollution and limit the negative impacts of industrial activities on the population. Preventing the illegal dumping of waste, controlling access, and optimising waste logistics routes are also among the overall objectives.

Finally, it should be noted that the objectives are aimed at both ensuring ecological sustainability and organising management processes in line with modern standards. As a result of these activities, institutional capacity for waste management in the city will be strengthened, the quality of life for the population will improve, and the city of Khachmaz will be provided with a safer and healthier living environment.

Financial analysis

The proposed measures are planned to reduce greenhouse gas emissions and increase the ecological sustainability of Khachmaz city in the field of waste management. The measures cover key areas such as landfill improvement, waste sorting and recycling, the establishment of composting plants, transport/logistics optimisation, and public awareness-raising.

- *The landfill upgrade* enhances safety and operational efficiency through fencing, an access control system, warning signs, and the phased installation of waste compartments. This measure contributes to an annual reduction of 500 tCO_2e and is funded by the municipality and the National Environmental Fund.
- *Sorting and container installation* – the separate collection of paper, cardboard, plastic, metal and glass waste and their dispatch to recycling facilities results in an annual emission saving of 1,000 tCO_2e. Funding is provided by the municipality and the private sector.
- *Construction of a composting plant* – reduces annual emissions by 2,250 tCO_2e through the biodegradation of food and other organic waste. This measure is funded by the National Environmental Fund and international projects.
- *Transport/logistics optimisation* – waste transport, route optimisation and vehicle modernisation make waste transport more efficient, reduce costs, and also minimise operational emissions.
- *Awareness-raising campaigns* – inform the public about waste sorting and recycling, optimising waste streams and contributing to an increase in environmental awareness by creating long-term behavioural changes.

Overall, this package of measures enables the city of Khachmaz to achieve annual emission savings of 3,750 tCO_2e. The measures also provide co-benefits: soil and water conservation, improved urban aesthetics, and enhanced public health and well-being. Funding is provided from various sources – the municipality, national funds, international projects, and the private sector.

Table 72. Mitigation measures for waste management in Khachmaz city

Activity	Description	Quantity / tonnes	Estimated investment (AZN)	CO_2 reduction (tCO_2e/year)	Financial resources
Landfill upgrade	Fencing, access control, warning signs, phased placement of waste cells	–	250,000	500	Local council, National Environmental Fund
Sorting and containers	Separate collection of paper/cardboard, plastic, metal and glass waste and transfer to sorting and recycling facilities.	2,000	80,000	1,000	Local authority, Private sector
Composting plant	Biological decomposition of food and other organic waste	4,500	300,000	2,250	National Environmental Fund, International Projects
Transport/logistics	Waste transport, route optimisation, vehicle modernisation	8,000	120,000	–	Local council
Awareness campaigns	Public awareness-raising on waste sorting and recycling	30,100 people	15,000	–	Local council, International projects
Total	–	–	765,000	3,750	Various sources (Municipal + Foundation + International + Private)

6.10 Adaptation measures

6.10.1 Population and public health

In the city of Khachmaz, climate change directly affects public health. During the summer months, heatwaves, drought, and air pollution pose a serious risk, particularly to vulnerable groups – children, the elderly, and those with chronic illnesses. Creating cooling zones in open public spaces and buildings ensures the population is protected from heat stress. These zones are located in schools, nurseries, and centres for the elderly, enhancing the comfort of the urban population.

Secondly, the importance of monitoring and early warning systems must be emphasised. Residents of Khachmaz must be promptly informed about severe weather events, floods, hurricanes, and heatwaves via SMS, mobile applications, and social media. These systems ensure the population can respond promptly to risks, mitigating the adverse effects of disasters. At the same time, within the public health monitoring framework, the potential spread of infectious diseases and water and air quality must be continuously monitored.

In the third phase, education and the promotion of public behaviour come to the fore. Residents should be informed about how to protect themselves from dehydration, physical impact, and heat-related risks when working and relaxing outdoors. Through public campaigns, seminars and brochures, the public acquires

knowledge on both disaster protection and maintaining a healthy lifestyle. These measures serve to reduce both short-term and long-term health risks (Table 74).

Table 73. Adaptation Measures to Climate Risks and Public Health Strategy

Type of activity	Description of the activity (Completely different for Khachmaz)
a. Health infrastructure	Reduce the risk of heat and dehydration in Khachmaz with the installation of shade and drinking water points in outdoor and public spaces. Provide safe recreational areas for children and the elderly.
b. Digital monitoring and alerting	Establish a city monitoring system that tracks information on weather conditions, heatwaves, flood and storm risks in real time and delivers it to residents via a mobile app.
c. Public Education and Behavioural Guidance	Use public campaigns, posters and social media to inform residents about how to protect themselves from the risks of heat, drought and air pollution. Explain to residents how to plan outdoor activities, manage water usage and take personal protective measures.
d. Environmental health measures	Enhance the microclimate by enriching Khachmaz's open spaces (parks, squares, riverbanks) with greenery. Also, monitor water quality and air purity using sensors and regular analyses.
e. Emergency preparedness	Develop urban evacuation plans, and organise shelters and relief centres to ensure the safety of the population during climatic events. Conduct training for volunteer and social groups.

6.10.2 Infrastructure

In Khachmaz, the resilience of infrastructure forms the basis of the city's defence against climate change. Roads, bridges, and transport systems must be protected from extreme events such as floods, inundations, and drought. Drainage systems that ensure the safe flow of water within the city during rain and floods enhance infrastructure resilience and help to maintain the smooth operation of transport. Providing shade and cooling facilities at pedestrian and bus stops enhances the comfort of both residents and tourists.

The energy and electricity grid must also be fortified against climate risks. Installing underground cables and providing backup power sources is crucial to prevent power cuts during storms, heavy rainfall, and heatwaves. The use of solar and wind energy enhances the city's energy diversification and helps to mitigate the effects of climate change. This approach ensures the resilience of both public and commercial buildings.

Furthermore, water and waste management systems must be modernised. The collection and reuse of rainwater, and equipping waste and sewage systems with modern treatment plants, ensures sanitation safety and environmental protection in Khachmaz. The availability of shelters and relief points during emergencies enhances urban resilience and population protection (Table 75).

Table 74. Measures for climate-resilient urban infrastructure

Type of activity	Description of activity
a. Sustainable road and transport infrastructure	Construction of rain, flood and drought-resistant roads, bridges and footbridges in Khachmaz and strengthening the existing network. Provision of bus stops and shade and cooling facilities for pedestrians.
b. Strengthening the energy and electricity network	Upgrading the city's power grid and installing underground cables and backup power sources to prevent power cuts during climatic events. Promoting the use of solar and wind energy.

c. Water management infrastructure	Creation of new drainage systems in Khachmaz for the collection and reuse of rainwater. Restoration of water diversion channels and natural water reservoirs to reduce the risk of flooding in river and coastal areas.
d. Waste and sanitation systems	Installation of modern treatment plants for the safe management of sewage and wastewater. Reducing landfills in the city and creating a waste sorting system.
e. Public safety and disaster infrastructure	Planning and signposting shelters, emergency relief points, and city evacuation routes for use during floods, storms, and other extreme events.

6.10.3 Urban greening

Urban greening is a key tool in combating climate change. The creation of new parks, boulevards, and recreational areas in Khachmaz provides the population with open-air leisure spaces and reduces heat stress. These areas also improve the city's aesthetic appearance, creating a pleasant environment for tourists and residents. Public parks and boulevards are intended as particularly safe recreational areas for children, the elderly, and families.

Enhancing streets and pavements with trees and shade-providing plants reduces the heat island effect and helps to improve air quality within the city. Green roofs and vegetated walls, in turn, reduce the heat load on buildings, minimise energy consumption and help regulate the microclimate. These measures not only enhance the city's overall sustainability but also provide aesthetic and ecological benefits.

The role of public participation is also highlighted. Involving residents in greening projects, voluntary tree-planting campaigns, and educational initiatives on plant conservation ensure long-term sustainability. At the same time, water-saving landscape designs enhance drought resilience and contribute to preserving the city's ecological balance (Table 76).

Table 75. Urban greening and microclimate mitigation measures

Type of activity	Description of the activity
a. Creation of parks and public green spaces	Establishing new parks, avenues and recreational areas in various districts of Khachmaz. Providing open-air recreational opportunities for children, the elderly and families.
b. Greened streets and roadsides	Planting trees, ornamental plants and shade strips along streets and roadsides throughout the city to soften the microclimate and reduce the heat island effect.
c. Green roofs and walls	Implement green roofs and vegetated walls on new and existing public buildings. This will help to absorb heat and purify the air.
d. Water-efficient landscape design	Conserve water supplies in parks and open spaces by using drought-resistant native plants and drip irrigation systems.
e. Public education and participation	Educate residents on greening and plant conservation, and involve them in tree planting and maintenance through volunteer programmes.

6.10.4 Biodiversity

The biodiversity of Khachmaz city and its surrounding areas is a key element in resilience to climate change. The protection and restoration of forests, riverbanks and coastal zones provides habitats for animal and plant species. These measures serve to preserve the city's ecological balance.

The creation of green corridors connects urban and rural areas, ensuring animal movement and genetic diversity. The sustainable management of river and coastal ecosystems reduces pollution and supports the

survival of fish and other aquatic life in water bodies. These measures are important both ecologically and economically, as biodiversity also contributes to tourism and agriculture.

Conserving native plant and fruit varieties and promoting biodiversity in agricultural areas enhances environmental resilience. Reducing the use of pesticides and chemical fertilisers, implementing biological control methods, and protecting agroecosystems ensure the resilience of agriculture and also strengthen urban ecosystems' resilience to climate change (Table 77).

Table 76. Strengthening green infrastructure and ecological resilience in Khachmaz city

Type of activity	Description of the activity
a. Protection of natural habitats	Protection and restoration of ecosystems in forest, river and coastal areas. Preventing the destruction of habitats for wild plant and animal species.
b. Creation of green corridors	Establishing green corridors connecting forests, parks, and water bodies in the urban and rural areas of Khachmaz. This will ensure animal movement and gene flow.
c. Protection of endemic and local species	Monitoring and protecting native plant varieties, rare and protected animal species. Establishment of nature reserves and protected areas.
d. Sustainable management of water ecosystems	To protect water quality in the Gudyalchay and other water bodies, creating conditions for the survival of fish and other aquatic ecosystems. Preventing pollution and controlling waste runoff.
e. Promotion of agrobiodiversity	Planting local plant and fruit varieties in agricultural areas to reduce the use of pesticides and chemical fertilisers. Creating a balance between agriculture and natural landscapes to enhance biodiversity.

7. Energy poverty assessment and social impact analysis (EPOV)

7.1 Methodological introduction

Energy poverty is an assessment of the principle of 'affordable and clean energy for all', one of the United Nations' Sustainable Development Goals (SDG 7), in the context of Khachmaz city. This assessment has been conducted within the framework of indicators proposed by the European Commission's Energy Poverty Advisory Hub (EPAH). The main objective of the analysis is to identify the following key risks in the city of Khachmaz, which has a population of 45,000:

- Inadequate heating/cooling of homes due to financial hardship.
- A large proportion of household income being directed towards energy costs (the '2M' indicator).
- Limited access to efficient public transport.

7.2 Analysis of energy consumption and material load

An in-depth analysis of the presented statistical data reveals the following critical findings:

Gas dependence and heat load: in the residential buildings sector, natural gas consumption amounts to 165,613.3 MWh, approximately 48 times greater than electricity consumption (3,480 MWh). This disproportion shows that the population's budget is directly dependent on gas tariffs and on weather conditions during the winter months. Since a large proportion of buildings are energy-inefficient (heat loss), low-income households are at risk of facing a 'heat or eat' dilemma.

Emission intensity: the buildings sector is responsible for 50.99% of total emissions (50,472 tCO_2e). This high share demonstrates that energy poverty in the city is primarily rooted in the housing sector.

7.3 Transport poverty

Khachmaz's transport indicators show that the population faces high mobility costs.

Fuel-type dependency: of the 3,466 passenger cars, 2,943 run on petrol and 450 on diesel. The presence of only one electric vehicle indicates that the transition to green transport is not yet accessible to the population, owing to financial barriers such as the high purchase price.

Weakness of public transport: the availability of only 76 buses is insufficient for a population of 45,000. This drives residents towards more expensive private transport or taxi services, which is a key factor creating 'transport poverty'.

7.4 Structural analysis of vulnerable groups

An analysis of the ethnic and social composition shows that Khachmaz is a multicultural and densely populated city. The population has increased from 22,000 to 45,000 since 1970, which has increased pressure on the housing stock:

Older Housing Stock: Pensioners and families with multiple children living in non-insulated, Soviet-era buildings in the central part of the city are in the highest risk group.

Service Sector: Service-sector buildings account for 21.14% of the natural-gas consumption and related natural-gas emissions recorded in the buildings inventory. Small business owners in this sector are vulnerable to rising energy costs, which indirectly affects the stability of jobs.

7.5 Action Plan and objectives for 2026–2030

The following strategic steps have been identified to eliminate energy poverty (Table 78):

"Green Building" Subsidies: Development of small-scale grant/support programmes at the municipal level for window replacement and roof insulation in buildings inhabited by low-income households.

Energy Awareness Centre: The establishment of a consultancy service to teach the public how to save energy and make effective use of the subsidised allowances provided by the state.

Collective Solar Projects: Redirecting energy generated by solar panels installed on the roofs of municipal buildings (with a total emissions share of 0.1%) to nearby vulnerable households or for street lighting (with a share of 0.12%).

Modernisation of Public Transport: Replacing at least 10% of the bus fleet with electric or hybrid vehicles by 2030.

Table 77. Areas of action and objectives for energy efficiency and social support measures

Area	Measure	Objective
Buildings	Thermal insulation of old buildings	To reduce energy loss
Buildings	Install energy-efficient heating systems	Heat provision for low-income households
Public sector	Installing solar panels	Reducing electricity costs and RES usage
Transport	Electric buses / SUMP	Reduce fuel costs, reduce carbon emissions
Socio-economic	Subsidies / social assistance	Energy support for low-income households
Public participation	Information campaigns	Consumer awareness of energy efficiency

7.6 Conclusion and monitoring

Reducing energy poverty in Khachmaz city is important not only for climate targets, but also for the social well-being of the population. Monitoring is planned annually during the implementation of the plan to analyse the results and to achieve a reduction in emissions.

Appendix 1. Detailed Table of Actions

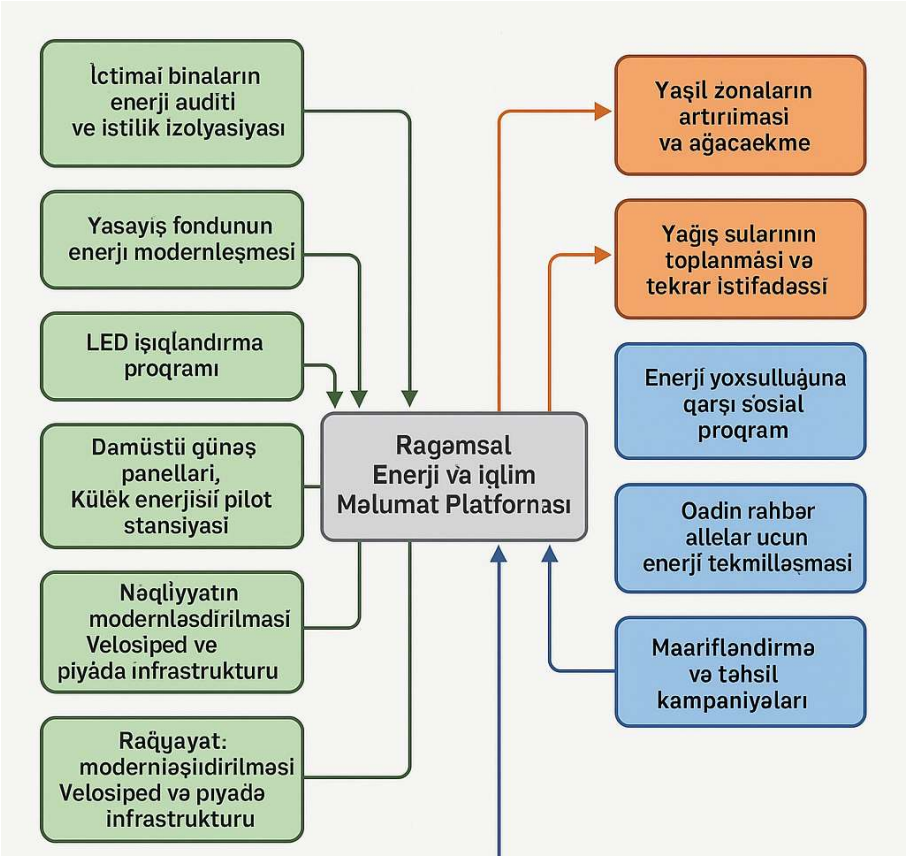
This table presents the initial package of measures for the city of Khachmaz, formulated based on the Task 1 results. The measures are grouped into three strategic pillars (Mitigation, Adaptation, Energy Poverty) and are presented in a structure aligned with the CoM 2025 guide.

No.	Name of the measure	Brief description of the measure	Category (Pillar)	Expected impact and outcome	Responsible body / partners	Estimated implementation period	Key Performance Indicators (KPIs)
1	**Energy audit and thermal insulation of public buildings**	Thermal insulation and energy efficiency measures in schools, hospitals and administrative buildings	Mitigation	Annual energy savings of 15–20 GWh, a reduction of 5–6 thousand tonnes of CO_2	Khachmaz Municipality, MENR, Ministry of Energy of the Republic of Azerbaijan	2026–2028	Energy saving (MWh/year), CO_2 reduction (t/year)
2	**Energy modernisation of the housing stock**	Renovation of roofs, windows and heating systems in old residential buildings	Mitigation	10% reduction in household energy costs	Municipality, NGO, Housing and Utilities System	2026–2030	Modernised flats (number), savings (%)
3	**LED Lighting Programme**	Full replacement of street and public space lighting with LED lamps	Mitigation	Annual energy savings of approximately 48 MWh and an estimated GHG reduction of 28.36 tCO_2e/year	Municipality, Azerishiq JSC	2026–2027	Share of LED systems (%), energy savings (MWh)
4	**Roof-mounted solar panels (PV)**	10 MW PV systems in public buildings	Mitigation	approximately 7,164 tCO_2e/year reduction, 12 GWh	Ministry of Energy of the Republic of Azerbaijan, AREA, Private sector	2026–2030	PV installed capacity (MW), generation (MWh)

				renewable energy per year			
5	**Wind energy pilot station (Yalama–Nabran)**	Installation of small power turbines and testing in the coastal zone	Mitigation	Local energy production, 1,000 t CO_2 reduction	AREA, MENR	2027–2030	Installed turbines (number), CO_2 reduction
6	**Modernisation of transport**	Deployment of electric and hybrid buses, 20% renewal of the bus fleet	Mitigation	10,000 t CO_2 reduction, improved air quality	relevant transport authority, Khachmaz District Executive Authority, Municipality	2026–2030	Electric buses (number), CO_2 reduction
7	**Creation of cycling and pedestrian infrastructure**	10 km of cycle and pedestrian paths in the city centre	Mitigation	Reduction of transport emissions, improvement of public health	Municipality, NGOs	2026–2028	Length of routes (km), level of use (%)
8	**Increasing green spaces and tree planting**	Increasing urban greenery by 20%, restoration of parks and boulevards	Adaptation	Reduction of the heat island effect, improvement of air quality	MENR, Municipality	2026–2035	New green spaces (ha), CO_2 absorption potential (t/yr)
9	**Rainwater harvesting and reuse**	Rainwater harvesting systems and filtration	Adaptation	Water resource conservation, flood risk reduction	State Water Resources Agency of Azerbaijan, Municipal	2026–2030	Systems installed (number), water collected (m^3)
10	**Monitoring of flood risks (Gudyalchay basin)**	Monitoring of risks with sensor and observation systems	Adaptation	Disaster risk reduction	MENR, Hydrometeorological Service	2026–2028	Number of installed sensors, number of alerts

11	**Soil and agricultural adaptation**	Drought-resistant varieties, agroforestry belts	Adaptation	10–15% increase in productivity	Ministry of Agriculture, MENR	2025–2035	Number of varieties (number), yield (%)
12	**Social programme against energy poverty**	Support for low-income households with energy-efficient appliances and insulation	Energy Poverty	1000 households to be covered, reduction in expenditure	Municipality, Ministry of Labour, NGOs	2026–2030	Families supported (number), energy burden (%)
13	**Energy improvements for female-headed households**	Modernisation in households selected on the principle of gender equality	Energy Poverty	Increasing gender balance, social inclusivity	Municipality, NGO, DMA	2026–2030	Female-headed households (number), participation rate (%)
14	**Awareness and education campaigns**	Public awareness-raising on 'green energy' and climate	Energy Poverty / Adaptation	Public awareness and behavioural changes	Municipalities, Ministry of Education, NGOs	2025–2030	Number of events (number), number of participants (number)
15	**Digital Energy and Climate Data Platform**	Tracking BEI, RVA and KPIs in a single system	All pillars	Expansion of monitoring and reporting capabilities	Municipality, MENR, Statistical Office	2026–2032	Platform activity (%), number of reports (number)


Güneş panellari
Veydelk turbinleri
İctimai binalarda istillk izolyasiyası
Velosiped yolları
Yağış şularının toplanması
Yaşıl zonaların genişlandirilmesi
Çeşidleme və takrar emal
Yaşıl zonaların genişlandirilmesi
Elektrik avtobuslar


İctimai binaların enerji auditi ve istilik izolyasiyası
Yasayiş fondunun enerjı modernleşmesi
LED işıqlandırma proqramı
Damüstii günəş panellari, Külək enerjisií pilot stansiyasi
Nəqliyyatın modernləsdirilmasi Velosiped ve piyàda ınfrastrukturu
Rağyayat: moderniəşiidirilməsi Velosiped və pıyadə infrastrukturu
Ragəmsal Enerji va iqlim Məlumat Platforması
Yaşil zonaların artırıimasi va ağacaekme
Yağış sularının toplanmàsi və tekrar istifadassï
Enerjí yoxsulluąuna qarşı sosial proqram
Oadin rahbər allelar ucun enerjí tekmilləşmasi
Maarifləndirmə və təhsil kampaniyəları

Appendix 2. Gantt Chart of the Action Plan (2025–2035)

Code	Action name	2025	2026	2027	2028	2029	2030	Brief Note
M1	Energy rehabilitation of public buildings	●	●	●	●	●	✓	15 GWh/year saving
M2	Energy efficiency of residential buildings		●	●	●	✓	✓	Programme on HOAs
M3	LED street lighting	●	●	✓				Full transition in 2027
M4	Solar PV systems		●	●	●	●	✓	10 MWp capacity
M6	Electric transport			●	●	●	✓	20% of the vehicle fleet to be electric or hybrid
A1	Stormwater management	●	●	●	●	✓		Reducing flooding incidents
A3	Caspian coast erosion management			●	●	●	✓	Long-term protection
S1	Insulation in social housing	●	●	●				500 flats
S2	Energy-efficient appliances voucher programme		●	●	●	●	✓	1000 families
A6	Early warning system	●	●	✓				Sensor and digital system

Symbols: ● – initial stage; ✓ – implementation and completion.

Source: Green Solutions and Consulting LLC, 2025.

Appendix 3. Estimated Budget and Sources of Funding (EUR)

Action group	Estimated cost (€)	Main sources	Description
Mitigation (M1–M9)	7,500,000	Municipality, State Programme, EU4Climate, GCF, private sector	Energy efficiency, renewable energy, transport
Adaptation (A1–A6)	4,200,000	MENR, FAO, IFI, State budget	Flood protection, water, drainage, coastal protection
Energy poverty (S1–S3)	1,100,000	Ministry of Labour and Social Protection of Population, donors, municipalities	Social support and awareness-raising
Management and monitoring	400,000	GIZ, EU Delegation	Secretariat, reporting and technical support
Total (10 years)	≈13,200,000	—	Average annual expenditure ≈1.3 million €

Note: The budget is preliminary; it will be calibrated based on the BEI and RVA results.

Appendix 4. Implementation and Monitoring Framework (Indicator Matrix)

Strategic objective	Key Performance Indicator (KPI)	2026 baseline	2030 target	Responsible body	Reporting mechanism
Reduction of CO_2 emissions	tCO_2e/year	100%	–35 %	Municipality, MENR	MyCovenant Portal
Energy efficiency	MWh/year savings	—	20–25 GWh	Ministry of Energy, Municipality	BEI update
Share of renewable energy	%	4%	20%	Ministry of Energy of the Republic of Azerbaijan, GSC	Annual report
Water loss level	%	35%	20%	Azerbaijan State Water Resources Agency	MENR Annual Report
Energy poverty	% of population	22%	17%	Ministry of Labour and Social Protection of Population of the Republic of Azerbaijan, Municipality	Social Indicators Database
Adaptation risks	Value of risk-related damage (EUR)	100%	–25 %	MENR, Ministry of Emergency Situations of the Republic of Azerbaijan (MES)	NAP monitoring system