Ministry of Natural Resources, Ecology and Technical Supervision
Kyrgyz Republic

Barriers Analysis and Enabling Framework Report

Part II
Technological Needs Assessment for climate change mitigation in Energy and Waste sectors

Supported by:

GREEN CLIMATE FUND

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

UN environment programme | copenhagen climate centre
supported by UNOPS

Bishkek, August 2023

Technology needs assessment (TNA) for mitigation
Barriers Analysis and Enabling Framework Report

National TNA Project Coordinator:
Mr. Azamat Temirkulov, Deputy Minister of Natural Resources and Technical Supervision of the Kyrgyz Republic, National Responsible Official for the UNFCCC, National Designated Person for the GCF.

Expert group:
Mr. Edilbek Bogombaev, Mitigation of the Energy Sector
Ms. Oksana Zabenko, Mitigation of the Waste Sector

UNEP Copenhagen Climate Centre TNA Coordination:
Mr. James Haselip
Mr. Paul Riemann

International TNA consultants:
Ms. Ala Druta, Republic of Moldova.
Mr. Yuri Matveev, Ukraine.
Ms. Jiska de Groot, South Africa.

Note
This publication is the result of a technology needs assessment project funded by the Green Climate Fund (GCF) and implemented by the United Nations Environment Program Copenhagen Climate Center (UNEP-CCC) on behalf of the Climate Technology Center and Network (CTCN). The views expressed in this publication are those of the authors and do not necessarily reflect the views of UNEP-CCC. We regret any errors or omissions that may have been made unintentionally. This publication may be reproduced in whole or in part and in any form for educational or non-commercial purposes without special permission from the copyright owner, provided the source is acknowledged.

Table of contents

List of illustrations

List of Table s

List of abbreviations

AGFCS	Automated gas filling compressor station
BGP	Biogas plants
CA	Central Asia
CFC	Climate Finance Centre at MNRET
CH	Central heating system
CNG	Compressed natural gas
DHU	Department of Housing and Utilities
EES	Energy Efficient Stoves (technology)
FEC	Fuel and energy complex
FER	Fuel and energy resources
GCF	Green Climate Fund
GDN	Gas distribution network
GDP	Gross domestic product
Gosstroy	State Agency for Architecture, Construction and Housing Utilities
HBO	LPG equipment
HPP	Hydropower plant
LPA	Logical problem analysis
LSG	Local government
MBT	Mechanical-biological waste treatment (technology)
ME	Ministry of Energy
MNRETS	Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution to the Paris Agreement
NGHIC	Use of Natural Gas for Heating Instead of Coal (technology)
NGOs	Non-governmental organizations
NLA	Normative legal acts
NSC	National Statistical Committee
PPP	Public private partnership
RES	Renewable energy sources
RSRS	Reception, storage and regasification station
SWOBGP	Use of solid organic waste for BGP (technology)
SW	solid waste
SWG	Sectoral working group
TAP	Technology Action Plan
TEB	Fuel and energy balance
TFS	Technical descriptions of technologies
TIPB	Thermal insulation of public buildings (technology)
TNA	Technology needs assessment
toe	Ton of oil equivalent
tce	Ton of coal equivalent
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNEP CCC	UNEP Copenhagen Climate Centre
UNFCCC	United Nations Framework Convention on Climate Change
WWOBGP	Use of waste water organic matter for BGP (technology)

Executive Summary

This report constitutes the deliverable of the second step of the "Technical Guidance and Support for Conducting a Sectoral Technology Needs Assessment (TNA) and Developing a Technology Action Plan for the Kyrgyz Republic" project. The project focuses on facilitating the transfer of climate mitigation technologies to Kyrgyzstan, specifically analyzing the prevailing obstacles and the conducive framework surrounding prioritized technologies within the Energy and Waste sectors. This document is the culmination of collaborative endeavours involving both national project experts and members of the Sectoral Working Groups (SWG), which encompass representatives from all relevant stakeholders within the designated sectors. As outlined in the project documentation, the TNA initiative encompasses three principal components or steps:

1. Identification and Prioritization of Technologies: This involves the identification and prioritization of technologies that align with Kyrgyzstan's mitigation and adaptation objectives, while also aligning with their national sustainable development aspirations and priorities.
2. Barriers and Enabling Frameworks: The project also focuses on recognizing barriers that impede the adoption and diffusion of prioritized technologies. It further entails devising enabling frameworks to surmount these barriers, facilitating the transfer, adoption, and diffusion of the selected technologies within the country.
3. Technology Action Plans (TAPs): This step entails crafting Technology Action Plans (TAPs) that outline specific activities, grounded in the developed enabling frameworks.

These activities are intended to foster the transfer, adoption, and diffusion of the selected technologies across sectors and cross-cutting domains. In addition, given that this project is funded through the GCF Readiness Programme, three Concept Notes aligned with the GCF format will be developed. These Concept Notes will play a pivotal role in facilitating the Climate Technology Transfer for Kyrgyzstan.

The primary objective of this report and the entirety of the second project stage was to evaluate barriers, identify technologies suitable for Kyrgyzstan, and elaborate on strategies to address and surmount these barriers through various interventions. This assessment will also serve as the basis for formulating TAPs, guided by the identified and prioritized measures emerging from the barrier analysis. To ensure logical coherence between project components two and three, robust links will be established between the barriers identified in the analysis and the subsequent policies and plans outlined in the TAPs. These policies and plans are designed to promote the transfer and diffusion of climate technologies.

This report comprises two chapters and three annexes. Chapter 1 delves into the process and outcomes of the barriers analysis and the identification of enabling frameworks for the Energy sector. Chapter 2 expounds on the corresponding process and outcomes for the Waste sector. The compilation of extensive lists of barriers for three prioritized technologies within each sector was undertaken through an online survey among members of the Sectoral Working Groups (SWG), employing a specially developed questionnaire. Subsequently, stakeholder workshops were conducted to validate and categorize the compiled barriers. A simple method was employed to distinguish key barriers from non-key ones, aided by a second round of online surveys to assign importance scores to the identified barriers.

The identified barriers to technology transfer were assigned to the following main categories:

- Economic and financial
- Market conditions

- Legal and regulatory
- Institutional and organisational capacity
- Human skills
- Technical
- Information and awareness.

The respective barrier tables were compiled through the participatory process, accurately encapsulating the outcomes. These tables can be found in Annex I for the Energy Sector (refer to tables 7−10) and Annex II for the Waste sector (refer to tables 11−14).A comprehensive analysis was undertaken to determine the most suitable measures, This entailed an in-depth exploration of current practices at the national level, harmonized with international benchmarks. The national experts adeptly adopted a participatory methodology, engaging a diverse spectrum of stakeholders throughout the analysis process. The same methodology was adopted for the formulation of measures. These measures were identified by categorizing barriers and subsequently deliberated upon with the Sectoral Working Groups (SWG).Subsequently, employing a Logical Problem Analysis (LPA), the SWGs combined key problem components. The LPA method enabled a coherent analysis of interconnected elements, revealing links between problem components and external factors. The cause-and-effect relationships were graphically presented as problem trees, with the primary issue serving as the root problem, causes represented at the base of the diagram, and their corresponding consequences portrayed at the apex of the diagram. (Refer to Annex I for the Energy Sector: figures 7, 10, 13; and Annex II for the Waste sector: figures 16, 19, 22).LPA analysis was also applied to delineate the process of transitioning from problems to solutions. The outputs as objectives trees are presented in Annex I for the Energy Sector: figures 8, 11, 14); and in Annex II for the Waste sector: figures 17, 20, 23

Furthermore, a market mapping exercise was conducted for all prioritized technologies, aimed at enhancing the understanding of the local technology market Concurrently, the entire of market system was scrutinized, encompassing its three fundamental components: the establishment of a conducive business milieu, stakeholders engaged within market chains and their interconnections, and the roles played by service providers. The market mapping exercise revealed that supporting early adopters (start-ups), along with other entities, through governmental support and pilot initiatives, significantly contributes to facilitating the transfer and diffusion of climate technologies. These strategic initiatives are outlined in Annex I for the Energy Sector (refer to figures 2, 9, 12) and Annex II for the Waste sector (refer to figures 15, 18, 21).For a comprehensive overview of the identified barriers and the proposed measures to surmount them within the Energy and Waste sectors of Kyrgyzstan, please refer to Executive Summary Tables 1 and 2 below.

Table 1. Identified barriers and proposed measures to mitigation technologies transfer in the Energy sector

Categories of barriers	Barriers and measures	Technology 1. Use of natural gas for heating instead of coal (NGHIC)	Technology 2. Thermal insulation of existing public buildings (TIPB)	Technology 3. Energy efficient stoves for the residential sector (EES)
1. Economic and financial	Barriers	High cost of implementation for public use; Lack of concessional funding	The high cost of insulation material; Lack of funds in the budget for the implementation of measures	High cost of energy-efficient boilers and stoves; Lack of concessional funding
	Measures	Creation of a system for financial support of gas use at all stages (design, connection, equipment)	Increase in budget financing; Attracting investments based on public private partnership (PPP) projects	Creation of a system of concessional financing for the purchase of EE stoves
2. Legal and regulatory	Barriers	Bureaucratic system for obtaining permission to connect to natural gas networks; Lack of state support for the transition of the private sector to gas heating.	Lack of a state program for the implementation of this technology; Lack of a system of incentives for the introduction of energy efficient and energy saving measures	Lack of government support to scale up EE stoves Lack of technical requirements for low capacity boilers and stoves;
	Measures	Creation of a transparent and operational system for connecting to gas networks; Development and launch of a system of state support for the transition of the private sector to gas heating.	Development of a state program for the implementation of this technology; Creation of a system of incentives and encouragement for the introduction and use of energy efficient and energy saving measures	Formation of a system of state support for scaling the use of stoves; Development of technical regulations
3. Market conditions	Barriers	Lack of natural gas networks; Risk of termination of natural gas supplies from neighbouring countries	Lack of information about modern energy saving technologies in buildings; Low awareness of the safety of materials used for insulation.	Lack or low awareness of climate issues and benefits from EE stoves;
	Measures	Further implementation of the project on gasification of the country up to the level of 60%;	The work of the mass media and local self-government (LSG) to disseminate information about	The work of the media and LSG, stakeholders to inform about climate issues and benefits from the use of EE stoves

Categories of barriers	Barriers and measures	Technology 1. Use of natural gas for heating instead of coal (NGHIC)	Technology 2. Thermal insulation of existing public buildings (TIPB)	Technology 3. Energy efficient stoves for the residential sector (EES)
			modern energy-saving technologies in buildings	
		Conclusion of long-term contracts for the supply of natural gas at a fixed price with reliable partners.	Increasing awareness of the safety of materials used for insulation	
4. Institutional	Barriers	Not identified	Not identified	Lack of laboratories for testing boilers and stoves
	Measures	Not identified	Not identified	Creation of certified laboratories
5. Technical	Barriers	Not identified	Not identified	Relative design complexity for manufacturers
	Measures	Not identified	Not identified	Establishment of mass production to master the manufacture of stoves and reduce their cost
6. Capacity building /human skills	Barriers	Not identified	Low awareness among decision makers about climate issues and energy saving benefits in existing public buildings Low qualification of thermal insulation personnel	Lack of skills in the operation of EE stoves by users
	Measures	Not identified	Raising awareness among decision makers about climate issues and the benefits of energy conservation in existing public buildings	Conducting mandatory initial training in the operation of EE stoves by users -
			Training and advanced training of personnel for thermal insulation	
7. Information and awareness	Barriers	Low awareness of the climate benefits and positive impacts of natural gas use	Not identified	Not identified

Categories of barriers	Barriers and measures	Technology 1. Use of natural gas for heating instead of coal (NGHIC)	Technology 2. Thermal insulation of existing public buildings (TIPB)	Technology 3. Energy efficient stoves for the residential sector (EES)
	Measures	Launch of an ongoing program to raise awareness of the climate benefits and positive impacts of natural gas		

Table 2. Identified barriers and proposed measures to overcome them for the technology transfer in the Waste sector

Categories of barriers	Barriers and measures	Technology 1.Mechanical and biological treatment of TO (MBT)	Technology 2.Use of solid organic waste for biogas plants (SWOBGP)	Technology 3.Use of waste water organic matted for biogas plants (WWOBGP)
1. Economic and financial	Barriers	High investment and operating costs	High investment and operating costs	High investment and operating costs
		No tariffs for the collection, processing and disposal of waste	Low tariffs for recycling and waste disposal	Low tariffs for water consumption and sanitation
	Measures	Attracting investments	Attracting investments	Attracting investments
		Revision of tariffs for garbage collection, support and development of the recycling sector.	Revision of tariffs for garbage collection, support and development of the recycling sector.	Revision of tariffs for water consumption and sanitation
2. Market	Barriers	Unauthorized removal of the useful fraction of waste (secondary raw materials) from waste collectors, garbage collection chambers and specialized vehicles for garbage disposal.	Lack of organization of a rational waste collection system that provides for the separate collection of food waste.	Not identified
			Insufficiency of raw materials for biogas plants.	Not identified
	Measures		Organization of a rational waste collection system that	Not identified

Categories of barriers	Barriers and measures	Technology 1.Mechanical and biological treatment of TO (MBT)	Technology 2.Use of solid organic waste for biogas plants (SWOBGP)	Technology 3.Use of waste water organic matted for biogas plants (WWOBGP)
		Amend the Law on Production and Consumption Wastes to ban unauthorized removal of useful fraction from waste collectors (secondary raw materials) from waste collectors, garbage collection chambers and specialized vehicles for garbage removal.	provides for the separate collection of food waste at the places of their formation.	
			Development of a network for the supply of food and green waste to the location of biogas plants.	
3. Regulatory and legal	Barriers	Imperfection of the legal base in the field of management of municipal solid waste and secondary resources.	Imperfection of the legal framework in the field of management of municipal solid waste and secondary resources.	Absence of a sectoral normative legal act on the regulation of tariffs in the sector of domestic and drinking water supply and sanitation.
		Lack of regular observations on the composition and amount of waste (morphological composition), accumulation rates, density.	There is no concept of secondary raw materials, processing, biogas and corresponding specific policies in this area.	
	Measures	Revision of legislation on the procedure for waste management, including separate collection, sorting, processing.	Revision of legislation on waste management, including the efficient use of food and green waste.	Develop a sectoral regulatory legal act on the regulation of tariffs in the sector of domestic and drinking water supply and sanitation.
		Implementation of monitoring of changes in morphological composition, study of accumulation rates, density of municipal solid waste.	Introduce such concepts as: secondary raw materials, processing, biogas, etc. into the law on production and consumption waste and relevant specific policies in this area.	

Categories of barriers	Barriers and measures	Technology 1.Mechanical and biological treatment of TO (MBT)	Technology 2.Use of solid organic waste for biogas plants (SWOBGP)	Technology 3.Use of waste water organic matted for biogas plants (WWOBGP)
4. Institutional	Barriers	Lack of a strategy/program for the sustainable management of waste and secondary resources	Lack of a strategy/program for the sustainable management of waste and secondary resources	Lack of a strategy/program for the sustainable management of waste and secondary resources
	Measures	Development of a strategy/program for the sustainable management of waste and secondary resources.	Development of a strategy/program for the sustainable management of waste and secondary resources.	Development of a strategy/program for the sustainable management of waste and secondary resources.
5. Capacity Building / Human Skills	Barriers	Lack of specialists in sustainable waste management.	Lack of specialists in sustainable waste management.	Lack of specialists in sustainable waste management.
	Measures	Increasing the capacity of colleges, universities in the field of sustainable waste management by introducing specialties in sustainable waste management.	Increasing the capacity of colleges, universities in the field of sustainable waste management by introducing specialties in sustainable waste management.	Increasing the capacity of colleges, universities in the field of sustainable waste management by introducing specialties in sustainable waste management.
6. Technical	Barriers	Low technical standards for waste management.	Lack of technical standards for the handling and processing of food waste.	Lack of technical expertise in the installation and maintenance of biogas plants.
			Lack of technical expertise in the installation and maintenance of biogas plants.	
	Measures	Development of special requirements for waste processing enterprises, as well as processing technologies.	Development of special requirements for waste processing enterprises, as well as processing technologies, regulations for handling food waste at public catering enterprises.	Increasing the role of Gosstroy in providing advice to expand and ensure regular training of personnel and organize the exchange of best practices in design and surveying.
			Increasing the role of Gosstroy in providing advice to expand and ensure regular training of	

Categories of barriers	Barriers and measures	Technology 1.Mechanical and biological treatment of TO (MBT)	Technology 2.Use of solid organic waste for biogas plants (SWOBGP)	Technology 3.Use of waste water organic matted for biogas plants (WWOBGP)
			personnel and organize the exchange of best practices in design and surveying.	
7. Information and awareness	Barriers	Low level of informing the population about the separate collection of municipal solid waste at the places of generation and collection.	Low level of public awareness about the separate collection of food waste at the places of generation and collection.	Lack of information about modern technologies for processing organic waste.
		Lack of awareness and understanding about sorting and recycling of solid waste on the part of the general population.	There is no information about the correct accumulation of organic waste.	Lack of information on good practices in the use of wastewater as feedstock for biogas plants.
	Measures	Increasing the level of public awareness about the separate collection of solid household waste at the places of generation and collection.	Creation of a manual on modern waste management and recycling technologies for municipalities and the population.	Raise awareness among decision makers about climate issues and the benefits of recycling.
		Organization of information campaigns, holding conferences, round Tables, exhibitions on the topic of minimizing education and optimizing waste management.	Carry out a campaign to raise awareness and inform the public about how to properly accumulate organic waste, what containers to use for this, and how often and when the collection will be.	Studying and informing about the good practices of using wastewater as a feedstock for biogas plants.

1 Energy Sector

Introduction

The Kyrgyz Republic (KR) has sufficient reserves of fuel and energy resources: approximately 2% of the total energy resources of Central Asia, including large reserves of coal and about 30% of the region's hydropower resources, of which only a tenth is currently developed.[1]The potential opportunities of the fuel and energy complex (FEC) are being realized insufficiently; in the structure of the fuel and energy balance (FEB), the share of energy imports is 22%[2], which has a negative impact on the reliability of the energy and fuel supply of the country.

The enterprises of the fuel and energy complex are characterized by low economic indicators of development, physical and moral depreciation of the main equipment, a high level of energy losses, a constant shortage of financial resources, an increased accident rate in energy networks and, as a result, blackouts and undersupply of energy carriers to consumers in the country's economy.

At present, the socio-economic development of the country from the standpoint of energy efficiency is energy-intensive. Comparison of the indicator of energy intensity of the gross domestic product (GDP) with the best international practice according to the International Energy Agency shows its high value - 1.1 toe/1000US dollars with an average world value of 0.24 toe/1000US dollars and 0.22-0.74 toe/1000US in developing countries.[3]

The share of electricity generation by source in 2022 was: coal - 14%; HPP - 84.7%; renewable energy sources (RES) (including small hydropower) - 1.3%[4], the potential of solar and wind is practically not used. Nevertheless, Kyrgyzstan has taken a course towards the development of the Green Economy and has included climate change and environmental issues in all strategic documents.

The government is implementing a policy to support the development of renewable energy sources. The principles of the development of the "green economy" are laid down in all strategic documents, and the legislation provides for a number of mechanisms for state support of innovative and energy-saving technologies.

However, specific measures are needed to overcome barriers to the introduction of priority technologies in the energy production and consumption, and energy efficiency subsectors in order to contribute to the voluntary overall NDC target adopted in the Kyrgyz Republic in 2021 to reduce greenhouse gas emissions.

In order to organize the barrier analysis process, the established sectoral working group representing relevant stakeholders was briefed on the approaches used. National consultants applied a collaborative approach to analyse barriers and identify enabling measures based on the TNA Barrier Guidebook[5].

As an initial step in the barrier analysis process, a desk review of policy papers and other relevant documents was undertaken to identify the main reasons why the technology is not currently widely adopted and why neither the private nor the public sector has invested in it. Further, a consultation process was conducted with stakeholders through direct interviews and questionnaires.

[1] https://minenergo.gov.kg/ru
[2] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[3] https://minenergo.gov.kg/ru
[4] https://esep.energo.kg/?p=6434
[5] Nygaard, I. and Hansen, U.E., 2015. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2021/01/overcoming-barriers-to-the-transfer-and-diffusion-of-climate-technologies-2nd-edition.pdf

The implementation of selected priority technologies will reduce greenhouse gas (GHG) emissions, improve the environment, reduce energy consumption and, accordingly, fuel consumption in general. In addition, additional jobs will be created during construction and operation.

This report as the second stage of the technology needs assessment (TNA) project for the introduction of climate resilient (mitigation) technologies in Kyrgyzstan aims to analyze the existing barriers and an enabling framework for selected priority technologies in the energy sector, which are presented in Table 3.

Table 3. Categories of selected technologies[6]

Selected Technologies	Technology category	Classification
Natural gas for heating instead of coal	Market item	Widespread consumption
Thermal insulation of existing public buildings	Not a market item	Publicly offered commodity
Energy efficient stoves for the private residential sector	Market item	Widespread consumption

It should be noted that the distribution of consumer goods and capital goods is predominantly indirectly influenced by politically changing market conditions, while the distribution of publicly offered and non-market goods is directly influenced by political decisions taken by governments and public entities regarding the implementation of certain projects.

The proposed measures will be reviewed by senior officials to decide on inclusion in the Technology Action Plan (TAP), which will be presented in the third report on this TNA project in Kyrgyzstan.

[6]Classification by categories of market goods according to the UNEP Guidelines. Nygard, I. and Hansen, U.E., 2015. Overcoming Barriers to the Transfer and Diffusion of Climate Technology: Second Edition. UNEP DTU Partnership, Copenhagen. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2021/01/overcoming-barriers-to-the-transfer-and-diffusion-of-climate-technologies-2nd-edition.pdf

1.1 Preliminary target for technology transfer and diffusion

In the adopted National Development Program of the Kyrgyz Republic for the period 2018-2040, it is stated that ensuring environmental sustainability with the country's economic growth will be achieved by minimizing negative environmental impacts, and one of the priorities will be the transition to the use of high-quality fuels, which will reduce the level of emissions of pollutants and greenhouse gases[7].

From the preliminary list of proposed technologies, the following priority technologies in the energy sector were selected:

- Natural gas for heating instead of coal
- Thermal insulation of existing public buildings
- Energy efficient stoves for residential private sector.

The dissemination of priority technologies in the energy sector will help achieve the strategic goals of improving the environment and energy efficiency, set in strategic government documents.

Preliminary targets for priority technologies in the energy efficiency subsector are presented below.

- *For natural gas for heating instead of coal:*

The General Gas Supply and Gasification Scheme of the Kyrgyz Republic is a project implemented by Gazprom Kyrgyzstan since 2014, in which the main aspect is the development of the republican gas supply and distribution system to provide existing and prospective gas consumers. General goals for the development of gas supply until 2030: gasification of about 400 settlements and more than 845,000 apartments and households; construction of inter-settlement gas pipelines up to 2,750 km long; construction of gas distribution pipelines in settlements over 4,400 km. At the same time, the level of gasification of the republic is planned to be increased to 60% with the initial 20% and the current level of 35%.[8] Information about this project, based on the main strategic documents and taking into account the operational information of the Ministry of Energy of the Kyrgyz Republic for 2022, is presented in Table 4.

Table 4. Main measures for the implementation of the General Gasification Plan of the Kyrgyz Republic

No.	Measures for gasification of the Kyrgyz Republic until 2030
1	Reconstruction of sections of the main gas pipeline Bukhara gas-bearing region - Tashkent-Bishkek-Alma-Ata (MG BGR-TBA) and the Sokuluk compressor station (CS Sokuluk);
2	The construction of the North-South gas pipeline is the main direction for ensuring gas supplies to the south;
3	Autonomous gasification of consumers in Issyk-Kul and Naryn regions using compressed natural gas (CNG)
4	CNG production at 4 units in Talas, Kara-Balta, Tokmok and Osh
5	Supply of CNG to 16 reception, storage and regasification stations (RSRS) in regions where an autonomous gasification scheme is envisaged
6	Installation of modular refuelling units at gas stations;
7	Delivery of CNG to RSRS and gas stations by road infrastructure

[7] https://www.gov.kg/ru/programs/8
[8] https://kyrgyzstan.gazprom.ru/about/project/genshema/

No.	Measures for gasification of the Kyrgyz Republic until 2030
8	Reconstruction of existing gas distribution networks (GDN) in accordance with the results of a technical audit as well as the expected future demand for gas
9	Reconstruction of gas distribution facilities based on the results of the audit;
10	Reconstruction of 4 operating automobile gas-filling compressor stations (CNG filling stations).

- *For thermal insulation of existing public buildings:*

At present, the total floor area of public and administrative buildings in Kyrgyzstan is 7.7 million m^2.[9]According to the International Bank for Reconstruction and Development[10], the area includes 9,780 buildings of the public sector, which are divided into three main categories:

- educational institutions (schools, kindergartens, high schools and other educational institutions);
- healthcare institutions (hospitals, polyclinics and other small medical institutions);
- other buildings (including administrative buildings and social protection buildings).

Public buildings consume approximately 850 GWh of energy per year, which is 6% of the country's primary energy consumption. Approximately 70-88% of the energy used in public buildings is used for space heating, with 60% of all public buildings using electricity for space heating. According to the results of a series of energy audits, subject to the implementation of the selected energy efficiency measures, the total technical energy saving potential is 50–60% of total energy consumption, or 500 GWh per year.

In 2021 the republican economy consumed 3.138 million Gcal of thermal energy and 16,820 GWh of electricity. The largest consumer of electrical energy is the population and the sector of communal and cultural needs (64.4%). According to the National Statistical Committee (NSC), the main consumer of thermal energy is the sector that provides consumers with electricity, gas, steam and air conditioning (82.4%).[11]

In accordance with the draft Program "Introduction of Energy Saving and Energy Efficiency Policy in the Kyrgyz Republic for 2023-2027"[12] it is planned to achieve a reduction in the consumption of all types of fuel and energy resources (FER), ensuring their savings in the amount of 190.1 thousand tce (122.673 toe) by 2027, through an increase in the efficiency of energy consumption. It is planned to adopt a new energy saving program in the Kyrgyz Republic, with clearly defined nationwide energy saving goals: reducing overall energy consumption, which in most developed countries exceeds 1% per year.

- *For energy efficient residential stoves:*

For 2021 according to NSC,[13] the housing stock in the Kyrgyz Republic amounted to 85.6 million m^2.

Coal consumption in 2021 in the housing and communal services (HCS) sector, including the population, amounted to 918.8 thousand tons.[14] Currently, more than 70% of households[15] in the Kyrgyz

[9] http://www.stat.kg/ru/opendata/category/288/
[10]Roadmap EE Public buildings KG WB/ ESMAP 2019
[11] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[12] http://koomtalkuu.gov.kg/ru/view-npa/2254
[13] http://www.stat.kg/ru/opendata/category/48/
[14] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[15] https://www.undp.org/kyrgyzstan/publications/air-quality-bishkek-assessment-emission-sources-and-roadmap-supporting-air-quality-management

Republic are heated by coal. Solid fuel stoves or boilers are used in private homes that are not connected to a central heating (CH) system. Most stoves and boilers are characterized by low efficiency, which leads to an increase in coal consumption by 20-30% compared to more efficient models.

As a result of high levels of indoor air pollution and smog during the heating season in Bishkek due to the use of traditional stove models, the Kyrgyz Republic is one of the countries in the Central Asia (CA) region with the highest rates of air pollution-related disease.

The use of energy efficient stoves will save up to 35% of coal and solve the problem of air pollution, reduce GHG emissions, preserve health, family budget and avoid losses in the economy due to population diseases[16].

The draft program "Implementation of the Energy Saving and Energy Efficiency Policy in the Kyrgyz Republic for 2023-2027" provides for an increase in the efficiency of energy consumption through the development of measures to involve the population in energy efficiency activities, by stimulating the owners of individual residential buildings who have implemented energy efficiency measures.

Investments in energy efficiency and policies that support energy efficiency save citizens money, reduce dependence on energy imports and reduce environmental pollution in general.

1.2 Barrier analysis and possible enabling measures for Technology 1 “Natural gas for heating instead of coal” (NGHIC)

1.2.1 General description of NGHIC technology

Using cleaner fuels such as natural gas in private households can help make the transition to a cleaner future. Coal is one of the main sources of local environmental pollution and climate change. When burned to generate heat and electricity, the carbon content of coal is 2.2 times that of natural gas; this means that burning coal releases more than twice as much CO_2 as burning natural gas to produce the same amount of energy[17].

Also, the efficiency of natural gas stoves reaches 90%, and those using coal up to 60%. Comfort when using gas stoves is an order of magnitude higher, since there is no dirt, dust and waste, and gas equipment can operate automatically. Also, cooking can be carried out in cleaner rooms and meets sanitary standards.

Among the economic, environmental and social benefits of gasification of the private residential sector are savings in fossil fuels and building materials, and minimal environmental impact. According to the TNA Kyrgyzstan report, only a possible problem with the unstable supply of imported gas, as well as a possible reduction in investment in expanding the gas pipeline network in the country, can affect its effectiveness.

The use of this technology will also help solve the problem of smog in Bishkek.

1.2.2 Identification of barriers to NGHIC technology

This section of the report aims to explain what currently stands in the way of the widespread adoption of natural gas for heating instead of coal technology, and what measures can be taken to remove existing barriers and obstacles.

[16]97409-WP-P133058-Box391503B-PUBLIC-Heating-Sector-Assessment-Report-Rus-KYR 2015 WB
[17]https://www.imf.org/ru/Blogs/Articles/2020/12/08/blog-a-greener-future-begins-with-a-shift-to-coal-alternatives

The methodology for identifying barriers to priority technologies is briefly described in the introduction. Thus, in order to organize the process of analysing barriers, a sectoral working group (SWG) was created, representing the relevant stakeholders - representatives with special knowledge in the field of housing gasification technology in the private sector. The following organizations and experts from stakeholders were involved: Ministry of Energy, LLC Gazprom Kyrgyzstan, State Agency for Construction Architecture and Housing and Public Utilities, RES experts - Association of Renewable Energy Sources of Kyrgyzstan, National Academy of Sciences of the Kyrgyz Republic, JSC Electric Stations, were informed about the approaches used. National consultants applied a collaborative approach to analyse barriers and identify enabling measures based on the TNA Barrier Guidebook[18].

As an initial step in the barrier analysis process, a desk review of policy papers and other relevant documents was undertaken to identify the main reasons why the technology is not currently widely adopted and why neither the private nor the public sector has invested in it. Further, a consultation process was conducted with stakeholders through direct interviews and questionnaires.

After compiling a long list of barriers, stakeholder workshops were organized to test the barriers and group them into different categories (informational, social, technological, economic/financial, regulatory / legal). To identify the most important barriers, a simple method was used to group them into key and non-key barriers and criteria.

Barriers to technology adoption have been identified in the following main categories:

- economic/financial barriers;
- market barriers;
- regulatory/legal
- institutional barriers
- technological barriers;
- capacity/skill barriers
- information barriers.

To determine the appropriate measures, a detailed analysis of current practice at the national level, as well as taking into account the practice of the international level, was carried out. The national consultants applied a participatory approach to the analysis through involving a wide range of stakeholders in the process. The same procedure was applied to determine the measures. Measures have been identified based on grouped barriers and are summarized in Table 2.

Using logical problem analysis (LPA), the sectoral working groups were able to combine the key elements of the problems, apply logical analysis of interrelated elements, and identify links between problem elements and external factors. Cause and effect relationships were organized as a problem tree, with the main problem as the starting problem, causes at the bottom of the tree, and their consequences at the top of the diagram. LPA analysis has also been used to define the process for taking action to move from problems to solutions. LPA tools help to analyse problems systematically and logically and bring together all the elements of a problem to enable stakeholders to understand and delineate problems in a given area in detail. (See Annex I: fig. 7, fig. 8).

Also, for the sub-sectors, a market mapping analysis was applied in order to better understand the development opportunities of the local technology market. The whole system was considered in the context of its three main components: creation of a business environment; participants in market chains and communications, as well as service providers. Support for early adopters, as well as others, by

[18] Nygaard, I. and Hansen, U.E., 2015. https://tech-action.unepccc.org/wp-content/uploads/sites/2/2021/01/overcoming-barriers-to-the-transfer-and-diffusion-of-climate-technologies-2nd-edition.pdf

governments and through pilot projects is important to facilitate technology transfer and diffusion. (See Annex I: Fig. 6).

As a first step, a desk study of policy papers and other relevant documents was conducted for this technology in order to identify the main reasons why the technology is not currently widely adopted. The discussion raised questions about why the private and public sectors do not have enough financial incentives to implement gasification projects. A collaborative approach was taken to analyze barriers and identify incentive measures in the heat-to-heating subsector.

The consultation process was carried out through interviews, questionnaires and brainstorming during the workshop and online exchange of information. An initial long list of barriers, based on questionnaires, was sent to all members of the GWG. Barriers were grouped into different categories (economic and financial, market, political, legal and regulatory, problems in networking technology users/groups; institutional and organizational, human skills; social, cultural and behavioural; information and awareness; technical and other barriers). The initial list of barriers was supplemented by barriers proposed by the participants during the discussion, and the summary list was checked (see Annex I tab. 7. Categories and number of barriers identified.) During the screening, stakeholders made recommendations based on their own experiences. In conclusion, they were discussed and identified as key barriers by voting of the participants of the sectoral working group.

1.2.2.1 Economic and financial barriers

The technology "Use of natural gas for heating instead of coal", or gasification of the private residential sector in Kyrgyzstan, is financed at the expense of the investor's own funds - Gazprom Kyrgyzstan, which finances the construction of the main and distribution gas network in villages and cities. The state provides only conditions for the promotion of this technology.

In reviewing the economic and financial barriers presented in Annex I tab. 8, the working group discussed what is currently preventing widespread adoption of the technology. The conclusions are based on economic analysis. Both the elements and the dimensions of the barriers were taken into account. Since the main capital costs for the construction of gas infrastructure are borne by the investor, barriers were identified that constrain the consumer from using it.

The main economic and financial barriers identified to the diffusion of "Natural Gas for Heating Instead of Coal" technologies include:

- High cost: project development and technical documentation; connection to networks; gas heating equipment for a private residential building
- Lack of available (soft) loans for the use of technology and connection to natural gas networks.

According to the NSC KR, the average salary per month in the republic amounted to 311 US dollars (rate 1 $ = 85.64 soms)[19] while the average cost of connecting a residential building is about 1,175 US dollars[20] with an average distance of 30 m to the gas pipeline network. About 50% is the cost of purchasing gas heating equipment.

The possibility of attracting financial resources is a prerequisite for the implementation of the selected environmental technology, due to the fact that it is not commercial, and its payback period can be determined through indirect indicators that are pronounced during the heating season and will require a certain long time. So the heating period in the Kyrgyz Republic lasts an average of 6.5 months a year, and the savings from the transition from coal for natural gas appears only during this period, and the payback period for investments in the use of this technology increases accordingly.

[19] http://www.stat.kg/ru/statistics/trud-i-zarabotnaya-plata/
[20] https://kaktus.media/doc/475718_gazifikaciia_ili_novyy_telefon_sravnivaem.html

High interest rates offered by local banks are in the range of 19-29%[21], consumer loans, complicate the implementation of projects using the proposed technology. Financial policies and legislation determine duties and taxes that result in additional costs for suppliers. Such an environment is not conducive to creating an attractive investment climate and ultimately translates into high investment costs or lack of access to cheap capital by owners of the private residential sector.

Based on the mapping of the sub-sector market structure (Annex I figure 6), it can be assumed that the number of market participants (owners and suppliers of technologies, buyers and users of products, representatives of donor organizations/international organizations; consultants, non-governmental organizations (NGOs), associations, information providers) in the current technology market is low, since existing market opportunities do not provide suitable conditions for the participation of other key players (resource suppliers, service providers) in the market chain. In addition, business extension services (financial services, market information, etc.) are very weak and practically do not function in the market chain. An enabling environment also does not provide suitable opportunities for the development of a local technology diffusion market.

1.2.2.2 Non-financial barriers

Non-financial barriers to the diffusion of natural gas heating technology instead of coal were analysed by the workshop participants based on a summary of the initial long list of barriers (see Annex I tab. 8) in seven categories (market imperfections, legislative and regulatory requirements, networking/grouping of technology users, institutional and organizational factors, capacity and human skills, information and awareness, technical and other barriers). Finally, four key categories of non-financial barriers were voted on: political, legal and regulatory; institutional and organizational capacity, technical and information capacity and awareness. Explanations of the main reasons hindering the spread of technology (marked with scores of 4-5) are presented below.

- *Risk of interruption of natural gas supplies from neighbouring states.*

The main supplier of natural gas for Kyrgyzstan is the Russian supplier and owner of all gas networks in the country - Gazprom PJSC[22]. Gazprom Kyrgyzstan is its structural subdivision with its 100% share ownership. Due to the current political situation, PJSC Gazprom was subjected to certain economic sanctions by the EU countries, the USA, and others. Therefore, there are certain concerns about guaranteed and stable gas supplies at an average price of $210/1000m^3 [23] for the population in the future.

- *Lack of state support for the transition of the private sector to gas heating.*

The Program for the Development of the Green Economy in the Kyrgyz Republic for 2019-2023 noted that a serious problem is the lack of real regulatory and regulatory mechanisms that stimulate potential participants in the energy saving process, as well as the investment deficit and weak financial support from the state in the implementation of energy saving policy. As a result, the gap in energy efficiency between current and optimal energy consumption continues to grow, which can be achieved using existing energy efficient measures and technologies.[24]

- *Low awareness of climate benefits and impacts of using natural gas instead of coal*

It is also necessary to note the low awareness of the public about the possibilities and benefits of an energy-saving style of management and lifestyle. One of the most common problems is the low priority

[21] https://www.akchabar.kg/ru/loans/potrebitelskye/
[22] https://www.gazprom.ru/about/
[23] https://regultek.gov.kg/ru/activities/5/3
[24] https://mineconom.gov.kg/froala/uploads/file/91827e3f83f5a04a78e2dc827b7ef37f9a69b383.pdf

of energy issues in comparison with the alternative needs of consumers. Energy efficient products tend to be more expensive and less well known than alternatives.

The population is poorly informed about the benefits of using climate technologies in everyday life.

Gender aspects of the use of this technology are important, since the main users of gas in everyday life, as a rule, are women, and the creation of comfortable and obligatory conditions for them, within the framework of sanitary standards, provides a real improvement in the social conditions of household management.

1.2.3 Identified measures

Appropriate action identification is the process of analysing the necessary actions to be taken to overcome existing barriers to the implementation of the priority selected technologies. These measures should be extended throughout the territory of the Kyrgyz Republic where the GDN will be built.

In order to identify appropriate measures, a detailed analysis of current practice at the national level was carried out taking into account international experience. The national consultants applied a participatory approach to the analysis and by involving a wide range of stakeholders in the process. The measures were determined based on grouped barriers. LPA analysis was applied to the process of identifying measures to move from problems to solutions. (See an Objective tree in Annex I fig. 8.)

As a rule, measures are divided into two main groups: financial and non-financial measures, since it is important for policy makers which measures can be implemented through legal or other assistance, and which measures should be funded (by national or external institutions).

1.2.3.1 Economic and financial measures

The main economic and financial measures are to ensure reasonable transaction costs, the absence of duties on the import of technologies, new equipment and machinery, as well as low investment costs.

Natural gas projects for heating instead of coal can receive economic support from communities through co-financing or provision of necessary land and territories, local tax exemptions, interest-free loans or revolving funds.

A legal act should be adopted to ensure the operation of a system of financial support for the promotion of technology. The following measures have been proposed:

- Creation of a system for financial support to cover the cost of project development and technical documentation for connection to natural gas networks
- Creation of a system for financial support to cover the cost of work and material when connected to natural gas networks.
- Creation of a system for financial support and coverage of the cost of gas equipment for gas heating.
- Development of a project to attract foreign investment for the accelerated implementation of the gasification of the republic.

Thus, RSK Bank OJSC and Gazprom Kyrgyzstan LLC are already presenting a joint loan product called Gasification. Now there is an opportunity to receive funds on favourable terms for the installation of heating boilers at home and gas-balloon equipment (GBE) for vehicles.[25]

[25] https://24.kg/biznes_info/267674_gazifitsiruysya_vmeste_srsk_bankom_igazprom_kyirgyizstan/

Advantages of the loan: no collateral; amount - up to 1.5 thousand US dollars; reduced interest rate — 18% (effective rate — 19.51%). Loan term: for connection of gas heating boilers up to 24 months; for connecting HBO up to 12 months.

Also, a special offer from Gazprom Kyrgyzstan LLC for customers who have issued a loan before August 31, 2023: get a discount from the company up to 3 thousand soms for gasification services! The loan product "Gasification" was created in order to help the population of the country - individuals and individual entrepreneurs - to carry out gasification of their residential buildings and provide them with a reliable and economical source of energy.

It should be noted that the per cent rate applied in this example is still high for the population, the real rate required for scaling is no more than 5-10% per annum.

1.2.3.2 Non-financial measures

It is necessary to take comprehensive measures aimed at including energy in the strategic development plan, consolidate the ideology of using natural gas for heating instead of coal, and adopt a policy that activates the introduction of this technology. The non-financial measures identified during the working group meetings and workshops seem to be more important at this stage, the measures developed using LPA analysis.

Non-financial measures include sufficient awareness raising among communities and residents, conducting energy audits to recognize and promote the benefits of natural gas technology for heating instead of coal (for one or more residential buildings), developing infrastructure to support the project, and forming and developing partnerships homeowners). The concluded intergovernmental long-term agreements on gas supply and the adoption of an appropriate methodology for setting tariffs will create a favourable basis and environment for the dissemination of technologies. The following measures have been proposed:

- Further implementation of the Gazprom Kyrgyzstan project on gasification of the country to the level of 60%
- Creation of a transparent and operational system for the development of technical documentation for connecting to networks
- Conclusion of long-term contracts for the supply of natural gas at a fixed price with reliable partners.
- Planning measures for the transition to local ecological fuel, semi-coke after enrichment of local coals, in the future
- Development and launch of a system of state support for the transition of the private sector to gas heating.
- Launch of an ongoing program to raise awareness of the climate benefits and impacts of using natural gas instead of coal
- Creation of Funds for financing and issuing affordable (soft) loans for the purchase of gas equipment and connection to natural gas networks.

1.3 Barrier analysis and possible enabling measures for Technology 2 “Thermal insulation of existing public buildings” (TIPB)

The policy of energy saving and energy efficiency is developing in our country at a slow pace, although there is significant potential in the Kyrgyz Republic. The Program for Energy Saving and Energy Efficiency Policy Planning in the Kyrgyz Republic for 2015-2017, which included a section on energy saving and energy efficiency in buildings, has not been fully implemented. There are no programs to

support the reconstruction and repair of buildings at the level of cities, regions and the country as a whole.

Currently, the fund of public and administrative buildings, according to statistics, is 7.7 million square meters.[26] Separate groups of buildings in operation (residential buildings, schools, kindergartens, etc.) are in need of major repairs or reconstruction. In fact, more than 85% of the housing stock, 93% of school buildings, 81% of kindergartens, 77% of administrative buildings, 60% of hospitals, family medicine centres were built before 1991, when energy saving issues were not relevant.

1.3.1 General description of TIPB technology

The use of the "thermal insulation of existing public buildings" technology is very relevant for the republic. Public buildings in the Kyrgyz Republic consume about 850 GWh of energy per year, which is 10% of the country's primary energy consumption (10% of national energy consumption and 11% of total coal consumption), and the public buildings sector is one of the largest end-users of energy.

At present, specific energy consumption averages 162 kWh per square metre, while demand averages 250 kWh per square metre. Approximately 70-88% of energy consumption in public buildings is used for space heating, with electricity used for space heating in 60% of all public buildings. Subject to the implementation of the selected energy efficiency measures, the total theoretical energy saving potential will be 50–60% of the total energy consumption, or 500 GWh per year.[27]

Modernization of 5,000 buildings with a total area of 5.3 million square metres will require an investment of 1.085 billion US dollars. As a result, the entire stock of public buildings will be brought into line with the energy efficiency requirements of class B. According to the legislation of the Kyrgyz Republic in the field of energy efficiency of buildings, class "B" is the minimum required energy efficiency class (see Table 5).

Table 5. The main classes of energy efficiency of buildings in the Kyrgyz Republic.[28]

Climate zone		Characteristics of the heating season		Demand for thermal energy, kWh/m^2 per year (according to energy efficiency classes)						
		Average outdoor tempera-ture, C	Number of days	A	B	C	D	E	F	G
I	Osh, Jalal-Abad, Kyzyl-Kiya	+1.1	140	<24	24-48	49-164	165-280	281-350	351-420	>515
II	Bishkek, Tok-mok, Toktogul	+0.2	150	<41	41-81	82-212	213-343-	344-429	430-515	>515
III	Cholpon-Ata, Kant, Belo-vodsk, Kara-Balta, Balykchi, Talas, Karakol	+1.2	178	<44	44-88	89-235	236-382	383-478	479-573	>573
IV	Kazarman, Kochkor, Shabdan	-2.6	195	<195	63-125	126-320	321-514	515-643	644-771	>771
V	Ak-Tash, Ravat	-2.2	217	<54	54-107	108-319	320-531	532-664	665-797	.797
VI	Susamyr, Naryn, Doorot-Korgon, Chatkal	-6.0	192	<62	62-123	124-343	344-563	564-704	705-845	>845

[26] https://mineconom.gov.kg/froala/uploads/file/6a0723b1ddba1f85fce34897e6654f6765710262.pdf
[27] 97409-WP-P133058-Box391503B-PUBLIC-RUSSIABN-Heating-Sector-Assessment-Report-Rus-KYR-2015 WB
[28] Regulations of the Kyrgyz Republic "On the procedure for energy certification of buildings". 2012http://cbd.minjust.gov.kg/act/view/ru-ru/93706/10?mode=tekst

Energy efficiency index		Annual specific consumption kWh/m^2	
		Warm	Electricity
A		<45	<50
B		46-65	51-65
C		66-85	66-75
D		86-105	76-85
E		106-125	86-95
F		126-145	96-105
G		>146	>105

Figure 1. Building energy label.

1.3.2 Identification of barriers to TIPB technology

The barriers identified as a result of the analysis of the thermal insulation technology of existing public buildings are divided into 4 groups (out of 8 identified for the sector): financial, normative legal acts (NLA)/regulatory, information, and human skills. One of the main obstacles is the lack of a state program for the implementation of this technology and, accordingly, the lack of a system to stimulate and encourage the implementation and use of energy efficiency and energy saving measures in existing public buildings, which are important in terms of efficiency and aimed, in particular, at reducing greenhouse gas emissions.

Based on the results of the analysis of the technology market map (see Annex I, fig. 9), the main market participants for the technology were identified.

The analysis performed shows that, unlike the previous technology, non-financial barriers have more weight and are more relevant at the current stage.

An LPA-based problem tree for existing public building insulation technology is presented in Annex I, fig. 10. Market research has shown that the basis for this technology is adequate, but requires the development of a regulatory framework (NLA), institutional framework for further promotion and development, which is now being formed in accordance with the decisions of the Government.

1.3.2.1 Economic and financial barriers

The main economic and financial barriers to this technology were identified as:

- Lack of necessary funds in the budget for the implementation of measures to improve the thermal insulation of existing buildings;
- Lack of an incentive/encouragement system for the introduction and use of energy efficient and saving measures in public buildings;
- The high cost of thermal insulation and the lack of a financing and return mechanism.

Also, the main reason for the decline in the heating sector is the low tariffs for heat and electricity, which are well below the level of cost recovery. The lack of a real financial cost recovery mechanism is a major financial barrier to the technology. Depending on the source of heat supply, tariffs for the population, according to some estimates, range from 13 to 50% of the cost of heat energy.[29]

[29] http://www.teploseti.kg/content/articles_view/1024

As a result, most heat supply companies operate at a loss and do not have sufficient funds to provide proper maintenance and overhaul. This leads to continuous asset obsolescence, inefficiency and poor quality of service. As a result, the heating sector has become highly dependent on subsidies, both direct subsidies from the republican or municipal budgets, and cross subsidies from electricity (heat generation by combined heat and power plants or CHPs).

However, low electricity tariffs encourage the use of electric heating, discouraging end-users from investing in energy efficiency due to the long payback period for costly energy efficiency measures.

1.3.2.2 Non-financial barriers

At this stage, non-financial barriers to existing technologies are more relevant, starting from the readiness of state bodies to act and adopt a state program for the implementation of this technology. This includes a lack of information about modern technologies, building technical and energy saving potential, and as a result, low awareness of decision makers on climate issues and the benefits of energy saving in public buildings. Lack of awareness and capacity building about energy efficiency technologies in buildings is another set of barriers.

Barriers related to unskilled technical staff and insufficient training are also critical to the technology. The lack of specialists in energy audit of buildings and the lack of awareness about energy efficiency technologies in buildings, about the safety of materials used for insulation, are of vital importance.

1.3.3 Identified measures

Taking into account that the implementation of energy efficiency measures in the public sector has a great social significance and a great potential for reducing GHG emissions, and given that this sector requires large-scale and long-term investments that have a real payback period due to the high energy saving potential, the implementation of the program becomes possible and expedient due to working financial resources and attracting funds from both internal and external. The LPA based Objective tree for the thermal insulation technology of existing public buildings is presented in Annex I, Figure 11.

1.3.3.1 Economic and financial measures

To overcome the identified financial barriers, the following measures are planned. First of all, the allocation of additional funds from the budget for the introduction of technology in especially significant social facilities (hospitals, schools, kindergartens). Development of projects in order to receive investments from external donors. It is planned to adopt NLA with specific indicators to stimulate the public sector to introduce energy efficient measures in public buildings. One of the measures will be to provide support to local producers of thermal insulation materials, in order to reduce their cost, through financial preferences (stimulating taxes). Also the Government of the Kyrgyz Republic has already made a decision on a systematic phased transition to economic tariffs for electricity, and began with its increase by 30% for the population from May 1, 2023. [30]

1.3.3.2 Non-financial measures

To ensure high-quality overhaul or reconstruction of the existing building stock, including increasing the energy efficiency of buildings, cost efficiency, reducing the consumption (use) of energy resources and greenhouse gas emissions into the atmosphere, it is planned to create a sustainable system of legal regulation. Determine in the Housing Code of the Kyrgyz Republic the rate of mandatory payment to

[30] https://regultek.gov.kg/ru/press-center/news/44

capital repair accumulation funds, develop criteria for the priority of capital repairs and launch a program for major repairs of buildings in a pilot mode.

It is planned to develop energy security standards for social, educational and healthcare facilities. Mechanisms will be developed for obtaining loans for the implementation of major repairs, energy-saving projects and activities, as well as subsidizing energy audits and energy certification procedures for buildings, and mechanisms for working with energy service companies will be determined.

In addition, technical solutions will be developed and approved for the overhaul of standard buildings, for the implementation of which funds from savings can be used, as well as standard projects of energy-efficient private houses, which will help ensure an effective investment in improving the energy efficiency of buildings.

The task also includes the development of by-laws for the operation and maintenance of residential buildings and municipal buildings. This will create a modern system for efficient operation and maintenance, implement energy management systems based on the ISO 50001 standard, which will lead to reduction in energy consumption and a reduction in greenhouse gas emissions.

1.4 Barriers analysis and possible enabling measures for Technology 3 "Energy efficient residential stoves" (EES)

In the Kyrgyz Republic, only 15% of the housing stock is heated centrally, 40% of urban households use inefficient coal stoves/boilers for heating. 57% of individual houses in Bishkek and 66% in Tokmok use solid fuels. The low coefficient of performance (COP) of such heaters entails an increase in coal consumption by 20-30% compared to more efficient models. Inefficient technologies exacerbate the negative health and environmental impacts of coal use. On average, the population of the Kyrgyz Republic annually burns, according to the NSC KR, 929 thousand tons of coal of various qualities.

1.4.1 General description of EES technology

The prevalence of inefficient individual heating systems is a major problem for the urban heating sector in the Kyrgyz Republic. The use of energy efficient stoves with an efficiency of 80% for private households will reduce coal consumption by an average of 35%.

The energy efficient stove has longer coal burning, high combustion temperature, less harmful pollutants, higher energy efficiency, complete combustion of coal. The stoves are used for heating rooms with an area of not more than 100 m^2, they can also be used for cooking. Within the framework of the World Bank (WB) project, about 98,000 similar energy efficient stoves in Ulaanbaatar (Mongolia) were installed.[31]

The stove has the following advantages:[32]

- Increasing the temperature in the combustion chamber through the use of refractory bricks;
- In the combustion chamber, turbulence is created, allowing efficient combustion of CO (carbon monoxide) and other combustion products, which leads to an increase in heat generation;
- Increasing the duration of burning up to 8 hours due to the supply of fuel to a limited area;
- Efficiency > 80% (for comparison, the efficiency of stoves offered on the market is 25-50%).

[31]97409-WP-P133058-Box391503B-PUBLIC-RUSSIABN-Heating-Sector-Assessment-Report-Rus-KYR-2015 WB page 95

[32] https://www.camp.kg/publications/energy/2?

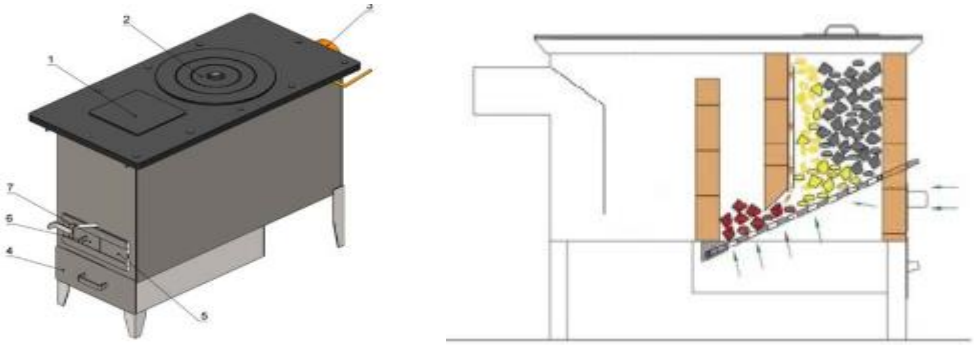

Figure 2. The view of energy-efficient stoves.

1.4.2 Identification of barriers to EES technology

As with other analyses, as an initial step in the process of identifying barriers, a desk review of policy papers and other relevant documents was conducted to identify the main reasons why the technology is currently being piloted and why neither the private nor the public sector has invested heavily in it.

Also, based on the results of the analysis of the technology market (see Annex I, fig. 12), the main market participants for the technology were identified.

Further, consultations were conducted with stakeholders through direct interviews and questionnaires. After compiling a long list of barriers, a stakeholder workshop was organized to test the barriers and group them into different categories (economic/financial barriers; market imperfections; regulatory/legal; institutional; informational; technological; social; barriers to capacity/skill building).

To identify the most important barriers, a method was applied to group them by score (from 1 to 5 in importance) and criteria such as initial, critical, important, less important and insignificant barriers.

Barriers to the adoption of energy efficient stove technology for the residential private sector were identified in five categories: economic/financial, institutional, legal/regulatory, information/awareness, technological, skills/capacity building.

The LPA based problem tree for energy efficient stove technology for the residential private sector is presented in Annex I, fig. 13.

1.4.2.1 Economic and financial barriers

After reviewing and analysing the data, the discussions identified the main financial barriers, such as:

- The high cost of energy efficient boilers and stoves in comparison with simple stoves;
- Lack of concessional financing for the purchase of energy efficient stoves;
- Lack of funds for the implementation of the project to scale up energy efficient stoves, as well as the lack of government support for this sector.

According to the NSC KR, 35.8% of the population of Bishkek[33]lives below the poverty line. For total permanent urban population as of January 1, 2021 equals 1069.5 million, this is about 382.9 thousand people[34]. With an average household size of 4.22 people in the Kyrgyz Republic, the number of energy efficient stoves in use could be approximately 90,730 units in Bishkek[35] as this category is in particular need of support. The average income of this category of the population is 77.62 US dollars per month

[33]http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/
[34]http://www.stat.kg/ru/opendata/category/39/
[35]https://ru.sputnik.kg/infographics/20181129/1042204610/kyrgyzstan-infografika-statistika-nacionalnyj-statisticheskij-komitet-semya-naselenie.html

per capita[36] (1$ = 85.64 soms), while the average cost of connecting a residential building to gas is about 1175 US dollars with an average distance of 30 m to the gas pipeline network. About 50% is the cost of purchasing gas heating equipment. Gas technology for this category of the population is expensive, and energy-efficient stove technology is a more affordable and economical option. It should also be noted that, as a rule, the use of central heating (CH) is not available, because mostly this group of the population lives in private houses.

Also during the discussions on the barriers, the working group concluded that the implementation of the technology may require financial support for some unavoidable costs, for example, for implementation of the technology it will be necessary to purchase and install the appropriate equipment (stoves, pipes, etc.). Financial support will be required to implement best practices, localize and adapt the technology. Another obstacle is the lack of mechanisms for economic incentives for technology.

1.4.2.2 Non-financial barriers

Non-financial barriers, after discussions in the working group, included:

- Lack or low awareness of climate issues and benefits from energy efficient stoves;
- Lack of technical requirements for low-capacity boilers and stoves;
- Lack of testing laboratories for boilers and stoves;
- The relative complexity of the design for manufacturers;
- Requirement of training in skills to operate energy efficient stoves by users;
- Lack of tax and customs preferences for imported energy-efficient boilers and stoves;
- Lack of government support to scale up the use of energy efficient stoves.

There are no certified laboratories in the Kyrgyz Republic to determine the energy efficiency of stoves, capacity, and GHG emissions. Among the barriers, one should also mention the lack of specialized human resources, the lack of technological experience and the low awareness of stove users about their operation and periodic maintenance.

1.4.3 Identified measures

Implementation of energy-efficient stove technology for the residential private sector requires a scalable program to introduce more efficient heating technologies on a small scale, including more efficient individual stoves, boilers and heat pumps.

International experience shows that such programs can bring significant benefits to residential customers in terms of reduced fuel consumption and costs, reduced indoor air pollution and improved comfort levels.

Such a program would also need to have high replication potential – both in urban and rural areas – given the large proportion of households currently using inefficient individual heating solutions. Replace inefficient coal stoves or boilers with more efficient models.

- For households that will have access to gas in the short term, inefficient coal-fired stoves or boilers will need to be replaced with individual gas-fired heaters or boilers.
- For residential consumers who will not have access to gas in the medium term, and who currently use traditional coal-fired stoves, the use of more efficient coal-fired models needs to be promoted.

[36] http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/

This could help reduce coal consumption by 25-35%, reduce indoor air pollution and improve comfort levels in buildings. As access to gas spreads, coal-fired boilers and stoves will need to be replaced with gas-fired models

An Objective tree based on the LPA analysis for energy efficient residential stoves is presented in Annex I, fig. 14.

1.4.3.1 Economic and financial measures

To overcome barriers, members of the working group proposed the following measures:

- Banks of the Kyrgyz Republic should develop and offer a loan product "Energy-Efficient Stoves" in the same way as for gasification of households.[37] Then the population will have the opportunity to receive funds on favourable terms for the installation of energy-efficient stoves and equipment for this technology. Advantages of the loan: no collateral; amount - up to 1.5 thousand US dollars; reduced interest rate - 5-10%. Loan term for the purchase of energy efficient stoves, equipment and materials for installation - 12-24 months.
- For the population living below the poverty line, it is necessary to install energy-efficient stoves on a grant basis, with the involvement of external donors.
- Allocation of funds from the budget and attraction of grant funds for the implementation of technology for the poor population.

The loan product "Energy Efficient Stoves" is needed to help the population of the country - individuals and individual entrepreneurs - to install energy-efficient stoves in their residential building and provide them with a reliable, environmentally friendly and economical source of energy.

It should be noted that this product also meets the principles of sustainable development of the republic. The transition to energy-efficient use of solid fuel helps to reduce air pollution and improve the environmental situation in the region.

1.4.3.2 Non-financial measures

To overcome the existing non-financial barriers to scaling up energy efficient stoves, it is necessary (after receiving support and financial assistance) to carry out large-scale work to introduce a new comprehensive state program. After the adoption of the program/system, it is necessary to revise numerous regulations and guidelines, as well as develop new NLAs. In addition, trainings should be organized for specialists planned to be involved in the implementation of the program. It is necessary to use the experience of countries in installing energy-efficient stoves and adapt it for Kyrgyzstan. The measures to be included and implemented are as follows:

- The work of the media and local self-government, stakeholders to inform about climate issues and benefits from the use of energy efficient stoves
- Formation of a system of state support for the wide scaling of the use of energy efficient stoves
- Development of technical requirements for low-capacity boilers and stoves
- Establishment of testing laboratories for boilers and stoves
- Establishment of mass production to master the manufacture of stoves and reduce their cost
- Provide mandatory initial training in skills for the operation of EE stoves by users
- Introduction of tax and customs preferences when importing energy-efficient boilers and stoves and manufacturing by local companies
- Establishment of a funding mechanism based on the Revolving Fund

[37] https://24.kg/biznes_info/267674_gazifitsiruysya_vmeste_srsk_bankom_igazprom_kyirgyizstan/

1.5 Linkages of the barriers identified

The analysis shows, and it should be noted, that the technologies of NGHIC and TIPB, as well as EES, are closely related to each other. Thus, the widespread development of gasification of the private sector may reduce interest in the installation of energy-efficient solid fuel stoves and vice versa. But this risk is possible only for a group of the population with an average income and the ability to use more expensive gas heating technology. At the same time, energy-efficient stoves are oriented towards the more modest budget of socially vulnerable families.

In addition, the use of thermal insulation in public buildings reduces the need to use both natural gas and other heating fuels, which will generally reduce the budget for maintenance and operation, as well as the level of GHG emissions into the atmosphere.

The technologies under consideration belong to the energy-efficiency sector and are the most important direction for reducing GHG emissions, saving money and improving the environmental situation in the country.

Barriers associated with the introduction of technologies in the energy sector were identified in seven categories: 1) economic and financial; 2) market conditions; 3) legal and regulatory; 4) institutional, 5) technical; 6) capacity/skill building, 7) information and awareness (see Table 1).

Mapping of the technology market of the energy sector are presented in Annex I in fig. 6, 9, 12.

In the combination of the identified barriers in the energy sector, general patterns can be noted. The nature of barriers is mainly considered as institutional and normative, due to the forms of ownership, changes in management systems, weak management and the lack of a clear policy, etc.

It should be noted that all technologies in the energy sector were previously introduced to one degree or another in many CIS countries.

The identified barriers are also due to the presence of many other current issues that require urgent solutions. The daily workload of such everyday issues leads to situational management, a departure from the set strategic objectives, which leads to postponing decisions and, ultimately, inefficient management of the industry.

The identified barriers in the industry are related to the extent that they are caused by the vagueness of the strategic plans adopted by the government, the lack of legislative norms, the implementation of requirements is not enshrined in legislation, and the lack of enforcement.

Problem trees based on the LPA for the three energy sector technologies are presented in Annex I in fig. 7, 10 and 13.

1.6 Enabling framework for overcoming the barriers in the Energy sector

The identified barriers and proposed measures to overcome barriers to technology transfer in the energy sector are summarized and presented in Table 1.

An effective way to identify how to overcome such barriers in the energy sector is to study and analyse international best practices, as well as adaptation and harmonization.

All technologies are successfully used in developed countries, contributing to the development of the national economy. This experience was reviewed and researched by the government of the country, scientific institutions, as well as individual experts.

The results of the study and analysis are provided to the authorized state bodies, as well as to the general public and all interested parties. As a favourable factor, it is necessary to note the willingness

of the Government of the Kyrgyz Republic to participate in international agreements to mitigate the effects of climate change and efforts to approve and adapt them, as well as support for efforts in this direction at the level of the President of the Kyrgyz Republic.

Important factors in creating the enabling environment are the engineering, technical and scientific potential of the country, as well as the effective assistance of relevant international organizations in its creation and development.

Trees of objectives schemes (measures) based on the LPA for the three priority technologies of the energy sector are presented in Annex I in fig. 8, 11, 14.

2 Waste Sector

Introduction

Today, in the Kyrgyz Republic, the problem of reduction, disposal and processing of municipal solid waste is of great importance due to the growing amount of accumulated and annually generated waste, requiring of large areas for their disposal. The demographic situation in the republic tends to increase the population, which creates new prerequisites for an increase in the volume of generated solid domestic waste. The growth of the urban population due to the increase in the level of migration from rural areas to cities makes a certain contribution to the deterioration of the socio-economic and environmental condition of cities. According to statistics, in 2010 the permanent population in the Kyrgyz Republic was 5,477.6 thousand people[38], in 2021 the resident population was 6,747.3 thousand people[39].

According to statistics in the Kyrgyz Republic, 1,229.6 tons of municipal solid waste were removed in 2021[40], including per capita - 191.0 kg, and in 2017 the volume of municipal solid waste per capita was 164.0 kg[41]. The increase in the intensity of waste generation per capita characterizes the absence of positive changes in social attitudes and production cycles and requires the adoption of additional social measures for the population, economic incentives for industry and increased environmental control by the state. More than 70 percent of the removed municipal solid waste falls on the cities of Bishkek, Osh and Chui region[42].

In the Kyrgyz Republic, the disposal of solid household waste is carried out by burial at sanitary landfills and unorganized landfills. As a result of the inventory of waste disposal sites on the territory of the Kyrgyz Republic, as of 2018, 406 landfills were present in the country[43] which occupy about 616 hectares (about 6 km^2). The study of the morphological composition of MSW is carried out only within the framework of international projects, so the latest information was obtained in the process of conducting an inventory of the places where consumer waste was placed on the territory of the Kyrgyz Republic.

Currently, the Government of the Kyrgyz Republic is implementing a sustainable waste management policy aimed at the complete elimination of spontaneous landfills, preventing the expansion of new landfills and the reduction of the territory of existing landfills, the introduction of low-waste, resource-saving technologies, recycling and safe disposal. Particular attention will be paid to the development of cost-effective infrastructure for the processing and disposal of household waste in cities.

However, to overcome barriers to the introduction of priority technologies in the Waste sector, specific measures are needed to contribute to the voluntary overall NDC target adopted in the Kyrgyz Republic in 2021 to reduce greenhouse gas emissions.

In order to organize the barrier analysis process, the established sectoral working group representing relevant stakeholders was briefed on the approaches used. National consultants applied a collaborative approach to analyze barriers and identify enabling measures based on the TNA Barrier Guidebook (Nygaard et al, 2015) .

[38] http://stat.kg/media/publicationarchive/0f99e52f-f88f-49e3-8b43-f5821e942ba1.pdf
[39] http://stat.kg/media/publicationarchive/c2680694-07a1-4728-9921-131cb00e6c46.pdf
[40] http://stat.kg/media/publicationarchive/c210d76d-91e9-4e8e-a597-e49217759846.pdf. page 52
[41] http://stat.kg/media/publicationarchive/c2680694-07a1-4728-9921-131cb00e6c46.pdf, page 42
[42] http://www.stat.kg/media/publicationarchive/aff32455-587b-478f-b293-07087a033cb6.pdf, page 11
[43] http://eco-expertise.org/wp-content/uploads/2009/06/201805251451523.pdf

As an initial step in the barrier analysis process, a desk review of policy papers and other relevant documents was undertaken to identify the main reasons why the technology is not currently widely adopted and why neither the private nor the public sector has invested in it. Further, a consultation process was conducted with stakeholders through direct interviews and questionnaires.

This report as the second stage of the Technology Needs Assessment (TNA) project for the introduction of climate mitigation technologies in Kyrgyzstan aims to analyse the existing barriers and favourable framework for the selected priority technologies in the waste sector, which are presented in Table 6.

Table 6. Categories of selected technologies[44]

Selected Technologies	Technology category	Classification
Mechanical-biological waste treatment	Not a market item	publicly offered item
Use of organic waste as raw material for a biogas plant	Not a market item	publicly offered item
Use of organic waste as raw material (wastewater) for a biogas plant	Not a market item	publicly offered item

It should be noted that the distribution of consumer goods and capital goods is predominantly indirectly influenced by politically changing market conditions, while the distribution of publicly offered and non-market goods is directly influenced by political decisions taken by governments and public entities regarding the implementation of certain projects.

The proposed measures will be reviewed by senior officials to decide on inclusion in the Technology Action Plan (TAP), which will be presented in the third report on this TNA project in Kyrgyzstan.

2.1 Preliminary targets for technology transfer and diffusion

In the adopted National Development Program of the Kyrgyz Republic for the period 2018-2040 is stated that the policy of sustainable waste management should become a matter of national importance, carried out through intersectoral, interregional and intermunicipal cooperation aimed at the complete elimination of spontaneous landfills, preventing the expansion of new and reduction in the territory of existing landfills.

During the implementation of the National Program, measures will be taken to reduce the level of their establishment (introduction of low-waste, resource-saving technologies), processing, reuse, and safe disposal. In parallel, economic mechanisms will be introduced to promote recycling, with the extraction of useful components from waste including electronic and electrical waste. Particular attention will be paid to the development of cost-effective infrastructure for the processing and disposal of household waste in cities.[45]

Based on the provided TNA methodology and multi-criteria analysis (MCA) approach[46], in the first Technology Needs Assessment report, the selected technologies in the Waste sector that received the highest scores and were identified in order of priority are further selected for further study of barriers and enabling conditions:

- Mechanical and biological treatment of MSW;

[44]Classification by categories of market goods according to Nygaard et al, 2015..
[45] https://www.gov.kg/ru/programs/8
[46]Multi-criteria analysis: a manual January 2009 Department for Communities and Local Government: Londonhttp://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf

- Use of organic waste as raw material for a biogas plant;
- Use of wastewater as raw material for a biogas plant.

The dissemination of priority technologies in the Waste sector will contribute to the achievement of the strategic goals of improving the environment and reducing the level of waste generation set in strategic government documents.

Preliminary targets for priority technologies in the Waste sector are presented below.

For mechanical and biological treatment of municipal solid waste (MSW):

Currently, there are practically no enterprises for the processing of solid household waste in the republic. Today, less than 10% of all household waste generated is recycled. Recycling is predominantly in the private sector, and the infrastructure needed to increase the recycling rate or switch to separate collection is still lacking.

Mechanical-biological treatment is a combination of mechanical and biological processes that are additionally used to treat mixed residual waste prior to disposal.

The aim of this combination is to minimize the environmental impacts of the deposited waste and to obtain some additional value from the waste by utilizing recyclable fractions and in some cases energy. MBT includes the following stages of waste treatment:

- sorting of municipal solid waste (MSW) - provides a significant reduction in the amount of generated waste, reducing their negative impact on the environment and allows you to extract useful components;
- processing of the selected amount of secondary raw materials;
- MSW composting is a biochemical process of decomposition of the organic part of MSW by microorganisms. As a result of the interaction of organic material, oxygen and bacteria, carbon dioxide, water and heat are released. The product of composting is organic fertilizer - compost or biofuel (raw compost).
- utilization of energy from the received RDF and (or) from biogas generated in biological processes.

To use organic waste as feedstock for a biogas plant:

Biogas production significantly reduces GHG emissions by displacing fossil fuels and energy-intensive mineral fertilizer industries, as well as reducing methane (CH_4) emissions to the atmosphere from storing fermentable organic materials such as organic waste (food and green waste) in landfills. In addition to renewable energy, biogas plants produce valuable nutritious and humus-rich fertilizers.

For the use of organic waste as raw material (wastewater) for a biogas plant:

The biogas plant produces biogas from primary sludge and excess activated sludge generated during the treatment of wastewater from urban wastewater treatment plants, as well as from imported organic material using anaerobic, mesophilic digestion technology. The use of biogas plants reduces emissions of methane (CH_4) into the atmosphere from the storage of fermentable organic materials such as organic waste (sludge). In addition to renewable energy, biogas plants produce valuable nutritious and humus-rich fertilizers.

The dissemination of priority technologies in the Waste sector will help achieve the strategic goals of improving the environment, reducing the amount of organic waste placed at sanitary landfills, and, accordingly, reducing CH_4 emissions.

2.2 Barriers analysis and possible enabling measures for Technology 1 "Mechanical and biological treatment of MSW" (MBT)

2.2.1 General description of the MBT technology

The purpose of the Mechanical Biological Waste Treatment (MBT) plant is to separate municipal solid waste into various usable materials that can be redirected from landfill (sold as a valuable material for recycling), as well as to convert organic waste into biogas and rich organic fertilizers[47].

MBT is applied to mixed wastes with a high organic content in order to achieve:

- stabilization and minimization of potential risk, together with a significant reduction in mass and volume through biodegradation, which can also enable the diversion of biodegradable waste from landfills;
- processing waste to form separate material streams, utilizing recyclable materials and making them more suitable for subsequent recycling processes.

The products of mechanical-biological treatment technology are:

- recyclable materials such as metals, paper, plastics, glass, etc.
- unsuitable materials (inert materials) safely disposed of in a sanitary landfill
- compost
- biogas (optional).

One of the versions of MBT plant is shown in Fig.3[48]. It consists of two systems, an automated (if necessary manual) solid waste separation unit which can separate mixed municipal waste into 5 types of materials: organics, plastics, ferrous metals, combustible materials and inert materials combined with a patented horizontal dry anaerobic fermentation unit.

The MBT system includes both mechanical and biological (aerobic) processing:

- receiving and sorting complex;
- deep processing complex;
- composting complex;
- biogas plant (optional).

[47]http://advaitaa.in/green_energy/mbt_plant.html
[48]http://advaitaa.in/green_energy/mbt_plant.html

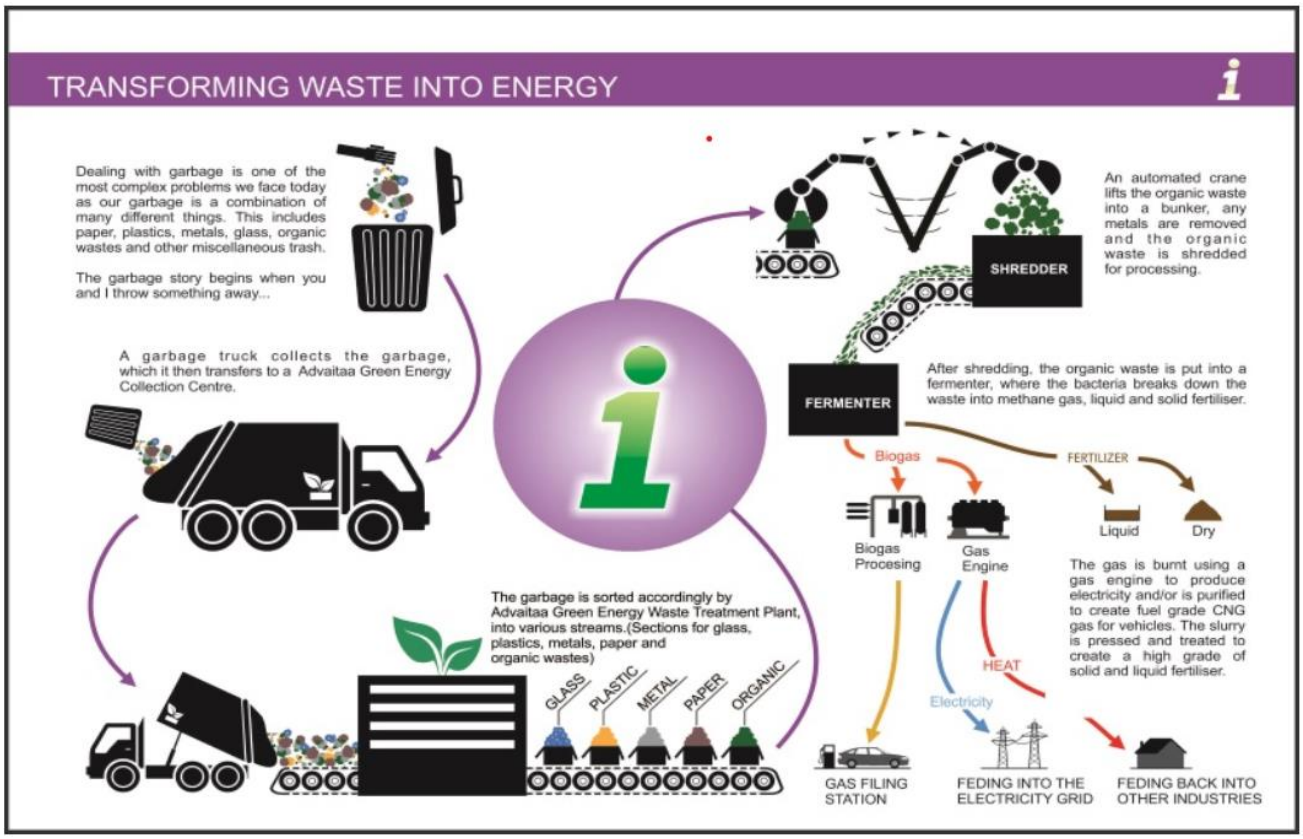

Figure 3. Mechanical Biological Treatment Plant[49]

The MBT system can become an integral part of the waste management infrastructure. Among the economic, environmental and social benefits of the MBT system are the following: reduction in the volume of municipal solid waste placed at the sanitary landfill, the possibility of sorting and processing the useful fraction of waste (paper, plastic, etc.), minimal impact on the environment, reduction of greenhouse gas emissions, and creation of new jobs.

2.2.2 Identification of barriers to MBT technology"

This section of the report aims to explain what currently impedes the large-scale dissemination of the technology "Mechanical and biological treatment of MSW", and what measures can be taken to eliminate existing barriers and obstacles.

The methodology for identifying barriers to priority technologies is briefly described in the introduction. Thus, in order to organize the process of analysing barriers, a sectoral working group (SWG) was created, representing the relevant stakeholders - representatives with special knowledge in the field of waste management.

The following organizations and experts from interested parties were involved, including such ministries and departments as:

- State Agency for Architecture, Construction, Housing and Communal Utilities (SASCHCU) under the Cabinet of Ministers of the Kyrgyz Republic;
- Department for the Development of Drinking Water Supply and Sanitation under the State Agency for Architecture, Construction, Housing and Communal Utilities under the Government of the Kyrgyz Republic

[49]http://advaitaa.in/green_energy/mbt_plant.html

- Department of City Economy of the Bishkek Mayor's Office;
- City Hall of Bishkek;
- Bishkek Agency for Development and Attraction of Investments;
- MP "Bishkek sanitary landfill";
- MP "Tazalyk".

The process began with an analysis of development barriers and climate change mitigation priorities in Kyrgyzstan, followed by a review and study of specific sub-sectoral targets needed to achieve national goals. National consultants applied a collaborative approach to analyse barriers and identify enabling measures based on Nygaard et al. (2015).

Then, in order to determine the underlying motivations and details of why the technology under discussion is not currently widely used, a desk study of policy documents and other relevant documents was conducted to identify the main reasons why the technology is not currently widely used and why neither the private nor the public sector has invested in it. In addition, a stakeholder consultation process was carried out through direct interviews and questionnaires.

After compiling a long list of barriers, stakeholder workshops were organized to test the barriers and group them into different categories (informational, technological, economic/financial, political/legal). To identify the most important barriers, a simple method was used to group them into key and non-key barriers and criteria.

Barriers to technology adoption were identified in the following main categories: economic/financial barriers, market conditions, legal, institutional, capacity building/staff, technical, information and awareness.

To determine the appropriate measures, a detailed analysis of current practice at the national level, as well as taking into account the practice of the international level, was carried out. The national consultants applied a participatory approach to the analysis through involving a wide range of stakeholders in the process. The same procedure was applied to determine the measures. Measures have been identified based on grouped barriers and are summarized in tab. 2.

Using Logical Problem Analysis (LPA), the Sectoral Working Groups were able to combine the key elements of the problems, apply a logical analysis of interrelated elements, and identify links between problem elements and external factors. Cause and effect relationships were organized as a problem tree, with the main problem as the starting problem, causes at the bottom of the tree, and their consequences at the top of the diagram. The LPA has also been used to define the process for taking action to move from problems to solutions. LPA tools help to analyse problems systematically and logically and bring together all the elements of a problem to enable stakeholders to understand the problems in a given area in detail and delineate its components. (See Annex II Fig. 16).

Also, for priority technologies, a market mapping analysis was applied in order to better understand the development opportunities of the local technology market. The whole system was considered in the context of its three main components: creation of a business environment; participants in market chains and communications, as well as service providers. Support for early adopters, as well as others, by governments and through pilot projects is important to facilitate technology transfer and diffusion. (See Annex II Fig. 18).

As a first step, a desk study of policy papers and other relevant documents was conducted for this technology in order to identify the main reasons why the technology is not currently widely adopted. The discussion touched upon the questions why the private and public sectors do not have enough financial incentives for the implementation of such projects. A collaborative approach was taken to analyse barriers and identify incentives for the introduction of this technology.

The consultation process was carried out through interviews, questionnaires and brainstorming during the workshop and online exchange of information. An initial long list of barriers, based on questionnaires, was sent to all members of the SWG. Barriers were grouped into different categories (economic and financial, market, political, legal and regulatory, problems in networking technology users/groups; institutional and organizational, human skills; social, cultural and behavioural; information and awareness; technical and other barriers). The initial list of barriers was supplemented by barriers proposed by the participants during the discussion, and the summary list was checked by the members of the SWG (see Annex I tab. 11. Categories and number of identified barriers). During the screening, stakeholders made recommendations based on their own experiences. At the end, the key barriers were discussed and identified as key barriers by vote of the participants.

At present, there is no separate collection and sorting system in Bishkek at the places where municipal solid waste is generated. The collection of generated waste is carried out in containers or bags with subsequent removal for disposal at a sanitary landfill. Unauthorized "sorting" of municipal solid waste is carried out at container sites by seizing the useful fraction by illegal collectors, waste disposal companies and sorters located directly at the landfill.

There is no processing of municipal solid waste at the state level, this segment is represented by the private sector. The main recycled material is plastic and paper, the number of which, according to the latest inventory of landfills[50] make up 26% and 1%, respectively, of the total volume of MSW. There is no statistics on the amount of recycled secondary raw materials; the National Statistical Committee does not have data on the volume of recycled secondary raw materials in physical terms.[51]

According to an expert assessment obtained during the preparation of NDC 2021, the amount of waste collected in 2050 in Bishkek will be 518.46 thousand tons, in 2020 the amount of collected waste was 326.1 thousand tons. Given the constant growth in the amount of municipal solid waste collected and placed at the sanitary landfill in Bishkek, it is necessary to introduce new technologies in order to reuse them as secondary material resources and obtain raw materials, energy, products and materials. The introduction of such technology as the MBT system will contribute to:

- the involvement of wastes such as plastic, paper, textiles, food and green waste in reuse;
- reduction of territories allocated for waste disposal;
- reducing the amount of disposed municipal solid waste, including organic fraction, which contribute to the formation of methane emissions.

The advantages of the technology are: the combination of special types of processing and recycling of materials and the production of various fractions of materials for further use, as well as additional jobs.

2.2.2.1 Economic and financial barriers

Currently, there are no waste processing plants in the Kyrgyz Republic. When considering economic and financial barriers to technology "Mechanical and biological treatment of MSW", presented in Annex II: Table 12, the working group discussed what currently hinders the large-scale dissemination of technology. The main economic and financial barriers to the introduction of this technology are:

- *High investment and operating costs*.

Involvement of international partners (EBRD) to solve the problem in the management of municipal solid waste in 2012 suggests that without investment, the construction of an MSW plant at the sanitary landfill in Bishkek can be a very difficult process. To date, in accordance with the response from the Bishkek Sanitary Landfill, the main part of the project "Solid waste management in the city of

[50] http://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf
[51] Response to request No. 20-022062 dated 12/15/2022

Bishkek" is over, however, only preliminary evaluation of works under the planned tender is executed. In November 2022, a presentation of a consultant on the implementation of the component "MSW sorting plant and green waste composting site" was held at the Bishkek City Hall. BSWM-7 component contract value: EUR 6,280,000[52].

- *Lack of tariffs for the collection, processing and disposal of waste.*

The system of work of district beautification and green farms operates on the basis of the Bishkek City Improvement Rules, which provide a mechanism for collecting payments for the removal of household waste from the population and organizations.

Tariff payments for the removal and disposal of solid household waste from the population and commercial enterprises are the main source of financing for this sector in Bishkek and throughout the Kyrgyz Republic. Tariffs for the removal and disposal of solid household waste in the Kyrgyz Republic are developed and approved by local keneshes (village/town councils) in their subordinate territories in the prescribed manner; in Bishkek, the tariffs are set by the Bishkek city kenesh.

In accordance with the resolution of the Bishkek city kenesh dated January 31, 2023 N 67, in order to improve the sanitary and environmental condition of the city of Bishkek, ensure break-even and profitable, reliable operation of the municipal enterprises "Tazalyk" and "Bishkek sanitary landfill", from February 1, 2023, the following tariffs for the removal and disposal of solid household waste were approved:

- for the population in the amount of 41 soms (0.43 EUR) per month per person, including 13 soms (0.13 EUR) for the provision of services for the disposal of solid household waste;
- for business entities, regardless of their form of ownership, in the amount of 361 soms (3.74 EUR) per m^2 or 2430 soms (25.2 EUR) per ton, including 81 soms (0.84 EUR) or 445 soms (4.61 EUR) per ton for the provision of services for the disposal of solid domestic waste;
- for business entities, regardless of the form of ownership, engaged in self-collection of solid domestic waste, in the amount of 445 soms (4.61 EUR) per ton for services for the disposal of solid domestic waste[53].

It should be noted that this tariff provides for payment for operations for the removal and disposal, but does not provide for the operation for the collection and processing of waste.

For example, if we compare the tariffs of the neighbouring state of Kazakhstan (Almaty), the tariff is charged for the collection, removal, processing and disposal of municipal solid waste:

- individuals of comfortable and unfinished households - 553.04 tenge / inhabitant per month or 108.23 soms (1 tenge = 0.19570 KGS) or 1.11 EUR;
- legal entities and private businesses - 2288.46 tenge / m^2 or 447.86 soms (4.60 EUR);
- the tariff for the processing and disposal of solid household waste for legal entities and private businesses is 5,600 tenge / ton or 1,095.93 soms (11.26 EUR).

Based on the results of the mapping analysis of the technology market and subsector (Annex II: Fig. 14), it can be assumed that the number of market participants (owners and suppliers of technologies, buyers and users of products, representatives of donor organizations / international organizations; consultants, NGOs, associations, information providers) in the current technology market is low, since the existing market opportunities do not provide enabling frames for the participation of other key players (resource suppliers, service providers) in the market chain. In addition, business extension services (financial services, market information, etc.) are very weak and practically do not function in

[52]Answer MP "BSP". Information on the SWM project, from 03/02/2021
[53]https://bishkek.gov.kg/ru/tariffs/3

the market chain. An enabling environment also does not provide suitable opportunities for the development of a local technology diffusion market.

2.2.2.2 Non-financial barriers

Non-financial barriers to the diffusion of MBT technology were analysed by the working group participants based on a summary of the initial long list of barriers (Annex II tab. 12) in the following categories: market conditions, legal, social, institutional, capacity building/staffing, technical, information and awareness. By voting members of the working group identified key categories of non-financial barriers: political, legal and regulatory; institutional, technical and informational and awareness. Explanations of the main reasons hindering the spread of technology (marked with scores of 4-5) are presented below.

- *Unauthorized removal of the useful fraction of waste (secondary raw materials) from waste collectors, garbage collection chambers and specialized vehicles for garbage disposal.*

Despite the Rules for the improvement of the city of Bishkek, Annex to the Resolution of the Bishkek City Kenesh of Deputies dated June 30, 2009 No. 77, paragraph 3.9 "Selecting secondary raw materials (cans, bottles, other items) from waste collectors, garbage collection chambers and specialized transport for garbage removal is not allowed[54] unauthorized extraction of useful fraction or recyclable materials is carried out. Informal collectors in Bishkek sort valuable fractions of municipal solid waste (plastic, cardboard, paper, etc.) directly from garbage cans and hand it over to private processors. The disposal of the useful fraction is also carried out by waste disposal companies, equipping the sides of the machines with bags for recyclable materials of interest to processors. And finally, at the landfill, the waste goes through the third stage of sorting in unsanitary conditions, the pickers sort the waste for private processing enterprises.

- *Imperfection of the legal base in the field of management of municipal solid waste and secondary resources.*

In the waste management system and in the legislation, there are no legal regulation mechanisms regulating the processes of involving secondary material resources in the economic turnover and specific requirements for business entities involved in waste processing. To date, there are no legislative norms regulating the collection and processing of secondary raw materials, and mechanisms for economic incentives for the development of the sector for processing secondary material resources are not used.

There is a mention in the regulations about waste that belongs to the category of secondary material resources, but there is no definition of this term and no approved such waste. Also, the definition of the term "secondary material resources" is not given.[55].

There are no mechanisms in the waste management system and legal regulation, regulating the processes of involving secondary material resources in economic circulation and specific requirements for business entities involved in waste processing.[56]

- *There are no regular observations on the composition and amount of waste (morphological composition), accumulation rates, density.*

The Kyrgyz Republic does not conduct regular monitoring of changes in the morphological composition of municipal solid waste, accumulation rates, and density. The morphological

[54] http://cbd.minjust.gov.kg/act/view/ru-ru/24079
[55] https://mineconom.gov.kg/froala/uploads/file/b858ba779d056d248fff3bbb7f8a97dda5233dfb.pdf
[56] http://eco-expertise.org/wp-content/uploads/2009/06/201805251451523.pdf

composition of MSW contains various fractions, to which various disposal methods should be applied (recycling, composting, disposal at landfills), and there is also no state statistical accounting of the volumes of processing and disposal of secondary material resources.

- *Lack of institutionalization, management programs for the treatment of solid waste and renewable energy sources.*

The current state institutional system in the field of waste management is characterized by:

- insufficient institutional capacity needed to plan, organize and implement an integrated waste management system at all levels (national and regional);
- insufficient level of coordination, corporatism and communication between the competent authorities;
- lack of an institution responsible for the regulation and development of the system of secondary resources;
- blurred boundaries of the division of responsibility between departments that carry out regulatory activities and control and supervisory functions;
- weak financial support, lack of financial stability;
- inadequate control, which creates the basis for the formation of unauthorized dumps[57]

- *Lack of a government waste management program.*

As of the current situation, there is no state program for waste management in the Kyrgyz Republic. In 2018, within the framework of the UNEP project "Strengthening the capacity of the Kyrgyz Republic in waste management throughout the life course", the State Program for the sustainable management of waste and secondary resources for 2019-2023 was developed.[58] As part of the preparation of the state program, the following work was carried out:

- legal analysis and assessment of the current system of state waste management in the Kyrgyz Republic;
- inventory of consumption waste disposal sites on the territory of the Kyrgyz Republic;
- Action plan for the implementation of the Program for the sustainable management of waste and secondary resources for 2019-2023.

Draft Decree of the Government of the Kyrgyz Republic "On Approval of the State Program for Sustainable Management of Waste and Secondary Resources for 2019-2023" was developed based on the objectives of the "Sustainable Development Goals until 2030 in the field of waste management", and is aimed at the implementation of the strategic planning document: Development Program of the Kyrgyz Republic for the period 2018-2022. "Unity, trust, creation", in accordance with which, the main objectives of the current policy of the Kyrgyz Republic for the next five years in the field of environmental protection, including in the field of waste management. However, the prepared document was not adopted.

- *Lack of specialists in the field of sustainable waste management.*

  In 2023, the Ministry of Natural Resources, Ecology and Environmental Management of the Kyrgyz Republic developed the Draft Concept of Environmental Safety of the Kyrgyz Republic, which states that in order to solve the problems associated with industrial and domestic waste, it is necessary to organize an environmental education system for heads of administrative territories, enterprises, and organizations for handling production and consumption waste.

[57] http://eco-expertise.org/wp-content/uploads/2009/06/201805251451523.pdf
[58] http://eco-expertise.org/sovershenstvovanie-ekologicheskoj-pol/stranovye/

In the Kyrgyz Republic, a number of educational institutions train graduates in the specialties "Ecology and Nature Management" and "Ecology and Environmental Protection". The main purpose of the educational standard for these specialties is to prepare in the field of the fundamentals of humanitarian, social, economic, mathematical, natural science and environmental knowledge. As you can see, the training of students in these specialties is general environmental, and the problem with solid waste is consecrated in the preparation of term papers or graduation design. Obviously, general environmental training will not provide sufficient knowledge to future specialists responsible for making decisions in the field of waste management, which includes systemically related operations for waste collection, disposal (transportation), sorting, processing and disposal.

- *Low technical standards for waste handling and processing.*

Special requirements for waste processing enterprises, as well as processing technologies in the national legislation in the field of waste management, are not currently developed[59]. Some hazardous types of consumer waste, such as: medical, construction, electronic and electrical waste, etc., generated in households and trade, due to the lack of a recycling system, directly fall into landfills.

In accordance with the requirements of the Procedure for handling production and consumption waste in the Kyrgyz Republic, approved by Decree of the Government of the Kyrgyz Republic dated August 5, 2015 No. 559, for disposal at waste disposal sites it is prohibited to accept waste that can be used as secondary resources, whole used tires, with the exception of their use as a stabilizing material during reclamation and oil products that are subject to processing and (or) disposal. Also, the collection of production and consumption waste belonging to the category of secondary material resources should be carried out at waste generation facilities separately in accordance with the directions of their use and processing. Despite these requirements, in fact more than 70% of the waste is placed in landfills[60].

- *Low level of informing the population about the separate collection of municipal solid waste at the places of generation and collection.*

There is a problem that is associated with the collection, sorting and processing of waste coming from different sources. Today, in Bishkek, as in other large cities of the Kyrgyz Republic, the usual method of waste management is common, which does not imply sorting solid household waste by type. Complicating the task of collecting and sorting waste is the fact that there are no containers for collecting garbage in the immediate vicinity, including a container for separate collection, which gives rise to spontaneous dumps and untimely waste disposal. In Bishkek, two MSW collection systems are currently used:

- about 50% of the population (residents of multi-storey buildings) place waste in containers at the waste sites of the city;
- about 50% of the population (residents of the private sector) transfer waste in bags / bags directly to the employees of the SE “Tazalyk” during collection on certain days of the week.
- Collection and removal of green waste is carried out by SE "Zelenstroy".

Considering the above factors, municipal solid waste collected in containers or bags is a complex heterogeneous mixture, and as a result of such collection, useful fractions lose their attractiveness for future reuse. Sorting household waste suggests that each resident will need to throw glass, paper and plastic into the appropriate containers. Also complicating the task of sorting waste by the population is the lack of popularization of the practice of sorting generated waste and collection points for recycling within the border of the area of residence.

[59] https://mineconom.gov.kg/froala/uploads/file/b858ba779d056d248fff3bbb7f8a97dda5233dfb.pdf
[60] http://eco-expertise.org/wp-content/uploads/2009/06/201805251451523.pdf

Within the framework of separate projects, the Bishkek City Hall equips special eco-sites for primary waste sorting, which are built in accordance with national, international standards and sanitary and hygienic standards.

The purpose of this project is:

- introduction a culture of separate collection and development of environmental awareness among citizens;
- improvement of the ecological situation and preservation of health;
- attracting private companies and increasing the revenue side of the city.

The project is being implemented at the expense of investors.

To date, information campaigns are being carried out in the Kyrgyz Republic, the promotion of sorting and reuse of waste. For example, in 2022, the Wastenet.kg project supported and implemented eight project ideas and innovative solutions of non-profit organizations aimed at reducing waste in landfills and promoting responsible consumption in two months.[61].

As you can see, within the framework of individual projects, work is being carried out to educate the population, including raising the level of culture and interest of the population in the field of waste collection.

2.2.3 Identified measures

Determination of appropriate measures is the process of analysing the necessary actions that need to be taken to overcome the existing barriers to the implementation of MBT technology. In order to identify appropriate measures, a detailed analysis of current practice at the national level was carried out taking into account international experience. The national consultants applied a participatory approach to the analysis and by involving a wide range of stakeholders in the process. The measures were determined based on grouped barriers. LPA analysis was applied to the process of identifying measures to move from problems to solutions. (See Annex II fig. 16.)

As a rule, measures are divided into two main groups: financial and non-financial measures, since it is important for policy makers which measures can be implemented through legal or other assistance, and which measures should be funded (by national or external institutions).

2.2.3.1 Economic and financial measures

The main economic and financial measures are:

- *attraction of investments* by:
    - project finance (PF). The PF is considered as a system that includes many elements (participants, objects of financing, contracts, risk management, infrastructure), which are closely interconnected and ensure the efficiency of the movement of financial flows. Investors can be donors providing funding on a grant basis and concessional funding, these are the Green Climate Fund (GCF) and other climate funds, USAID, GIZ, as well as the WB, ADB, EBRD group, which, when providing funds, have a grant component of up to 30% of the loan.
    - public-private partnership (PPP). In accordance with the Law of the Kyrgyz Republic dated August 11, 2021 No. 98 “On Public-Private Partnerships”, a Public-Private Partnership (hereinafter - PPP) is a cooperation between public and private partners in order to develop and implement projects for the creation and / or modernization, operation and maintenance of infrastructure facilities and / or infrastructure services.

[61] https://wastenet.kg/ru/poleznaja-informacija/innovacionnye-proekty.html

The use of PPP in the waste management sector implies effective interaction between the state and business, the pooling of resources and potential, which makes it possible to find solutions that reconcile environmental requirements and requirements for the quality of services with the economic opportunities of business and utility consumers.

- *Revision of tariffs for garbage collection, support and development of the recycling sector.*

The main condition for the stable operation of municipal enterprises and the waste management industry is the formation of a sustainable financial flow. To do this, the tariff system should: provide coverage for current and capital costs, encourage producers and consumers to more rational waste management, encourage the introduction of economically and environmentally efficient waste management methods and low-waste technologies in general[62].

In the event of a revision of tariffs, in order to support and develop the solid domestic waste processing sector, it is proposed to include in the tariff such waste management operations as collection and recycling of waste. Waste collection is understood as the activity of organized reception of waste from individuals and legal entities by specialized organizations in order to further send such waste for recovery or disposal. Waste collection operations include auxiliary operations for the sorting and accumulation of waste during the collection process. Waste processing is understood as mechanical, physical, chemical and (or) biological processes aimed at extracting useful components, raw materials and (or) materials suitable for further use in the production (manufacturing) of products from waste.

2.2.3.2 Non-financial measures

So far undertaken measures aimed at developing and supporting the waste management industry. Non-financial measures proposed by members of the working group and selected through discussions, workshops and seminars can help advance the technology of MBT and seem to be more important at this stage. Selected non-financial measures include measures such as:

- improvement of the legislation of the Kyrgyz Republic in the field of municipal solid waste management revision of the legislation on the procedure for handling waste, including separate collection, sorting, processing, the introduction of regular monitoring of changes in the morphological composition, the study of accumulation rates, the density of solid domestic waste;
- development of a state program for waste management;
- strengthening the existing system of institutions of state regulation in the field of waste management;
- increasing the capacity of colleges, universities in the field of sustainable waste management, holding seminars and trainings for specialists from state bodies in the field of waste management;
- the need for labour depends mainly on the capacity of the plant. The integration of manual sorting steps naturally requires additional manpower. Rather complex process designs require specially trained and qualified personnel to properly operate the plant and control the process steps.
- If an updated law “On Production and Consumption Waste” is adopted, which proposes the introduction of rules for the ownership of waste and transactions with it, since waste can acquire value during further processing, it may be difficult for informal collectors of recyclable materials to remove the useful fraction from waste bins and then transfer them to recycling companies. In this case, the possibility of providing jobs at the future sorting and processing complex as official workers (with training and employment contracts) is being considered.

[62] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3835042

- development of special requirements for waste processing enterprises, as well as processing technologies;
- increasing the level of informing the population about the separate collection of municipal solid waste at the places of generation and collection. To form a competent and responsible approach to waste management, both for government agencies and the public, organizing information campaigns, holding conferences, roundtables, exhibitions on the topic of minimizing education and optimizing waste management.

2.3 Barriers analysis and possible enabling measures for Technology 2 “Use of solid waste organic for a biogas plant" (SWOBGP)

The accumulation of household and industrial waste is an urgent environmental problem. According to forecast data, in the Kyrgyz Republic, the amount of disposed municipal solid waste in 2030 under the "Business as usual" scenario will reach 1,381.5 thousand tons[63], which will require both additional space (land resources) and additional financial costs for disposal. The amount of organic waste removed to the sanitary landfill is 49% of the total composition of household waste[64].

One of the methods of treatment of organic waste is anaerobic digestion. As of the current situation, in the Kyrgyz Republic, organic waste (food) is not used as a raw material for biogas plants, there is no system for separate collection and sorting at the places of waste generation. Also, there are no legislative norms regulating the collection and processing of secondary raw materials, mechanisms of economic incentives for the development of the sector of processing of secondary material resources are not used. There is a mention in the regulations about waste that belongs to the category of secondary material resources, but there is no definition of this term and no approved such waste. Also, the definition of the term "secondary material resources", "biodegradable waste", "food waste", "organic waste", "biogas" is not given.

To reduce the amount of organic waste that ends up in sanitary landfills and use them as raw materials for a biogas plant, it is necessary to introduce a system for the separate collection of food waste. The use of organic waste (food) as a raw material for biogas plants will significantly reduce the amount of waste placed at the sanitary landfills in Bishkek and Osh, respectively, and GHG emissions.

2.3.1 General description of the SWOBGP technology

Anaerobic digestion has a number of advantages: the formation of a smaller amount of secondary waste compared to aerobic disposal, the efficient processing of wet (60% or more) waste, the destruction of pathogenic organisms, especially when using multi-stage reactors or when using an intermediate stage - pasteurization), the possibility of using fermentation products as a fertilizer, the formation of environmentally friendly fuel - biogas[65]

Anaerobic digestion is the gradual bacteriological decomposition of organic waste material in the (relative) absence of oxygen to produce methane, carbon dioxide and water. The main goal of this process is to reduce the biological activity, mass and reactivity of the waste and to produce biogas that

[63]NOUV, 2021
[64] http://eco-expertise.org/wp-content/uploads/2009/06/201805251451523.pdf
[65]https://kpfu.ru/portal/docs/F_812971224/153_1_est_15.pdf

can be used as an energy source[66]. Figure 4 shows a schematic overview of a wet anaerobic digestion process with various potential uses for the produced biogas and digestate[67].

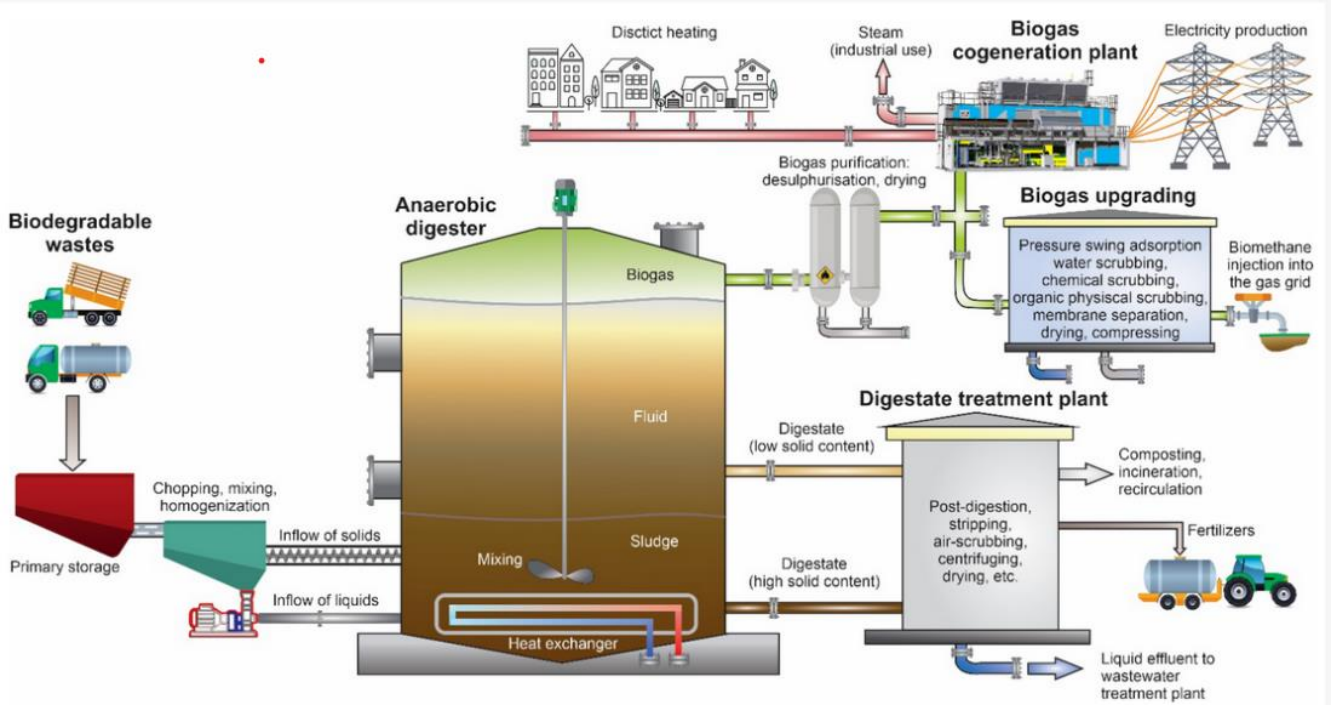

Figure 4. Schematic representation of the production and use of biogas

Feedstock sources for biogas plants are almost any organic waste: organic residues from the production of food, beverages or feed, including household products, food and expired products, products from retail markets and green market waste. To obtain the required quantity and quality of waste as a raw material for a biogas plant, it is necessary to sort food waste at the places of its formation.

During anaerobic digestion, biodegradable material is converted into a combustible gas, commonly known as biogas, which is predominantly composed of methane and carbon dioxide. Biogas can be burned on site to produce heat and/or electricity, it can be purified and used as a fuel, or it can be injected into the national gas grid[68]. Biogas contains on average 65% methane, 30% carbon dioxide, 1% hydrogen sulphide, and trace amounts of nitrogen, oxygen, hydrogen and carbon monoxide. The calorific value of biogas is 20-25 MJ/m^3, which is equivalent to the combustion of 0.6 litres of gasoline; 0.85 litres of alcohol or 1.7 kg of firewood. In biogas plants, after fermentation, a valuable ecological fertilizer is obtained - a fluid that increases yield by 2-3 times and reduces the cost of purchasing imported mineral fertilizers[69].

2.3.2. Identification of barriers for SWOBGP technology

The barriers identified as a result of the analysis of the technology "Use of organic waste as feedstock for a biogas plant" are defined in the following main categories: economic / financial barriers, market conditions, legal, institutional, capacity building / personnel, technical, information and awareness. One of the main barriers to the implementation of the technology "Use of organic waste as a raw

[66]BEST PRACTICE MUNICIPAL WASTE MANAGEMENT. Information pool on approaches towards a sustainable design of municipal waste management and supporting technologies and equipment. Umwelt Bundesamt (BMU). Texte 40/2018
[67]https://www.mdpi.com/2071-1050/14/3/1823
[68]https://www.mdpi.com/2071-1050/14/3/1823
[69]http://www.creeed.net/wp-content/uploads/2013/12/biogas%20broshure%20rus.pdf

material for a biogas plant" is the lack of a state program for waste management and the imperfection of the legal framework in the field of management of municipal solid waste and secondary resources

Based on the results of the mapping analysis of the sub-sector market (See Annex II fig. 17), the main market players for the technology were identified.

The analysis carried out shows that non-financial barriers have more weight and are more relevant at the current stage.

The LPA-based problem tree for the technology is presented in Annex II fig. 18. Market research has shown that the basis for this technology is adequate, but requires the development of a regulatory framework, institutional framework for further promotion and development, which is now being formed in accordance with the decisions of the Government.

2.3.2.1 Economic and financial barriers

The main barriers to this technology were identified as:

- high investment and operating costs;
- no fee collection, waste recycling. In accordance with the resolution of the Bishkek City Kenesh dated January 31, 2023 N 67, the Tazalyk municipal enterprise and the Bishkek Sanitary Landfill collect a fee for the removal and disposal of solid household waste. The tariff does not include such processes as collection and processing. Separate collection of food waste involves collection in separate special containers and processing during the day, which will require additional financial costs for collection, transportation and, accordingly, processing. The organization of a system for the separate collection of organic waste will require a rethinking of the existing system of solid waste management in municipal enterprises.

2.3.2.2 Non-financial barriers

At this stage, non-financial barriers to existing technologies are more relevant, ranging from the readiness of state bodies to act and adopt a state program for waste management. Including the lack of information about modern technologies, the need to introduce separate collection of solid waste and, as a result, low awareness of decision makers on climate issues and the benefits of using secondary resources. Explanations of the main reasons hindering the spread of technology are presented below.

- lack of organization of a rational waste collection system that provides for the separate collection of food waste, insufficient raw material base for biogas plants;
- imperfection of the legal base in the field of management of municipal solid waste and secondary resources;
- lack of a management program for the management of MSW and RES;
- insufficient institutional capacity needed to plan, organize and implement an integrated waste management system at all levels (national and regional);
- lack of an institution responsible for the regulation and development of the system of secondary resources;
- lack of specialists in the field of sustainable waste management;
- lack of technical standards for the handling and processing of food waste, special requirements for waste processing enterprises, as well as processing technologies in the national legislation in the field of waste management, currently not indicated[70];
- there are no rules and requirements for organizing the collection and storage of food waste, the Regulations for the handling of food waste at public catering establishments;

[70] https://mineconom.gov.kg/froala/uploads/file/b858ba779d056d248fff3bbb7f8a97dda5233dfb.pdf

- low level of informing the population about the separate collection of food waste at the places of generation and collection, there is no information about the correct accumulation of organic waste.

2.3.3 Identified measures

Taking into account that the implementation of measures on the technology "Use of organic waste as a raw material for a biogas plant" has an environmental significance and a great potential for reducing greenhouse gas emissions, the implementation of measures becomes possible and expedient at the expense of working financial resources and attraction of funds, both internal and external. The LPA-based task tree for the technology is presented in Annex II fig. 19.

2.3.3.1 Economic and financial measures

To overcome the identified financial barriers, it is planned to take the following measures: first of all, it is the development of projects in order to receive investments from external donors, attract external investors, and allocate additional funds from the budget for the introduction of separate collection of solid waste. The main condition for the stable operation of municipal enterprises and the waste management industry is the formation of a sustainable financial flow. To do this, the tariff system should provide coverage of current and capital costs. In the event of a revision of tariffs, in order to support and develop the MSW processing sector, it is necessary to include in the tariff such waste management operations as collection and processing of waste.

2.3.3.2 Non-financial measures

To ensure the introduction of technology, it is necessary to organize a rational waste collection system that provides for the separate collection of food waste at the places of their formation. The introduction of separate collection of food waste in the places of their formation is an inevitable condition for their use in order to involve them in the processing process. For the successful implementation of large-scale schemes for the separate collection of food waste, the involvement and participation of the population in the process is essential. To ensure the uninterrupted operation of a biogas plant, it is necessary to develop a network for the supply of food and green waste to the installation site, by concluding agreements on the regular supply of waste with food industry and public catering enterprises, green markets.

If the modernized law “On Production and Consumption Wastes” is adopted, it will be necessary to develop legislative norms regulating the collection and processing of secondary raw materials, mechanisms for economic incentives for the development of the secondary material resources processing sector, the procedure for organizing the collection, storage, and removal of food waste from the place of their formation, requirements for the separate collection of waste, including the types or groups (set of types) of waste subject to mandatory separate collection, taking into account technical, economic and environmental feasibility.

The operation of a digester plant requires specially trained personnel, especially for plant management and operational control. Depending on the type of process and the size of the plant, the number of personnel must be at least 3 qualified specialists.

The task also includes a campaign to raise awareness and inform the public about how to properly accumulate organic waste, what containers to use for this, and how often and when removal will be carried out.

2.4 Barriers analysis and possible enabling measures for Technology 3 “The use of waste water organic matter for biogas plant” (WWOBGP)

This technology in the Kyrgyz Republic is little studied and was not used as a pilot project. The National Statistical Committee does not regularly collect data on the amount of sludge generated and the amount placed on storage sites, and there is no information on its further use. Reporting to the National Statistical Committee is based on the volume of wastewater passed through treatment facilities, thousand m3/year. Also a big problem is the wear and tear of existing treatment facilities. According to the data of the Bishkekvodokanal Production Association, the aeration station (treatment facilities) of the city of Bishkek was built in the 1970s. The treatment facilities are located in the village of Prigorodnoye and serve not only the city of Bishkek, but also partly the Chui region.

The area of the aeration station is 51 hectares. On its territory there are technical facilities in which wastewater treatment takes place. The design capacity of the enterprise is 380,000 m^3 of sewage per day, in fact, the aeration station receives an average of 220,000-230,000 m^3 per day of sewage.

Production at wastewater treatment plants is quite complex. Water is purified in three stages. The first stage is mechanical cleaning, the second is biological cleaning, and the third is disinfection with chlorine.

Over the years of its operation, the treatment facilities have become physically and technically obsolete. During this time, many objects dilapidated. Corrosion affected pipelines, metal frame and reinforced concrete structures due to the aggressive environment of wastewater. The aeration station needs a large-scale reconstruction and modernization using the latest technologies. The station is maintained by 240 people. The mode of operation is round-the-clock, specific, associated with a certain danger, rather dirty and harsh. Due to low wages, there is an outflow of highly qualified personnel.

Despite the fact that the equipment and facilities have long worked out their operational life, the company is operating normally. But if you do not carry out the reconstruction and modernization of treatment facilities at the enterprise, an emergency situation may arise. And the money that the company earns is only enough for current repairs.

In 2023, within the framework of the international project "Rehabilitation of water supply and sewerage systems of the city of Bishkek", financed by the Government of the Swiss Confederation and the EBRD, it is planned to complete the construction of a sewer collector with a length of 11 km. The pipeline will connect the new sewer line with the Bishkek wastewater treatment plant. Social facilities, private and multi-apartment buildings in the south-western part of the city will be connected to the sewer networks. And this is an additional load on the station[71].

Obviously, from the current situation, the introduction of the technology of “Use of waste water organic matter for a biogas plant” will require additional financial investments as a part of reconstruction of treatment facilities in Bishkek.

2.4.1 General description of WWOBGP technology

The biogas complex produces biogas from primary sludge and excess activated sludge generated during the treatment of wastewater from urban wastewater treatment plants, as well as from imported organic material using anaerobic, mesophilic digestion technology. In Fig.5 the process of production and use of biogas is presented. After purification, the biogas is fed into the combined heat and power (CHP) generator system[72].

[71] https://bishkeksuukanal.kg/blog/159
[72] https://esemag.com/wastewater/wastewater-biogas-power-system/

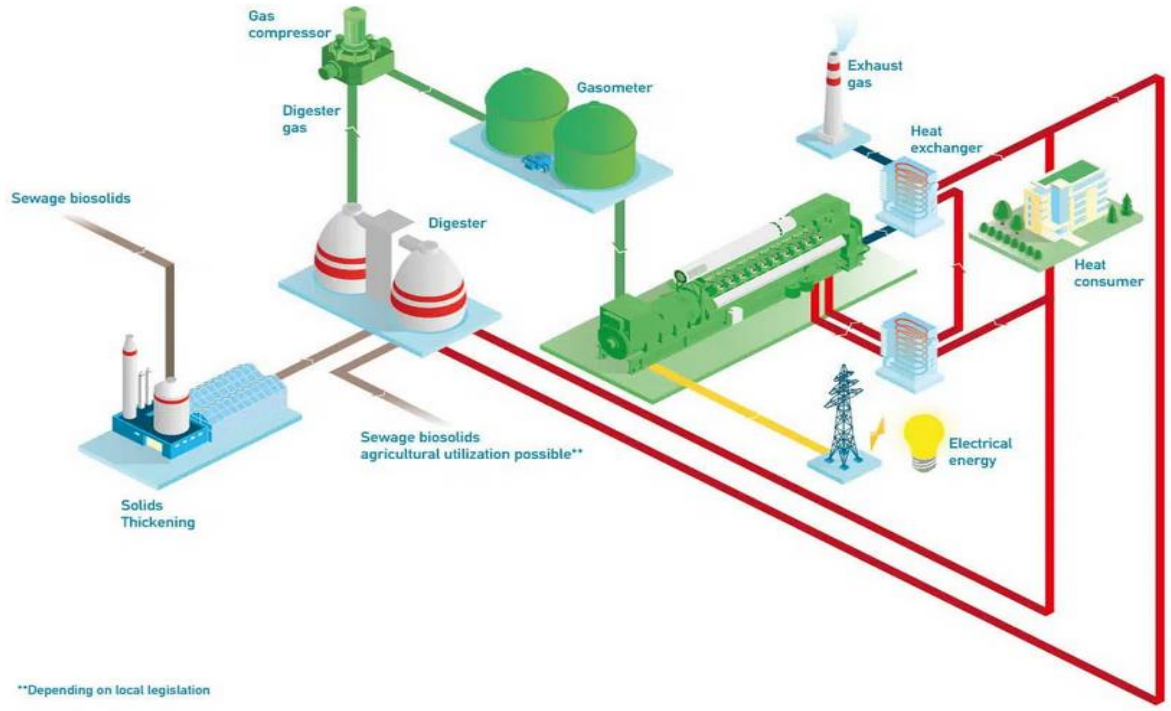

Figure 5. The process of production and use of biogas[73]

In a biogas plant, after fermentation, a valuable ecological fertilizer is obtained - a fluid that increases productivity of soil by 2-3 times and reduces the cost of purchasing imported mineral fertilizers. The biogas production process is divided into four stages:

- preparation of source material;
- waste processing (fermentation), consisting of hydrolysis, acetogenesis, acidogenesis and methanogenesis;
- conversion of biogas into renewable electricity and useful heat using gas engines;
- digestate post-processing.

Advantages of the technology: relatively free raw materials. Work continuously and constantly. Recycling. Generation of heat and electricity. Cost of Electricity - The weighted average in Europe was $0.088/kWh and the rest of the world was $0.070/kWh, in Kyrgyzstan, the weighted average from May 1, 2023 is 2.12 soms per kWh or $0.024.

2.4.2 Identification of barriers for WWOBGP technology

As with other analyses, as an initial step in the process of identifying barriers, a desk review of policy papers and other relevant documents was conducted to identify the main reasons why the technology is not currently being applied and why neither the private nor the public sector has invested heavily in it.

Also, based on the results of the market mapping analysis (see Annex II fig. 20), the main market participants for the technology were identified. Further, consultations were conducted with stakeholders through direct interviews and questionnaires.

[73] https://www.kts-eng.com/ru/solutions/gaz-stochnih-vod/

To identify the most important barriers, a method was applied to group them by score (from 1 to 5 in importance) and criteria such as initial, critical, important, less important and insignificant barriers. Barriers to technology adoption were identified in five categories: economic/financial barriers, market conditions, legal, institutional, capacity building/human resources, technical, information and awareness.

The LPA-based problem tree for the technology "Use of organic waste as raw material (waste water) for a biogas plant" is presented in Annex II fig. 22.

2.4.2.1 Economic and financial barriers

The main barriers to this technology were identified as:

- high cost of capital, investments in technology are considered risky;
- low expected rate of return, low tariffs for water consumption and sanitation.

The lack of a real financial cost recovery mechanism is a major financial barrier to the technology. The tariff policy for wastewater services today does not correspond to the costs that are necessary for wastewater treatment according to the standards. Fee for drains for the population - 2.3 soms (0.0023 EUR) per m^2 for budgetary organizations - 3 soms (0.0031 EUR) per m^2, for other consumers - 6 soms (0.0061 EUR) per 1 m^2. In addition, the operation of the station is directly related to electricity. From 2021, the electricity tariff has been increased by 40%. And this tariff policy will increase annually with the rate of inflation. At the same time, financial resources are not allocated from the republican and city budgets.

2.4.2.2 Non-financial barriers

The barriers to this technology were analysed by the working group members based on a generalized initial long list of barriers. Non-financial barriers, after discussions in the working group, included:

- the absence of a sectoral normative legal act on the regulation of tariffs in the sector of domestic and drinking water supply and sanitation;
- lack of a renewable energy development program;
- lack of specialists in the field of sustainable waste management;
- the problem of further maintenance of biogas plants due to the lack of local service companies and;
- lack of positive practice of applying this Technology in the Kyrgyz Republic;
- lack of information about modern technologies for processing organic waste.

2.4.3 Identified measures

Determination of appropriate measures is the process of analyzing the necessary actions that need to be taken to overcome the existing barriers to the implementation of the technology "Use of organic waste as raw material (waste water) for a biogas plant" was done. In order to identify appropriate measures, a detailed analysis of current practice at the national level was carried out taking into account international experience. The national consultants applied a participatory approach to the analysis and by involving a wide range of stakeholders in the process. The measures were determined based on grouped barriers. LPA analysis was applied to the process of identifying measures to move from problems to solutions. (See Annex II, figure 22.)

As a rule, measures are divided into two main groups: financial and non-financial measures, since it is important for policy makers which measures can be implemented through legal or other assistance, and which measures should be funded (by national or external institutions).

2.4.3.1 Economic and financial measures

The main economic and financial measures are:

- *Attracting investments* through
    - project finance (PF). The PF is considered as a system that includes many elements (participants, objects of financing, contracts, risk management, infrastructure), which are closely interconnected and ensure the efficiency of the movement of financial flows. Investors can be donors providing funding on a grant basis and concessional funding, these are the Green Climate Fund (GCF) and other climate funds, USAID, GIZ, as well as the WB, ADB, EBRD group, which, when providing funds, have a grant component of up to 30% of the loan.
    - public-private partnership (PPP). In accordance with the Law of the Kyrgyz Republic dated August 11, 2021 No. 98 "On Public-Private Partnerships", a Public-Private Partnership (hereinafter - PPP) is a cooperation between public and private partners in order to develop and implement projects for the creation and / or modernization, operation and maintenance of infrastructure facilities and / or infrastructure services. The use of PPP in the waste management sector implies effective interaction between the state and business, the pooling of resources and potential, which makes it possible to find solutions that reconcile environmental requirements and requirements for the quality of services with the economic opportunities of business and utility consumers.
- *Tariff revision*. The main condition for the stable operation of municipal enterprises and the waste management industry is the formation of a sustainable financial flow. To do this, the tariff system should: provide coverage for current and capital costs, waste management and low-waste technologies in general[74].

2.4.3.2 Non-financial measures

Taking into account that the implementation of activities on the technology "Use of the waste water organic matter for biogas plants" has the potential to reduce greenhouse gas emissions, it is necessary to take comprehensive measures, which include such measures as improving the regulatory framework, training personnel to manage the complex of a biogas plant, raising awareness as decision makers about good wastewater management practices.

During the discussions, the members of the working group proposed the following measures:

- development of a sectoral normative legal act on the regulation of tariffs in the sector of domestic and drinking water supply and sanitation.
- development of a RES strategy/program.
- increasing the capacity of colleges, universities in the field of waste management.
- The operation of a digester plant requires specially trained personnel, especially for plant management and operational control. Depending on the type of process and the size of the plant, the number of personnel must be at least 3 qualified specialists.
- increasing the role of the Department of Development of Drinking Water Supply and Sanitation in providing advice to expand and ensure regular training of personnel and organize the exchange of best practices in design, survey;
- creation of a service company;
- studying and informing foreign examples.

[74] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3835042

- raising awareness among decision makers about climate issues and the benefits of recycling. Studying and informing about the good practices of using wastewater as a feedstock for biogas plants.

2.5 Linkages of barriers identified

The analysis shows, and it should be noted, that the technologies of the MBT and the SWOBGP, as well as the WWOBGP are closely related. Thus, the introduction of separate collection and sorted food waste at the MBT will ensure an uninterrupted supply of raw materials, i.e. food and green waste for biogas plants.

In addition, the use of biogas reduces the need to use both natural gas and other fuels for heat supply, which will generally reduce the cost of maintenance and operation, as well as the level of GHG emissions into the atmosphere.

The technologies under consideration belong to the Waste sector and are the most important direction for reducing GHG emissions, saving money and improving the environmental situation in the country.

Barriers associated with the introduction of technologies in the Waste sector were identified in seven categories: 1) economic, financial; 2) market; 3) legal; 4) institutional; 5) personnel; 6) technical; 7) informational (see Table 2).

Technology market maps of the Waste sector are presented in Annex II fig. 15, 18, and 21.

In the combination of identified barriers in the Waste sector, general patterns can be noted. The nature of the barriers is mainly seen as institutional and regulatory, requiring the improvement of the legal framework and the waste management system at the institutional level, a clear policy in the field of waste management, improvement of the quality of management and expansion of the information field.

One of the most important barriers hindering the development of the Waste sector is the fact that the public and business have a low level of awareness of technologies in the field of waste management and do not treat waste as a business model. Lack of financial capacity is also a major obstacle. Another common barrier for the three technologies is the lack of national policies and mechanisms for economic promotion by the government aimed at developing the Waste sector.

It should be noted that the technologies chosen as priorities in the Waste sector have already been introduced to one degree or another both in the near and far abroad.

A favourable environment for overcoming barriers in the Waste sector can be the improvement of the regulatory framework, the development of a program for waste management and renewable energy, the organization of information, increased activity and the formation of an understanding of waste as a business model, both among the population and business.

The problem trees based on the LPA for the three technologies in the Waste sector are presented in Annex II in fig. 16, 19, and 22.

2.6 Enabling framework for overcoming the barriers in the Waste sector

Barriers identified and proposed measures to overcome barriers to technology transfer in the Waste sector are summarized and presented in Table 2.

The most effective way to overcome barriers to the introduction of technologies in the Waste sector is to study and analyse international best practices, as well as adaptation and harmonization. Another important factor is facilitating access to finance. In addition, an appropriate legal framework should be developed, law enforcement mechanisms and effective mechanisms for economic incentives should

be created. Coordination between various ministries, departments and other government bodies should also be improved.

It should be noted that the selected technologies are successfully used in developed countries, contributing to the development of the national economy. This experience was reviewed and researched by the government of the country, scientific institutions, as well as individual experts.

The results of the study and analysis are provided to the authorized state bodies, as well as to the general public and all interested parties. As a favourable factor, it is necessary to note the readiness of the Government of the Kyrgyz Republic to participate in international agreements on mitigation of the consequences of climate change and efforts to approve them, as well as support for efforts in this direction at the level of the President of the Kyrgyz Republic.

Important factors in creating a favourable environment are the engineering, technical and scientific potential of the country, the assistance of relevant international organizations in its creation and development, the use of domestic experience in the field of using a biogas plant in agriculture.

The tree of tasks (measures) based on the LPA for the three priority technologies of the waste sector are presented in Annex II in Figures 17, 20, and 23.

List of references

National legislative documents

1. Constitution of the Kyrgyz Republic. Law No. 59 of 2021
2. Land Code No. 574-XII, 1991
3. Budget Code of the Kyrgyz Republic No. 59, 2016
4. Law of the Kyrgyz Republic "On Energy" No. 56 dated October 30, 1996.
5. Law of the Kyrgyz Republic “On Innovation Activity” No. 128 dated November 26, 1999.
6. Law of the Kyrgyz Republic “On the Basics of Technical Regulation in the Kyrgyz Republic” dated May 22, 2004 No. 67;
7. Law of the Kyrgyz Republic "On the system of scientific and technical information" No. 108 of October 8, 1999.
8. Law of the Kyrgyz Republic "On State Support for Small Business" No. 73 dated May 25, 2007.
9. Law of the Kyrgyz Republic "On the protection of the rights of entrepreneurs" No. 15 dated February 1, 2001.
10. Law “On State Guarantees of Equal Rights and Equal Opportunities for Men and Women”
11. Law of the Kyrgyz Republic “On Electric Power Industry” No. 8 dated January 28, 1997.
12. Law of the Kyrgyz Republic “On Renewable Energy Sources” No. 283 dated December 31, 2008.

National Policy Documents

13. President of the Kyrgyz Republic. 2018. National Development Strategy for 2018-2040. Approved by Resolution No. 22 of October 31, 2018.
14. President of the Kyrgyz Republic. 2021. National Development Program of the Kyrgyz Republic until 2026. Decree of October 14, 2021
15. Government of the Kyrgyz Republic. 2008. Draft National Energy Program of the Kyrgyz Republic for 2008-2010 and the strategy for the development of the fuel and energy complex until 2025. Government Decree No. 47 of February 13, 2008.
16. Government of the Kyrgyz Republic. 2018 National Gender Strategy (NGS) to Achieve Gender Equality by 2020
17. Government of the Kyrgyz Republic. 2017. The concept of scientific and innovative development of the Kyrgyz Republic until 2022. Decree of February 8, 2017 No. 79.
18. Government of the Kyrgyz Republic. Strategy for Sustainable Development of Industry of the Kyrgyz Republic for 2019-2023. Decree of September 27, 2019, No. 502.
19. Government of the Kyrgyz Republic. 2017. State Program for the Development of Intellectual Property in the Kyrgyz Republic for 2017-2021. Government Decree of July 6, 2017 No. 424.
20. President of the Kyrgyz Republic. 2020. “On urgent measures to enhance the introduction of digital technologies in the public administration of the Kyrgyz Republic.” Decree of December 17, 2020 UP No. 64.
21. Government of the Kyrgyz Republic. 2022. Action plan for digitalization of management and development of digital infrastructure in the Kyrgyz Republic for 2022-2023. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 2-r dated January 12, 2022.
22. Government of the Kyrgyz Republic. 2021. Education Development Program of the Kyrgyz Republic for 2021-2040. Government Decree No. 200 of May 4, 2021.
23. Government of the Kyrgyz Republic. 2018. The concept of "green" economy in the Kyrgyz Republic, approved by the Resolution of the Jogorku Kenesh of July 28, 2018 No. 2532-VI.
24. Government of the Kyrgyz Republic. 2019. Green Economy Development Program for 2019-2023 Approved by Government Decree No. 605 dated November 14, 2019.
25. Documents on migration and adaptation to climate change
26. Government of the Kyrgyz Republic. 2021. Nationally Determined Contribution (NDC) to the UNFCCC Paris Agreement in 2021.

27. Government of the Kyrgyz Republic. 2018. The concept of comprehensive protection of the population and territories of the Kyrgyz Republic from emergency situations for 2018-2030. Government Decree of January 29, 2018 No. 58.
28. State Agency for Environmental Protection and Forestry. UNEP, GEF. 2016. Third National Communication of the Kyrgyz Republic to the UNFCCC.
29. Government of the Kyrgyz Republic. 2013. Priority directions of adaptation to climate change in the Kyrgyz Republic until 2017.
30. Ministry of Emergency Situations. 2015. Program for Adaptation of the Emergency Sector; Approval Order No. 692 of 07/07/2015
31. Ministry of Health care. 2011. Health Sector Adaptation Program; Approval Order No. 531 dated October 31, 2011
32. State Agency for Environmental Protection and Forestry. 2015. Adaptation Program for the Forest and Biodiversity Sector. Approval Order No. 01-9/110 dated April 17, 2015
33. Ministry of Natural Resources, Ecology and Technical Supervision, GEF. Draft Fourth National Communication of the Kyrgyz Republic under the UNFCCC". 2022.

Scientific publications

34. Kuzmichenok V.A. 2009. Probabilistic assessment of the possible evolution of glaciers and runoff in Kyrgyzstan under projected climate changes. Materials of glaciological studies.
35. Wang Yu, Yue H., Peng K., He K., Hong S. and Brian B. A. 2020. Recent response of grassland net primary productivity to climate and anthropogenic factors in Kyrgyzstan.
36. World Bank Group and Asian Development Bank. 2021. Climate Risk Profile: Kyrgyz Republic.
37. Sh. Ilyasov, O. Zabenko, N. Gaydamak, A. Kirilenko, N. Myrsaliev, V. Shebchenko, L. Penkina. 2013. Climate profile of the Kyrgyz Republic.
38. HYDROC 2021. Assessing Risks and Vulnerability to Climate Change. "National report for the NDC of Kyrgyzstan".
39. Climate Change 2014. Impacts, adaptation and vulnerability. Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,https://www.ipcc.ch/report/ar5/

National statistics data

40. NSC. Fuel and energy balance for 2015-2020 http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
41. NSC. Kyrgyzstan in numbers. 2020. Bishkek. 2021.
42. NSC. Industry statistics for 2021. http://www.stat.kg/ru/statistics/promyshlennost
43. NSC. Employed population by type of economic activity. http://www.stat.kg/ru/statistics/zanyatost/
44. National Statistical Committee. Population. http://www.stat.kg/ru/statistics/naselenie/
45. National Statistical Committee. Small and medium businesses. http://www.stat.kg/ru/statistics/maloe-i-srednee-predprinimatelsvo/
46. Water Resources Service under the Ministry of Agriculture. https://www.water.gov.kg/index.php?option=com_content&view=article&id=228&Itemid=1274&lang=ru
47. NSC. GDP by type of economic activity. http://www.stat.kg/ru/statistics/nacionalnye-scheta/
48. NSC. Foreign economic activity.http://www.stat.kg/ru/statistics/vneshneekomicheskaya-deyatelnost/
49. NSC. Standards of living. http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/

Other publications and resources on Technology

50. CTCN website: https://www.ctc-n.org/collection/climatetechwiki
51. UNEP CCC website:https://tech-action.unepccc.org/tna-database/

52. FAO. 2017. Implementation of climate technologies in the agri-food sector. Methodology.https://www.fao.org/3/i7022e/i7022e.pdf
53. Del Mar Polo, M., Santos, N., Berdikeev, S. 2022. Implementation of Climate Technology in the Agri-Food System: Investment Opportunities in the Kyrgyz Republic. Rome, FAO.
54. James Haselip, Rasa Narkeviciute, Jorge Rogat and Sara Traerup. 2019. TNA Step by Step. UNEP-DTU partnership.
55. Jiska De Groot. 2018. Gender-Responsive Technology Needs Assessment Guide. UNEP-DTU partnership.
56. Ala Druce. 2015. Identify identified individuals and involve them in the Technology Needs Identification/TNA process. UNEP-DTU partnership.
57. Sara Trærup and Riyong Kim Bakkegaard (Riyong Kim Bakkegaard). 2015. Assessing and Prioritizing Technologies for Adaptation to Climate Demand.
58. Nygaard, I. and Hansen, U.E.. 2015. Overcoming Barriers to the Transfer and Diffusion of Climate Technology: Second Edition. UNEP DTU Partnership, Copenhagen.
59. Clements, R., J. Haggar, A. Quesada & J. Torres (2011). Technologies for adaptation to climate change - Agricultural sector. X. Zhu (ed.). UNEP Risho Center, Roskilde, 2011
60. Elliot, M., Armstrong, A., Lobullo, J. & Bartram, J. (2011). Climate change adaptation technologies - water sector. T. De Lopez (ed.). Roskilde: UNEP Riso Centre.
61. Overcoming Barriers to the Transfer and Diffusion of Climate Technologies, Second Edition, UNEP DTU Partnership, Department of Management Engineering, Authors Ivan Nygaard, Ulrich Elmer Hansenhttp://www.tech-action.org
62. Multi-criteria analysis: a manual January 2009 Department for Communities and Local Government: London http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf
63. National Development Strategy of the Kyrgyz Republic for 2018-2040https://www.gov.kg/ru/programs/8
64. Sustainable Development Goals 2030https://www.gov.kg/ru/p/sustainable_development
65. Fourth National Communication of the Kyrgyz Republic, 2021
66. NDC 2021 https://kyrgyzstan.un.org
67. Analytical report on the inventory of consumption waste disposal sites on the territory of the Kyrgyz Republichttp://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf
68. Basis for the development of a set of measures for the modernization of waste management. Preparation of a national strategy (concept) for waste management until 2025.http://eco-expertise.org/wp-content/uploads/2009/06/201805251451523.pdf
69. Processes in Kyrgyzstan. Comprehensive analysis of the current state of the municipal solid waste (MSW) management systemhttp://eco-expertise.org/sovershenstvovanie-ekologicheskoj-pol/stranovye/
70. Analysis of the regulatory impact of the Draft Law of the Kyrgyz Republic “On production and consumption wastehttps://mineconom.gov.kg/froala/uploads/file/b858ba779d056d248fff3bbb7f8a97dda5233dfb.pdf
71. On the draft law "On production and consumption waste". Registration number 6-8497/23, registration date 12-06-2023.http://www.kenesh.kg/ru/draftlaw/636204/show
72. Rules for the improvement of the city of Bishkek. Annex to the resolution of the Bikek city Kenesh of deputies dated June 30, 2009 No. 77http://cbd.minjust.gov.kg/act/view/ru-ru/24079
73. Answer MP "BSP". Information on the SWM project, from 03/02/2021
74. Response to input. No. 6-1593 dated October 25, 2022 “On the need to supply food waste for a biogas plant on the territory of the PF “Fluid”.
75. Kyrgyzstan in numbers. Statistical collection. Bishkek, 2011http://stat.kg/media/publicationarchive/0f99e52f-f88f-49e3-8b43-f5821e942ba1.pdf

76. Kyrgyzstan in numbers. Statistical collection. Bishkek, 2022http://stat.kg/media/publicationarchive/c2680694-07a1-4728-9921-131cb00e6c46.pdf
77. Environment in the Kyrgyz Republic, 2017-2021. Statistical collection. Bishkek - 2022http://stat.kg/media/publicationarchive/c210d76d-91e9-4e8e-a597-e49217759846.pdf
78. Environment in the Kyrgyz Republic, 2016-2020. Statistical collection. Bishkek - 2021http://stat.kg/media/publicationarchive/3b14c243-e1c2-43d8-a647-46bf65fad902.pdf
79. Statistics of the Sustainable Development Goals in the Kyrgyz Republic. National Statistical Committee of the Kyrgyz Republic. Statistical collection. Bishkek 2022http://www.stat.kg/media/publicationarchive/aff32455-587b-478f-b293-07087a033cb6.pdf
80. The state of the environment in the Kyrgyz Republic, including the ecological situation in the area of Lake Issyk-Kul. 2021. Statistical Bulletin. Bishkek, 2022http://stat.kg/media/publicationarchive/2293d6a3-ce9f-4367-98ce-455b22953a62.pdf
81. Official site of the City Hall of Bishkek. New tariffs for garbage collection in Bishkekhttps://bishkek.gov.kg/ru/tariffs/3
82. Official site of the City Hall of Bishkek. Containers for separate collection of waste appeared in the capital's schoolshttps://bishkek.gov.kg/ru/post/26164
83. Methodology for calculating the tariff for services for the collection, transportation and disposal of municipal solid waste in the territory of the Kyrgyz Republichttps://gosstroy.gov.kg/metodika-rascheta-tarifa-na-uslugi-po-s/
84. "Methane Meaning": how much CH4 humanity emits and what to do with ithttps://rusecounion.ru/ru/methane-matters
85. Analysis of modern practices of municipal solid waste management and development of recommendations for the Russian Federationhttps://papers.ssrn.com/sol3/papers.cfm?abstract_id=3835042
86. On approval of tariffs for the collection, removal, disposal, processing and disposal of municipal solid waste in the city of Almaty. Decision of the XXI session of the maslikhat of the city of Almaty of the VI convocation dated September 15, 2017 No. 146. Registered by the Department of Justice of the city of Almaty on September 22, 2017 No. 1405https://adilet.zan.kz/rus/docs/V17R0001405
87. Biogas plants for gas productionhttps://greda.kz/p59616395-biogazovye-ustanovki-dlya.html

Annex I: Market Maps, Problem and Objective Trees, Barriers' Tables

Energy Sector

Figure 6. LPA: Market mapping for the "Use of natural gas for heating instead of coal" technology

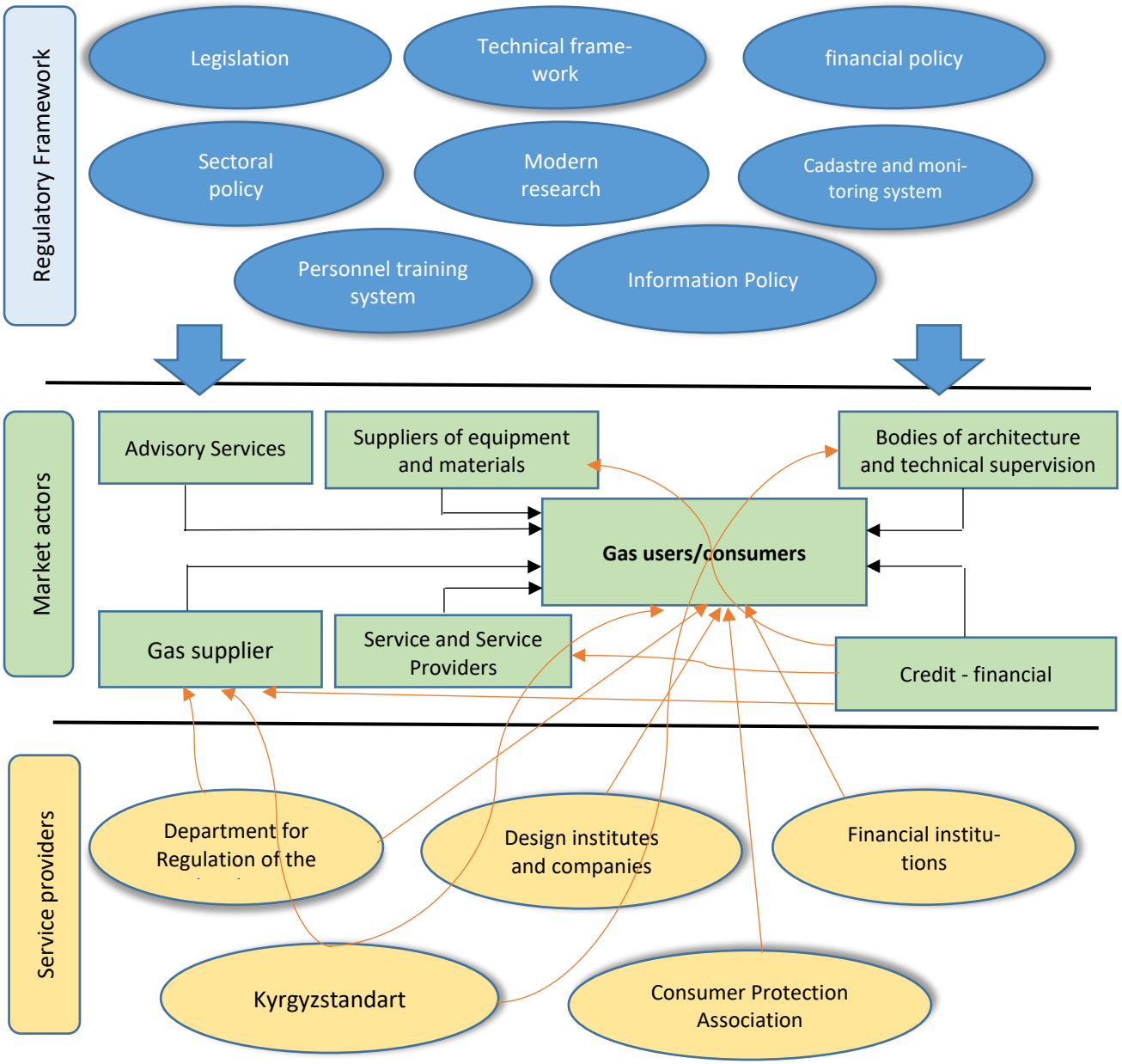

Figure 7. LPA: Problem tree for the "Use of natural gas for heating instead of coal" technology

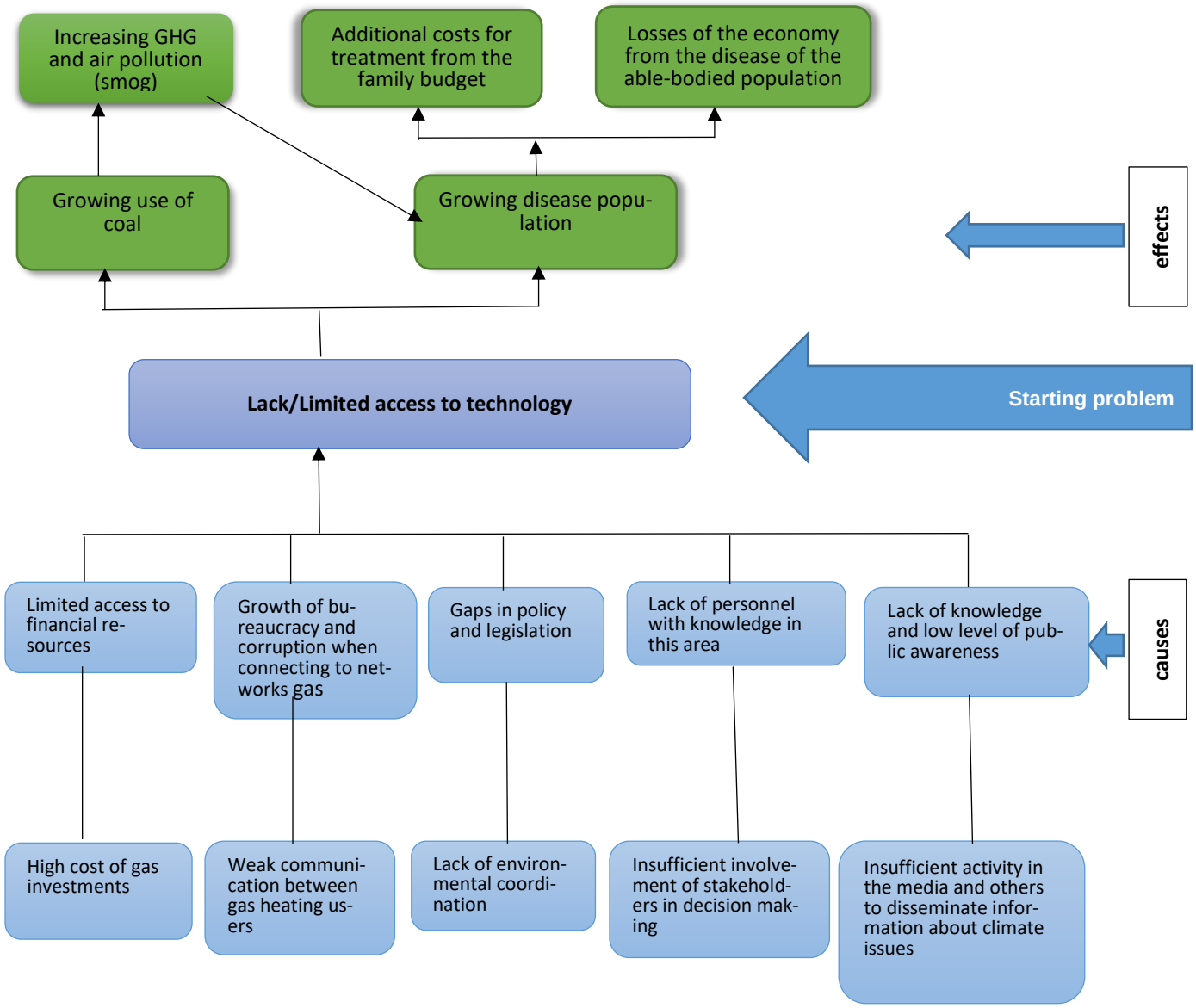

Figure 8. LPA: Objective tree for the "Use of natural gas for heating instead of coal" technology

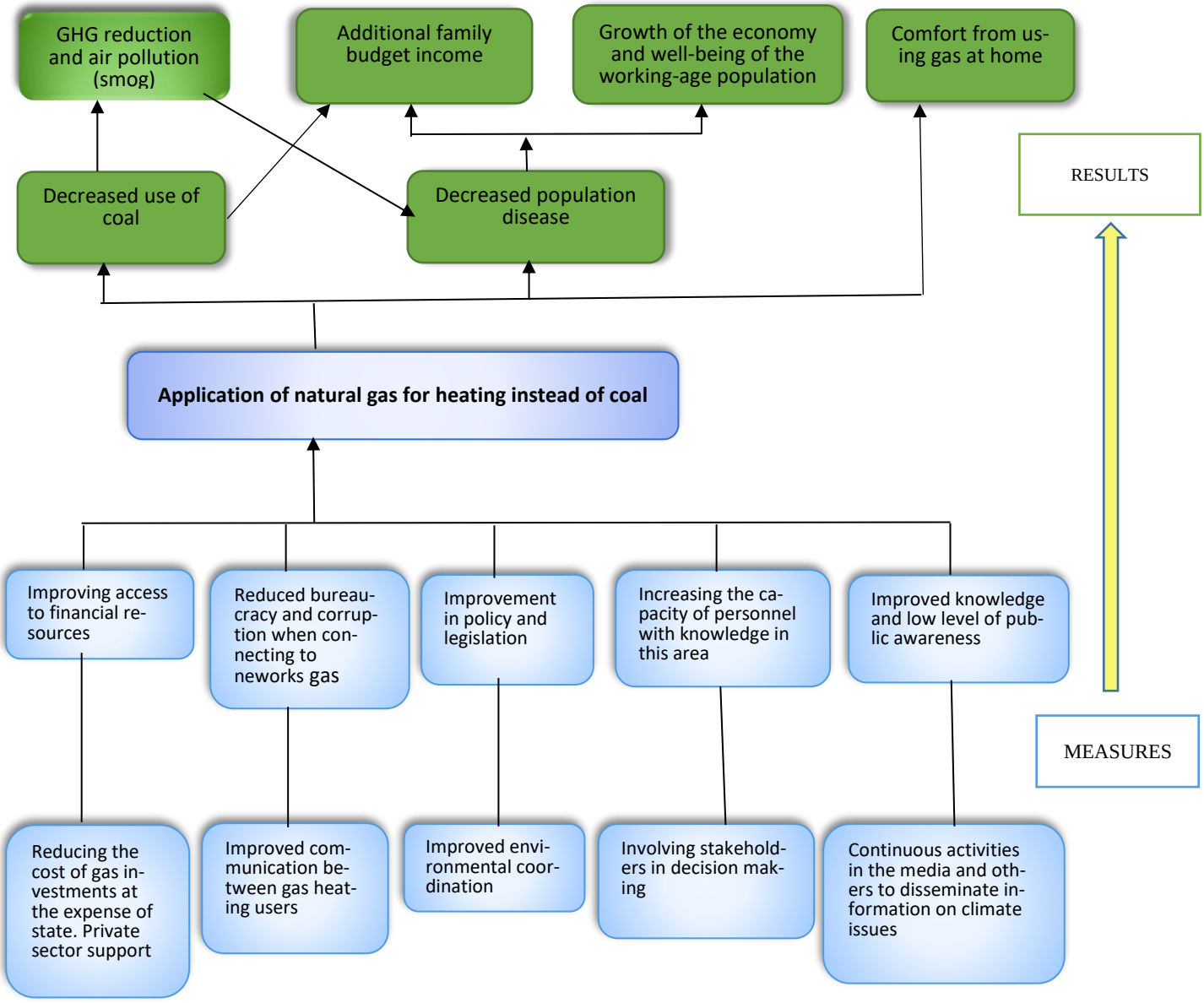

Table 7. Categories and number of identified barriers to technology adoption for the energy sector

Designation	Barrier	Quantity
a	Economic/financial	10
b	Market imperfection	2
c	institutional	1
d	NLA/Regulatory	7
e	Information/Awareness	4
i	Technical /Technological	1
f	Human skills/potential	3

Designa-tion	Barrier	Quantity
k	Social/cultural	
l	Others/Environment	
m	Creation of a network (communities) of technology users	
	Total	28

Table 8. Categories and names of identified barriers to the technology of the HLPG in the energy sector

No.	Designa-tion	Name of the barrier
1	b	Lack of networks for natural gas
2	d	Bureaucratic system for obtaining permission to connect to natural gas networks
3	a	High cost of project development and technical documentation for connection to natural gas networks
4	a	High cost of work and material when connected to natural gas networks.
5	a	The high cost of gas equipment for gas heating.
6	a	High cost and possible increase in the price of natural gas
7	b	Risk of termination of natural gas supplies from neighbouring countries
8	d	Lack of state support for the transition of the private sector to gas heating.
9	e	Low awareness of climate benefits and impacts of using natural gas instead of coal.
10	a	Lack of available (soft) loans for the purchase of gas equipment and connection to natural gas networks.

Figure 9. LPA analysis: Market mapping for the "Thermal insulation of existing public buildings" technology

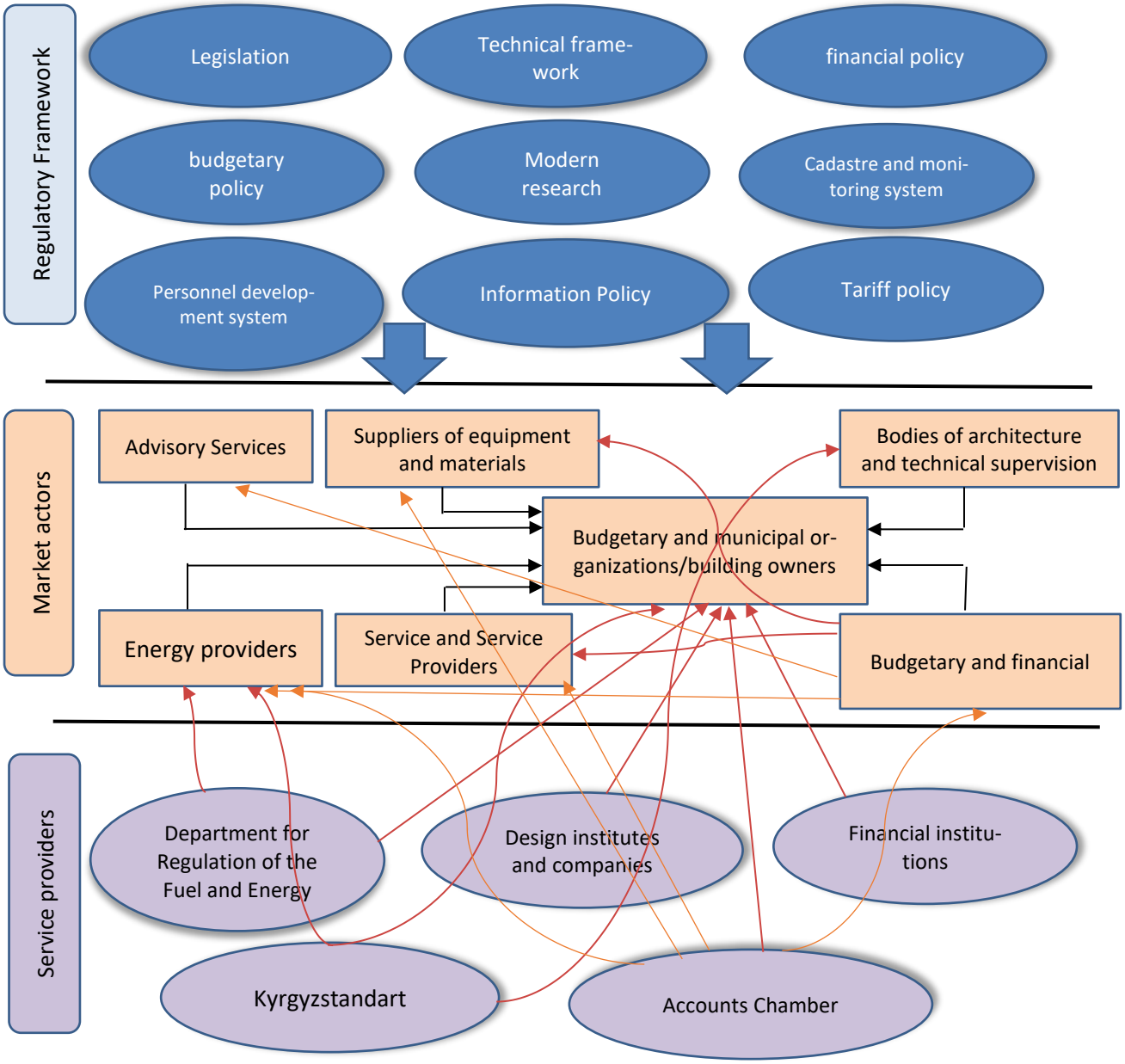

Figure 10. LPA analysis: Problem tree for the "Thermal insulation of existing public buildings" technology

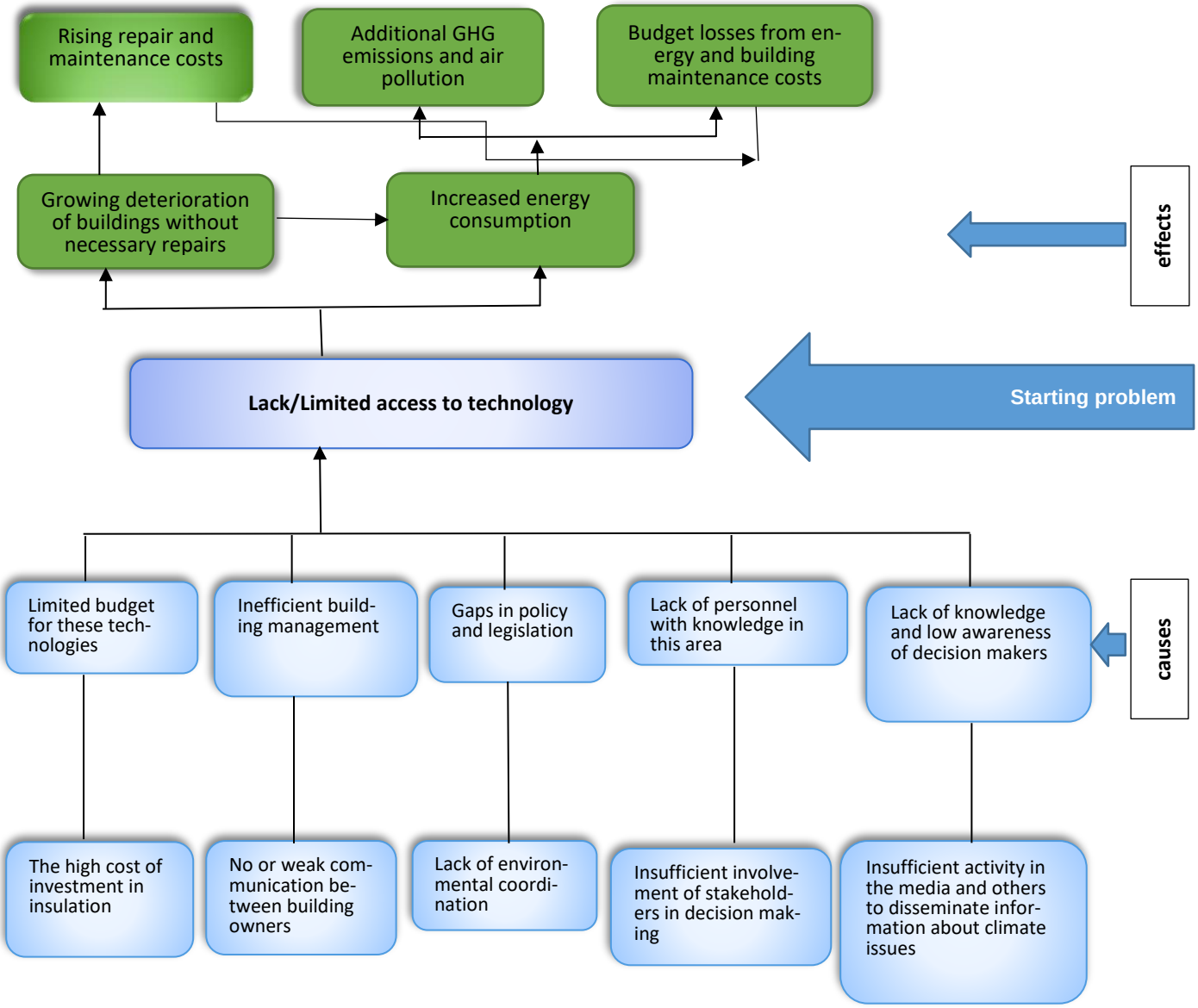

Figure 11. LPA analysis: Objectives tree for the "Thermal insulation of existing public buildings" technology

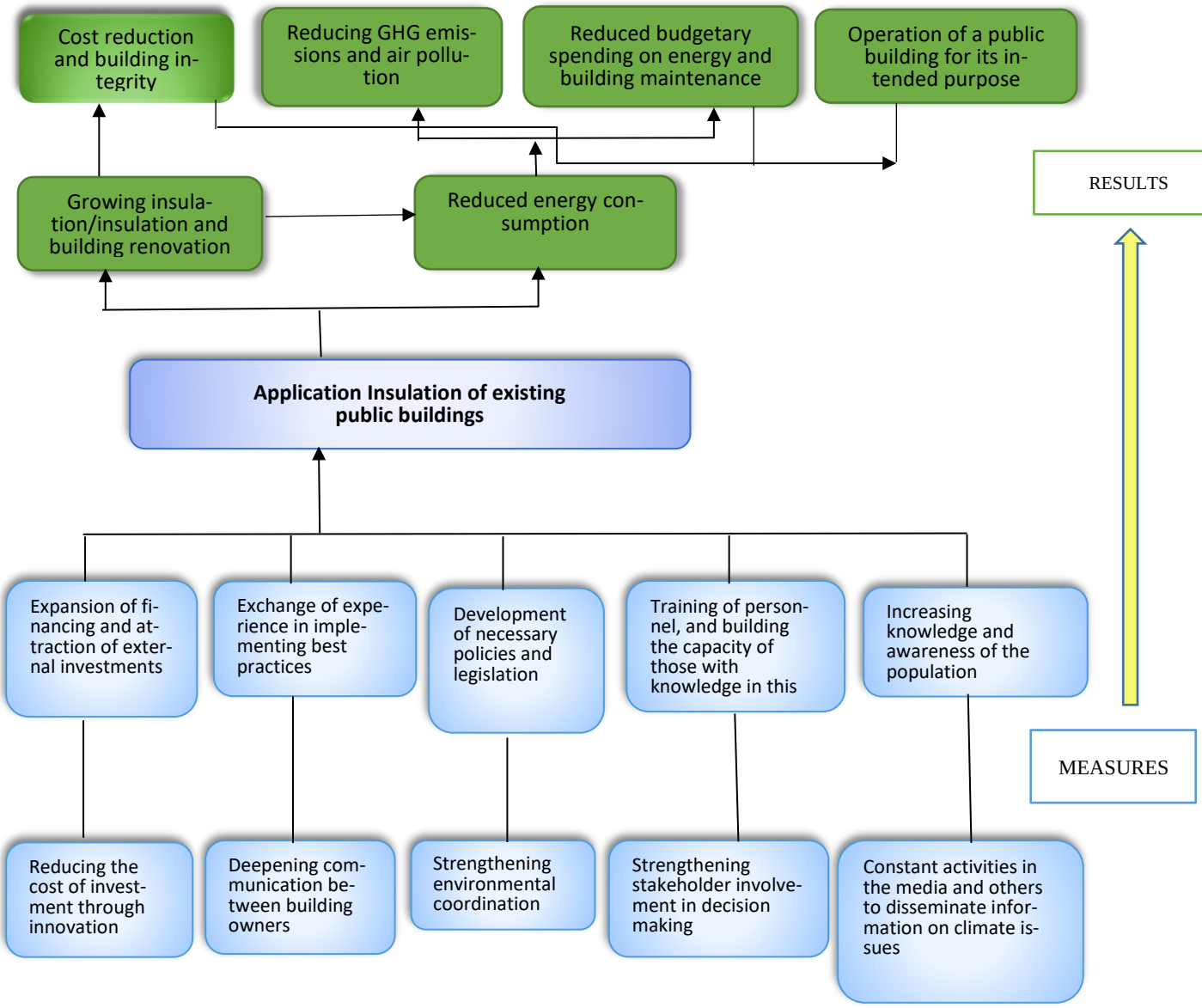

Table 9. Categories and names of identified barriers to HIH technology in the energy sector

No.	Designation	Name of the barrier
1	f	Low awareness among decision makers about climate issues and energy saving benefits in existing public buildings
2	e	Lack of information about modern energy saving technologies in buildings
3	a	Lack of necessary funds in the budget for the implementation of measures to improve the insulation of existing buildings
4	d	Lack of a system of incentives and encouragement for the introduction and use of energy efficient and energy saving measures in existing public buildings.
5	d	Lack of a state program for the implementation of this technology
6	a	Increased expenditure of additional funds from the budget
7	e	Low awareness of the safety of materials used for insulation.
8	a	High cost of thermal insulation and lack of financing and return mechanism

No.	Designation	Name of the barrier
9	f	Low qualification of foremen (builders) for thermal insulation (low quality of thermal insulation work)

Figure 12. LPA Analysis: Market Mapping for Energy Efficient Stoves for the Residential Private Sector technology

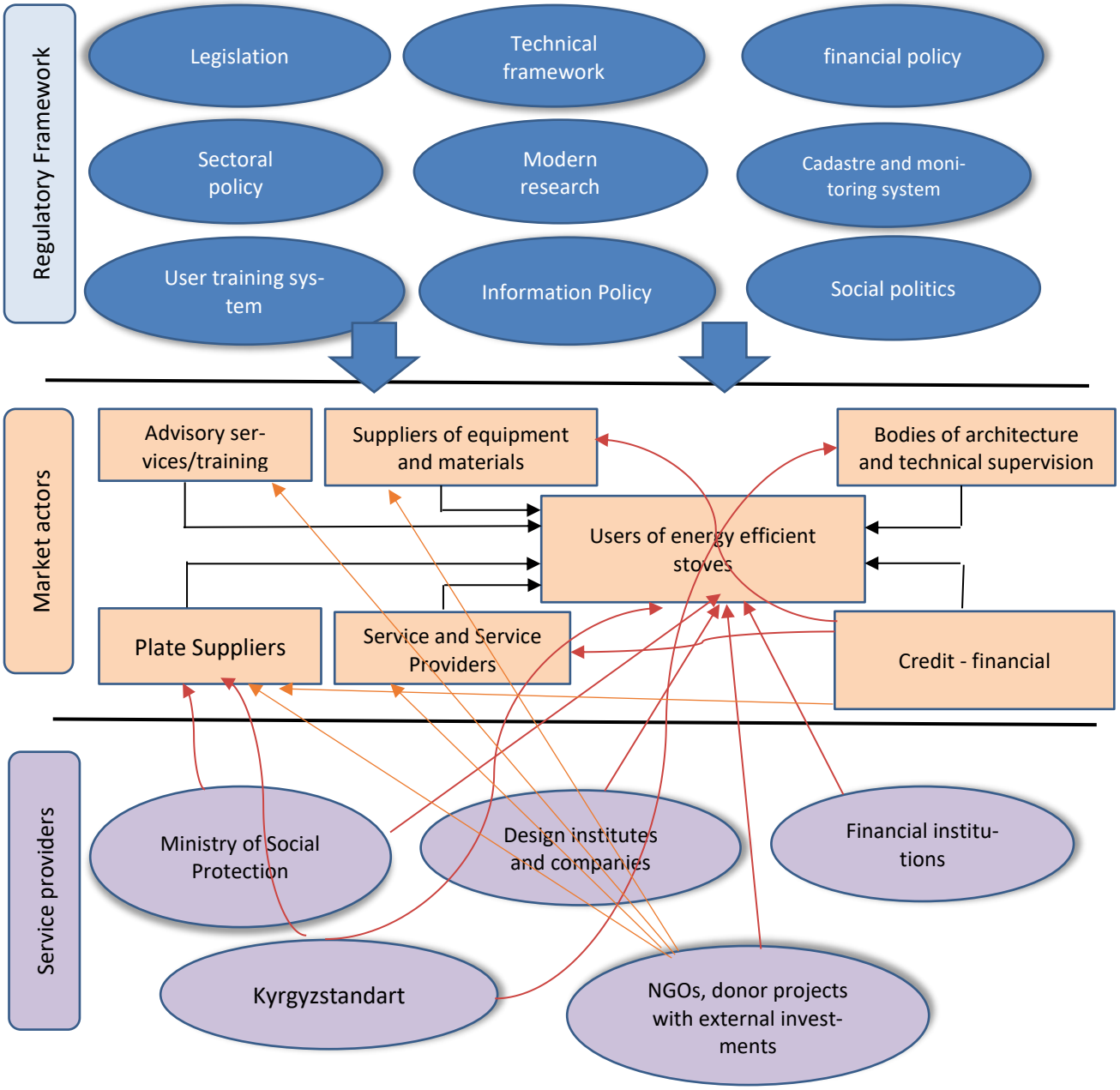

Figure 13. LPA analysis: Problems tree of problems for the "Energy-efficient stoves for residential private sector" technology

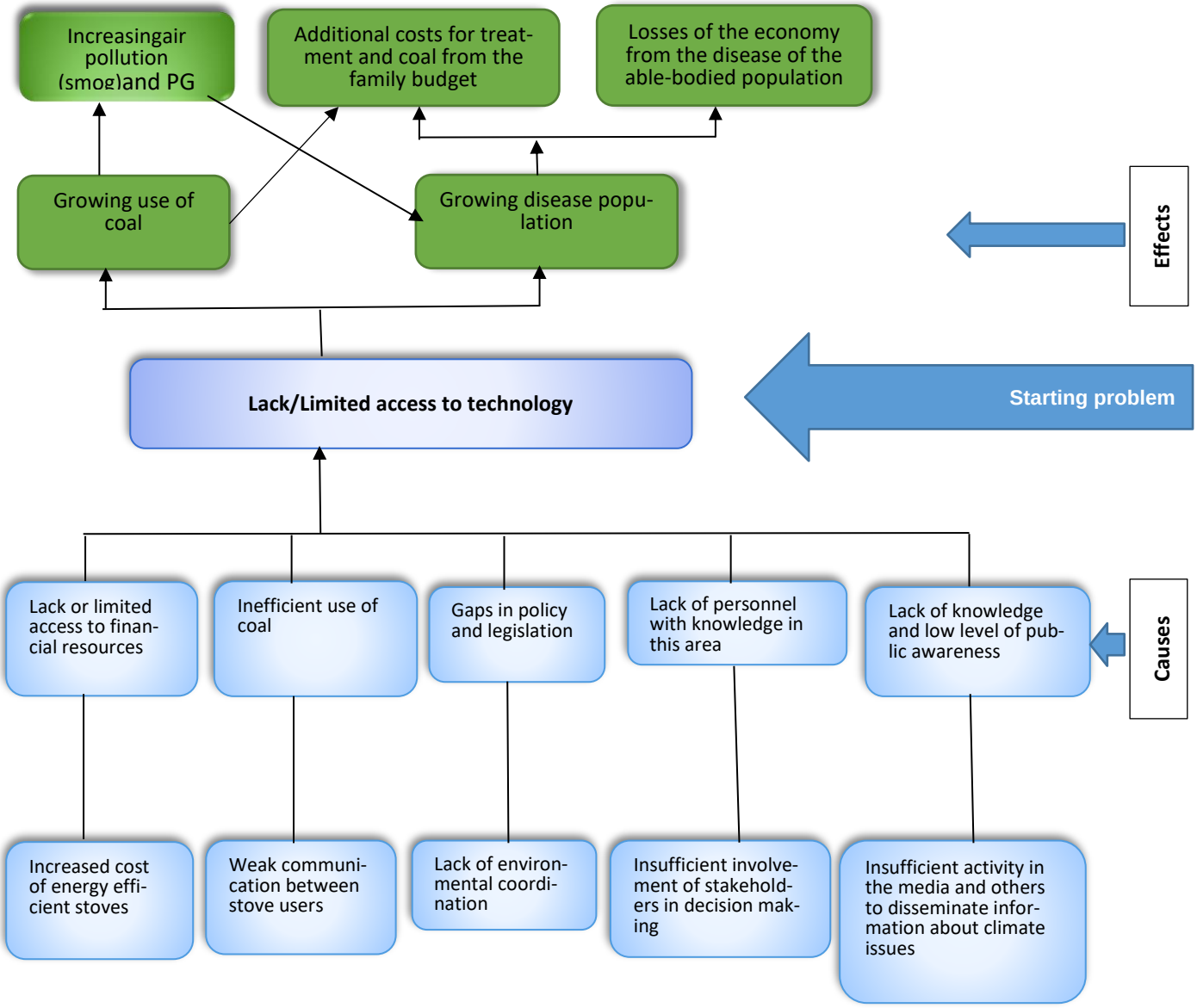

Figure 14. LPA: Objectives tree for the technology "Energy-efficient stoves for residential private sector" technology

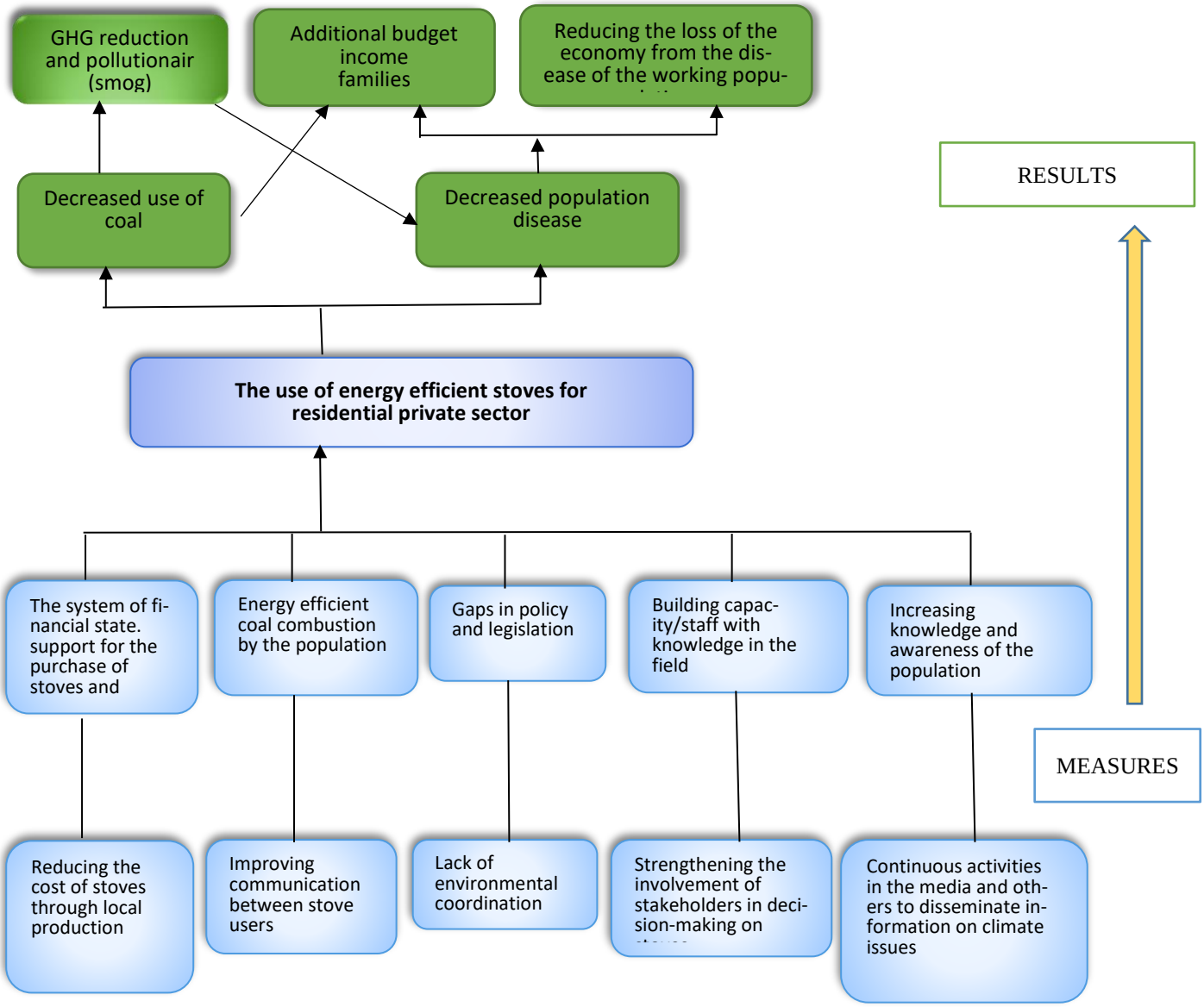

Table 10. P 4. Categories and names of the identified barriers to EPS technology in the energy sector

No.	Designation	Name of the barrier
1	e	Lack or low awareness of climate issues and benefits of energy efficient stoves
2	d	Lack of government support to scale up the use of energy efficient stoves
3	a	Lack of concessional financing for the purchase of energy efficient stoves
4	d	Lack of technical requirements for small boilers and stoves
5	c	Lack of testing laboratories for boilers and stoves
6	i	Relative design complexity for manufacturers to manufacture
7	f	Requires training in skills to operate EE stoves by users
8	a	High cost of energy efficient boilers and stoves
9	d	Lack of tax and customs preferences when importing imported energy-efficient boilers and stoves

Annex II: Market Maps, Problem and Objective Trees, and Barriers' Tables

Waste Sector

Figure 15. LPA: Market mapping for the "Mechanical and biological treatment of MSW" technology

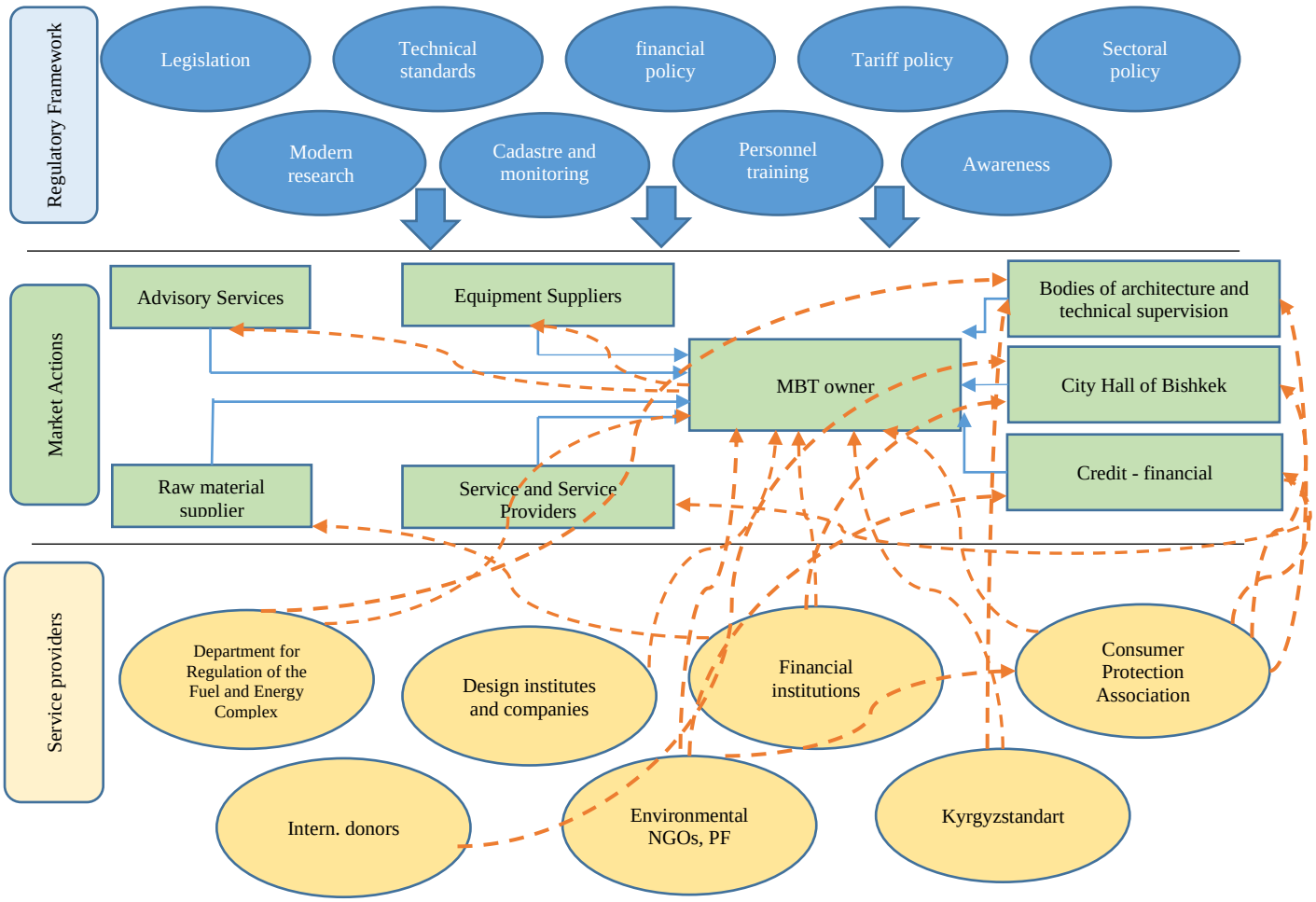

Figure 16. LPA: Problem tree for the "Mechanical and biological treatment of MSW" technology

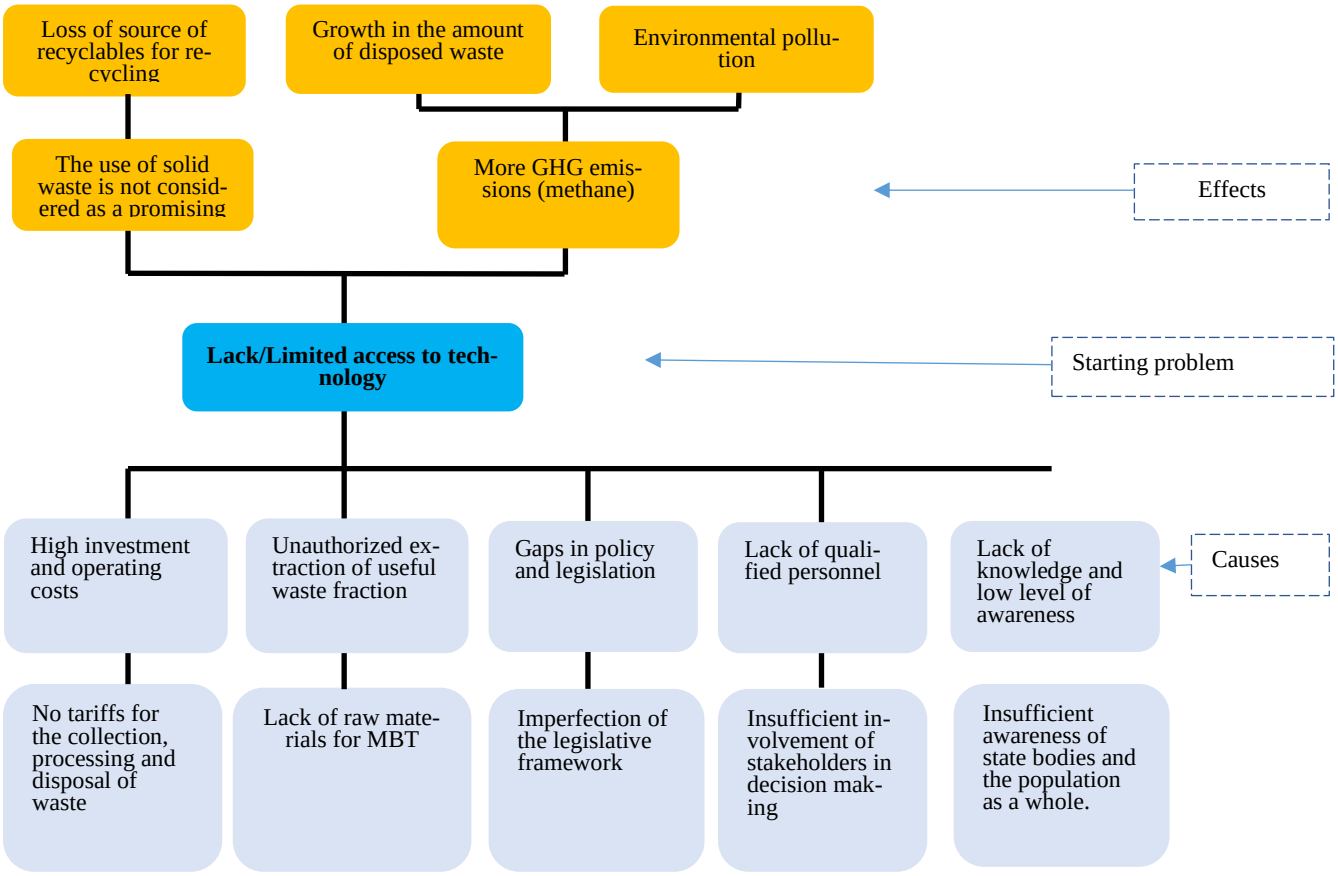

Figure 17. LPA: Objectives tree for the "Mechanical and biological treatment of MSW" technology

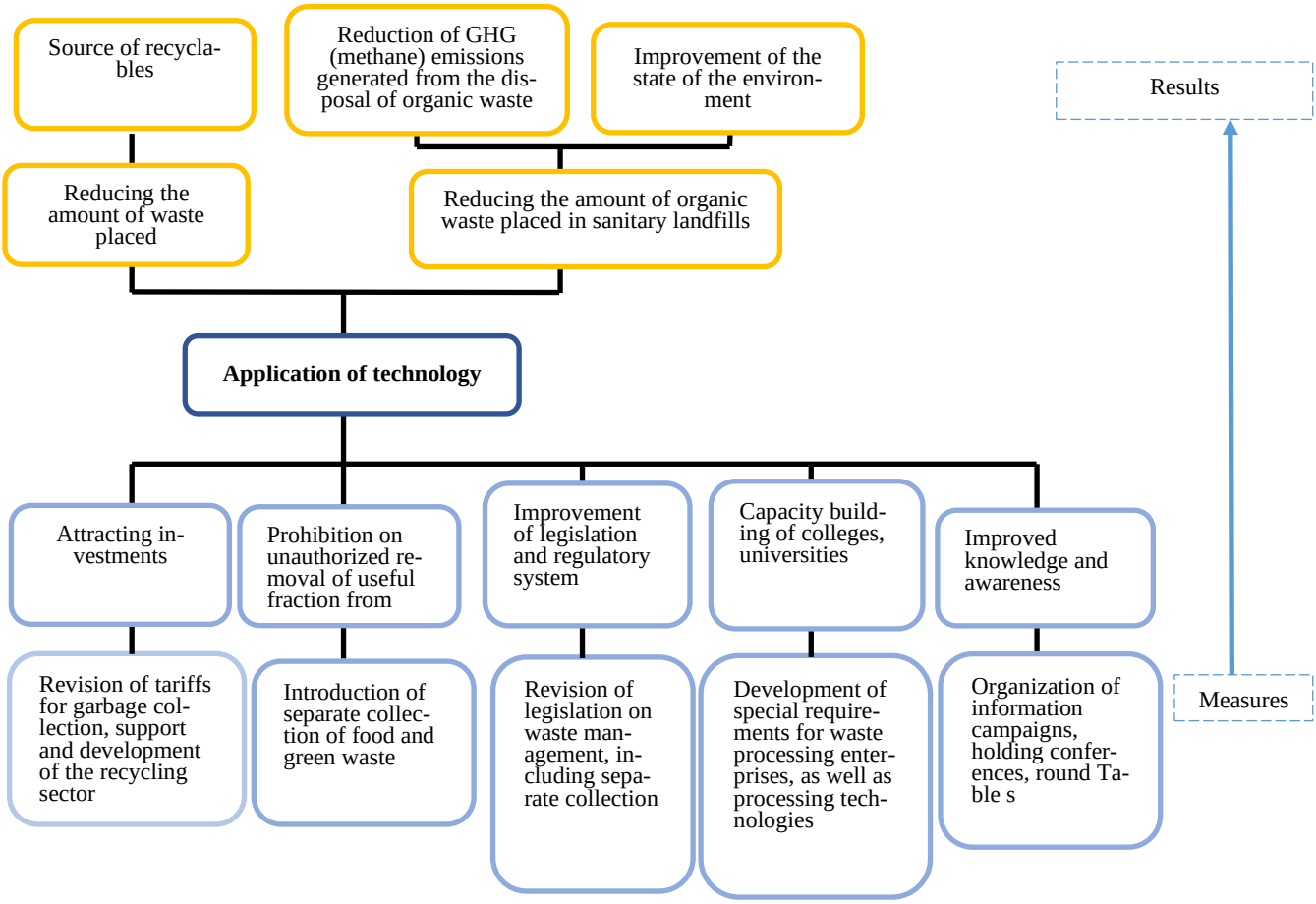

Table 11. Categories and number of identified barriers related to the introduction of technologies for the Waste sector

Designation	Barrier	Quantity
a	Economic / financial	6
b	Market	3
c	institutional	3
d	Legal	5
e	Informational	6
i	Technical	4
f	Human Resources/Capacity Building	3
a	Economic / financial	6
b	Market	3
c	institutional	3
	Total	42

Table 12. Categories and names of identified technology barriers "Mechanical and biological treatment of MSW"

No.	Designation	Name of the barrier
1	b	Unauthorized seizure of the useful fraction of waste (secondary raw materials) from waste collectors, garbage collection chambers and specialized transport for garbage disposal
2		Lack of a strategy/program for the sustainable management of waste and secondary resources
3	a	High investment and operating costs
4	a	No tariffs for the collection, processing and disposal of waste
5	d	Imperfection of the legal base in the field of management of municipal solid waste and secondary resources.
6	d	Lack of regular observations on the composition and amount of waste (morphological composition), accumulation rates, density.
7	f	Lack of specialists in sustainable waste management
8	i	Low technical standards for waste management.
9	e	Low level of informing the population about the separate collection of municipal solid waste at the places of generation and collection.
10	e	Lack of awareness and understanding about sorting and recycling of solid waste on the part of the general population.

Figure 18. LPA: Market mapping for the "Use of solid waste organic for biogas plants" technology

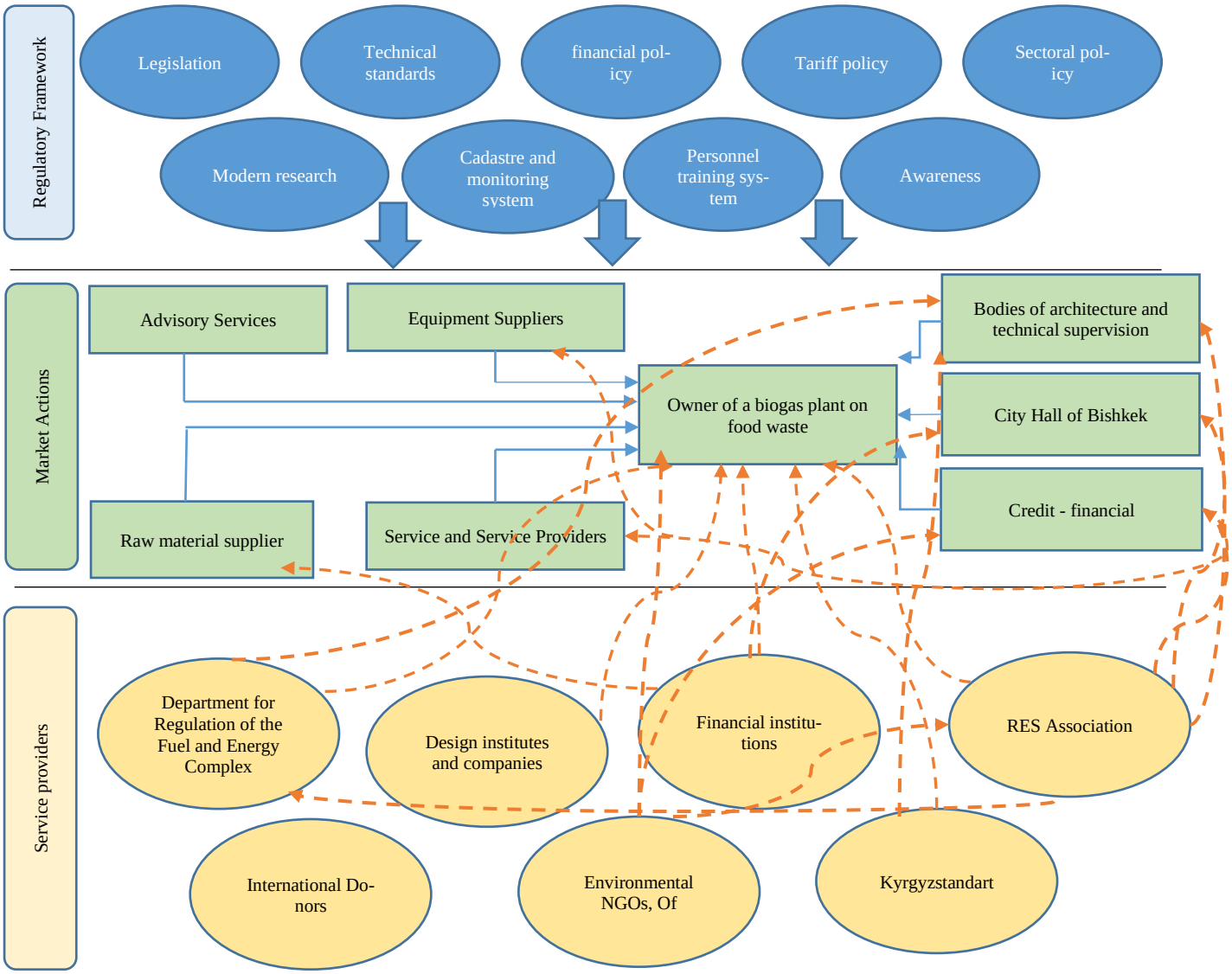

Figure 19. LPA: Problem tree for the "Use of solid waste organic for biogas plants" technology

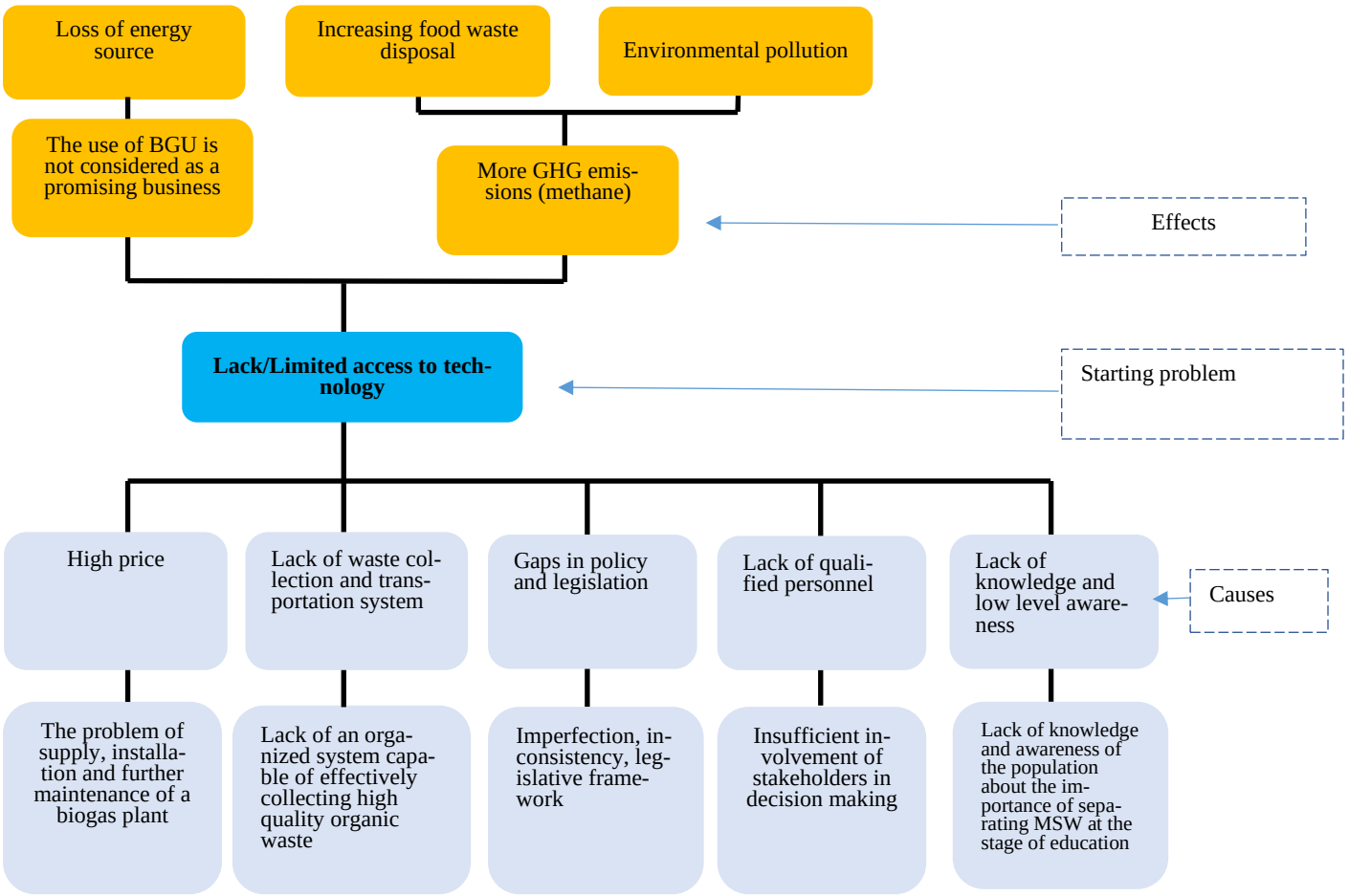

Figure 20. LPA: Objectives tree for the "Use of solid waste organic for biogas plants" technology

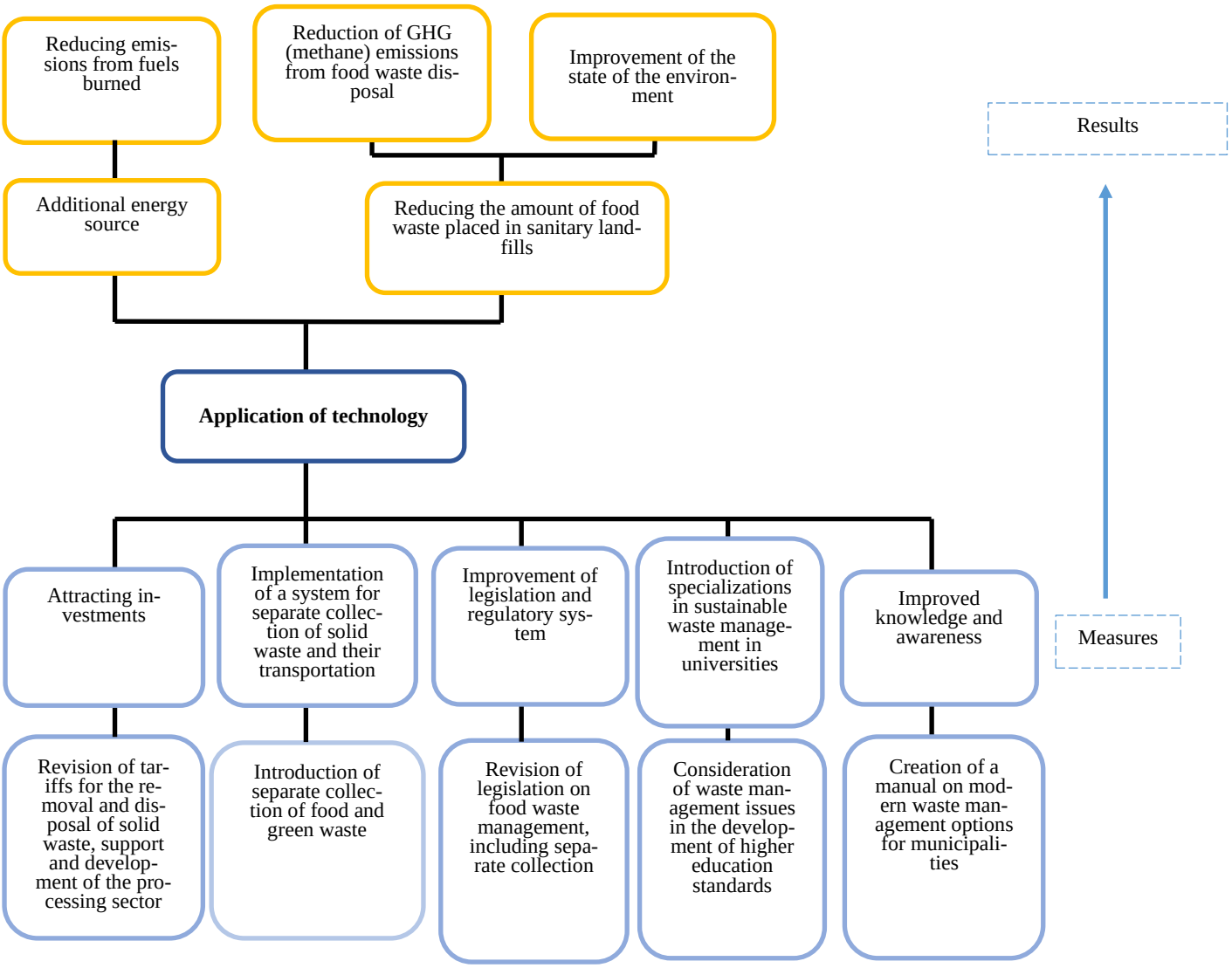

Table 13. Categories and names of identified barriers to the technology "Use of organic waste in biogas plants»

No.	Designation	Name of the barrier
1	a	High investment and operating costs
2	a	Low tariffs for recycling and waste disposal
3	b	Lack of organization of a rational waste collection system that provides for the separate collection of food waste.
4	b	Insufficiency of raw materials for biogas plants.
5	d	Imperfection of the legal base in the field of management of municipal solid waste and secondary resources.
6	d	There is no concept of secondary raw materials, processing, biogas and corresponding specific policies in this area.

No.	Designa-tion	Name of the barrier
7	c	Lack of a strategy/program for the sustainable management of waste and secondary re-sources
8	f	Lack of specialists in sustainable waste management.
9	i	Lack of technical standards for the handling and processing of food waste.
10	i	Lack of technical expertise in the installation and maintenance of biogas plants.
eleve n	e	Low level of public awareness about the separate collection of food waste at the places of generation and collection.
12	e	There is no information about the correct accumulation of organic waste.

Figure 21. LPA: Market mapping for the "Use of Waste Water Organic Matter for Biogas Plants" technology

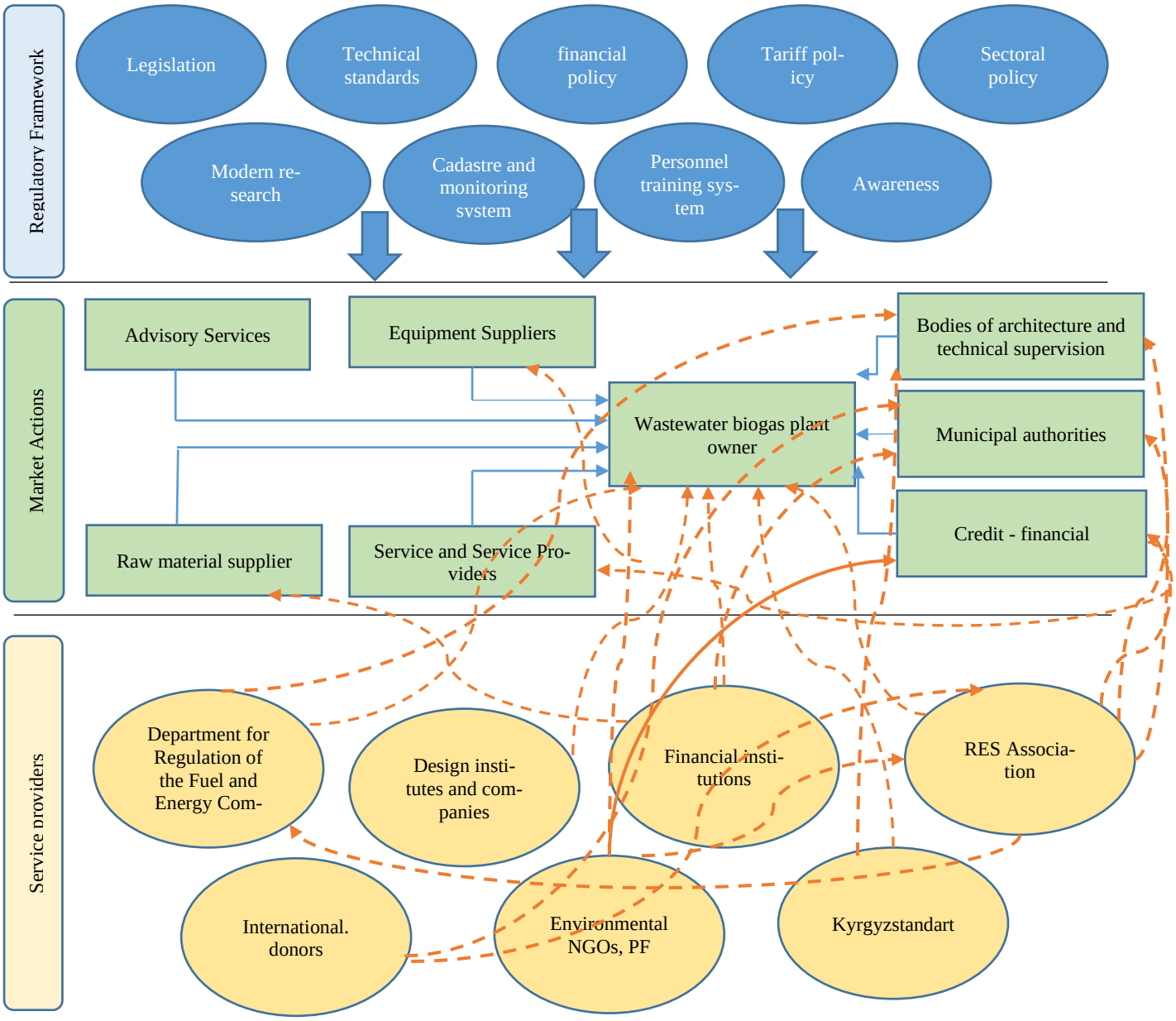

Figure 22. LPA: Problem tree for the "Use of Waste Water Organic Matter for Biogas Plants" technology

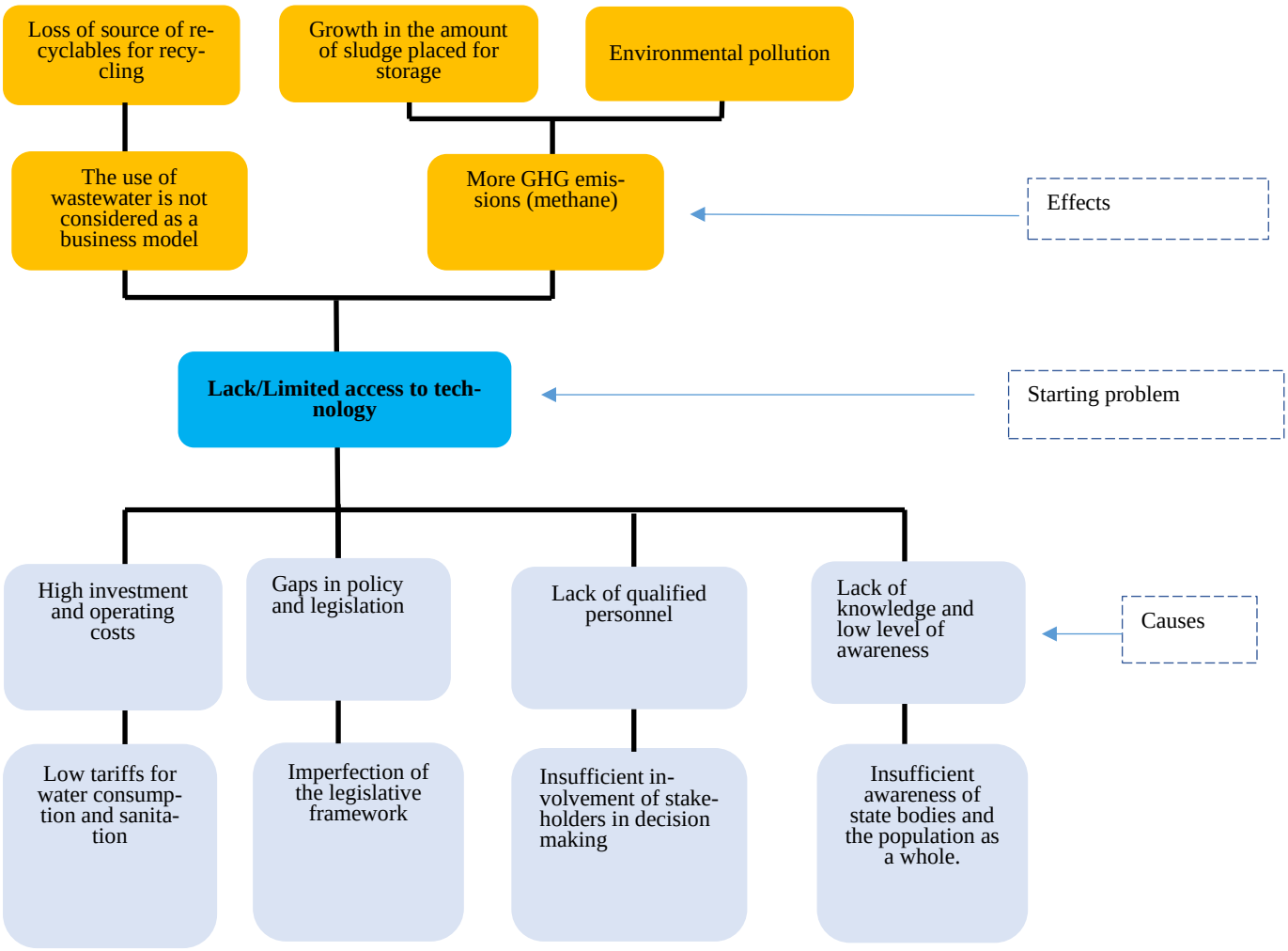

Figure 23. LPA: Objective tree for the "Use of Waste Water Organic Matter for Biogas Plants" technology

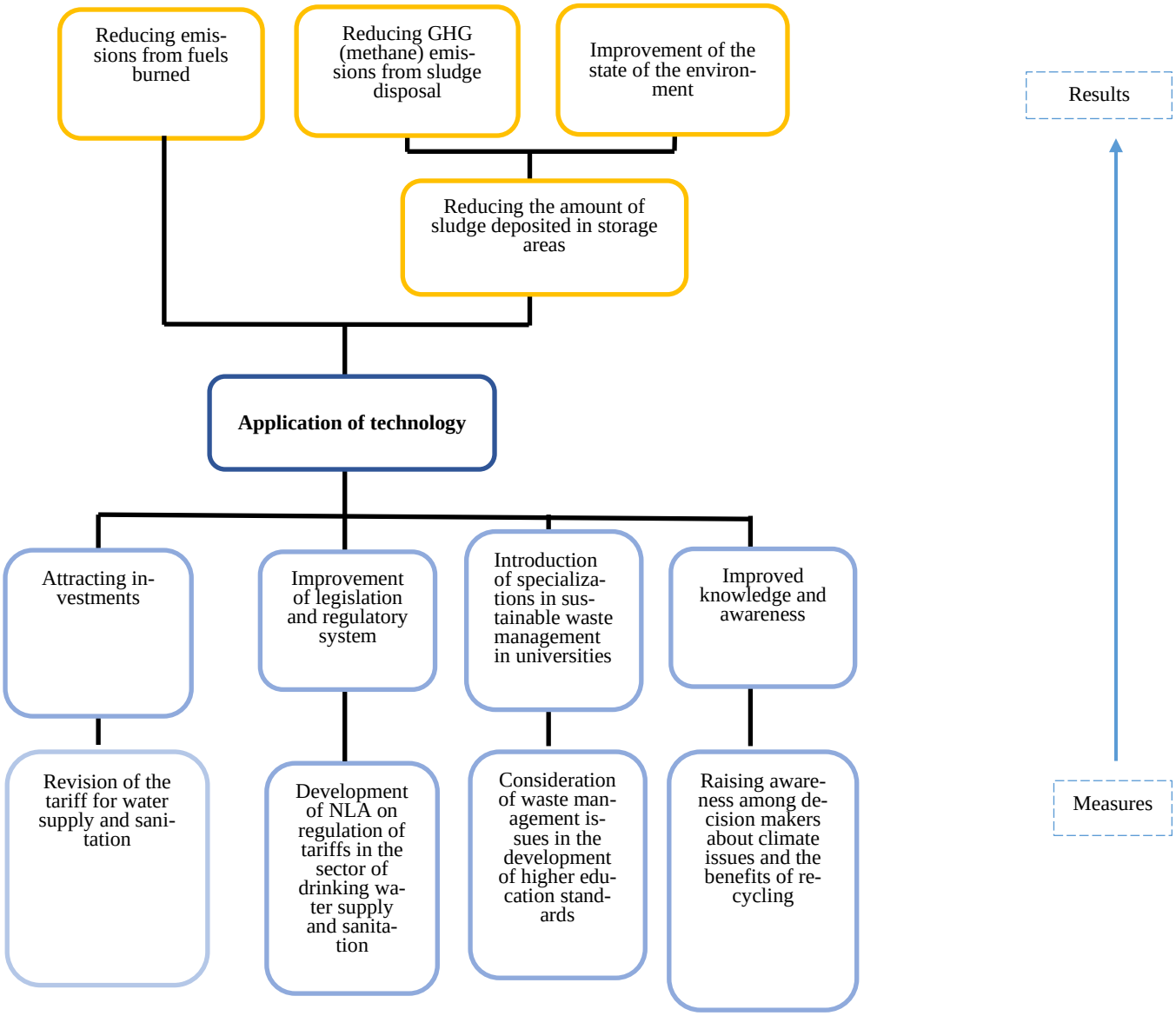

Table 14. Categories and names of identified barriers for the technology "Use of Waste water organic matter for biogas plants

No.	Designation	Name of the barrier
1	a	High investment and operating costs
2	a	Low tariffs for water consumption and sanitation
3	d	Absence of a sectoral normative legal act on the regulation of tariffs in the sector of domestic and drinking water supply and sanitation.
4	c	Lack of a strategy/program for the sustainable management of waste and secondary resources

No.	Desig-nation	Name of the barrier
5	f	Lack of specialists in sustainable waste management.
6	i	Lack of technical expertise in the installation and maintenance of biogas plants.
7	e	Lack of information about modern technologies for processing organic waste.
8	e	Lack of information on good practices in the use of wastewater as feedstock for biogas plants.

Annex III: List of stakeholders involved and their contacts

Energy Sector

no.	Full name	Organization, position	Contacts
1.	Esengeldiev Ermek	Climate Finance Centre, Expert, MNRET	0556 08 40 00 ermek.esen-geldiev@gmail.com
2.	Akbaraliev Dastan	Agencies for development and investment. City Hall of Bishkek	0708 312996 d.akbaraliev@meria.kg
3.	Nurbekov Atay	Ministry of Energy of the Kyrgyz Republic, Leading Specialist of the Department of Energy Efficiency, Energy Saving and Development of RES	0555 700 494 otdelvie21@mail.ru
4.	Esengulov Mirbek Omurbekovich	Ministry of Energy of the Kyrgyz Republic, Chief Specialist of the Department state policy in the electric power industry	0553 009 375 mirbek-es@yandex.ru
5.	Musabekov Nurmat	Ministry of Transport and Communications of the Kyrgyz Republic. Leading Specialist of the Road Transport Department of the Road and Railway Transport Department	(0312) 314067 0551 130688 nurmatm@gmail.com
6.	Samarets Svetlana	OJSC Electric Stations. Deputy Head of PTO of Bishkek CHPP	0555 771 607 es@infotel.kg
7.	Zhdanova Angela	OJSC Electric Stations. Ecologist of Bishkek CHPP	0554 944014Anjela.zhda-nova@yandex.ru
8.	Atakanov Aidar	LLC Gazprom Kyrgyzstan. Head of the development department	0772 163 738 aidarbek.ataka-nov@gmail.com
9.	Vedeneva Tatiana	Center for RES and EE. The president	(0312) 533 763 0555 755306 info@creeed.net
10.	Kazakova Eleonora+	RES Association. Chairman	 vienergy.kg@gmail.com
11.	Karbasheva Kunduz +	Chairman of the Association of Wind and Solar Power Plants. JSC "Kyrgyz Wind system" Deputy Director	0755 741718 info@pogruz.kg
12.	Iskembaev Azamat Zhakypovich	Bishkek Solar LLC. CEO	0501 138 393 bishkeksolarre@gmail.com
13.	Madumarov Artur	Kyrgyz-German LLC NEW-TEK, Deputy. Directors	0770 050 551 a.madumarov@newtek-schmid.com
14.	Obozov Alaibek Zhumabekovich+	NAS KR, Laboratory of RES, Doctor of Technical Sciences, Professor	0559 190 606 obozov-a@mail.ru
15.	Abduvaliev Maksat.	IVPGGE NAS KR, Head. Hydropower Laboratory	0550 056 442 abduldaev59@mail.ru
16.	Abylaev Timur	Agency for Development and Attraction of Investments. Vice president. City Hall of Bishkek	0555 004344 timur.abylaev@gmail.com
17.	Zhaparov Ulukbek Kvdyrzhanovich	Agency for Development and Attraction of Investments. Head of Investment Department. City Hall of Bishkek	0771 128529 u.japarov@meria.kg

no.	Full name	Organization, position	Contacts
18.	Mukanbetov Emil	OJSC "Chakan HPP" Head of the Department of Prospective Development	0550 581 157 emil.mukhambetov@gmail.com
19.	Vedenev Alexey Gavrilovich	Chairman, PF "Fluid", Development of biogas technologies	0705 104 109 contact@fluid-biogas.com
20.	Ismailov Ruslan	PF "CAMP Ala-Too", Energy Expert	0772 113 568 ruslani@camp.kg
21.	Zhumashev Murat	PF "CAMP Ala-Too", Coordinator	0556 640 419murat@camp.kg
22.	Kolesnikov Andrey	LLC "220 KG", equipment. FES	0555 461 818 office@220.kg
23.	Bidinov Urmatbek	ARIS, Coordinator, Heat Supply Improvement Project	0558 883 886 ubidinov@aris.kg
24.	Abdyrasulova Nurzat	OF UNISON, Chairman	(0755) 741718 office@unisongroup.org

Waste sector

No.	Full name	Organization, position	Contacts
1.	Obodoev Dostuk	MNRET KR, Center for Climate Finance, Director	dostuk.obodoev.88@mail.ru
2.	Mederaliyev Einar Dzhumabekovich	Ministry of Energy and Environmental Protection of the Kyrgyz Republic, Department of Environmental Protection	0505502402 0772 160758 (whatsapp) einvironment@mnr.gov.kg
3.	Ulanbekov Talantbek Ulanbekovich	City Hall of Bishkek, head of the OBO department	0505002007 ulanbekovtalantbek@gmail.com
4.	Dzhumaliev Nurlan Dzhaparbekovich	Director of MP "Bishkek Sanitary Polygon"	0559233233 mp_bsp@mail.ru
5.	Maatkulov Abas Atantayevich	Deputy Director for Planning and Development of the SE of the enterprise "Tazalyk"	0312 345-102, (reception) 0312 345-073, (general department) 0555080810 mptazalyk@mail.ru abas1609@mail.ru
6.	Karimov Alibek Abdyganievich	Specialist of the department for the development and monitoring of housing and communal services of Gosstroy	0312 312-924 Common department ali.k.7189@mail.ru
7.	Orozbakieva Shayyrgul Galievna	Leading Specialist of the Department for the Development of Drinking Water Supply and Sanitation at the State Agency for Construction Architecture and Housing and Communal Services	0312 312-924 Common department orozbakieva@mail.ru
8.	Dzhumanalieva Ainura Satybekovna	Climate Finance Center under the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic	555 56 20 00 ainuradjm@gmail.com adjumanaliyeva@gmail.com
9.	Moldokulov Kurmanbek	Bishkek Development Agency, director	0557-858888 kurmanbek78@gmail.com

No.	Full name	Organization, position	Contacts
10.	Kulmurzaeva Aisuluu Kuvatbekovna	Bishkek Development Agency	0505043044 aisuluukulmurzaeva@gmail.com
11.	Bakirov B.Zh.	Bishkek Development Agency	0999117709 Bakytbek.bakirov.76@mail.ru
12.	Sultambaev Medetbek Oroskulovich	ARIS Senior Monitoring and Evaluation Specialist	MSultanbaev@aris.kg, 30-17-78 add. 197 0702803251
13.	Baidakova Natalya Sergeevna	CSR Central Asia Environmental Safety Expert	0700 204-734 wastenet.projects@gmail.com
14.	Vedeneva Tatiana	Center for RES and EE. The president	0312 533-766 0555 755306 info@creeed.net
15.	Abduldaev Maksat Sekenovich	Institute of Water Problems Hydropower of the National Academy of Sciences of the Kyrgyz Republic. Head of Hydropower Laboratory	abduldaev59@mail.ru 0550056442
16.	Podrezov Andrey Olegovich	KRSU, Head of the Department of Meteorology, Climatology and Environmental Protection	0550 428-379 andrey_podrezov@mail.ru
17.	Obozov Alaibek Zhumabekovich	NAS KR, Laboratory of RES, Doctor of Technical Sciences, Professor	0559 190 606 obozov-a@mail.ru