Kazakhstan: Energy Efficiency Transformation in Astana and Almaty

Supported by

Municipal Energy Efficiency Plan for the City of ALMATY

November 2017

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Exchange rate US$ 1 = KZT 222 (as of 2015)

Energy consumption and expenditure in the report is for the baseline year 2015.

Content

List of Abbreviations

ALES	Almaty Energy System	IT	Individual Private Transport
AOA	Apartment Owners Association	KEGOC	Kazakhstan Electricity Grid Operating Company
BEMS	Building Energy Management Systems	KPI	Key Performance Indicator
CA	City Administration (Akimat)	KZT	Kazakh Tenge
CB	Commercial Buildings/Industry Sector	LED	Light Emitting Diode
CFL	Compact Fluorescent Light	LPG	Liquid Pressed Gas
CHP	Combined Heat And Power Plant (cogeneration)	LRT	Light Rail Transport
CNG	Compressed Natural Gas	MEA	Municipal Energy Agency
DH	District Heating	MoF	Ministry of Finance
DHW	Domestic Hot Water	MoID	Ministry of Investments and Development
EBRD	European Bank for Reconstruction and Development	MSW	Municipal Solid Waste
EE	Energy Efficiency	MW	Megawatt
EEDI	Institute of the Electricity and Energy Efficiency Development	PB	Public (municipal) Buildings
EERF	Energy Efficiency Revolving Fund	PBP (T)	Payback Period (time)
EL	Electricity sector - Power supply	PEC	Primary Energy Consumption
EM	Energy Management	PPP	Public Private Partnership
EPC	Energy Performance Contracting	PT	Public Transport
ESA	Energy Service Agreements	PV	Photovoltaic - Solar power generation
ESCO	Energy Service Company	RE (S)	Renewable Energy (Sources)
ESMAP	Energy Sector Management Assistance Program	REI	Relative Energy Intensity
FEC	Final Energy Consumption	SCADA	Supervisory Control And Data Acquisition System
GDP	Gross Domestic Product = GRP	SL	Street Lighting Sector
GRP	Gross Regional Product	SPV	Special Purpose Vehicle
GHG	greenhouse gas emissions	TA	Technical Assistance
GoK	Government of Kazakhstan	TRACE	Tool for Rapid Assessment of City Energy
GWh	Giga Watt Hours = Million Kilo Watt Hours	TWh	Terra Watthour - billion kWh
HDI	Human Development Index	VAT	Value Added Tax
HFO	(heavy) Heating fuel oil (mazut)	VSD	Variable speed drive
HPS	High Pressure Sodium	WB	The World Bank
IBRD	International Bank for Reconstruction and Development	WS	Water & Wastewater
IFI	International Financial Institution	WWTP	Wastewater Treatment Plant
		yr	year

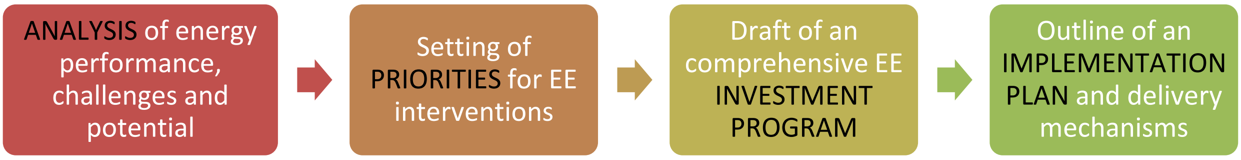
1 Executive Summary

This report outlines the results and key findings of an energy efficiency (EE) study - "Energy Efficiency Transformation in Astana and Almaty" - conducted by the World Bank between November 2016 and November 2017 in Almaty, using the Tool for Rapid Assessment of City Energy (TRACE 2.0). The objective of this study is to outline an urban EE strategy for the next 13 years for the city of Almaty, up to 2030, by assessing the energy performance of the municipal service sectors and identifying and prioritizing EE opportunities along with a sound implementation plan.

The overarching objectives of the municipal EE plan are to reduce energy consumption, diminish related expenditures from the municipal budget, and improve municipal service delivery for city residents. The plan includes a host of qualitative targets, from reducing the Greenhouse Gas (GHG) emissions and Primary Energy Consumption (PEC), avoiding an increase in the energy bills to improving performance of local public service providers and enabling the environment to attract private investments for EE interventions.

The methodology applied comprises four steps, namely assessment of the energy performance, prioritization of sectors with highest energy potential savings, and drafting and implementation of the EE plan (see Figure 1 below).

Figure 1. Steps for preparing the EE plan



The assessment was made by benchmarking Almaty against other cities with similar features (like human development index by country, climate etc.), thus allowing for a comparison of energy key performance indicators (KPIs), and then drawing certain performance targets by sector. The team conducted interviews with the City Administration (CA) of Almaty, municipal service providers and other relevant stakeholders, in addition to organizing a couple of technical workshops aimed at identifying sector challenges and discussing about the EE investment program and potential delivery mechanisms for the implementation of the plan.

Energy Efficiency Context

This EE plan is very timely and in line with the strategies and targets set at the national and local level in Kazakhstan in order to reduce energy consumption and improve performance in most sectors, including public services. Under the Green Economy Concept (GEC) adopted in 2013, Kazakhstan has embarked on an ambitious path to transition from an energy-driven economy to a green and more diversified, competitive economy by 2050, a plan that should add more than half million new jobs. Some of the key GECs' long-term goals suggest that Kazakhstan should rely more on renewable energy sources (RES) and reduce the energy intensity of the GDP by 25% by 2020 and by 50% by 2050.

The endorsement of the EE matter by the top leadership of the country in recent years has created a great momentum for cites to commit to energy and climate related targets at the local level, thus sending the right signals to municipal authorities to acknowledge the importance and benefits of EE, and making them think seriously about how to reduce energy and related expenses by taking ownership of EE projects. EE investments in municipal urban infrastructure - such as district heating, street lighting and public transport - can improve the city's capacity to deliver good quality services and meet the service demand in the near future, reduce specific energy consumption and make better use of municipal finances. Such interventions are not only conducive to improving overall living condition for the city residents in a clean healthy environment, but also to significantly reducing the energy related spending from the local budget, hence allowing the money to be directed to other local priorities.

Energy Performance Challenges

Almaty faces a constant population and economic growth which requires an expansion of reliable energy and municipal service delivery. Most of the city's infrastructures, such as central heat supply network, water pipes or the residential and public buildings stock are old, with high energy intensity and incur losses. In addition to some recent initiatives meant to improve the capacity and performance in public transport and some retrofit programs for central heating and potable water sector, there is still a huge demand to modernize the infrastructure and meet the future needs with regard to energy and municipal services.

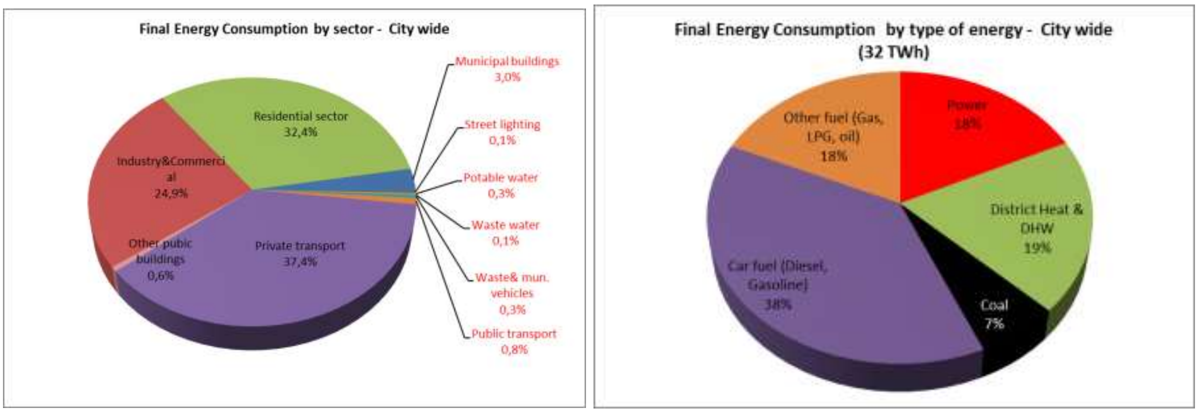
As of now, Almaty incurs high energy losses for district heat and electricity generation, as well as for energy distribution at end-users, mainly in the residential sector. In 2015, the baseline year for this study, the PEC in Almaty amounted to 42.4 billion kWh, of which 22% are losses in the energy transformation and distribution system for final district heat and power users. The level of losses is nearly the same as the final energy consumption (FEC) for the entire residential sector in the city. Due to the increase in the mobility of the city residents, private and commercial transport has reached critical levels in terms of density, congestion and GHG emissions. The latest local initiatives targeting modernization of the public bus fleet are highly unlikely to meet the demand and the expectations for a fast and attractive public transportation that ultimately should make people use less their personal vehicles and shift to an efficient, high-capacity public transport system.

The increasing costs for energy as well as for the maintenance of municipal service facilities put an additional challenge on Almaty and its CA, especially with regard to street lighting and public buildings. Despite some high saving potential of 40-60% in these sectors, the financial incentives necessary to pursue complex EE investments are limited due to budget regulations and low profitability of the respective interventions. Moreover, the lack of funding and delivery financing mechanisms to implement these EE measures, together with some poor implementation capacity, are also big obstacles.

The energy flow of the city of Almaty in the year 2015 (presented as a Sankey diagram in Annex 1), illustrates the consumption of primary energy in all municipal sectors, with a city-wide FEC of 32,325 GWh. The transport sector is the largest energy consumer, using approximately 37% of the final energy in the form of gasoline and diesel. The residential sector needs annually 10.4 billion kWh, accounting for one third of the city-wide FEC. The final energy use in all municipal service sectors amounts to 1,565 GWh, which represents 5% of Almaty's FEC. Among these, the largest user are the municipal public buildings (65%), followed by public transport, potable water and street lighting.

In 2015, the annual energy expenditure for all sectors in Almaty was KZT 390 billion (US$ 1.7 billion), which is about 5% of the city's GDP. Of this, the energy bills for all the six sectors that are under the CA control (i.e., public transport, municipal buildings, street lighting, waste, water & wastewater) cost KZT 14.3 billion (US$ 64 million), which is 3.1% of the municipal budget (see Figure 2 below).

Figure 2. City-wide energy consumption in Almaty by sector (left) and by type of energy (right)



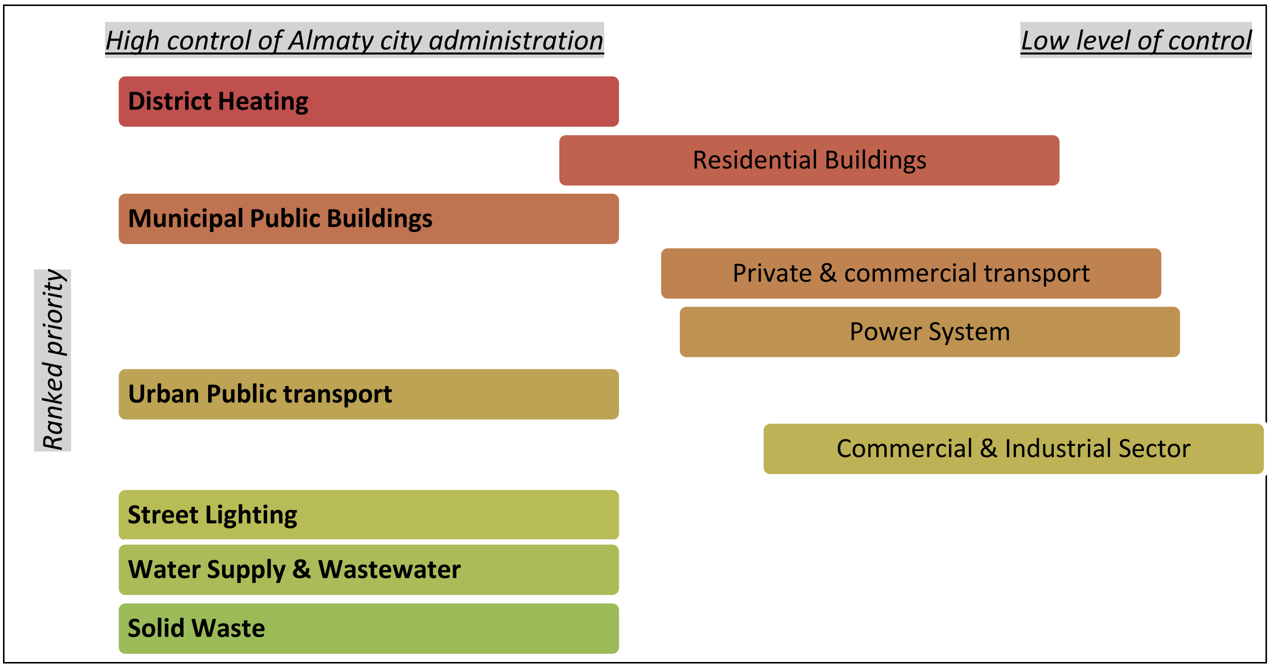
Priority Areas for Intervention

The TRACE methodology is based primarily on benchmarking of the city against other peer cities, identifying sectors with most EE potential based on which most appropriate EE measures are recommended. (Details about the TRACE 2.0 Methodology are provided in Section 2 of this report). The TRACE analysis uses three key factors to prioritize sectors for the EE interventions, namely energy spending, energy intensity, and the level of control of the CA over the sector (see Figure 3 below).

Figure 3. Key factors for TRACE analysis

The TRACE study has identified six priority sectors in Almaty with significant potential savings. Specific demand driven factors, like increasing efficiency in energy production and distribution, in parallel with reducing energy intensity for final energy consumption, diminishing primary coal consumption and traffic density to lower the inner-city GHGs level, were taken into consideration. Overall, ten sectors were identified for EE interventions. The top priority sectors with large energy savings potential and significant influence from the CA are district heating, municipal public buildings, urban transport, street lighting, water & wastewater and waste. Four more sectors with some limited municipal control are also included, i.e., residential buildings, private & commercial transport, power system, and the commercial & industrial sector.

Figure 4. Sectors and level of city control



Energy Efficiency Strategy

The overall EE strategy should be based on two types of interventions, namely the EE investment program and a set of non-investment measures. The *investment measures* comprise a pipeline of direct EE projects that could generate physical final energy savings, help reduce energy losses and use more renewable energy (RE). They can also bring some co-benefits in the form of better quality of services and comfort at end-users, in addition to reducing operation and maintenance (O&M) costs.

Additional non-investment interventions should complement the core solutions by enabling an appropriate environment to carry out the EE plan, and they could include project preparation, development of adequate financing and delivery mechanisms, and local policies that should set up the necessary regulatory framework and help build local institutional capacity.

Box 1. Pillars for EE strategy

Pillars for the EE strategy

A) *Increase in Quality of Municipal Services & Living Conditions*
- Increase the quality of public services (e.g., heating, public transport)
- Increase comfort and/or meet the demands
- Reduction of GHG emissions
- Increase attractiveness of the city to residents and tourists
- Meet the future challenges and energy needs as a consequence of the city growth

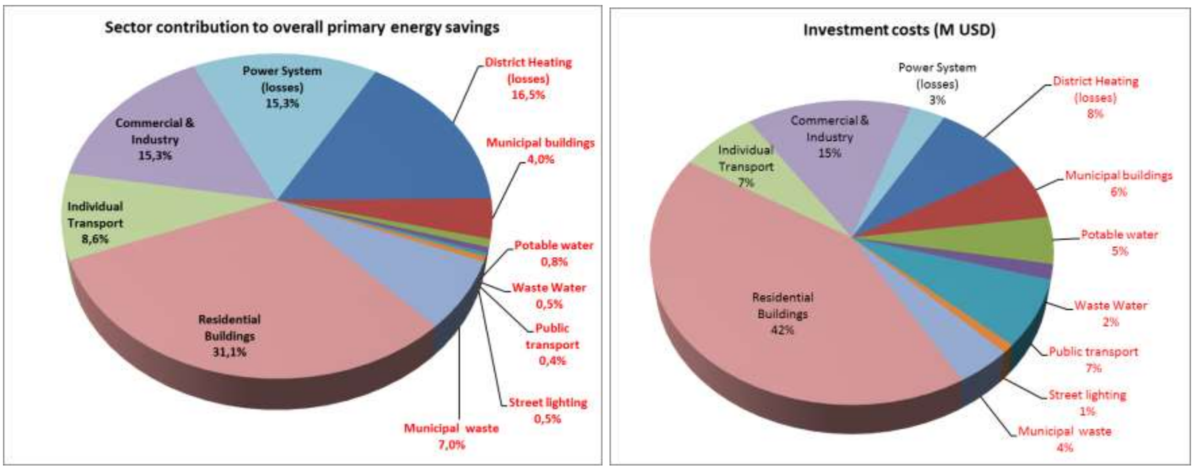
B) Resource Savings
- Lower the city-wide energy demand (energy intensity)
- Reduction of PEC
- Increase the use of RES
- Avoid escalation of energy bills and limit budget spending
- Use of additional revenue source

C) Sustainable Development
- Improvement of the performance of municipal public service operators
- Implementation of energy management in all sectors, an activity led by the CA
- Change in consumer's behavior towards EE
- Set-up an adequate environment to attract private investments in EE
- Increase and develop capacities for program implementation
- Develop a financing delivery mechanisms and bring in private partners for energy performance contracting (EPC) within the frame of Public-Private Partnership (PPP).

Energy Efficiency Investment Program

The EE investment plan for Almaty consists of 54 EE measures split into ten sector investment packages on the short, medium-, and long term spanning over the next 13 years until 2030, with total investments of US$ 3.25 billion[1]. The table at the end of this executive summary provides a brief overview of the EE measures - including initial capital investments, estimated energy saving and cost benefits, responsible parties, and a proposed schedule for the execution of the intervention.

Figure 5. Primary energy consumption by sectors (left) and Investment costs by sector (right)



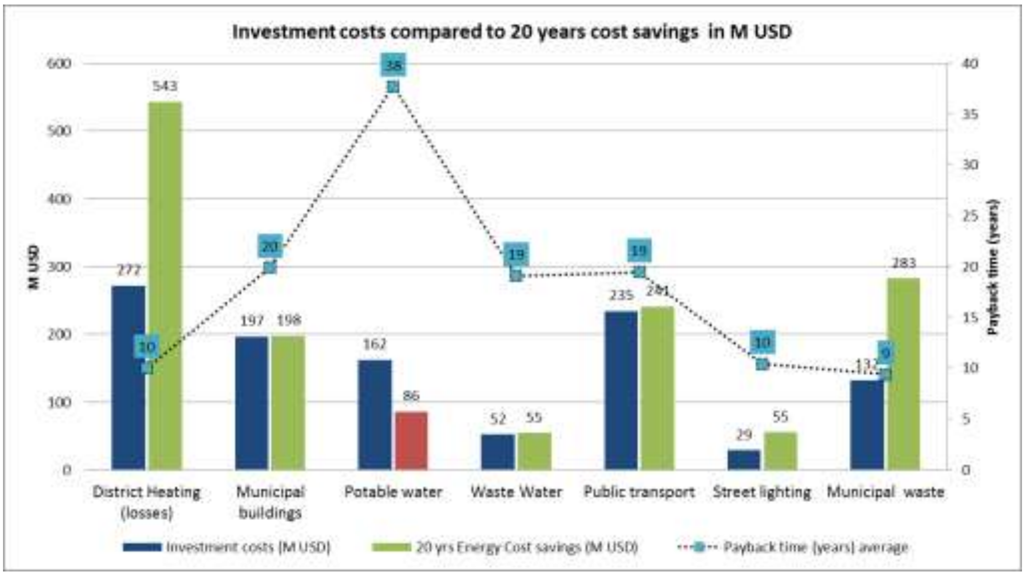
[1] Initial costs estimates on the basis of 2017; including material, equipment, installation and VAT

This complex EE plan to be implemented between 2018 and 2030 could reduce the energy consumption in Almaty by 24% (compared to 2015) and achieve annual primary energy savings of 10.4 billion kWh by 2030. This could be translated into city-wide energy cost savings of US$ 289 million per year.[2] Most of the primary energy savings (53%) can be obtained by cutting about half of the natural gas consumption - to approximately 577 million m³ per year. 30% savings could be achieved in the form of fuel - up to 45 million liters of gas & diesel and 0.9 million tons of coal per year. Reducing the consumption is particularly important to diminish the GHG emissions in order to improve the air quality in the city. The EE program can deliver annual reduction of 2.9 million tons of CO_2 emissions equivalent, which represents a quarter of the baseline year GHGs. Considering a phased implementation over a 13-year period, the achievable total cumulative energy savings can sum up to 76 billion kWh, resulting in a specific investment demand of US$ 0.04 per each kWh of energy saved. This savings per invested amount ratio is in the range of average energy costs for public and residential customers (at the level of 2015).

Of all 54 EE measures, 42 interventions target the municipal service sectors that under the direct influence of the city government, and they require US$ 1.1 billion capital investment. These investments could save 34% of the overall energy consumption in these sectors. The savings obtained equal to 1.94 billion kWh per year which would translate into US$ 73 million annual savings. For example, seven measures aim to improve energy performance in municipal public buildings (US$ 197 million), ten to curb losses in the district heating sector (US$ 272 million), nine to reduce fuel consumption and increase attractiveness of the public transport system (US$ 235 million), while other nine interventions seek to reduce losses in the water pipes and improve overall performance in the water & wastewater sector (US$ 215 million).

A preliminary cost-benefit analysis has been performed for these EE measures.[3,4] A rough comparison between the investment costs and achievable energy costs savings over a 20-year period shows that the accumulated energy cost savings in most sectors exceed the investment costs, which indicate a positive ratio over the lifecycle of the intervention (except for measures in the water supply sector).

Figure 6. Investments costs compared to savings



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[2] This is calculated considering a scenario of energy cost increase by 1.5-2% per year for the period 2018 to 2030.

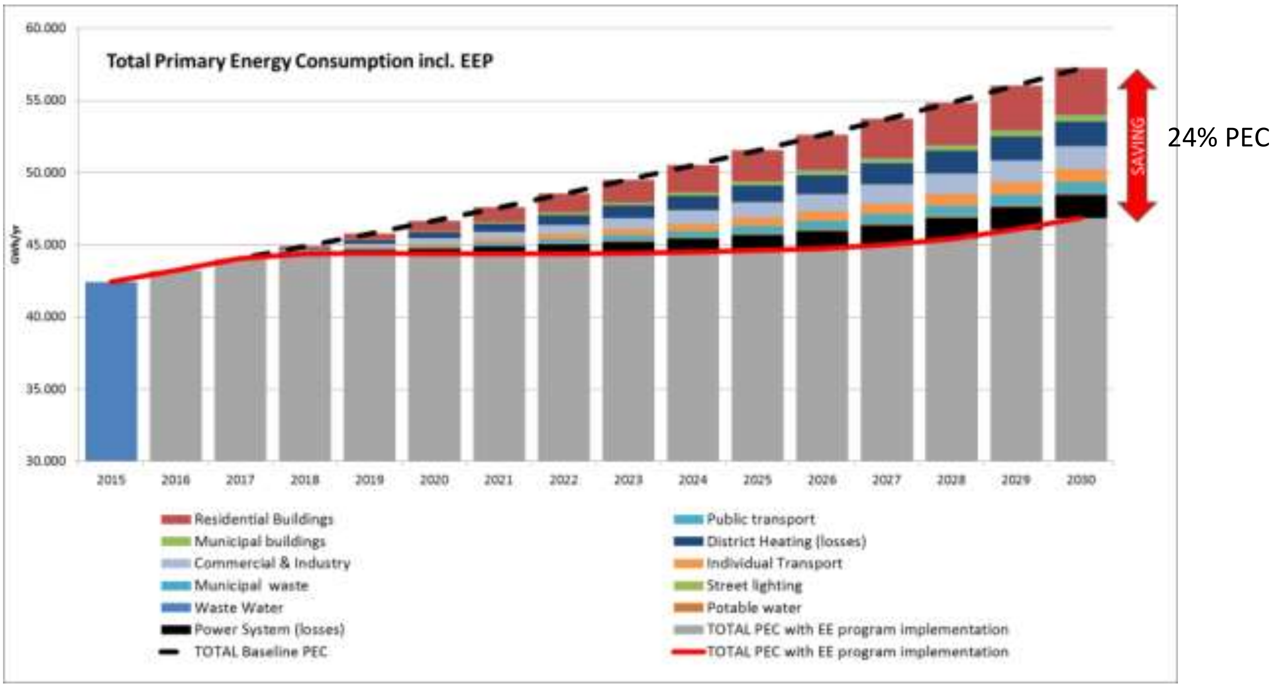
[3] The preliminary assessment of the economic analysis considers the energy cost savings. Investments into non-energy infrastructure, such as waste, water & wastewater, building retrofit and transport deliver additional economic benefits of improved service/infrastructure and extended lifetime which reduce the payback time. A more detailed socio-economic analysis is needed to monetize such co-benefits.

[4] All assumptions made for this assessment are available in Annex 2 of this report.

The payback time for each measure varies, depending on the investment and its financial benefits, between five to more than 30 years, with an average of 12 years. EE investments meant to reduce losses, power and central heat generation and distribution are more profitable, with less than 10 years of payback time. Similar acceptable level of profitability is indicated for interventions focusing on RE generation, such as biogas, landfill gas, waste-to-energy and solar photovoltaic panels. These projects have great potential for PPPs and could attract private partners/investors. Large-scale projects above US$ 50 million in public transport, water infrastructure or public and residential building retrofit should be seen as long-term investments since they have long payback time spanning from 20 to 30 years. The additional comfort, social and environmental benefits pertained to these interventions could actually justify their execution on the short- and medium run. Usually, such investments are paid back throughout the lifetime of the facility.

A scenario considering 1 to 2% average annual increase in local population and economy in Almaty over the next decade would significantly impact the demand for municipal services and energy supply. For example, the PEC is expected to go up by 35% (to 57,250 GWh) by 2030 (see Figure 7 below). The projected energy savings could help overturn this trend and slow down the energy demand up to 10% by 2030, provided the EE plan would be carried out starting 2018. From this forecast, one must see how important is to undertake the EE interventions under a comprehensive EE investment program.

Figure 7.Primary energy consumption by 2030 and potential savings



Setting Energy Efficiency Targets

Based on the above energy saving projections, the expected city-wide targets for the EE program were calculated. Some of them are presented in Table 1 below.

Table 1. EE targets for Almaty by 2030

Indicator	Value in 2015	Targets to be achieved by implementation of the recommended EE program by 2030
City-wide Primary Energy Consumption (PEC)	42 TWh	reduction by 24% - target savings of 10.4 TWh/year
Primary energy coal consumption (all sectors)	13.5 TWh coal = 2.6 million tons of coal	reduction by 30% - target savings of 0.8 million tons of coal compared to baseline year 2015
Primary energy gas	10.2 TWh gas = 1,080	reduction by 50% - target savings of 577 million m³

Indicator	Value in 2015	Targets to be achieved by implementation of the recommended EE program by 2030
consumption (all sectors)	million m³ gas	gas compared to baseline year 2015
Use of RE	almost 0 (zero)	1.0 TWh/year generated from RE = at least 2% of PEC
CO_2 emissions (city-wide)	11.2 million tons of CO_2 equivalent	25% reduction; equivalent to 2.8 million tons of CO_2 equivalent per year
Energy consumption in municipal sectors [5]	5.7 TWh	34% reduction; target savings of 1.9 TWh
Municipal public buildings	984 GWh	26% reduction; target savings of 253 GWh/year

These figures can be achieved by the energy saving targets for the key sectors (see Table 2 below).

Table 2.Energy savings by sectors

MUNICIPAL BUILDINGS	DISTRICT HEATING	STREET LIGHTING
✓ Minimum 40% energy savings of heat for all facilities (schools, kindergartens) by building retrofit ✓ 50% energy savings for lighting by replacement of indoor lighting	✓ Reduction of energy losses for district heat generation and distribution from 37% to 25%	✓ Minimum 60% energy savings for the entire public lighting system
PUBLIC TRANSPORTATION	POTABLE WATER	SOLID WASTE
✓ Increase of urban mobility by improving capacity, service and attractiveness of public transport ✓ 5-10% reduction of individual motorized transport by increasing the attractiveness of public transport as an alternative to individual cars	✓ Minimum 40% reduction of water losses ✓ 20% electricity savings at pumping stations for water supply and wastewater treatment	✓ Minimum of 80% of the waste volume is sorted and prepared for recycling or composting ✓ Reducing 30% of the fuel consumption for waste collection vehicles

Implementation Strategy and Roadmap

There are some important pre-requisites to set the ground for the implementation of the municipal EE plan. To this end, the CA of Almaty should undertake immediate actions in three key areas that should enable an adequate environment for a successful execution of the plan.

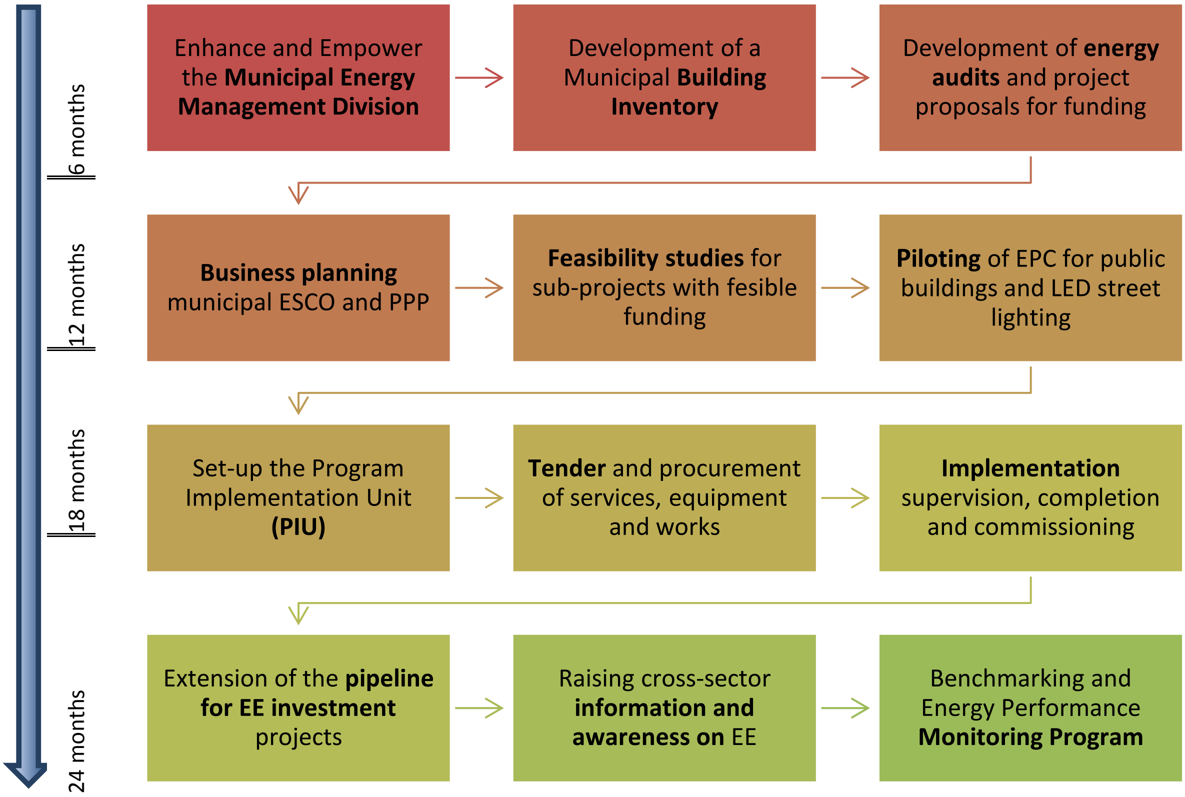
- *First*, the city council of Almaty should **adopt a short- and medium-term EE plan** in order to politically commit to straight-forward EE targets.
- *Second*, the CA should **strengthen the EE delivery capacity** by establishing a municipal EE agency that should draft and oversee the implementation of the EE plan. The key elements for such dedicated administrative EE unit/EE agency are a clear mandate to undertake the given responsibilities and deliver upon them, adequate number of qualified staff and an appropriate budget.
- *Finally*, the Almaty CA should undertake quick steps to **develop and promote sustainable EE financing mechanisms** (by using government programs, loans, commercial sector financing and PPP schemes) that should take into account multi-year energy savings to repay EE investments.

[5] In 2015, the final energy consumption of the sectors under city administration's control (including district heating losses) amounted to 5,713 GWh (13% of the overall city energy consumption). Under a "business as usual development" scenario (without the Energy Efficiency Plan in place), this part of the municipal sector energy consumption is expected to go up to 7,800 GWh/year in 2030.

Achieving the EE targets and energy savings envisioned in this EE plan would require an integrated transformation approach to allow scaling-up the investments (e.g., sound energy audits, good feasibility studies), sustainable delivery and financing mechanisms in the form of EPC, ESCO etc., and good local delivery capacity (e.g., by an EE agency).

The comprehensive package of the EE interventions needs a clear roadmap to adequately plan and implement these measures. While investment measures are only one component of this roadmap, the other element is the non-investment activities that should provide support to the CA city in setting up the framework and delivery capacity for these investments. A general roadmap for scaling-up EE in municipal sectors with straightforward activities for the next six, 12, 18, and 24 months was designed. For example, one of the actions to be taken by the CA in the next period of time is to give more powers and responsibilities to the existing energy management division. In the first year, the CA should draft the business plan for the ESCO/PPP and pilot an EPC-PPP model in street lighting and public buildings, while in the next year it should deal with procurement of works and services, work implementation & supervision, benchmarking and energy performance monitoring program etc. (Details are available in Figure 8 below).

Figure 8. Short- and mid-term actions for the EE program



Sustainable Energy Efficiency Financing

Finally, in order to translate the activities from paper into some real actions, every strategy and plan needs a key element: funds. This goes for the Almaty EE plan as well. The execution of the EE program requires significant amount of money that could come from different sources. A combination of three types of funding sources is necessary to pull off the US$ 3.25 billion estimated to cover all 54 EE interventions in Almaty. These could be i) grants from the municipal budget or government programs, ii) debt loan financing form government programs or commercial financial institutions, with soft-loan conditions (if possible), and iii) commercial funding in the form of PPP, service or operation contracts.

In order to implement the EE program, the local authorities of Almaty should design a suitable financing structure, based on the financial viability and project features, to meet the loan or private co-financing requirements. In general, a successful approach for structuring the project financing involves three steps. The first step would be to design a project or make some adjustments as to make it attractive to commercial/PPP funding. The second step should focus on getting the external debt loans or grant funding from different sources. Finally, the last stage is about covering the remaining funding demand from municipal budget investment grants. Currently, there are a few on-going programs with attractive financing conditions targeting modernization of public, urban and social infrastructure (such as DAMU or Nurly Zhol) that could be potential funding sources for the EE program. The CA of Almaty should consider these programs and prepare feasible applications for these funds.

Most of the measures included in the EE plan should be implemented under specific financing and delivery frameworks. Service contracts for energy performance could be developed with private suppliers, based on the existing PPP legislation. Such service contracts would be best suited for straightforward, profitable, low risk projects, like the replacement of street lights or changing the public building indoor lighting with LEDs. For more complex EE investments (e.g., the retrofit of buildings and of the heat supply system) where the city could have high long-term benefits an institutional PPP model in the form of a municipal ESCO could work. This ESCO could implement different types of EE projects under the EPC delivery mechanism by enjoying the financial compensation revenues under the PPP regulation. If proven successful, the ESCO could have a great chance to evolve, on the medium-run, into an Energy Efficiency Revolving Fund, and use the revenues obtained from the EPC to fund new EE projects.

In the next period of time, the CA of Almaty could consider piloting the EPC-PPP model for some interventions, such as LEDs in street lighting or replacement of the indoor lighting with LED in public buildings. Depending on the results, some well-designed projects should be promoted to potential private partners in order to get them involved in this new business area. The PPP Center of Almaty is expected to play a crucial role in designing the project as such as to make it attractive to private partners. The lessons learnt from these EE pilot interventions should ultimately enable tuning and restructuring this delivering scheme as to meet the expectations and requirements by potential interested partners, funders or donors.

A separate concept note on EPC-PPP has been developed by the WB team, detailing how this scheme could actually work in the local context in Kazakhstan. It outlines the legal framework on the PPP, the key requirements for EE interventions, as well as the three business models that could be considered by the local authorities for implementing EE measures – namely, service contracts PPP, operation (concession) contracts, and a joint venture under a Special Purpose Vehicle in the form of ESCO.

Summary of energy efficiency investment measures of the EE plan

Energy Saving Investment Measures	**Details about implementation**	**Estimated investment costs[6] (million US$)**	**Expected Results**				**Timeline**	**Responsible party for implementation**
			Energy savings (%)	**Annual energy saving (million kWh/yr)**	**Annual energy cost savings (million US$/yr)[7]**	**Payback time (years)[8]**		
1	2	3	4	5	6	7	8	9
Priority 1: SECTOR - District Heating (DH)								
DH distribution: Automation of DH distribution and improved heat metering, Implementation of SCADA	28,362 DH supplied buildings (90% of the building stock)	14	EE 2% of distributed district heating	178	2.8	5	2018-2025	Almaty City Administration, Almaty, Division of Energy, Housing and Communal Services LLP Almaty Teplo Seti
DH distribution: Rehabilitation DH Pumping stations, Replacement of pumps (with variable speed drives -VSD)	48 DH pump stations (60% of all)	1	EE 15% of power for DH company	6	0.3	2	2018-2021	
DH distribution: DH Network Maintenance and Upgrade Program, DH pipeline insulation, regulation and balancing	15 km DH network (30% of the network)	11	EE 25% of DH distribution losses	181	2.8	4	2018-2023	
DH distribution: DH network rehabilitation, pipeline replacement	15 km DH network main pipeline	60	EE 60% of DH distribution losses	435	6.8	9	2018-2026	
DH distribution: Increase DH supply, storage and balancing capacity by construction of DH transmission pipeline (13 km) between CHP 1 and CHP 2 and Construction of new DH transmission pipelines (30 km) to district Boiler west	43 km DH main pipeline	129	EE 5% of DH losses + DH supply	627	9.8	13	2020-2025	JSC "Almaty Power Stations" ALES
DH distribution: Pilot project for Turbo-aggregation of DH network pumps (steam from turbine)	2 DH main pumps	1	EE 60% of power for DH company	4	0.2	5	2018-2022	
DH generation: Boiler Houses reconstruction and rehabilitation, small and medium boiler houses ATKE, including condensing gas boilers/ economizers at boilers	32 ATKE boiler houses (80% of the facilities)	48	EE 30% of DH generation losses HOB	252	3.6	13	2018-2023	LLC "Almatyteplokommunenergo" ATKE
DH generation: Conversion of 100 autonomous boilers (coal, power, mazut) at public facilities,	100 small boiler houses	3	EE 50% of DH generation losses	3	0.1	33	2018-2023	

[6] Initial costs estimate at the level of 2017, including material, equipment, installation (plus VAT).
[7] Assumption of energy cost increase by 1.5-2% per year.
[8] Considering energy cost savings only.

Energy Saving Investment Measures	**Details about implementation**	**Estimated investment costs[6] (million US$)**	**Expected Results**				**Timeline**	**Responsible party for implementation**
			Energy savings (%)	**Annual energy saving (million kWh/yr)**	**Annual energy cost savings (million US$/yr)[7]**	**Payback time (years)[8]**		
1	2	3	4	5	6	7	8	9
Pervomaika village and south district to efficient gas fired boilers			HOB					
DH generation: High efficient heat generation facilities (e.g., heat pumps, gas condensing boilers) at zones of decentralized heat supply	100 small boilers, average 100 kW	5	EE 30% of DH generation losses HOB	14	0.8	6	2023-2028	Almaty City Administration, Almaty, Division of Energy, Housing and Communal Services
DH generation: Large solar water heater for up-heating of DH feed water (water losses)	2 solar collector systems, 1000 m², 1 MW capacity	1	EE 95% of renewable DH generation	13	0.1	8	2026-2029	
Priority 2: SECTOR - Municipal Public Buildings (PB)								
EE Retrofit Program of municipal schools including: a) Retrofit of building envelop: Replacements of windows, insulation, b) Modernization of heating and hot water system: Replacement of heat piping, radiators, thermostat valves, hydraulic balancing, automated heating sub-station, temperature and consumption control, metering, frequency control (VFD) pumps	974,453 m² in 140 public schools & higher education buildings (70% of the building stock)	78	EE 45% of district heating	122	2.0	39	2018-2022	Almaty City Administration, Division of Education
EE Retrofit Program of municipal kindergartens including: a) Retrofit of building envelop, b) Modernization of heating and hot water system	373,800 m² in 124 public pre-schools (70% of the building stock)	37	EE 45% of district heating	57	0.9	40	2018-2022	
EE Retrofit Program of municipal medical facilities (hospitals, policlinics, etc,) including: a) Retrofit of building envelop, b) Modernization of heating and hot water system	300,000 m² in 43 public health buildings (100% of the building stock)	36	EE 65% of district heating	111	1.8	20	2018-2022	Almaty City Administration, Division of Health
EE Retrofit Program of other municipal facilities (administration, culture facilities, libraries, etc.) including: a) Retrofit of building envelop, b) Modernization of heating and hot water system	270,000 m² in 45 administration buildings(90% of the building stock)	19	EE 40% of district heating	40	0.6	29	2018-2022	Almaty City Administration, property management
Replacement of indoor lighting for all municipal public buildings	2,526,076 m² in 472 public buildings (100% of the building	23	EE 50% of power	60	4.1	6	2018-2020	Almaty City Administration, Division of

Energy Saving Investment Measures	Details about implementation	Estimated investment costs[6] (million US$)	Expected Results				Timeline	Responsible party for implementation
			Energy savings (%)	Annual energy saving (million kWh/yr)	Annual energy cost savings (million US$/yr)[7]	Payback time (years)[8]		
1	2	3	4	5	6	7	8	9
	stock)							Education/ health
Solar Hot Water Program for education and medical facilities	144 solar systems 40 m² collector (60% of all)	1	EE 70% district heating	6	0.1	15	2020-2028	
Building Energy Management Systems (BEMS) for large buildings (> 20,000 m²)	500,000 m² for BMS in 20 buildings	2	EE 20% of district heating + Power	17	0.3	9	2020-2025	Almaty City Administration Division of property management
Priority 3: SECTOR - Public Transport (PT)								
Modernization of metro indoor lighting and escalator systems	9 Metro stations	1.1	EE 60% of power	4	0.2	5	2018-2020	Almaty Metropolitan
Conversion of public diesel buses fleet to compressed gas (CNG)	585 urban diesel busses (25% of fleet) + fueling infrastructure (6)	26	EE 25% of diesel	17	0.6	41	2020-2023	Green Bus Company
Replacement of trolley busses, to modern and energy-efficient busses	194 trolley busses (90% % of fleet)	6	EE 20% of power	9	0.4	13	- 2023	
Conversion public and private taxis (400 units) to compressed gas	390 taxi cars (30% of fleet)	1	EE 15% of diesel	5	0.3	3	2021-2028	Almaty City Administration, Division Natural Resources/ Transport
Development of Bike Sharing System - Establishment and extension of infrastructure for non-motorized transport (bikes)	30 bike share hubs for 50 bikes + 30 km lanes	1	EE 0.1% of gasoline individual cars, 100% replacement of related fuel	7	0.4	2	- 2020 In progress	Almaty City Administration, Division of Planning
P+R (Park & Ride) system with 3 hubs	4 P&R hubs at metro/tram terminal + 300 parking	1.6	EE 0.1% of gasoline individual cars	12	0.7	2	2020-2026	Almaty City Administration, Division of Planning
Traffic Flow Optimization, "Intelligent Transportation System", dispatching system, priority bus lanes	10 bus fleet routes	2.1	EE 1% mix of power/CNG	1	0.1	20	2017 - 2022	Almaty City Administration, Division of Natural Resources/Transport
Construction of Light rail system, 12 km	12 km rail + 8 trains +	42	EE 0.3% of gasoline	41	2.5	17	2020-	Almaty Metropolitan

Energy Saving Investment Measures	Details about implementation	Estimated investment costs[6] (million US$)	Expected Results				Timeline	Responsible party for implementation
			Energy savings (%)	Annual energy saving (million kWh/yr)	Annual energy cost savings (million US$/yr)[7]	Payback time (years)[8]		
1	2	3	4	5	6	7	8	9
	6 stations		individual cars				2015	
Metro network extension to total 3 lines, 20 km	20 km rail + 12 trains + 6 stations	154	EE 0.9% of gasoline individual cars	113	6.7	23	2020-2028	
Priority 4: SECTOR - Street Lighting (SL)								
Street + Public Space LED Lighting Program, including replacement and adaptation of power supply network for advanced LED street lighting: retrofit, voltage stabilization, wiring, time management, diming, remote control	77,563 Light points (96% of all) + 4,409 km of SL power supply network (approx. 80% of network)	29	EE 70% of power	54	2.8	10	2017-2020	Almaty City Administration, Division for Energy, Housing and Communal Service, Almaty Kalalyk Zharyk
Priority 5: SECTOR - Potable Water & Wastewater (PW/WW)								
Increase of the performance water distribution networks; Replacement of outworn pipelines and valves	1,459 km water distribution net (50% of network)	146	EE 45% of power for water pumping	17	0.9	170	2018-2025	Almaty City Administration, Division of Energy housing and Communal service, Communal Enterprise “Tospa Su”
Improve Efficiency of Pumps and Motors in water supply system	20 pumping stations (50% of all)	2	EE 10% of power for water pumping	11	0.5	3	2017-2020	Communal Enterprise “Tospa Su”
Active Leak Detection and Pressure Management Program	100 control points	0.4	EE 5% of power for water pumping	4	0.2	2	2021-2025	Communal Enterprise “Tospa Su”
Improved Water Metering	186,955 metering points (30% of all)	13	EE 10% of power for water pumping	21	1.1	12	2018-2022	Communal Enterprise “Tospa Su”
Support program for residential users for Water Efficient Fixtures and Fittings	623,185 customer points (50% of all)	1	EE 15% of power for water pumping	32	1.6	1	2022-2028	Almaty City Administration, Division of Energy housing and Communal service,
Improve Performance of sewage/ canalization networks, new mainline collectors; replacement of the obsolete networks	763 km water canalization (50% of the network)	38	EE 10% of power for water pumping	1	0.0	2,571	2020-2025	Communal Enterprise “Su Zhelisi”

Energy Saving Investment Measures	Details about implementation	Estimated investment costs[6] (million US$)	Expected Results				Timeline	Responsible party for implementation
			Energy savings (%)	Annual energy saving (million kWh/yr)	Annual energy cost savings (million US$/yr)[7]	Payback time (years)[8]		
1	2	3	4	5	6	7	8	9
Improve Efficiency of Pumps and Motors, Modernization of 7 WW pumping stations (out of 19)	7 pumping stations (35% of all)	1	EE 10% of power for water pumping	1	0.0	13	2020-2025	
Retrofit of Waste Water Treatment Plant	At one WWPT	1	EE 15% of power in WWTP	4	0.2	5	2021-2024	
Biogas production from waste water sludge at WWTP	1 biogas plant + CHP (approx. 5 MW el. capacity)	13	Renewable energy power 100%	49	2.5	5	2023-2026	Almaty City Administration, Division of Energy housing and Communal service
Priority 6: SECTOR – Municipal Solid Waste (SW)								
Fuel-Efficient Waste Vehicle Operations, vehicle replacement: Conversion of waste collection vehicles to CNG + fueling infrastructure	214 waste collection trucks (90% of the waste rolling stock)+ fueling infrastructure (6)	15	EE 20% of diesel	10	0.6	24	2019-2022	Almaty City Administration Division for Natural Resources, Almaty Tartip
Waste Collection Route Optimization, GPS tracking and hauling management, central dispatch center	238 waste collection trucks	1	EE 10% of CNG/ diesel	6	0.3	3	2018-2022	
Construction of modern waste sorting complex and transfer station near to CHP plant: including sorting, recycling, composting station + Increase sorting and recycling: new container sites and containers/bins enabling sorting	452,200 t of municipal waste to landfill + 7,685 waste bins	9	EE 25% of CNG/diesel for waste delivery to landfill + revenues from recycling	14	1.7	5	2020-2023	
Bio waste to energy: biogas plant	biogas plant + CHP (approx. 5 MW)	13	Renewable energy 100%	97	5.0	3	2022-2028	
Landfill Gas Capture Program	Landfill gas capture plant + CHP (approx. a 10 MW)	35	Renewable energy 100% heat and power	49	2.5	14	2022-2028	Almaty City Administration, Division for Energy, ALES
Waste-to-Energy Plant	Waste incineration plant for waste that cannot be recycled, capacity of up to 100	60	Renewable energy 90%	547	4.0	15	2022-2030	

Energy Saving Investment Measures	Details about implementation	Estimated investment costs[6] (million US$)	Expected Results				Timeline	Responsible party for implementation
			Energy savings (%)	Annual energy saving (million kWh/yr)	Annual energy cost savings (million US$/yr)[7]	Payback time (years)[8]		
1	2	3	4	5	6	7	8	9
	MW (heat and power. 3:1)							
Priority 7: SECTOR - Residential Buildings (RB)								
Implementation of individual automated heating stations in the multi-store residential buildings	7,203 multi-floor residential buildings (26% of building stock)	180	EE 26% of DH to multi-floor residential buildings	978	13.6	13	2019-2025	Almaty City administration, Division of Housing and Communal Service
Installation of individual heat meters in all apartments and introducing consumption based billing	7,200 multi-floor residential buildings (26% of building stock)	12	EE 5% of DH to multi-floor residential buildings	188	2.6	4	2018-2030	Apartment Owners Associations + ALSEKO
Replacement of elevator equipment	2,118 of above 6 floor residential buildings (30% of building stock)	42	EE 25% of power to > 9 floor buildings	8	0.5	89	2018-2025	Apartment Owners Associations
Retrofit of residential multi-store buildings	15 million m² in 16,948 multi-floor residential buildings (60% of building stock)	608	EE 35-45% of DH to multi-floor residential buildings	1.317	18.3	33	2020-2030	
Solar Rooftop for Residential Buildings	1,694,760 roof area on multi-floor Residential buildings	530	Renewable energy power 100%	742	51.4	10	2025-2030	City Administration - Division of Energy, Almaty Energo Service
Priority 8: SECTOR – Private Transport / Vehicles (IT)								
Enforcement of Vehicle Emissions Standards, empower technical inspectors, service stations, penalty system for non-compliance	Applying to 277,000 individual and commercial vehicles (reaching out to 50% of the fleet)	208	10% fuel consumption of individual and commercial cars	604	35.9	6	2020-2024	Almaty City Administration, Division of Natural Resources
Increase attractiveness of low-emission vehicles: Development of Vehicle Charging Infrastructure	40 individual and commercial vehicles	12	15% fuel consumption of	91	5.4	2	2023-2030	Almaty City Administration,

Energy Saving Investment Measures	Details about implementation	Estimated investment costs[6] (million US$)	Expected Results				Timeline	Responsible party for implementation
			Energy savings (%)	Annual energy saving (million kWh/yr)	Annual energy cost savings (million US$/yr)[7]	Payback time (years)[8]		
1	2	3	4	5	6	7	8	9
Electric, LPG and CNG vehicles (20+20 stations)	(reaching out to 5% of the fleet)		individual and commercial cars					Division of Transport
Car parking Management and Restraint Measures in city center + inspection service	Applied to 60 km of roads (covering 1% of the fleet)	3	20% fuel consumption of individual and commercial cars	24	1.4	2	2020-2030	Almaty City Administration, Division of Planning/ natural Resources
Priority 9: SECTOR - Power System (EL- Electricity)								
City-wide Installation of automated distribution system Rehabilitation of 6 KV network Rebuilding of 35 KV substations to 10 kV Transformer upgrade program Reduction of Non-technical losses program	According to investment program of Almaty Zharyk Company (AZhK)	60	EE 30% reduction of power transmission& distribution losses of share 30%	192	9.8	6	2022-2027	City Administration, Division of Energy, JSC Almaty Zharyk Company
Increase of capacity for power transmission lines	by voltage shift to 500/750 kV to increased supply from Ekibastuz hydropower stations	40	Avoidance of power generation losses in CHP, 200 MW replacement	1.398	5.2	8	2019-2025	Almaty Energy System
Priority 10: SECTOR - Commercial Buildings & Industry (CB)								
Development of EE credit lines for SME, commercial and industry (with special incentives for Almaty - e.g., grant or tax deduction component)	1,498 relevant commercial entities (10% of all)	300	40% share of energy consumption in energy intensive industry	1.349	54.6	5	2029-2025	City Administration, Division of Economy
Information and support program for Solar Rooftops for industrial and commercial buildings	555,120 m² of roof area on large industry buildings (20% of the building stock)	173	Renewable energy power 100%	243	16.8	10	2020-2027	

2 Energy Performance Assessment of the City of Almaty

2.1 Objectives of the Study

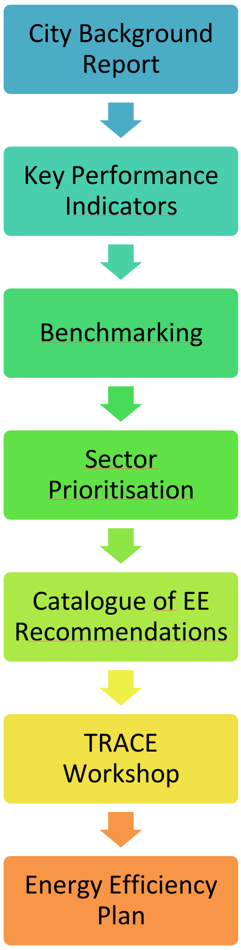
This study aim assess the energy performance of the municipal service sectors in Almaty and identify and prioritize EE opportunities in order to outline an urban EE strategy for the next 13 years - from 2017 to 2030 - along with a sound implementation plan for the city.

The Energy Efficiency Plan for the City of Almaty was developed in connection to the World Bank's (WB) Kazakhstan Energy Efficiency Project (KEEP) with support from the Energy Sector Management Assistance Program – ESMAP, a multi-donor technical assistance fund managed by the WB.

The plan was prepared by using the Tool for Rapid Assessment of City Energy (TRACE), a tool developed by the WB through ESMAP, which aims to a assess the EE potential of the city, identify sectors with the most improvement potential, and recommend a set of EE measures (including timeline, costs and savings). The TRACE assessment is done through:

- Benchmarking the city EE performance in comparison with peer cities around the world;
- Prioritizing sectors based on energy-saving potential, expenditure and city authority control, and identifying appropriate EE interventions; and
- Prioritizing actions based on the city's implementation capacity and planning horizon.

2.2 Process of Energy Efficiency Diagnostics



This TRACE EE assessment started in February 2017 with data collection and compilation, a process that benefited of support from the City Administration of Almaty, as well as from different utility and municipal service divisions.

Based on this data, a number of Key Performance Indicators (KPI) for Almaty were calculated and aggregated into TRACE.

The Sector prioritization pointing to those municipal service areas with the highest energy saving potential took into consideration a few elements, namely a) the municipal energy spending, b) potential energy savings related to the relative energy intensity, and c) the level of control of the city authority over the respective sectors, including budget, regulation and enforcement in implementing EE measures.

Based on data collected and interviews with city authorities and municipal service providers, a long list of potential EE recommendations was compiled, base on the city's needs. The proposed EE interventions were presented and discussed with the local authorities during a decision review workshop in May 2017 in Almaty.

During the workshop, city authorities, utility companies and local stakeholders have agreed on the intervention areas for the city energy efficiency plan, under an integrated approach.

The Almaty Energy Efficiency Plan is in line with the decisions taken in the workshop focusing on certain priorities, interventions and targets. The plan looks into the EE potentials and benefits of a refined list of EE investment measures, and finally, outlines an implementation strategy for the plan.

2.3 Country Background

Kazakhstan has 14 regions (oblasts),[9] 86 cities (including 41 cities of republican and regional subordination), 175 districts, 35 settlements, and 2,468 "aul" (rural) administrations. Astana and Almaty, the current and the former capital city, respectively, are of “important status”, and they do not belong to any region. Oblasts are divided into districts and cities/municipalities. Cities/municipalities are further split into municipality districts (rayons). Oblasts, municipalities and districts are managed by akims (governors). The President of the country appoints the governors for the oblasts and the mayors of Astana and Almaty. Regional governors appoint the municipal governors, who further pick the rayon/district governors.

Kazakhstan is the largest economy in Central Asia, due to its vast natural resources of hydrocarbon and minerals. Oil and gas reserves are concentrated in the western regions. The country has the ninth largest proven oil reserves and the 15th largest proven natural gas reserves in the world, with hydrocarbons making the equivalent of nearly 18% of GDP and 60% of exports (as of 2015).[10] Energy sector is the backbone of the economy. Around 60% of the assets belong to the state, mostly grouped under Samruk Kazyna, a wealth funds and a joint stock company that owns entirely or in part many important companies from the energy, transport and financial sectors. The main companies under Samruk include KazMunaiGas – the state oil and gas entity, KazTransGas – the state gas company, KEGOC – the national state energy grid operator, and KazAtomProm – the national importer of uranium, rare metals, and nuclear fuel components for power plants, Samruk Energy – state generation company, in addition to several others, such as the postal service and the national air transport operator. Between 17 to 20% of value added to GDP is made by state enterprises.

With a Human Development Index (HDI) of 0.788 (as of 2014), Kazakhstan is among top 60 countries in the world in terms of life expectancy, education and per capita income.[11] The energy driven economy had helped this Central Asian nation to transition from lower-middle-income to upper-middle-income status in less than two decades, making to the upper-middle-income group in 2006. Since 2002, GDP per capita has risen six-fold while the poverty rate has fallen sharply. In 2015, the GDP was US$184.4 billion, with the GDP per capita US$10,501 (as per current exchange rate). In 2015, the average income in Kazakhstan was US$ 364 per month, and only 0.04% of the population lived below poverty line on less than US$ 1.9/day (as per poverty headcount nations at poverty line).[12] The life expectancy also indicated good figures, i.e., 69.6 years.

Service sector employs approximately 62% of the labor force in the country, with almost 12% working in industry and the rest in agriculture. Agricultural development and production sector are on the top of the agenda. Grain and industrial crops such as wheat, barley, and millet occupy up to 70% of farm lands in the northern Kazakhstan, while rice, cotton, and tobacco are grown in the south. Energy and extractives products, like oil and oil products, natural gas, ferrous metals, chemicals, machinery, grain, wool, meat, and coal comprises Kazakhstan’s main exports. The country ranks 15th for crude oil producer and 10th for crude oil exports. The main imports consist of machinery and equipment, metal products and food. Russia and China are the key trading partners, in addition to a few European countries like Germany, France and Italy. As a landlocked country, Kazakhstan relies on Russia for its oil exports to Europe. In 2010, Kazakhstan, Belarus and Russia established a customs union to boost foreign investment and improve trade, an entity that later evolved into the Single Economic Space in 2012 and into the Eurasian Economic Union in 2015.

Kazakhstan’s economy is still adjusting after the decline of domestic and external demand trade due to international oil crises. The drop-in oil price since 2014 brought some negative consequences for both domestic consumption and investor confidence. Kazakhstan suffered from the collapse of global

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[9] The 14 oblasts are: Akmola, Aktobe, Almaty, Atyrau, East Kazakhstan, Karaganda, Kostanay, Kyzylorda, Mangystau, North Kazakhstan, Pavlodar, South Kazakhstan, West Kazakhstan, and Zhambyl.

[10] World Bank Country overviews available at: http://www.worldbank.org/en/country/kazakhstan/overview

[11] HDI for 2014 – report available at http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf

[12] World Bank PovCalNethttp://iresearch.worldbank.org/PovcalNet/povOnDemand.aspx

oil prices, with the GDP growth slowing from 4.1 percent (year-on-year) to only one percent during the following year.[13] The drop-in oil price by more than 50% triggered cuts in export revenues by almost a half, along with decline of foreign direct investments and devaluation of the local currency (tenge or KZT). To counter the oil crisis repercussion, the Government of Kazakhstan (GoK) implemented some rapid fiscal changes together with monetary and exchange-rate policy adjustments. In August 2015, the country moved to a floating exchange rate and shifted its monetary policy to an inflation-targeting regime; by the end of 2014, the local currency had lost about a third of its value against the US dollar.

On the long run, the main challenge for Kazakhstan is to shift from an economic development model based on natural resource extraction to a more diversified, competitive economy. In recent years, the country has embarked on an ambitious program to diversity its economy, with a specific target on sectors like transport, pharmaceuticals, telecommunications, petrochemicals and food processing. But despite of these efforts, economic diversification has proven quite difficult, especially until 2014, when oil prices were high. Although Kazakhstan had taken significant steps toward a more transparent, less-regulated, and market-driven business environment, the country is still facing challenges and constraints related to governance, infrastructure, institutions, the investment climate, the rule of law, benefiting from little incentives for investments in physical capital and new technologies. The government has set as target to transition to a green economy by 2050, a move which is expected to increase the GDP by 3% and create more than half million new jobs.

2.4 Almaty City Background and Context

Geography: The largest city in the country, Almaty was the capital city of Kazakhstan until 1997, when the capital was moved to Astana in the north, in an attempt to mitigate the growing effects of Almaty. Astana and Almaty are cities with a special status (in addition to Baikonur town). The city is located in the southern Kazakhstan, in the foothills of the Trans-Ili Alatau Mountains at an elevation of 700–900 meters, where the Bolshaya and Malaya Almaatinka rivers run into the plain. Almaty has eight districts (rayons) – namely Almaly, Auezov, Bostandyk, Medeu, Nauryzbay, Turksib and Jetysu.

Climate: The climate in Almaty is continental, with hot summers and cold winters, with some influence of mountain-valley circulation which is more present in the northern part of the city, in the transition zone of the mountain slopes to the plains.[14] Winters can be as cold as -5°C on average, while summers are mild, with an average of 24°C. The frost covers the city from mid-October through mid-April, bringing very cold weather between December and February. For about a month in the summer, temperatures go beyond 30 °C. April and May are the wettest months, accumulating a third of the city's annual precipitation. The south and southeast parts of Kazakhstan are on a seismic active zone with maximum magnitudes of expected earthquakes ranging from 6.0 to 8.3 (Richter scale). Almaty had witnessed several strong earthquakes throughout the time; one the most destructive was produced in 1911 when the city experienced massive destructions.

Demographics: An old historical city, Almaty has 1.7 million inhabitants – around 10% of the population in the country – spread over 682 km². The city has expanded during recent years with the annexation of a few suburban settlements. The population in Almaty increased by 11.5% in the last three years due to migration, expansion of the city's areas and natural population growth. More than 54% of the city residents are women and 45% are men, with an overall age average of 33.4 years (as of 2015).[15]

The major economic, financial, commercial and cultural center in Kazakhstan, Almaty is also the most developed ethnically and culturally diverse city. Ethnic Kazakhs account for 51% of the city population, Russians for 33%, Uyghurs for 5.7%, with the rest comprising of Tatars, Koreans,

[13] Kazakhstan – Economic Update no.2 Fall 2015 -- Adjusting to lower oil prices; Challenges ahead available at https://openknowledge.worldbank.org/bitstream/handle/10986/23236/101506.pdf?sequence=5
[14] According to Köppen climate classification
[15] Division of Statistics in Almaty

Ukrainians and other ethnic groups.

Economy: The largest economic center of Kazakhstan, Almaty was ranked 1st in the country in terms of Gross Regional Product (GRP) in 2015, accounting for 22.3% of the total production in the region.[16] The GRP per capita was KZT 54.3 million. Service sector makes for more than half of the local economy, trade for more than 35%, industry (including food industry) for 5%, and transport for 5.5%. The city is also a center for the development of small and medium-sized businesses.

A household survey performed in 2015 indicated that approximately 465,000 people were unemployed, pointing to an unemployment rate to 5.3%, down by 0.3% over the last three years. Average monthly salary in Almaty was KZT 159,513, while the minimum pension was around KZT 20,000. The Financial Post placed Almaty in Top 10 of the nearly 100 cities with the fastest economic growth. However, Almaty is lagging behind many developed cities in the world in terms of infrastructure and environment indicator. The local economy is dominated by manufacturing, followed by engineering and generation, transmission and distribution of power (more details in Annex 2 of this report).

The key financial and economic center in Kazakhstan, Almaty generates around 20% of the country's GDP. According In 2015, the local GDP was US$ 36 billion, with US$ 21,150 GDP/capita. Almaty, in addition to Astana and Mangistay and Atyrai oblasts, are donors to the national budget. According to the Globalization and World City (GaWC) ranking in 2012, Almaty is a Beta-Global City linking moderate economic regions into the world, in the same range as European cities like Sofia, Rotterdam and Birmingham.[17] Almaty is considered Kazakhstan's key financial hub; the city is hosts to the main banks in the country as well as to the Kazakh stock-exchange. Almaty is also the country's main transport hub, connected by an airport and several railways, in addition to a few transport facilities under planning or construction. One of the most ambitious local plans is to have the Western Europe-Western China highway passing through Almaty. Both the city and the Almaty's region economy are on the rise, and is expected to grow by 6% per year by 2020.[18]

A tourist attraction in the country due to its historical location, Almaty has a well-developed service infrastructure. The city attracts approximately one-fifth of the total domestic and foreign tourists in Kazakhstan (more than 700,000 people). Almaty is the main education center in the country, hosting around 30 universities. It is also the key center for international sports, with internationally-renowned Shymbulak ski resort and Medeo skating rink hosting major sport events, including the 2017 Winter Universiade.

2.5 Energy Efficiency - Legal and Institutional Framework

For many years, energy efficiency (EE) was not a priority for the GoK. The *Law on Energy Saving* was adopted in 1997, but it remained mainly declarative in nature due to lack of specific national goals about EE, action plans, legislation and methodology to support EE. In recent years, EE has become more like a policy priority to the GoK in the attempt to prevent serious growth-slowing energy shortages, improve industrial competitiveness, and mitigate consequences of the recently rapid rise in domestic energy price.

The President's speech "New Decade – New Upturn in the Economy – New Opportunities for Kazakhstan" delivered on January 29, 2010 set the path to advance and strengthen the EE topic. A few months later, the leadership of the country set publicly the goal to reduce energy intensity of the national economy by 10% by 2015 and by 25% by 2020, hence making EE a top policy priority.

A new *Law on Energy Saving and Energy Efficiency* was approved in 2012, and later amended in 2015. The country has approved the State program "Energy Efficiency-2020" and the Strategic Development Plan until 2020. In early 2010s, the Complex Plan on EE for the period 2012-2015 was

[16] Division of Statistics in Almaty

[17] The World According to GaWC in 2012 available at *http://www.lboro.ac.uk/gawc/world2012t.html*

[18] http://www.worldbank.org/en/results/2015/04/30/keeping-the-lights-on-in-kazakhstans-largest-city

prepared.

Kazakhstan ratified *the Paris Agreement* in November 2016 and committed to fulfillment of the proposed target as its first Intended Nationally Determined Contributions (INDC). In its *Nationally Determined Contributions (NDC),* Kazakhstan pledges to an economy wide absolute reduction of greenhouse gas (GHG) emissions of 15% from the 1990 levels by 2030. Kazakhstan has also stated its interest in increasing its climate change mitigation targets to 25% from the 1990 emissions levels, should there be additional international support and finance access to international carbon markets and low carbon technology transfer. Kazakhstan plans to update the GEP in the immediate period of time and revise the indicative targets for key sector based on the updated projection on the economic growth.

The key entity at the national level overseeing all activities on EE is the Ministry of Investments and Development (MoID). The MoID has a dedicated unit -- the Committee on Industrial Development and Industrial Safety that is responsible for EE policy, ensuring that the EE legislation follows the primary and secondary legislation. The MoID also supervises the State Energy Registry (SER) according to article 5 of the Energy Efficiency Law. Companies enrolled in the SER are mandated to provide the energy audits and then implement the audit's recommendations.

Public or private entities with energy consumption exceeding 1,500 toe/year must report to the registry. They should conduct energy audits (for the period until up to year 2016), prepare an EE plan, apply EE retrofit measures, and implement an energy management system. There are approximately 7,500 entities listed under SER, of which 765 private enterprises, 2,505 public companies, and 4,284 government organizations. By November 15 each year, local authorities must send to the SER operator information about all entities registered with SER. By March 1st, companies must provide to information on several issues, like volume of production, consumption, transmission and losses of energy and water in a calendar year; EE and savings plan developed based on energy audits; results following implementation of EE plan; actual energy consumption per unit of production and/or spending of energy for heating per unit area of buildings and structures. They also must submit a copy of the conclusions of the energy audit and fill in information about metering equipment, if any. Before August 15, SER must prepare an assessment to be submitted to the MoID.

According to the EE legislation, municipalities (akimats) are the institutional players at the local level in the field of EE. Local authorities are responsible to include EE activities in the local development programs, implement the state policy on EE and monitor compliance with normative energy consumption of public facilities. Moreover, they are responsible to develop the regional EE Complex Plan and update the MoID on the implementation process. Local governments should also execute EE and conservation measures included in the EE program, monitor compliance with energy standards in the public sector, and organize energy audits in public institutions. The cities are also in charge for thermal insulation of public buildings. Also, according to the law, they must buy and install metering and automated heat control systems in public institutions, introduce energy savings solutions in the street lighting sector, and organize recycling of mercury lamps from the city residents.

2.6 Key Strategies with Relevance to Energy and Energy Efficiency

2.6.1 National Level

The "Kazakhstan 2030" Strategy for Development was made public in 1997, and outlines a long-term development plan directed at transforming the country into a stable and ecologically sustained and developing economy.[19] One of the seven priority areas focuses on power resources. By 2030, Kazakhstan should accelerate the development of the domestic energy infrastructure, settle the issue regarding self-sufficiency and competitive independence, on one hand, and use wisely its

[19] Strategy Kazakhstan 2030 available at http://www.akorda.kz/en/official_documents/strategies_and_programs

strategic resources to make savings for future generations, on the other hand.

The main areas of interventions regarding EE target new energy-saving technologies, equipment, heat substations, metering systems and precision instruments, and increase in the fuel and energy balance of renewable and alternative energy sources. New legislation and regulations is necessary to establish appropriate mechanisms as to encourage companies to implement EE measures. New financial instruments are needed, such as urban revolving financial mechanism to help accumulate funds based on the budgetary framework, and identify a corresponding body at the city level.

The "Kazakhstan 2020" Strategic Development Plan is adopted as a short-term phase plan to support the implementation of Strategy "Kazakhstan – 2030". The document aims to address a few issues after the recent oil crises, such as economy diversification through industrialization and development of infrastructure, and high quality house and communal services. The mid-term indicative targets in key sectors should improve the business environment and social services. The plan also aims to reduce the energy intensity of the GDP by 25% compared to the 2008 baseline.

Kazakhstan Strategy 2050 is a long-term plan consisting of 100 concrete steps that should trigger an institutional reform to place the country among top 30 advanced nations in the world by 2050, from its currently ranking position of 51st.[20] The program was made public by the president in May 2015, and targets the power sector reform, among other issues. In the future, Kazakhstan wants to introduce the single buyer model that should reduce the differentiate tariffs in the region, expand the regional electricity companies and reduce the cost of electricity transmission to end users, and introduce a new tariff policy to stimulate investments in the energy sector (the tariff should have one component to finance the capital cost and another one to cover the variable cost of electricity generation). Step #59 of the strategy refers to energy savings companies (ESCOs) by attracting strategic investors to the energy saving industry. Priority should be given to development of private sector companies to provide energy saving services with financial returns and profit obtained from the reduction of energy costs.

The *Green Economy Policy (GEP)* is a policy concept approved in 2013 aimed at diversifying Kazakhstan's economy through careful use of resource in parallel with development of renewable energy sources (RES).[21] Closely connected to *Kazakhstan Strategy 2050*, the GEP is the country's new economic policy under which the "green economy" should increase the GDP by 3% and create more than half millions of new jobs. By 2020, 3% of power should be generated from RES (solar and wind) and the clean energy share should increase by 30% by 2030 and by 50% by 2050. A third of the total waste should generate green energy by 2050.

On the long-term, Kazakhstan aims to reduce the GHGs by 40% by 2050 (as compared to 2012 levels) and increase the share of natural gas-based power plants to 30% by 2050. In the field of EE, the GoK is determined to reduce the intensity of the GDP by 30% by 2030 and by 50% by 2050 (compared to the levels of 2008). Municipal waste coverage should achieve 100% by 2050, while recycling waste should be at 40% by 2030 and 50% by 2050. The law on renewable energy (RE) and ecology was amended in 2016 to further encourage the newly developing green sector/industry in the country.

The Feed-in-Tariff policy was established in 2013 for the next 15 years, in an attempt to increase power generation from RES, which currently makes less than 1% of the energy mix in Kazakhstan, as well as help the GoK to carry out the GEP. Other provisions regarding RE include mandatory purchase of electricity generated using RES by the single off-taker Financial Settlement Center under KEGOC[22] and mandatory connection of RES facilities to transmission or distribution networks by the grid operating company. There are no licensing requirements for RE generation.

Nurly Zhol (the Bright Path to the Future) is a US$ 9 billion domestic stimulus plan launched in 2014

[20] Strategy Kazakhstan 2050 available at: http://strategy2050.kz/en/page/message_text2014/ and http://strategy2050.kz/en/

[21] Green Economy Policy was approved by the Decree of the President on May 30, 2013 (#577)

[22] KEGOC – Kazakhstan Electricity Grid Operating Company

with the main target to improve the critical infrastructure and priority sector in the country, and drive economic growth by state and foreign direct investments.[23] The program provides attractive loans with a small interest rate and six-year grace period. The program should be able to shift the productivity from the oil sector to other areas, like agribusiness, manufacturing, tourism, information technology and finance. The main target of the program is to bring about infrastructure development in seven areas, namely transportation and logistics, industrial energy, public utilities, housing, social sector, and small-medium enterprises. In addition to building high-voltage transmission lines and balancing energy access to rural areas through a balanced energy supply, the program pledges to invest US$ 450 million per year to modernize heat & water infrastructure and development of social housing, and KZT 20 billion for new kindergartens. *Nurly Zhol* focuses on the development and modernization of hard infrastructure, like roads and ports, and should create 4,500 new jobs (in the SME sector), with overall 200,000 new jobs in the country.

2.6.2 Strategies for Almaty

The Almaty 2020 Development Program is the local strategy for the 2016-2020 period aimed at ensuring sustainable development of the city, by increasing the attractiveness of the city to both people and businesses.[24] The areas of interest include development of infrastructure, environment, land resource and social sectors, including sustainable industrial growth and increase EE, improving the pre-school and secondary education system and develop competitive healthcare system. Other measures include development of housing, improve public transport, diminish pollution, improve solid waste management, better social protection and enable a favorable investment climate. Implementation of the plan requires KZT 2.1 trillion investments from public and private funds (approximately US$ 9 billion).

Some of the measures target the energy sector. For example, the intervention include modernization and upgrade of the heat supply system, replacement of automated heating and power station (CHP-1) with natural gas-based equipment with 1,300 Gcal/hour capacity, while new heat pipes and boilers should be developed in poorly covered neighborhoods. The program also targets losses in the power sector by diminishing the transit powers through municipal networks, while new power stations should be built to cover the future demand.

Table 3. Almaty 2020 Plan – Relevant target indicators by 2020

Economy	• Increase GRP by 12.5% and reach GRP per capita to KZT 57.7 million → increase GRP by three times as compared to year 2000 • Increase capital investment by 2.5. times as compared to year 2000 • Increase income per capita 2 times as compared to year 2000
Social services	• 100% coverage for preschool education for children age 3 to 6 (including development of private preschools) • Full compliance with national regulation for secondary education • 5.1% unemployment rate

Infrastructure & energy	• Increase of constructions by 134%
	  ○ Increase of public construction 2.5 times from 3.21 million m^2 to 7.94 million m^2
	    ▪ social construction by 2,7 times (from 1.53 million m^2 to 4,06 million m^2)
	    ▪ municipal constructions by 2.3 times – from 1.68 million m^2 to 3.88 million m^2
	  ○ 6.5 million m^2 of new residential buildings
	• Reduce by 51% condominiums requiring major repair
	• Increase share of public transport to 48%
	• 100% access to potable water and 85% to wastewater/sewage
	    ▪ Increase in daily water supply up to 1.08 million m^3
	    ▪ Increase in daily sewage capacity to 626,000 m^3
	• Increase upgraded distribution networks by 1.8% for heat, 2% for power, and b1.5%

[23] More about Nurly Zhol program is available at: http://www.kazakhembus.com/content/nurly-zhol-0
[24] Almaty GenPlan 2020 is available at http://www.almaty.kz/page.php?page_id=380&lang=2

	for gas. • 4.25% share in renewable energy • Increase in gas supply by 1.2 million m^3/hour
Environmental & land resources	• Growth of territory from 115,000 hectares (ha) to 260,000 ha • 100% coverage for waste collection and management

The *General Master Plan for Almaty by 2030 (GenPlan)* is outlining the city development targets up to year 2030. The document is split a into medium-term plan covering the 2016-2021 period, and a long-term program covering the 2021-2030 period. Local utility provider offered inputs to identify the most appropriate solutions necessary to meet the future demands. The document is expected to be completed and launched in 2017.

The main directions of the master plan focus on developing of a modern, new, eco-friendly industry and telecom sector by increasing the number of internet providers. The urban planning for the next two decades is considering 30% growth in terms of both population and territory. Estimates indicate 2.7 million city residents by 2030, a situation that would require additional infrastructure for utilities, like potable water & sewage, heat & power, but also for housing, education and healthcare facilities. In the next two decades Almaty is expected to consolidate its position as the key financial and business center in the country, laying the ground for a significant increase in the number of SMEs.

Finally, the *Almaty Energy Complex 2015-2020* focuses on energy resources to prompt a sustainable economic growth, in parallel with a steady increase in the quality of life, and enabling the optimal organizational, legal and economic conditions for achieving EE indicators. The plan had identified up to 30% potential savings in residential and public buildings. Reducing the energy consumption for heating by KZT 27 million per year, diminishing consumption from an average 190 kWh/m^2 per year to 120 kWh/m^2 per year, introducing EE lighting, thermal insulation of buildings and of automated heat points and heat pipes, automated block heaters and energy audits are only a few of the EE measures included in the plan. The document also calls for the establishment of an Energy Management Unit of with 3-5 people at the city administration level. The city already has an Energy Unit that focuses more on heat and power supply issues. However, the Energy Division of the Almaty City Administration does not have a dedicated EE unit, and also lacks qualified personnel to cover EE issues. In recent years there have been a few attempts to set up a dedicated EE unit, but there have been some issues with the legal framework.

2.7 Almaty Local Budget Framework

The national and local budgets are regulated by the Budget Code. Astana, Almaty and two regions are donors to the republican (national) budget. The city budget is drafted and managed by the Budget Division of the city administration. The budgetary cycle has three years. The budget has two funding sources, namely local revenues and the national budget. 40% of the local budget is made of local revenues from tax collection, and 60% are earmarked transfers from the national budget for investments and other expenses. This share split is in place since year 2000, although local expenditures went up in recent years.

The spending is split into two types of expenditures, i.e., for operations and investments. About 80% of the earmarked funds go for investments, with the rest of money is used for specific expenditures. Overall, 55% of the budget covers operations costs, including salaries and public services, while 45% is used for investments. Most of the money collected from local taxes and revenues cover the operation costs of the public sectors, including schools, street lighting, waste collection and road cleaning. The city budget also covers the expenditures for street lighting in municipal districts. The district (rayon) kindergartens receive from the city budget a monthly lump sum of KZT 20,000 per child, an amount that should cover operation costs of the facilities and salaries. There are no subsidies from the national budget to municipal services.

40% of investments usually finance the ongoing projects. If earmarked funds for investments are not spent by the end of the fiscal year, cities must return the money to the Ministry of Finance (MoF) or ask for an extension. Sometimes transfers from the national budget are delayed, hence they trigger further delays for tenders for selection of service providers.

The budget projection for the next year is made based on some 10% increase of the existing budget. Annually, there are three budget adjustments. There are three restrictions for debt limits, namely (i) they should maximum 75% of the revenues (excluding liabilities), (ii) cannot exceed 10% of the total budget, and (iii) accumulated debts should be less than 75% of the total budget. It is important to note that the city cannot borrow money for daily operation expenditures. A special provision under article 210 of the Budget Code allows Astana and Almaty to issue bonds in case of excess money.

The Budget Division is in charge of collecting investment proposals from all divisions within the city hall. Since money is cannot cover the local needs, the city must ask for more funds from the national budget. The local investment plan is prepared by the line ministries and sent for approval to the MoF and further to the Committee of the Financing of Kazakhstan. If projects do not receive money in a given fiscal year (due to lack of funds), they are considered for the next fiscal years. Whenever some surplus from local taxes is available, the city administration and the local council (maslikat) decides on how the money should be spent.

The city can decide how to spend the excess money in a specific public sector, based on recommendations from the respective stakeholder. For example, the school prepares a proposal and financial plan for an alternative use of the funds in the next fiscal year, which is sent to the division of education in the city administration, the entity that is administratively responsible for the schools in the city. Subsequently, the proposal goes to the Financial Planning Unit and further to the specific working group (maslikat) within the local council. Once it gets the green light from the working group, the proposal goes for approval in the city's local assembly.

Table 4. City key statistics of 2015[25]

№	Indicator	Value in 2015	Unit
1	Population	1.703.400	people
3	Municipal Area	628	km^2
2	Population Density	2,712	people/km^2
4	Primary Energy Consumption	42,427	GWh
5	Employment Rate	above 95%	
6	Human Development Index (HDI)[26]	0.79	
7	Total annual municipal budget	2,083 462.5	million US$ billion KZT
8	Spending for Energy (for municipal sectors: public transport, municipal buildings, street lighting, waste, water and wastewater)	64.53 equal to 3.1%	million US$ of municipal budget
9	Municipality expenditures for energy in public buildings	35.6 equal to 1.7%	million US$ of municipal budget
10	GDP (2015)	36 8,000 21,155	billion US$ billion KZT US$ per capita

[25] It was agreed with the City Administration and the World Bank team to apply data of the year 2015 as baseline data for the TRACE assessment and the following EE assessment.
[26] UN Human Development Reports available at https://hdr.undp.org/en/data; Value for Kazakhstan,2015

3 Municipal Energy Consumption and Sector Analysis

3.1 City-wide Energy Consumption and Key Performance Indicators

In 2015, the total primary energy consumed in Almaty was 42.4 TWh (42.4 billion kWh) of which coal, natural gas and car fuel accounted for about 30% each. Coal and gas is primarily used for heat generation or heat and power cogeneration (CHP) facilities. 60% of the electricity in the city is generated by local CHPs, while 40% is supplied by KECOG, the national transmission grid operator in Kazakhstan, with a small portion provided from regional hydropower plants.

Figure 9. Share of primary energy consumption

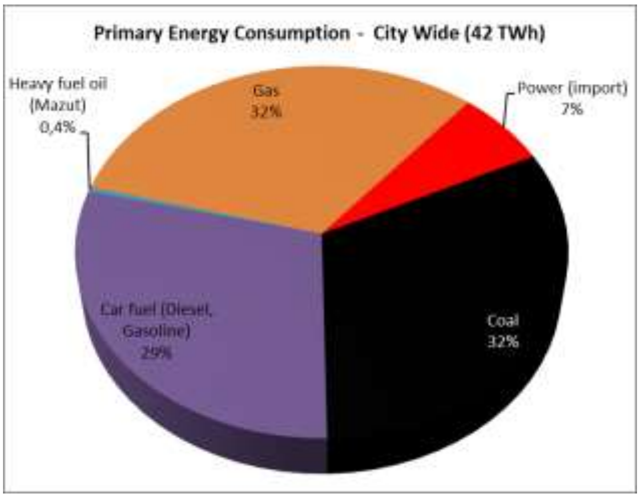
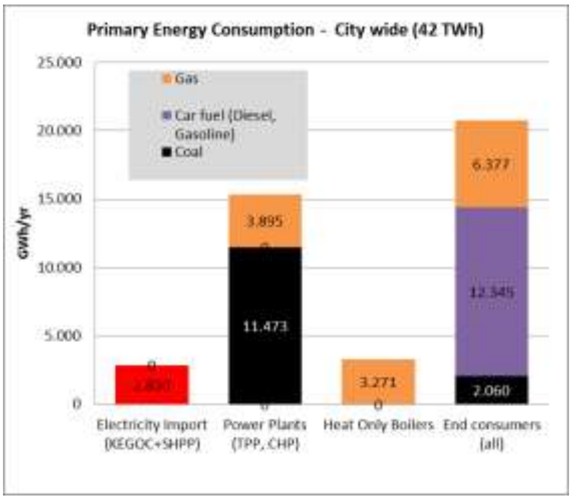


Figure 10. Use of primary energy

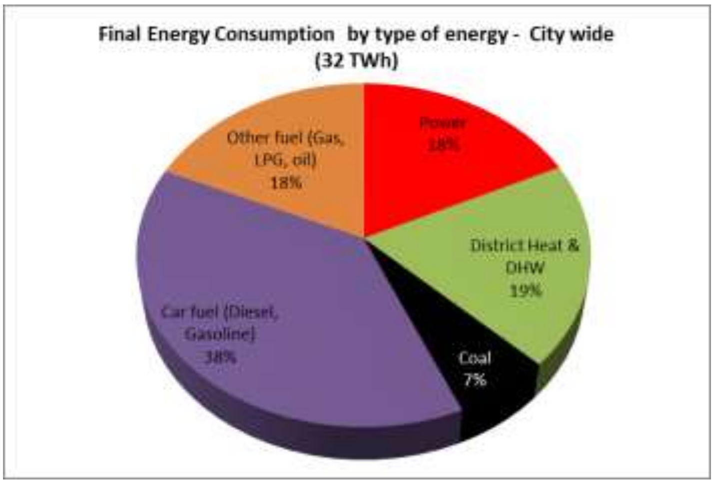


The energy transformation and distribution losses for district heat and electricity in Almaty account for 22% of the Primary Energy Consumption (PEC) - i.e., 9.359 GWh in 2015 - which is almost at the same level as the final energy consumption (FEC) for the entire residential sector in the city (10,440 GWh). Considering the generation and distribution losses, the primary energy factor for electricity is 1.9 – which means that 1 kWh of power delivered to the final consumer requires 1.9 KWh of primary energy (mix of gas and coal). For district heat the primary energy factor is 1.6.

Since the price for the natural gas used by the power and heating plants is six times higher (KZT 2.5/kWh) than the domestic coal sold to the energy utilities (0.4 KTZ/kWh), there is a strong economic motivation towards shifting from natural gas to coal in the local CHP plants. Although it would lower the production costs for power and heat, this would have some negative influences on local GHG emissions, in addition to lower combustion efficiency.

The energy flow of Almaty in the baseline year 2015 is presented in Annex 1 as a Sankey diagram, illustrating the consumption of primary energy carriers in all municipal sectors and summing up the municipal wide final energy consumption. In 2015, the FEC in Almaty was 32,325 GWh. The largest use of the FEC is the car fuel in the form of gasoline and diesel (38%), with district heat and power holding 19% each.

Figure 11. City-wide final energy consumption



The residential sector consumes annually 10.4 billion kWh, which is one-third of the city-wide final energy consumption. This percentage is at the same level for cities in European and other industrialized countries, but is lower than the average for cities in Kazakhstan. The industry and commercial sector consumes a quarter of the final energy.

Figure 12. Primary and final energy consumption

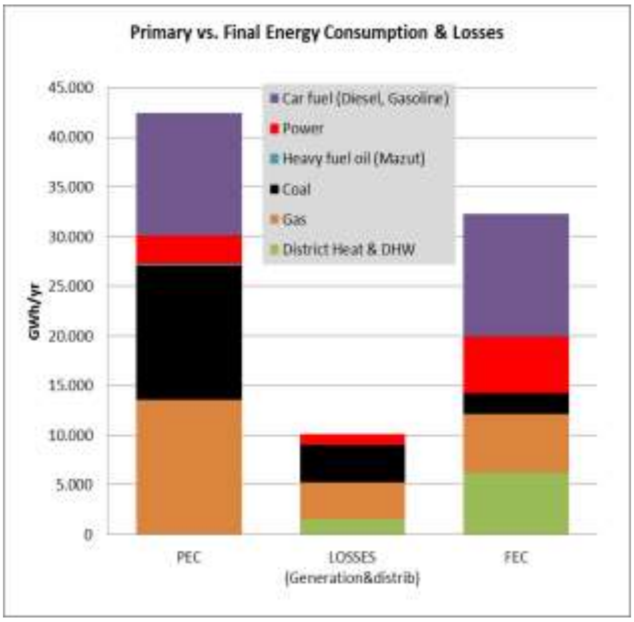
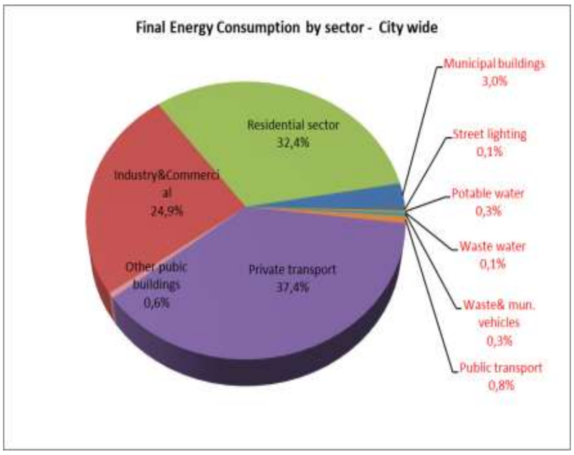
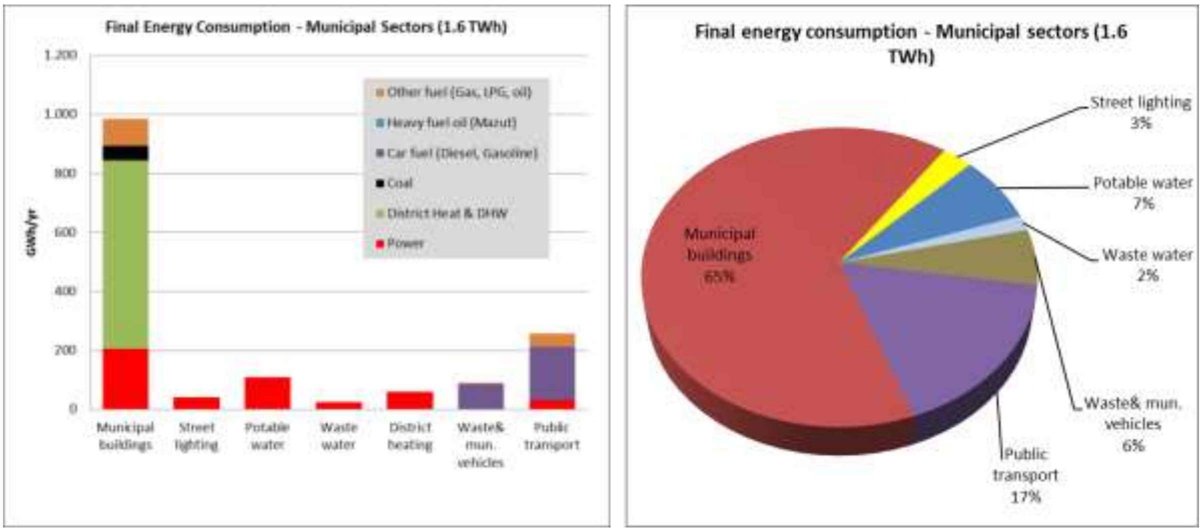


Figure 13. City-wide FEC by sector



Most of the energy consumed in Almaty is used to generate heat (44%), followed by car fuel and electricity. The residential sector is the main consumer of the district heat (63% of total heat). The key power user is the local industry (58%). The final energy consumption in municipal service sectors amounts to 1,565 GWh in 2015, which represents 5% of Almaty's FEC. The largest energy consumer are the municipal public buildings, with 984 GWh (65% of municipal sector consumption), followed by public transport, potable water and street lighting (see Figure 14 below).

Figure 14. Share of municipal wide final energy consumption by energy carrier

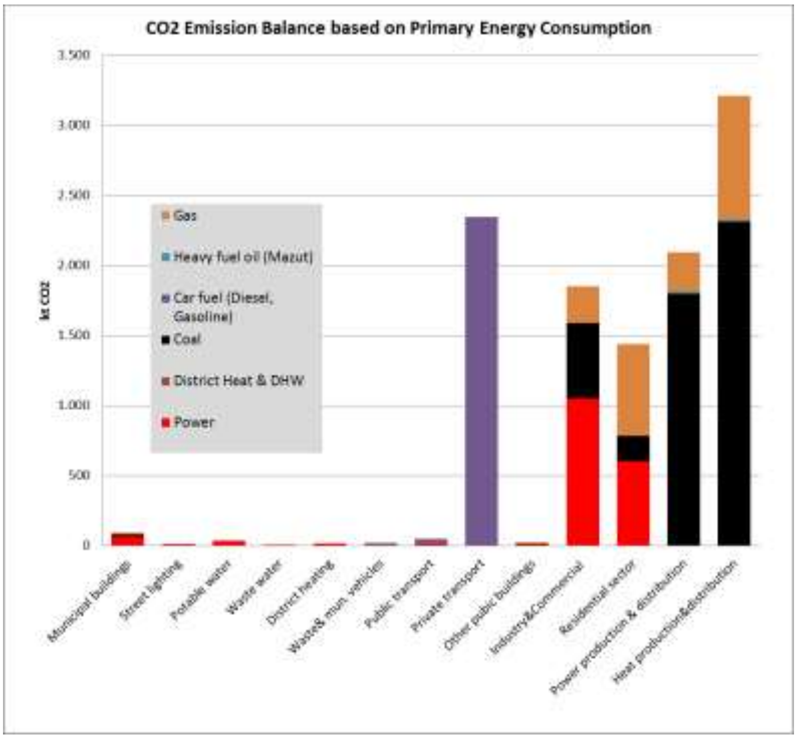


3.1.1 CO_2 Emission Balance

Due to extensive use of coal for power and heat generation greenhouse gas (GHG) emissions have reached 11.2 million tons in 2015[27], with a high value of 0.264 kg CO_2 per kWh of primary energy use. Highest emissions factors are calculated for heat and power generation – with an average of 0.5 kg CO_2/kWh (more details in Annex 3).

The emission factor for electricity produced in cogeneration plants in Almaty (0.64 kg CO_2 /kWh) is one third less than the country's wide electricity emission factor of 0.9 kg CO_2/kWh. Thus, the locally produced electricity in CHP plants is cleaner than the imported electricity from KEGOC. The primary sources of CO_2 emissions are heat and power generation, in addition to distribution losses (summing up 48%), followed by emissions from the transport sector (21%).

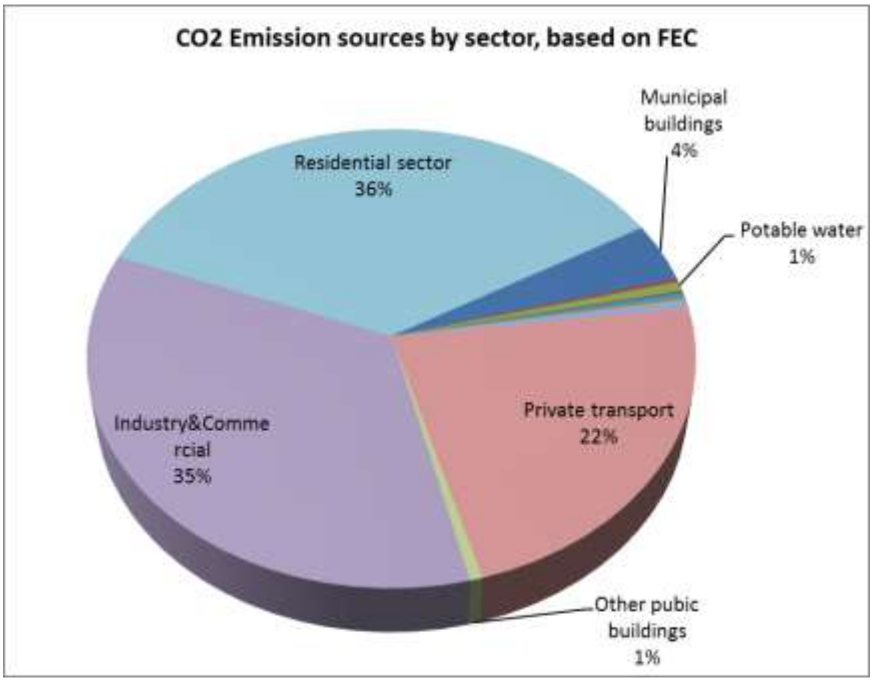
Figure 15. CO_2 emission sources by sector



[27] Source: Expert calculation based in the primary energy balance 2015.

Both residential and industry & commercial sectors are the largest generators of GHGs in Almaty, with 3.6-3.7 million tons of emissions annually (35% each), followed by the private transport.

Figure 16. Emission sources by final energy consumption sectors



3.2 Energy Performance Benchmarking

The benchmarking component of the TRACE tool is intended to assess the energy performance of the city compared to other peer cities. For this exercise, the Almaty city's wide and sectoral Key Performance Indicators (KPI) are compared with KPIs of other cities through the built-in peer city data. For an illustrative comparison with Almaty a number of large size peer cities of similar HDI, climate and features have been chosen from the TRACE database, such as Bucharest (Romania), Astana (Kazakhstan), Belgrade (Serbia), Baku (Azerbaijan), Banja Luka (Bosnia and Herzegovina), Sarajevo (Croatia), Sofia (Bulgaria), Teheran (Iran), Tallinn (Estonia), Tbilisi (Georgia), Kiev (Ukraine), and Urumqi (China). Tables 5 and 6 provide a summary of some of the KPIs.

Table 5. Key Performance Indicators for municipality wide energy consumption

Key Performance Indicators (TRACE)		
Primary energy consumption (PEC) per capita	24,907	kWh/capita/year
PEC per capita	4,031	kWh_e/capita/year
Thermal energy consumption per capita	5,000	kWh_T/capita/year
Primary energy consumption per GDP	1,17	kWh/US$
Energy supply coverage	100	%

TRACE delivers 27 KPIs for the city of Almaty. The complete list of municipal energy data for the baseline year 2015 is available in Annex 7.

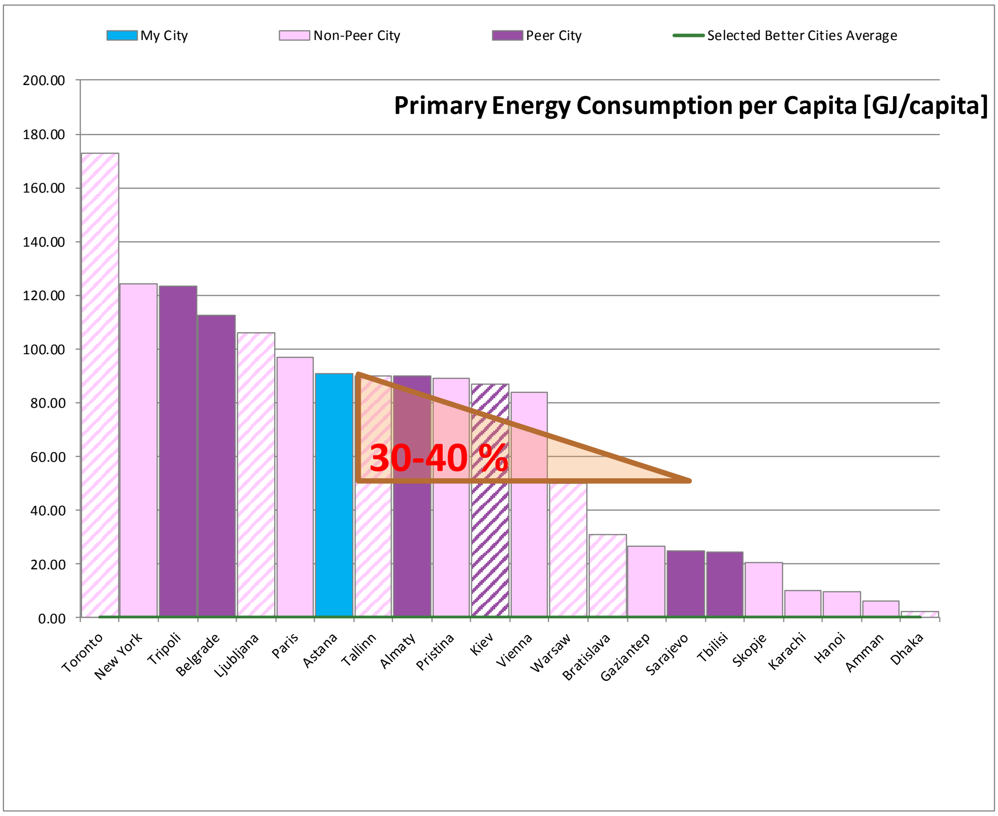
Table 6: Summary benchmarking of KPIs by sector

Sector	Selected KPI		Comparison with better performing cities	Energy saving potential
Municipal-wide energy	Annual primary energy consumption per capita	90 GJ/capita	Low performance	20-30%
	Annual primary energy	4.2 MJ/US$	Medium performance	n/a

Sector	Selected KPI		Comparison with better performing cities	Energy saving potential
	consumption per GDP	GDP		
Solid Waste	Annual waste generation	399 Approx. kg/capita	Medium performance	25-30%
	Solid waste recycled	< 5 %	Low performance	n/a
Water Supply and Wastewater	Energy density of potable water production	0.78 kWh_e/m^3	Low performance	20-30%
	Percentage of non-revenue water	37 %	Low performance	60%
	Energy density of Wastewater processing and cleaning	0.19 kWh_e/m^3	Medium performance	10-20%
Street Lighting	Annual electricity consumed per light point (LP)	483 kWh_e/LP	low performance, but not meeting standards	50-65%
Municipal Public Buildings	Annual energy consumption	195 kWh_{th}/m^2 51 kWh_{el}/m^2	Low performance Low performance	30-50%
District Heating	Losses in DH network	20 %	Low performance	20-25%
Municipal Public Transport	Public transport energy consumption	0.04 MJ/pass km	Medium performance	20-25%
	Public transport mode split	45%	Medium to high performance	10%

The primary energy consumption per capita in Almaty of 90 GJ/capita (24,907 kWh/capita) in 2015 is high among the peer cities in terms of specific annual energy consumption per inhabitant. Almaty ranks medium-to-low for PEC per capita in comparison with other peer cities. This is primarily caused by: (i) long heating period with cold climate, (ii) availability of coal and gas, (iii) important high industrial, service and trade activities, and (iv) high losses for final energy generation, as well as high inefficient energy use at end users. The theoretical energy saving potential for Almaty is approximately 30-40%, a figure that would achieve the level of better performing peer cities. A benchmarking of the sector KPIs is undertaken in the sector analysis below.

Figure 17. Benchmark of primary energy consumption



The primary energy consumption per GDP for Almaty is with 1.2 kWh/GDP, which is medium performance due to the moderate GDP of the city – i.e., US$ 21,200 per capita/year (this accounts for 60% of GDP/capita ratio of cities in Western Europe[28]) and also due to the high annual primary energy consumption of 42,427 GWh.

3.3 Sector Analysis

This section below outlines the analysis performed based on the TRACE methodology on the sectors that are under the city government's control, like municipal buildings, water & wastewater, public transport, solid waste, street lighting, heat and power. In addition, the study covers also sectors that over city authorities do not have much leverage on, like residential buildings or private transport. These sections are not only relevant in understanding the overall picture of city-wide consumption, but also their contribution to achieving energy savings in Almaty. Detailed analyses of these non-municipal sectors are provided in Annex 4 of the report.

3.4 Municipal Public Buildings

3.4.1 Institutional Framework

The public buildings in Almaty are managed by different divisions of the city administration. Schools are managed by the Division of Education, while kindergartens are coordinated by the district (rayon) authorities. Healthcare facilities are under the Division of Health, sports facilities are under the division responsible for sports, and buildings hosting cultural and social activities are managed by the respective divisions. Part of the budget for education, health care, cultural etc. activities comes from the respective line ministries – for example, the Ministry of Education allocates some money for schools, while the Ministry of Health gives funds for local hospitals. Kindergartens are financed from the Almaty local government via the seven district administrations, based on a lump sum of KZT 20,000 per month per child that should cover the costs for operations, utilities, and salaries.

The divisions from the city administration receive requests from local entities (schools, hospitals etc.) for investments and renovation works, and then they allocate the money based on needs and available funds. Funds for schools are distributed through the Division of Economy to the district municipalities (rayons), and they further give them to the schools. The Special Repair Act allocates overall KZT 700 million per year for all schools in Almaty, which would come to maximum KZT 3 million per school (approximately US$ 90,000, with an average of US$ 20/m^2). However, the budget surplus made by schools cannot be used by these education facilities, so the money goes back to the city divisions and the local budget. On the other hand, kindergartens receive an annual amount per child for current repairs (an index of 5 MRP), which can be accumulated and used for further repairing in the next years. For emergency repairing the city government disburses the money, as needed. The local administration through the Division of Education allocates the money for energy expenditures based on the power/heat/natural gas bills for the previous year.

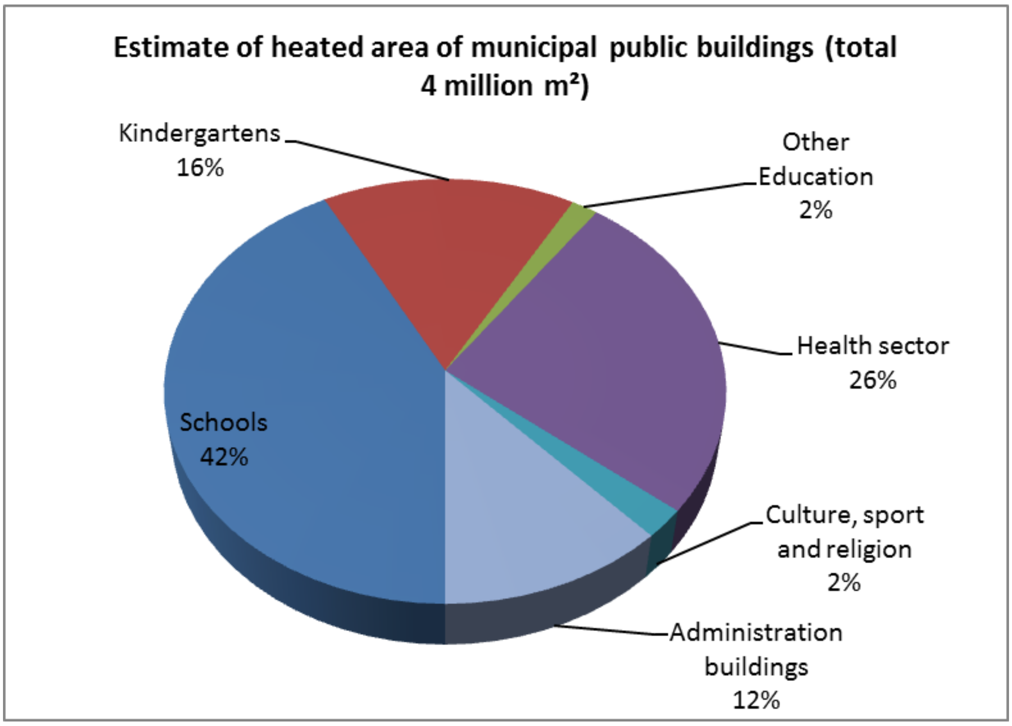
Municipal entities, like schools, hospitals, request money for building renovation and major investments from the city division. Money is allocated based on priorities and availability of funds. The schools have different budget setting than the kindergartens. Funds for schools are allocated through a line in the local budget. The money comes from the national budget through the Ministry of Education, then to the city's Division of Education, and from here it goes further the school. Financial savings cannot be used for other projects, as the money goes either back to the local budget or is distributed in the form of financial bonuses to employees. As result, the next year budget is reduced. Kindergartens are managed by the districts, and they get a lump sum per month per child that should cover operation costs, including utilities, salaries etc. The facilities receive an annual amount per child for current repairs which can be accumulated and used in the next years. Money for energy related expenditures are allocated based on previous year's bills.

[28] Eurostat database available at: http://ec.europa.eu/eurostat/web/metropolitan-regions/data/database

3.4.2 Infrastructure

Municipal buildings in Almaty account for 7% of the total building area in Almaty. There are nearly 1,000 public buildings in Almaty covering 4 million m^2 [29]. More than two-thirds of the surface comprises 584 education facilities, of which 244 schools & high-schools and 330 kindergartens, with other 17 buildings hosting boarding schools, orphanages, etc. There are 150 healthcare facilities spread across 1 million m^2, and 71 local and religion institutions and sports facilities. Almaty has 200 municipal office buildings accounting for 10% of the total area (see figure 18 below). Since the city was the capital until late 1990s, Almaty still accommodates 725 government offices totaling 942,000 m^2. However, these buildings are not under managed by the city administration.

Figure 18. Heated area of municipal buildings in Almaty, total approx. 3 million m^2



The population upsurge in Almaty in recent years led to an increase in demand for education facilities. In 2015, there were 584 education buildings in the city. 215,000 kids were enrolled in 330 kindergartens/pre-schools of which approximately two-thirds (228 units) are private and one-third are public. There are 244 schools of which 201 are public schools, with overall 212,000 pupils enrolled. The existing education buildings struggle to accommodate the student demand in the city, hence some schools are overcrowded. Under the Nurly Zhol program aimed at improving the critical infrastructure in Kazakhstan, a few schools were developed or extended. For example, the schools #57 & #157 have been extended to accommodate additional 900 pupils each, while a building for 500 students was built at school #168. Schools and kindergartens in Almaty are a mix of old and relatively new buildings - most of them were built in the 1980s and 1990s, some are even from 1930s and 1950s, while only a few were built in recent years.

The site visits performed by the team in few education facilities in Almaty has highlighted that while most of the buildings are more or less in good shape, in many cases the lighting and heating/energy equipment and systems are quite inefficient. Many buildings are overheated, with temperature exceeding the normative of 20°C, and there is no temperature control or thermostat neither at building or room level. Many of the schools and kindergartens are equipped with poor CFLs and T5 lamps and PVC windows. Often time renovation and repair consists merely of painting the walls, replacement of carpentry and lighting, but no proper thermal insulation or building retrofit.

[29] This figure takes into consideration the overall heated area.

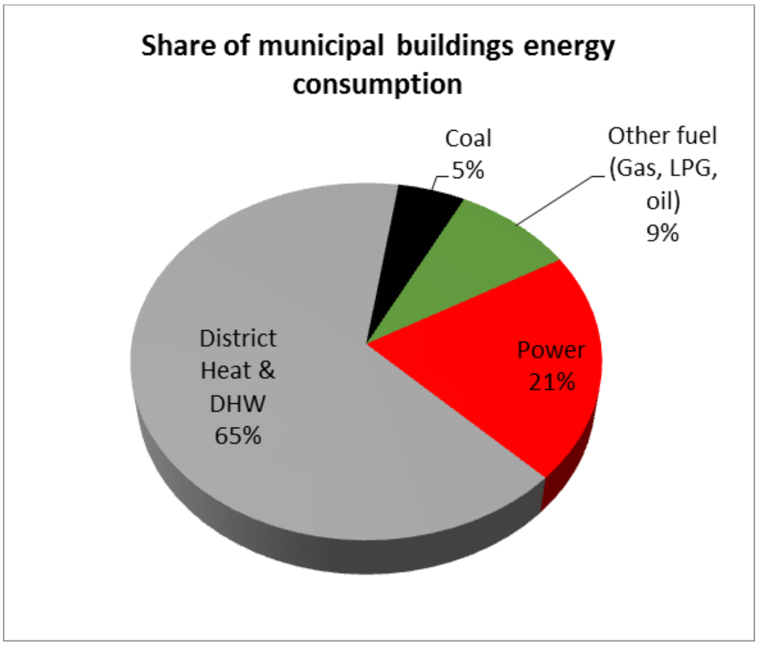
Most of the investments in the education facilities are covered from the city budget, and sometimes with support from other entities. For example, under a pilot project funded by the United Nations European Economic Commissions for Europe, automatic heat control at the building level were installed in 12 schools in 2004, a project that is fully paid for itself. The heat consumption came down by 26%, while the economic impact was around 20-30%; the project also introduced highly-efficient lamps (only limited LEDs) that reduced the electricity bill from 30% to 60%.

The Almaty administration is responsible for 43 local health care facilities that mostly run 24/7 and are energy intense. The city also has several cultural and leisure facilities, like theaters, libraries, concert halls etc., of which seven large buildings are managed by the city administration. Almaty has approximately 150 buildings that host sports activities, including stadium and swimming. As it is the country's main education center, Almaty is host to over 40 higher-education institutions that enroll 150,000 students. More than half of the students come from different regions in Kazakhstan and need housing, a situation that puts additional some challenges on universities and local authorities.

3.4.3 Energy Performance

Two-thirds of the energy used in public buildings in Almaty is heat and hot water, and a fifth is power (see Figure 19 below).

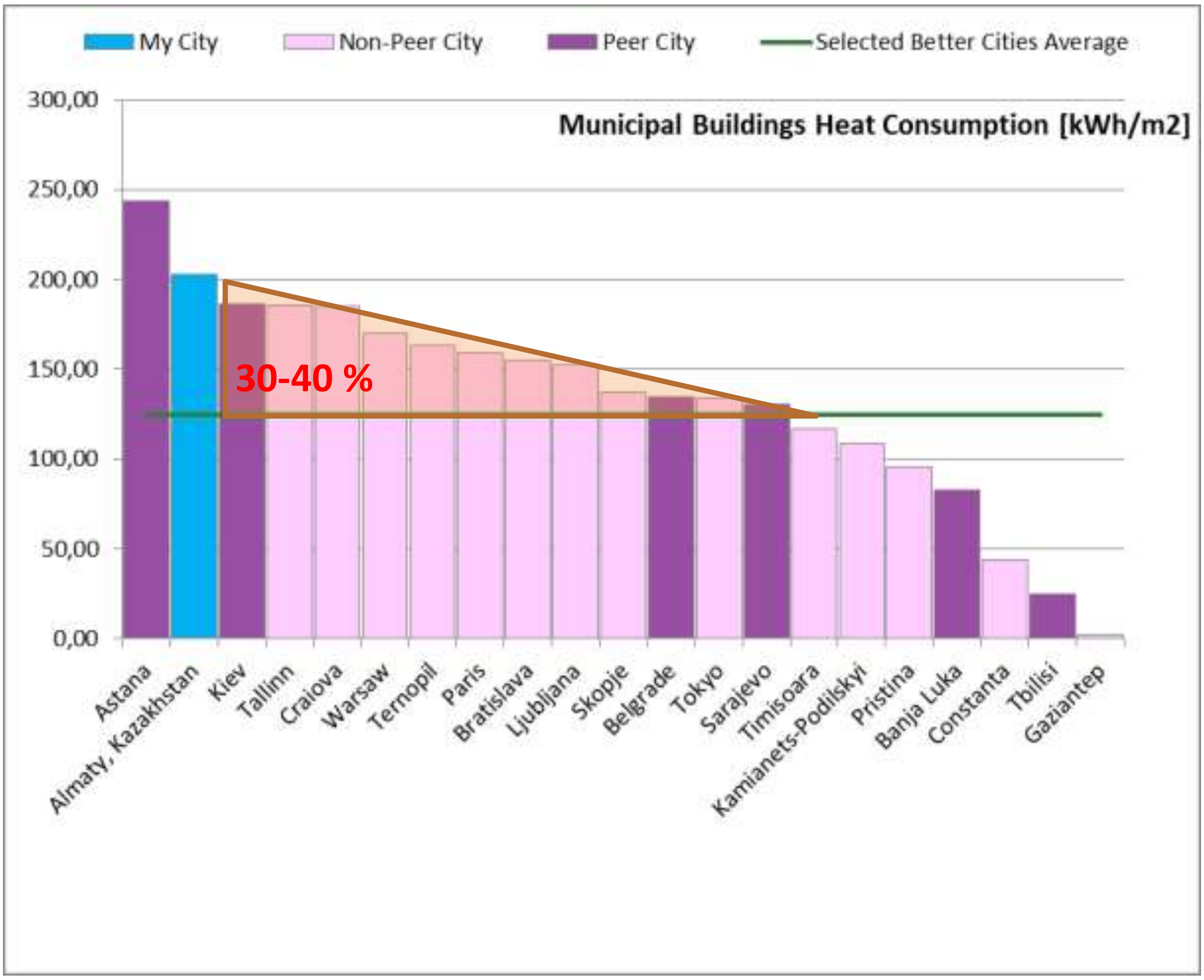
Figure 19. Share of energy consumption in municipal buildings in Almaty



Overall, municipal buildings in the city need 204,000,000 kWh of electricity in a year time, which would be 51 kWh/m². This figure puts Almaty in the middle of the benchmarking compared to cities with similar HDI in the TRACE database. Almaty is performing comparable to Belgrade and Astana, but requires more power than Sarajevo or Kiev.

Public buildings in Almaty use 779 million kWh of heat per year, which makes 195 kWh/m². Due to its cold climate in winter time, Almaty is the second highest energy intense city in the TRACE 2.0 database compared to cities with similar HDI, after Astana. The city requires 8% more heat per square meter than Kiev and a third more than Belgrade or Sarajevo, cities that also have cold winters.

Figure 20. Heat consumption in municipal buildings in Almaty



Public sector is a major energy user, consuming 15% of electricity and 30% of heat generated in the country. Expert estimates indicate that schools are the largest energy consumer among public buildings in Almaty (274,405 MWh), followed by healthcare units (124,497 MWh) and kindergartens (around 100,000 MWh). When it comes to specific consumption, the difference between these buildings is not so big, as it ranges from 190 per kWh/m² for administrative offices to 193 kWh/m² for hospitals and 200 kWh/m² for education facilities. Like education facilities, public offices are overheated, and since thermostat or valves to regulate the temperature are not available people must open the windows to cool down the rooms.

The annual energy bill for municipal buildings in Almaty is US$ 35.6 million, which accounts for 2% of the municipal budget. Energy tariffs for public sector are slightly higher than for the residential sector. Public sector is charged KZT 23.12 per Kwh of electricity (US$ 0.10); KZT 5,177 per Gcal (KZT 4.5/kWh or US$ 0.02/kWh); and KZT 31 per cubic meter of natural gas (KZT 3.3 /kWh or US$ 0.01/kWh). Low tariffs for energy encourage consumption.

3.4.4 Main Challenges in the Public Buildings Sector

Based on a comparison with peer cities and considering the local authority control over the sector and energy expenditure, the TRACE analysis shows that public building sector in Almaty has some good 40% energy savings potential.

This potential can be mainly achieved by some EE measures that not only would reduce energy consumption, but also improve level of comfort in buildings. Some of the EE measures could include replacement of existing inefficient lighting system with LEDs, installing efficient carpentry – such as double glazed windows, insulated door - introducing heat distribution system with temperature control at the level of buildings, heating point/substation and rooms, and insulation of the heat pipe in the building basement. Proper thermal insulation of buildings would help increase significantly the level of comfort in the facilities. Modernization of heating points in the basement is necessary in some buildings. Some facilities need some serious rehabilitation of heat and hot water pipes (in addition to equipping heaters with thermostats). Setting up an automated energy consumption monitoring system would also allow to better control the energy consumption and improve operation of the facilities. Lack of adequate energy audits for public buildings is an issue; subsequently, the energy audits must be monitored and, eventually, implemented. Although a few EE measures could be implemented right away, some may require prior steps to be undertaken.

- *Lack of aggregated data on public buildings:* The local government of Almaty does not have a proper database with all municipal buildings for which the city pays the energy bill. There are different types of buildings that belong to various divisions in the city hall, and no data aggregation is available. A building inventory including area, energy consumption and technical condition of the facilities is necessary, and should help city managers to prioritize buildings for EE projects.
- *Lack of funds*: Money for school rehabilitation is a major problem. Schools must submit to the Division of Education the list of major repair (e.g., replacement of the indoor lighting with LEDs), and funds should be disbursed based on work prioritization and availability of money. The city has no leverage to influence the quality of materials used for new constructions.
- *Lack of financial mechanism to allow retaining EE savings* - Any financial savings made by schools and kindergartens must be returned to the city budget. Kindergartens get a monthly lump sum per child that should cover expenses for salaries, utilities, investments, services etc. Any savings that could be obtained from potential energy savings must go back to the city budget.
- *Adequate energy audits*: Education facilities must put together an energy and safety monitoring audits every three years. However, these audits have only some basic information about building infrastructure, with no information on energy consumption, much less any EE recommendations. This limited technical information is not enough to produce an adequate energy audit. As of now, there is no follow-up on the energy monitoring neither by the school nor by the local government. The energy monitoring is performed by companies (not registered energy monitoring entities) selected under a tender funded from the local budget.
- *Limited trained staff for maintenance:* The city administration has only a small number of qualified personnel to ensure maintenance of the district heating points in public buildings.

Other Types of Buildings

There are a number of public buildings in Almaty that belong to the central government. Although they are not managed by the CA, they were considered for the FEC. Some details on government buildings are available in Annex 3.

The TRACE analysis also looked into residential and commercial & commercial buildings in Almaty that are not under the CA control.[30] The **residential sector** is the largest energy user in the city. Most of the 157,516 residential buildings comprising nearly 640,000 apartments are owned by private individuals who are organized under apartment owner associations (AOAs). 80% of the residential housing stock is old. Residential buildings required the largest amount of energy per square meter, among all types of buildings. A detailed analysis focusing on infrastructure, energy performance and issues in the residential sector in Almaty is provided in Annex 2. The **industrial & commercial sector** in Almaty comprises 37,600 buildings totaling 12.4 million m². 42% of the energy consumed is power, with heat and hot water accounting for 19%. The sector is very energy intense; it requires 270 kwh/m² of energy, for an annual expenditure of US$ 320 million.

[30] For individual residential buildings, and industry & commercial buildings no reliable data or statistics on facilities and energy consumption are available. Assumptions have been made based on interviews conducted with the city administration and energy utilities in order to draw a holistic, city-wide picture of energy consumption. No further research or analysis was undertaken.

3.5 Street Lighting

3.5.1 Institutional Framework

The street lighting (SL) system in Almaty is managed by the city administration and operated by LLP Almaty Kala Zharyk, a company owned by the local government. The sector is supervised by the Division of Natural Resources of the Almaty administration. Although there is only one operator in the city, a tender is organized every year and the contract is awarded to the same company. The money to operate the SL system, including operate and maintenance (O&M), is covered from the local budget. The maintenance services have been outsourced to a private consortium through a tender and covered from the city budget. There are plans to privatize the SL operator in the near future.

3.5.2 Infrastructure

Around 92% of the city roads in Almaty are covered by SL, which makes that 5,511 kilometers out of 6,000 kilometers of the city roads are lit. While public illumination is 100% in downtown area and other neighborhoods, the coverage in some of the suburbs is only 70-80%. There are nearly 86,000 bulbs mounted on 80,795 lighting poles of nine-meter height. Most of the poles have one luminary, and 6% have two lamps each. A few poles located in large roads (highways) have four lamps each.

A big burden for the SL operator is the maintenance of the network. Since there is no automatic switch control in place, monitoring of the luminaries is done manually and by site inspection. The integration of an automated, remote control combining operation, in addition to time switch and dimming function would help increase the quality of illumination and reduce the O&M related costs.

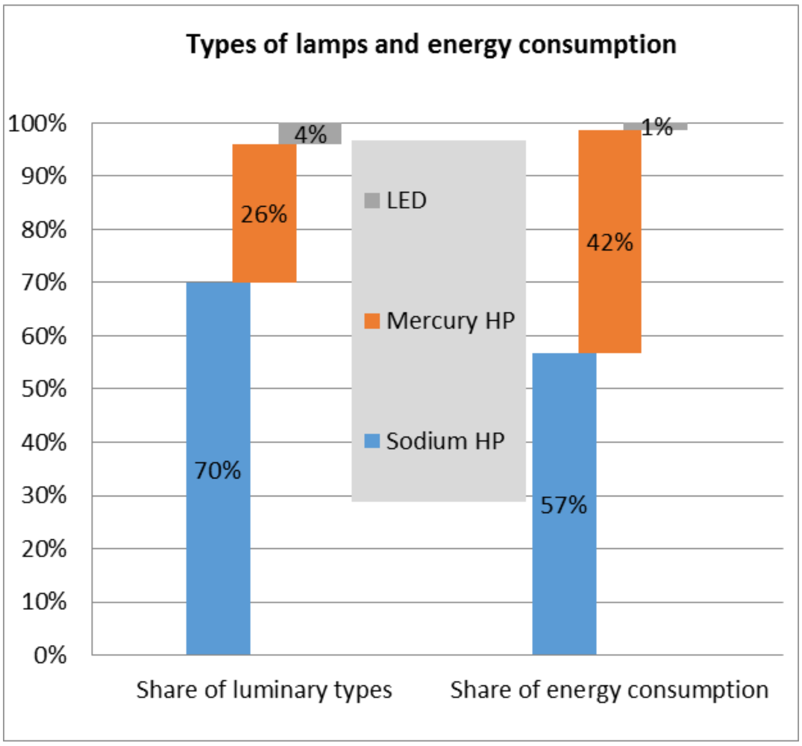
Most lamps in Almaty are high-pressure sodium (HPS) and mercury high-pressure (MHP), with a few LEDs. 70% of the lamps are HPS of 60/125/150W and 26% are MHP of 250W. LEDs of 60/90/125W intensity account for 4% of the public lights in the city, and they were installed free of charge by three Kazakh LED producers in an attempt to promote these highly-efficient bulbs. One of the companies is placing on its expense 6,000 LEDs, of which 3,504 lamps being already installed. Another producer has put some 500 lamps, while another company placed 40 LEDs. However, not all LEDs work well because of high voltage fluctuation in the power distribution network.

The LEDs representing 4% percent of the lamps use only one percent of the energy necessary to operate the SL network, while mercury lamps accounting for 26% of the lights in the city consume 42% of electricity. In addition, the life time of the sodium and mercury bulbs is quite low, only 1.5 years on average.

Most of the lighting poles are in good shape, but some needs rehabilitation (at least 3% of them). In recent years, the local authorities have replaced the poles along 62 kilometers of streets located near the city borders. On average, replacing one lighting pole (including the related works) cost between KZT 120,000 and KZT 150,000 (US$ 540 –US$ 675).

Public lighting in Almaty is still using the former Soviet standards for illumination (SNIP). Street lights are on for approximately 4,000 hours/year. Lighting is controlled by street cabinets equipped with time control. Although there is no dimming system in place as such, the existing norms could allow reducing the light intensity from midnight to 5 AM. There are three electricity tariff levels in place for SL, with an average of KZT 17.4/kWh (the lowest is during nighttime, at KZT 9.3/kWh).

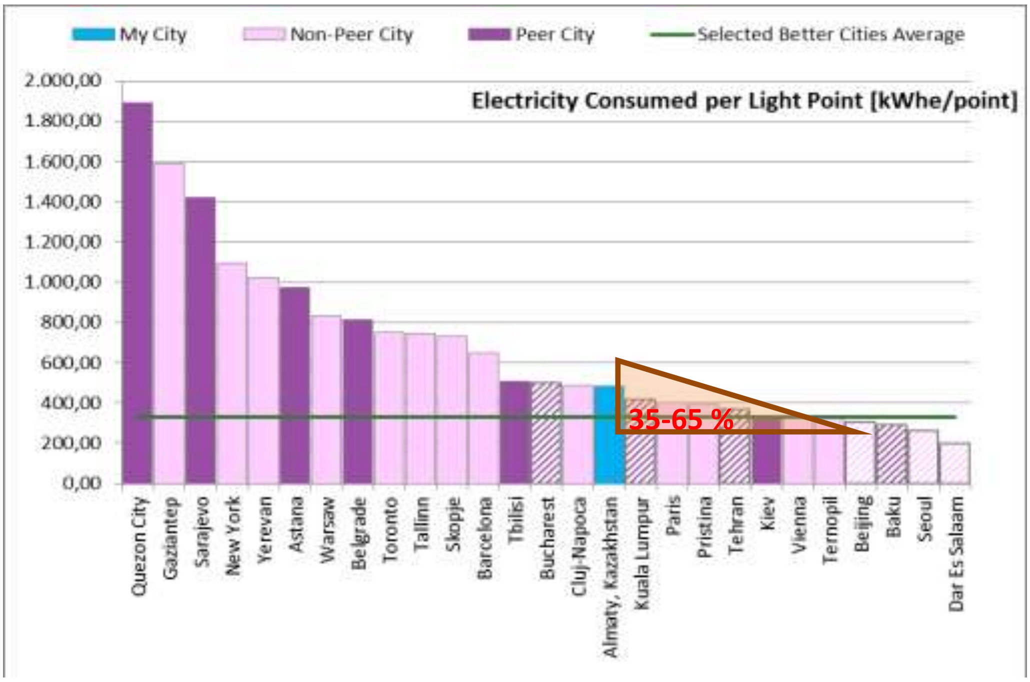
Figure 21.Types of lamps and related energy consumption in Almaty



3.5.3 Energy Performance

Almaty requires some 41.3 million kWh of electricity to operate the SL system, which makes 7,508 kWh of electricity to lit one kilometer of roads. According to the benchmarking made by TRACE 2.0, Almaty is an efficient city among peers with similar Human Development Index (HDI) in the data base, using some 30% less electricity per lit roads than Tbilisi, for example. The Kazakh city needs 483 kWh/light point. This is less than the electricity consumed by peers like Belgrade or Sarajevo, it is similar to Tbilisi, but almost 50% higher than in Kiev. The energy related expenditure to operate the public lighting network in Almaty is US$ 2.67 million, which represents 50% of the budget for the SL sector. The annual public failure rate is 3%.

Figure 22. Energy consumption per light pole in Almaty



3.5.4 Main Challenges in the Street Lighting Sector

The benchmarking based on TRACE 2.0 analysis indicates that the theoretical relative energy intensity for the SL sector in Almaty has 32% potential savings. Experts and technical estimates indicate that replacement of inefficient mercury bulbs with LEDs could actually increase the energy savings potential to 60%. However, there are some issues that could challenge the LEDs in Almaty.

- *High voltage fluctuation*: The SL system has some high voltage fluctuation, up to 260V, which can affect the lifetime of the LED lamps. Hence, prior to installing any LEDs, the city administration should address the voltage fluctuation and stabilize the voltage level in the system. 30% of the power distribution network comprising 1,600 kilometers of electric network should be replaced and retrofit in order to enable adequate conditions for the LEDs.
- *Use of products from domestic manufacturers*: The existing legislation is encouraging domestic producers. The public procurement legislation requires public entities to use 70% local content for the equipment they purchase. There are five domestic manufacturing companies in Kazakhstan that produce LED equipment about few times cheaper than international providers. For example, domestic LED poles are available for KZT 120,000-KZT 150,000 each, as compared to KZT 800,000 per pole produced by international providers. Also, a local LED luminary (fixture) is available for around US$ 350-US$ 400, twice cheaper than the one from international producers. Although Kazakh products are a whole lot cheaper, their technical performance and quality of lamps does not always meet the international standards. Local LEDs are of lower quality in terms of efficiency and lifetime, in addition to limited warranty.

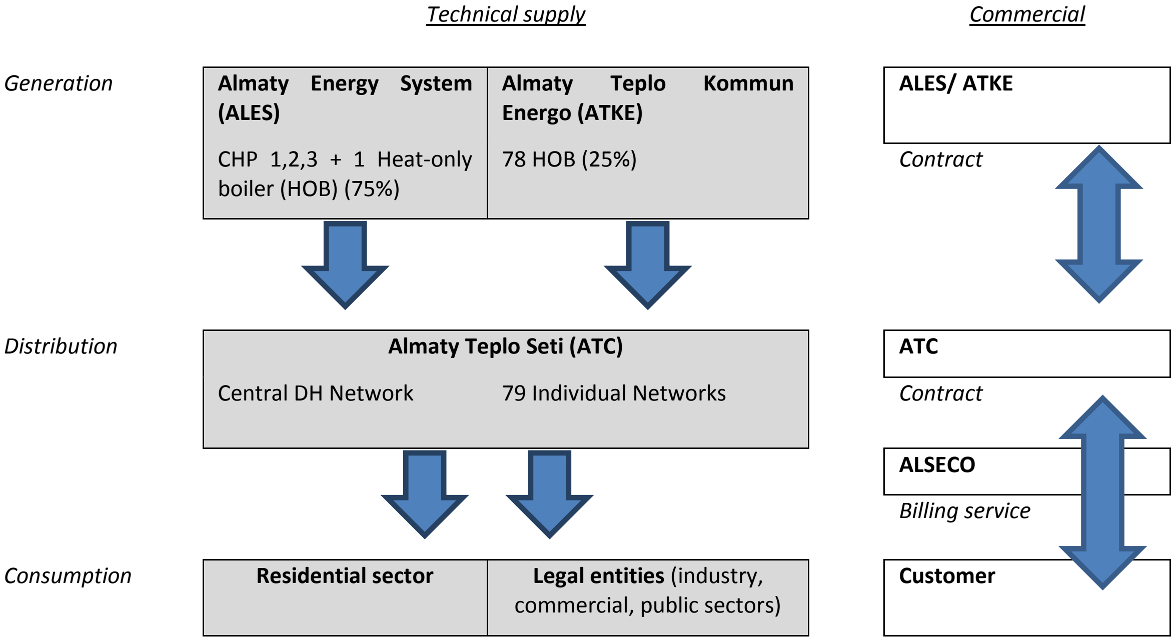
3.6 Sector Analysis - District Heating

3.6.1 Institutional Framework and Ownership Structure

The district heating (DH) in Almaty is a very complex system organized under different players involved from heat generation throughout delivery to end-users. The technical production and supply of heat stays with Almaty Energy System (ALES), a joint stock company of 3,000 staff that belongs to Samruk-Energy holding (part of the sovereign national welfare fund Samruk-Kazyna) and by Almaty Teplo Kommun Energo (AKTE), an entity under the Almaty city government. The heat distribution is provided by Almaty Teplo Seti (ATC), a company owned by the city administration. ATC buys heat from ALES and ATKE, and then sells and delivers to the customers. Between ATC and the end-users there is another player, namely Alseco, the billing company responsible for printing all utility bills in Almaty. The heat sector is regulated by the Energy Law and the Anti-Monopoly and Natural Resources Agency (AMNRA). The city of Almaty is also a small stakeholder in the DH sector, since the heat and heat/hot water network between the plants belong to the municipality.

The commercial distribution and billing of district heat is separated from the technical generation and distribution. ATC buys heat from the generation companies ALES and AKTE and sells it to end-users at a tariff approved by the AMNRA.

Figure 23. Structure of heat generation and distribution in Almaty



Tariffs are set for a five-year period. Last tariff adjustment was in 2012, and the next one is expected in 2017. The proposals for new tariffs have been already submitted to AMNRA, awaiting response from the energy regulator. The new proposed tariffs are higher; the current tariffs do not cover the cost of heat production after the fuel price went up in recent years. Customers in the residential sector without heat meters pay 30% more than those who have such devices.

Table 7. District Heat energy tariffs in Almaty (including VAT)

Population without heat meters	KZT 5,634.51/Gcal
Population with heat meters	KZT 4,119.86/Gcal
Other consumers without heat meters	KZT 7,043.14/Gcal
Other consumers with heat meters	KZT 4,621.90/Gcal
Consumers in old house in critical conditions with no option of installing heat meters	KZT 4,695.43/Gcal

ATC is subcontracting Alseco to prepare and deliver the heat/hot water bills to clients. A private entity with 100 staff, Alseco prepares and prints all utility bills for customers in the residential sector (e.g., heat, water, wastewater, power, waste, natural gas, etc.), in addition to other services. All utility services expenses are printed on a single bill. Alseco also develops software programs for more than 500 services (including public utilities) for commercial and public sector clients. Schools and hospitals can calculate their bills by using this program.

ATC runs a tender every year to contract the billing services from Alseco. The company receives a lump sum fee per service for each customer. The revenues depend on the number of bills printed. Alseco also prints the bills for Astana. People can pay the bills partially if they do not have money to pay them in full. Around 95% of the customers pay their heat/hot water bills. Overall, 80% of utility bills in Almaty are paid every month and 20% every other month. Services can be disconnected if customers do no pay the bills. First to be disconnected is the power service, followed by sewage. People can also pay their dues online or via transfers, in addition to dedicated payment counters.

3.6.2 Infrastructure

Central Heat Generation

6,731,000 Gcal of heat is produced annually in Almaty of which 75% comes from ALES and 25% from AKTE. ALES produces heat for both Almaty city and Almaty region. ALES generates heat and electricity in three combined heat and power (CHP) plants, in addition to a Heat-only Boiler (HOB). In

2015, 60% of the district heat was made of solid fuel coal. CHP-1 and CHP-3 operate mostly on natural gas (more than 90%), while CHP-2 uses coal (99.5%) and some mazut. Mazut is mostly used in CHP-3. Overall, ALES can generate 4,975,000 Gcal of heat annually - of which 24.1% by CHP-1, 64% by CHP-2, 1.8% by CHP-3, and 10% by the HOB. CHPs 1 & 2 produce both power and heat, with CHP-3 focusing primarily on electricity and only very little on heat.

CHP-1 has three steam turbines with total nominal capacity of 145 MW, in addition to six high pressure steam boilers and seven water heating boilers of 100 Gcal/hour. The plant runs 95% on natural gas and 5% on mazut, and can prepare 1,200 Gcal per hour. CHP-2 has an electric power capacity of 510 MW, in addition to 1,176 Gcal/hour. The plant generates the largest share of heat for Almaty. It operates according to the heat consumption schedule, and generates additional electric power in the steam-condensing mode. CHP-3 is equipped with three turbines with a total capacity of 173 MW. The facility focuses primarily on power generation, hence it produces only little heat. In addition, 1,100 Gcal/hour is produced at West Heat Complex (ZTK), a boiler house running 80% on natural gas and with some 20% on mazut. The heat is sent from CHP-2 to ZTK, and from here it goes further through seven heat mains to a few communities in western Almaty. The most efficient plants are ZTK (95%) and CHP-1 (81%), while the least efficient are CHP-2 (60%) and CHP-3 (38%). In the case of CHPs these figures take into consideration power generation as well.

A quarter of the centralized heat in Almaty is produced by Almaty Teplo Kommun Energo (ATKE) in 78 HOBs with a total heat generation capacity of 1,300 Gcal/hour, most of them individual units of less 100 Gcal/ hour. Only three large boilers over 100 Gcal/hour are interconnected. None of the boilers are connected to end-users. 71 boilers run on natural gas, one each on coal, diesel, and power, and two on oil. 1.7 million Gcal heat is produced every year for which 240 million m³ of natural gas is needed. The efficiency of the boilers is 90% on average. Only two boilers are new. Most of the HOBs are from the ‘60s, ‘70s and ‘80s, but they are still in good shape and perform quite well due to recent upgrades by new burners.

Almaty has also 93 autonomous boilers connected to education and health facilities in city districts that are linked to the DH system, of which 53% use solid and liquid fuels. Currently, an autonomous boiler houses is in the process to switch from coal to natural gas at its boilers in Saviour and Sanatorium Kamenskoye plateau. The heat produced by these individual boilers with local customers is ten times cheaper than the heat generated by large boilers.

8% of AKTE’s annual KZT 9 billion budget comes from the local administration in the form of subsidies for major retrofits (approximately KZT 650 million). AKTE spends around US$ 1 million to rehabilitate one boiler house. The annual energy bill to operate the HOBs is KZT 1 billion. Most of the natural gas used by ALES and AKTE comes from Uzbekistan at a special price of KZT 23/m³ (with an energy content of 9.5 kWh/m³). The coal is brought from Karaganda and Ekibastuz regions in Kazakhstan at KZT 1,800/ton (with energy content of 5,080 kWh/ton).

District Heat Distribution

The heat in Almaty is distributed by Almaty Teplovuy Seti (ATC), a company owned 100% by the city administration. The heat distribution company buys 75% of the heat from ALES and 25% from AKTE. 64% of the customers are in the residential sector and 35% in industrial and commercial sectors. ATC delivers heat and hot water to 356,569 clients in the residential sector, in additional to 470 public buildings, 600 customers from the industrial sector, and 7,638 in the commercial sector. Overall, ATC caters heat and hot water to approximately 700,000 people. Part of the heat produced by ALES is sold by ATC to the Almaty region.

However, not all buildings in Almaty are connected to the centralized heating system. Single housing units have individual heating systems based on natural gas. In some communities, households would like to connect to natural gas pipes but the volatile land prone to earthquake conditions in the region is a big impediment. A district from southern Almaty where most of the well-off people reside has some deficit of heat supply; hence, ATC must place additional boilers to transform the heat from most powerful boilers to smaller units that lack thermal energy. The district has some high demand for new heat generation and distribution capacities. A number of automated district heating points have been set up throughout the city, but they are not properly maintained. ATC owns a service company that provides maintenance service to the heating points at the building level.

The DH in Almaty is structured as a cascade system in four hydraulic zones. The network covers 1,145.8 km of which 738.3 km (approximately 64%) are worn-out. 13% of the network (153.9 km) was rehabilitated between 2008 and 2016. Individual heating sub-stations were installed in new residential buildings, including heat exchanger, temperature-based control for heat flow and heat meters. The company had installed 4,741 heat meters in multi-storey buildings, and additional 2,748 should be placed in the near future. The DH network supply pumps are located in CHPs and boiler houses, and they are all equipped with frequency control drives.

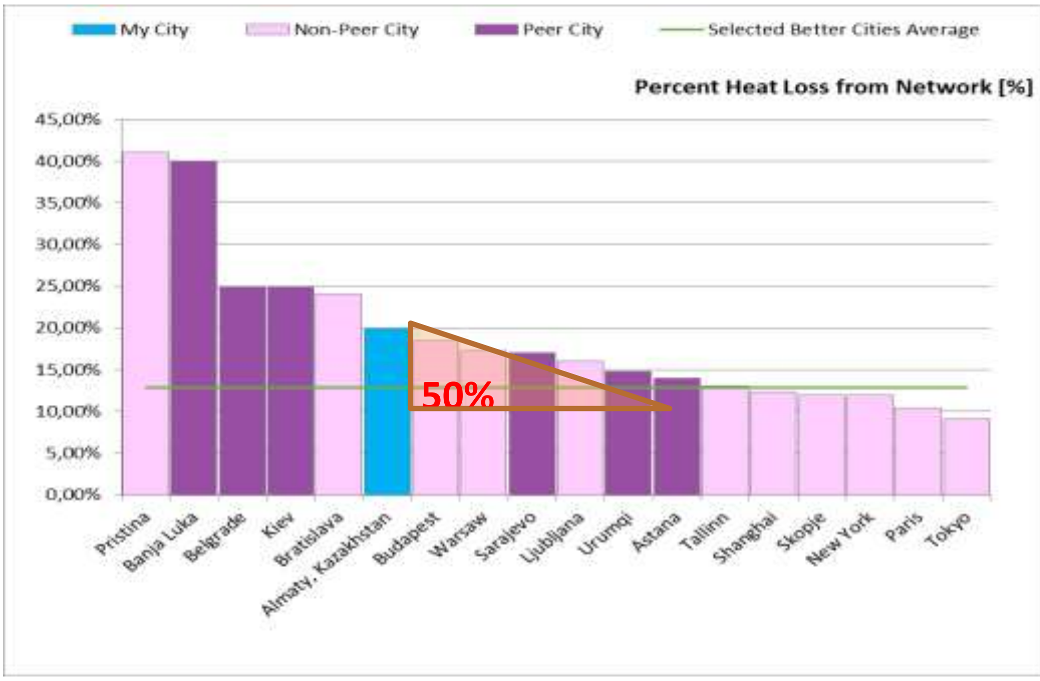
Since the heating season in Almaty lasts for six months - from October 15 through April 15 - a large amount of heat must be supplied to customers. In 2015, 5,362,779 Gcal were distributed of which 3,990,448 Gcal was used for heat and 1,372,331 Gcal to prepare hot water. Two-thirds of the total energy was supplied to the residential sector, 11% to public sector, and 25% to industrial & commercial sectors.

ATC does not receive any subsidies from the city budget for O&M of the DH network, but only for emergency case, major repairs and investments, such as rehabilitation of pipes. For example, KZT 5.9 million was spent from the local budget to upgrade 8 km of pipes. The city subsidizes around 5 to 7% of the losses, but not the tariffs. Some projects are under way, including replacement of old pipes and development of a new network. Since two-thirds of the existing network is obsolete, the rehabilitation or replacement of some of the heat pipes is an urgent matter.

3.6.3 Energy Performance

The total thermal energy produced in 2015 in Almaty amounted to 6,731,000 Gcal (7.76 billion kWh) of which only 5,363,000 Gcal was distributed to end-users. The heat losses in the system in Almaty account for 20%, including technical and non-technical losses. The figure is smaller than in Banja Luka or Belgrade, but higher than in Sarajevo, according to the benchmarking made by TRACE 2.0. The system incurs some real technical losses of 15-17%, which are below the normative losses. Main heat losses occur in the transmission network. For example, of the 36 million m^3 of hot water produced 4 million m^3 (around 11%) is lost due to obsolete, leaking pipes. The DH distribution network incurs 4,000 m^3/hour. The average fuel efficiency of the heat generation in Almaty is 79%. Heat & hot water losses due to technical losses are US$ 120 million.

Figure 24. Power losses in the network in Almaty



3.6.4 Main Challenges in the Heat Sector

Expert estimates indicate that DH in Almaty has some great potential to improve its efficiency by 50% if some interventions are made both in the generation and distribution system. Some of the HOBs that belong to ATKE could be replaced and retrofitted, while the boilers using mazut and electricity should shift to natural gas. ALES is planning to shift the heat generation from CHP-1 based on natural gas to more heat produced in CHP-2 running on coal as it is much cheaper. This should increase the plant efficiency from 60% to 80%. The Division of Energy from the city administration provides financial support for a feasibility study in this respect. To increase the heat transmission capacity by improving network heat storage and balancing, ALES needs to install 14 km of transmission pipes between CHP-1 and CHP-2 and 30 km of new transmission pipeline between ZTK and CHP-2.

ATC aims to reduce the heat losses in the network, use additional pipes to connect new customers, and expand the metering system to more customers. The main issue in the DH system is the rehabilitation and modernization of heat pipes. For example, the modernization/rehabilitation of 7 km of pipes would save some 30,000 Gcal annually. At the same time, insulation of almost 4 km pipes in addition to regulating the heat valves could reduce losses by 50,000 Gcal/year (this would require KZT 600 million investments). Automation of heat transfer, in addition to automated IHS at end-users could trigger better hydraulic balancing. The efficiency of the DH system can be further increased by setting-up solar heat plants for up-heating the losses in the network. With 300 sunny days in a year and variable cloudiness, Almaty could make use of its solar energy to pre-heat water in autonomous heating systems in health and education facilities.

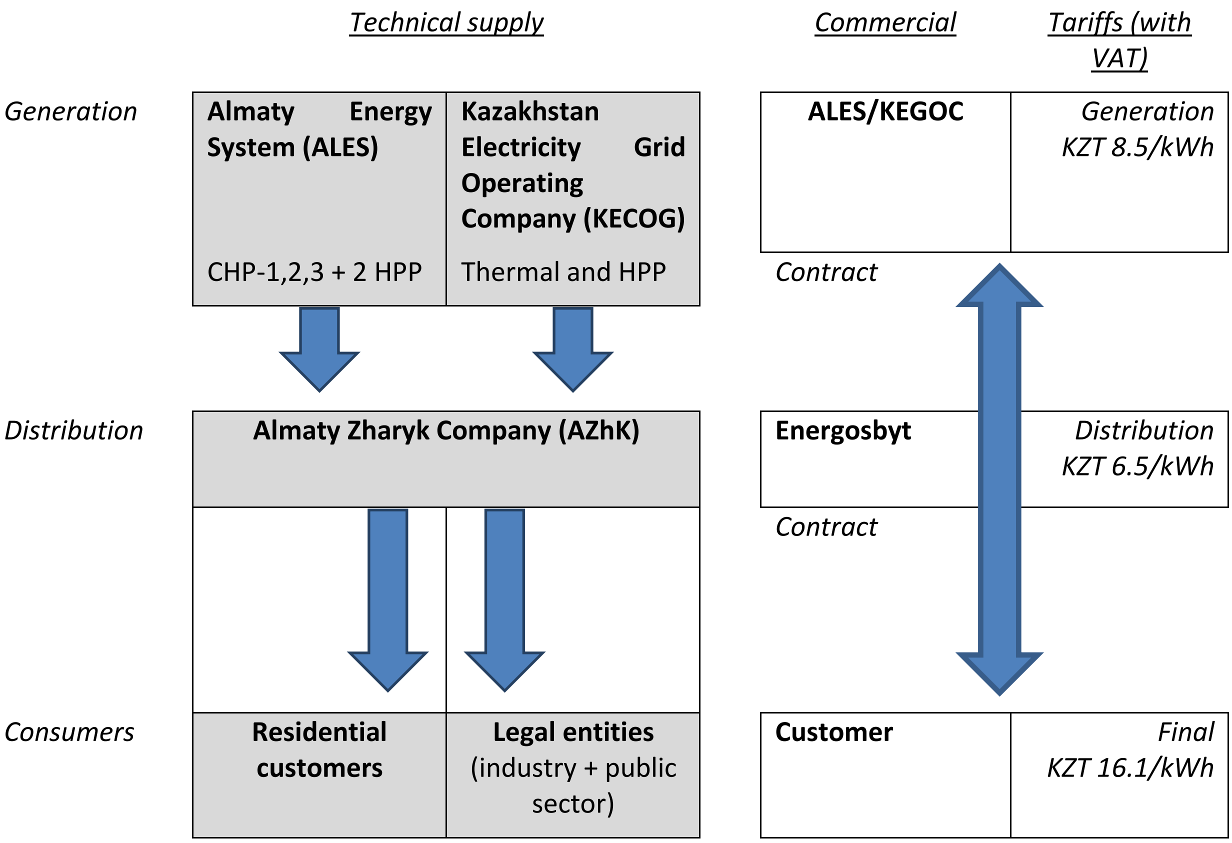
- *High wear and tear of equipment*: Most of the equipment in DH sector, like in all other utility areas (such as electricity and water) has a high rate of wear and tear. Basically, 60% of the utility equipment is more than 25 years old. Hence, one of big problems here is how to integrate modern technology in this old infrastructure and equipment.
- *Aging infrastructure:* 70% of the engineering infrastructure in the DH system in Almaty, such as TPP, substations, backbone networks, and boilers, has exhausted their service life. The old infrastructure and malfunctioning equipment can become a serious for the entire DH system and lead to frequent accidents in the network and blackouts of energy supply, like heat or gas.
- *Lack of sufficient funds:* Both ALES and ATKE have concrete plans to improve operation and efficiency of the DH system, but they do not have enough funds. Although ALES belong to Samruk-Kazyna, the welfare fund does not financially support any investments for the CHPs. Since the city administration does not provide ALES with funds either, then the heat plant must rely solely on revenues from energy production. Although ATC, the distribution company, is owned by the local government and money for major repairs is allocated from the local budget, these funds are very limited as compared to the needs. Since two-thirds of the network is obsolete, heat pipe rehabilitation or replacement is an urgent matter that should require money from both local and national budget.

3.7 Sector Analysis - Power

3.7.1 Institutional Framework

There are several players in the power system in Almaty involved in generation, distribution and billing. Around 63% of the power in the city is generated by Almaty Power Stations (ALES) and 37% is purchased from State Kazakhstan Electricity Grid Operating Company (KEGOC). The technical distribution of electricity to end-users is done by Almaty Zharyk Company (AZhK), with Almaty Energosbyt covering the commercial side. Like for heat and other utilities, Alseco is responsible for the power bills. The power system is regulated by the Energy Law and the AMNRA. The Almaty administration is a stakeholder in the local electricity sector since it owns some of the power-substations.

Figure 25. Structure of power generation and distribution in Almaty



3.7.2 Infrastructure

Power Generation

In 2015, the power coverage was 100% in the city center, with some deficit in a few communities in south Almaty. KEGOC delivers annually 2.8 TWh from the thermal power plants, of which 90% from the Pavlodar-Ekibastuz facility and 10% from the hydropower plants from the Almaty region.

ALES produces 10,100 GWh of energy, of which 57% is thermal energy and 43% is electricity. Overall, more than 4,300 GWh of electricity is produced in the power plants owned by ALES. 60% (2,546 GWh) of power is produced in CHP-2 running on coal and with overall 40 MW capacity. CHP-1 has 102 MW capacity, and it can produce 355 GWh year (8.8% of the total power). With an installed capacity of 173 MW capacity, CHP-3 focuses more on power generation as it produced 27% of the electricity in the city, i.e., 1,135 GWh (only little heat which is supplied to small settlements). The natural gas used to generate power comes from Uzbekistan, while the coal is supplied from Karaganda and Ekibastus regions. While CHP-1 operates in co-generation, CHP-2 can produce electricity without generating heat.

Although some new equipment was installed, most of the turbines and boilers are old, with more than 200,000 hours in services and should be modernized. For example, all six boilers and two of the three turbines that are part of CHP-1 were commissioned in the ‘60s and ‘70s. Two of the six turbines in CHP-2 are over 35 years old, while CHP-3 with its six boilers and four turbines was commissioned in mid-60s. CHP-1 requires annually some 200,000,000 m^3 of natural gas, 25,400 tons of coal and 1,400 tons of mazut. CHP-2 generates the bulk of power and heat for Almaty – 3.2 million Gcal and more than 2,500 GWh of power – and needs 2.23 million tons of coal and 5,200 tons of mazut. The CHP-3 runs mainly on natural gas, using 210 million m^3 of natural gas and 8,800 tons of mazut. Expert estimates indicate that overall, the power and heat generation system in Almaty requires 18,814 GWh of energy input, of which 61% is coal (2.26 million tons) and 38% is natural gas (755 million m^3).

Power Distribution

The physical distribution of power stays with **Alatay Zharyk (AZhK)**, an entity owned by Samruk-

Energy. AZhK caters to 91% of users in Almaty, namely 781,000 customers of which 35% in the residential sector, up to 30% in the industrial sector, 30% in the commercial sector, and 5% in the public sector. The remaining 9% of consumers comprising of large industrial companies are supplied directly by KECOG.

The average annual electricity load in Almaty is between 600-700 MW. So far, the city did not have power shortages. But the expected city expansion and population growth in the future would require additional 700 MW generation capacity. According to AZhK, while consumption in the residential sector came down by 10%, it went slightly up in the industrial sector. The energy consumption diminished from 6 billion/kWh in 2014 to 5.85 billion kWh in 2015 due to the economic crisis that had affected the local industry. Until then, the industry used to be the main power user in Almaty.

AZhK operates the medium and low voltage power network of 0.4 KV and 10kV to 35 kV. The company supplies electricity to residential, public, and commercial clients sector via 237 power sub-stations of which 209 belong to AZhK and 34 to the city administration. The power is distributed for KZT 5.83/kWh, a tariff approved by AMNRA. Although is responsible for the physical rehabilitation of the supply network, AZhK does not deal with commercial electricity losses.

While AZhK is responsible for the technical power distribution**, Almaty Energosbyt** deals with the commercial supply. A 100% commercial entity, Energosbyt buys electricity from AZhK and other sources, including Kyrgyzstan, and then sells it to clients from the residential, commercial and public sectors. Of the 6,886 GWh power produced in 2015, Energosbyt has billed 5,771 GWh. The largest share of 40% went to the commercial sector, about a third to the residential sector, 22% was supplied to the local industry, and 3.9% to the public sector.

The power incurs technical losses because of old equipment. The bulk of transformers are 30-40 years old. Most of the transmission lines are of 0.4 KV and incur the highest losses. In 2010 losses in the distribution network were 26%, but came down to 16% after some of the 6V transmission lines and transformers were replaced during 2010 and 2015. The company plan on further reducing the losses to 12% by 2020. Since it owns the old substations, the city should cover the rehabilitation of this network from the local budget. AZhK distributes meters to end-users.

Energosbyt has introduced differentiated tariffs in an attempt to balance the power cuts during peak hours. There are three tariffs applied for population. The lowest tariff is in the nighttime after 9 PM - KZT 5.08, when people prefer to use the washing machines. Just like in the DH sector, electricity tariffs are regulated by the AMNRA. New tariffs were enforced in 2017 for a five-year period.

Table 8.Electricity tariffs in Almaty - KZT/kWh (including 12% VAT)

Type of customer	Daytime tariff (7 AM to 11 AM)	Nighttime tariff (11 PM to 7 AM)	Peak hours tariff (7 PM to 11 PM)
Public Buildings and Street Lighting	23.12	5.08	-
Industry and utilities (District Heating, Water)	18.03	5.08	37.72
Residential Sector	Up to 90 kWh per person/month)	90-160 kWh/month	Above 160 kWh/month)
Households	16.02	21.64	27.05

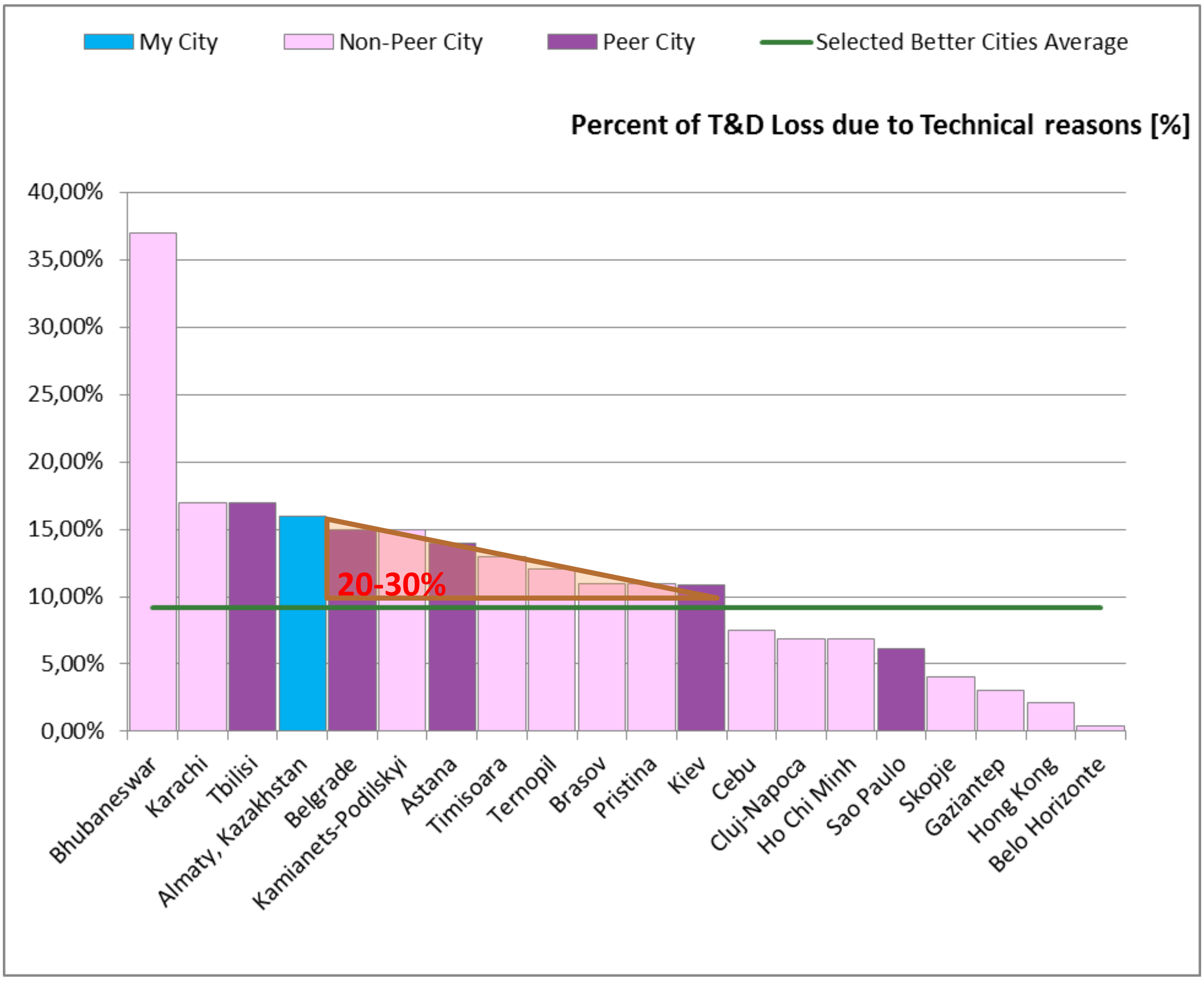
According to local authorities, 1,104 power outages are identified every year in the 6-10 KV distribution network. The power supply system in Almaty incurs high losses, and has high level of wear and tear due to old infrastructure. Almaty has one of the most obsolete power distribution infrastructures in the country. The network has deteriorated dramatically between 2013 and 2015. Only 5% of power distribution network was rehabilitated or upgraded in recent years. The rehabilitation work was able to reduce losses from 15.7% in 2013 to 14.3% in 2015.

3.7.3 Energy Performance

According to AKhZ, while power consumption in the residential sector came down by 10%, it slightly went up in the industrial sector. Consumption somewhat came down since 2014 - from around 6 billion kWh to 5.85 billion kWh in 2015.

In 2015, Almaty produced 6.86 billion kWh of which 17% were losses. Technical losses account for 16% (a little over 1 billion kWh), in addition to 1% (64.7 million kWh) commercial losses. Technical losses in the power system in Almaty are comparable with those in Tbilisi, but they are slightly higher than in Belgrade and almost twice bigger than in Kiev. Expert estimates that the power generation system is less efficient than the heat production - 61% vs. 79%. Most of the losses (491 GWh) occur in the 6-10 KV network. Financial losses in the power sector in Almaty are around US$ 400 million/year.

Figure 26. Technical Losses in the Power Sector in Almaty

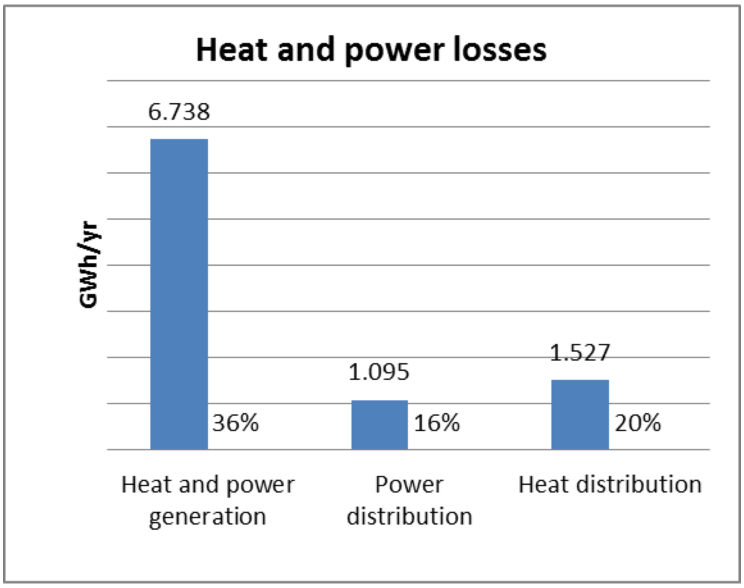


The TRACE 2.0 analysis has identified 30% theoretical energy savings potential to improve efficiency of the power sector in Almaty, a figure which subsequently was reviewed to a more realistic 20%.

3.7.4 Main Challenges in the Power Sector

The overall losses of district heat and power production and distribution amount to 9.4 billion kWh primary energy in 2015, which represents 22% of the city-wide Primary Energy Consumption (PEC).

Figure 27. Primary energy closes in district heat and power generation and distribution



An energy audit performed by an independent company in 2014 outlines a few measures to increase efficiency of the heat and power generation facilities in Almaty. ALES has a five-year EE plan to increase efficiency by 4% to 5% for KZT 5 billion investments (US$ 22.5 million).

Some measures target the generation system, while some focus on the power supply network. ALES plans to install gas-based turbines in CHP-1 to shift production from coal-based to natural gas. The company also considers replacing the steam turbine and the 4 MW pumps. Some EE interventions could reduce transformation losses and operation costs by upgrading the 6 KV network, installing automated systems, and replacing the 35 KV substations with 10 KV substations. As of now, only 0.1% of the electricity in Almaty is renewable energy (RE), but the local administration has ambitious plans to increase this figure by 10% by 2030. Anyway, integration of RE into the grid and power distribution system would pose some challenges in terms of balancing and quality of power. Besides some technical interventions, ALES can implement an operational management plan to monitor energy consumption that would not require additional investments.

- *Old infrastructure and equipment:* The power supply and transformation network in Almaty is quite old, and needs to be upgraded, while part of the infrastructure should be replaced.
- *Insufficient funds:* Since it does not get any money from Samruk, the owner of the power holding, the company must rely more or less on its own sources for any improvements in the power and heat system. First, usually the money is allocated for maintenance and repair works, and if funds are still available, they can be used for investments. Alternative funding sources could be loans from commercial banks or other financial institutions, while some grant applications from the city administration could help cover major retrofit and specific extension of network. The city government is funding a feasibility study to assess ways to increase efficiency and capacity of CHP-1 & 2.
- *Uncertainty in future planning:* Almaty is expanding its territory, the population is growing, and so the existing infrastructure will soon not be able to meet the demand. The key stakeholders in the power and heat sector wait for the local authorities to unveil the city development plan for the period up to 2030, as to get some clarity about the developments in the city in the next decade. The analysis should indicate more details about the city territory expansion, so the utilities could plan how to develop the infrastructure accordingly. Preliminary forecasts indicate that by 2030 Almaty should have 2.7 million residents, which would require additional 700 MW installed capacity. This would require additional generation facilities and equipment, as well as power transmission and transformation network.

Natural Gas Supply

The city-wide natural gas consumption in 2015 in Almaty was 49 million m³. Natural gas is supplied to end-users by a 5,000 km of distribution network. 43 % of the natural gas is used to generate heat, 35% goes to the residential sector, 15% to the industry and commercial sector, while municipal buildings use 0.8%. More details about the natural gas supply in Almaty is provided in Annex 4.

3.8 Sector Analysis - Potable Water

3.8.1 Institutional Framework

The water system in Almaty is operated by three entities grouped under Almaty Su holding, a company under the city administration. Bastay is responsible for water production, Su Zhelisi for water distribution to end-users, while Tospasu is in charge with wastewater (WW) and sewage services. Although they belong to the same holding, these companies have different management, as well as and own strategies and investment plans. The water sector is monitored and coordinated by the Division of the Housing and Communal Service of the Almaty City Hall. All investments in the water & wastewater sector are subject to prior approval from the city administration.

3.8.2 Infrastructure

There are four water sources for Almaty, namely two rivers - Big and Small Almaty - and two underground water intakes of Almaty and Talgar fields. In 2015, the water coverage in the city was 95%, except for the Nauryzbai neighborhood where only 15% people have access to potable water. Water is catered to 1.6 million people in Almaty, with a total of 623,185 water connections. Su Zhelisi caters directly to 80% of the city customers, while 20% is delivered to downstream water distribution entities, such as condominiums, cottages, industrial parks, etc.

Water is pumped from the main water reservoirs by 10 pumping station, in addition to 43 well pumps. Most well pumps are new, but they are not equipped with variable speed controllers. The water distribution company Su Zhelisi use 156 well pumps located in different areas in the city. The water transmission network managed by Bastay has 124 km, while Su Zhelisi covers almost 3,000 km of distribution pipes. Not everywhere in Almaty the quality of water meets the standards. And that is primarily because the distribution water supply system at district levels was built by the residents without complying with the SNIP construction requirements.

The residents of Almaty consume 141 liters of water per capita per day, which is rather a small figure compared to other cities in the TRACE database with similar HDI. The city produces 140 million m^3 of water annually. The water consumption came down by 3% during the 2013-2015 period. The residential and commercial sectors are largest consumers, using almost a half of the water produced. Power & district heating and air conditioning producers are the second largest user, with 50 million m^3 of water, while the manufacturing sector needs only 4.2 million m^3 of water. 86.9% of the city residents have individual water meters, mostly in residential buildings. However, only three-quarters of the overall users have water meters. Additional 76,000 meters are necessary to cover the demand.

The water losses in the system is 37%, of which technical accounts for 60% and non-technical for 40%. The losses are higher than in comparable cities – for example, they are below those in Tbilisi and Banja Luka, but five times higher than in Kiev. Water losses are not metered at end-users, and they are above the norms, especially in single houses and suburbs. According to the Almaty Development Plan, 40% of the losses are incurred at the level of customers' network, mainly because of the poor condition of the water pipes. 65% of pipes have already reached their end of life cycle, they are worn out and sustain leakages. There are also some problems with the collection of revenues, since not all city residents pay their water bills in time.

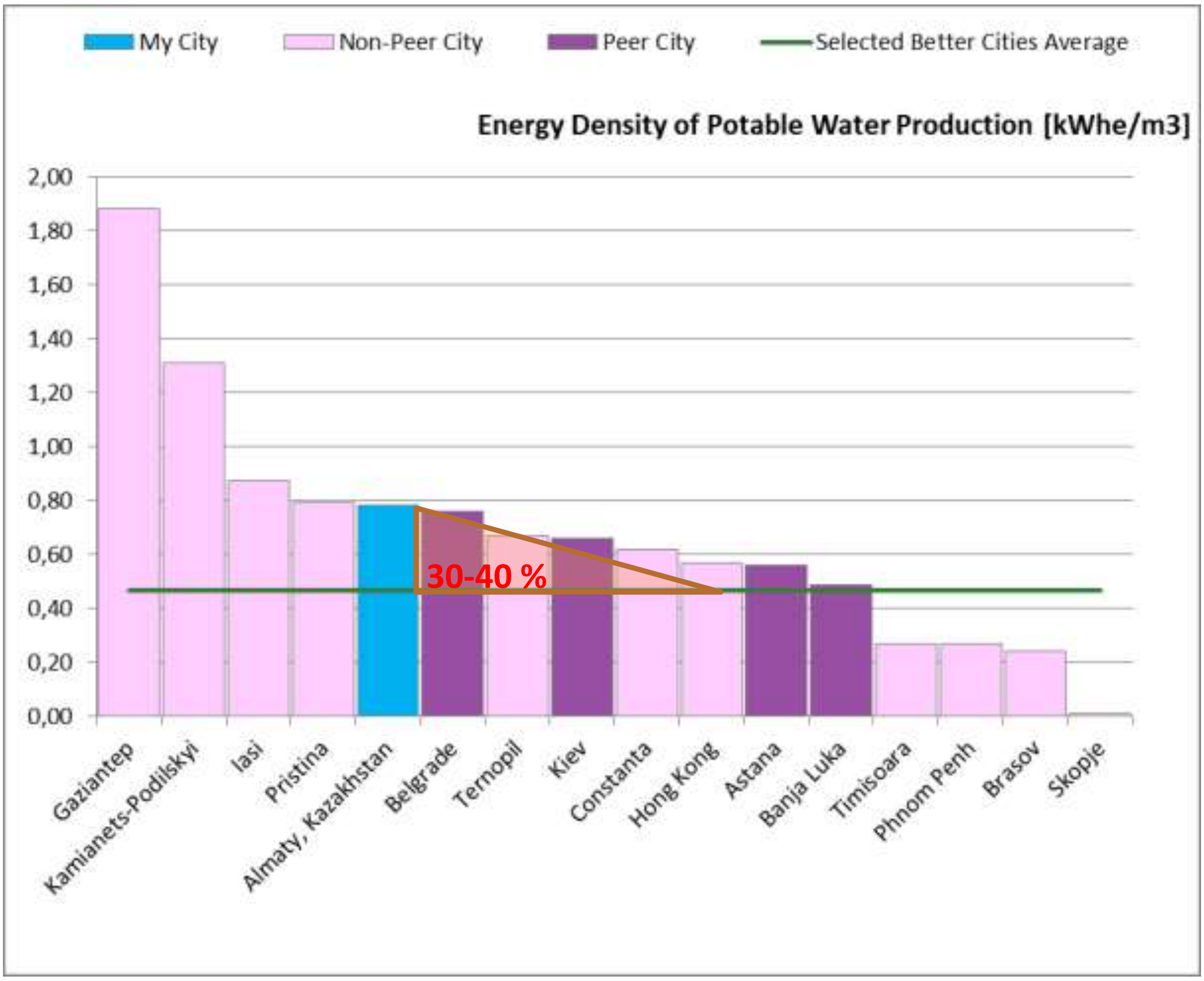
Annually, the city allocates from the local budget KZT 1 billion/year (US$ 4.5 million). Between 2006 and 2014, some of the water pipes and pumping stations were rehabilitated through government-supported credit lines with a grace period of 10 years.

Water tariffs must be approved by the ARNM and are differentiated by types of consumers. Water is billed based on a flat rate, and includes the water losses. As of December 2015, the average water and sanitation tariff in Almaty is KZT 93 per m^3. The residential sector pays the lowest tariff, i.e., KZ 50/m^3 (without VAT), while clients from the public sector, commercial and industry almost three times more - KZT 136/m^3. The water operator can make some profit. The investment returns are possible primarily because of the high tariffs applied to most clients (except for the city residents).

3.8.3 Energy Performance

Overall, in 2015 Almaty required 109 million kWh of electricity to produce 140 million of m^3 of water. This would come to 0.77 kWh of power used to produce and deliver one cubic meter of water. The water system in Almaty is quite high energy intense because it needs power for both pumping and distribution. The energy consumption is similar to Belgrade, but higher than in Kiev or Banja Luka.

Figure 28. Energy density to produce potable water in Almaty



The water holding pays 16 KZT for one kWh of power. The annual cost of electricity necessary to produce and distribute water in Almaty is KZT 1.7 billion (US$ 7.6 million). The water production related expenditures (including energy) are around US$ 18.8 million, while the expenses with the water distribution are twice higher (US$ 43.2 million). The total cost for the water and wastewater utility in Almaty is US$ 85.3 million. Of this, US$ 9.2 million covers the energy bill, which accounts for 11% of the total water utility operation expenditure.

3.9 Sector Analysis - Wastewater

3.9.1 Infrastructure

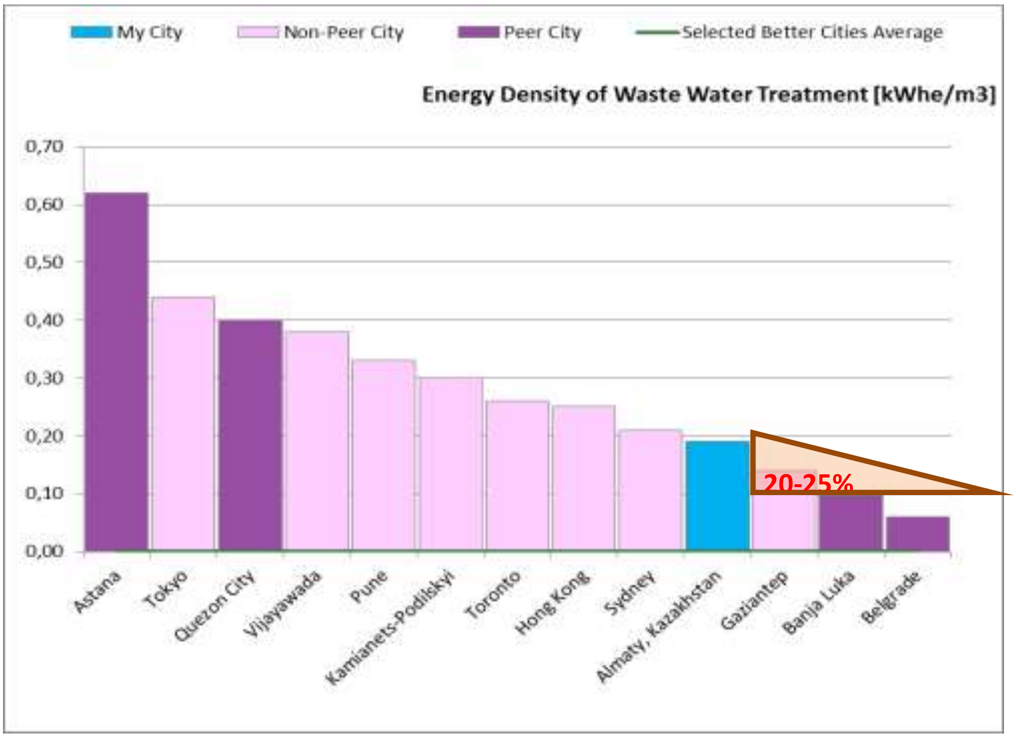
Only 74% of the city residents are connected to the 1,525 km of sewage network in Almaty. There are 488,735 connections to the sewage system, covering 1.24 million people. The coverage is 100% in downtown area, but only 50% in the suburbs. The Nauryzbai neighborhood has its own system of 8.9 km, which is 6% of the total length of the sewage network. The sewage network gets depreciated by approximately 2% per year. For example, in 2015 64% of the sewage pipes were worn-out as compared to 59% in 2012. Most of the network is more than 50 years old. According to the Almaty Development Plan, the level of wear and tear of the sewage network in Almaty is three times higher than in other comparable cities.

Only 98.6% of the total wastewater (WW) produced in Almaty is treated (125.4 million m^3). 19 pumping stations drive the wastewater to collection points and then further to the only one treatment plant in the city, overflowing into to Lake Balkhash. 12 of the pumping stations have been modernized in recent years. The WW treatment plant is equipped with mechanical and biological treatment and has a capacity of 640,000 m^3 daily. The plant treats WW coming from Almaty, in addition to some comming from nearby mountain resorts and the cities of Talgar and Kaskelen. As of now, the facility cannot produce biogas, but there are plans as such in the future. Since the capacity of plant will not be able to meet the demand in the near future, due to population and city growth, a new facility is already under planning.

3.9.2 Energy Performance

Almaty uses 0.19 kWh of power to treat one m^3 of WW, which is less than the amount used in other cities with similar HDI, according to the benchmarking using TRACE. Almaty needs less energy than Quezon, for example, but twice more than Banja Luka or Belgrade. Annually, the city uses 24.3 million kWh of power to treat wastewater. At 16.6 KZT per kWh of electricity, this is some 380 million KZT (US$ 1.7 million). Residents pay KZT 26 for one cubic meter of sewage (US$ 0.11), while public and other entities KZT 47 (US$ 0.21). 30% of revenue comes from the residential sector, and the rest from the public and commercial sectors.

Figure 29. Energy used to treat one cubic meter of wastewater in Almaty



3.9.3 Main Challenges in the Water & Wastewater Sector

The TRACE 2.0 analysis based on benchmarking with peer cities shows that the potable water system in Almaty has 55% potential energy savings, and 21% for the WW system. However, experts had review this potential based on field observations and interviews with water stakeholders to more a realistic figure of 30% for potable water and 10% for WW.

Since most of energy is consumed for pumping and water distribution, one of the key EE measures to help realize the savings potential is equipping the remaining seven pumping stations with variable speed controllers. Such speed controllers are essentially for any green potable or hydronic water pumping system; this not only helps reduce energy and related costs, but also can extend the life-cycle of the system and increase its efficiency. The rehabilitation of a third of the water network in critical condition by replacing the obsolete leaking pipes could reduce the water losses and improve overall efficiency of the system. Increasing the capital repairs could not only diminish the number of accidents in the system, but also reduce the depreciation level of the pipes, as well as overall losses in the network. The city should continue expand the metering program to all customers. By installing digesters to produce biogas at the WW plant could reduce the amount of energy necessary to operate the facility.

- *Long distance to water sources:* Since water sources are not located in the city, water transmission requires adequate infrastructure and a large amount of energy to pump it all the way to end-users. Given this, even if the pumping system would be modernized this would not reduce significantly the expenses related to water distribution.
- *Old water/WW infrastructure* – One of the main issues in the water system in Almaty is the old water network. One-third of the potable water distribution pipes and one-third of the sewage network are in critical condition. The obsolete, poorly insulated pipes are the main culprit for incurring one-third of losses in the water network.
- *Water losses:* The aging water network poses a serious challenge for energy savings. Water losses are reflected in the energy bill. More energy used for pumping but less water sold is translated eventually into commercial losses. Replacing the water infrastructure and insulating of part of the pipes would help reduce the water losses, and hence save energy.
- *Lack of funding:* Perhaps the biggest challenge in the water sector in Almaty is the lack of funds to make significant improvements in the water infrastructure. The annual investment budget of US$ 4.5 million is not enough to cover the needs in the water sector. The water tariffs and other revenues cannot cover the expenses for key interventions. Hence, most of strategies and investment plans are rather on paper with little chance of being actually executed. For example, the WW operator has plans to produce biogas at the WW treatment facility, but it does not have the money. A biogas plant with 0.5 MW capacity needs KZT 4.5 billion investments (US$ 20 million). The pre-feasibility study indicates a seven-year payback time for the bio-gas plant. However, neither the water holding nor the city has the money to initiate the project, and they could support from the private sector. The local government could assess options to improve and expand the water system in the city, like using a 25-year loan under Nurly Zhol program (with six-year grace period and small interest rate) or upgrading pumping stations and building new water pipes via government credit lines.
- *Low tariffs* –For any investments the water operator must rely primarily on its own funds since there are no subsidies from the city budget. The water tariffs for residents, who are the largest share of clients, are artificially kept low for social reasons, and so water revenues are quite limited. There is little money for investments, and often time it gets postponed. The lack of funds also prevents ensuring an adequate maintenance of the water network.

3.10 Sector Analysis - Municipal Solid Waste

3.10.1 Institutional Framework

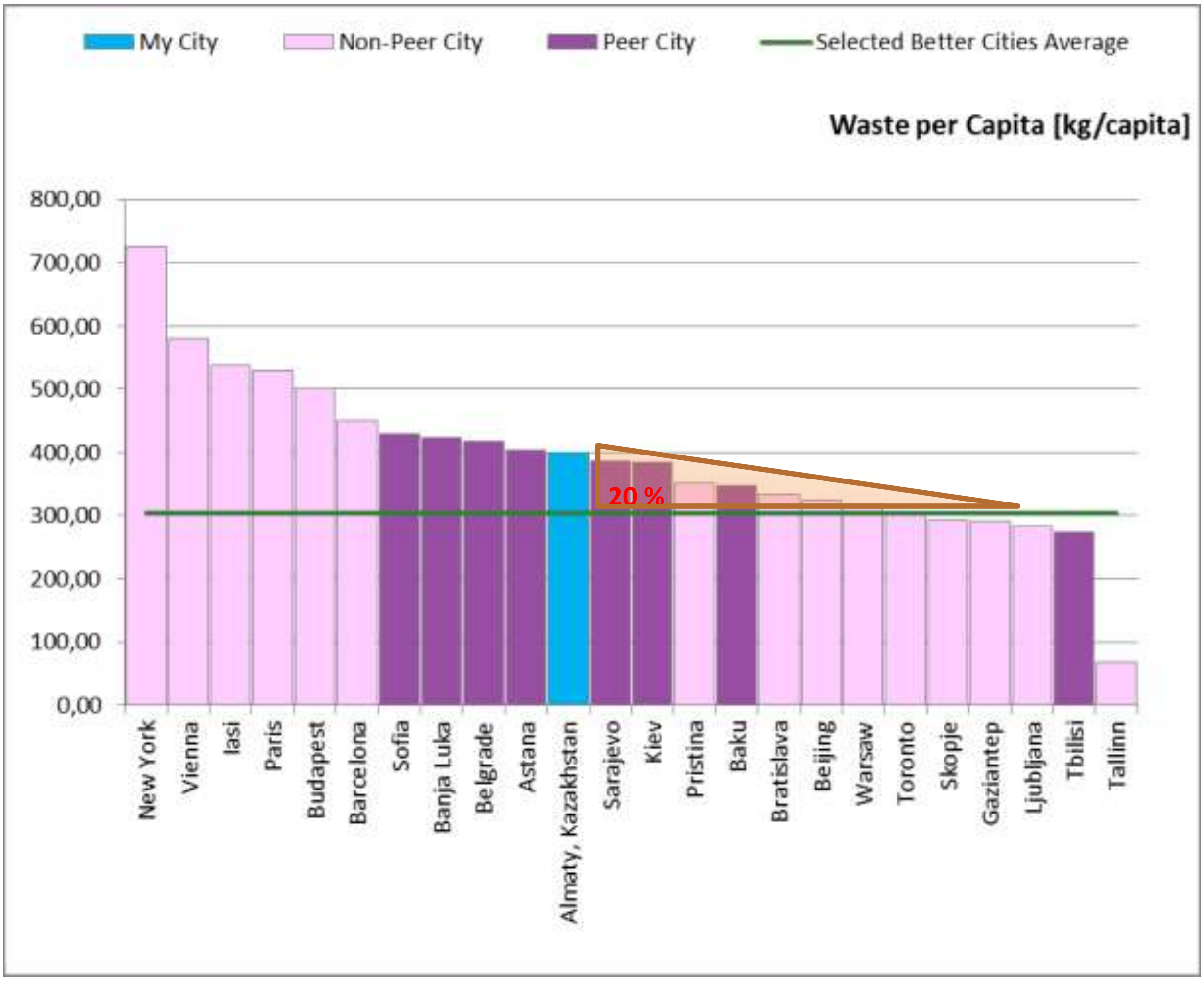
Municipal solid waste collection (MSW) and management in Almaty is organized under 32 private operators, and one public entity that belongs to the city administration. As per the Environmental Code of Kazakhstan, city authorities must monitor collection and disposal of MSW. The MSW in Almaty is supervised by the Division of Natural Resources of the city administration. The MSW operators have a three-year agreement with the city government. Waste collection fees are issued and managed by Alseco in one single bill covering all utilities.

3.10.2 Infrastructure

SMW accounts for 95% of the total waste in the city, with the rest comes from industry and other sectors. MSW collection and management is split between private and public operators. The largest operator is Tartip, a private entity with 30% shares from the city government. The company has 70% market share and collects garbage from residents using 238 waste trucks. 10% of the total waste fleet in Almaty is CNG vehicles.

Almaty generates 399 kg of waste per capita, a figure which puts the city in the middle of the TRACE 2.0 database compared with peers with similar HDI. This amount is slightly smaller than in Sofia and Belgrade, but higher than Baku or Kiev. Solid waste operators cater to 522,033 customers/households. Trash is picked from the city residents every other day.

Figure 30. Waste generation per capita in Almaty



Currently, there is no waste recycling in place at the household level. There has been an attempt to introduce recycling under a pilot program to separately collect plastic, paper, and glass and subsequently send them to two sorting/recycling facilities in the city. However, due to lack of economic incentives, weak technical equipment, and unavailable domestic market for recycling, the project was suspended. As of now, some sorting is done manually at the landfill. In addition, a few dedicated recycling trash bins were installed throughout the city for plastic and metal, but people do not place the items accordingly. Although there are penalties for misplacing items in trash cans, they are not actually enforced. Almaty has two sorting stations with a capacity of 450,000 tons, with actual annual processed waste of some 50,000 tons (7% of the total waste collected). There are plans to build a new sorting facility near the district heating plant. Currently, Almaty has a transfer station nearby the district heating plant, located 10 km away from the city center.

All MSW generated is captured. 93% of the MSW generated goes to the landfill, and a small amount to proxy facilities. The landfill is a private facility 35 km away from the city center, in the in Karasai district. It receives 1,200-1,500 tons of waste dxaily, while additional 400-500 tons per day is dumped to a mini landfill nearby. Most of the factories from Almaty bring the waste directly to the landfill. Approximately 680,000,000 tons of garbage is disposed annually at the landfill. The landfill has an adequate capacity to receive garbage in the next 10-15 years, and could extend it by another seven years. However, the city expansion and population growth should increase the amount of waste generated -- to 800,000 tons in 2017 and 900,000 tons in 2020 (25% up as compared to 2015). Preliminary estimates from the city development plan indicate that the landfill has already accumulated some 10 million tons, and the facility gets rapidly filled in because of lack of recycling.

There are some 7,600 public waste containers of 1.1 m³ volume each, 1,373 containers yards, and 1,000 containers of 0.75 m³ capacity installed in the chutes (trash rooms) of the condominium buildings. People pay a monthly charge of KZT 341 for waste collection services, while the legal entities must pay KZT 1,412 per m³. Individual households are charged by cubic meter of waste.

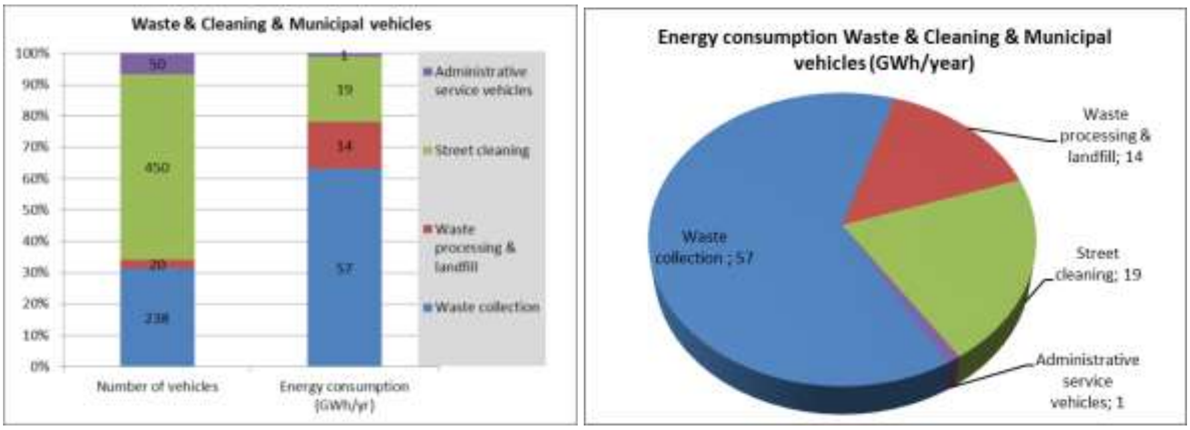
The local administration provides street sanitation services through the city-owned company, Tazaluk. The company uses 450 vehicles to clean the streets and public places, like markets and parks. They also water the public areas in the summer and remove the snow from the streets in the winter. In addition, the city administration operates some 50 cars for administrative services.

3.10.3 Energy Performance

Expert estimates indicate that Almaty needs 91 GWh per year of fuel to operate the vehicles for street sanitation and waste collection and disposal, translated into KZT 925 million (US$ 4.16 million). 71 GWh is used for collection of waste and processing garbage at the landfill, while 20 GWh is for street sanitation and other activities related to this sector. Almost two-thirds of the energy in the SWM sector is spent for collection activities.

This study has identified 758 vehicles involved in the waste sector in Almaty, including for street sanitation. The city administration set some requirements for waste trucks. 10% of the waste trucks in Almaty are CNG vehicles. 450 trucks dealing with sanitation activities use 19 GWh of energy per year, which is only 20% of the total energy consumed in the sector (see Figure 31 below). The waste fleet requires more than half of the overall energy used in the sector.

Figure 31. Energy consumption for waste collection and street sanitation in Almaty



3.10.4 Main Challenges in the Solid Waste Sector

The TRACE 2.0 benchmarking against comparable cities with similar HDI shows that the theoretical energy savings potential for the solid waste sector in Almaty is 14%. However, the actual potential based according to expert estimates is slightly higher. 20% energy savings can be actually achieved in the MSW in Almaty by replacing some of the waste fleet with more efficient vehicles, development of a modern transfer station and a facility for waste incineration. The amount of garbage disposed at the landfill can be reduced by merely introducing a genuine separate collection program for recyclables at the household level. Less waste at the landfill should translate into less energy for waste management.

The city has already a plan to improve SWM system on the short and medium term, in line with the draft State Program on the Development of the SWM–2020 that set a 50% target for recycling and places all waste activities (e.g., collection, transportation, disposal, and management) under one single operator. On the medium run, the recycling rate should go up to 75% by 2020. Almaty is planning to build a landfill gas extraction with 10 MW generation capacity and a waste-to-energy (incineration) plant of 80-100 MW capacity, and sell the energy produced to the power & heat utility.

While the city managers are committed to improve SWM through both policy and infrastructure devlopment, the sector is facing several challenges that could hinder these plans.

- *SWM system is not integrated*: There are too many players in the waste sector in Almaty, with very little or no coordination among them. Overall, there are 30 active waste collection companies. Also, Almaty struggles with inadequate quality of waste collection services, and both local authorities and waste/sanitation operators make serious efforts to keep the city clean, in line with sanitary standards.
- *Limited funds and low tariffs*: The tariffs for waste collection and disposal services are pretty low. A waste collection and management fee of KZT 341/month/person can hardly cover the operation costs. The waste fees should increase, since these are the only funding source. Additional revenues could be made from recycling waste and waste-to-power generation.
- *Limited recycling:* Almaty does not have adequate waste selection arrangements. The process is at its very early stage, with only few households taking part to the separate waste collection system. Although some waste sorting/recycling capacities are available, these are not fully operational. The city has some ambitious plans to reduce the amount of waste sent to the landfill and increase the share of recycling.

3.11 Sector Analysis - Public Transport

3.11.1 Institutional Framework

The public transport (PT) in Almaty is coordinated by the CA, through the transport division. While the CA owns the fleet and the infrastructure, the rolling stock is operated by 19 private operators. The Division of Natural Resources of the CA oversees and monitors the transport operators. The metro system is operated by the CA and managed by a special entity.

3.11.2 Infrastructure

PT in Almaty is organized under buses, trolleybuses and metro. The over-ground fleet has 1,535 vehicles of which 1,320 buses and 200 trolleybuses. The bus fleet comprises medium-sized vehicles of 10 to 12 meter length, organized under nine depots and operated by 19 private transport companies. The city has 96 bus routes covering 1,964 km and 2,000 stops. In recent years, the CA undertook steps to improve the PT system by purchasing several ecological vehicles. Some vehicles are made in China, while some by Kazakh manufacturers. The cost of one ecological bus produced in Kazakhstan is approximately US$ 340,000. Half of the buses are owned by the city, while the other half has been leased out by the city to private operators.

55% of the fleet is CNG buses, while 40% (585 vehicles) use Diesel, mainly Euro 5 and 6. All 734 CNG buses are owned by the city and operated by a private entity, Green Bus Company, under a five-year lease. The company has an option of purchasing the vehicles after the end of the contract. Green Bus Company holds more than half of the market share. The city commissioned the last batch of new 200 ecological buses in 2014, with financial support from the local budget and Qazak Banki. 35 environmentally fuel Daewoo buses were delivered in June 2016.[31] CNG vehicles get fueled from give stations located in the depot and a few places in the city. Overall, 10% of the vehicles are less than 15 years old, 17% is between 5 and 10 years, and almost two thirds are quite new, are up to five years. The city has a few dedicated bus lanes.

There are 169 trolley buses in service, with an average life of 11 years, on eight routes covering 120 kilometers of network. They are also operated by Green Bus Company. The frequency of buses is between 5 and 15 minutes, depending on the time and the route. Buses and trolleybuses operate from 5:30 in the morning until 10 in the evening.

The metro system has become functional in 2012, and is operated by Almaty Metropolitan, an entity under the CA. There is only one metro line that covers 11.3 km/8.6 km, with nine stops in the downtown area. The metro operates with seven new trains of two-three years old running every 15 minutes, from 6 am to 11 pm. 40,000-50,000 passengers rely on metro daily during the week, and 18,000 during the weekend. The metro system is equipped with escalators and elevators for disabled people, and also has tactile paths for visually impaired passengers.

E-ticketing was introduced in Almaty in 2014. There are two types of e-cards - one for regular passengers and one for special/vulnerable groups. Overall, 900,000 people use buses and trolleybuses for their daily trips; three-quarters are paid with smart trip cards and 25% via paper tickets. The cost per trip is KZT 80 for both ground and underground transport. While it does not provide the operators with subsidies, the CA provides free transportation to war veterans and elderly beyond 75 years old and offers 50% discount low income groups.[32] Where students are in town, the city pays KZT 288 million/month in subsidies and KZT 209 million/per month in the summer where schools are closed for the summer break.

[31] Ecological CNG buses available at: http://astanatimes.com/2016/06/green-buses-introduced-in-almaty/

[32] More info available here: http://astanatimes.com/2015/10/almaty-public-transport-introduces-new-electronic-ticketing-system/

According to the TRACE 2.0 benchmarking, 45% of the daily trips in Almaty are made by PT, 52% by private cars, and only three percent of the city residents walk or use bikes. The PT share for Almaty is comparable to Sarajevo and Tallinn, it is smaller than in Bucharest and Belgrade, but higher than in Sofia or Tbilisi. Until a few years ago, most people would rather use their own cars for their daily commutes. But in recent years there has been an increasing tendency to shift to PT. For example, in 2016 the number of passengers went up by 15% as compared to 2015 (12.6 million v. 10.6 million).[33]

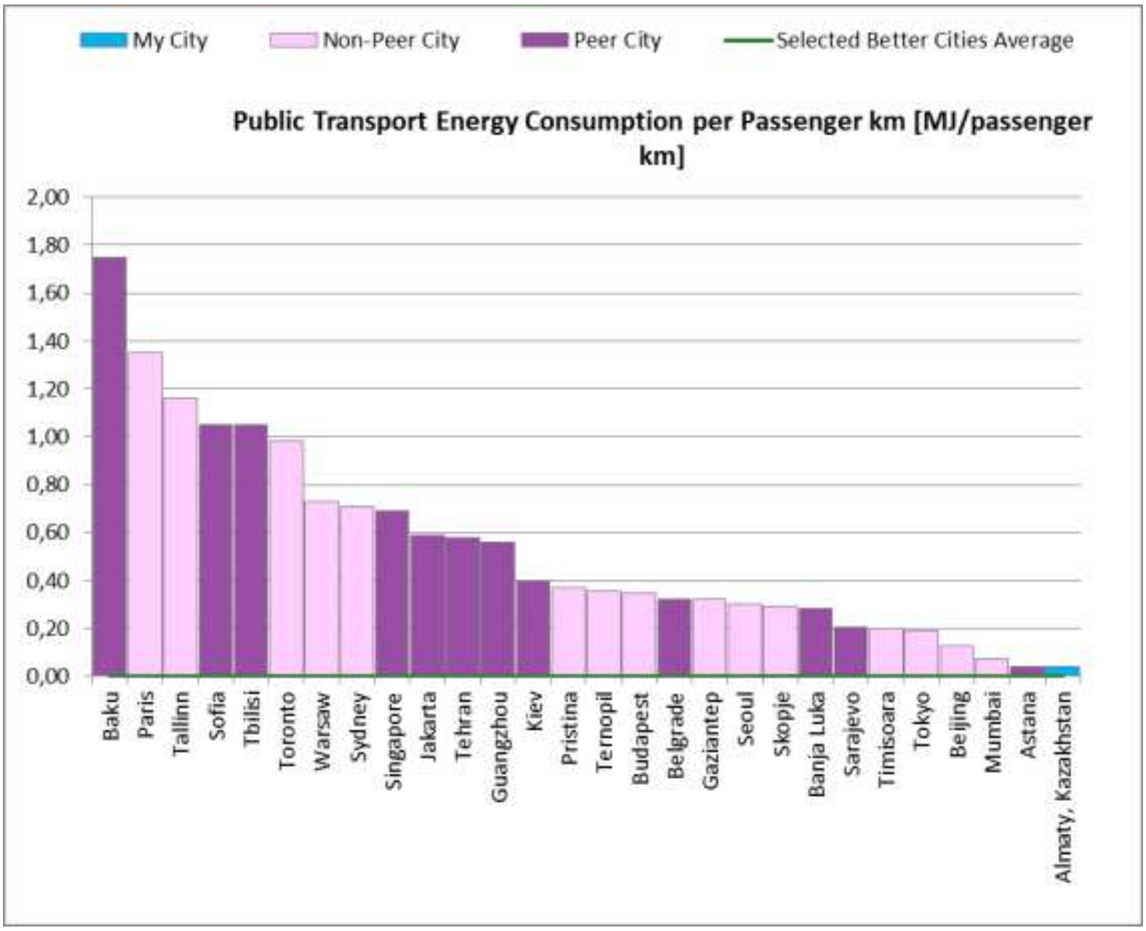
There are 1,300 taxis in the city. A third of them are ecologically friendly Eco taxis managed by the CA. The rest of the cars are operated by private companies. Taxis do not require licensing from the CA, and there is no ceiling for tariffs.

3.11.3 Energy Performance

The TRACE 2.0 assessment shows that Almaty has the most efficient PT compared to peer cities, with 0.04 kWh/passenger km. For example, the PT system in Almaty uses ten times less energy than Kiev. Although this figure is quite small, it does not necessarily mean that the system is actually efficient, but rather that is overloaded to meet the demand. Expert analysis indicates that among all vehicles, taxis are the most inefficient. Annually, the city-wide spends US$ 12.7 million to cover the fuel to operate the PT sector.

Operators get some discount for fuel and pay KZT 40-60 per liter (as opposed to KZT 50-70/liter). Diesel buses need 35-47 liters per 100 km, while the CNGs 50-70 liters of natural gas per 100 km

Figure 32. Energy consumption per pass/km for public transport in Almaty



According to expert estimates, the PT system has around 480 million passengers annually, of which 94% use buses and trolleybuses, 2.2% the metro and the rest take the taxi. CNG busses and the

[33] http://astanatimes.com/2017/01/almaty-metro-prepares-for-universiade/

metro are the most efficient means of transportation. For example, the CNG buses holding 45% of the total passenger km share require only 17% of the fuel consumed. The most inefficient are taxis – they need almost half of the overall fuel for only 36% share of passenger/km.

Figure 33. Public transport share pass/km and fuel use

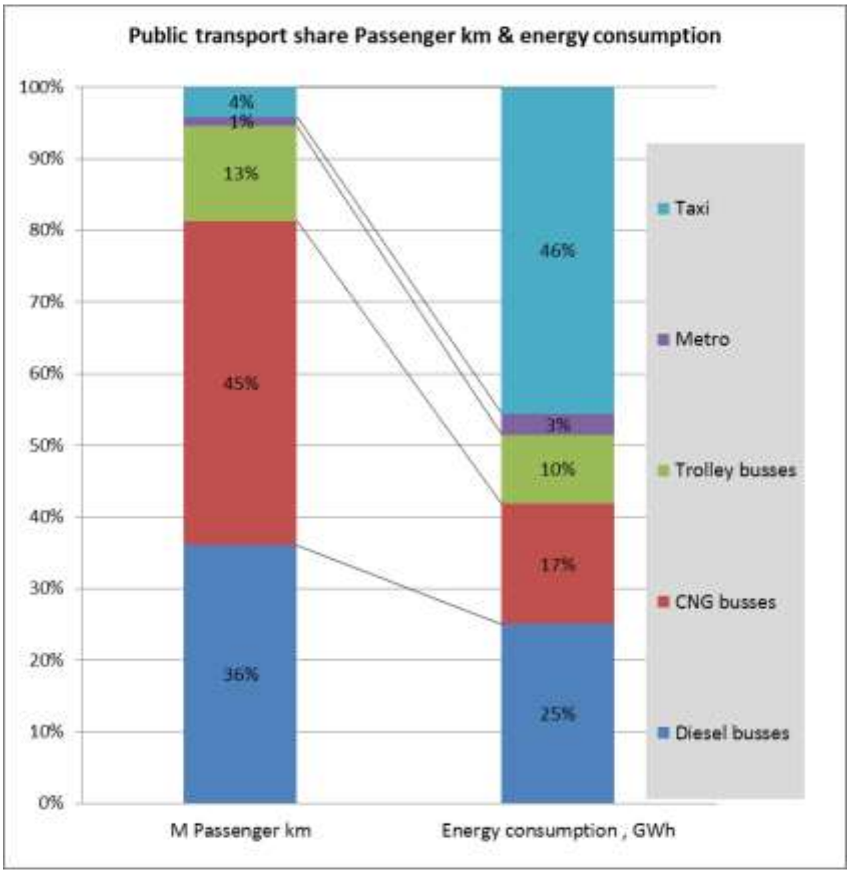
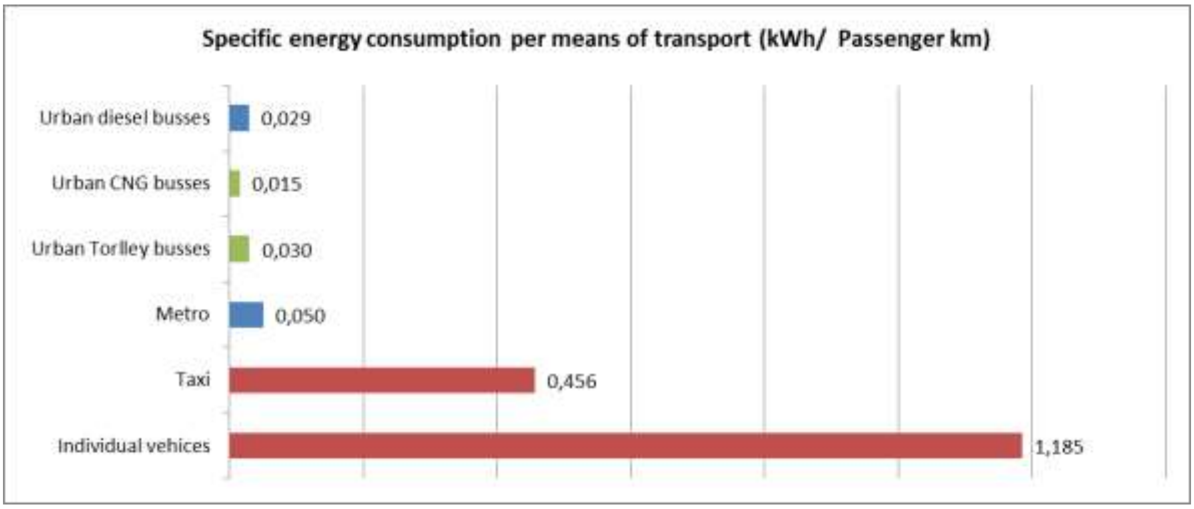


Figure 34 illustrates the energy performance of different types of urban transport per passenger km (transport of one passenger for one km). PT is the most efficient. The specific energy consumption is below 0.04 kWh/km. The CNG busses are the most efficient. Individual private transport is 30 times less efficient with approximately 1-1.2 kWh/km. This indicates that the immediate target is to shift transport modality from private (individual) to efficient PT means. Hence, the challenge for the PT transport comfort in terms of reliability, frequency and speed.

Figure 34. Specific energy consumption per means of transport (kWh/ Passenger km)



Private Transport[34]

52% of the daily commutes in Almaty are done by the 554,000 registered private cars in the city. In addition, there are 185,000 cars that travel into Almaty every day, placing additional burden on the road infrastructure and traffic congestion in the city. The private transport in Almaty is one of the most energy intense, with an annual overall fuel expenditure of more than half billion dollars. More details about private transport in Almaty is available in Annex 2.

3.11.4 Main Challenges in the Urban Transport Sector

The TRACE 2.0 analysis points to 22% theoretical potential energy savings for the PT system and 15% for private transport in Almaty, and this could be achieved by implementing some of the EE measures. The city is interested in expanding the metro line. This should be accompanied by equipping the metro stations with LEDs and expanding the operation hours of the metro. Adding more clean buses, like CNG and trolleybuses, would help reduce fuel use and improve the air quality in the city. The number of existing CNG fueling stations should increase as well.

Also, the city could also expand the CNG taxi fleet. A study prepared by the Organization for Economic Development and Cooperation (OECD) 2016 for the transport sector in Almaty and Astana in 2016 assessed the scenarios for purchasing different few types of rolling stocks. For example, while CNG buses are very efficient and least noisy, they need quite some time to charge, between three to six hours. While Liquefied Petroleum Gas (LPG) buses would have a fast-fueling process, the level of work required to set up the stations is very complex. CNGs need 60-70 m^3 of natural gas to run 100 km, LPG 36 km of liquefied petroleum for every 100 km, and the advanced clean diesel buses (known as EEV) between 40 to 50 liters. As of 2015, the CNG was identified as the cost-effective bus (KZT 48/liter), followed by diesel (KZT 127/liter) and LPG (KZT 150/liter). More green buses would mean less GHG emissions in the city. For example, additional 146 CNG buses would cost KZT 5.1 billion (US$ 23 million) of which around US$ 11 million could be covered from the local budget; this would reduce the annual emissions by CO2 4,534 tones. Alternatively, 343 CNG vehicles for KZT 12.1 billion (of which KZT 5.8 billion as local subsidies) would double the amount of annual GHGs avoided.

Another key intervention the CA has in mind to increase efficiency of the PT is introducing licensing per km, a scheme that would actually enforce GHGs per km and new technologies to allow monitoring and measuring the GHGs. The Almaty CA is planning to build three park-and-ride facilities in the west, east and north sides of the cities, where people, especially daily commuters, could leave their cars and take public transport to continue the trips. At the same time, the development of 12 km of light rail system should increase the speed and reduce significantly the travel time in the city.

There are some easy-to-implement measures at minimum costs that could improve the overall performance of the urban transport in Almaty. One such intervention is to extend the bus and trolley bus services by a couple of hours, and hence hire more drivers. Also, installing electronic boards in bus stops to display information about route and bus schedule would allow people to better plan their trips and save travel time. The CA may also consider hiking parking fees and restrict traffic in some areas (e.g., turn some streets into pedestrian networks) to discourage people drive their cars and rather use PT.

The CA is planning to develop additional three bus lines, build a few more bus depots, and expand the dedicated bus lines. The city could also modernize the existing non-motorized network and expand the bike lanes.

- *Lack of legislative powers to increase performance of the bus operators:* Although it owns the rolling stock and the transport infrastructure, the CA does not have any power or leverage to increase performance of bus operators, as these are private companies. However, the CA is

[34] More details about Almaty's private transport performance is available in Annex 3.

thinking to provide training for bus drivers to teach them drive more efficiently, thus reduce fuel consumption.

- *Local budget funding:* The OECD study highlights that while CNGs are very efficient, they are very costly, like three times more expensive than diesel buses (KZT 44 million v. KZT 16 million or US$ 207,000 vs US$ 72,000). For CNG or LPG buses the share of co-financing from public funds should not exceed 48%, while the maximum 52% should come from private funds. For modern diesel buses, the local contribution from the local budget could be 81% of the cost.
- *Low cost of fuel*: The relative low cost of fuel - KZT 138/liter in 2015/2016 (equivalent of US$ 0.62/liter) - is expected to encourage people to use their cars for their daily commutes.
- *Traffic congestion and increasing number of private cars:* Traffic congestion during rush hours, with several traffic jams and bottlenecks make people spend more time in traffic, hence use more fuel. With a higher standard of living as compared to other regions in the country, Almaty will continue to attract more people, and they would buy cars which would continue to put pressure on the road loads in the city. In addition, the number of cars transiting Almaty daily would increase the load on the road and would also aggravate traffic management. At the same time, the insufficient number of parking in residential areas and business centers places adds more challenges to the local roads capacity.

4 Prioritizing Sectors

TRACE 2.0 helps rapidly assess the energy use in a city in order to identify and prioritize sectors and recommend specific EE interventions. For this purpose, the sectors with the highest energy savings potential that are both achievable due to the control and impact by the municipality and financially viable are highlighted and presented in Table 9 below.

The process for identifying priority sectors takes into consideration three main issues:

- **relative spending on energy** in each sector, either at a municipal level or for the entire city (public and private);
- **Relative Energy Intensity** (REI) of the sector as theoretical energy savings potential based on the benchmarking exercise and the consultant's estimate after reviewing each sector; and
- **degree of control or influence** the CA has over each sector, with the level of budgetary control being the most important factor.

Table 9. Summary of sectors by spending for energy, REI and EE potential

Sector	Energy spending (in million US$ including VAT) in 2015	Theoretical Energy Savings Potential = Relative Energy Intensity[35]	Municipal level of control
Public Transportation	12.7	20-25%	HIGH
Private Transport	555	10-15%	LOW
Municipal public buildings	35.6	30-50%	HIGH
Street Lighting	2.7	50-65%	HIGH
Power (losses)	401	15-20%	LOW
District Heating (losses)	120.4	20-25%	MEDIUM
Potable Water	7.6	20-30%	HIGH
Wastewater	1.7	10-20%	HIGH
Solid Waste & Municipal Vehicles	4.2	20-25%	HIGH
Other Public Buildings	5.2	30-40%	LOW
Residential Sector	287	35-45%	LOW
Commercial & Industrial sector	320	15-25%	LOW

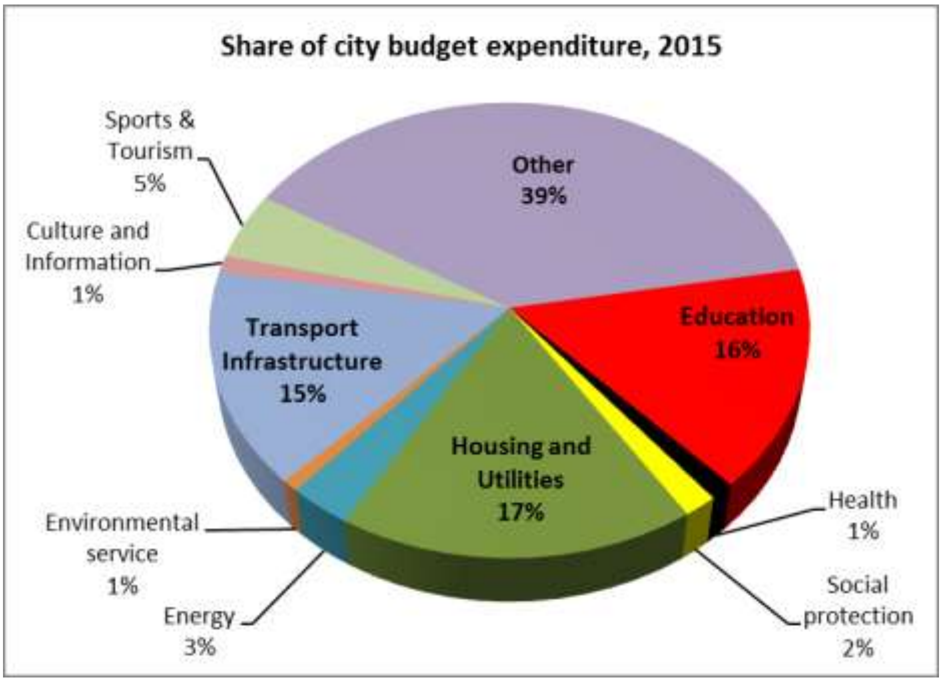
The overall annual expenditure for energy in Almaty is approximately US$ 1.75 billion (KZT 390 billion) in 2015, which is about 5% of the GDP of the city.

4.1 Energy Expenditures

In 2015, the budget of Almaty was KZT 470 billion. More than half of the money was used to cover operation expenditures and support education, housing & utilities, and transport services (Figure 35).

[35] The Relative Energy Intensity is the potential improvement in the given sector. It is calculated using the average of municipalities under similar conditions, performing better than Almaty city. For example, if the specific heat consumption per area of municipal public buildings for a selected number of similar municipalities performing better than Almaty is 125 kWh/m², and the buildings in Almaty consume in average 195 kWh/m², then its relative energy intensity is (195-125)/195= 35%.

Figure 35. Main sectors covered from the city budget of total expenditures of KZT 283.6 billion



The local revenues for the local budget for the 2015-2017 period are based on forecast parameters of macroeconomic and regional indicators for the medium term, previous dynamics of salary growth, and revenue estimates for 2015. The forecast local revenues indicate KZT 427 billion in 2015, KZT 329 billion for 2016, and KZT 356 billion for 2017. For example, in 2015 KZT 279 million (65% of the budget) came from tax revenues, and 137 billion (35%) from income transfers and loans.

Approximately 60% of the city budget covers operation costs of the public sector, like education (16%), housing and communal services (18%), and transport (15%). District governments (rayon akimats) receive money to operate the street lighting network, whereas waste collection and street cleaning services are covered from the local budget. The Almaty CA can decide how to spend the surplus. In 2016 the city managed to achieve budget surplus. If the transfers from the national budget are not spent in the given fiscal year, money must be returned to the central budget.

Table 10. Municipal energy spending

Energy spending (for municipal public transport, municipal buildings, street lighting, waste, water and wastewater services) in 2015[36]	US$ 64.5 million (KZT 14.3 billion)
Energy spending for municipal services as percentage of annual budget	3.1%
Of which energy spending for municipal buildings	US$ 35.6 million (KZT 7.9 billion)
Energy spending for public buildings as percentage of annual budget	1.7%

The energy spending for municipal sector facilities and services (e.g., municipal buildings, street lighting, waste, water and wastewater) amounts to US$ 64.5 million in 2015 (3.7 % of city-wide energy spending), of which 55% covers the energy bill in municipal buildings.

[36] Energy spending for heat and power supply are covered by the utilities and calculated within the energy tariff.

Figure 36. Share of city-wide energy spending KZT 390 billion

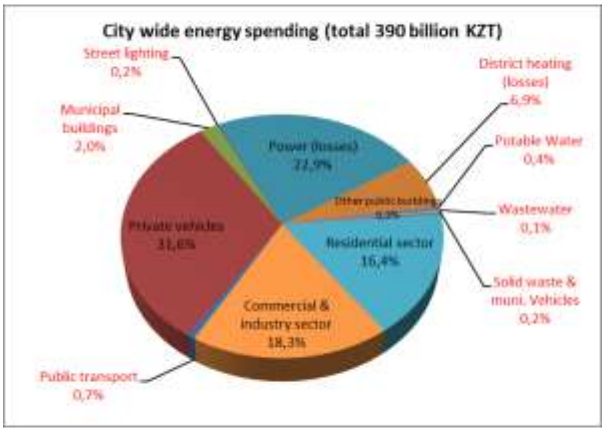
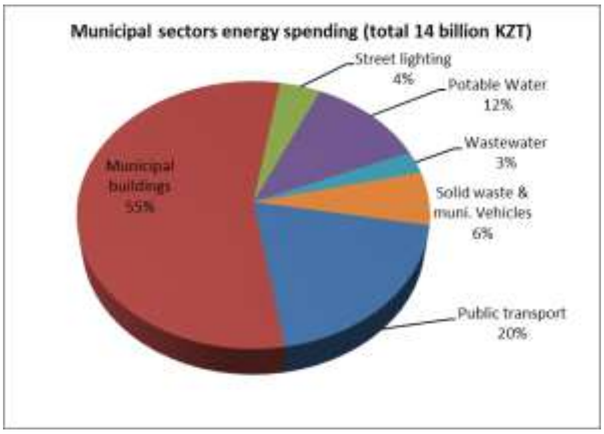
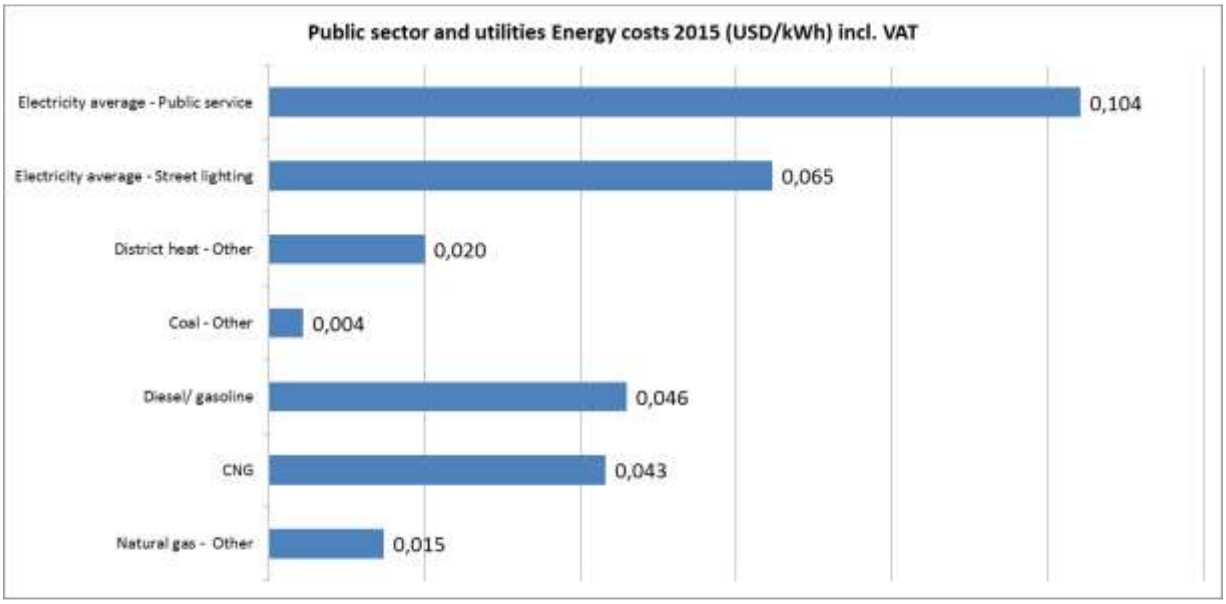


Figure 37. Share of municipal sectors energy spending (KZT 14.3 billion)



The cost per unit (kWh) of energy for public entities vary depending on the type and quality of the energy used (e.g., 1 kWh of power is five times more expensive than 1 kWh of district heat). High quality energy carriers, like gasoline and power, are more expensive than gas and district heat.

Figure 38. Energy costs for public entities, 2015 (US$ per kWh)



Despite the fact that energy consumption in the sectors that are under direct city control represents only 4% of total city-wide energy consumption, successful interventions in these sectors are important to increase awareness of city residents about energy savings potential and EE benefits. Moreover, energy savings in these sectors will directly contribute to reducing the energy costs, as well as diminishing municipal budget spending or government subsidies.

4.2 Level of Municipal Control across Sectors

The city can have different levels of influence and control over utilities and energy end-users. The various types of ownership of the energy consuming facilities in different sectors can limit or strengthen the budget control and the enforcement power of the city government. Hence, an inherent part of the urban energy diagnostic is to determine the degree of authority or control the municipality can exert on municipal/local energy stakeholders.

Table 11. Key to the municipal authority control

	National Stakeholder	The city has virtually no control; decisions are taken at a national level.
	Local Stakeholder	This city is one of many stakeholders who take decisions at a local level
	Local Committee	The city is formally represented on a committee that take decisions
	Multi-Agency	The city is one of several agencies with a formal decision-making role
	Policy Formulator	The city can directly set policy in the sector
	Regulator/Enforcer	The city can directly set policy in the sector and enforce compliance
	Budget Control	The city has direct control over expenditure in this sector.

The examples below show the level of municipal influence and control for two sectors.

Example A: Municipal buildings – HIGH level of control: When the city is responsible for all building codes, regulations and permits, it means that the city has high regulatory control. Since all building operations related costs, like energy, maintenance and investments are paid by the municipal budget then the city has high budgetary control and direct incentives to invest in energy efficient equipment. Finally, as owner of the building, this gives the city the necessary degree of influence to ask the building user to implement certain energy savings measures.

Example B: Private transport - LOW level of control: Since the municipality cannot control the fuel consumption of the private vehicles, nor impose performance any legislation, the CA has low regulatory control over this sector. As all energy expenses for the private transport are covered by individuals (private people), it means that the CA has some low budgetary control over this sector. Finally, the city has only limited influence to enforce EE in the private transport sector. The CA could help people to shift from individual to public transport by increase the capacity and attractiveness of the latter. In turn, this could reduce fuel consumption in private transport sector.

As shown in Table 12 below, the CA has full control over the following sectors: municipal public buildings, district heat, street lighting, water supply & wastewater, and waste management. These sectors will be the primary focus for the municipal EE plan.

Table 12: City control over sectors – regulatory, budgetary and enforcement

Sector	Municipality authority level of power		
	Regulatory	Budget control	Influence and enforcement
Public Transportation	HIGH	MEDIUM	HIGH
Private Vehicles	LOW	LOW	MEDIUM
Municipal Public Buildings	HIGH	HIGH	HIGH
Street Lighting	HIGH	HIGH	HIGH
Power (losses)	LOW	LOW	MEDIUM
District Heating (losses)	HIGH	HIGH	HIGH
Potable Water	HIGH	MEDIUM	HIGH
Wastewater	HIGH	MEDIUM	HIGH
Solid Waste & Municipal Vehicles	HIGH	MEDIUM	HIGH
Other Public Buildings	LOW	LOW	LOW
Residential Sector	LOW	LOW	MEDIUM
Commercial & Industry Sector	LOW	LOW	LOW

The city has low or no regulatory or budget control and EE enforcement power on the sectors like power supply, private individual transport as well as residential, commercial and non-municipal public buildings, since they are commercially/individually organized or controlled by the central government. The city could influence those sectors by involving stakeholders in the process of municipal energy planning, as well as by increasing awareness on the EE benefits.

For the sectors with low level municipal control, only a few EE interventions are recommended, and they could be initiated by the CA within the EE program in close cooperation with the relevant stakeholders. However, the financial involvement from the city budget shall be limited, since these are commercial facilities or privately owned, hence the financial benefits of potential EE investments would stay with these private stakeholders.

4.3 Municipal Energy Challenges

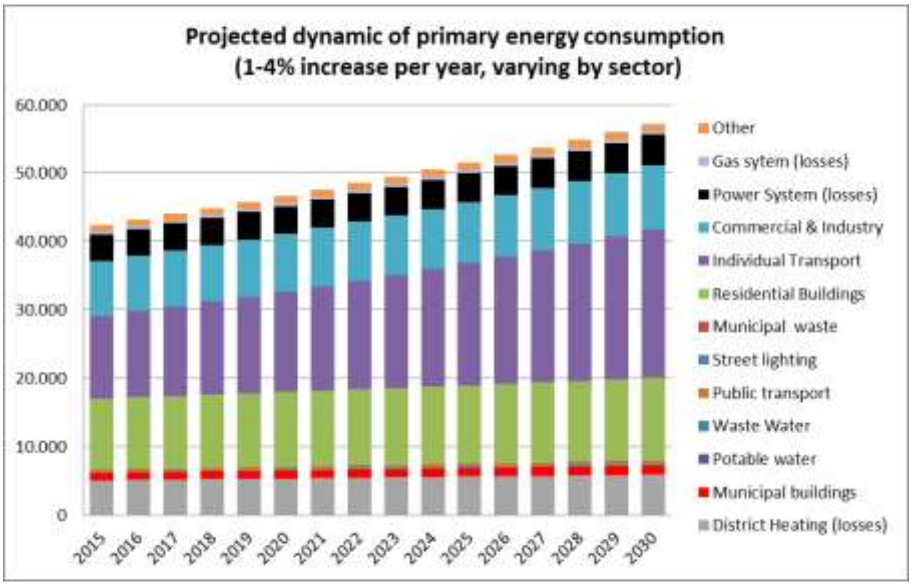
Almaty is facing three types of challenges regarding EE (see Table 13) that should be addressed in the municipal EE plan when outlining specific EE interventions and targets.

Table 13. Municipal Energy Challenges

Economic and demographic challenges	Overall municipal level energy challenges	Sector specific challenges
Increasing: ➢ Population ➢ Demand for energy ➢ Demand for municipal services ➢ Maintenance cost ➢ City budget spending ➢ GHGs, NOx and particle emissions Limitations in: ➢ Performance of facilities ➢ Funds for investments ➢ Incentives to invest in energy efficient technologies ➢ Awareness of energy efficiency Other influences ➢ Weak energy efficiency policy implementation	❖ High specific energy consumption of city public services (buildings, lighting) ❖ Increasing demand to provide service to new customers ❖ High costs for maintenance and repair ❖ High and escalating budget spending for energy supply due to increasing in energy tariffs ❖ Limitations for investment funds for retrofit or extension of infrastructure ❖ Out-dated, inefficient and partly worn-out equipment and facilities ❖ Decreasing availability of facilities and unreliable supply, such as electricity and water supply ❖ Limited capacities on preparation and implementation of energy saving and retrofit measures ❖ Limited capacities of human capital: municipal staff does not have the tools to enforce energy performance regulations ❖ Low awareness of EE opportunities and behavior due to low energy tariffs and lack of information	Municipal public buildings (PB) - High specific energy consumption - High and escalating budget spending for energy supply - Requirement for in-depth analysis and energy audits District heating (DH) - High losses in heat generation and distribution Street lighting (SL) - High costs for replacement and maintenance - Demand for improvement of illumination Water and Wastewater (WWS) - High water consumption patterns - High energy intensity for water processing and supply Solid Waste (SW) - High and increasing fuel costs for waste fleet - Low rate of recycling and energetic use

Under a 'business-as-usual' scenario without EE interventions and a complex EE investment program, one can project that the city-wide primary energy consumption shall go up by one third from 42.5 billion kWh for the baseline year 2015 to 57.3 billion kWh in 2030. This rise is caused by an assumed 1% increase per year in population (and commercial activities), 1-2% annual increase in municipal services/buildings and up-to 4% annual increase in public and private transport. This energy and development forecasts for Almaty indicate that EE interventions in the form of a concerted EE investment program could overcome the increasing trend in the energy use in the city.

Figure 39. Projected dynamic of city-wide primary energy consumption without EE interventions



4.4 Sector Prioritization

The TRACE sector prioritization indicates that the top three sectors with highest energy savings potential in Almaty are district heating, residential buildings, and municipal buildings (see Figure 40).

Figure 40. Sector ranking from TRACE Figure 41. Sector ranking

Sector	Potential for the Sector: Score (1*2*3) 'City Wide' spend in orange	Rank (1 is highest)
PUBLIC TRANSPORTATION	2.787.017	6
PRIVATE VEHICLES	8.328.866	4
MUNICIPAL BUILDINGS	14.260.922	3
COMMERCIAL BUILDINGS	2.565.341	7
RESIDENTIAL BUILDINGS	25.876.474	2
STREET LIGHTING	1.605.275	8
POWER	8.032.916	5
DISTRICT HEATING	26.493.530	1
INDUSTRY		
POTABLE WATER	1.529.975	9
WASTEWATER	171.257	11
SOLID WASTE	624.754	10

The key sector features and challenges together with the analysis of the EE potential were presented and discussed during the TRACE workshop in Almaty in May 2017. According to the sector prioritization, the EE interventions shall focus on 10 sectors and cross-sectoral measures. The interventions in the municipal EE plan must be structured as such as to address the main challenges of each sector, as swell target specific benefits. The areas of intervention for each sector are justified by the potential EE benefits for the city, such as the reduction of the energy cost/bills and increase in the level of comfort inside the facilities.

5 Energy Efficiency Program

5.1 Intervention Strategy and Types of Measures

The EE strategy should be based on two types of interventions, namely investments and non-investment measures.

A) **INVESTMENT MEASURES:** They comprise a pipeline of direct EE investment projects that can generate physical energy savings with co-benefits in the form of increase of services and comfort at end-users, in addition to reducing O&M costs. The investments should be prioritized based on:
   1) **Reduction of energy demand and consumption** for end-users, mainly in buildings;
   2) **Reduction of energy losses** for heat and power generation and distribution; and
   3) **Use of renewable energy (RE)** sources, whenever these are technically and economically feasible to substitute fossil fuels.

The next section of this report will outline the 54 EE measures, investments (costs), and benefits.[37]

B) **ADDITIONAL NON-INVESTMENT MEASURES AND POLICIES AT MUNICIPAL LEVEL**: These are requirements and prerequisites in order (i) to enable the investment program implementation by investment preparation, development of financing and delivery mechanisms, (ii) develop a conducive local regulatory framework, (iii) develop local institutional capacity, and (iv) raise public awareness on EE.

The investment and non-investment measures of the EE plan have been developed during a complex process that included (i) interviews with relevant stakeholders of the city of Almaty, (ii) available investment plans from utilities and service suppliers, (iii) analysis of existing and previous EE and urban development plans, (iv) recommendations from the TRACE 2.0 model, and (v) expert recommendations on relevant EE measures, based on experience and best practices.

5.2 Overall Energy Saving Targets

The overarching objectives of the municipal EE plan are to reduce energy consumption, diminish related expenditures from the municipal budget, and improve municipal service delivery for city residents. The qualitative targets can be summarized in three pillars, as following:

Table 14. Summary of qualitative targets of the EE program

Increase of municipal services & living quality	Resource savings	Sustainable development
- Increase the quality of the **service level** (e.g., heating, health conditions) - Increase comfort and /or meeting the demands - Reduction of greenhouse gas **emissions** - Increase the **attractiveness** of the city - Meeting the challenges and energy demand in the future of city growth	- Lower the city-wide energy demand (**energy intensity**) - Reduction of primary energy consumption - Increase the use of **renewable energy** - Avoid escalation of energy bills and limit budget spending - Use of additional revenue sources	- Improvement of **performance** of municipal companies - Implementation of **energy management** in all sectors, an activity led by the city authority - Change of **consumer's behavior** towards EE - Setting up the environment to attract **investment in EE** - Increase and develop **capacities** for program implementation - Development of financing delivery mechanisms (EPC, PPP)

[37] Investments for the extension of urban infrastructure and performance increase of utilities are not listed in the EE plan, since those measures will not have a direct saving effect compare to the baseline energy consumption of the year 2015, they are not an inherent part of the municipal energy savings plan.

This municipal EE plan should be implemented between 2018 and 2030, and it would help achieve annual final energy savings of 6,628 GWh, which will lead to around 21% reduction in final energy consumption. The 54 city-wide EE investment measures could achieve up to 10,383 GWh primary energy savings, which would save up to 16% of the overall primary energy consumption (PEC) in Almaty, as compared to the baseline year 2015.

The CA showed interest in learning more about the technical and economic energy saving potential of the sectors under the city control, as presented in Table 14. Considering the 42 EE investment measures in the municipal service sectors - district heat, water & wastewater, waste, street lighting, public buildings and transport - the energy savings could achieve 1,941 GWh by the target year of 2030, which would account for 29% of the respective baseline consumption. The EE interventions in the sectors under the city control could generate annually US$ 73 million in savings, which would be 4% of the current municipal budget. The EE quantitative targets of the EE plan are outlined below.

Table 15. Summary of quantitative targets of the EE program

Municipal Public Buildings
✓ Minimum 40% energy saving of heat energy for all facilities (schools, kindergartens) by building retrofit ✓ 50% energy saving for lighting by replacement of indoor lighting ✓ Use of renewable energy to cover minimum of 5% of hot water demand
Street Lighting
✓ Minimum 60% energy saving for the entire public lighting system in the city
District Heating
✓ Reduction of energy losses for district heat generation and distribution from 37% to 25%
Water & Wastewater
✓ Minimum 40% reduction of water losses ✓ 20% electricity savings at pumping stations for water supply, wastewater and treatment
Public Transport
✓ Increase of urban mobility by improvement of capacity, service and attractiveness of public transport ✓ 5-10% reduction of individual motorized transport by increasing the attractiveness of public transport as alternative to individual cars
Solid Waste Management
✓ Minimum of 80% of the waste volume is sorted and prepared for recycling or composting ✓ Reduction of 30% the fuel consumption for waste collection vehicles

In addition to cost savings for energy related expenditures, the EE measures hasve additional co-benefits that are often overlooked. These co-benefits are summarized in Table 16 below. Investments in sustainable and environmental friendly urban infrastructure could not only increase attractiveness of Almaty to city residents, tourists and businesses, but also raise awareness on modern energy savings technologies and practices. In addition to benefits, the EE measures could support the city to expand energy savings interventions to other sectors, such as residential and commercial.

Table 16. Energy efficiency benefits

Sector	Example of EE measures	Multiple benefits
Municipal Public Buildings	• **Retrofit** of public buildings such as schools, kindergartens and administrative offices • Improved building energy management • Automated heating sub-stations in buildings	• Increased room comfort and health • Improved learning/working environment • Increased **lifetime of** buildings
District Heating	• Increase **efficiency** of heat generation (boilers) • Reduction of **distribution losses** (pipelines)	• Better hydraulic **balancing** • Higher heat availability to connect new customers
Street Lighting	• Upgrade of street lamps to **LEDs** • **Extension** of the street lighting network including illumination of sidewalks, promenades, parks, etc.	• Increased traffic safety • Improved attractiveness of sites for city residents and tourists
Water Supply and Wastewater	• **Retrofit** of potable water supply network • Improved water **metering** for all consumers • Rehabilitation of water pumping stations • Active **leak detection** and pressure management	• Reduction of water **losses** • Increased sanitary comfort • Continuous **water supply** at adequate pressure • Higher water availability to connect new customers
Solid Waste	• Construction of **waste transfer sorting**, recycling and composting stations • Energetic **use of wastes** (biogas, landfill gas, incineration)	• Reduction of environmental **pollution and waste volume** • Additional **revenues from sale** of recycled products and renewable energy
Urban Transport (public & private)	• Upgrade of public busses **low emission vehicles** • Promotion of non-motorized mobility (**biking)** • Increase capacity, reliability and comfort of public transport	• Reduced local **air pollution** • Improvement of passenger comfort • Reduced individual motorized transport • **Better access** to sites for city residents and tourists
Residential Buildings	• **Retrofit** of multi-floor buildings • Program for efficient indoor lighting • Automated heating sub-stations • Apartment-based heat metering and consumption-based billing	• Improved room **comfort** • Increased **awareness** on EE • **Fair energy billing** based on actual consumption • Lowering the **energy bill**
Power System	• **Solar** power generation • SMART metering • **Retrofit** of sub-stations and power lines	• Reduction of power distribution losses • Load shifting and **capacity** to connect new customers
Commercial & Industrial Sector	• Dedicated **financing program** (credit + co-financing) for EE technologies	• Lower **energy intensity** of production/ service • Increased **awareness** for EE • Improvement of **competitiveness**

5.3 Energy Efficiency Investment Program

The preliminary list of 54 EE measures comprising 10 sector investment packages was presented to the CA and relevant local stakeholders during a workshop in Almaty in May 2017. A preliminary cost-benefit and financial assessment for these EE measures has been performed.[38]

5.3.1 Priority 1: Investments in District Heating

Centralized heat is the key supply for space heating and hot water in Almaty. The centralized heating system covers 80% of the public buildings, 50% of residential and commercial sectors heat demand in the city. The recommended investments in the DH system in Almaty focus on reduction of losses for heat generation and improvement of distribution facilities, which total 5,080 GWh as of 2015. At the same time, they target energy savings for end-users in the buildings and industry sectors. In addition, investments in the DH infrastructure at end-users can improve the hydraulic balancing. This would allow new customers to connect to the network and introduce consumption-based billing. The ten EE measures listed below would require total investments of US$ 273 million.

Code	Energy Saving Measures	Details of applications	Estimated investment costs[39]	
			(million US$)	Specific costs
DH-01	DH distribution: Automation of DH distribution and improved heat metering; Implementation of SCADA	– 28,362 DH supplied buildings (90% of the building stock)	14	US$ 500/ building
DH-02	DH distribution: Rehabilitation DH Pumping stations; Replacement of pumps (with variable speed drives - VSD)	– 48 DH pump stations (60% of all)	1	US$ 15,000 /pumping station
DH-03	DH distribution: DH Network Maintenance and Upgrade Program, DH pipeline insulation, regulation and balancing	– 15 km DH network (30% of the network)	11	US$ 0.75 million/km
DH-04	DH distribution: DH network rehabilitation, pipeline replacement	– 15 km DH network main pipeline	60	US$ 4 million/km
DH-05	DH distribution: Increase DH supply, storage and balancing capacity by construction of DH transmission pipeline (13 km) between CHP 1 and CHP 2 and Construction of new DH transmission pipelines (30 km) to district Boiler west	– 43 km DH main pipeline	129	US$ 3 million /km
DH-06	DH distribution: Pilot project for Turbo-aggregation of DH network pumps (steam from turbine)	– 2 DH main pumps	1	US$ 0.5 million/ unit
DH-07	DH generation: Boiler Houses reconstruction and rehabilitation, small and medium boiler houses ATKE, including condensing gas boilers/ economizers at Boilers	– 32 ATKE boiler houses (80% of the facilities)	48	US$ 1.5 million per boiler house

[38] All assumptions made for this assessment are available in Annex 2 of this report.
[39] Initial costs estimates on the basis of 2017; including material, equipment, installation and VAT

Code	Energy Saving Measures	Details of applications	Estimated investment costs[39]	
			(million US$)	Specific costs
DH-08	DH generation: Conversion of 100 autonomous boilers (coal, power, mazut) at public facilities, Pervomaika village and south district to efficient gas fired boilers	– 100 small boiler houses	3	US$ 25,000 per boiler house
DH-09	DH generation: High efficient heat generation facilities (e.g., heat pumps, gas condensing boilers) at zones of decentralized heat supply	– 100 small boilers, average 100 kW	5	US$ 50,000 per boiler
DH-10	DH generation: Large solar water heater for up-heating of DH feed water (water losses)	– 2 solar collector systems, 1000 m², capacity 1 MW	1	US$ 260,000 / unit

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving [40](million kWh/year)	Annual energy cost savings (million US$ /year)[41]	Simple Payback time (years)[42]
DH-01	DH: Automated distribution & metering	EE 2% of distributed district heating	178	2.8	5
DH-02	DH: Retrofit of pumping stations	EE 15% of power for DH company	6	0.3	2
DH-03	DH: Network upgrade & insulation	EE 25% of DH distribution losses	181	2.8	4
DH-04	DH: Pipeline replacement	EE 60% of DH distribution losses	435	6.8	9
DH-05	DH: CHP interconnection pipelines	EE 5% of DH losses + DH supply	627	9.8	13
DH-06	DH: Turbo pumps at CHP	EE 60% of power for DH company	4	0.2	5
DH-07	DH: ATKE boiler retrofit	EE 30% of DH generation losses HOB	252	3.6	13
DH-08	DH: Empowering autonomous boilers	EE 50% of DH generation losses HOB	3	0.1	33
DH-09	DH: Advanced decentral boilers	EE 30% of DH generation losses HOB	14	0.8	6
DH-10	DH: Solar collector plant for feed-water	EE 95% of renewable DH generation	13	0.1	8

[40] Primary energy savings considering the primary energy factor - e.g., 1.9 for power, 1.6 for district heat, and 1.0 for other energy carriers.
[41] Assumption of energy cost increase of 1.5-2% per year
[42] Considering only energy cost savings

The implementation of the entire investment package in DH could reduce the energy losses up to 1,087 GWh/year, which would diminish by 33% the losses in the DH generation and distribution system by 33% (as compared to 2015). By applying the primary energy factor for heat and power in Almaty[43], the implementation of this investment package could save annually 1,712 GWh of primary energy, which would equal to 69 million m³ of gas and 210,000 tons of coal input to CHP and HOBs for heat generation. The energy costs savings could be US$ 27 million per year. The interventions in the DH system are economically viable, with an average 10-12 years payback time for this investment package. Since currently 61% of generated by coal, the EE interventions could reduce drastically the emissions (up to 445 ktons CO_2/year) and air pollution. Almaty could start with a few measures with quick investment returns, like automated distribution and individual heating substations. Reduction of own energy consumption in HOBs and CHPs as well as replacement of heat pipes should be planned as a long-term program, based on the ongoing technical depreciation of the network.

The parties that should implement the EE measures in the DH sector should be the Almaty CA, with its Division of Energy, Housing and Communal Services, as well as the heat generation and distribution providers, namely ALES JSC Almaty Power Stations and LLP Almaty Teplo Seti.

Additional non-investment measures may include support for project preparation,[44] such as a) feasibility studies and investment project design, b) technical specification, tendering and procurement, and c) qualified construction supervision along with capacity building and guidance for best practices for equipment installation.

5.3.2 Priority 2: Investments in Municipal Public Buildings

The EE plan has designed seven EE interventions for municipal public buildings that would require total investments of US$ 196 million (see table below).

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
PB-01	EE Retrofit Program of municipal schools including: a) Retrofit of building envelop: Replacements of windows, insulation, b) Modernization of heating and hot water system: Replacement of heat piping, radiators, thermostat valves, hydraulic balancing, automated heating sub-station, temperature and consumption control, metering, frequency control (VFD) pumps	– 974,453 m² in 140 public schools & higher education buildings (70% of the building stock)	78	US$ 80/m² floor area
PB-02	EE Retrofit Program of municipal kindergartens including: a) Retrofit of building envelop, b) Modernization of heating and hot water system	– 373,800 m² in 124 public pre-schools (70% of the building stock)	37	US$ 100 /m² floor area
PB-03	EE Retrofit Program of municipal medical facilities (hospitals, policlinics, etc.,)	– 300,000 m² in 43 public health	36	US$ 120/m²

[43] Primary energy savings considering the primary energy factor - e.g., 1.9 for power, 1.6 for district heat, and 1.0 for other energy carriers.

[44]The project preparation comprising a) feasibility studies and investment project design, b) technical specification, tendering and procurement, and c) qualified construction supervision along with capacity building and guidance for best practices for equipment installation – will be referred further in the report as **"support for project preparation".**

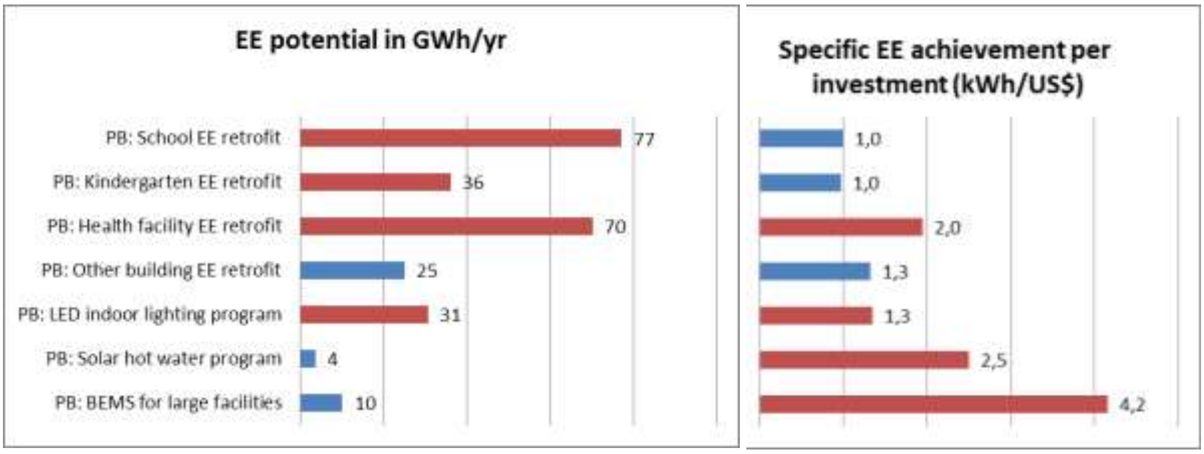
Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
	including: a) Retrofit of building envelop, b) Modernization of heating and hot water system	buildings (100% of the building stock)		floor area
PB-04	EE Retrofit Program of other municipal facilities (administration, culture facilities, libraries, etc.) including: a) Retrofit of building envelop, b) Modernization of heating and hot water system	– 270,000 m² in 45 administration buildings (90% of the building stock)	19	US$ 70/m² floor area
PB-05	Replacement of indoor lighting for all municipal public buildings	– 2,526,076 m² in 472 public buildings (100% of the building stock)	23	US$ 9/m² floor area
PB-06	Solar Hot Water Program for education and medical facilities	– 144 solar systems 40 m² collector (60% of all)	1	US$ 10,000 per unit
PB-07	Building Energy Management Systems (BEMS) for large buildings (> 20,000 m²)	– 500,000 m² for BMS in 20 buildings	2	US$ 5/m² floor area

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$ /year)	Simple Payback time (years)
PB-01	PB: School EE retrofit	EE 45% of district heat	122	2.0	39
PB-02	PB: Kindergarten EE retrofit	EE 45% of district heat	57	0.9	40
PB-03	PB: Health facility EE retrofit	EE 65% of district heat	111	1.8	20
PB-04	PB: Other building EE retrofit	EE 40% of district heat	40	0.6	29
PB-05	PB: LED indoor lighting program	EE 50% of power	60	4.1	6
PB-06	PB: Solar hot water program	EE 70% of district heat	6	0.1	15
PB-07	PB: BEMS for large facilities	EE 20% of district heat + Power	17	0.3	9

If all these EE would be implemented, Almaty could save 253 GWh/year of energy in public buildings, which is 26% less than the 2015 consumption. If the primary energy factor for heat and power is applied, Almaty could save 412 GWh of primary energy. The specific annual primary energy savings per each invested dollar could reach 2.1 kWh, according to experts, is a good ratio for such investments. Primary energy savings of 11.6 million m³ of natural gas per year could be achieved. Highest savings are triggered by EE building retrofit of education and health facilities, with a good cost benefit ratio of 1-2 kWh annual savings per each invested dollar.

Figure 42. Energy savings potential and specific annual savings per investments in public buildings



The implementation of this EE investment package in the public buildings in Almaty could avoid energy related costs of US$ 10 million per year. The simple payback time[45] for this package is 20 years on average. Besides energy savings and lowering the energy bills, the EE measures in municipal buildings bring additional benefits, like improving comfort in the facilities and helping extend the life-time of the building.

Although it would save up to 50% of energy, a complete building retrofit is costly (up to 120 US$/m² and difficult to implement. Hence, the city may consider starting with less costly measures. For example, the replacement of the lighting system inside buildings is quite an easy to execute, profitable measures with only six years of payback time. Also, it is recommended to start with easy-to-implement pilot projects in the facilities that need repairs. This approach can help the city to gain experience and build capacity for complex future project planning and implementation.

Recommended implementation schedule

Ideally, the public buildings investment package should start with a “Complex energy efficiency retrofit of municipal schools, kindergartens, and hospitals” program that could include thermal retrofit, EE lighting and RE heating for buildings having highest energy consumption and maximum energy saving potential. A combination of EE measures can achieve 25 years of payback time, which is less than the project lifetime or extended building life. In addition to economic benefits, the EE measures could increase the indoor comfort for children and teachers. Since the CA has limited funds to execute interventions to all buildings at a same time, a short- to medium-term two-phase implementation horizon is recommended, with 20-25 buildings per year.

The entities responsible for the implementation of the EE measures in public buildings should be the CA and its education and health divisions.

Additional non-investment measures could include:

- A benchmark analysis on energy consumption and energy audit program for all buildings;
- Project preparation (see footnote 44)
- Energy consumption monitoring program;
- Capacity building program for the technical staff operating the facility; and
- Education and behavioral change training for employees/users of municipal buildings.

Accompanying measures at central government level could include:

- Introduction of green public procurement criteria for energy appliances in public buildings;
- Minimum requirements for thermal quality of new buildings;
- Certification scheme for buildings; and
- Leveraging commercial financing using ESCO under an Energy Performance Contracting (EPC)

[45] Considering additional operation costs and cost savings

approach.

A few projects are suggested below. The opportunities for an EPC under the Public-Private Partnership (PPP) scheme should be considered, and business concept for this delivery mechanism should be developed.

Retrofit of 3 hospitals with highest demand for improvement (out of PB-03), approximately 100,000 m² heated area	US$ 12 million investments
LED indoor lighting for 100 public buildings	US$ 6 million investments

5.3.3 Priority 3: Investments in Public Transport

Five EE interventions requiring US$ nearly 235 million investments could help extend and improve public transport services in Almaty that could increase mobility and save energy and GHGs.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(US$ million)	Specific costs (million=M)
PT-01	Modernization of metro indoor lighting and escalator systems	– 9 Metro stations	1.1	US$ 120,00 per station
PT-02	Conversion of public diesel buses fleet to compressed gas (CNG)	– 585 urban diesel busses (25% of fleet) + fueling infrastructure (6)	26	US$ 40,000 per vehicle + US$ 0.5 per fueling station
PT-03	Replacement of trolley busses, to modern and energy-efficient busses	– 194 trolley busses (90% % of fleet)	6	US$ 30,000 per vehicle
PT-04	Conversion public and private taxis (400 units) to compressed gas	– 390 taxi cars (30% of fleet)	1	US$ 2,500 per vehicle
PT-05	Development of Bike Sharing System - Establishment and extension of infrastructure for non-motorized transport (bikes)	– 30 bike share hubs for 50 bikes + 30 km lanes	1	US$ 27,000 /km
PT-06	P+R (Park & Ride) system with 3 hubs	– 4 P&R hubs at metro/tram terminal + 300 parking	1.6	US$ 400,000 per station
PT-07	Traffic Flow Optimization, "Intelligent Transportation System", dispatching system, priority bus lanes	– 10 bus fleet routes	2.1	US$ 200,000/ route
PT-08	Construction of Light Rail system, 12 km	– 12 km rail + 8 trains + 6 stations	42	US$2 M/km, US$2 M/train, US$0.3 M /station
PT-09	Metro network extension to total 3 lines, 20 km	– 20 km rail + 12 trains + 6 stations	154	US$ 20 M/km, US$ 3 M/train, US$3 M /station

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$ /year)	Simple Payback time (years)[46]
PT-01	PT: LED Metro lighting & EE escalators	EE 60% of power	4	0.2	5
PT-02	PT: Replacement of diesel busses by CNG	EE 25% of diesel	17	0.6	41
PT-03	PT: Renewal of trolley bus fleet	EE 20% of power	9	0.4	13
PT-04	PT: Conversion of taxis to CNG	EE 15% of diesel	5	0.3	3
PT-05	PT: Extend of bike renting system	EE 0,1% of gasoline individual cars, 100% replacement of related fuel	7	0.4	2
PT-06	PT: Park & Ride hubs	EE 0.1% of gasoline individual cars	12	0.7	2
PT-07	PT: Traffic Flow Optimization	EE 1% mix of power/ CNG	1	0.1	20
PT-08	PT: Light Rail Train (LRT)	EE 0,3% of gasoline individual cars	41	2.5	17
PT-09	PT: Extension of Metro network	EE 0,9% of gasoline individual cars	113	6.7	23

The implementation of this investment package could save up to 198 GWh/year for the PT sector in Almaty, which is 9% less, compared to the energy used in 2015. Additional 172 GWh/year in fuel savings for private cars can be made by shifting urban mobility to public transport means.

Primary energy savings in the form of 3 million liters of gasoline/diesel per year could be achieved, which could translate into US$ 12 million annually. The simple payback of the investments in PT varies from three to over 40 years. Long payback times are incurred by interventions based on modern, innovative technologies and their high costs for associated infrastructure (e.g., tracks and stations for LRT and metro). One could be mislead by only considering the energy costs savings, and should also consider additional economic and environmental benefits in order to justify investing in a modern urban transport infrastructure. Energy cost savings could be achieved by transport operators by replacing diesel and gasoline buses with cheaper CNG (10-20% less), on one hand, and by people after they start using PT instead of their cars, on the other hand. Anyway, the shift in the transport modes would require an attractive, affordable and reliable PT.

The investments in PT are medium-term measures, and their implementation should be closely coordinated with the local transport companies, while funded by commercial stakeholders. The CA City should facilitate and coordinate among relevant parties.

The parties involved in implementing the EE measures in the PT sector should be the CA and its Division Natural Resources/Transport and Division of Urban Planning, as well as the main transport service providers, namely Almaty Metropolitan and Green Bus Company.

There are a few **non-investment measures** that could help set the appropriate environment for

[46] The preliminary assessment of the economic analysis is considering only the energy/fuel cost savings. Investments in non-energy infrastructure, such as transport generate economic values of improved service/infrastructure, will reduce the payback time. A more detailed socio-economic analysis is needed to monetize such co-benefits.

subsequent interventions. They include:

- Procurement guide for energy (emission) performance of public vehicles (e.g. busses, cars);
- Investment project for express buses - feasibility study and investment project design, technical specification & tendering and procurement, and ensuring CNG fueling capacities; and
- Capacity building program for relevant technical people.

An integrated PT development study combining optimized bus routes, express bus-shuttle, and improved connections at public transport hubs should be undertaken.

5.3.4 Priority 4: Investments in Street Lighting

Retrofitting street lights with light-emitting diode (LED) technology from mercury or high-pressure sodium vapor lamps can significantly increase EE in street lighting (SL), lower O&M costs, and achieve significant energy savings. The energy and maintenance-related savings could achieve 50% on average and, depending on the scale, up to 75% per year over the lifetime of the LED. Specific benefits of the LEDs include reduced GHG emissions, improved nighttime visibility, better color rendering and more uniform lighting distribution that could eliminate dark areas between poles. Typically, LEDs have a long operational lifetime between 50,000 to 100,000 hours, which is roughly 25 years. For street lights retrofit a number of design factors should be considered based on cost and availability of fixtures, such as type of fixture and bulb wattage. The EE interventions in the SL sector in Almaty would need US$ 29 million investments.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
SL-01	Street + Public Space LED Lighting Program, including replacement and adaptation of power supply network for advanced LED street lighting: retrofit, voltage stabilization, wiring, time management, diming, remote control	– 77,563 Light points (96% of all) + 4,409 km of SL power supply network (approx. 80% of network)	29	US$ 350 per light point, 400 per km

The implementation of these EE measures could help the city save up to 28 GWh/year, which accounts for 65% to 70% of energy consumption for the baseline year 2015. Around 54 GWh of primary energy can be saved.[47] Preliminary estimates indicate that the specific annual primary energy savings per each invested dollar is 1.9 kWh. The primary energy savings will be mainly in the form of coal and natural gas (used for power generation), with gas savings of 3.4 million m^3 per year. The energy costs savings could be as high US$ 2.8 million per year, while the overall savings (including maintenance and bulb replacement) would be up to US$ 5 million per year.[48] The simple payback time of the investment package in the SL sector is four to five years.

To ensure performance and long lifetime of the LED luminaries, this measure would also include renewal of the SL associated power system (around some 80% of the network) and partially replacement of the lighting poles. Automatic time control and nighttime dimming devices shall be included as well. During the project implementation, an environmentally sound disposal of the replaced HP mercury bulbs by a certified service provider is necessary.

The responsible parties for the implementation of the SL investments should be the Almaty CA, the city Division for Energy, Housing and Communal Service, and Almaty Kalalyk Zharyk, the SL operator.

[47] Primary energy savings considering the primary energy factor, e.g. 1.9 for power, 1.6 for district heat, and 1.0 for other energy carriers.
[48] Considering that a minimum of 40% of overall costs of SL are used for bulb replacement and maintenance. Assumption of energy cost increase of 1.5-2% per year reduction of costs for maintenance and bulb change.

The modernization of existing public lighting system requires detailed information about latest technologies and the condition of the SL network. A proper inventory for future monitoring and maintenance would need a database with the following information:

- Streets/roads: name, street width (lanes for traffic/pedestrians), street category (main road, secondary roads, local roads, etc.)
- Poles: height, distance between poles, type of poles (standing/wall), brackets, condition
- Luminaries/lamps: type (technical/historical/decorative), technology and capacity of lamps
- Operation: operation control (manually, astronomic clock, photo cells), operating hours, condition of the cabinets and cables, type of supply (public grid, separate grid).

A few non-investment measures in the SL sector could help with the implementation of EE interventions and with monitoring the results, and could include:

- City-wide integrated public lighting assessment program including energy audits;
- Benchmark analysis for street lighting energy consumption;
- Procurement guide for new street lighting systems;
- Support for project preparation (see footnote 44)
- Energy consumption monitoring program;
- Capacity building program for technical operators of the facilities; and
- Leveraging commercial financing using ESCOs under EPC.

Between 2018 and 2019, the CA could focus initially on a short-term pilot project to replace approximately 16,000 light points with LED in two districts, with focus on straightforward LED street lighting and power network retrofit. This intervention would require a financial effort of US$ 6-7 million. An **EPC under PPP scheme** should be considered, and a business concept for this delivery mechanism should be developed.

Other investment measures that could contribute to urban development but with very limited EE benefits are the expansion of the SL network, extension of illumination on sidewalks, promenades, parks, etc., and the installation of pedestrian street and rail crossing lights.

5.3.5 Priority 5: Investments in Potable Water & Wastewater

Nine EE measures with a total cost of US$ 215 million to improve the water and wastewater (WW) sector in Almaty have been identified, of which US$ 162 million for interventions in water supply and US$ 52 million in sewage/sanitation.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
PW-01	Increase of the performance water distribution networks; Replacement of outworn pipelines and valves	– 1,459 km water distribution net (50% of network)	146	US$ 100,000 /km
PW-02	Improve Efficiency of Pumps and Motors in water supply system	– 20 pumping stations (50% of all)	2	US$ 80,000 /station
PW-03	Active Leak Detection and Pressure Management Program	– 100 control points	0.4	US$ 4,000/point
PW-04	Improved water metering	– 186,955 metering points (30% of all)	13	US$ 71 /meter
PW-05	Support program for residential users for Water Efficient Fixtures	– 623,185 customer points (50% of all)	1	US$ 2 /fixture

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
	and Fittings			
WW-01	Improve Performance of sewage/ canalization networks, new mainline collectors; replacement of the obsolete networks	– 763 km water canalization (50% of the network)	38	US$ 50,000 /km
WW-02	Improve Efficiency of Pumps and Motors, Modernization of 7 WW pumping stations (out of 19)	– 7 pumping stations (35% of all)	1	US$ 80,000 /station
WW-03	Retrofit of WW Treatment Plant	– At one WWPT	1	US$ 1 million
WW-04	Biogas production from WW sludge at WW treatment plant	– 1 biogas plant + CHP (approx. 5 MW capacity)	13	US$ 2,500 /kW capacity

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$/year)	Simple Payback time (years) [49]
PW-01	PW: Retrofit water network	EE 45% of power for water pumping	17	0.9	170
PW-02	PW: Retrofit pumping stations	EE 10% of power for water pumping	11	0.5	3
PW-03	PW: Active leak detection	EE 5% of power for water pumping	4	0.2	2
PW-04	PW: Improved water metering program	EE 10% of power for water pumping	21	1.1	12
PW-05	PW: Water saving fitting program for residents	EE 15% of power for water pumping	32	1.6	1
WW-01	WW: Retrofit sewage network	EE 10% of power for water pumping	1	0.0	2,571
WW-02	WW: Retrofit of pumping stations	EE 10% of power for water pumping	1	0.0	13
WW-03	WW: Retrofit of WW treatment plant	EE 15% of power in WWTP	4	0.2	5
WW-04	WW: Biogas plant from sludge	Renewable energy power 100%	49	2.5	5

The implementation of this investment package in the water sector should be able to save up to 46

[49] The preliminary assessment of the economic analysis is considering only the energy cost savings. Investments into non-energy infrastructure, such as water and waste water generate economic values of improved service/infrastructure which reduce the payback time. A more detailed socio-economic analysis is needed to monetarize such co-benefits.

GWh/year (mainly power) and could produce annually 25 GWh of electricity from RE in the form of biogas. The electricity produced from RES could cover the demand of electricity for pumping or, alternatively, be sold via the local power utilities. Considering the primary energy coefficient for power (saved or substituted by RE electricity), the primary energy savings obtained could amount to 138 GWh per year or 5.5 million m³ of biogas per year. 40% of energy could be saved in the water sector compared to the 2015 energy consumption. Estimates for power generation from RES indicate that the sewage/sanitation sector can become a net producer of electricity.

The energy costs savings achieved and the revenues obtained from the sale or substitution of energy with RE necessary to operate the water sector could be US$ 7 million per year. The simple payback time for these EE measures varies from three to above 100 years. Very long payback times are calculated for potable water supply and wastewater network retrofits. The network retrofit is a long-term investment that should keep up with the on-going technical depreciation. Straight forward interventions, such as replacement of pumps and development of the biogas plant, are financially viable as they have short payback periods. The biogas plant could be build under Public-Private-Partnership with private operators.

The EE interventions in the water/WW system should be undertaken by the CA and its Division of Energy, Housing and Communal Services, together with the Communal Enterprise Tospa Su, the water company, and the Communal Enterprise Su Zhelisi, the sewage system operator.

Additional non-investment measures could include:

- support for project preparation (see footnote 44)
- energy and water consumption monitoring program;
- education program for water savings; and
- capacity building program for technical operators of the water/WW facilities.

Although they have no or very limited EE benefits, there are a few measures that could support the water infrastructure development, like expanding the potable water distribution and wastewater collection networks to new city districts, or the construction of a new WW treatment plant.

5.3.6 Priority 6: Investment Package in Municipal Solid Waste

The TRACE 2.0 analysis has identified six EE measures to improve performance of the solid waste sector in Almaty that would require US$ 133 million investments.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs (million=M)
SW-01	Fuel-Efficient Waste Vehicle Operations, vehicle replacement: Conversion of waste collection vehicles to CNG + fueling infrastructure	– 214 waste collection trucks (90% of the waste rolling stock) + fueling infrastructure (6)	15	US$ 70,000 /truck and share of infrastructure
SW-02	Waste Collection Route Optimization, GPS tracking and hauling management, central dispatch center	– 238 waste collection trucks	1	US$ 500/ vehicle
SW-03	Construction of modern waste sorting complex and transfer station near to CHP plant: including sorting, recycling, composting station + Increase sorting and recycling: new container sites and containers/bins enabling sorting	– Related to 452,200 t of municipal waste (70%) to landfill + 7,685 waste bins	9	US$ 5 M/ unit US$ 500/ per trash bin
SW-04	Bio waste to energy: Biogas plant	– Biogas plant + CHP (approx. 5 MW)	13	US$ 2,500 /kW capacity

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs (million=M)
SW-05	Landfill Gas Capture Program	– Landfill gas capture plant + CHP (approx. a 10 MW)	35	US$ 3,500 /kW capacity
SW-06	Waste-to-Energy Plant	– Waste incineration plant for waste that cannot be recycled, up to 100 MW (heat + power. 3:1)	60	US$ 700-1,000/kW capacity

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$ /year)	Simple Payback time (years)
SW-01	Collection vehicle conversion to CNG	EE 20% of diesel	10	0.6	24
SW-02	Collection route optimization system	EE 10% of CNG/diesel	6	0.3	3
SW-03	Waste sorting, transfer and recycling station	Reduction of waste volume to landfill by 50%; EE 25% of CNG/diesel for waste delivery to landfill + revenues from recycling	14	1.7	5
SW-05	Biogas plant for bio-waste	Renewable energy 100%	97	5.0	3
SW-06	Landfill Gas Capture and CHP	Renewable energy 100 % heat and power	49	2.5	14
SW-07	Waste-to-Energy incineration plant	Renewable energy 90%	547	4.0	15

The implementation of this investment package could save up to 30 GWh/year (mainly car fuel). 440 GWh of RE as by-product of municipal waste (biogas, landfill gas and waste-to-energy) can be produced. The RE power could be sold and distributed via the local heat/power utility. Almaty can achieve US$ 14.1 million per year in energy cost-related savings and revenues obtained from RE (heat and power). This investment package should have a simple payback time of nine years.

Recommended implementation schedule

The investments in intermediate transfer stations comprising of recycling and composting facilities (SW-03) need comprehensive feasibility studies that should look into the entire waste management cycle – from waste collection and transportation to recycling and disposal to the landfill. The city should also replace the waste collection trucks with more efficient vehicles.

Additional non-investment measures in the solid waste sector could help with the execution of the EE investments and with the monitoring and evaluation (M&E) aspects. These could be:

- a complex study for the municipal solid waste system including collection, transport, recycling, landfill and RE generation;
- support project preparation (see footnote 44);
- waste collection monitoring program;

- public campaign for waste sorting and reduction; and
- capacity building program for technical operators of the waste management facilities.

The parties involved in the implementation of the EE measures in the solid waste sector are the CA through its Division for Natural Resources, the key player involved in waste collection (Almaty Tartip) and the landfill operator. For projects like landfill gas to energy, bio waste to energy and waste-to-energy plant, the Division for Energy from the CA should partner the power plant operator, ALES.

5.3.7 Priority 7: Investments in Residential Buildings

The EE measures recommended in the residential sector in Almaty target primarily the centralized heating system of the multi-apartment residential buildings. These interventions aim to achieve multiple results, like a reliable and affordable heating service for residents in micro-districts with multi-floor buildings, increasing the comfort in homes, bettering the health and living conditions, expanding the lifetime of the building, and reducing non-technical losses and energy waste by implementing an accurate metering and consumption based-billing. These five EE measures listed below would require investments of US$ 1,371 million.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
RB-01	Implementation of individual automated heating stations (IHS) in the multi-store residential buildings	– 7,203 multi-floor residential buildings (26% of building stock)	180	US$ 25,000 per IHS
RB-02	Installation of individual heat meters in all apartments and introducing consumption based billing	– 7,200 multi-floor residential buildings (26% of building stock)	12	US$ 20/meter
RB-03	Replacement of elevator equipment	– 2,118 above 6-floor residential buildings (30% of building stock)	42	US$ 20,000/ building (3-6 lifts)
RB-04	Retrofit of residential multi-store buildings	– 15 million m² in 16,948 multi-floor residential buildings (60% of building stock)	608	US$ 70/m²
RB-05	Solar Rooftop for Residential Buildings	– 1,694,760 roof area on multi-floor residential buildings	530	US$ 2,500 per kWp of PV module

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$/year)	Simple Payback time (years)
RB-01	RB: Automated heating sub-stations	EE 26% of DH to mulita-floor residential buildings	978	13.6	13
RB-02	RB: Individual heat metering and billing program	EE 5% of DH to multi-floor residential buildings	188	2.6	4
RB-03	RB: EE elevators	EE 25% of power to > 9	8	0.5	89

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$/year)	Simple Payback time (years)
		floor buildings			
RB-04	RB: EE retrofit of buildings	EE 35-45% of DH to multi-floor residential buildings	1.317	18.3	33
RB-05	RB: Solar Rooftop photovoltaic (PV)	RE power 100%	742	51.4	10

The implementation of this investment package could save up to 1,953 GWh/year in Almaty. The RB-01 & RB-02 measures target 26% of the residential buildings in the city. The largest measure RB-04 focusing on complex building retrofit targets almost 17,000 multi-floor residential buildings (60% of the respective building stock in the city), and could reduce energy consumption by up to 45%, as compared to 2015. The specific annual energy savings for each invested dollar is 1.4 kWh. Final energy savings should be heat (80%) and electricity generated from RE, both making to 3,233 GWh total primary energy savings, which could translate into 210 million m³ of natural gas avoided.

The simple payback time[50] vary from four to more than 60 years. Metering and public space lighting have a relative short payback of seven to eight years, while a complete building retrofit that could save up to 45% energy is a costly long-term investment to be recovered in 30 years. The savings for residents (measure RB-04) should amount to US$ 18 million per year. Some benefits should be acquired by the DH operator and some at the end-consumer level.

Recommendations for implementation

RE generated by solar rooftop PVs (measure RB-05) could make US$ 51 million revenues under the current feed-in-tariff (FiT) regulation. Operations contracts for RE are profitable for power generation projects under the FiTscheme. This intervention has eight to ten years' payback time, and could be implemented by commercial, professional operators.

The CA through its Division of Housing and Communal Services together with the Apartment Owners Associations (AOA) and the billing company Alseko could be involved in the implementation process. For solar rooftop PVs the Division of Energy from the CA should cooperate with the ALES, the power plant operator. This intervention could be implemented under a PPP.

Additional non-investment measures in the residential sector could include:

- Introduction of energy efficient procurement criteria for new residential buildings;
- Development of a building code with minimum requirements for thermal quality for new and existing buildings;
- Mandatory energy audits and certification for buildings
- Financing program for residential building rehabilitation (window replacement, thermal insulation, efficient boilers etc.) in cooperation with commercial banks in the form of credit lines with partly governmental grant contribution;
- Building inventory for all residential buildings;
- Support for project Preparation (see footnote 44)
- Energy consumption monitoring program; and
- Capacity building program for technical staff operators of the facility and AOAs.

A few additional measures with limited EE benefits could contribute to the overall urban residential

[50] Considering additional operation costs and cost savings

housing development in Almaty - e.g., building residential buildings with high EE performance.

5.3.8 Priority 8: Investments in Private Transport

The shift from individual private vehicles to an attractive public transport can lower GHG emissions and improve air quality in Almaty. Since buses are owned by private operators, investments in new, more efficient vehicles are entirely up them. Hence, a number of soft infrastructure and regulatory measures could help the transport modal shift from private to public transport. The three EE interventions targeting the private (individual) transport need US$ 223 million investments.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
IT-01	Enforcement of Vehicle Emissions Standards, empower technical inspectors, service stations, penalty system for non-compliance	– Applying to 277,000 individual and commercial vehicles (reaching out to 50% of the fleet)	208	US$ 100 per inspection
IT-02	Increase attractiveness of low-emission vehicles: Development of Vehicle Charging Infrastructure Electric, LPG and CNG vehicles	– 40 individual and commercial vehicles (reaching out to 5% of the fleet) + assumed 20 power +20 CNG stations	12	US$ 300,000 per charging/fueling station
IT-03	Car parking Management and Restraint Measures in city center + inspection service	– Applied to 60 km of roads (covering 1% of the fleet)	3	US$ 3,000 /km + 15 parking-management

Preliminary energy saving benefits and economic analysis

Code	Short title of measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$/year)	Simple Payback time (years)
IT-01	IT: Enforcement of Vehicle Emission standards Program	10% fuel consumption of individual and commercial cars	604	35.9	6
IT-02	IT: Fueling & charging stations for low-emission vehicles	15% fuel consumption of individual and commercial cars	91	5.4	2
IT-03	IT: Traffic & parking restraint in center	20% fuel consumption of individual and commercial cars	24	1.4	2

These measures could save up to 892 GWh/year, which are the equivalent of 72 million liters of car fuel. The theoretical payback time for these measures is between three to five to six years.

These EE measures should be implemented by the Almaty CA through its divisions of natural resources, of transport and of urban planning. To enhance the vehicle emission standards the CA of Almaty should coordinate with the Ministry of Transport. The energy savings would be achieved by individual (private or commercial) car operators, with no impact on the municipal budget.

5.3.9 Priority 9: Investments in Power Sector

The EE investments in the power sector aim reduce losses in the distribution system and increase capacity and quality of the power supply in Almaty. The EE plan has two measures totaling US$ 100 million that have been identified from interviews with the Division of Energy, and by analyzing the investment plans of Almaty Energy System, the power utility, and JSC Almaty Zharyk, the SL operator.

Code	Energy Saving Measures	Details of applications	Estimated investment costs (million US$)
EL-01	▪ City-wide Installation of automated distribution system ▪ Rehabilitation of 6 KV network ▪ Rebuilding of 35 KV substations to 10 kV ▪ Transformer upgrade program ▪ Reduction of Non-technical losses program	– according to investment program of Almaty Zharyk Company (AZhK)	60
EL-02	Increase of capacity for power transmission lines	– by voltage shift to 500/750 kV to increased supply from Ekibastuz hydropower stations	40

Preliminary energy saving benefits and economic analysis

Code	Short title of measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$/year)	Simple Payback time (years)
EL-01	EL: Retrofit of distribution network	EE 30% reduction of power transmission& distribution losses of share 30%	192	9.8	6
EL-02	EL: Network capacity increase to import hydropower	Avoidance of power generation losses in CHP, 200 MW replacement	1.398	5.2	8

The retrofit of the power distribution network (EL-01) would help Almaty to reduce losses in the system and save up to 192 GWh/year primary energy. The measure EL-02 targeting hydropower imports should enable RE from regional hydropower plants in order to cover the increasing electricity demand in the city, while in turn, avoid building a new 200 MW power plant.

Considering the primary energy factor for electricity in Almaty, the primary energy savings could total up to 1.6 billion kWh per year (the equivalent of 100 million m^3 of natural gas). The expected costs savings should sum up to US$ 15 million/year. These EE measures should be implemented by JSC Almaty Zharyk Company and Almaty Energy System.

5.3.10 Priority 10: Investments in Commercial & Industry Sector

It should be mentioned upfront that investments in commercial facilities and buildings are under the discretion of the respective legal commercial entities/companies, and they are subject to their business strategy, EE potential and profitability of projects. In many cases, commercial entities lack information on EE/RE technologies and have limited access to finance. Below are some measures that could be taken by the Almaty CA to stimulate EE and RE generation in the industrial &

commercial sector, summing up to US$ 473 million capital investments.

Code	Energy Saving Measures	Details of applications	Estimated investment costs	
			(million US$)	Specific costs
CB-01	Development of EE credit lines for SME, commercial and industry (with special incentives for Almaty e.g., grant or tax deduction component)	– 1,498 relevant commercial entities (10% of all)	300	200,000 per measure in average
CB-02	Information and support program for Solar Rooftops for industrial and commercial buildings	– 555,120 m² of roof area on large industry buildings (20% of the building stock)	173	2,500 per kWp of PV module

The programs can be structured as credit lines (in cooperation with commercial banks), blended with grant incentives of some 5-10% in form of investment grant, loan repay, loan guarantee, or tax deduction scheme. The contribution from the city budget is estimated at US$ 50 million.

Preliminary energy saving benefits and economic analysis

Code	Measure	Energy saving (%)	Annual energy saving (million kWh/year)	Annual energy cost savings (million US$ /year)	Simple Payback time (years)
CB-01	CB: EE credit line	40% share of energy consumption in energy intensive industry	1.349	54.6	5
CB-02	CB: Solar (PV) rooftop program	RE power 100%	243	16.8	10

The implementation of this investment package could save up to 1,024 GWh/year of primary energy in the commercial and industrial sector, with a theoretical payback time of seven years. Although the interventions would not bring any financial returns to the municipal budget, some financial support from the city government is needed in order to achieve energy and costs savings commercial entities, The RE generated by the solar rooftops of the industrial facilities (measure CB-02) could bring in revenues of US$ 17 million/year under the FiT regulation. The clean energy produced could be sold to the local power utility. This RE intervention could be implemented by commercial operators, and it could have ten years in payback time. This measure could be delivered under a PPP. The CA could develop an entity to deliver ESCO services.

5.4 Projected Program Results and Benefits

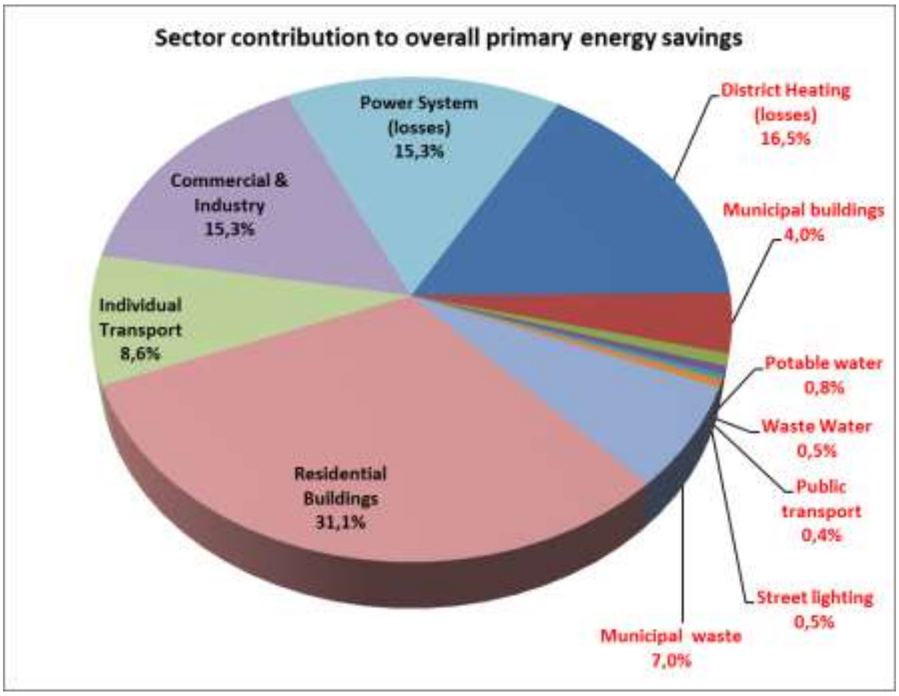
5.4.1 Energy Savings by Sector

The implementation of the municipal EE plan could save up to 10.4 billion kWh/year of primary energy in Almaty in 2030, which is 24% of the city-wide primary energy consumption of the baseline year 2015.

The primary energy savings in the six municipal energy sectors under the CA control (i.e., street lighting, water/wastewater, municipal buildings, district heating, waste management, and public transport) amount to 3,076 GWh/year. This figure accounts for 30% of achievable city-wide energy savings and for 16% of the city-wide primary energy consumption (as of 2015). The highest energy savings could be achieved in the residential sector (30%) and district heating (17%) by reducing energy losses from the heat & power generation and distribution, which altogether would translate into 4,945 GWh/year of primary energy savings.

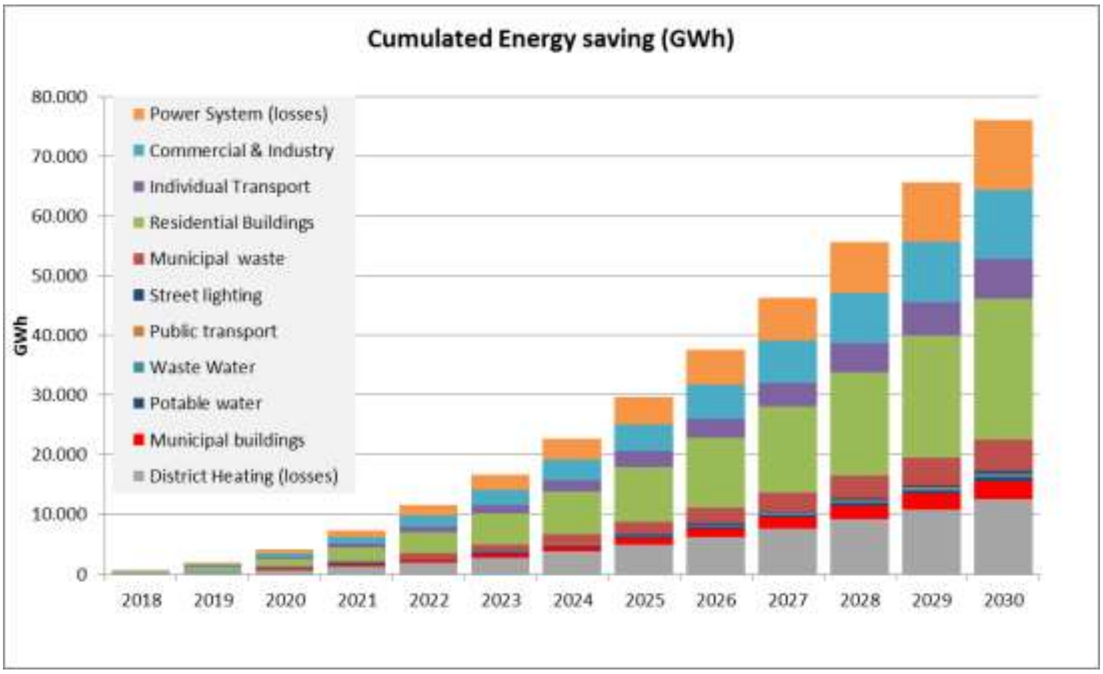
Medium energy saving potentials of 930 GWh/year have been identified in the private & public transport sector (9% savings), power sector by reducing the losses in the system (12% savings) and commercial & industrial sector (15% savings). Significant potential energy saving up to 412 GWh/year (4% savings) was identified in public buildings. A lower level of absolute energy savings is expected to be obtained in street lighting, water & sewage and municipal waste sectors.

Figure 43. Sector contribution to overall annual energy saving potential of 10,383 GWh/year



Between 2018 and 2030 the EE program could achieve total cumulative energy savings of 76,000 GWh, resulting in a specific investment demand of US$ 0.04 per saved kWh of energy. This figure is in the range of average energy costs for public and residential customers at the level of 2015.

Figure 44. Projection of cumulated energy savings in the program period 2018 to 2030



The overall final energy savings envisioned in the EE plan of 10,383 GWh/year are projected to result in city-wide energy cost savings of US$ 289 million per year.[51] Over 14-year implementation period and considering a phased-implementation, this will sum-up to US$ 4.3 billion. The savings accumulated in the seven municipal sectors through final energy savings of 2,288 GWh/year would translate into US$ 73 million per year. Other financial benefits could be in the form of cost cut from O&M and extension of the lifetime of the facilities. The estimated results of the EE program for Almaty has interim targets for 2022 and final targets for 2030 (see Table 17 below).

Table 17. Energy saving targets

Years	**2015 Value**	**2022 Target**		**2030 Target**	
Municipal sectors	**Primary energy consumption (GWh/year)**	**Primary Energy saving compared to 2015**	**Annual primary energy saving (GWh/year)**	**Primary Energy saving compared to 2015**	**Annual primary energy saving (GWh/year)**
District Heating (losses)	5,080	13%	685	34%	1,712
Municipal Buildings	984	17%	165	42%	412
Potable Water	109	31%	34	77%	84
Wastewater	24	89%	22	222%	54
Public Transport	257	6%	15	14%	36
Street Lighting	41	52%	22	131%	54
Municipal Waste	91	318%	289	795%	723
Residential Buildings	10,439	12%	1,293	31%	3,233
Individual Transport	12,079	3%	357	7%	892
Commercial & Industry	8,048	8%	637	20%	1,592
Power System (losses)	3,857	16%	636	41%	1,589
TOTAL	**42,427**	**10%**	**4,153**	**24%**	**10,383**

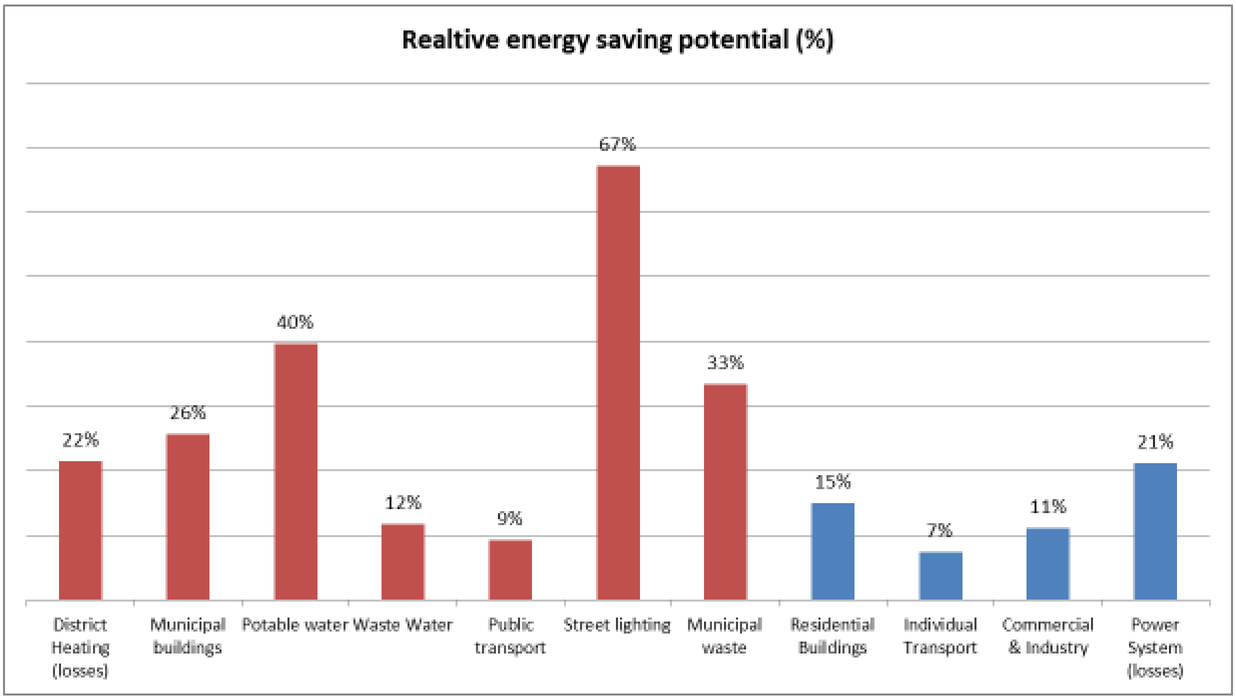
As outlined in Table 17, most of the primary energy savings (94%) can be achieved through savings of 577 million m³ per year of natural, of which 75% is from power and heat generation. In addition, up to 782,000 tons of coal could be avoided (for heat and power production). Another major savings could be in the form of car fuel, up to 75 million liters diesel/gasoline per year.

All targeted municipal sectors have high relative energy saving in the range from 9% to 67%. The TRACE 2.0 study has identified lower energy savings ratios below 20% for non-municipal sectors, such as residential or private transport. This low ratio is because the EE interventions in those sectors and which pertain to soft infrastructure and regulatory measures can target only some of the end-users.

[51] This is calculated based on energy cost escalation scenario of annually 1.5-2% for the period 2018 to 2030.

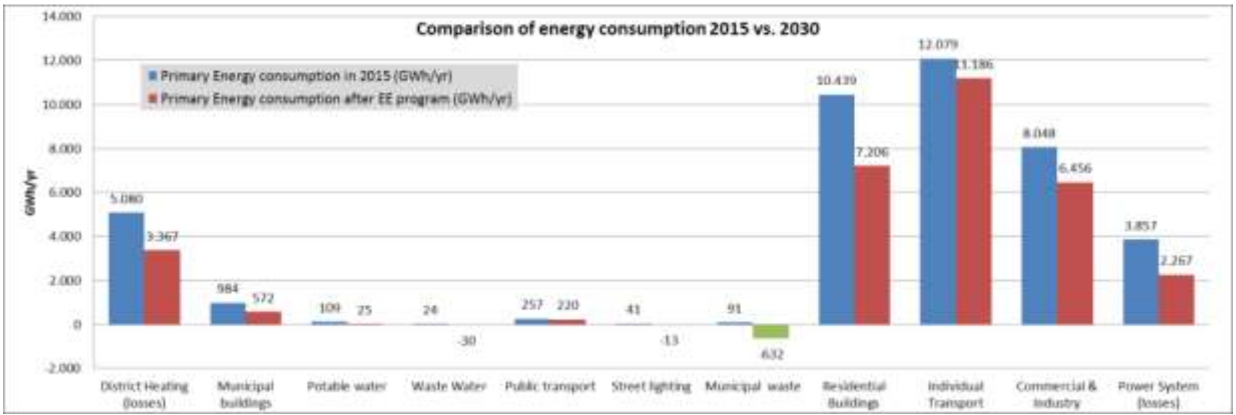
Due to increasing urbanization, additional energy savings such as regulatory measures in the housing sector, were not considered at this stage.

Figure 45. Achievable energy saving ratios by sector



A comparison between the energy consumption in 2015 and the estimated value after the full implementation of the EE program in 2030 shows that the energy demand in the sectors under municipal control could be substantially reduced by 46% in primary energy (with final energy saving of 34%). The waste sector can even turn from an energy consume to a net energy producer, able to generate power & heat from RE produced from waste.

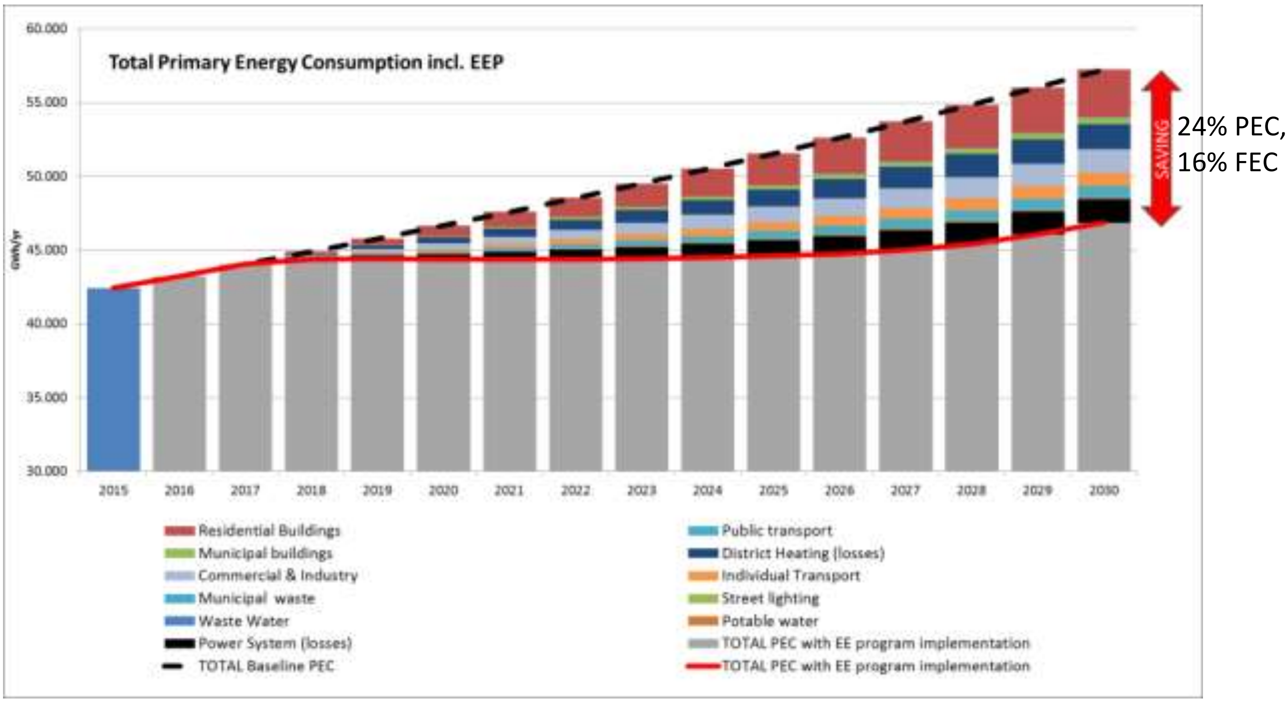
Figure 46. Comparison of energy consumption 2016 vs. 2030



5.4.2 Impact on Primary Energy Balance

Without an EE program in place, the expansion and development of Almaty (1% annual increase in population and commercial activities, 1 to 2% in municipal services and up-to 4% annual increase in public and private transport) is expected to lead to a surplus of 57.2 billion kWh of electricity in 2030. Hence, by 2030 Almaty would require 35% more energy than in 2015. The achievable savings by implementing the EE program (starting in 2018) could overturn this trend and help reduce drastically the energy use in the city. The 35% increase in the PEC can be reduced by at least two-thirds, to 10% (46 TWh in 2030 - see Figure 57). The forecast energy development indicates that this energy demand trend could be hampered by a comprehensive EE investment program.

Figure 47. Projected annual primary energy saving achievements up to 2030



5.4.3 GHG Emission Savings

The implementation of the EE program could lead to 2.9 million tons of CO_2 equivalent savings, which is 26% less GHG emissions as compared to 2015 (11.2 million tons CO_2 emission). Over the program implementation period of 13 years, up to 27 million tons of emissions could be mitigated. There is some high potential in reducing the particle emissions from the local CHPs and boilers relying on natural gas and more coal, with some limited filter-based technology. Avoiding 0.8 million tons of coal per year could help substantially improve the air quality in Almaty. The emission abatement could cost US$ 1,136 per ton of CO_2 per year, which is almost four times higher than the global average for any EE investment.[52] This high specific cost can be explained by the fact that a few expensive measures in some sectors, such as water, transport or waste, although have low energy emission/savings, they actually prompt higher additional benefits, like comfort and supply services.

5.5 Economic and Financial Analysis of the Investment Measures

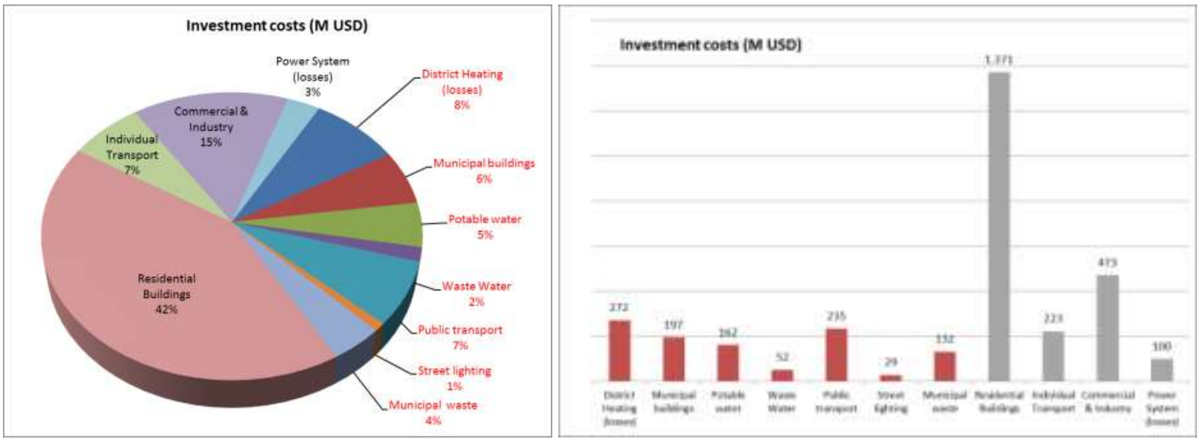
5.5.1 Initial costs for EE measures

The total estimated costs for all 54 EE measures for Almaty amount to US$ 3,247 million[53], of which:

- 8% for power & district heating sector
- 7% for public and private transport sector
- 6% for municipal buildings
- 7% for the potable water and wastewater sector
- 2% for waste management sector
- 1% for street lighting
- 42% for residential buildings
- 15% for commercial & industry sector
- 3% for power system

[52] Climate Change 2014: Mitigation of Climate Change; Cambridge University Press; http://www.ipcc.ch
[53] Investment costs are estimated at the assumption of: the level of 2017 prices, including import duties (on demand), installation, using the currency exchange rate as of May, 2017 (US$ 1 = 310 KZT).

Figure 48. Share (%) and absolute (US$ M) investment cost by sector

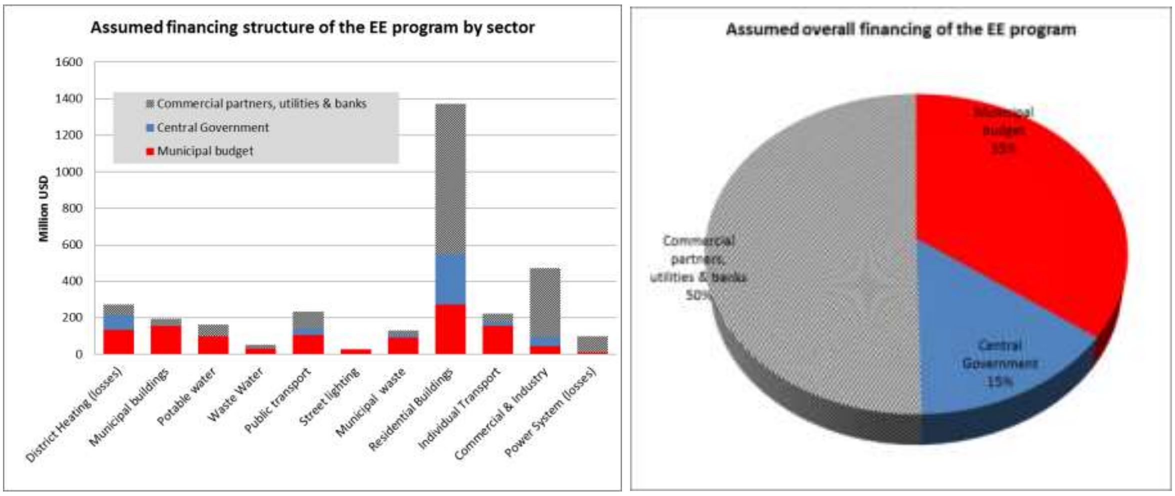


5.5.2 Preliminary Structure of Program Financing

As described in the Sector Analysis section above, there is a wide range of ownerships of the facilities, responsibilities and control over municipal sectors, in addition to expected benefits. Thus, different stakeholders should take part and contribute to financing and implementing of the municipal EE program. The table below outlines potential stakeholders and funding sources.

Stakeholder	Main related sectors or projects	Financing source and type	Total expected financing to the EE program
City of Almaty	Public Buildings, Street Lighting, Waste, Public Transport (partially), Residential Buildings and District Heating	Municipal budget (grants)	Up-to US$ 1,137 million, 35% of total
Central government agencies/ ministries	Utilities: gas, power, water Agencies: transport, waste Partly Residential Buildings and District Heating	Government programs (grants or loans)	Up to US$ 475 million, 15% of total
Commercial entities (service suppliers)	Utilities: District Heating, Power, water ESCO: buildings, industry Domestic commercial banks and IFIs: credits for street lighting, buildings, commercial	Commercial funding (equity or loans)	Up to US$ 1,636 million, 50% of total

Figure 49. Assumed financing structure of the EE program by sector and financier



The recommended investment packages need a phased implementation. This is justified by a number of issues, such as a) complexity and investment demand, b) different priorities due to investment profitability, c) time to prepare the feasibility studies and financial structuring, and d) available capacity and framework as key pre-requisites for a successful implementation. It is recommended to start with short-term measures between 2018 and 2022 to deliver immediate energy savings and benefits, and then continue with long-term measures for the 2023-2030 period.

The EE program could be implemented in four phases:

→ Phase I – start in 2018

→ Phase II – 2018-2020 - pilot and most profitable projects (5-9% of total costs)

→ Phase III – 2020-2026 - intensive implementation (9 -10% of total costs)

→ Phase IV0 – 2027-2030 - completion of remaining long-term projects (4-8% of total costs).

The annual financing demand during the most intensive project implementation phase between 2020 and 2026 would require capital investments between US$ 250 million and US$ 300 million.

Figure 50. Speed of program implementation

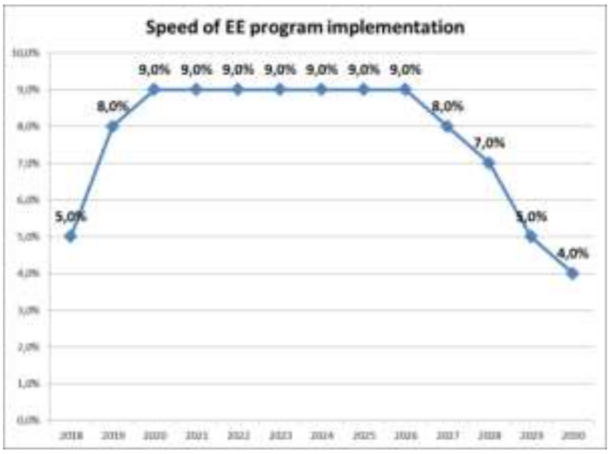
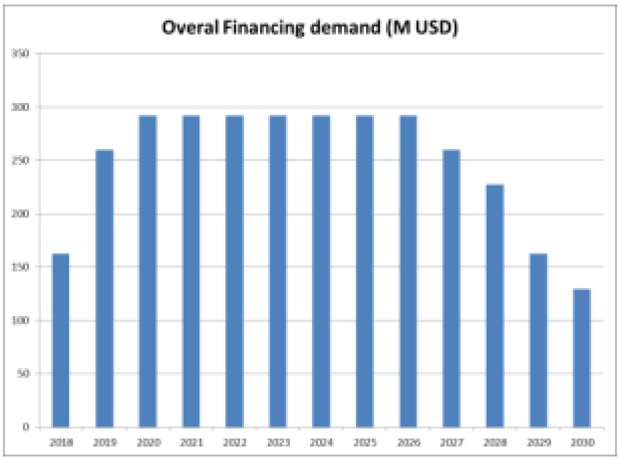
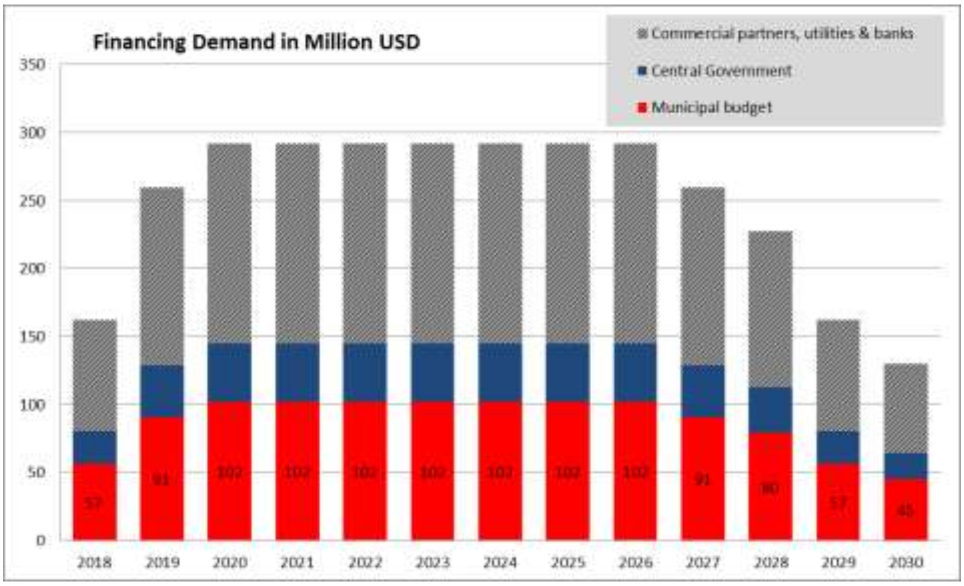


Figure 51. Annual financing needs in million US$



The annual financing demand from the municipal budget (35% of the total) should be between 80 and US$ 100 million per year, which is 5% of the city budget (as of 2015 level). This maximum amount of US$ 100 million is by US$ 30 million higher as the projected annual energy cost savings needed to implement the EE program for the municipal sectors.

Figure 52. Funding demand and sources necessary to implement the EE Plan



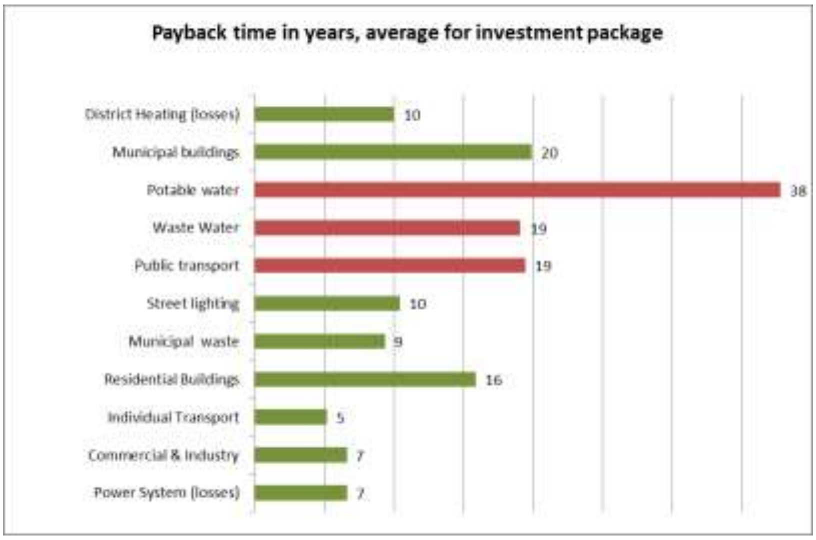
The CA should undertake some steps to facilitate co-financing from governmental programs (grants or loans), IFIs and commercial banks (loans), and also stimulate the utilities and the private partners to take part in the EE program. The actions would include (i) preparation of feasible projects or sub-programs, (ii) development of appropriate delivery mechanisms, and (iii) development of sound financing/project proposals.

5.6 Ranking and Profitability of the Investment Packages

The profitability analysis of the EE investments depends on a few elements. These are a) the energy savings ratio compared to the baseline consumption of the facility and potentially avoided energy demand, b) saved energy costs[54] based on specific levels of energy tariffs and the forecast, and c) investment costs for the EE measures.

The payback time was calculated based on assumptions considering the energy saving multiplied by the projected energy costs (at an increase of 1.5-2% per year on average) and compared to the energy costs of the baseline year 2015. Depending on investments and monetary benefits, the payback time for each measure varies between five to more than 30 years.

Figure 53. Average profitability of investment packages

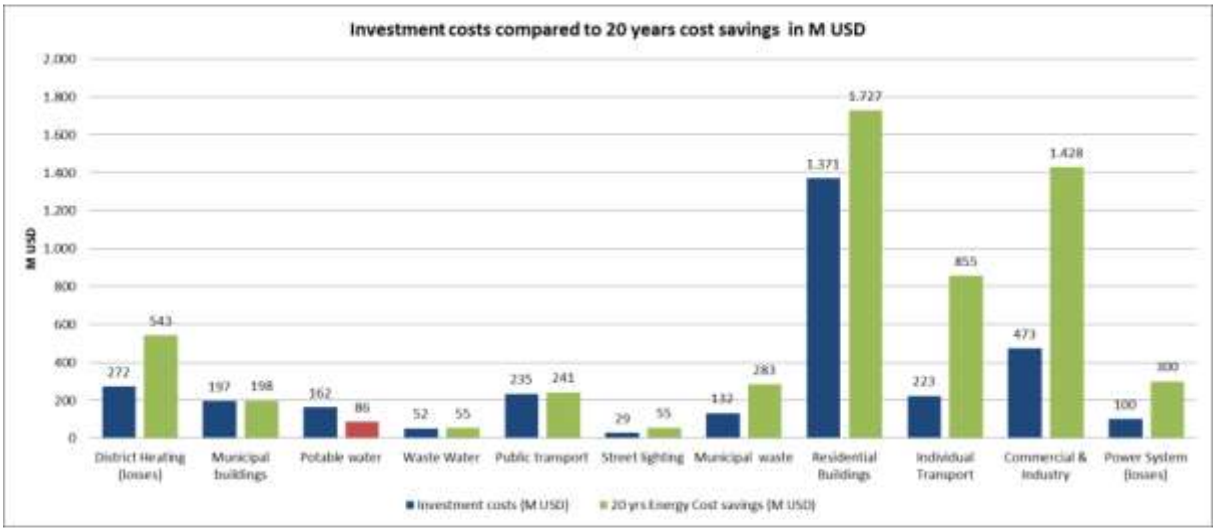


The overall specific primary energy saving is 3.2 kWh per year per each US dollar invested. In some sectors, like potable water and public transport, the short-term socio-economic and environmental benefits must be taken into consideration in the cost-benefit analysis. The 20 to 30 years payback time for EE building retrofit might seem to be long, but the investments are recovered during the lifetime of the building, in addition to gaining more comfort inside the facility.

A rough comparison of the investment costs with the achievable energy (and maintenance) costs savings over a period of 20 years shows that in most sectors (except water supply) the accumulated **cost savings exceed the investment costs**. As mentioned above, energy saving investments in public buildings, water & wastewater sectors are long-term measures. Any decision to undertake such interventions should take into consideration the comfort and environmental gains as well. The proposed investments in the municipal waste, wastewater, street lighting and transport sectors are less costly and have high profitability, due to additional monetary and environmental benefits.

[54] Including an assumption of additional non-energy costs benefits (maintenance) or additional operation costs

Figure 54. Investment costs compared to 20 - years cost savings



EE investments targeting losses in the power and district heat generation and distribution systems are profitable, with less than 10 years of payback time. Similar acceptable level of profitability is indicated for RE generation, such as biogas, landfill gas, waste to energy and solar PV. These projects have great potential for PPPs and should be able to attract private partners/investors.

Based on upfront investment capital and profitability by the payback time, EE investments can be of three types, as shown in Table 18 below.

- Investments below US$ 5 million with relative **good profitability** in potable water, district heating, public buildings and waste sectors should implemented first, in addition to LED in SL.
- A number of medium-sized investment projects indicate **acceptable profitability** within the lifetime of the equipment. These projects are in the buildings, district heating and waste sectors and should be considered for the short- and medium term implementation.
- Large-scale investments above US$ 50 million, such as public and residential building retrofit and development of public transport infrastructure are **long-term investments** since they have **long payback times**. The comfort, social and environmental benefits they bring could make a case to implement them in the short- and medium run.

Table 18. Payback time of projects according to investment level

Investment range	Payback time < 10 years	10-20 years	Above 20 years
< US$ 10 million	DH: Retrofit of pumping stations DH: Turbo Pumps at CHP DH: Advanced de-centralized boilers DH: Solar collector plant for feed-water PB: BEMS for large facilities PW: Retrofit pumping stations PW: Active leak detection PW: Residents water saving fittings WW: Retrofit of WW treatment plant PT: LED Metro lighting & EE escalators PT: Conversion of taxis to CNG SL: Street + Public space LED program SW: Collection route optimization system SW: Waste transfer + recycling station IT: Traffic & parking restraint in the city center	PB: Solar hot water program WW: retrofit of pumping stations PT: Renewal of trolley bus fleet PT: Traffic flow optimization	DH: Retrofit of autonomous boilers PT: Extend the bike renting system PT: Park & Ride hubs SW: New bins for waste sorting
US$ 10 – 100 million	DH: Automated distribution & metering DH: Network upgrade & insulation DH: Pipeline replacement PB: LED indoor lighting program WW: Biogas plant from sludge SW: Biogas plant for bio-waste RB: Individual heat metering and billing IT: Fuelling stations for low-emission vehicles EL: Retrofit of distribution network EL: Network capacity increase to import hydropower	DH: ATKE boiler retrofit PW: Improved water metering program PT: Light Rail SW: Landfill Gas Capture and CHP SW: Waste to Energy incineration plant	PB: School EE retrofit PB: Kindergarten EE retrofit PB: Health facility EE retrofit PB: Other building EE retrofit WW: Retrofit canalization network PT: Replacement of diesel busses by CNG SW: Collection vehicle conversion to CNG RB: EE elevators
Above US$ 100 million	IT: Enforcement of vehicle emission standards CB: EE credit line	DH: CHP interconnection pipelines RB: Automated heating sub-stations RB: Solar (PV) rooftop program CB: Solar (PV) rooftop program	PW: Retrofit water network PT: Extension of metro network RB: EE retrofit of buildings

6 Implementation Plan

6.1 Implementation Strategy

A successful implementation of the municipal EE plan requires ownership and a great deal of commitment from municipal stakeholders. A structured sector analysis to define challenges and measures and understand the associated co-benefits should be developed. It is important to coordinate local policies in order to address the barriers across all sectors. The CA plays a crucial role in setting the cross-sectoral framework for EE. Local authorities can stimulate EE investments and accelerate implementation through a few strategies and policies. Once in place, monitoring, enforcement and evaluation of such strategies are crucial in identifying the gaps and achieving the targets. Also, by compiling the end-user data and reporting it to decision makers could help the stakeholders become more knowledgeable about EE policies.

Hence, the city should focus on the following three key areas:

(i) **Adoption of the EE plan** by the municipal council to set and endorse the EE targets (→ **stakeholder involvement**);
(ii) Development and promotion of **sustainable EE financing mechanisms** (e.g., apply for funds from central governmental programs, loans, commercial banks and PPP schemes) that takes into account multi-year energy savings to repay EE investments; and
(iii) Strengthening **EE delivery capacity** at the CA level by setting up a dedicated **EE unit** responsible for overseeing the implementation of the EE plan.

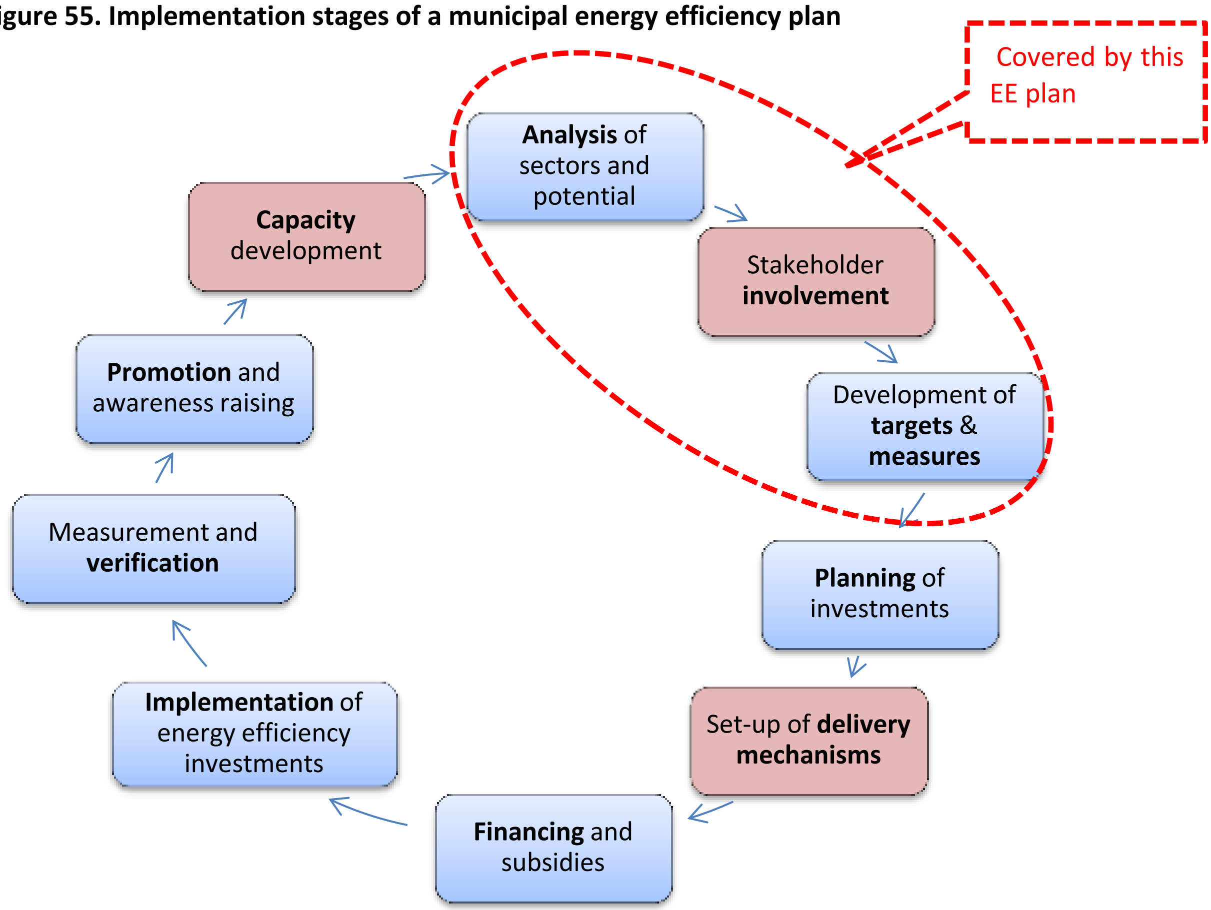
The three pillars necessary for the implementation strategy of the EE plan are summarized follow.

Table 19. Pillars for the EE program implementation strategy

Institutional and capacity development	Financing and delivery mechanisms	Support regulatory framework measures
❑ EE Strategy and Action Plan (in progress) ❑ Energy Efficiency Municipal Task Force ❑ Establishment of municipal energy management (EM) division, enhance and extend its powers, and enable cross-sector activities and communication ❑ Implementation of energy saving responsible in all CA divisions, including training and a certification ❑ Awareness raising and EE promotion programs for all sectors ❑ Capacity building programs ❑ Inventory of all public buildings ❑ Information program and guidelines for EE technologies, EE procurement and project preparation	❑ Feasibility studies and Capital Investment Planning ❑ Purchasing and Service Contracts ❑ Energy Performance contracting ❑ Establishment of a municipal energy service company (ESCO) ❑ Development of municipal EE revolving funds ❑ Preparation of EE project application to "Nurly Zhol" program ❑ Support program for public institutions EE investment projects	❑ Developing a set of regulations and methods for energy saving ❑ Establishment of test databases and laboratories for product certification ❑ Minimum EE performance indicators for equipment and material for new and retrofit ❑ Green Building Guidelines for New Building permits

The Figure 55 below outlines the steps necessary for a successful implementation of a municipal EE plan. The first three steps are covered by this municipal EE program.'

Figure 55. Implementation stages of a municipal energy efficiency plan



The measures aimed at reducing energy consumption in the public sector should ultimately help curb the energy costs, hence create some fiscal space for other government expenditures (e.g., social services, social infrastructure investments, etc.). However, there are several constraints, even in developed countries, that can pose challenges for the implementation of EE programs, such as accounting rules, rigid public sector procurement rules and limited access to budget or project financing. For instance, the procurement criteria about the lowest price do not reflect the life-time benefits of the energy saving investments. High quality materials and equipment with good energy performance are more expensive, but they are able to achieve higher energy costs savings during their life-time cycle. A key element in achieving long-term benefits is to have a professional construction and equipment installation. The lowest cost for installation/construction works might not always benefit of experienced, professional workers. Consequently, public procurement procedures should be adjusted in order to select an offer that combines equipment and works performance together with most optimum cost and life-time benefits. For this purpose, the quality related requirements in the technical specification of the tender documents must be mentioned very clearly, and this should be reflected as such in the evaluation process.

Key factors for implementation of EE program are:

Commitment	Coordination	Capacities
✓ **Commitment and ownership** of an integrated program by top city managers ✓ Government level **defined targets** ✓ Established link of EE policy to the city development policies ✓ EE potential recognized as **key pillar** of sustainable development	✓ **Pool of stakeholders** and decision makers from the city and utilities to agree on the conceptual approach ✓ **Comprehensive analysis** of sector features and challenges, consumption and spending ✓ **Prioritized sectors** for EE intervention ✓ Investment plan prepared ✓ Preliminary projects identified and pilot projects under way ✓ Coordination of EE measures is integrated in the CA	✓ **Understanding** that EE investments could generate economic **returns** ✓ Turn technical proposals into an **investment plan** to approach financers ✓ **Cooperation** with IFIs & donor funding mechanisms ✓ **Mobilization** of international development assistance ✓ EPC as delivery mechanisms ✓ **Capacity** for project and program implementation

6.2 Strengthening Energy Efficiency Delivery Capacity

Building institutional capacity and establishing a focal point focusing on EE in the city is critical for any successful implementation for an EE program. This could be done by establishing a dedicated municipal division for energy EE within the CA.

The existing sub-division for Energy Efficiency within the Division of Energy of the CA of Almaty focuses on heat and electricity supply, and has limited cross sector outreach to other municipal service sectors, such as transport, waste or public buildings. The EE sub-division should undertake more responsibilities pertaining to EE in the public service areas, as well as coordinate and implement the recommended municipal EE program. However, the staffing, responsibilities, tools, project management skills and the capacity to perform adequate energy monitoring and investment planning of the EE sub-division are rather limited. The CA could use some support to build institutional capacity in order to be able to implement the EE program. Best practices in European Union countries illustrate that Municipal Energy Agency (MEA) is the most adequate entity that could help implement the EE program.

6.2.1 Recommendation 1: Establishment of a Municipal Energy Agency

6.2.1.1 Role and Mandate of the Municipal Energy Agency

The CA of Almaty should establish a MEA, with its main role of managing implementation of the city EE program, as well as providing support throughout the execution of the EE interventions. As outlined above, the overall city transformation towards EE can be achieved only by applying a spectrum of investment and non-investment interventions, in addition to technical and non-technical measures. Some accompanying measures to enable the sound preparation and implementation of the EE investments, such as auditing, project structuring, development of tenders, financial structuring and fund raising, as well as monitoring and verification of EE results, are needed.

In order to improve the energy performance for all end consumer groups, including residential, commercial & industrial and public sectors, the city should have information and benefit of support in raising awareness and stimulating EE projects, initiatives and final investments.

6.2.1.2 Tasks of the Municipal Energy Agency

Some preliminary tasks of the MEA should comprise of general horizontal activities, in addition to specific strategies and measures in buildings, district heating and transport sectors.

A) General Horizontal Activities

- **EE data collection and indicators***:* Reliable, timely and detailed data on final energy use, technologies and opportunities in all sectors that could contribute to the development of EE strategies and policies.
- Establishment of a **Municipal EE task force**: This should involve regular meetings of stakeholders to inform and report on program implementation progress and develop EE solutions.
- Transforming EE technical proposals into a viable investment plan to approach financers/ donors.
- **Capital investment planning** for EE measures comprising preparation of pipeline of investments, financial structuring and fund raising.
- **Investment project support**: Organizing and supervising technical specifications, tendering and procurement, as well as qualified construction supervision along with capacity building and guidance to apply best practices.
- Preparation, purchasing and **supervision of energy audits** and feasibility studies for municipal educational and medical facilities (an audit program for up to 200 buildings).
- **Public relation implementation support**, dissemination of program results (information made available on relevant homepages, newspaper articles and newsletters).
- **Monitoring, enforcement and evaluation of EE measures:** Monitor, enforce, evaluate, and periodically update EE measures in all sectors. The program effectiveness should be evaluated during and after implementation, and the results should be used as inputs to for future decisions. Monitoring and evaluation with baseline assessments and periodic review and reporting should be established for new policies and measures.
- Setting up of an **energy consumption monitoring program**.
- **Awareness raising and EE promotion programs** for all sectors by organizing events, competitions and awards (e.g., in schools) and development and distribution of information materials on EE.
- Preparation and implementation of a scheme to integrate energy performance and **life-cycle cost assessment** for purchasing and service contracts, procurement guidelines for lighting[55], devices.
- **Preparation of Energy Performance Contracting (EPC)** by setting up the contracting frame, preparatory energy audits, tender documents and procurements of ESCO services.

B) Strategy and Measures in the Building Sector

Buildings hold great potential for cost-effective energy savings. Barriers such as split incentives between users/tenants and owners/landlords, lack of awareness about efficient technologies, absence of qualified technicians and initial high capital investments threaten market-driven energy savings measures. The CA can eliminate these barriers and achieve building sector energy savings by implementing a package of measures, such as:

- Mandatory building energy codes and minimum energy performance standards (MEPS):
    - All new buildings, as well as those undergoing renovation should meet the energy codes and minimum energy performance standards that tend to minimize life-cycle costs.
    - Support and encourage construction of buildings with higher energy performance standards.
    - Implement policies to improve the EE of **existing buildings** with emphasis on significant improvements on building envelopes and systems during the renovation process. Measures should include:

[55] Besides quality requirements for materials/products such as lifetime and the fulfillment of standards, tender documents for street lighting should include certain criteria for the future lighting level in refurbished streets in the city. The shift to LED lamps has to be carefully prepared because the municipalities have very limited experience regarding the most appropriate capacity/luminous flux/light distribution. Simple replacement of lights is not enough. Due to new technologies, nowadays the luminous flux of LEDs can be much lower than those of conventional bulbs because LED lights have very focused lighting areas. In addition, the data provided by manufactures in the data sheets for LED luminaries is not yet standardized, hence this might allow some non-comparable bids.

- An ambitious timeline and renovation rate for cost-effective reduction of energy consumption in existing buildings.
- MEPS for the building as a whole during the renovation process, including key building-envelope components and energy-using systems.
- Measures to help building owners and tenants to improve EE in existing facilities:
  - Energy audits, energy ratings and certification schemes.
  - Incentives encouraging investments in long-lasting building envelope and system improvements, and increased market penetration of new high-efficiency products.
  - Training to improve the quality and reliability of building retrofit services.
  - Information on financing opportunities.
  - A strong commitment from the CA to improve efficiency of public-sector buildings
- Require building **energy performance labels or certificates** with information from owners, buyers and renters.
- Establish policies to improve the EE **performance of critical building components** to improve the overall energy performance of new and existing buildings, such as advanced control of district heat supply at end-users.
- Repair/ refurbishment of buildings should include basic EE improvements.

Municipal Public Buildings	• Establishment of a municipal building inventory, benchmarking and energy performance monitoring • Energy audits, heat demand assessment and feasibility studies for retrofit • Capacity building program for technical staff operators of the facility • Education & behavior change of employees/users of the city-owned buildings
Residential Buildings	• Building inventory of all residential buildings • Energy audits, heat demand assessment • Capacity building program for technical staff operating the facility and apartment-owner associations • Energy consumption monitoring program for multi-apartment buildings

C) Strategy and activities in the District Heating Sector

- Heat energy consumption standards should encourage installation of meters and heat control devices close to actual heat consumption (for public/commercial buildings at building level, for residential buildings in apartments/rooms) to provide incentives to regulate temperature according to demand and limit waste of energy.
- Develop regulatory measures to ensure that energy utilities support cost-effective, verifiable end-user EE improvements.
- Ensure that verifiable EE options can compete directly with energy supply options in equipment procurement and wholesale markets.
- Compel appropriate energy sector entities (e.g., regulated utility, competitive retail supplier or third-party entity) to deliver cost-effective EE to end-users.
- Require that energy customers be provided with cost-reflective pricing, supporting information and technology necessary to better understand and manage the use of energy.
- Use energy tariffs as a funding mechanism for EE.

D) Strategy and activities in the Transport Sector

The transport sector remains one of the most challenging areas for improving EE. Several measures could tap energy-savings in this sector, notably:

- Enable policies to increase the overall EE of local transport systems, and promote shift to more efficient transport modes, e.g., increase capacity and attractiveness of public transport.
- Build the infrastructure for green and more efficient vehicles, such as electric or CNG cars.
- Implement and periodically strengthen mandatory fuel-efficiency standards for vehicles.

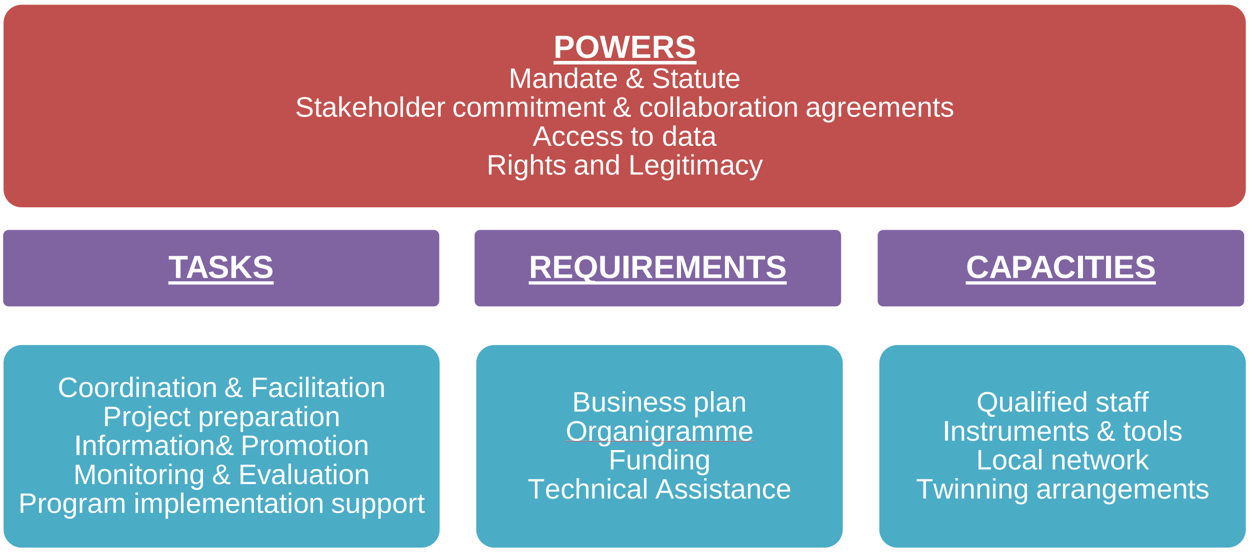
The CA should adopt policies to increase attractiveness of the urban transport, ensuring that

- Users pay the economic, environmental and energy security-related costs of the transport.
- The transport infrastructure is built and maintained to support the most energy and economically efficient and environmentally friendly transport modes.
- Urban and commercial development planning takes into account the likely implications for transport and energy demand.

6.2.1.3 Organization and institutional provisions

The organizational structure of the MEA could be a) commercial legal entity, b) subsidiary of a municipal utility (district heating company), or c) a dedicated administrative unit within the CA.

Figure 56. Key requirements and elements of a Municipal Energy Agency



For the beginning, the only viable option is for the CA to establish a sub-division (or an office) of the existing Energy Efficiency Division that should act as the MEA. On one hand, the CA have some vetted interested in advancing the EE topic, as they know that successful implementation of EE interventions would help make considerably savings to the municipal budget. On the other hand, the market for business for EE consultancy (e.g., utilities and companies) is not yet mature. Nevertheless, on the medium-run, the MEA should transform into a semi-commercial service provider, once the demand for EE services would rise in other sectors than public sectors.

The key requirements for setting-up of the MEA are a clear mandate, qualified staff and adequate budget. The minimum staffing of the MEA shall be of 10-12 people, including: a director, sector specialists and engineers with expertise in engineering, economists (investment project related), a legal expert and a public relations specialist (for promotion/information tasks). In order to expand the Division of Energy Efficiency of the City of Almaty, a capacity building program shall be planned right from the beginning. International donors can be approached to provide technical assistance for business planning and capacity building of the new agency.

Box 2.Municipal Energy Agency Frankfurt (Main), Germany

The Energy Agency (Energiereferat) was founded in 1990 as a part of Frankfurt's environmental department to develop and implement the energy and climate protection plan for the city. In 2008 the city council agreed on a concept of 50 energy savings and climate protection measures. This concept has concrete steps on how Frankfurt can meet its obligations of reducing CO_2 emissions by 10% every 5 years.

The Agency concentrates on four main areas, namely 1) electricity savings, 2) energy planning and combined heat and power supply, 3) reduction of energy consumption and use of renewable energies for buildings, and 4) Masterplan 100% Climate Protection - combining activities in the mentioned areas above

The Agency is developing a concept on how the city can be supplied only by renewable energies by 2050. City residents, architects, urban planners and businesses will be involved in this process.

The Agency's main task is to implement measures for climate protection by bringing together various partners. It sets up feasibility studies and deals and manages with project implementation. The Agency is not a competitor to consultants, planners or investors, but manages projects carried out by different partners. Thus, EE and climate protection can be combined altogether with economic development and job creation.

The City of Frankfurt is member of several European alliances, such as Climate Alliance, Energy Cities and Euro Cities. Frankfurt also signed the Covenant of Mayors in 2008. The Energy Agency is involved in different EU-Projects, such as CHP goes Green (IEE), CASH (URBACT) and PRO EE (IEE).

Source: http://www.frankfurt.de

The Managenergy Network (*http://www.managenergy.net),* established by initiative of the European Union in 2002 aims to assist actors from the public sector working on EE and RE actions at the local and regional levels.

6.3 Promoting Sustainable Energy Efficiency Financing

There are a number of barriers to the implementation of EE programs, including inflexible public procurement procedures for equipment and services and one-year budget appropriations limiting funding of capital upgrades. Financing municipal EE projects can be challenging since cities are often locked into a vicious budget-cycle constraints, while the old infrastructure forces them to use inefficiently use costly energy resources.

EE financing is different from other forms of investment financing. While investment projects are often financed against the underlying asset – a tangible good – EE interventions generate most of their values by future cash-flows obtained from energy savings. Some issues should be sort it out before embarking on the EE plan, such as bundling/pooling of public procurement, multi-year public accounting practices, budget capture and savings retention – benefit sharing schemes.

6.3.1 Financing Mechanisms for Energy Efficiency in Municipalities

The financing mechanisms used typically by cities have an increasing dependence on commercial as opposed to public sources of funding, and they are broadly grouped into four categories.

- **Budget financing with capital recovery.** This includes direct financing from municipal budgets, use of external grants and of budget-capture mechanisms, e.g., fund from the Ministry of Finance (MoF) or a parent budgeting agency using donor funds, with repayments in the form of reduced future budgetary outlays.
- **Dedicated funds developed to address EE**. This requires revolving funds that after being established from the national budget or donor funds to become self-sustaining. The World Bank outlined the design for an EE fund in Kazakhstan in 2016.
- **Direct lending by International Financial Institutions (IFIs) to municipal utilities**. This comprises a public-sector financing mechanisms - provided by donors and/or national or regional governments to municipalities - that can help leverage commercial financing.

- **Leveraging commercial financing using** ESCOs under the energy saving performance contracting (ESPC) approach.

With the exception of budget financing, other funding sources for municipal EE investments require specific mechanisms to ensure repayments of funds, typically through cash-flows generated by reduced energy costs resulting from EE projects implementation. Such repayments need well-defined procedures for determining project baselines, assessment and verification of energy and cost savings, and retention of budgetary savings. Access to non-budgetary financing is linked to the creditworthiness of the municipality, its borrowing capacity, and the delivery mechanisms used for its EE projects. Energy Service Agreements (ESAs) are being used lately to access such financing.

6.3.2 Capital Budgeting in City Governments

The capital budgeting is a tool used for expenditure planning that often includes a multiyear capital improvement plan and preparation of annual capital budget. The capital improvement plan is important because for the purchase, development, expansion or rehabilitation of physical assets, (such as public buildings) requires large money outlays, often beyond the limits of the annual budget. Dedicated long-term planning should ensure that projects are evaluated in a systematic manner, from both technical and financial perspective, thus help the CA select feasible projects that can fit in the municipality's operating and financial capabilities.

Under this approach, financing is provided by a government agency at municipal or central level, such as the MOF, by combining government budget allocations and IFIs or donor funds. This type of funding covers EE investments in public buildings and facilities belonging to the city government. The funding recipient "repays" the funds through savings generated by the investment project in the form of reduced budgets for energy bills in future years ("budget financing"). The energy expenditure is usually based on the energy cost savings. The fund flow to pay for EE improvements follows the same pattern as the regular appropriations from the MOF. The repayment to the MOF could be complete or partial; the partial approach encourages municipal utilities and public agencies to participate in the program because they can retain a share of the savings.

Table 20. The logical flow of a capital planning and budgeting process

Phases	Steps	Results
Planning	Update inventory and assess asset condition; Identify projects; Project evaluation	Infrastructure inventory and analysis of the condition and adequacy of energy and maintenance spending; project list with rough cost estimates (capital improvement plan); detailed construction costs and operation costs; estimation of revenues, comparison with strategic plans, and cost-benefit analysis to identify priorities.
Budgeting	Project ranking	Ranking of projects using capital budgeting methods.
	Financing	Financing arrangements for projects to be included in the budget.
	Budget	Expenditures included in budget proposals of the respective city divisions and placing them in the budget lines; including project operating costs in the long-term budget forecasts for the time when the project is completed and operational.
Execution	Procurement Monitoring	Selection of project contractors; review of physical and financial progress of the project; coordination of spending with revenue flow.
Auditing	External audit	Ex-post review of financial records upon project completion.

The capital budget should have cost estimates for all proposed projects including investment costs and their financial implication on the operating budget. Capital budget preparation requires ranking the project proposals based on the capital budgeting methods, such as payback period, the net present value method, internal rate of return, or profitability index. Box 3 below presents an example of capital budgeting financed by the WB in the Former Yugoslav Republic of Macedonia.

Box 3. Example of Budget Financing: Macedonia

The WB provided a US$ 25 million loan (later expanded to US$ 75 million) to Macedonia to fund the Municipal Services Improvement Project which sought to improve the transparency, financial sustainability and delivery of municipal services in the participating municipalities through a focus on revenue-generating public services and investment projects with cost-saving potential. The loan funds were managed by the Ministry of Finance (MOF) and were on-lent to eligible municipalities through sub-loan and grant agreements on the same terms as the WB loan. The loan repayments were in the form of reduced budget outlays to the municipalities for energy.

Eligible borrowers were creditworthy municipalities that had received MOF approval to borrow, with publicly announced budgets and audit reports. The loan program was supplemented by technical assistance funds for capacity building and institutional reform, and by a performance-based investment grant fund that provided incentives and rewards to cities for implementing initiatives to improve service delivery performance.

Source: World Bank (2009 and 2012b).

6.3.3 Commercial Financing - Provisions and Limitations for Debt Financing

If the city is unable to raise investment funds, it can consider borrowing money from commercial banks and repaying the debt from the cost savings. The city's ability to access external financing is influenced by the national legislation. The city's limited power in raising revenues does restrict its ability to borrow commercial funds for EE projects. Lenders, who are generally more concerned about the city's capacity to service the debt by increasing taxes or user charges, require appropriate collateral/additional resources. Based on banking regulations and commercial lending practices and guidelines, the assets purchased under an EE project are unlikely to be accepted as collateral/additional resources in the case of commercial loans. Many such assets cannot be liquidated to be used elsewhere if the borrower defaults on the loan. Hence, lenders tend to look for either security over municipal assets or for recourse.[56]

The constraints the cities have regarding their own revenues, dependence on transfers and limitations on getting additional resources, in addition to offering recourse to revenue flows – make the local administrations, especially small cities, to be perceived non-creditworthy by lenders. As such, cities may have to rely on new lenders who are likely to need more time to conduct due diligence. Local administrations with bigger and more stable revenues and good borrowing capacity may be able to get money from commercial banks for EE projects.

Also, EE projects generate cost savings, instead of new revenues, relative to a baseline (the costs of energy use in the absence of the EE project). Banks may have issues in defining a baseline, measuring and verifying the savings compared to the baseline, and assuring that EE savings are dedicated to debt service. These challenges can make many banks be reluctant in lending for EE projects. Transaction costs can be another constraint, especially for small cities. Unless lenders are confident that they can develop a portfolio of EE projects with standardized due diligence and processing methodology, they are likely to reluctant to fund EE projects, especially if they know not much about EE investments.

6.3.4 Direct Lending from IFIs to Municipal Utilities

Improving EE in municipal utilities (such as water or district heat supply) often entails large infrastructure investments. Hence, an IFI may provide a loan directly to a municipal utility, with a sovereign guarantee from the national government. Such option has some advantages, as following:

- While the municipal utility could repay the loan with low risk, it may not meet the creditworthiness requirements of commercial banks, and therefore, would not get the money without the IFI loan.

[56] Recourse is used in this respect as: A type of loan that allows a lender to seek financial damages if the borrower fails to pay the liability, and if the value of the underlying asset is not enough to cover it. A recourse loan allows the lender to go after the debtor's assets that were not used as loan collateral in case of default.

- Incentives are aligned between the lender and borrower to seek approval for the economically justified tariffs from the national regulator.
- The IFI and the utility can work together during project preparation and implementation, including on customized capacity building for feasibility analysis, procurement and financial management.

However, one of the disadvantages of this approach is that the IFI should appraise each loan, which would be quite unfeasible for small and medium-sized municipal utilities or projects.
A scheme showing the fund flow for IFIs loans to municipal utilities in presented in Annex

6.3.5 Leveraging Commercial Financing with Private ESCOs

One way to overcome hurdles for financing EE investments could be by introducing the energy performing contracts (EPCs). However, this remains quite challenging for EE financing due to the limitations in municipal borrowing and the early stage for private energy service companies (ESCOs).

The EPC can be a promising delivery mechanism under which an ESCO finances EE investments and, subsequently, gets paid through the full or partial annual energy savings achieved throughout the contract period. Under an EPC, the revenues obtained from energy savings should be used to refinance obligations and also fund other EE interventions. Hence, the EPC could establish a corridor to enable EE savings cash flow from one project to another. The EPC is in line with policies promoted at the highest level in Kazakhstan. The concept of ESCO was outlined during the president’s speech on the Kazakhstan 2050 Strategy and its Step #59 referring to attracting investments in EE through ESCOs, as well as during a parliamentary meeting in February 2017 with the MoID.[57]

EE investments under the EPC scheme would first need embarking on a few steps to set an adequate ground for project implementation, including development of the EPC framework, setting up guarantees, and outlining expected results following execution of EE measures.

Private ESCOs can help overcome barriers in scaling-up implementation of EE projects in the public sector. They can (a) offer a range of services throughout energy services value chain and (b) provide the technical skills and resources to identify and implement EE opportunities, execute services using performance based contracts (reducing the risks to the municipal utilities and public agencies), facilitate access from commercial banks, and enable energy users to pay for services out of the cost savings.

Box 4: Energy Service Agreements (ESA)

Under an ESA, EE Revolving Fund, ESCO or other EE agreements, the service provider covers a full package of services to identify, finance, implement and monitor EE projects. The client is usually required to pay in full or partially for their baseline energy bill, and to cover the investment cost and associated fees until the end of the contract. ESA payments can also be bundled with the client’s energy bills.

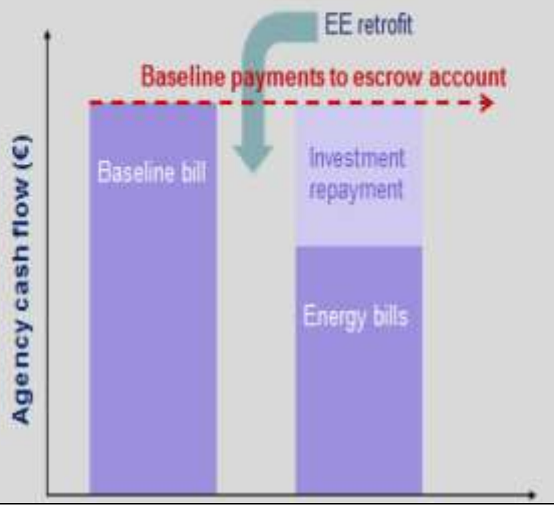
In this case, the figure on the right illustrates how a client’s cash flows under the ESA looks like, with payments that are equal to their baseline energy bill. In some cases, the contract duration has a fixed term; in other cases, the contract can be terminated after an agreed level of payment has been made, which can encourage the client to save more energy.

[57] The meeting was held under “Advisory board on economy policy under Nur Otan”, with the Ministry of Investment and Development.

For municipal clients, ESAs are generally not viewed by MOFs as municipal debt, since they can be long-term contractual commitments or a form of utility service. If both the client and the Fund are public, public procurement rules may not be required, henc making the financing approach a whole lot simpler. This also provides a dual advantage to the client of having relatively simple agreement and allowing carrying very little risk.

Sources: Authors; Kim et al., 2013. Innovations and Opportunities in Energy Efficiency Finance. New York: Wilson Sonsini Goodrich & Rosati, May 2013

Source: The World Bank; Western Balkans: Scaling Up Energy Efficiency in Buildings, June 2014.



To implement the EPC, a set of legislative, regulatory and policy initiatives are necessary, such as:

- Creating a large and stable demand for energy services projects in the public sector;
- Removing barriers to public procurement of EE services and establishing clear regulations and procedures for public agencies to work with private ESCOs (budget regulation, procurement regulation); and
- Facilitating adequate and affordable financing of private ESCO projects.

For example, the budgets in the public sector are often submitted and approved on a single-year basis rather than an extended (e.g., five years) period. This makes multi-year planning for facility upgrades quite difficult and, in general, can impede the multi-year contracting. The time span of an annual budget is too short for adjusting expenditure priorities. This is particularly problematic for EPCs, since such contracts require several years of energy savings in order to allow recover the investments. Multi-year budgeting could ensure that commitments made by governments are consistent with the medium-term fiscal outlook. Multi-year budgeting would also allow for better connections between policies, planning and budgeting.

6.3.6 Recommendation 2: Establishment of a Municipal Public ESCO

As outlined above, the most appropriate delivery scheme for EE measures should be an EPC operated by a municipal ESCO. A municipal ESCO is the most appropriate entity for developing, financing and implementing EE projects in municipal buildings and street lighting.

The existing legislation on public procurement and budgeting does not allow public entities to sign EPC contracts. Since there is no legislation on ESCO and developing such legal framework would be a long, complicated process, the EPC scheme could be set and implemented under the existing public-private partnership (PPP) legislation. The legal framework for PPP could enable the environment for EPC, help design the EPC contracts (e.g., PPP-EPC), and streamline the revenues for the EE interventions. The maximum duration of a PPP could be 30 years, while a PPP contract could be executed through a Special Purpose Vehicle (SPV) in the form of ESCO.

To attract the private sector, the EPC-PPP scheme should be designed based on a PPP in-built model that would partner a public (super) ESCO with companies from the private sector. The EPC-PPP scheme could take the shape of a public ESCO designed in the structure of a Joint-Venture PPP between the public and private sector. Essentially, two types of stakeholders are involved in the EPC-PPP structure playing a direct/indirect role, namely public and private actors.

The ESCO could be responsible for project development and implementation, and partial project financing. Preparation and monitoring shall be undertaken by an independent or the city affiliated energy agency, while the implementation by a commercial entity, namely the ESCO. This independent ESCO could be a commercial entity with shares from the city CA or a municipal utility. If all EPC-related steps would be implemented by one entity, some bias situations and conflicts of interest would be inevitable, and so the ESCO business would not be commercially sustainable. The disadvantage of this approach is the participation of commercial partners and having standardized procedures for tendering of services. The CA, as beneficiary of the project and of energy savings, could provide loan guarantees or partly contribute to initial costs and return on investments to the ESCO from energy savings.

A separate concept note on EPC-PPP has been developed by the WB team, detailing how this scheme could actually work in the local context in Kazakhstan. It outlines three business models that could be considered by the local authorities, namely service contracts PPP, operation (concession) contracts, and a joint venture under a Special Purpose Vehicle in the form of ESCO.

Getting started

To turn the EE program into practice a practical pilot scheme of delivery mechanism needs to be established for the most viable pilot projects, with acceptable capital investment. The CA of Almaty could prepare a business plan for the ESCO and strengthen its administrative and financial capacity to develop feasibility studies for pilot projects and raise funds for the start-up capital. The EPC-PPP scheme should be tested in municipal public buildings, such as schools/kindergartens and/or street lighting. There could be three types of interventions, as presented below.

a) ***Complex retrofit thermal retrofit program of public buildings:*** An EE retrofit investment program in municipal buildings is in line with measures PB-01/02/03 of the Almaty EE program. A pilot scheme could target a pool of buildings with highest specific energy consumption and demand for retrofit. Such pilot project could include three hospitals with an overall area of 100,000 m² and average 45% in EE savings that would require US$ 12 million investments.
b) ***Indoor LED lighting program for schools:*** The pilot scheme could cover 100 large schools in Almaty. The US$ 6 million investments could prompt 50% in energy savings. These pilot projects, if proven successful, could be scaled-up to other buildings in the city (like kindergartens).
c) ***Public street lighting by LED:*** A pilot project for an LED street lighting program could focus on 16,000 light points in two city district. The investment costs are between US$ 6 to US$ 7 million. Energy savings of average 65% and less maintenance-related costs could lead to annual savings of US$ 1 million over a payback time period of seven to nine years.

Box 5: Municipal Energy Service Company and Municipal Energy Efficiency Revolving Fund in Ternopil

Ternopil, a medium-sized city in the West of Ukraine, has received technical assistance from the WB's ESMAP program to deploy TRACE and develop a municipal Energy Efficiency Transformation Program in 2015. The plan was adopted by the City Council in early 2016. The investment program recommended retrofitting of 46 municipal buildings, mainly schools and kindergartens, for total investments of US$ 11.4, with heat energy saving potential of 60-75% - up to 16 GWh per year. Limited funds from the local budget, on the one hand, and high commitments by the CA, on the other hand, led to a delivery mechanism based on the EPC scheme.

International consultants developed business plan for a municipal ESCO and strategy to the set-up of municipal Energy Efficiency Revolving Fund (EERF) under the city's financial department. The business model is based on a revolving fund that will finance energy saving investments carried out by the municipal ESCO starting with selected and most economically viable buildings. The municipal ESCO will be a subsidiary company of the city owned district heating company, while the EERF will be a separate, fenced account in the city budget, which should help arrange investment contributions for the EE projects identified by the Energy Office of the city. This institutional setting will ensure transparent procedures along with a reduction of transaction and operational costs. This model will use up-front funding from the city budget to retrofit 5 public buildings. The financial benefits are expected to flow back to the EERF, hence provide new capital for EE investment for the next buildings. The EERF provides funds for energy facilities in municipal entities and for investment preparation. The EERF has applied for funds from the Ukrainian Municipal Infrastructure Facility (funded by the European Investment Bank and administrated by the Ministry of Regional Development) for scaling-up EE measures. The implementation based on funds available from energy cost savings revenues will enable 10-15 building retrofits over a 10-years period, while ensuring the financial self-sustainability of the scheme.

Source: World Bank (2016), City Administration of Ternopil (2016)

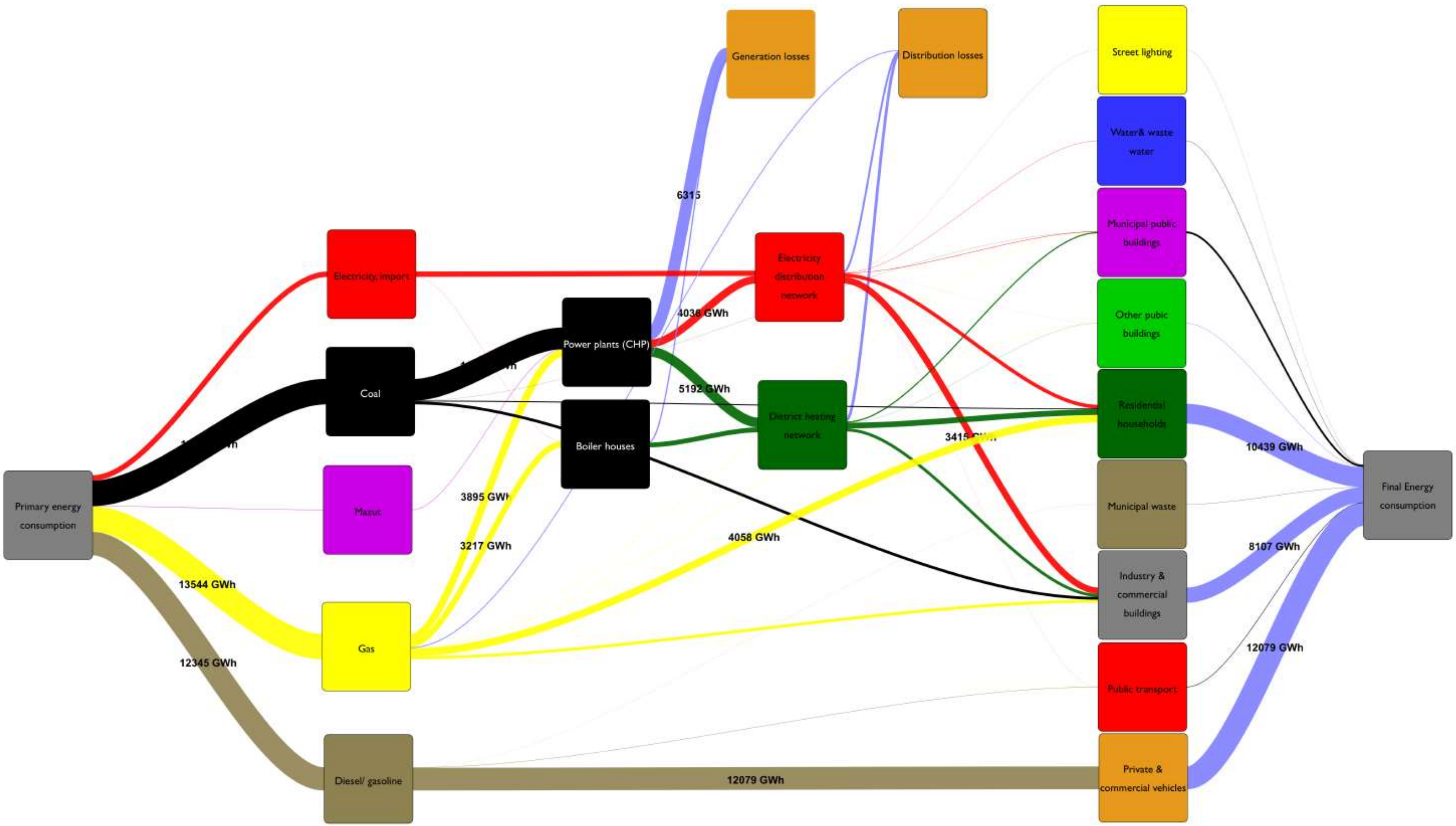
6.4 Program Implementation Roadmap

The city needs a comprehensive package of measures to address the challenges in the municipal sectors. Almaty should have a clear roadmap to implement the EE measures. Non-investment activities should help establish the framework and delivery capacity for investments. Table 21 below presents a general roadmap for scaling-up EE in municipal sectors for the next two years.

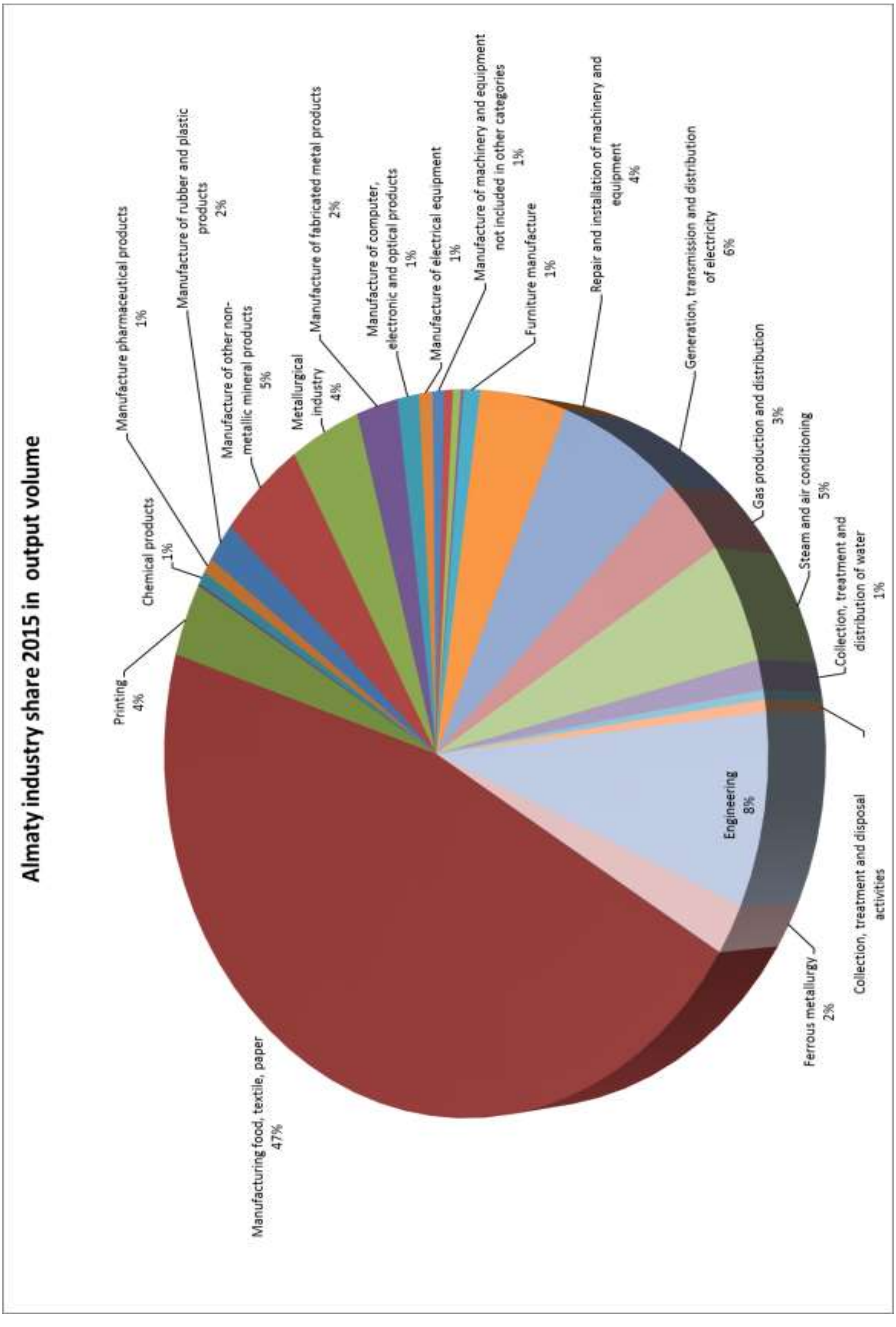
Table 21: Recommended short to mid-term actions to begin implementation of the EE Program

6 months	Enhance and Empower the **Municipal Energy Management Division** →	Development of a Municipal **Building Inventory** →	Development of **energy audits** and project proposals for funding
12 months	**Business planning** municipal ESCO and PPP →	**Feasibility studies** for sub-projects with fesible funding →	**Piloting** of EPC for public buildings and LED street lighting
18 months	Set-up the Program Implementation Unit **(PIU)** →	**Tender** and procurement of services, equipment and works →	**Implementation** supervision, completion and commissioning
24 months	Extension of the **pipeline for EE investment** projects →	Raising cross-sector **information and awareness on** EE →	Benchmarking and Energy Performance **Monitoring Program**

Annex 1: Sankey Energy Flow Diagram for Almaty City in 2015 in GWh/year



Annex 2: Industrial Sector Contribution to the Gross Regional Product in Almaty



Annex 3: City-wide Energy Consumption and GHG Emissions Factors

Figure 57. Share of city-wide final energy consumption by sector and energy carrier

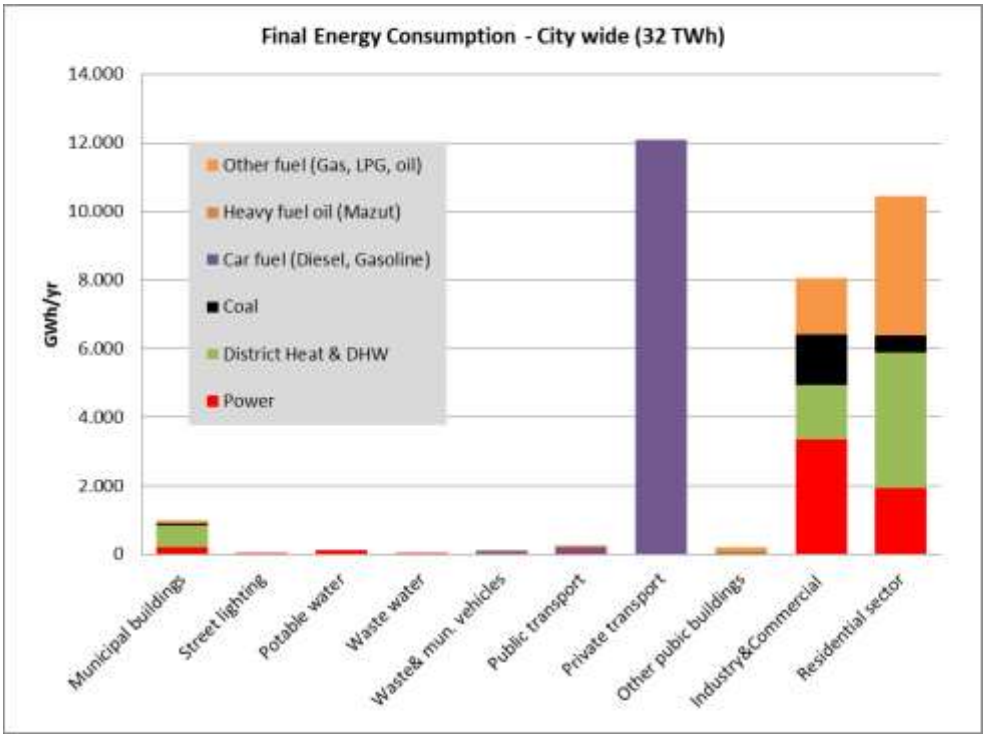


Figure 58. CO_2 emission factors

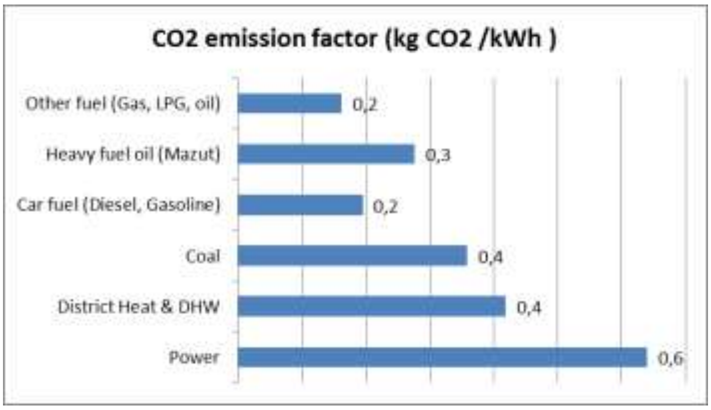
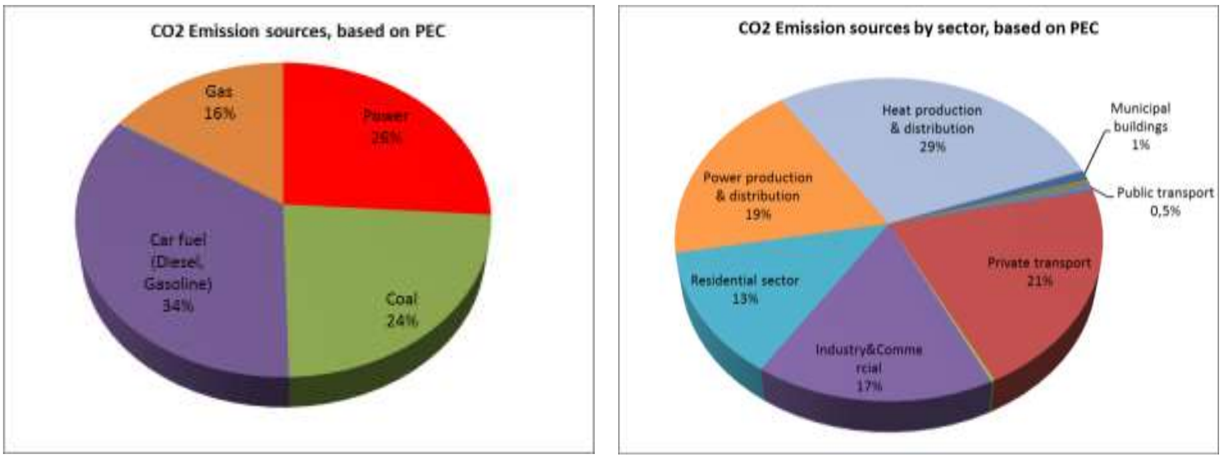


Figure 59. CO_2 emission sources based on primary energy balance



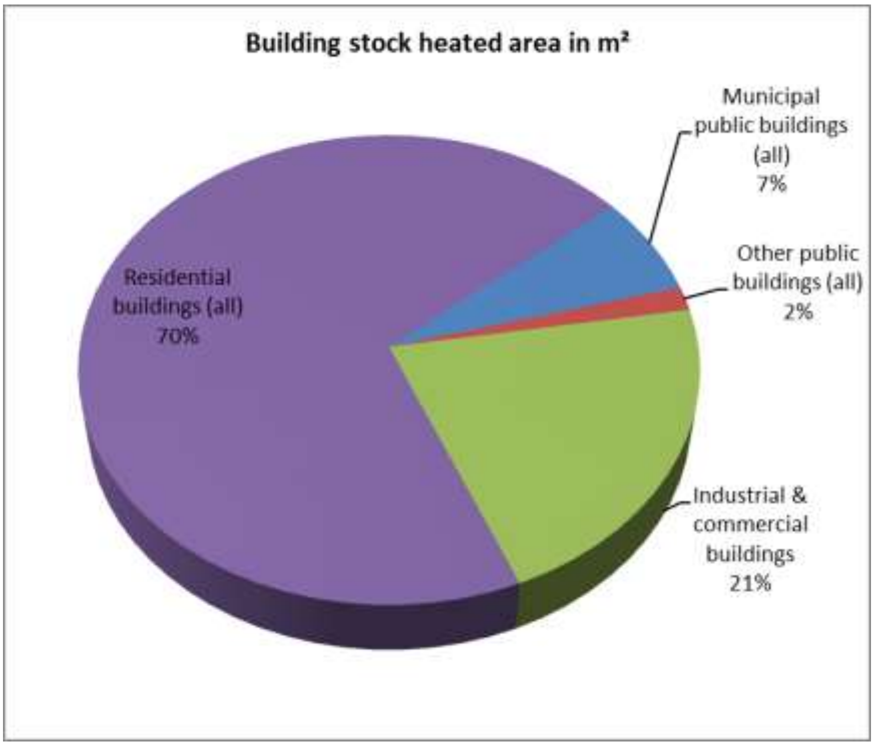
Annex 4: Sector Analysis – Non-Municipal Sectors

1. Sector Analysis Residential Sector

1.1. Infrastructure – Building Stock

The residential sector is one the largest energy user in Almaty. Residential buildings account for 70% of the total building heated area in the city (as shown in the figure 60 below). The city has 157,516 residential buildings, totaling 40.7 million m² comprising 639,142 apartments. Around 28,250 are multi-storey buildings and 129,000 are individual residential buildings. 60% of the housing in the residential sector is privately owned, 20% is owned by the public sector, and 20% is rentals.

Figure 60. Building stock in Almaty - heated area



80% of the residential buildings are old houses and 20% are new buildings. Most apartment buildings have nine floors with 54 apartments each, while residential buildings have usually 12-16 floors. The city also has small stock (8,135 units) of two-storey constructions from the Soviet Union period, facilities that were built for workers and used as multi-family housing per unit. Due to population growth, in recent years Almaty is experiencing a substantial growth in the residential housing sector by one million m² annually.

The vast majority of the real estate stock in Almaty is privately owned. Residents pay their utility bills directly to the supplier. The water, power and cooking gas is metered and billed based on actual consumption, while district heat is calculated on the share of the building consumption.

The apartments in the residential buildings have been privatized by tenants and by the apartment owners' associations (AOAs). Building owners delegate to AOAs the rights on building maintenance. AOAs can contract companies, including an ESCO, for providing maintenance services to the buildings. However, most AOAs do not have much power and their role AOAs regarding building management should strengthen. As a part of this process, the responsibility for building maintenance as well as for the payments of utilities at the building level has been transferred to tenants. AOAs are responsible for maintenance of common areas and the technical building system. Building maintenance is financed through monthly charges collected from tenants and paid directly to utility companies.

However, AOAs did not play a significant role regarding utility services, and the utilities must deal with a large number of individual clients. While it is quite inconvenient for utilities, this also limits the tenants' option to implement any energy savings measures at the building level. Also, building residents lack information and capacity with regard to managing the AOAs and to dealing with residents who do not pay their bills or with vacated apartments.

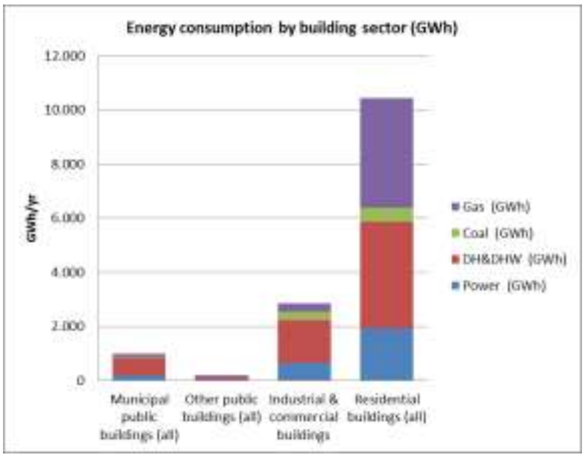
The CA has no control over the energy use in buildings, and only very little influence on the types of energy saving technologies that should be used. The chief architect office in the CA grants construction permits for new residential buildings. The performance criteria are incorporated in the construction laws. The capacity to enforce the performance norms is also limited.

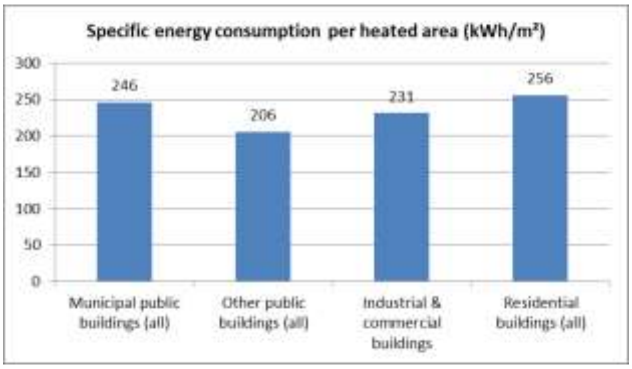
1.2. Energy Performance

Residential and public buildings use the largest amount of energy among the entire building stock in the city --250 kWh/m² - which is 10% more than industrial facilities, for example (see figure 61). 65% of the energy consumed in public buildings is district heat, with power consumption accounting for 21%. Coal and gas is used in a limited amount, for space heating mostly.

Overall, there are 58.1 million m² of buildings in Almaty, including all types of buildings, consuming 14,481 GWh of energy. This is 144,078,000,000 KZT. The residential sector is the largest user among all types of buildings the city, with heat and gas accounting for almost equal shares. The industrial and commercial sector is the second largest user. Municipal buildings are the third largest consumer among buildings in Almaty; the heat holds the largest share, followed by power and gas.

Figure 61. Comparison of absolute and specific energy consumption in different buildings in Almaty

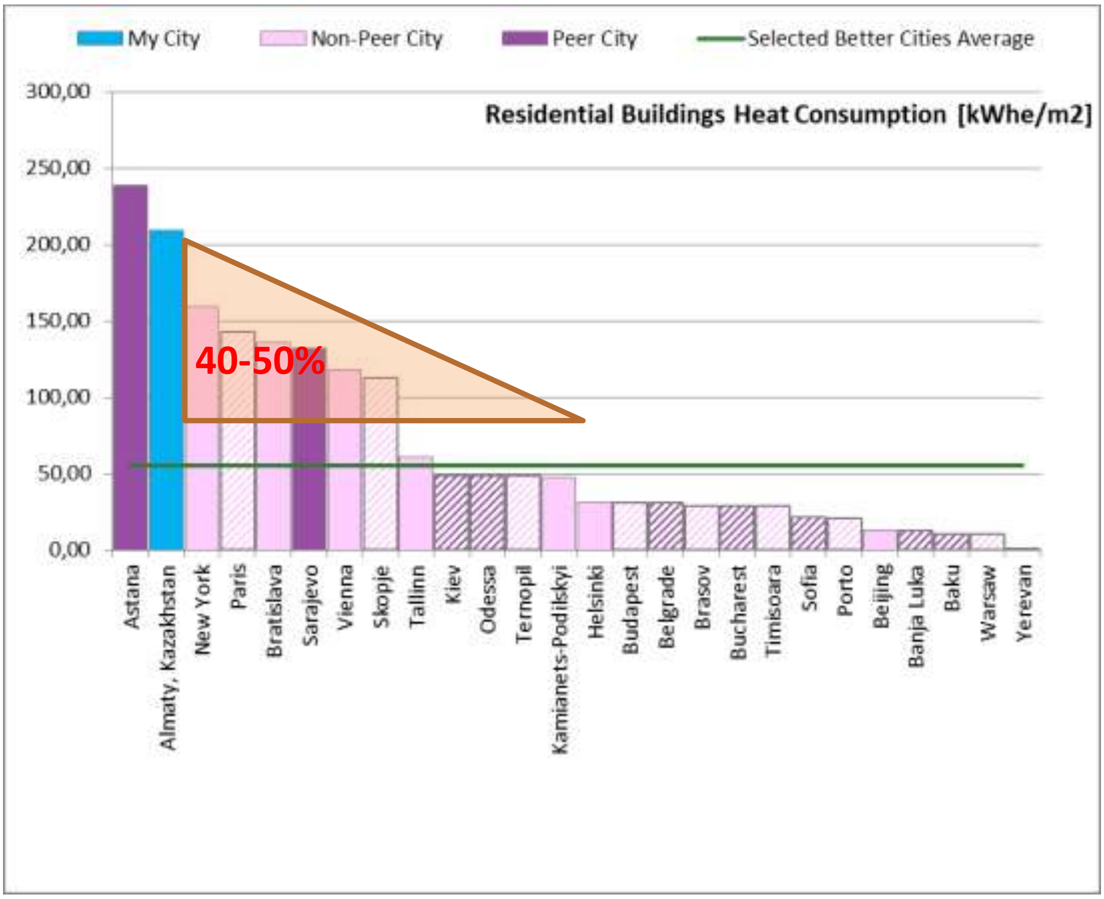




The total energy consumed in the residential sector in Almaty in 2015 amounted to 10,439 GWh, of which power was 18%, almost 38% district heat, 39% natural gas & oil, and coal 5%. Expert estimates shows that overall annual energy expenditure in residential buildings in Almaty is KZT 63.8 billion (US$ 287 million). Although electricity is 18% of the total energy use, the power bill accounts for 56% of the overall energy bill, at a tariff of KZT 18.8 /kWh (US$ 0.08). Conversely, although accounts for 38% of the energy balance, district heat is only 25% of the bill. The cost of 1 kWh of heat including 12 VAT is KZT 4 (US$ 0.01/kWh).

The benchmarking made by TRACE 2.0 in comparison with peer cities with similar HDI shows that Almaty has one of the highest heat consumption, with 209 kWh/m². Almaty is placed in the middle of the comparable cities for electricity use, with 47 kWh m², below Sofia or Belgrade, but above Astana, Kiev or Tbilisi (only 30 kWh/ m²). Heat is cheaper for clients who have heat meters than those without meters (KZT 4,614/Gcal vs. KZT 6,310 /Gcal).

Figure 62. Heat consumption in residential buildings in Almaty



1.3. Main Challenges in the Residential Building Sector

With an expected annual increase in population of average 1%[58], the residential living area in Almaty is expected to expand by 20%, to 50 million m² in 2030, while the energy demand would go up to 12,100 GWh.

The results of the benchmarking based on the TRACE 2.0 analysis indicate that the theoretical relative energy intensity for the municipal buildings sector in Almaty has 40-50% potential savings. This potential can be mainly achieved by implementing EE measures that not only would reduce energy consumption, but also improve the level of comfort in buildings. These include LEDs, a heat distribution system with temperature control at the building level, heating point/substation and

[58] The population of Almaty grew fast over the last decade, around 3-5% annually. The trend of population growth has decline slightly by 1-2% per year, according to interviews with the architecture office of Almaty.

rooms, and insulation of heat pipes in the building basement. Proper thermal insulation of buildings would increase the level of comfort in apartments. In addition, the heating points in the basements should also be modernized. Some buildings need serious rehabilitation of the heat pipes. An automated energy consumption monitoring system would better control the energy consumption. Although some EE measures could be implemented immediately, some may require prior steps.

- *Lack of aggregated data on buildings:* Like many cities around the world, Almaty does not have records with aggregated data on all buildings in the city.
- *Lack of financial mechanism to retain EE savings:* While the options to get public sector financing for investments for the rehabilitation of the municipal infrastructure have significantly diversified in recent years in Kazakhstan, there is a continuous need to attract private sector financing to complement funds from the municipal and central budgets. Private sector investments are necessary in order to facilitate implementation of EE investments at the consumer side, as well as for improving EE for the suppliers. Suppliers are managed by private companies or by entities under municipal ownership which actually work as independent commercial entities.
- *Lack of capacity*: The city lacks experience in using new institutional and financial mechanisms for developing, financing and implementing EE investments in both supply and demand side, like Energy Service Companies (ESCOs), private-public partnerships (PPPs) vendor credits, leasing etc.
- *Lack of adequate energy audits*: Education facilities are required by the law to have energy and safety monitoring audits every three years. However, these audits have only basic information about building infrastructure and no information on energy consumption, much less any EE recommendations. This limited technical information is not enough to produce an adequate energy audit. Moreover, there is no follow-up on the energy monitoring neither by the school nor by the local government. Energy monitoring reports are performed by companies selected under a tender, and paid from the local budget.
- *Limited trained staff for maintenance*: The AOAs have a few people trained for general maintenance service, but they have limited technical and financial capacity regarding energy saving measures.
- *Building codes with no EE standards:* Kazakhstan still uses the ex-Soviet building codes. Although the codes have been updated, they do not include EE requirements.
- *Lack of good quality contractors*: There are only a few companies that could carry out and deliver good quality retrofit and construction work.
- *Limited awareness on EE*: Finally, like in many cities around the world, local knowledge about EE and its benefits is quite limited, and not many can actually understand how savings could be achieved by reducing energy consumption. In residential buildings, less energy usage, with actual consumption based billing, would translate in less money spent from the residents' pockets.

2. Other Public Buildings

Based on expert estimates and compared with some very limited data obtained from energy utilities, the overall area of the 700 government buildings has been calculated to 1 million m². Overall energy consumption of approximately 194 GWh per year was considered for the energy balance. Specific power consumption is 24 kWh/m², and heat consumption is 182 kWh/m². The city has no say over the operation and energy supply of the central government buildings.

3. Sector Analysis - Private Transport

3.1. Infrastructure

There are 554,000 private cars in Almaty, hence it can be assumed that almost every other third person in the city owns a vehicle. In addition, approximately 185,000 cars travel into Almaty daily from other places. 52% of the daily commutes are made by private cars, and only 3% by walking or bikes. On average, a person drives around 30-35 km per day.

The number of transport users had gone up between 2013 and 2015. According to the Division of Statistics of Almaty and the Division of Passenger Transport from the CA, the number of people using public transport increased by 7%, while those relying on private cars went up by 4%. The number of cars driving daily into Almaty also went up by 10%.

Congestion in Almaty is estimated at around 936 hours in year period, with traffic bottlenecks during the morning and evening rush hours, when usually people drive in to/from work. The city has a few parking facilities, some located nearby or at the malls. However, most of the time people leave their cars on the streets, on the road sides or near sidewalks.

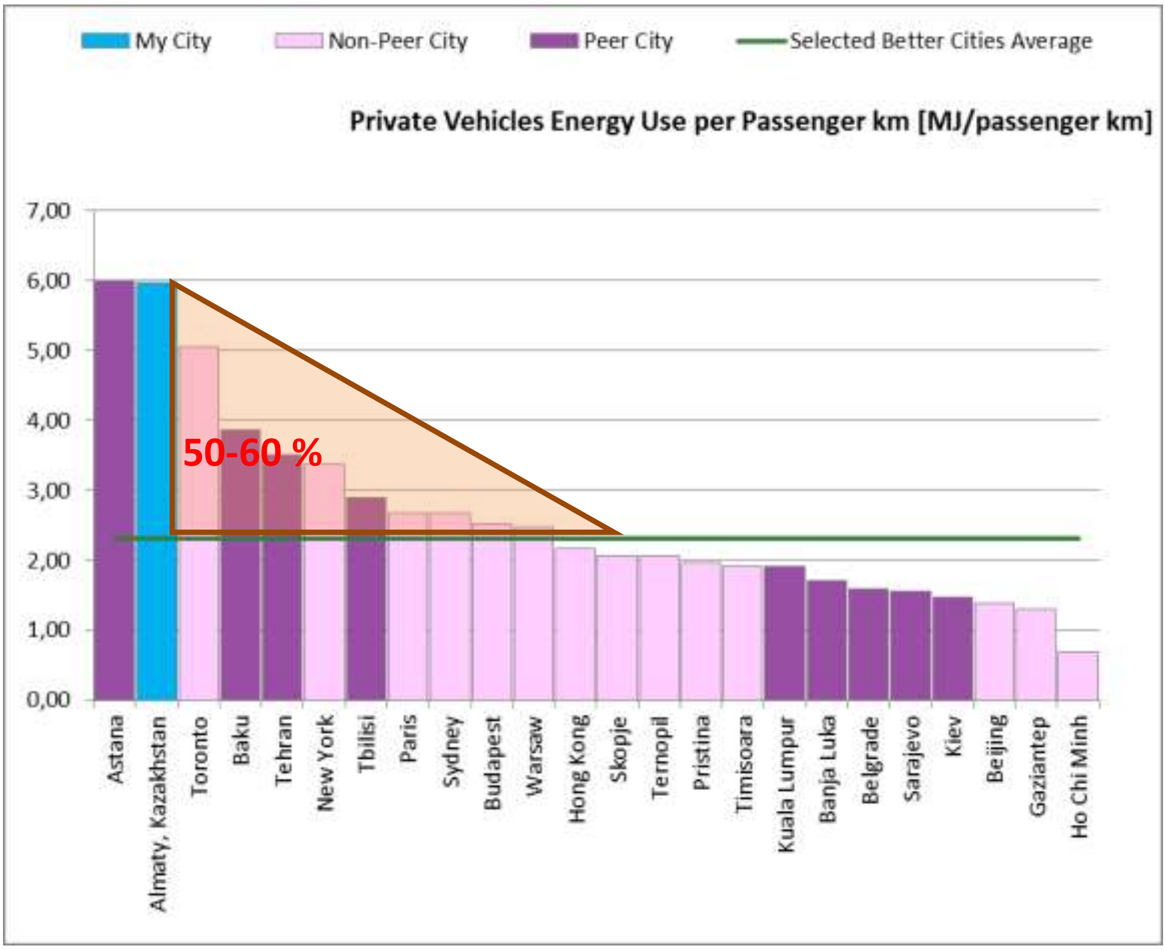
Almaty has 24 km of bike network and a bike sharing program (veloparkovki) managed by the CA from where people can rent out bicycles. Some 120 docking stations for bikes are available in Almaty, in addition to 700-900 parking spots.

3.2. Energy Performance

The TRACE 2.0 analysis shows that Almaty needs 6 MJ per passenger kilometer (with overall 43 billion MJ fuel in 2015) to operate the private transport. By comparison, Almaty requires 30% more energy than Baku and twice as much as Tbilisi.

This high energy consumption can be explained by high share of the private transport among transport modes, in addition to large distances travelled by cars daily. Almost two thirds of the daily commutes take place by private vehicles. Most cars are large vehicles, many of them SUVs with big fuel consumption (average estimate of 20 liter/100 km). Annually, private cars in Almaty spend US$ 555 million for fuel.

Figure 63. Private Transport Energy Performance



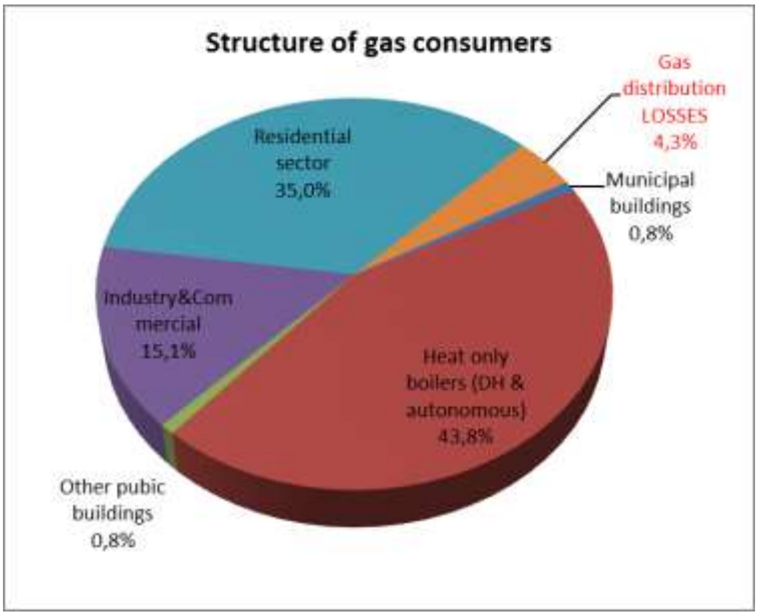
Among all means of transportation, private vehicles have the highest energy consumption in the city – 1.2 kWh/per passenger kilometer. By comparison, this figure is 60% higher than for taxis, almost 80 times higher than for CNG buses, and 23 times higher than for the metro. No mechanism at the city level is available to monitor energy consumption for private or public transport.

4. Natural Gas Supply

The city-wide natural gas consumption in 2015 in Almaty was 49 million m³. Natural gas is supplied to end-users by a 5,000 km of distribution network. There are four distribution companies, of which ACE KazTransGas-Aimak is the main player. The city has good levels of gas supply, with a gas security index in 2015 of 95-97% for residential buildings. 43% of the natural gas is used to generate heat, 35% goes to the residential sector, 15% to the industry and commercial sector, while municipal buildings use 0.8%. However, only 65% of private individual houses (approximately 31,000) are connected to the natural gas network. The city consumes only a small amount of liquefied gas, since nowadays the tendency is to switch to natural gas. In 2015, the natural gas losses were approximately 49 million m³ (4.3% of the supply).

To improve the gas distribution capacity in Almaty (in sub-urban settlements in particular) and the overall performance of the system, the local government is planning to build a bypass pipeline for Natural Gas Distribution Station 2 and a transmission network ring around the city. This should help sort out the heat supply issue in the residential and commercial buildings relying on natural gas.

Figure 64. Gas consumption in Almaty



Annex 5: Direct Lending from IFIs for Municipal Utilities

Below is the scheme for lending and repaying the loan from energy savings.

Annex 6: Municipal Energy Baseline and Development Scenario

Methodology for the quantitative analysis of sectors

The EE investment recommendations were analyzed both from qualitative and quantitative perspective. The qualitative evaluation took into consideration the implementing environment, such as regulatory frameworks and capacities. The quantitative evaluation of investment projects was carried out in terms of energy and cost efficiency of the projects, as well as the potential impact to reduce the municipality's energy balance.

The baseline year for all collected data is 2015. The sector analysis uses average cost per energy type in the sector, which subsequently has been used for performing the economic assessment of the respective projects in the specific sector.

Energy cost savings as results of reduced energy consumption were calculated at the average cost of energy over the implementation period from 2018 to 2030. The profitability of each recommended EE investment measure is indicated as simple Payback Time (PBT) by using initial costs and annual saved costs (including some assumptions for additional operation costs or additional non-energy costs savings). A cash flow analysis can be prepared only after a more detailed assessment of selected pilot projects.

Assumptions on energy prices, tariffs and investment costs

The average cost of energy has been determined by a scenario considering the escalation of the energy price. It is necessary to apply such forecast to project the financial benefits and overall profitability of investments over the entire program implementation period from 2018 to 2030. The estimated growth patterns of the energy costs are presented in the Figures 65-67 below. The following assumptions have been applied for the preliminary assessment of EE recommendations/ EE measures.

- *Investment costs* at the level of 2017 price, including import duties (on demand), installation, using the currency exchange rate as of May, 2017 (US$ 1 = 310 KZT)
- *Emission factors* for primary energy carriers of the baseline year 2015; the CO_2 emission factor are presented in Table 23 below.

Table 22. Emission coefficients

Energy carrier	CO2 emission factor primary energy side (kg CO_2 /kWh)
Power (import from KEGOC)	0,90
Power (from city power plants)	0,58
District heat (mix PP&HOB)	0,56
Coal (average Karaganda/Ekibastuz source)	0,36
Diesel/ gasoline	0,19
CNG	0,29
LPG	0,11
Heavy fuel oil (mazut)	0,28
Natural gas	0,16

- *The payback* time is preliminarily calculated based on annually saved energy costs. For this purpose, the 15-year average tariff of the respective final energy carrier is used for the period 2018 to 2030. A moderate annual increase of energy costs of 1.5-2% was assumed.
- The *implementation period* of the EE measure begins in 2018, with the earliest delivery of EE benefits in 2019. Each EE measure is assumed to be completed by 2030.

Average energy commodities prices used for carrying out simple financial calculation are indicated in Figures 65-67 below.

Figure 65. Energy costs for public entities (US$ per kWh) in 2015[59]

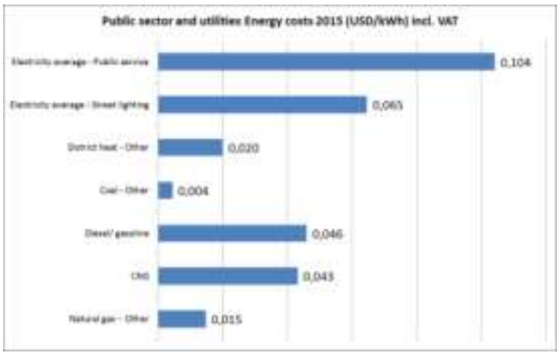


Figure 66. Energy costs for public entities (KZT per kWh 20 years average 2017-37

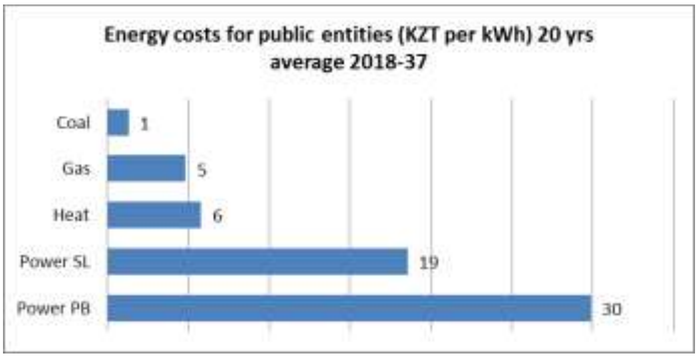
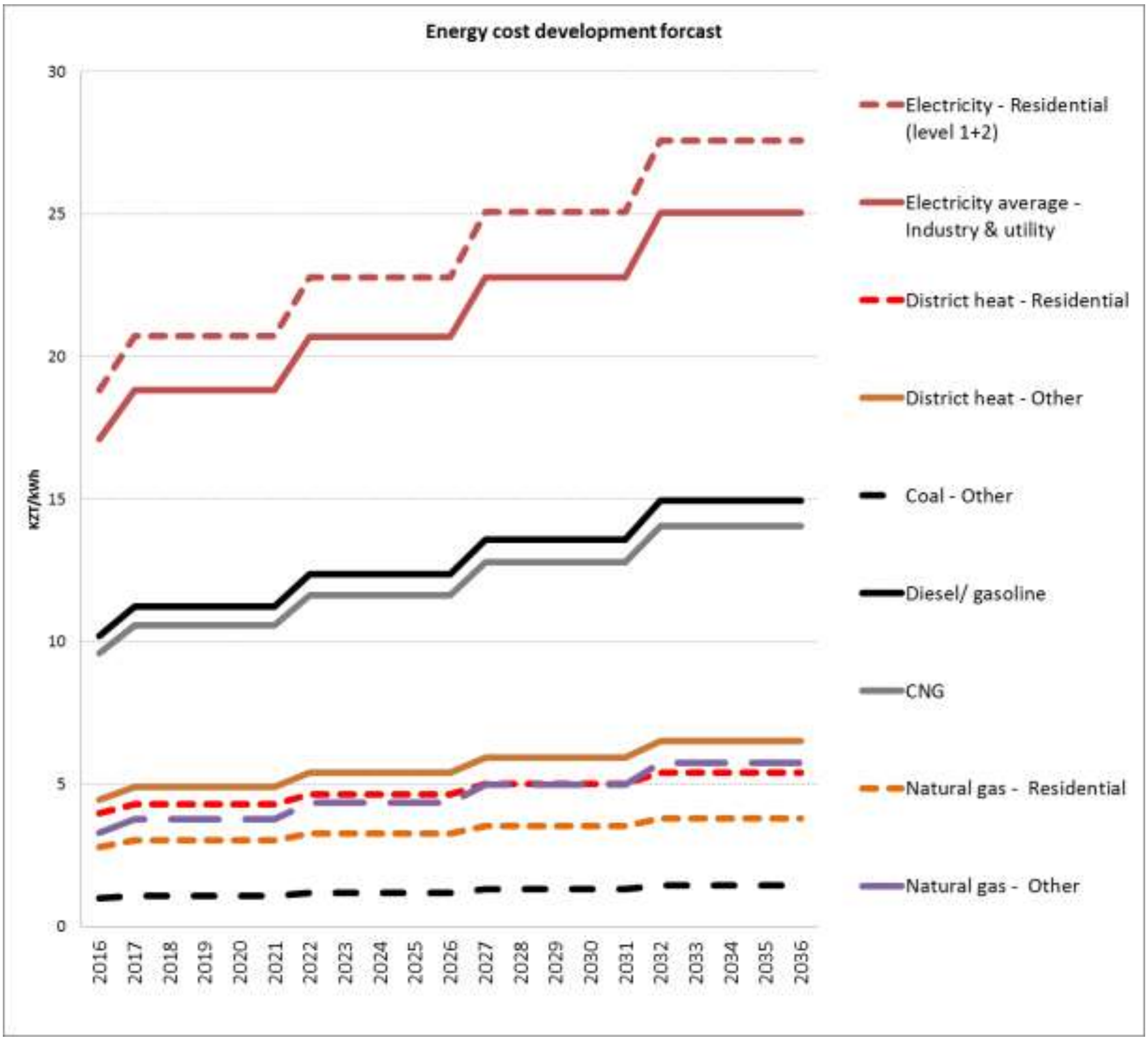


Figure 67. Forecast of energy price development (average 1.5 – 2% increase per year)



[59] Average exchange rate in 2015: US$ 1 = 222 KZT

Annex 7: Municipality Key Performance Indicators in 2015

Municipality Wide Data	**Value**
Population within municipal boundary	1,703,400
Total GDP within Municipality boundary (US$)	36,036,036,036
Total kWhe, electricity consumed	6,866,000,000
Total GJ, primary energy consumed	152,735,475
Total municipal Municipality budget (US$)	2,083,333,333
Total number of households	639,142
Municipal Municipality energy spend (US$)	64,528,780
Municipal area (km^2)	628
Climate type (tropical, arid, continental, temperate)	continental
Human Development Index (by country)	0,780, Kaz average
Transportation Data Points	
Public transportation fuel consumption (MJ)	256,505,740
Private transportation fuel consumption (MJ)	43,483,238,400
Public transportation passenger kilometers	6,201,707,200
Private transportation passenger kilometers	7,279,560,000
Transportation Mode Split (private motorized, public motorized, walk/cycle)	52%, 45%, 3%
High capacity transit (meter)	8,600
Bike Lanes (meters)	24,000
Buildings Data Points	
Electricity consumption in municipal buildings (kWhe)	204,300,000
Fuel / heat consumption in municipal buildings (kWht)	779,755,762
Total energy expenditure for municipal buildings (US$)	35,652,304
Municipal buildings, floor area (m^2)	4,001,770
Municipal buildings, average US$/kWh	0.036
Commercial buildings, average US$/kWh	0.040
Residential buildings, average US$/kWh	0.028
Street Lighting Data Points	
Total electricity consumption of street lights (kWhe)	41,376,387
Total length of roads (km)	6,000
Length of lit roads (km)	5,511
Number of light poles	80,795
Total energy expenditure for street lights (US$)	80,795
Average electric rates for street lights (US$/kWh)	0.0647
Power and Heat Data Points	
Technical T&D losses (kWhe)	1,095,000,000
Non technical T&D losses (kWhe)	64,796,393
Number of households with authorized electrical service	639,142 (100%)
Total electricity produced (kWh)	6,866,000,000
Water & Wastewater Data Points	
Total amount of water sold (m^3)	87,666,577
Energy consumed to produce potable water (kWh_e)	108,863,610
Total amount of potable water produced (m^3)	140,096,183
Energy consumed to treat wastewater (kWh_e)	24,371,226
Total amount of treated wastewater (m^3)	125,400,000
Energy expenditures of the water utility, US$	9,362,448
Total expenditures of a water utility	85,322,859
Number of households with potable water service	95%
Number of households with connection to the public sewage system	488,730
Average water rates (US$/$m^3$)	0.42
Waste Data Points	
Amount of solid waste generated within the municipal boundary (tons)	680,000
Amount of solid waste that is recycled (tons)	2-5%
Amount of solid waste that goes to landfill (tons)	650,000

Annex 8: Main Financing Options for Municipal Energy Efficiency[60]

Mechanism	Main features	Advantages	Limitations	Performance Risk Allocation
Budget Financing				
Grants	Investment costs funded by grant(s) from donor or national government to municipality	Indefinite term No financing costs Can be applied to all municipalities	Limited grant funding available May encourage non-viable projects Not sustainable or scalable	Donor or government providing the grant
General Budget	EE project investment costs funded from general municipal revenues	Can build market capacity No additional financing costs	Budget resources often limited Sustainability not assured	Municipality
Budget Capture	Financing to municipalities for EE projects from MoF, with repayment through savings from these projects	Makes viability clearer Builds market capacity Provides security to financiers	Can be difficult to ring-fence May require recourse to budget Sustainability not assured	Municipality or financier, depending on extent of recourse
Energy Efficiency Funds				
Energy Efficiency Funds	Independent, publicly owned entity provides financing for EE to public clients, with repayments based on estimated energy cost savings	Financially self-sustaining Can finance municipalities that are not able to borrow; Can leverage funds by pooling or bundling of projects and develop simple ESCO models	Recovering operating costs may be difficult in early fund years Reliance on good fund manager Needs municipal repayment mechanism	Fund in the first instance Ultimately, sponsors of the fund
Public Support for Commercial Financing				
Dedicated Credit Lines	'Soft' public loans to commercial institutions for on-lending to municipalities for EE projects	Allows municipalities to undertake own procurement/implementation Can be scalable Funds can revolve	Serves only creditworthy municipalities Requires strong and willing bank partners to develop project pipeline	Entity providing the credit line, commercial financier, and municipality, depending on sharing of losses
Credit and Risk Guarantees	Risk sharing guarantee from donor or national government that covers part of commercial lenders' loss from loan defaults	Allows leverage of public funds Addresses risk perception of commercial lenders regarding EE projects	Can serve only a limited number of municipalities Requires strong and willing bank partners to develop project pipeline	Guarantor for the covered part of the loan and commercial financier for the uncovered part
Commercial Financing				
Commercial Loans	Commercial financing institutions lend money to municipalities for EE projects either directly or through ESCOs using the ESPC mechanism	Mobilizes commercial financing Can be scalable and sustainable Full project cycle is financed With ESPC, risks are transferred to the ESCOs	Banks or ESCOs exposed to bear credit risk Creditworthy municipalities only High due diligence costs ESCO industry hard to develop	Commercial financier, municipality, or ESCO

[60] Source: Financing Municipal Energy Efficiency Projects, ESMAP, The World Bank, 2015