Synthesis Report

Unlocking Energy Efficiency Potentials in Cities in Kazakhstan

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This report is part of the project led by Yabei Zhang, with a team comprising of Ana Maria Manuela Mot, Reiner Behnke, Askulu Kushanova, Aliya Iskhakova, and Feng Liu. The work was done in close collaboration between the World Bank team and the city administrations of Astana and Almaty, benefitting from tremendous support from discussions with key professionals from both city administrations, municipal service providers, utilities and relevant stakeholders.

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

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

List of Abbreviations

CA	City Administration (Akimat)	GoK	Government of Kazakhstan
CFL	Compact Fluorescent Light	GWh	Giga Watt Hours = Million Kilo Watt Hours
CHP	Combined Heat And Power Plant (cogeneration)	HDI	Human Development Index
CNG	Compressed Natural Gas	HPS	High Pressure Sodium
DH	District Heating	KPI	Key Performance Indicator
EE	Energy Efficiency	KZT	Kazakh Tenge
EERF	Energy Efficiency Revolving Fund	LED	Light Emitting Diode
EPC	Energy Performance Contracting	PEC	Primary Energy Consumption
ESCO	Energy Service Company	PPP	Public Private Partnership
ESMAP	Energy Sector Management Assistance Program	RE (S)	Renewable Energy (Sources)
GDP	Gross Domestic Product = GRP	SL	Street Lighting Sector
GRP	Gross Regional Product	SPV	Special Purpose Vehicle
GHG	Greenhouse Gas Emissions	TRACE	Tool for Rapid Assessment of City Energy

Introduction

An energy-driven economy, Kazakhstan is adjusting after the drop-in of the oil price in 2012 that triggered a decline in the country's trade and exports, currently undergoing a process of economic diversification towards a sustainable, green economy that should cut by half the energy intensity of the country's GDP by 2050. In this context, EE policies are important tools in helping address the growth-slowing of energy shortages, improve industrial competitiveness, and mitigate the consequences of the rapid rise in domestic energy price.

This report outlines the key results and findings of an energy efficiency (EE) study "Energy Efficiency Transformation in Astana and Almaty" conducted by the World Bank (WB) between November 2016 and November 2017 in Astana, using the Tool for Rapid Assessment of City Energy (TRACE 2.0).[1] It outlines the urban EE strategies for the next 12 years for Astana and 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. This study comes in line with recent targets set at the national and local level in Kazakhstan to reduce energy consumption and improve performance in most sectors, including public services.

The analyses and EE plans were developed based on a quick assessment of the energy performance of municipal services and prioritization of sectors having the highest energy savings potential. The analyses compared a host of energy related key performance indicators (KPIs) against figures from peer cities with similar features - human development index (HDI) or climate - and looked at the overall performance, challenges and development plans in the public service sectors that are usually managed by the city government. The sectors coordinated by the local administration and for which energy bills are covered from the local budget are street lighting, municipal buildings, public transport, water & wastewater, solid waste, and heat & power.

The conclusion of the study indicates that annually cities can save millions of dollars for the local budgets should they invest in EE interventions in municipal service sectors. This requires an integrated approach that should include a few "ingredients", namely money, investment plan, good projects, financing and delivery mechanisms, and implementation capacity. If some of these recommended EE solutions start to be implemented in Astana and Almaty as pilot projects under a genuine, clear implementation strategy, they can produce concrete savings and results which can subsequently be replicated by other municipalities in Kazakhstan based on their local needs. At the national level, this

[1] The two city reports as part of City Energy Efficiency Transformation Program for Almaty and Astana are available at: http://documents.worldbank.org/curated/en/362411510931587832/municipal-energy-efficiency-plan-for-the-city-of-Astana

http://documents.worldbank.org/curated/en/855641510934183633/municipal-energy-efficiency-plan-for-the-city-of-Almaty

The Russian versions of the reports are available at:
http://documents.worldbank.org/curated/en/237951510931818828/Казахстан-повышение-энергоэффективности-в-г-Астане-и-г-Алматы-Муниципальный-план-повышения

http://documents.worldbank.org/curated/en/344481510934872551/Казахстан-повышение-энергоэффективности-в-г-Астане-и-г-Алматы-Муниципальный-план-повышения would mean billions of kilowatts of energy savings which would translate into cost savings of hundreds of millions of dollars. In addition, 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, meet the future demand, reduce specific energy consumption, and make better use of local financial resources.

1. Why Energy Efficiency?

More than 50% of the people in the world live in cities, and this share is expected to increase to almost 64% by 2050, with 94% of the upsurge occurring in developing nations. Today, cities produce 80% of the global GDP, consume two-thirds of the global energy and are responsible for 70% of greenhouse gas (GHG) emissions. The rapid urbanization of cities in developing countries is a big challenge for both city residents and local authorities because the rise in the incomes and associated increases in living standards put a serious pressure to the already insufficient municipal services and infrastructure – namely, street lighting, public buildings (e.g., hospitals, schools), district heating and power distribution, solid waste collection and management, public transport, and water pumping & sewage.

Buildings and transport are the main global energy consumers. One-third of global energy is used in the buildings sector – including residential and commercial facilities – whether it is used for cooking, water heating, space heating, cooling and ventilating, refrigerating or for using electronic and mechanical devices. Transport sector is responsible for 67% of the oil (fuel) consumption globally and 23% of the energy related GHG emissions, in addition to 18% of all the man-made emissions in the global economy.[2] Energy related GHG emissions are expected to increase by 40% by 2040.

Box 1. ***Benefits of Energy Efficiency***

- **More money for the local/national budget**
  - Fosters: economic growth; savings in the form of avoided energy costs; opportunities; development of new industries based on reduction of energy waste; new jobs.
  - Local governments provide reliable public services while reducing the related costs.
  - Less money on energy bills = more money for the local budget.
- **End-user benefits**
  - Improves indoor comfort in public/private facilities (schools, hospitals), lowers consumption, and saves money on energy bills.
  - High-efficient appliances and building envelop can reduce the energy bill by minimum 30% and offer comfortable environment for people.
- **Environmental improvement**
  - Saves energy resources (e.g., coal), mitigates climate change and avoids pollution.
  - Less energy = less fuel and GHG emissions → less polluted environment + improved quality of air
  - Enhances the quality of life for people and helps them breathe cleaner air = less health related issues
- **Capacity to supply new customers**
  - Development of new connections to cater to new customers → increase the capacity of the network.
- **Raising awareness**
  - Reduce consumption and trigger energy and financial savings at local/national level.

[2] Sustainable Mobility for All available at: www.sum4all.org

Considered as the “first fuel” of energy policy makers and governments, EE is a critical policy tool that can help meet growing energy demands through clean and cheap energy, increase competitiveness, generate employment, secure energy, reduce poverty, and benefit development. EE is a win-win option since energy savings can bring positive returns to all stakeholders, including governments/cities, energy consumers, and environment. While local governments can reduce the energy related costs of municipal services - by replacing old mercury/sodium vapor lamps with very efficient light-emitting diode (LED), for instance - city residents can benefit better services and live in a less polluted and healthier environment.

2. Country & Cities Overview

An energy driven-economy, Kazakhstan is the largest and wealthiest of the Central Asian countries, with ninth largest proven oil reserves and the 15th largest proven natural gas reserves in the world and hydrocarbons making the equivalent of nearly 18% of GDP and 60% of exports (as of 2015).[3] Around 60% of 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 public companies from energy, transport and financial sectors.

With an HDI of 0.788, Kazakhstan is among top 60 countries in the world in terms of life expectancy, education and per capita income.[4] The country transitioned 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. The average income in Kazakhstan was US$ 364 per month in 2015, and only 0.04% of the population lived below poverty line on less than US$ 1.9/day.[5]

62% of the labor force in Kazakhstan works in the service sector, almost 12% in industry, while a quarter is employed in agriculture. Energy and extractives products (like oil & oil derivate, natural gas, ferrous metals, coal), in addition to chemicals, machinery, grain, wool, and meat comprise Kazakhstan’s main exports. Kazakhstan ranks 15th for crude oil producer and 10th for crude oil exports in the world. A landlocked country, Kazakhstan relies on Russia for its oil export to Europe. In 2010, Kazakhstan, Russia and Belarus have established a Customs Union to boost foreign investment and improve trade, which later evolved into the Single Economic Space (2012) and the Eurasian Economic Union (2015).

Like many energy-driven economies, Kazakhstan’s economy is adjusting after the decline of domestic and external demand trade due to the recent international oil crises in 2014, which slowed down the GDP growth from 4.1% (year-on-year) to only 1 (one) percent in 2015 and led to almost 50% cut in export revenues, along with the decline of foreign direct investments and deterioration of the local currency (tenge or KZT)[6]. To counter the oil crisis, the Government of Kazakhstan (GoK) implemented a few 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.

The recent oil crisis flagged once again the need for an economic diversification and shift from a natural

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

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

[5] As per poverty headcount nations at poverty line - World Bank PovCalNethttp://iresearch.worldbank.org/PovcalNet/povOnDemand.aspx

[6] 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

resource extraction based economic development model to a more diversified, competitive economy. In 2013, the country has embarked on an ambitious path to diversity its economy under the Green Economy Policy (GEP), targeting sectors like transport, pharmaceuticals, telecommunications, petrochemicals and food processing. By 2050, Kazakhstan should transition to a more diversified economy green, which would increase the GDP by 3% and create over half million new jobs.

However, the economic diversification has proven quite a difficult endeavor so far, especially until 2014, when oil prices were still high. Despite of 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, investment climate, rule of law, and there are little incentives for investments in physical capital and new technologies.

Box 2. *ASTANA*

- Population: 872,700 - 2nd largest city in Kazakhstan
- Climate: extreme continental with great variations in temperatures from -35°C to + 30°C
- Economy
  - Investments up by 30 times and the gross regional product (GRP) by 90 times since the ’90s
  - 25% of residents employed by small-medium enterprises (2015)
  - 9.9% of the country’s GDP = 15% of the state budget and 9% of overall investments
  - GDP: US$ 21.6 billion - US$ 24,820 GDP/capita (2015)
  - Donor to the state budget

Box 3. ALMATY

- Population: 1.7 million
- Largest city and economic center in Kazakhstan
- Climate: continental with hot summers (30°C) and cold winters (-5°C)
- Economy
  - Investments: 22.3% of the GRP - 1st in the country (2015)
  - GRP/capita: KZT 54.3 million (2015)
  - Services - 50%, trade - 35%, transport - 5.5%, industry - 5%
  - Top 10 of 100 cities worldwide with the fastest economic growth
  - Donor to the state budget

3. Overview of Energy Efficiency Strategies and Policies

In recent years, Kazakhstan has increasingly given priority to EE and made it a top national policy priority by committing to reduce consumption and achieve savings. This was a timely response to addressing the serious growth-slowing energy shortages, improving industrial competitiveness, and mitigating consequences of the rapid rise in domestic energy price. First time the EE topic was endorsed by the president of Kazakhstan in a speech delivered in 2010, then soon after that few targets were set to reduce energy intensity of the economy by 10% by 2015 and by 25% by 2020. Ever since, EE was included in most of the key national strategies and plans, and the *Law on Energy Saving and Energy Efficiency* was approved in 2012 (amended in 2015).

According to the *Kazakhstan 2030 Strategy for Development*, the country should concentrate on power resources, and by 2030 it should improve the energy infrastructure by focusing EE new energy-saving technologies, equipment, heat substations, and metering, while increasing the fuel and energy balance of renewable and alternative energy sources.[7] The *Kazakhstan 2020 Strategic Development Plan* (supporting the Strategy Kazakhstan 2030) calls for cutting on the energy intensity of the GDP by 25% as compared to the 2008 baseline. *Kazakhstan Strategy 2050,* a document outlining 100 steps towards placing the country among top 30 advanced nations in the world by 2050, targets the power sector reform, among other issues.[8] Step #59 calls for the establishment of energy savings companies (ESCOs) by attracting private strategic investors in the energy saving industry. Kazakhstan wants to introduce the single buyer model - which would reduce the differentiated tariffs in the region, expand the regional electricity companies and diminish the cost of power transmission to end-users - and a new tariff policy to stimulate investments in the energy sector.[9]

As part of the *Green Economy Policy (*GEP) Kazakhstan plans to reduce the energy intensity of the GDP by 25% by 2020 and by 50% by 2050, and rely more on renewable energy sources (RES). By 2020 3% of power should be generated from RES (solar and wind) and the share of clean energy share should increase by 30% by 2030 and by 50% until 2050.[10] The GHG emissions should reduce by 40% by 2050 (as compared to 2012 levels), while the number of natural gas-based power plant should increase by 30%. The energy intensity of the GDP should go down by 30% by 2030 and by 50% by 2050 (compared to the levels of 2008).

In line with the GEP*,* the *Feed-in-Tariff* policy for the next 15 years is aimed at expanding the power generation from RES, which currently is less than 1% of the energy mix in Kazakhstan. Energy sector development is also part of the *Nurly Zhol (the Bright Path to the Future*), a US$ 9 billion domestic stimulus plan targeting the critical infrastructure and priority sectors, like industrial energy, and public utilities.[11] The program plans to build high-voltage transmission lines and balance energy access to rural areas through a balanced energy supply, and pledges annually US$ 450 million to modernize heat & water infrastructure and develop social housing across the country.

In November 2016, Kazakhstan has ratified the *Paris Agreement on Climate Change*, pledging to fulfill the first Intended Nationally Determined Contributions (INDCs) towards an economy wide-absolute reduction of GHG emissions of 15% from 1990 emissions levels by 2030. The climate mitigation targets could even go up to 25%, should there be additional international support and finance, access to international carbon markets and low carbon technology transfer.

The EE approach was also translated in the local strategies. For example, according to the *Astana Development Plan for 2016-2020,* the capital of Kazakhstan should reduce the energy intensity of its GRP by 10% by 2020 as compared to the 2013 baseline by using energy savings technologies in housing and transport, and improve EE in sectors like street lighting, transport, heat and water. The *Energy Efficiency Plan for Astana 2016-2020* aims to reduce consumption by 10% by 2018 and by 15% by 2020 as compared to 2015. While the *2020 Development Program for Almaty* outlines EE measures, improve public transport and solid waste management and diminish air pollution, the *Almaty Energy Complex 2015-2020* identified up to 30% potential savings in residential and public buildings.

One of the first EE measures enforced at the national level require private entities exceeding annual consumption of 1,500 toe/year to report to the State Energy Registry, a body under the Ministry of

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7 Strategy Kazakhstan 2030 available at http://www.akorda.kz/en/official_documents/strategies_and_programs

8 Strategy Kazakhstan 2050 available at: http://strategy2050.kz/en/page/message_text2014/ and http://strategy2050.kz/en/ Currently, Kazakhstan is placed 51st nation in the world.

9 The tariffs should have one component to finance the capital cost and another one to cover the variable cost of electricity generation.

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

11 Nurly Zhol – more details about this program are available at: http://www.kazakhembus.com/content/nurly-zhol-0

Investments and Development which is responsible of EE policies, and conduct annual audits, prepare an EE plan, apply retrofit measures and an energy management system.

4. Municipal Energy Consumption Profile and Sector Analysis

The TRACE analysis assessing the energy performance of Astana and Almaty highlighted the need to invest in the local infrastructure to improve the quality of municipal services and develop new infrastructure to enhance access to energy and municipal service delivery in light of the territorial and population growth in the near future.

Box 4. Tool for Rapid Assessment of City Energy (TRACE)

Developed by the World Bank, TRACE is a practical, simple and quick tool that helps municipalities to perform a city-wide energy diagnostic to get a quick overview of the energy performance and EE potential of the sectors that usually are under the local government control and provides recommendations for improving these areas. The tool focuses primarily on municipal services (urban transport, municipal buildings, water & wastewater, solid waste management, public lighting, and power & heat), in addition to some areas outside the local authorities' influence, such as residential and commercial buildings. In each sector, TRACE uses a benchmarking algorithm to evaluate energy cost savings potential and, based on factoring in the level of influence from the local government, it prioritizes what local authorities should do according to where the biggest savings can be achieved (including with timeline, costs and savings).

TRACE Process

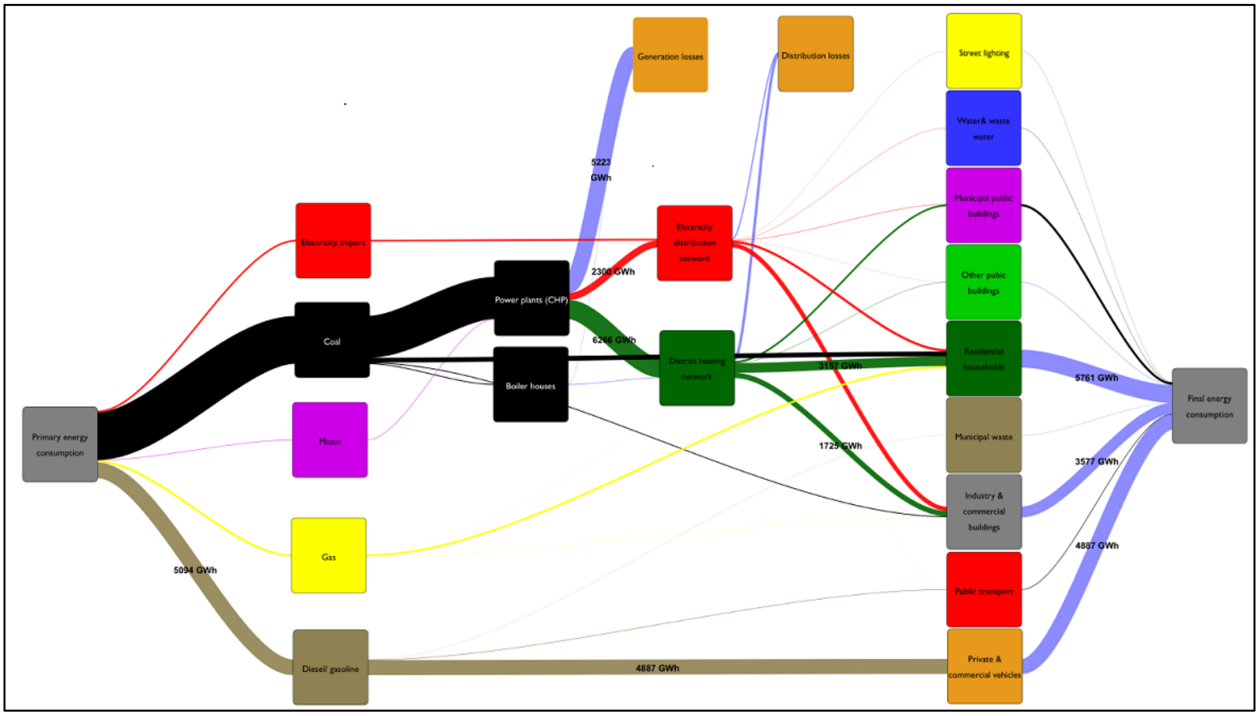
- 1. Benchmarking the city's energy performance using around 100 key performance indicators (KPIs) in comparison with peer cities around based on features like climate, HDI, population, primary energy per unit of GDP etc. The TRACE database has information on more than 160 cities worldwide.
- 2. Prioritizing sectors based on energy-saving potential, expenditure and city authority control, and identifying appropriate EE interventions.
- 3. Prioritizing actions based on the city's implementation capacity and planning horizon.

The TRACE in diagnostics help cities to prioritize municipal sectors with highest potential energy savings, develop an investment pipeline for the city, prioritize investments based on their cost-effectiveness, prepare pre-feasibility studies and embark on a medium-long term sustainable development urban agenda. TRACE was implemented in over 60 cities in Europe-Central Asia, Latin America, Africa and Asia.

For this analysis, in addition to the data obtained from the Astana and Almaty municipal governments - based on which the KPIs were calculated - the WB team travelled to Kazakhstan to conduct interviews with utilities and municipal service providers and visit facilities to get an overall picture of the city performance and capacity.

The data collected helped produce the Sankey diagram (see Figure 1 below) with the energy balance of the primary and final consumption, hence providing an overall picture of the city's energy consumption for the baseline year of 2015.

Figure 1. Sankey diagram for Astana illustrating the energy consumption in the city in 2015

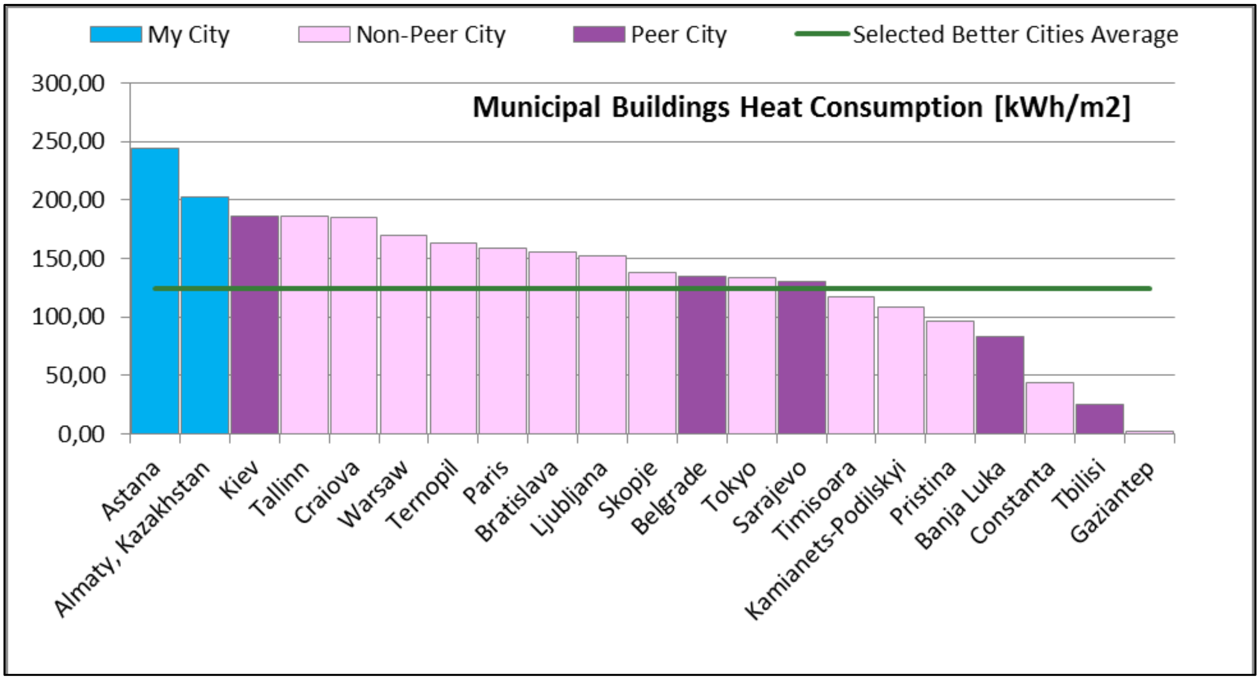


Astana and Almaty rank medium-to-high for Primary Energy Consumption (PEC) per capita (90-91GJ/capita) in comparison with other peer cities. This high PEC is primarily caused by: (i) harsh cold climate that requires long heating period (especially in Astana); (ii) availability of coal (there is natural in Almaty but very limited in Astana); iii) important trade, service and industrial activities (in Almaty); and iv) high losses for final energy production and high inefficient energy consumption at end-users. Overall, the two cities in Kazakhstan have 30-40% theoretical energy savings potential to achieve the level of the better performing peer cities in the TRACE database.

- **Municipal Buildings (energy savings potential: up to 50%)**

Up to half of energy consumed in municipal buildings - such as schools, kindergartens, cultural, sports centers etc. – can be saved if EE measures were applied. Municipal buildings account for 7% of the building stock each in Astana and Almaty. Astana has 400 municipal buildings spread on nearly 2.5 million m², with more than 300 education facilities. Almaty has almost 1,000 public buildings with a total floor area of 4 million m² of which two-thirds comprises of 584 education facilities. Like in all Central Asian countries, most schools in Kazakhstan were built in the Soviet times and only a few are constructions from the '90s. Most schools are overcrowded and can hardly meet the demand. While buildings are more or less in good shape, they are equipped with inefficient lighting and heating systems - e.g., CFLs, T5 lamps and PVC windows. The bulk of schools are connected to the centralized heating network, but many are overheated since there is no temperature control at building or room level. Public sector consumes 15% of electricity and 30% of heat generated in Kazakhstan. Municipal buildings in the Kazakh cities have the highest heat consumption - between 200 kWh/m² and 250 kWh/m².

Figure 2. Municipal buildings in Astana and Almaty have the highest energy consumption

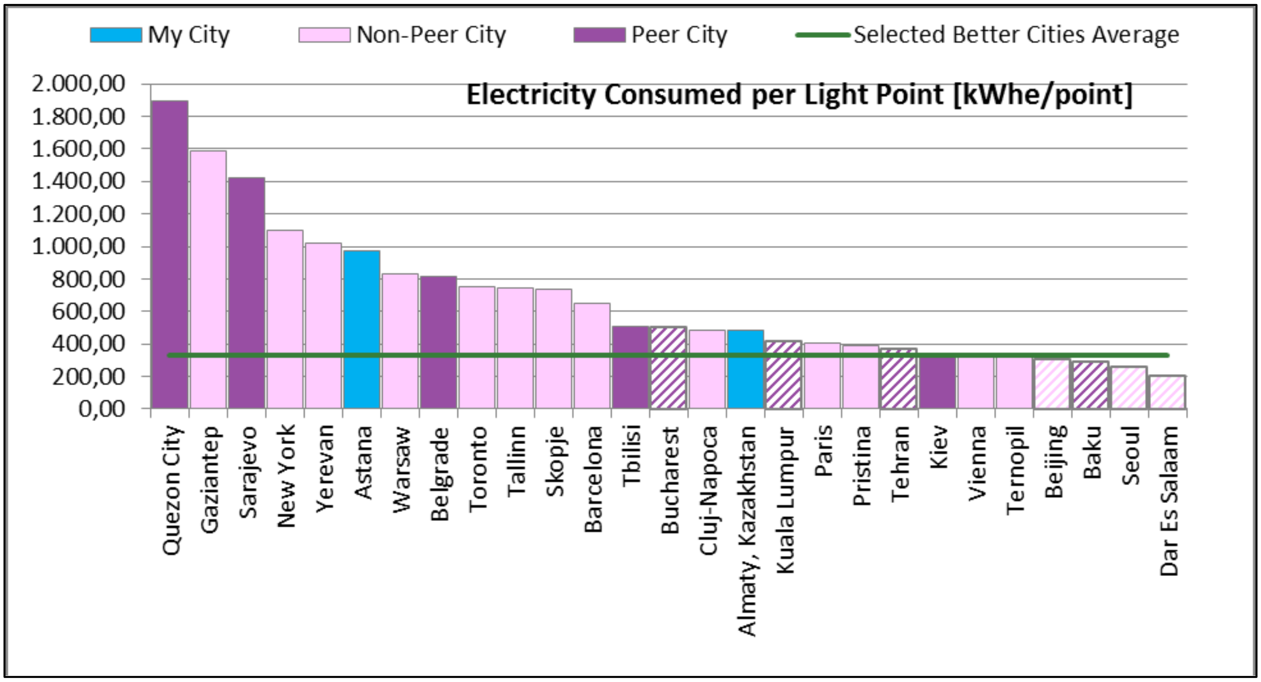


The main problems are the lack of a database comprising of energy consumption and technical details for all municipal buildings, the old Soviet building codes with no EE requirements, the lack of adequate energy audits, limited staff to ensure maintenance of the buildings' heating points, in addition to a limited pool of contractors able to carry out good quality retrofit and construction works. Perhaps the biggest issue is the lack of funds. Except for kindergartens that are under the district administrations (rayon akimats), municipal buildings are managed by different divisions of the CAs (e.g., the Division of Education is in charge with schools) and get money from the respective line ministries – e.g., the Ministry of Education allocates money for education facilities - and from the local budget. However, local budgets cannot meet the demand for building rehabilitation and retrofit, and often time renovation consists merely of painting the walls or replacement of carpentry and lighting, with no proper thermal insulation. Moreover, education facilities cannot retain EE savings as any money saved by schools must be returned to the local budget.

- **Street Lighting (energy savings potential: 50%)**

Street lighting is another sector where significant energy savings can be achieved. Street lighting coverage is good in both Astana (98%) and Almaty (92% - with only 80% in the suburbs) and is done by high-pressure sodium (HPS) and high-pressure mercury (HPM) lamps. Most of the lamps in Astana are HPS with a few LEDs, while 70% of the street lights in Almaty are HPS with a quarter mercury. 5% of the lamps in Almaty are LEDs, and they were installed as pilots by four Kazakh LED producers to promote these highly efficient bulbs. Consumption varies based on the type and quality of lamps. For example, 70% of the HPS street lights in Astana use 82% of the energy necessary to operate the network, while the lamps placed in parks accounting for 30% of lights require only 18% of electricity. Like in the building sector, street lighting in Kazakhstan uses the former soviet standards for illumination (SNIP), with no dimming options in place. The capital city of Kazakhstan needs twice more energy per light pole than Almaty.

Figure 3. Electricity consumption per light point



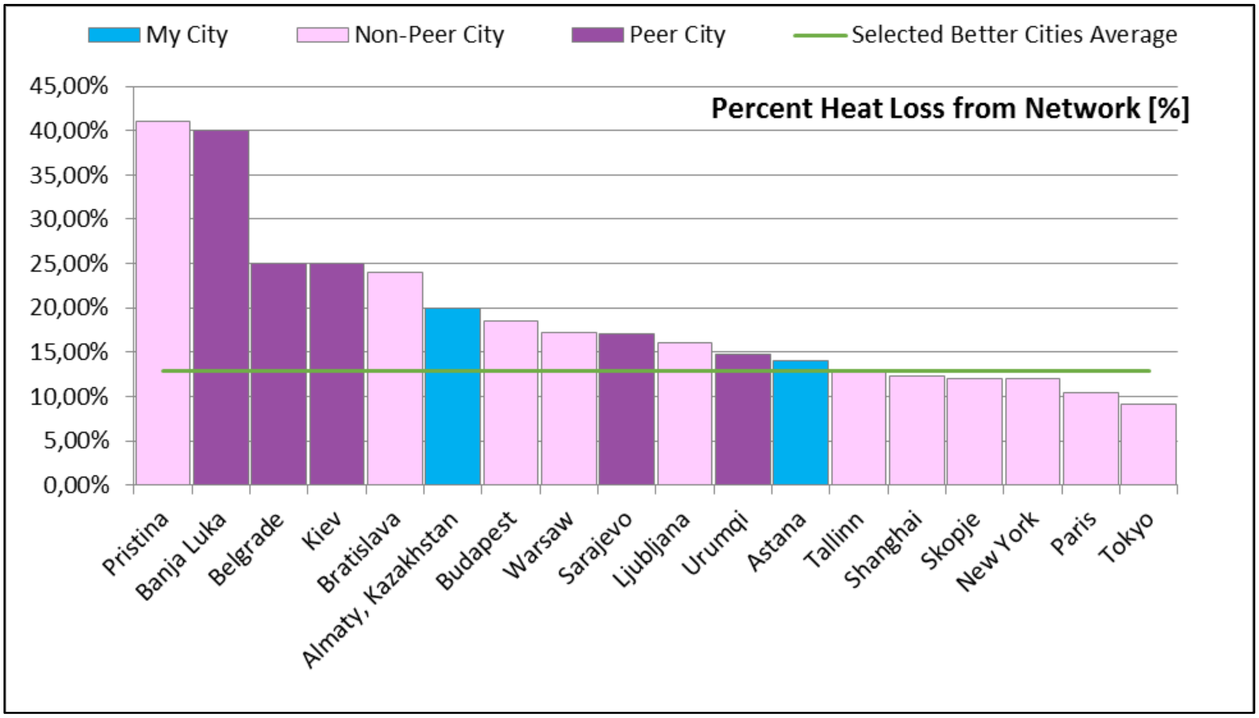
The key issues in the SL system are related to the high voltage fluctuation (especially in Almaty) and the mandatory use of domestic products of up to 70% for equipment purchased by public entities. While this is a good way to encourage the local economy, the LEDs produced by domestic manufacturers - although a few times cheaper than by international providers - have issues with the technical performance and the quality of lamps.

- **Heat & Power (energy savings potential: 10-30%)**

The district heating (DH) and power sector is either managed by the city governments through their own companies or by other entities. In Astana, the power & heat generation and transmission system is under Astana Energy Service (AES), while an independent billing company is responsible for the commercial distribution of heat and billing. In Almaty, the DH & power system involves several players. Almaty Energy System (ALES), part of the Samruk-Kazyna welfare fund, deals with heat & power generation, whereas Almaty Teplo Seti (ATC), a company under CA is responsible for the energy distribution, and a private entity takes care of billing. Most of the thermal energy and power is produced by combined heat and power (CHP) plants with some heat generated in boiler houses running on coal and natural gas in Almaty and coal and mazut in Astana (the capital city does not have natural gas pipes). 40% of the electricity supplied to Astana is purchased from KECOG from imports. In general, the heat and power generation infrastructure is old, and some boiler houses are more than 50 years old (in Almaty), although they operate at decent standards. All residential buildings are connected to the centralized heating network, while individual houses (in Almaty) have their own heating systems.

The power losses are between 13% and 15%, with heat losses between 13.6% in Astana and 20% in Almaty, overall losses translated into hundreds of millions of dollars annually. Only power losses alone in Astana in 2015 were the equivalent of US$ 150 million, while Almaty lost energy was the equivalent of US$ 120 million. Heat and power losses in Astana account for 22% of the city's PEC.

Figure 4. Heat loss in the network



The main challenges in the power & heat sector are the aging infrastructure, high wear-and-tear of the equipment, poor quality of energy audits for the CHP plants, lack of regulation regarding the maintenance of heat network, in addition to limited funds for investments. For example, 70% of the engineering infrastructure in the DH system in Almaty, such as substations and boilers, has exhausted their service life. In Astana half of the heat distribution network is more than 50 years old – although a third of the pipes are pre-insulated. Energy utilities must find own resources for investments, since they cannot rely on the city budgets or financial support from owners. For instance, Astana can invest only KZT 1 billion (US$ 3 million) annually, money that hardly can cover any needs.

The utilities juggle to keep the energy tariffs at affordable levels and make revenues. Although the tariff policy has a financial component for modernization and development of the network, the energy tariffs cannot cover the investments. In addition, heat tariffs are kept low artificially for social reasons, they are below the cost recovery level and cross-subsidized by the CAs. Without subsidies, the cost of heat for residential clients could increase even by five times. The increase in the energy demand given the rapid population and territorial expansion puts serious pressure on both utilities and local administrations. For example, estimates show that the demand for housing in Astana would go up from 14.7 million m² (in 2014) to 23.7 million m² by 2020 and to 37 million m² by 2030, which would require additional power and heat generation and delivery network.

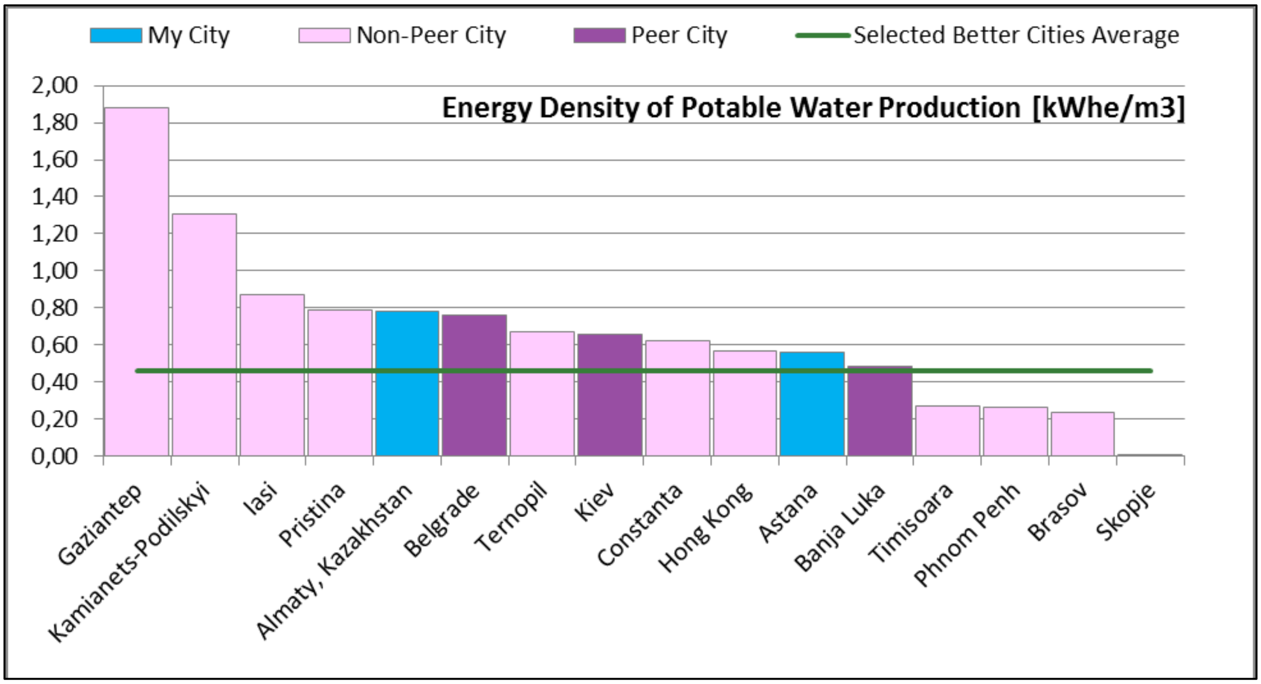
- **Water and Wastewater (energy savings potential: 10-30%)**

While water coverage is good - 95%, sewage services are catered to only to half of those living in suburbs in Almaty and to 90% of the water users in Astana. Two-thirds of the residential clients in Astana and 87% in Almaty have water meters. Each city has a wastewater treatment plant, with the second facility being under planning. Cities have made some investments in the water network in recent years. Astana expanded the water pipes by 240 km, while some water pipes and pumping stations were rehabilitated in Almaty through government-supported credit lines.

While Almaty needs more energy to produce one cubic meter of water than Astana (0.77 kWh v. 0.56

kWh), the capital city requires three times more energy to treat one cubic meter of wastewater (0.62 kWh). Water losses in the distribution system in Almaty are higher than in Astana (37% v.25%), and part occur at end-users while part gets lost in the water pipes.

Figure 5. Energy used to produce one cubic meter of water

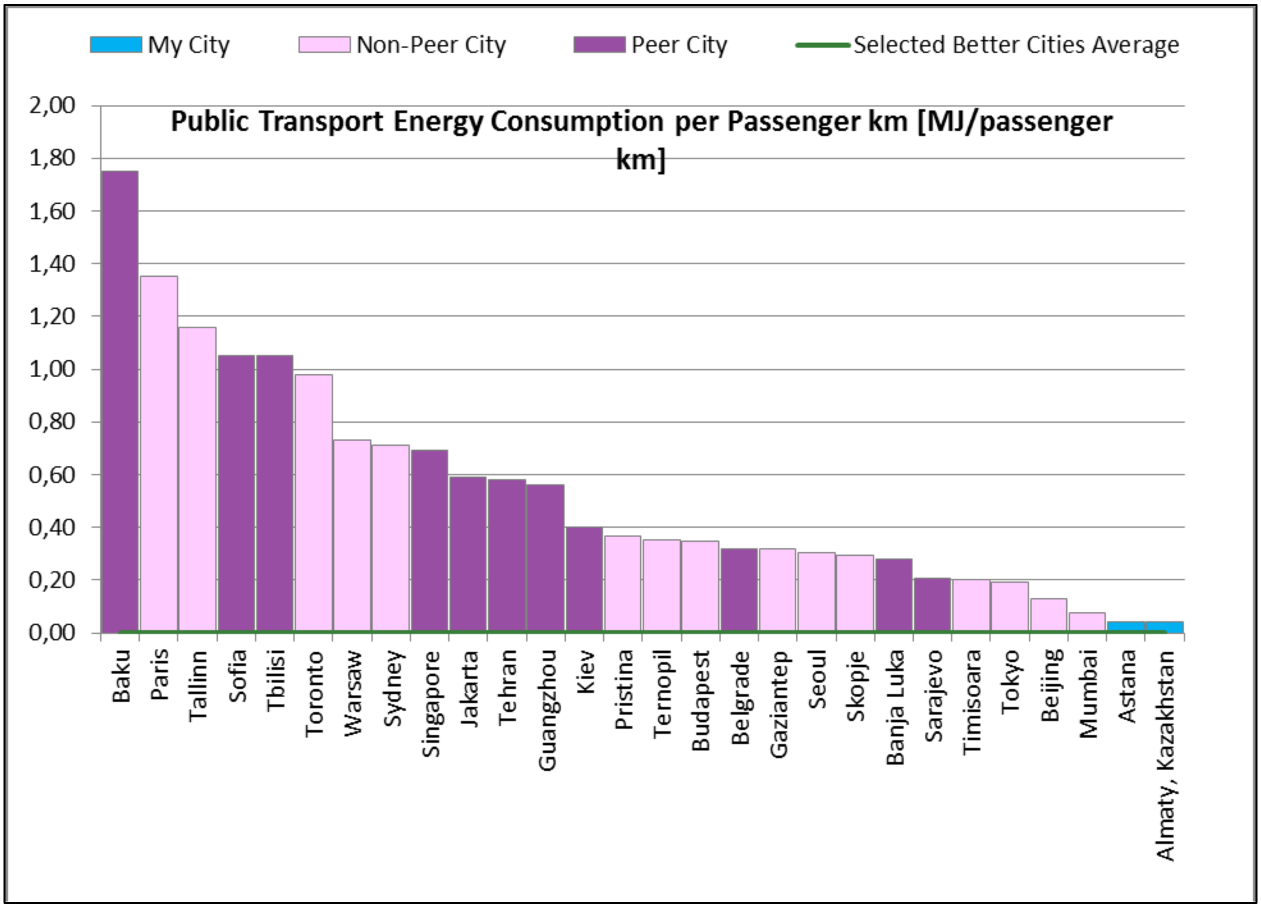


The main problems are related to the old network, limited water infrastructure to meet the future demand and low water tariffs. Around one-third of the water and sewage network is in critical condition, and the obsolete, leaking pipes are the main culprit for water losses. The city growth puts pressure on the existing network; for example, in Astana the network should expand by 5% yearly to cover the demand. Although the water operators belong to the CAs, they do not get subsidies from the local budgets and must rely on their own funds. The water tariffs for residents are artificially kept low for social reasons and can cover neither the maintenance works nor investments. In addition, not all clients pay their bills in time.

- **Transport (energy savings potential: 20-30%)**

Public transport system is operated by private operators with supervision from the CAs. In recent years, efforts were made to renew and improve the system. For example, 55% of buses in Almaty run on natural gas, while Astana is in the process of purchasing hundreds of new buses. But despite these efforts, public transport is partially underdeveloped and not too attractive to people, although the number of users went up in recent years. Only one third of the daily commutes in Astana and 45% in Almaty are done by public transportation means, while the rest primarily by private cars. Public transport share is higher in Almaty as people have more options - buses, trolleybuses and metro - unlike in Astana where they rely only on buses. The quality of the fleet is also a turnoff, as many buses are old and inefficient. Public transport is not subsidized, and the CAs subsidy tariffs only for low income groups. Although the TRACE analysis indicates that Almaty and Astana have efficient public transport, (0.04 kWh/passenger km), the system is actually inefficient and cannot meet the demand.

Figure 6. Public transport consumption

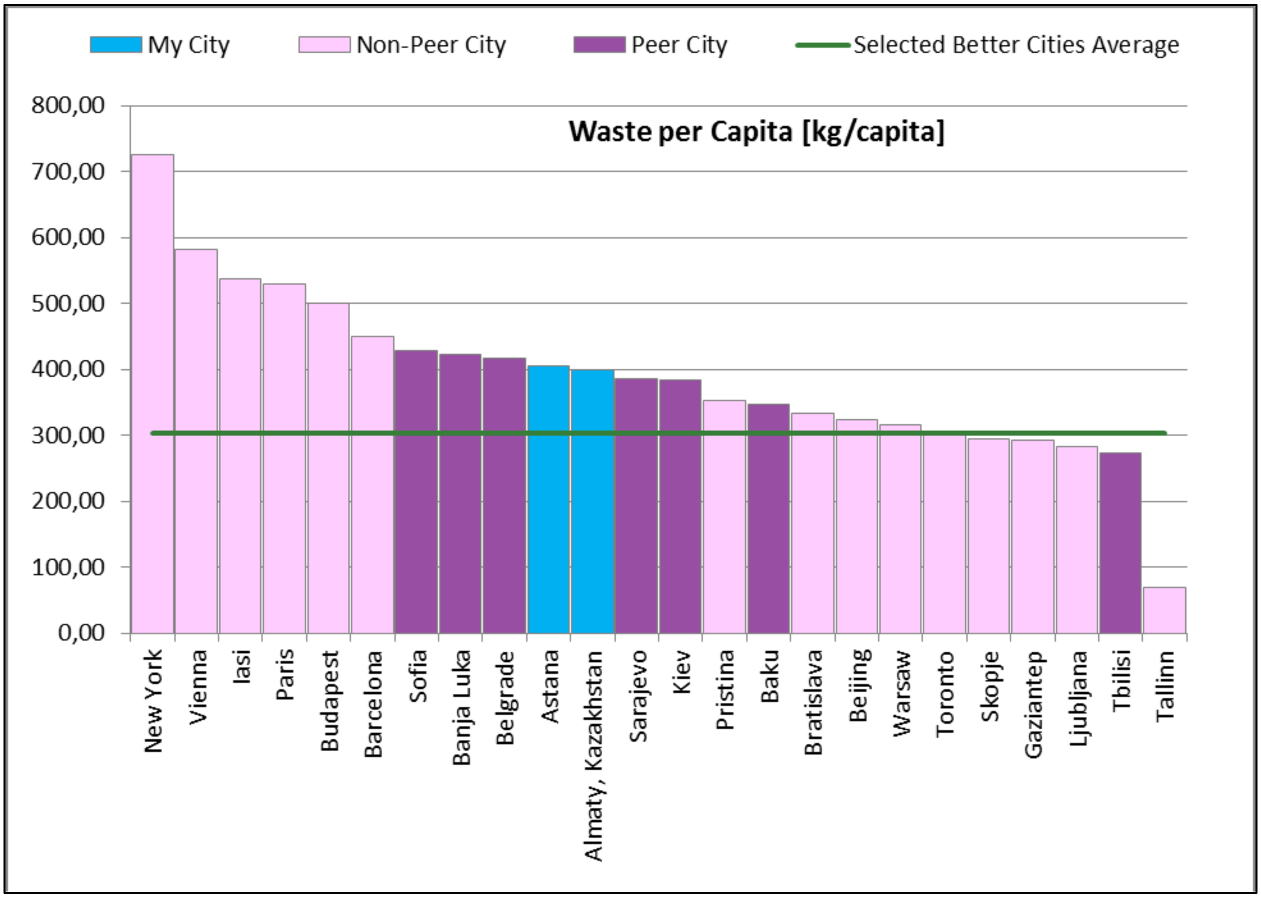


Fuel efficiency of buses (some still use Euro 4 diesel), lack of legislation to increase performance of transport operators, and low cost of fuel (KZT 138/liter = US$ 0.62) are some of the key issues in the transport sector. In Astana, the lack of natural gas infrastructure is an impediment for buying more CNG buses. The increasing number of private cars and traffic congestion are also big challenges. With around half million cars in each Astana and Almaty, in addition to tens of thousands of vehicles driving in daily from other regions, cities have reached critical levels in terms of transport density, congestion and GHG emissions. Today municipalities struggle with heavy traffic congestion and bottlenecks during rush hours, and one could expect that this would only aggravate in the future, with peopling buying more cars, hence overloading the city roads and worsening traffic management.

- **Solid Waste (energy savings potential: 25%)**

Supervised by the local administration, the solid waste sector is managed by private operators that are responsible for picking up the trash from city residents and take it to the landfill, in addition to ensuring street sanitation services. The landfill is also operated by private entities. Both Astana and Almaty generate an average amount of trash per capita (around 400 kg). Although the waste collection fleet is fairly new (in Almaty they run on CNGs), the waste trucks can hardly meet the demand.

Figure 7. Waste generation per capita



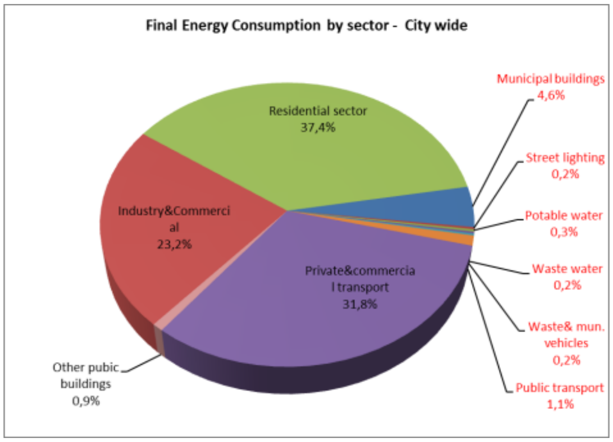
Solid waste management is a very complex sector with several issues ranging from too many players (in Almaty there are no less than 32 operators), inadequate quality of waste collection and sanitation services, to low tariffs that hardly can cover the operation costs. There is no separate selection in place (the system is piloted at a few households in Almaty), thus recycling is very limited (5%). Most of the waste collected from the commercial sector goes to illegal dumping sites and removing them is quite costly. Finally, the population growth is expected to generate more trash, which would require additional infrastructure. For example, forecast indicates that between 2020 and 2030 waste generation in Astana would go up by 40% - from 492,000,000 kg to 684,000,000 kg.

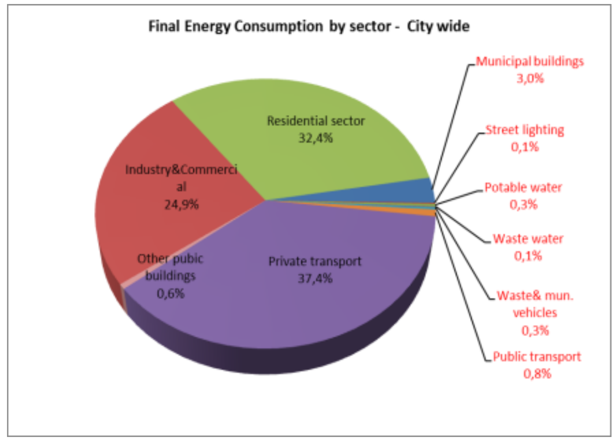
5. Sector Prioritization and Suggested EE Programs

The total energy consumption in all sectors in cities accounts between 3 to 5% of the local GDP. This is translated into US$ 1.7 billion in Almaty, which is 5% of city GDP, and US$ 746 million in Astana, representing 3.4 % of the local GDP. The energy bills for municipal sectors only (those under the local government control) were US$ 34 million for Astana and US$ 64 million for Almaty – make for 2% of the local budget in the capital city and 3.1 % in Almaty.

The residential sector in Astana and private transport in Almaty, respectively, have the highest energy consumption (37-40%). They are followed by private transport (31%) and commercial and industrial sector (almost 25%) in Astana, and residential (33%) and commercial sector in Almaty. Overall, municipal service sectors account for 7% in Astana and 5% in Almaty. Among these the highest consumption is in municipal buildings (65-70%) including heat, electricity and natural gas.

Figure 8. City-wide energy consumption in Astana (left) and Almaty (right)



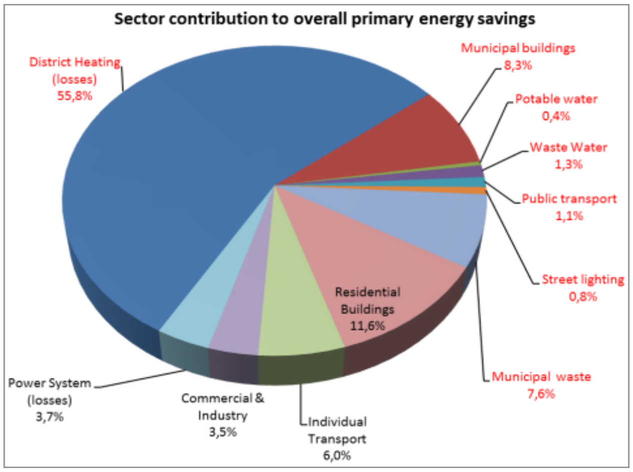


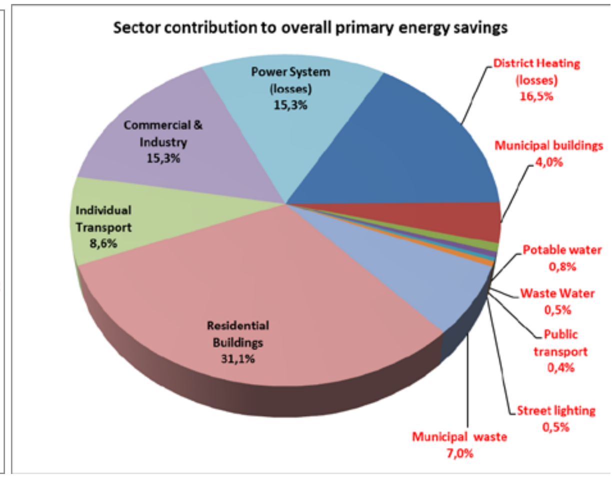
The priority sectors with large energy savings potential and influence from the local governments are municipal buildings, street lighting, transport, district heating, waste and water & wastewater. The sectors with limited municipal control - i.e., residential, commercial & industrial, power and private transport - also have important potential. EE measures include investments that essentially could generate physical final energy savings, reduce losses, improve the quality of services, and diminish operation and maintenance (O&M) costs, and non-investment interventions meant to enable environment for the EE measures, such as project preparation, development of adequate financing and delivery mechanisms, in addition to policies to improve the regulatory framework and help build local institutional capacity.

Overall, over 100 EE interventions in all sectors have been identified in both cities totaling investments of US$ 5.6 billion of which US$ 1.3 billion in Astana and US$ 4.3 billion in Almaty. If these investments are to be implemented in the next 12 years, they could reduce the PEC by almost a quarter, save more than 15 billion kWh of energy annually, which would translate into cost savings of US$ 429 million per year, of which US$ 140 million for Astana and US$ 289 million for Almaty.

The EE plan for Astana indicates that the city can obtain 5,013 GWh/per year in primary energy savings with total investment costs for all sectors of US$ 1.3 billion in the next 12 years. More than half of these savings would be achieved in the district heating sector (reducing losses in the generation and distribution system), which would require US$ 240 million investment, which is 18% of the overall cost investments. The EE plan for Almaty has identified that the city can achieve annual energy savings of 10,383 GWh for total investment costs of US$ 4.3 billion. The largest savings (42%) are in residential buildings - a sector outside the purview of the city government, where approximately US$ 1.8 billion should be invested - e.g., 42% of the overall investments.

Figure 9. Annual primary energy savings by sectors - 5,013 GWh in Astana (left) and 10,383 GWh in Almaty (right)





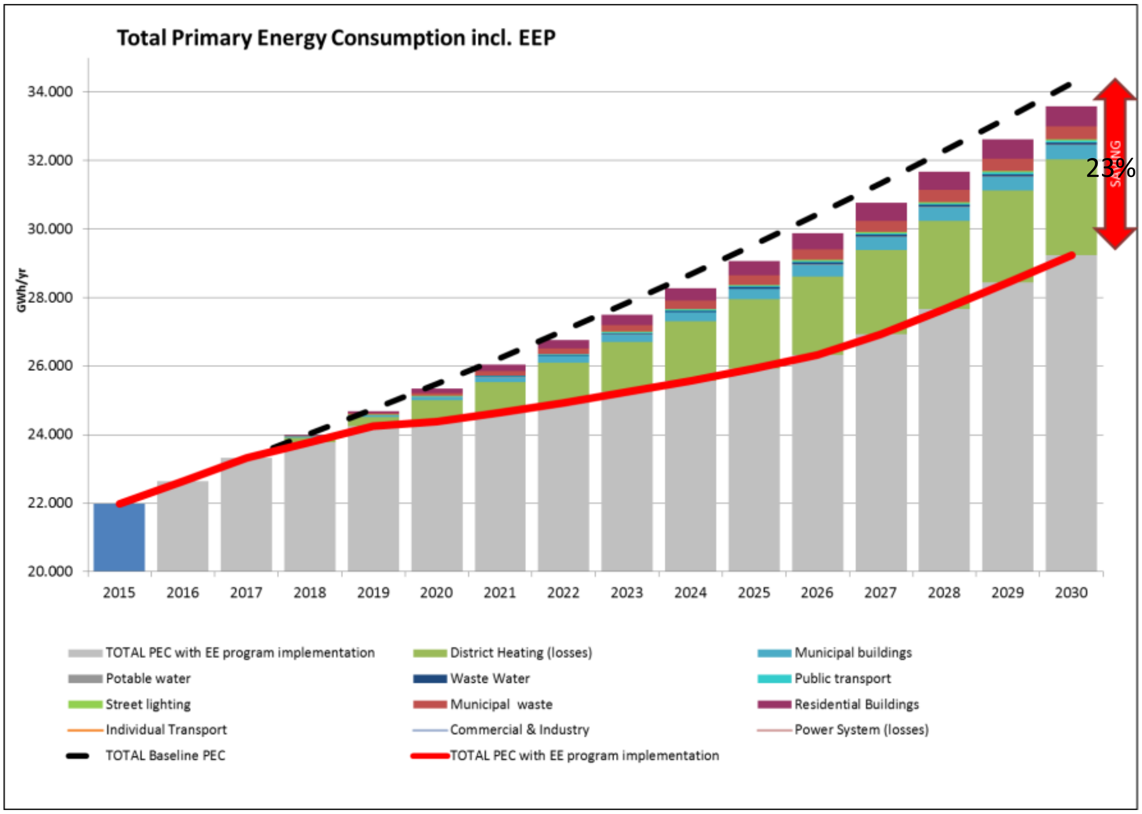
94% of the primary energy savings in Astana can be obtained by cutting 1 million ton of coal per year, while other savings could come from avoiding 28 million liters of car fuel per year. 53% of savings in Almaty could be achieved by cutting half of the annual natural gas consumption, while 30% could be obtained by avoiding 45 million liters of gas & diesel and almost a million ton of coal. The coal reduction would diminish cumulative 4.6 million tons of CO_2 emission equivalent per year. Considering a phased implementation over a 12-year period, the achievable total cumulative energy savings for both Astana and Almaty are around 150 billion kWh, resulting in a specific investment demand of US$ 0.02 per each kWh of energy saved for Astana and US$ 0.04 per each kWh of energy saved for Almaty.

Most of the EE measures target the municipal service sectors and require a total of US$ 1.85 billion capital investment for both cities – of which US$ 700 million in Astana and US$ 1.1 billion in Almaty. These investments could save 43% of the total energy consumption in Astana and 34% in Almaty, translated into overall annual savings of US$ 67 million for Astana and US$ 76 million for Almaty. For example, in Astana ten measures aim to improve municipal public buildings (US$ 150 million), eight to curb losses in the district heating sector (US$ 240 million), eight to reduce fuel consumption and increase attractiveness of the public transport system (US$ 294 million), while eight would diminish losses in the water pipes and improve overall performance of the water & wastewater sector (US$ 81 million). The accumulated savings in most sectors exceed the investments costs, which is a positive ratio over the lifecycle of the intervention (except for those in the public transport and water supply).

Depending on investment and its financial benefits, the payback time for each measure varies between 4 to more than 50 years in Astana, with an average of 10 years, and between 5 to over 30 years in Almaty, with an average of 12 years. EE investments targeting losses in the power and central heat generation and distribution system are more profitable, with less than 8 years of payback time. Similar profitability scenario is indicated for interventions targeting renewable energy, such as biogas, landfill gas, waste-to-energy, and photovoltaic panels. These projects have great potential for public private partnerships (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 are long-term investments with a payback time spanning from 25 to over 50 years. The additional comfort, social and environmental benefits could justify carrying out these long-term investments in the short- and medium run, and usually, they are paid back throughout the lifetime of the facility.

A scenario considering an average 3% annual increase in population and economy in Astana over the next decade would significantly impact the demand for municipal services and energy supply. For example, while the PEC in Astana is expected to go up by 55% - to 34,250 GWh by 2030, the projected energy savings could slow down this trend by up to 33% by 2030 (see Figure 10 below). The city-wide targets in Astana can save a lot of energy and reduce the bills, hence save money to the local budget.

Figure 10. Primary energy consumption trend by 2030 and potential savings in Astana



Similarly, an average annual increase in population and economic development in Almaty of 1 to 2% would make the PEC go up by 35% (to 57,250 GWh) by 2030. The EE plans and the projected energy savings could slow down the energy demand up to 10% by 2030, diminish the city-wide PEC and related GHG emissions by almost a quarter and use 34 to 43% less energy in municipal sectors. (see Table 1 below).

Table 1. Energy saving targets for Almaty and Astana

Indicator	Value in 2015		Target reduction and savings by 2030 (compared to the 2015 baseline)	
	Almaty	Astana	Almaty	Astana
City-wide PEC	42 TWh	22 TWh	24% reduction→10.4 TWh/yr	reduction by 23% →5 TWh/yr
Primary energy coal consumption (all sectors)	13.5 TWh coal = 2.6 million tons coal	15.5 TWh coal = 3.3 million tons coal	30% reduction → 0.8 million tons	reduction by 30% →1 million tons
Primary energy gas consumption (all sectors)	10.2 TWh gas = 1,080 million m³ gas	N/A	50% reduction → 577 million m³ gas	N/A
Use of renewable	almost 0 (zero)	almost 0 (zero)	1.0 TWh/yr generated from	417 GWh/yr generated by

Indicator	Value in 2015		Target reduction and savings by 2030 (compared to the 2015 baseline)	
	Almaty	Astana	Almaty	Astana
energy (RE)			RE = minimum 2% of PEC	RE = minimum 2% of PEC
CO_2 emissions (city-wide)	11.2 million tons CO_2 equivalent	7 million tons CO_2 equivalent	25% reduction = 2.8 million tons CO_2 equivalent/ yr	24% reduction = to 1.7 million tons CO_2 equivalent/yr
Energy consumption in municipal sectors	5.7 TWh	5 TWh	34% reduction →1.9 TWh	43% reduction →2.3 TWh
Municipal public buildings	984 GWh	711 GWh	26% reduction →253 GWh/yr	35% reduction →250 GWh/yr

The energy targets at the city level can be achieved by a host of EE interventions primarily in municipal sectors, and these savings are ultimately going to be reflected in less money spent from the city budget.

Table 2. Energy savings by municipal sectors for Almaty and Astana

MUNICIPAL BUILDINGS	DISTRICT HEATING	STREET LIGHTING
✓ Heat energy savings by building retrofit • Almaty - 40% • Astana - 30% ✓ Energy savings by replacement of indoor lighting • Almaty - 50% • Astana - 50%	✓ Reduce energy losses for heat generation and distribution • Almaty - from 37% to 25% • Astana - from 38% to 22%	✓ Energy savings for the public lighting system • 60% - Almaty • 60% - Astana
PUBLIC TRANSPORTATION	**POTABLE WATER**	**SOLID WASTE**
✓ Increase urban mobility by improving capacity, service and attractiveness of public transport ✓ Reduce individual motorized transport by increasing attractiveness of public transport • Almaty - 5-10% • Astana - 5-10%	✓ Reduce water losses • Almaty - 40% • Astana - 40% ✓ Electricity savings for water pumping & wastewater treatment • Almaty - 20% • Astana - 25%	✓ 80% of waste is sorted and prepared for recycling or composting - Astana/Almaty ✓ Reduce 30% of fuel consumption for waste collections vehicles – Astana/Almaty

6. Implementation Strategy

In order to put in practice the EE measures, specific actions should be taken at the local level, in addition to some at the national level. A successful implementation of the EE plan and achieving the EE targets require an integrated transformation approach based on three main pillars, namely scaling-up municipal EE investments, strengthening EE delivery capacity, and promoting sustainable EE mechanism.

Before anything else, the city should take ownership of the EE plan and commit to a straightforward, sound implementation of the EE plan. To this end, they should politically endorse the EE plan and approve it in the local council. Then, they should establish a municipal EE agency with a clear mandate and adequate staff to oversee the implementation of the EE plan and EE solutions, including monitoring and verification.

Box. 5 Municipal Energy Agency in Frankfurt

The Energy Agency (Energiereferat) was established in 1990 as part of Frankfurt's environmental department to develop the energy and climate protection plan for the city. In 2008 the city council endorsed 50 energy savings and climate protection measures, putting forward concrete steps to meet the target of reducing the CO 2 emissions by 10% every five years.

The Agency focuses on four main areas, namely a) electricity savings, b) energy planning and combined heat & power supply, c) reduction of energy consumption and use of renewable energy for buildings, and d) Masterplan 100% Climate Protection, a document combining all the above-mentioned activities. The Agency prepared a concept about how the city could be supplied by renewable energies only by 2050, a plan that brings together city residents, urban planners, architects, and various businesses.

The main task of the Agency is to implement measures targeting climate protection through various partners, preparing feasibility studies and providing project management for activities carried out by different partners. In this way, EE and climate protection can combine economic development and job creation. Frankfurt has joined a number of European alliances (such as Energy Cities), is a signatory of the Covenant of Mayors (the mainstream European movement involving cities voluntarily committing to increase EE, use of RES and reduce GHG emissions), and is also involved in various EU-funded projects.

The city must prepare a good comprehensive investment plan with feasible and realistic EE targets and a few well-prepared EE pilot projects with sound analysis and bankable feasibility studies that should appeal to potential donors and financiers. In addition, the local administration should strengthen the capacity to produce sound energy audits, good feasibility studies and sector strategies (for example, a local plan for district heating development). A special attention should be paid to institutional development to enable the EE delivery mechanism but also to strengthen the capacity to prepare and implement EE measures together and ensure monitoring of the EE program. An energy management system with monitoring and verification mechanisms should be put in place. Finally, the municipality should engage in an active and solid coordination with national government agencies.

A roadmap for scaling-up EE in municipal sectors should be set up and outline straightforward activities for the first 24 months. This should pilot the EPC model in street lighting and few public buildings during the first year, and deal with procurement of works and services, work implementation & supervision, benchmarking etc. in the second year.

7. Financial/Delivery Mechanisms - EPC under PPP

EE interventions need two key elements: financial/delivery mechanism and money. Together with relevant stakeholders, the city should identify sustainable delivery and financing mechanisms for the EE interventions, such as energy performance contracting (EPC), energy savings companies (ESCO) etc., and promote them through government programs, loans, commercial sector financing and PPP schemes with multi-year energy savings to repay EE investments.

Service contracts for energy performance can be developed with private suppliers, based on the existing public-private partnership (PPP) legislative framework. Since Kazakhstan does not have specific legislation on ESCOs and developing such legal framework would be a very long, steady process, the EPC scheme could be set up and used for EE interventions under the existing PPP legislation. Depending on the local context and potential partners, there could be a few EPC type business models under the PPP framework – namely, service contracts PPP, operation (concession) contracts, and a joint venture under a Special Purpose Vehicle (SPV) in the form of ESCO. Service contracts could work 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., public buildings retrofit or heat supply) an SPV in the form of ESCO could be used. If proven successful, the ESCO could evolve, on the medium-run, into an Energy Efficiency Revolving Fund, and use the revenues obtained from the EPC to fund new EE projects (see the case of the ESCO-turned revolving fund in Ternopil).

Box. 6 Municipal Energy Service Company and Municipal Energy Revolving Fund in Ternopil

Ternopil, a medium-size city in the Western Ukraine, has received technical assistance from the WB's ESMAP program to deploy TRACE and develop an EE Transformation program in 2015. The plan was adopted by the city council in early 2016. The investment program recommended the retrofit of 46 municipal buildings, mainly schools, kindergartens, for US$ 11.4 investments, with heat energy savings potential of 60-75% - up to 16 GWh per year. The limited funds from the city budget and high commitments by the city administration led to a delivery mechanism based on EPC.

International consultants developed a business plan for a municipal ESCO and strategy to set up the municipal Energy Efficiency Revolving Fund (EERF) under the local financial department. The business model is based on a revolving fund that would finance energy saving investments carried out by the municipal ESCO beginning with a pool of most economically viable buildings. The municipal ESCO should be a subsidiary company of the city owned district heating company, while the EERF funds would 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 Ternopil. 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 the EE investments for the next buildings. The EERF has applied for funds from the Ukrainian Municipal Infrastructure Facility (funded by the European Investment Bank and administered by the Ministry of Regional Development) for scaling-up EE measures. The implementation based on funds available from energy cost savings revenues will enable the retrofit of 10-15 buildings over a 10-year period, while ensuring the financial self-sustainability of the this delivery mechanism.

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

Since city budgets alone cannot fund the EE investments, a combination of funds from different sources (and stakeholders) is necessary. These can 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. The GoK should provide support to cities to co-finance the EE investments through government programs like DAMU or Nhurly Zhol, or get money from international financial institutions (IFIs). A financing structure based on the financial viability and project features is necessary to meet the loan or the private co-financing requirements, such as project design or adjustments to it as to become attractive to commercial/PPP funding, external debt loans or grants, and covering the remaining demand from the municipal budget.

The EPC scheme should be piloted for easy-to-implement measures, like LED in street lighting or replacement of the indoor lighting with LED in public buildings. For example, Almaty could modernize the public lighting in the city by placing 20,000 LEDs with dimming control in two districts under a PPP involving the city administration and the street lighting operator (owned by the local administration) under a US$ 9.2 million investment project. The project could save nearly 15 million kWh per year (62% of the existing consumption) which would translate into US$ 1.1 million.

Depending on the results, some well-designed projects should be promoted to potential private partners to get them involved into this new business area. The lessons learnt from these EE pilot interventions should ultimately enable tune and restructure this financing and delivering scheme in order to meet the expectations and requirements by potential interested partners, funders or donors.

On the long run, new legislation and regulation is necessary to establish the adequate mechanisms to encourage companies to undertake implementation of EE measures.

Conclusion

The EE assessment, the EE plan and the implementation strategy for Astana and Almaty could act as a local best-case practice and subsequently be adopted by other cities in Kazakhstan. Once the first EE projects are implemented and the EPC delivery mechanism proves successful, this could be replicated by other cities based on their local priorities and needs. Just like Astana and Almaty, they should begin by outlining priorities and preparing an EE plan that should be adopted by the local council, set up a municipal EE agency, and start with easy-to-implement interventions.