Tartu City Government

TARTU ENERGY EFFICIENCY ACTION PLAN

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Tartu 2016

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1. LEGISTLATION, GOALS and TRENDS

1.1 Energy and Climate legislation on national level

Estonian competition ability strategy "Eesti 2020" states that during previous decades Estonia has reduced its GHG emissions. The emissions in 2010 are 200085 thousand tonns and it is 53% lower compared to year 1990. EU is reducing GHG emissions by implementing emissions trading system and it is Esonia's national duty to set reduction goals on sectors that are not included in the international trading system. Following table describes Estonian goals for reduction of GHG emissions:

GHG emissions compared to 2005		
2005 level	**Goal 2015**	**Goal 2020**
5647 000 T	6156 000 T	6269 000 T (+11% compared 2005)
Renewable energy		
2009 level	Goal 2015	Goal 2020
19,5%	23,6%	25%
Energy consumption remain on 2010 level		
2009 level	Goal 2015	Goal 2020
2818 ktoe	2986 ktoe	2818 ktoe

Table 1.1 Climate change mitigation goals (Eesti 2020; 2014; page 23; https://riigikantselei.ee/sites/default/files/elfinder/article_files/eesti2020_08.05.2014_kodulehele.pdf)

A midterm report on achieving the goals was published on 6th of January 2015. It states that Estonia is achieving the goals it has set for itself. Emission and consumption indicators are below the set goals. Level or renewables in energy production is 25,8%. The report states that Estonian economy is still one of the most energy and recourse needy in Europe. For increasing energy efficiency in Estonian economy it is important to work with all sectors of economy, but most important of them being households, industry, transportation, and public sector. The report stresses the need for the public sector to take initiative and to be a role model in utilizing innovative and energy efficient solutions. Two new goals are set for public sector:

- Increase energy efficiency in public buildings. Improve surveillance on reaching energy efficiency minimum goals.
- It is important to increase the use of "green procurements" that take into account life-cycle principles and to prefer energy efficient solutions in construction and equipment procurements. It is also important to share the experiences, best practices, demonstrate financial savings, reduction of CO2 emissions, positive impact on Estonian economy, the public and the people.

1.2 Energy efficiency and climate change mitigation in Tartu

Tartu development strategy 2030 names environmentally sound thinking, coping with changes caused by climate change and mitigation of climate change as the city's challenges. Vison 2030 for the city states that "Tartu is a city for active, creative and happy people. Tartu is a university city, capital of Estonian education, city of youth, a center for services with a smart environment. It is an inspirational, natural city with a unique heritage." Sub vision 5.3 states that "Tartu is a city with an inspirational environment" with a sub goal "Tartu is an inspirational and cooperative city with a secure city environment that is being developed in a sustainable manner".

In 2014 Tartu joined the Covenant of Mayors and has set itself a goal of reducing greenhouse gas emissions by 20%, increasing energy efficiency by 20% and increasing the use of sustainable energy sources to 20% of it's overall energy consumption by the year 2020 (Tartu Linnavolikogu 20. Veebruari 2014 otsus nr 54 http://info.raad.tartu.ee/webaktid.nsf/web/viited/VOLO2014022000054 2.02.2015). With joining the Covenant of Mayors the city has produced a "Greenhouse gas emission inventory" and a "Tartu Sustainable Energy Action Plan 2015-2020" (SEAP).

1.3 Goals for Energy Efficiency Action Plan

The action plan in hand concentrates on giving an overview if energy consumption in Tartu City Government and on means of reaching set goals. Focus for the action plan is on Tartu City Government as an organization rather than the whole city of Tartu. The energy efficiency action plan focuses on energy consumption since it is the single most impactful factor in creating GHG emissions.

The goals for Tartu City Government energy consumption are:

- Goal 1: by yr. 2020 to maintain the energy consumption level of yr. 2010 (Eesti 2020)
- Goal 2: by yr. 2020 to maintain electricity consumption of year 2010.

1.4 Method

Energy consumption in Tartu City Government can be divided into 5 main domains:

- Consumption of heat in public buildings
- Consumption in electricity in public buildings

- Consumption of electricity in street lighting
- Consumption of energy in public transport
- Consumption of energy in city government transport

The comparison year is 2010. Current situation is described by the year 2014. Most of investments bay Tartu City Government impacting energy consumption were made in years 2011, 2012 and 2013. The energy consumption during investing years might not correctly illustrate the situation so the year 2014 was chosen.

The consumption of heat in public buildings in different years is not directly comparable for the impact of outside temperature. The winter of 2010 was a cold on with lots of snowfall. The winter of 2014 in comparison was very mild with temperatures rarely falling below 0'C and little snowfall. To make years comparable Tallinn Technical University has proposed adjustment technique to eliminate the impact of difference in outside temperature from calculations.

The years 2010 and 2014 are made comparable by following equation:

$Q_N = (Q_{teg} – C) \times S_n / S_{teg} + C$

Q_N – norm year heat consumption , MWh;

Q_{teg} – actual heat consumption, MWh;

S_N – norm year degree days (chosen accordingly to balance temperature in the building);

S_{teg} – degree days in an actual year (choses at the same balance temperature as S_N);

C – heat consumption not impacted by outside temperature, MWh.

It is not possible to determine how much electricity was consumed for heating public buildings. Therefore it is presumed that none of the electricity was consumed for heating, electricity consumption is not adjusted accordingly to the outside temperature and the electricity consumption during different years is directly comparable.

2. ENERGY CONSUMPTION IN 2010 AND 2014

Tartu City Government's energy consumption is created in 5 key fields:

- heat consumption in public buildings,
- electricity consumption in public buildings,
- electricity consumption in street lighting,
- energy consumption in public transportation
- energy consumption in city government transportation.

In 2010 Tartu City Government consumed almost 71 GWh of energy. The consumption reduced to 65 GWh of energy by the year 2014. The total amounts. Energy consumed in different fields is described in the next table:

	2010	2014	Abs.change	Rel.change
Heat (MWh)	39 021	32 088	-6 933	-18%
Electricity in buildings (MWh)	9 406	10 257	+851	+9%
Street lighting (MWh)	7 456	7 361	-95	-1%
Public transportation (MWh)	14 834	15 081	247	+2%
City Gov. Transportation (MWh)	15	73	+58	+379%
TOTAL	70 732	64 860	-5 872	-8%

Table 2.1 Tartu City Government energy consumption in 2010 and 2014

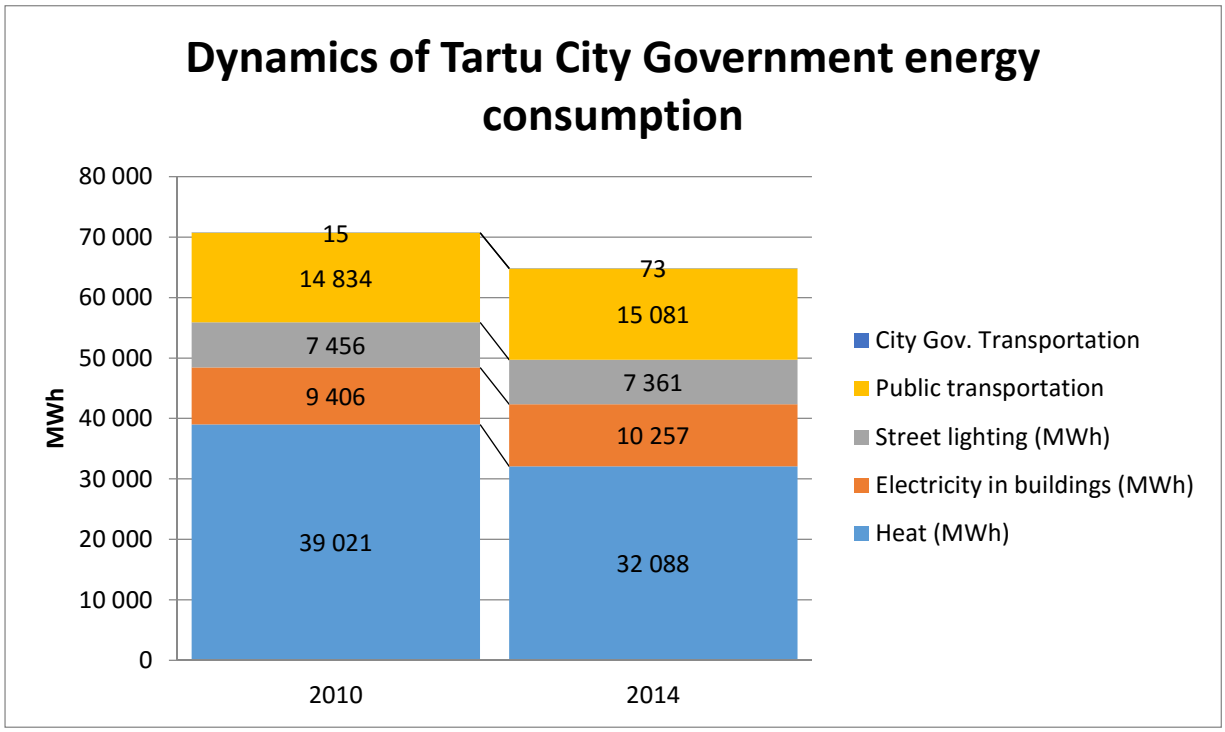


Diagram 2.1 Energy consumption by types in 2010 and 2014

2.1 Energy consumption in public buildings

Tartu City Government owns more than 380 000 m^2 of property. This includes fully owned buildings and residential and non-residential property in co-owned buildings. In 2014 Tartu City government owned 252 buildings. The number of buildings has decreased since 2010 by 34 buildings. It is the result of ongoing demolition of soviet-era military base buildings. All together around 50 buildings will be demolished by the end of 2016. List of Tartu city owned buildings includes schools, kindergartens, sports facilities, administration buildings, residential buildings, museums, libraries, buildings out of use and other buildings. This paper looks at buildings that have activities directly controlled by different departments of Tartu City Government. This paper does not include

- premises that are outside of fully owned buildings,
- sports facilities
- buildings that are used by non-profit organizations event if City of Tartu is one of co-founders of the organization.
- rental buildings for private sector
- buildings out of use and destined for demolition

	2010		**2014**	
	count	size	count	size
Buildings	286	363 166	252	359 757
Residential property	305	11 401	271	9 346
Non-residential property	108	14 168	96	13 708
KOKKU		**388 735**		**382 811**

Table 2.2 Tartu City Government Property.

Current paper includes 95 building as illustrated by following table:

Type	**Number**	**Size**
Residential	11	15 819
Other educational	6	8 151
Administration	6	8 874
Vocational education	6	36 360
Museums, libraries	6	8 467
Other	6	5 686
Schools	24	124 112
Kindergartens	30	58 398
TOTAL	**95**	**269 877**

Table 2.3 Number and size of public buildings

Nearly ¼ of energy used in public buildings was in form of electricity. ¾ of energy was used as heating and hot water for the buildings supplied by the district heating system.

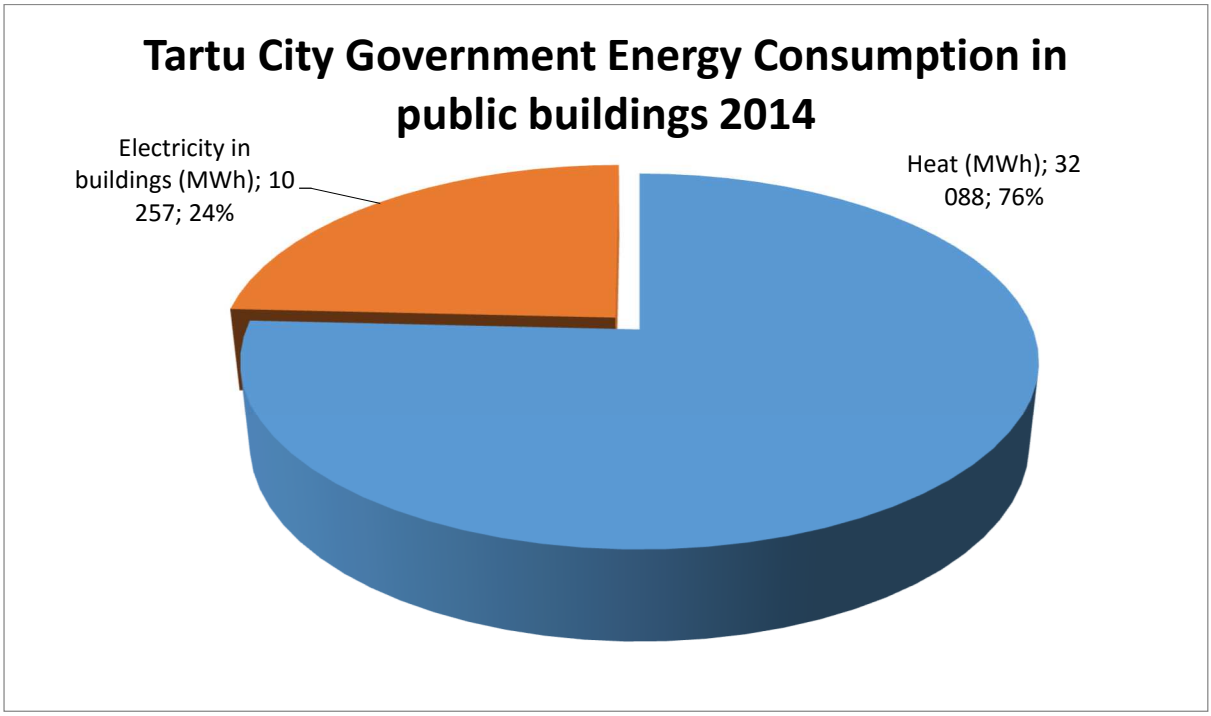


Diagram 2.2 Tartu City Government Energy Consumption in public buildings 2014

The consumption of energy in 2014 was 12,5% or over 6 GWh lower compared to 2010. Heat energy consumption reduced by 6933 MWh and electricity consumption increased by 851 MWh. The decrease was mainly result of a much warmer year.

Adjusted heat energy consumption demonstrates a 2,6% reduction of consumption. Electricity consumption is not adjusted since it is impossible to determine how much of energy was and is used for heating purposes. For calculation purposes it is presumed that none is used for heating purposes. Unadjusted electricity consumption demonstrates 9,2% increase. This resulted in 0,2% decrease in overall adjusted energy consumption as the decrease in heat consumption was cancelled by the increase of electricity consumption.

The dynamics of energy consumption are described by following table and diagrams:

Adjusted	2010	2014	2010	2014	Abs.change	Rel.change
Heat (MWh)	**36 558**	35 590	80%	78%	-968	-2,6%
Electricity in buildings (MWh)	**9 406**	**10 270**	20%	22%	+865	+9,2%
TOTAL	**45 963**	**45 860**	**100%**	**100%**	**-103**	**-0,2%**

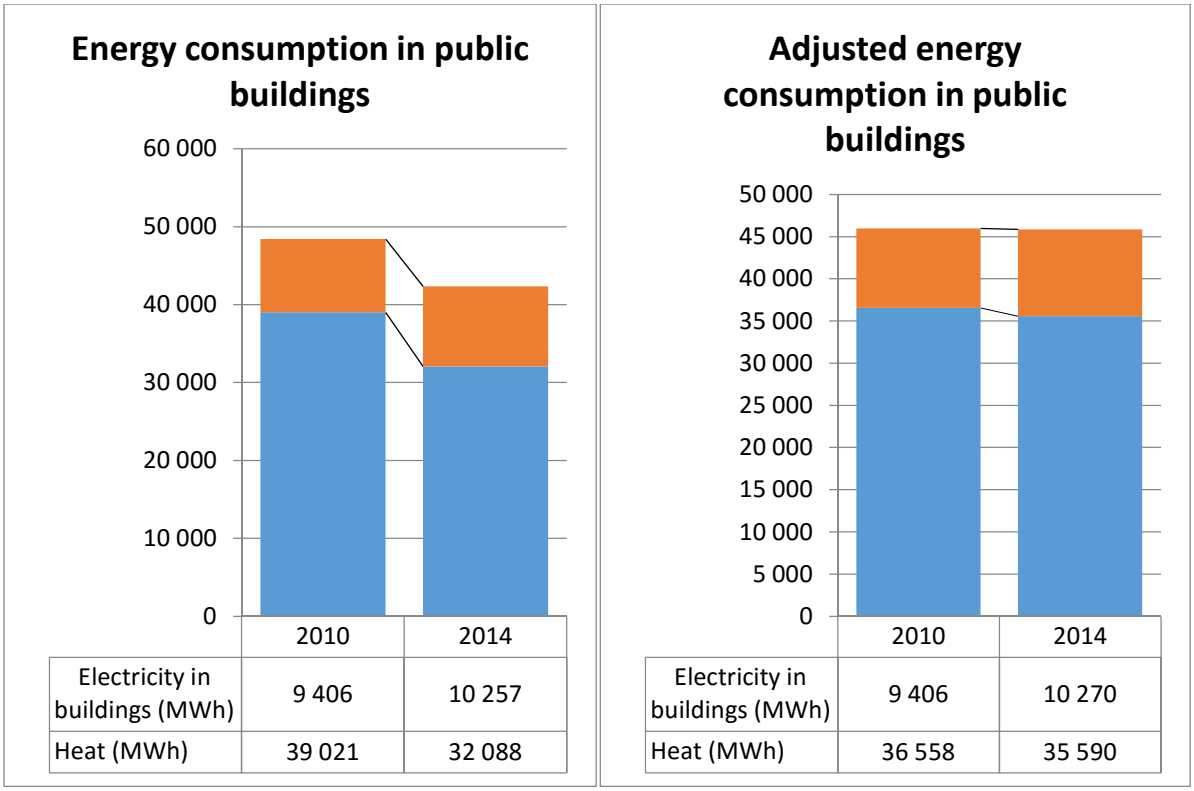


Diagram 2.3 Electricity and head consumption in public buildings

The changes in adjusted energy consumption are the result of a number of investments made mainly to schools and kindergartens. The investments include energy efficiency measures, kindergarten extensions and kitchen renovations. Investments and the effects are described in following paragraphs.

Energy consumption in schools

Tartu has 24 schools with total premises of 124 112 m^2. Most of the schools have been built between 1960 and 1990. Tartu has a few schools in historic buildings. The schools are connected to the city's district heating grid, have central heating and mostly natural ventilation. The schools constructed between 1969 and 1990 were designed without energy efficiency in mind. The walls are bad insulators and windows were designed not to be air tight as to allow fresh air into the classrooms and serve as ventilation. The indoor climate in the schools is uneven. Different rooms of same school may have different temperature and air quality.

In 2010 the schools consumed a total of 18,334 GWh of energy. Total energy consumption in 2014 was 15,698 GWh. The reduction is mostly the result of 2014 being a much warmer year

than 2010. Adjusted heat consumption shows reduction of consumption by 5,3% and increase in consumption of electricity by 8,4%. The dynamics are illustrated by following diagrams.

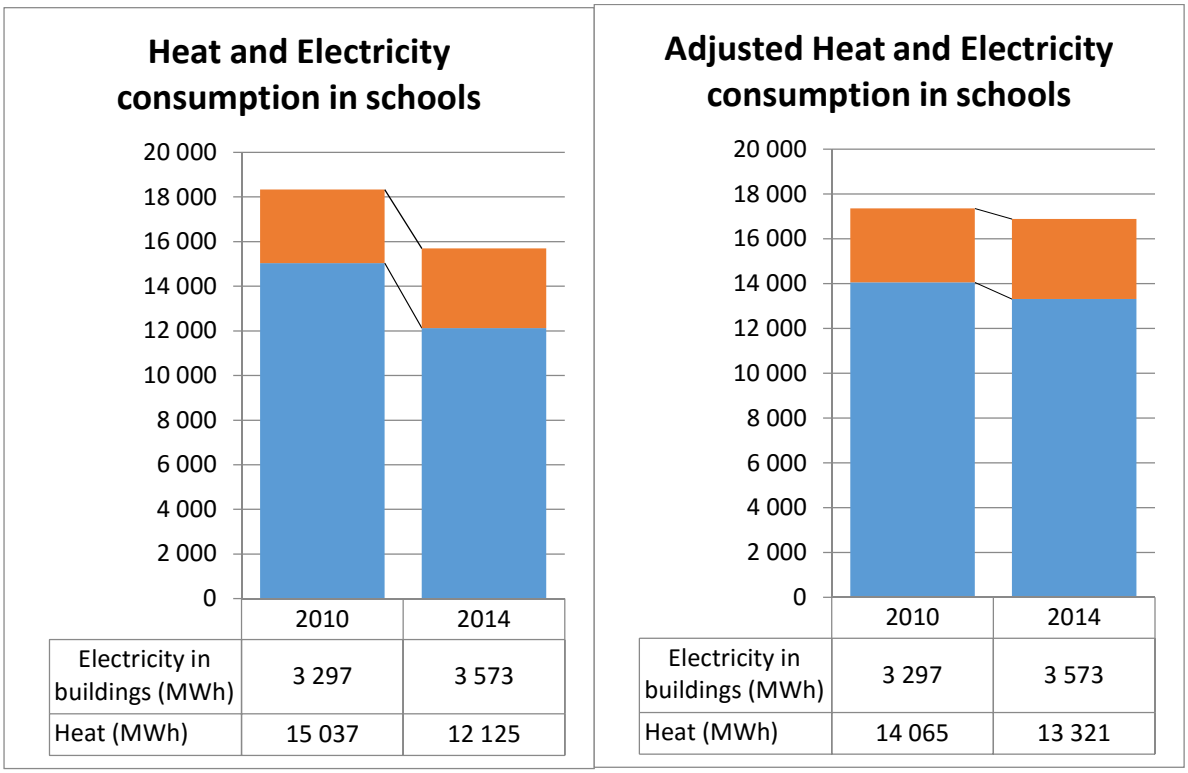


Diagram 2.4 Electricity and head consumption in schools

The city of Tartu has made a large number of investments into its schools between years 2010 and 2014. Most of investments were financed by successful sale of unused national GHG emissions quotas. The investments had a clear purpose of increasing efficiency and improving indoor climate in schools.

The city decided to invest in 7 schools:

- Kristjan Jaak Petersoni Gymnasium, Kaunase pst 70
- Tartu Kivilinna School, Kaunase pst 71
- Tartu Kesklinna School, Kroonuaia 7
- Tartu Karlova School, Lina 2
- Tartu Tamme School, Tamme pst 24A
- Tartu Forseliuse School, Tähe 103
- Tartu Aleksander Puškini School, Uus 54

The total results of the investments are illustrated by following table:

Year	2010	2014	Change (total)	Change %
Heat, MWh	6081,6	4535,7	-1546,0	-25%
Heat, MWh/m2	0,134	0,100	-0,034	
Adj. heat. MWh	5688,1	4981,2	-706,9	-12%
Adj. heat. MWh/m2	0,125	0,109	-0,016	
Electricity MWh	1313,0	1452,9	139,9	11%
Electricity MWh/m2	0,0289	0,0319	0,003	
TOTAL (Adj.heat + Electricity)	**7001,2**	**6434,2**	**-567,0**	**-8%**
Premises (m2)	45 500			
KWh/m2/a	153,9	141,4		
No. of children	5484	5074	-410	-7%

Table 2.4 Impact on investments in 7 school buildings

The investments were mostly into renovation of central heating systems, insulation (walls, roofs, basement, attic), and installation of new windows. Only 3 schools had investments into ventilation systems.

The main result of the investments was a clear improvement of indoor climate in the schools. At the same time there has been reduction of heat consumption by 12% or 706 MWh. At the same time electricity consumption has increased by 11% or by 139 MWh. Total consumption reduced by 8% or 567 MWh.

Clear investment into energy efficiency into schools is possible only if indoor climate is satisfactory and investments are directed at reducing consumption while maintaining climate quality. The investments into Tartu schools intend to improve indoor climate while reducing energy consumption. Reaching ventilation norms would mean installation of ventilation systems. Also investment into insulation and new windows stops natural ventilation through imperfections and creates new risks for indoor air quality. This means that investment into reduction of heat consumption results in higher demand for mechanic ventilation that in turn results in increase of electricity consumption.

Best example of the results is Aleksander Puškin School in Annelinna district of Tartu. The school is meant for Russian speaking students and it used for classes from 1st to 12th. In 2013 all Russian speaking high school (or gymnasium; grades from 10 to 12) students were decided to gather into Annelinna Gymnasium. This meant the reduction of no of children from 746 to 520 in A. Puškin School.

The school buildings A-wing was renovated before the year 2010. The ventilation shafts were created and in 2012 a heat recovery ventilation machine was installed and ventilation started operating. The ventilation operates in 3 top floors of the A-wing. In 2012 the cafeteria rooms and kitchen rooms were fully renovated. The kitchen is operated by private company using its own machinery. The installation of ventilation machine and new kitchen equipment have resulted in electricity consumption increase of 56% or 75,1 MWh per year.

As a result of insulation, instalment of new windows and renovation of central heating system the heat consumption has increased by 8%. As a result of the investments the temperature between different classrooms, wings of the school and different floors has equalized. The temperature in classrooms is following current regulations. The energy consumption per square meter is slightly below average for renovated schools. So the slight increase in heat energy consumption is a sign of increase in indoor climate quality yet at the same time the school consumes relatively less energy than other renovated schools.

Year	**2010**	**2014**	**Abs.change**	**Rel.Change**
Heat, MWh	713,0	660,7	-52,3	-7%
Heat, MWh/m2	0,104	0,096	-0,008	0%
Adj. heat. MWh	669,3	722,7	+053,4	+8%
Adj. heat. MWh/m2	0,098	0,105	+0,008	0%
Electricity MWh	134,3	209,4	+75,1	+56%
Electricity MWh/m2	0,0196	0,0305	0,0	0%
TOTAL (Adj.heat + Electricity)	**803,7**	**932,2**	**+128,6**	**+16%**
Premises	6862,4			
KWh/m2/a	117,1	135,8		
No. of children	746	520	-226	-30%

Table 2.5 Impact of investments in Tartu A. Puskin school

Schools with insulation investments and renovated central heating systems demonstrate heat consumption reduction between 17% and 28%.

Energy consumption in kindergartens

In 2014 City of Tartu had 30 kindergartens with 58 398 m^2 of premises for 5293 children. Most of the kindergartens have been built between 1960 and 1990. The schools have central heating and mostly natural ventilation. The kindergartens constructed between 1960 and 1990 were designed without energy efficiency in mind. The walls are bad insulators and windows were designed not to be air tight as to allow fresh air into the classrooms and serve as ventilation.

The kindergartens consumed 12,4 GWh of energy in 2010 and 10,8 GWh of energy in 2014. Most of the energy savings are a result of 2014 being a considerately warmer year than 2010. Adjusted energy consumption demonstrates only a 0,2% decrease of energy consumption in 2014 compared to 2010. During the time electricity consumption increased by 10% and adjusted heat consumption decreased by 1,5%. The dynamics are demonstrated in table and diagrams below:

Year	2010	2014	Abs.change	Rel.Change
Heat, MWh	11028,6	9388,2	-1640,4	-15%
Heat, MWh/m2	0,193	0,161	-0,033	-17%
Adj. heat. MWh	10379,0	10219,5	-159,6	-2%
Adj. heat. MWh/m2	0,182	0,175	-0,007	-4%
Electricity MWh	1364,4	1495,8	131,4	+10%
Electricity MWh/m2	0,0239	0,0256	0,0	+7%
TOTAL (Adj.heat + Electricity)	**11743,6**	**11715,4**	**-28,2**	**0%**
Premices	57 042	58 398	1355,7	+2%
KWh/m2/a	201,1	200,6	-0,5	0%
No. of children	5093,0	5293,0	200,0	+4%

Table 2.6 energy consumption in Tartu kindergartens

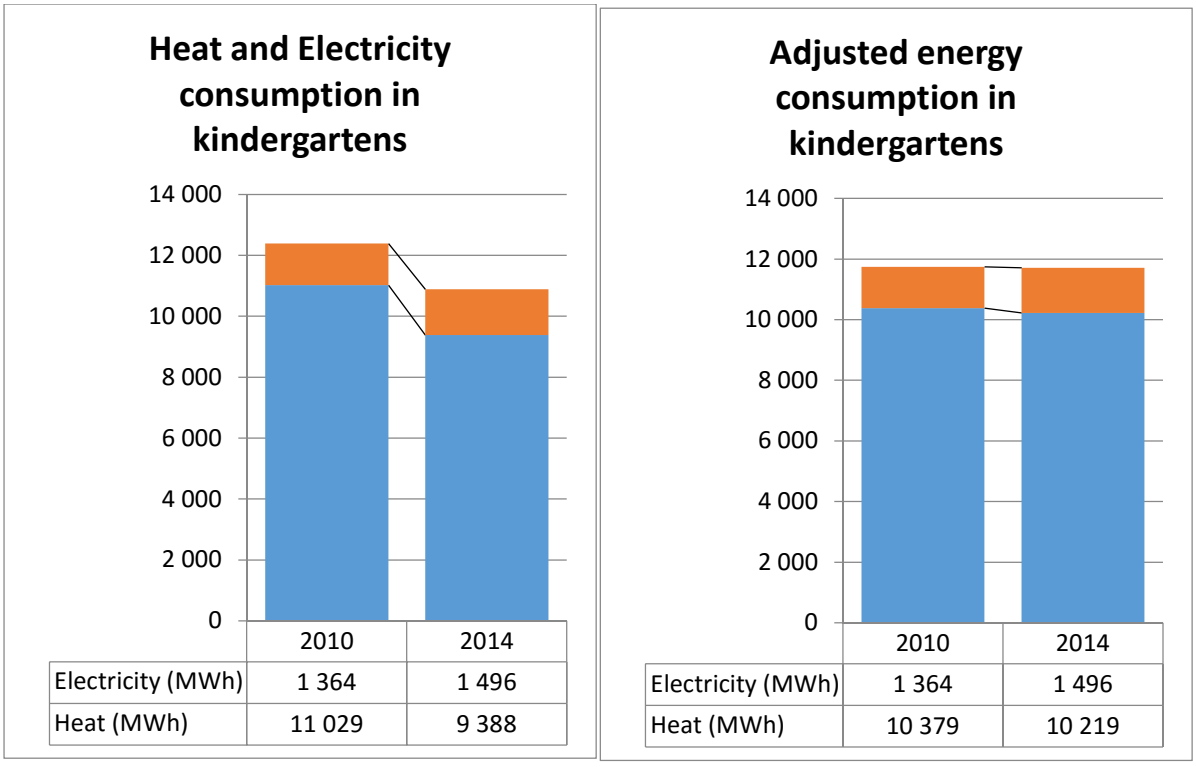


Diagram 2.5 Energy consumption in Tartu kindergartens

City of Tartu made 3 types of investments into the city's kindergartens between years 2010 and 2014:

First type of investments were financed by successful sale of unused national GHG emissions quotas. The investments concentrated on improving indoor climate and increasing energy efficiency. They included insulation works, installing efficient windows and renovation of central heating systems. Second investments were directed at increasing the kindergarten services by creating new rooms and possibilities for more children to attend kindergartens. Third investments were made into the kitchens for the kindergartens to be able to feed the larger number of children.

Kindergarten energy efficiency investments

The investments into improving indoor climate and improving energy efficiency included 6 kindergartens. The investments were made into wall, roof and basement insulation and renovation of central heating system. Some of the kindergartens had some of windows changed as the windows were partially changed in years before. One of the kindergartens had only insulation works done. One kindergarten was fully renovated excluding ventilation.

The overall result of investments in the 6 kindergartens resulted in 25% decrease on heat consumption. The kindergartens showed no significant change in electricity consumption due to the nature of the investments. Results are described by the table below:

Year	2010	2014	Abs.change	Rel.Change
Heat, MWh	2049,2	1330,1	-719,1	-35%
Heat, MWh/m2	0,211	0,137	-0,074	
Adj. heat. MWh	1927,1	1443,1	-484,0	-25%
Adj. heat. MWh/m2	0,199	0,149	-0,050	
Electricity MWh	208,6	218,4	9,8	5%
Electricity MWh/m2	0,022	0,023		
TOTAL (Adj.heat + Electricity)	**2135,7**	**1661,6**	**-474,1**	**-22%**
Premises	9693,6			
KWh/m2/a	220,3	171,4		
No. of children	1185,0	1195,0	**10,0**	**1%**

Table 2.7 Impact of investments in renovated kindergartens

Best results were reached in Tartu Kindergarten Tõruke. The investments included renovation of central heating system, insulation of walls, roof and basement, new windows and new doors. As a result the heat consumption was decreased by 53% and electricity consumption decreased by 18%. The kindergarten consists of the main building and two extensions. The extensions were of such bad building quality that they had to be additionally heated by electricity. Changes in consumption are described by following table:

Year	2010	2014	Abs.change	Rel.Change
Heat, MWh	224,2	91,4	-132,8	-59%
Heat, MWh/m2	0,286	0,117	-0,170	
Adj. heat. MWh	210,5	98,6	-111,9	-53%
Adj. heat. MWh/m2	0,269	0,126	-0,143	
Electricity MWh	27,3	22,4	-4,9	-18%
Electricity MWh/m2	0,0349	0,0286		
TOTAL (Adj.heat + Electricity)	**237,8**	**121,0**	**-116,8**	**-49%**
Premises	783			
KWh/m2/a	303,7	154,5		
No. of children	89,0	89,0	0,0	0%

Table 2.8 Impact of renovations in Tartu Kindergarten Tõruke

Overall a few rules can be deduced from the energy efficiency investments into 6 kindergartens:

- Only insulation of walls can give about 10% saving on typical Tartu kindergartens.
- As a single measure for energy efficiency renovation of central heating system is most beneficial to reducing heat consumption in buildings.
- Full renovation with new central heating system, new windows and doors and insulation of walls, roof and basement can give around 50% reduction of heat consumption.

New kindergarten classroom and kitchen investment

In 2012 and 2013 the City of Tartu invested in creating new classroom into existing kindergartens to reduce the deficit of kindergarten places in Tartu. It was mainly done by extensions but few had new rooms created into existing unused rooms. All new classrooms are built accordingly to current regulations. The new classrooms are heated by existing central heating systems, the lighting used is consistent with current standards and fresh air is provided by heat recovering ventilation system. Ventilation only serves new classrooms. Already existing rooms are not connected to the new ventilation system. All kindergartens with new extensions had investments made to renovate kitchens and install new equipment and kitchen ventilation.

Overall result of the investments:

- 13 new classrooms
- 174 additional places
- Additional 1356 m^2 or increase by 6%
- Overall increase of heat consumption by 10%

- Relative increase of heat consumption 3% per m^2
- Increase of electricity consumption by 30%
- Relative increase of electricity consumption 22% per m^2

Kindergartens demonstrated increase of electricity consumption between 15% and 50% while comparing the two years. The increase in electricity consumption is mainly produced by new kitchen equipment, increased number of children and in smaller amounts by the ventilation system. Changes in energy consumption are demonstrated by following table:

Year	2010	2014	Change (total)	Change %
Heat, MWh	4697,2	4436,3	-260,9	-6%
Heat, MWh/m2	0,220	0,195	-0,025	-11%
Adj. heat. MWh	4418,3	4839,8	421,5	10%
Adj. heat. MWh/m2	0,207	0,213	0,006	3%
Electricity MWh	359,0	467,6	108,6	30%
Electricity MWh/m2	0,017	0,021	0,0	22%
TOTAL (Adj.heat + Electricity)	**4777,2**	**5307,4**	**530,1**	**11%**
Premises	21364,8	22720,5	1355,7	6%
KWh/m2/a	243,4	249,4	6,1	2%
No. of children	2030,0	2195,0	165,0	8%

Table 2.9 Impact of new classroom investments on kindergartens

Newest kindergartens

City of Tartu has two so called new kindergartens as they were built during past 20 years. They are Tartu Kindergarten Lotte constructed on 2008 and Tartu Kindergarten Klaabu constructed in 2009. They are similar in size with around 2000 m^2 and room for 140 children. Yet they are different in construction as Lotte is 1-storey and Klaabu is 2-storey building. Lotte has large glass surfaces used in its façade as Klaabu is with more traditionally sized windows. This results in Lotte using 165 kWh/m^2 per year as Klaabu uses 110 kWh/m^2 (overall kindergarten average in 2014 is 175 kWh/m^2/yr) of heat in a year. Both kindergartens demonstrate high usage of electricity with around 45kWh/m^2/yr (overall kindergarten average in 2014 is 25 kWh/m^2/yr) as both kindergartens were built according to current regulations.

Energy consumption in administration buildings

Tartu City Government uses 6 buildings witch are all situated in historic central area of Tartu but mainly around the city square. The buildings amount to total of 9532 m^2 of space. All

administrational buildings are marked as heritage and renovation works can be done only by following strict regulations.

The buildings consumed total of 1401 MWh of heat and 488 MWh of electricity in 2014. The consumption of heat has increased by 14% as consumption of electricity has reduced by 14%. No major investments have been made to the buildings. Investments have mainly included renovation of offices in the buildings.

The changes are mostly the result of central heating issues in two buildings - Raekoja plats 12 and Küüni 3/5. The buildings have central heating systems that were not providing sufficient heat in different rooms of the buildings. This resulted in use of additional electric radiators. The problem with central heating is caused by faulty automation. To increase temperature in the buildings a manual setting was set to ensure sufficient temperature in the room at wintertime. The settings are the same at autumn and spring and create overheating of the rooms. The central heating radiators are equipped with thermo-regulators to enable the occupants to adjust the temperature of the room. But the wrong settings still mean wasted heat in the system.

The reduction in electricity consumption is a result of different factors. The adjustment of central heating system and warmer winter eliminated the need for additional electric heating in the rooms. All ICT technology has been replaced by more energy efficient equipment.
The changes in energy consumption in administrational buildings are described in the following table:

Year	**2010**	**2014**	**Change (total)**	**Change %**
Heat, MWh	1323,3	1268,0	-55,3	-4%
Heat, MWh/m2	0,139	0,133	-0,006	
Adj. heat. MWh	1233,5	1401,0	+167,5	+14%
Adj. heat. MWh/m2	0,129	0,147	0,018	
Electricity MWh	566,4	488,8	-77,6	-14%
Electricity MWh/m2	0,0594	0,0513		
TOTAL (Adj.heat + Electricity)	**1800,0**	**1889,9**	**+89,9**	**+5%**
Premises	9531,6			
KWh/m2/a	188,8	198,3		
No. of children				

Table 2.10 Energy consumption in administrational buildings

Energy consumption in vocational education buildings

Tartu Vocational Education Center is situated at two locations – Kopli 1 at southern side of Tartu and Põllu 11 on the northern side of Tartu.

Kopli 1 has a size of 26 387 m^2 and it includes studying facilities and dormitory. In 2012 investment were made into renovating the roof of the complex. The investments have not had a significant impact on energy consumption of the complex. The heat energy consumption in both 2010 and 2014 was 111 KWh/m^2 and consumption of electricity was 69 kWh/m^2. There have been no other significant investments that would impact energy consumption in the building.

Põllu 11 complex consists of study building, workshop, dormitory, side building and stadium building. In 2012 investments were made into workshop, dormitory and study building. As a result of the investments the building received new insulation, windows were replaced, roofs were renovated and insulated, new central heating system was installed and natural ventilation vents were added.

The result of the investments was much improved indoor climate of the facilities and the heat energy consumption was reduced by 40% or 553 MWh per year end electricity consumption by 47Mwh or 7%. Overall energy consumption in Põllu 11 complex has reduced by 29% or 600 MWh per year.

Energy consumption in other buildings

Other buildings consist of 17 buildings with different functions with overall net size of 28 700 m^2. The list includes shelter for children, museums, libraries and commercial buildings. No significant investments have been made to decrease energy consumption in the buildings.

Year	2010	2014	Abs.change	Rel.Change
Heat, MWh	5153,1	4244,2	-908,8	-18%
Heat, MWh/m2	0,180	0,148	-0,032	
Adj. heat. MWh	4806,3	4684,6	-121,6	-3%
Adj. heat. MWh/m2	0,167	0,163	-0,004	
Electricity MWh	1630,9	1465,5	-165,4	-10%
Electricity MWh/m2	0,0568	0,0511		
TOTAL (Adj.heat + Electricity)	**6437,3**	**6150,3**	**-287,0**	**-4%**
Premises	28699,3			
KWh/m2/a	224,3	214,3		

Table 2.12 energy consumption in buildings with various functions

City is the owner of 4 wood heated residential buildings, but receiving accurate data on wood and electricity consumption in these buildings is not possible. So the buildings are left out of analysis. There have been no significant investments into 7 residential buildings connected to district heating network.

Year	2010	2014	Abs.change	Rel.Change
Heat, MWh	2316,4	2256,3	-60,1	-3%
Heat, MWh/m2	0,160	0,156	-0,004	
Adj. heat. MWh	2234,5	2441,6	+207,1	+9%
Adj. heat. MWh/m2	0,154	0,168	+0,014	
Electricity MWh	451,2	467,3	+16,1	4+%
Electricity MWh/m2	0,0311	0,0322		
TOTAL (Adj.heat + Electricity)	**2685,9**	**2909,1**	**+223,2**	**+8%**
Premises	14506,1			
KWh/m2/a	185,1	200,5		

Table 2.13 Energy consumption in residential buildings

2.2 Energy consumption in street lighting

In 2014 City of Tartu had 321 km of fully lit streets that were illuminated by 11 547 lamps. The lamps are connected by 227km of air-cables and 126km of underground cables. The lamps are operated from 151 switchboards. 92% or 10 620 of lamps used in Tartu were high pressure sodium (HPS) lamps. Additionally 295 HID and 632 LED lamps were in use. 10% of energy used in street lighting in 2014 was from renewable energy. The rate will rise to 20% by the year 2015.

In 2010 7456 MWh of electricity was consumed in street lighting. The consumption has decreased to 7361 MWh by the year 2014. The decrease is marginal with just 95 MWh or just over 2%. In 2014 City of Tartu had 321 km of fully lit streets that were illuminated by 11 547 lamps. The lamps are operated from 151 switchboards. 92% or 10 620 of lamps used in Tartu were high pressure sodium (HPS) lamps. Additionally 295 HID and 632 LED lamps were in use.

Kesklinn or central are of Tartu and Annelinn the main residential district of Tartu were the largest electricity consuming districts in Tartu amounting to 25% overall or 1867 MWh. The districts also have 2971 luminaries and 46 of the city’s 152 street lighting switchboards.

District	2014 (MWh)	Share
Annelinn	755	10%
Ihaste	605	8%
Jaamamõisa	121	2%
Kesklinn	1 112	15%
Karlova	689	9%
Maarjamõisa	209	3%
Raadi-Kruusamäe	371	5%
Ropka	319	4%
Ropka industreal district	358	5%
Ränilinn	530	7%
Tammelinn	572	8%
Tähtvere	338	5%
Vaksali	347	5%
Veeriku	450	6%
Ülejõe	587	8%
TOTAL	**7 361**	**100%**

Table 2.14 Street lighting energy consumption by city districts

Seasonal changes in street lighting between January 2013 and May 2015 are illustrated in following diagram. Unfortunately energy consumption data in different districts for the year 2010 is not available.

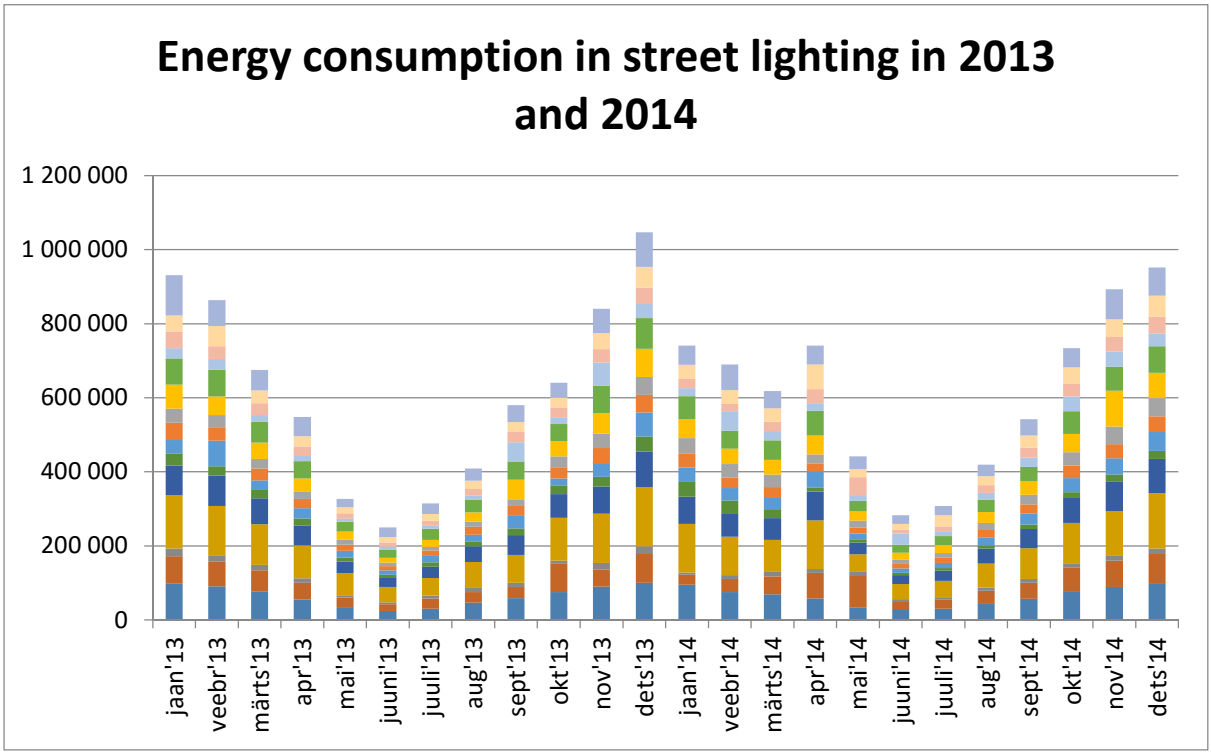


Diagram 2.6 Energy consumption in street lighting in 2013 and 2014

2.3 Energy consumption in Transportation

In 2010 Tartu City Government consumed in transportation 14,85 GWh of energy. By 2014 the energy consumption had increased by 2% to 15,15 GWh.

	2010	2014	Abs.change	Rel.change
Public transportation	14 834	15 081	247	2%
City Gov. Transportation	15	73	58	379%
KOKKU	14 849	15 154	305	2%

Table 2.15 Energy consumption in transportation in 2010 and 2014.

Tartu public transportation traveled around 3 600 000 km in 2010. In 2014 the number of miles had increased around 2% to 3 660 000 km. The energy consumption in public transportation has also increased by 2% consuming 14 834 MWh in 2010 and 15 081 MWh in 2014. The energy consumption is set to increase by 2020. Tartu City Government has set a goal to use only gas busses and power the busses with biogas. The result being decreased environmental impact of public transportation.

By 2014 the number of cars used by Tartu City Government had increased from 10 gasoline or diesel powered vehicles to 47:

- 5 CNG cars
- 34 electric cars
- 6 gasoline or diesel cars
- 2 diesel vans

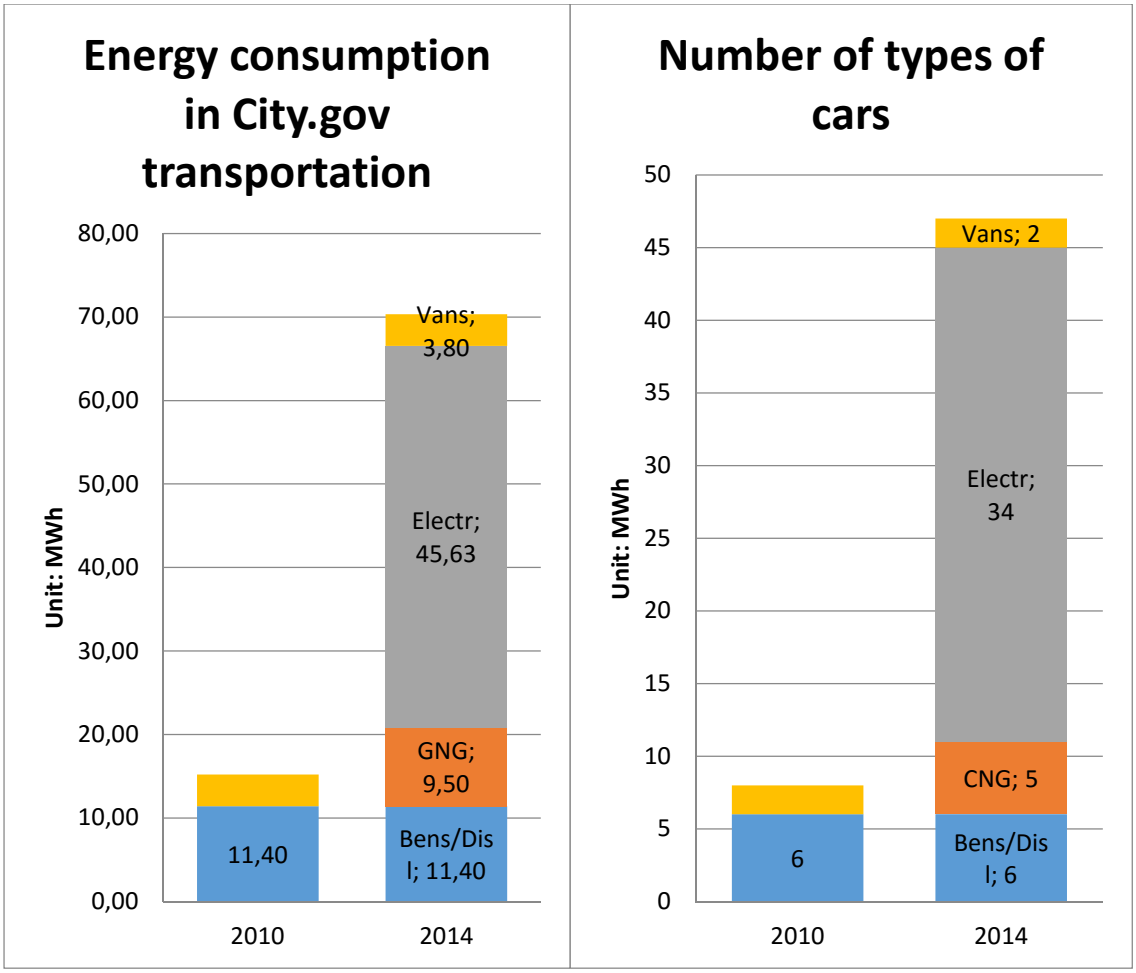


Diagram 2.7 Tartu City government transportation; number of cars and energy consumed.

As the number of cars has increased by 4 times the energy consumption has increased by similar margin from 15,2 MWh in 2010 to 70 MWh in 2014.

The decision to buy electric vehicles for the city government was made thanks to national initiative to develop nationwide charging network and to subsidize buying of electric vehicles in public and private sector. The EV-s are being used by social services department. The new cars have not created new services but have substantially increased the quality and speed of services provided by the city government to people in need.

To reduce the energy consumption by city gov. vehicles the current gasoline, diesel and CNG powered vehicles will be replaced by EV-s when the need arises.

3. ENERGY CONSUMPTION IN 2020

Tartu City Government energy consumption in 2020 will be 64,6 GWh. This is just under 4 GWh reduction compared to the year 2010. Biggest savings in energy consumption will come from reduction of heat consumption in public buildings and electricity consumption in street lighting.

	2010 (MWh)	2014 (MWh)	2020 (MWh)	20vs10 (MWh)	20vs14 (MWh)	20vs10	20vs14
Heat (adjusted)	36 558	35 590	32 634	-3 924	-2 956	-11%	-8%
Electricity in buildings	9 525	10 270	11 484	+1 959	+1 214	+21%	+12%
Street lighting	7 456	7 361	3 887	-3 569	-3 475	-48%	-47%
Public transportation	14 834	15 081	16 482	+1 648	+1 401	+11%	+9%
City Gov. Transportation	15	73	94	+79	+21	+517%	+29%
TOTAL	**68 388**	**68 375**	**64 581**	**-3 807**	**-3 795**	**-6%**	**-6%**

Table 3.1 Tartu City Government energy consumption in 2010, 2014 and 2020.

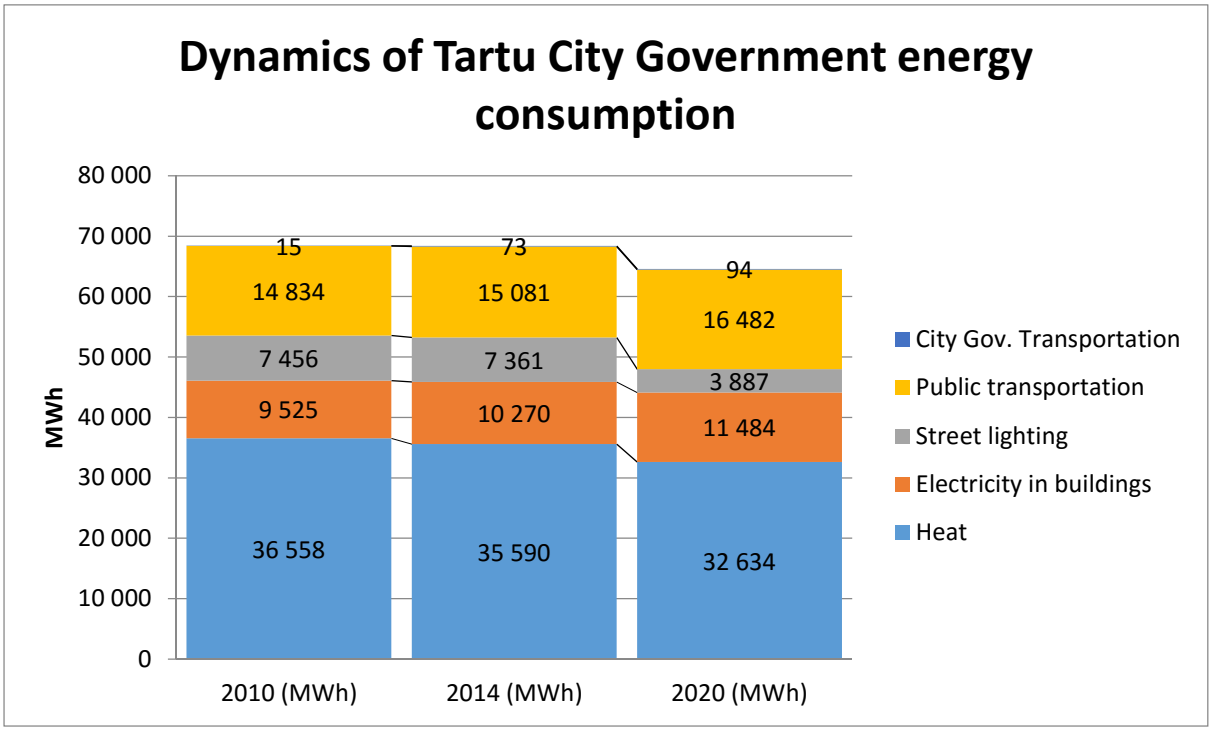


Diagram 3.1 Dynamics of Tartu City Government energy consumption

Following diagram of energy consumption by type shows the areas with biggest increase and decrease of energy consumption.

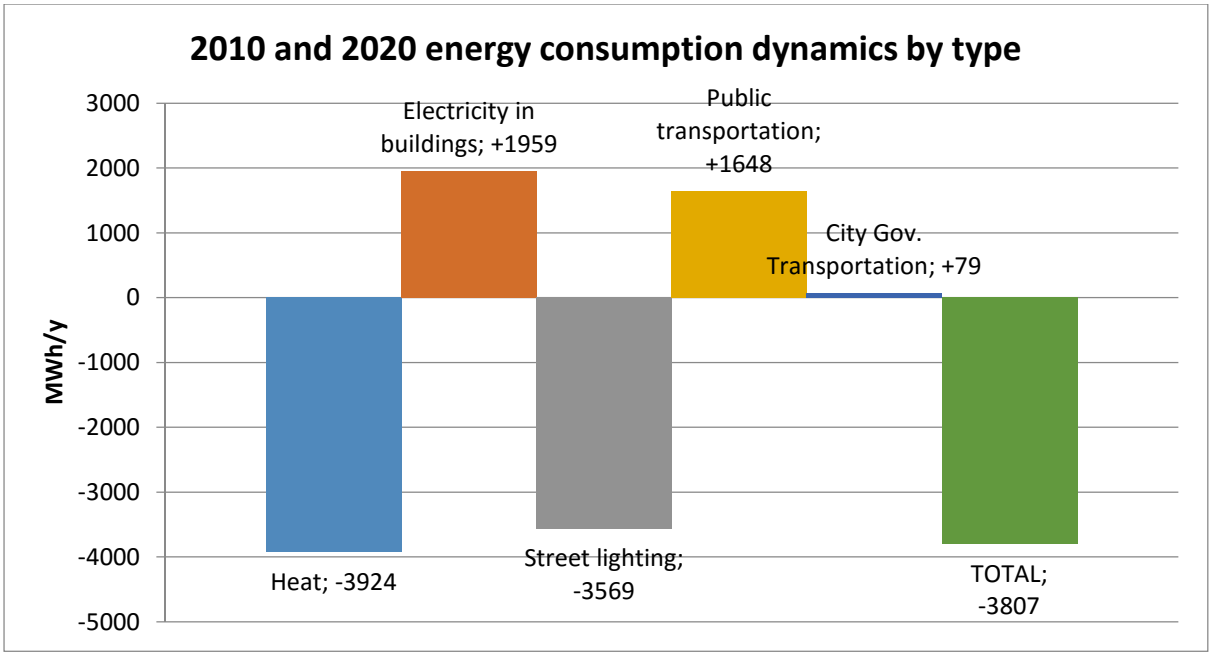


Diagram 3.1 Energy consumption dynamics by consumption type in 2020 compared to 2010.

3.1 Public buildings

Tartu City Government is planning the following large scale renovation and construction works during years 2016 to 2020:

- 1 new kindergarten
- 1 new wing to an existing kindergarten
- 2 fully renovated kindergartens
- 2 fully renovated schools
- 1 new school stadium building

The design process for Pepleri street kindergarten was finished in 2015. The projected heat consumption is 54 kWh/m^2/year and projected electricity consumption is 43 kWh/m^2/year. Same goals are set for fully renovated kindergartens and the kindergarten's extension. The energy consumption goals for two fully renovated schools are 20 kWh/m^2/year of heat and 89 kWh/m^2/year of electricity. The numbers are identical to fully renovated Tartu Tamme Gymnasium building at Nooruse street 9. The renovation was finished in 2015 and the building is a valid reference point for future renovations.

The overall energy consumption in 2020 in public buildings is predicted to decrease by 4% compared to 2010. Heat consumption is predicted to decrease by 11% as electricity

consumption will increase by 21%. The tendency for savings in heat consumption to turn into increased consumption in electricity is strong. Roughly 2 MWh of saved heat is replaced by one extra MWh of electricity consumed. The trends are described by diagrams and table below.

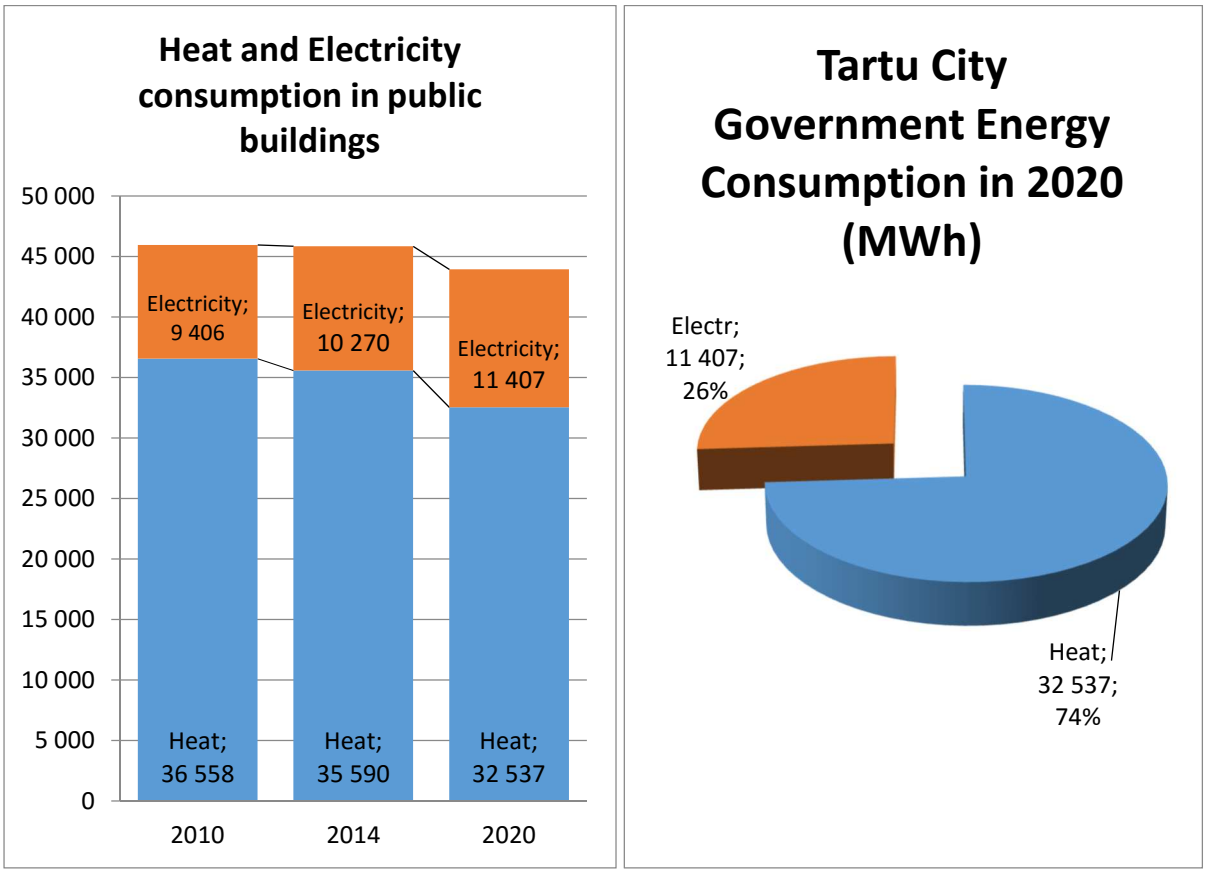


Diagram 3.3 Energy consumption in public buildings in 2020 (units: MWh)

	2010 (MWh)	2014 (MWh)	2020 (MWh)	20vs10 (MWh)	20vs14 (MWh)	20vs10	20vs14
Heat (adjusted)	36 558	35 590	32 634	-3 924	-2 956	-11%	-8%
Electricity	9 406	10 270	11 484	1 959	1 214	21%	12%
TOTAL	**45 963**	**45 860**	**43 943**	**-2 020**	**-1 917**	**-4,4%**	**-4%**

Table 3.2 Energy consumption in public buildings in 2020

Additional activities that will impact energy consumption in buildings:

- Procurement of energy efficient office equipment will decrease electricity consumption
- Fixing central heating issues in 2 administration buildings will decrease heat consumption
- Renovation of kitchens in schools and kindergartens will increase electricity consumption
- Regular renovation works in administration buildings with installment of new LED lighting will decrease electricity consumption.

Tartu Sustainable Energy Action Plan states a goal to reduce heat energy consumption in municipal buildings by the year 2020 compared to year 2010. Reaching the goal demands renovation of all Tartu schools and kindergartens to the energy consumption level reached in renovated kindergartens after 2012-2013 investments. To reach the average heat energy consumption should be 130 kWh/m^2 in all kindergartens and 100 kWh/m^2 in all schools. In this case heat consumption in schools and kindergartens would decrease by 27%.

As described before Tartu has just finished renovating Nooruse 9 school building and will start construction of new Pepleri kindergarten. Both buildings are very energy efficient and have some of the lowest calculated energy consumptions in Tartu public buildings. If all schools and kindergartens were renovated to the level of the two exemplary buildings then energy consumption in both educational buildings would decrease by 75%. This would decrease overall municipal building energy consumption by 54%. The schools would have to use no more than 20kWh/m^2 and kindergartens not more than 54 kWh/m^2. Full renovation of educational buildings double electricity consumption in the buildings.

3.2 Street lighting

In 2015 around 600 of luminaries with the highest energy consumption were replaced by LED luminaries. This means that more than 1000 luminaries of 11 547 are LED-luminaries. Tartu City government is planning on replacing the remaining luminaries during next 9 years.

In order to plan for the replacement, the city has been divided into 9 street lighting areas comparable in area, number of luminaries, number of switch boards and in energy consumption. For the next 9 years every year all existing luminaries in one area will be replaced by new LED luminaries. The areas are indicated on a map below.

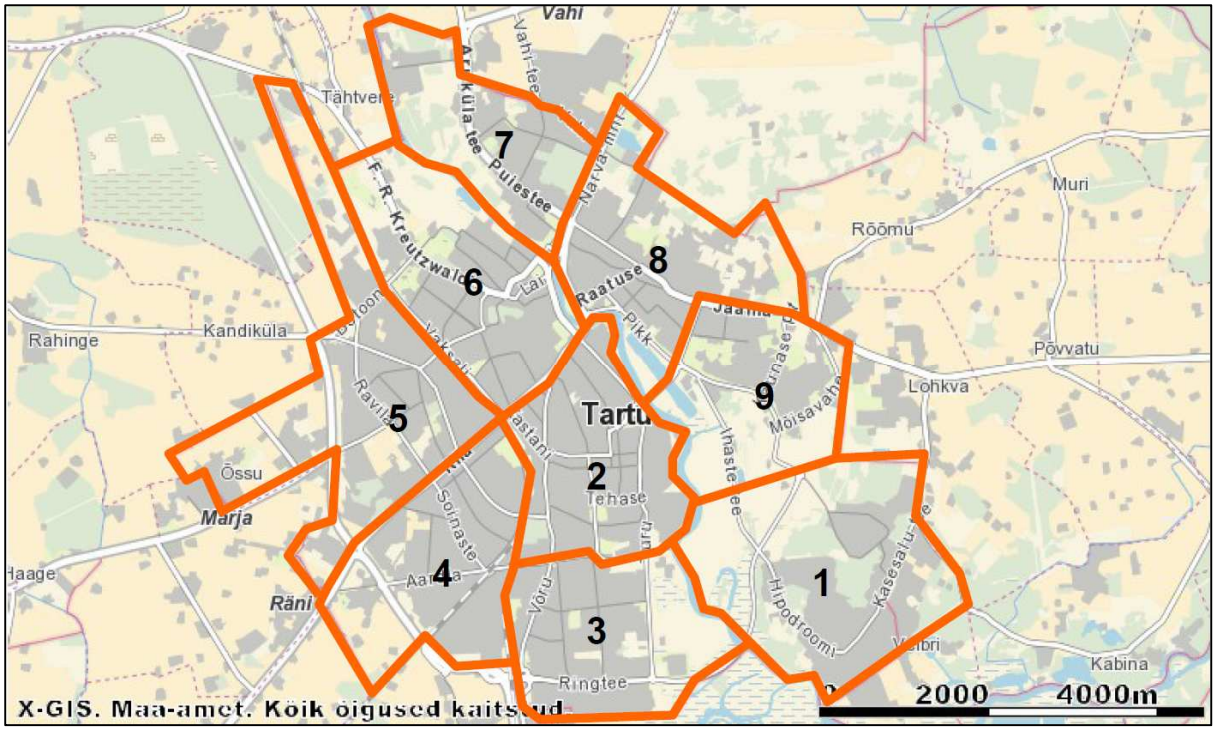


Diagram 3.4 Map of Tartu street lighting areas

Average calculated energy savings per luminary are around 70%. Actual savings may vary depending on area, power of luminaries and specifics of the street that the luminaries are situated on. Calculations show that at current energy prices and savings of 70% the investment payback period is between 8 and 9 years.

As a result of the investments new LED luminaries will replace existing luminaries in 5 districts by the end of year 2020. The number of luminaries to be replaced is around 7200 or 68% of all luminaries. This will decrease annual energy consumption in 2020 by 48% or by 3,57 GWh. As a result of 9 year full investment plan the energy consumption in 2024 will have been decreased by 70% or by 5,24 GWh compared to 2010.

Areas	2010	2014	2020	2024
1. Ihaste		538	538	161
2. Kesklinn-Karlova		1 099	330	330
3. Ropka		622	622	187
4. Tammelinn		892	268	268
5. Veeriku-Ravila		837	251	251
6. Kesklinn-Tähtvere-Supilinn		1 295	389	389
7. Raadi-Kruusamäe-Kvissentali		642	642	193

8. Annelinn-Ülejõe-Raadi		596	596	179
9. Annelinn		841	252	252
City in 2010	7 456			
TOTAL	7 456	7 361	3 887	2 208

Table 3.3 Tartu street lighting energy consumption by areas (units: MWh; no area info available for 2010)

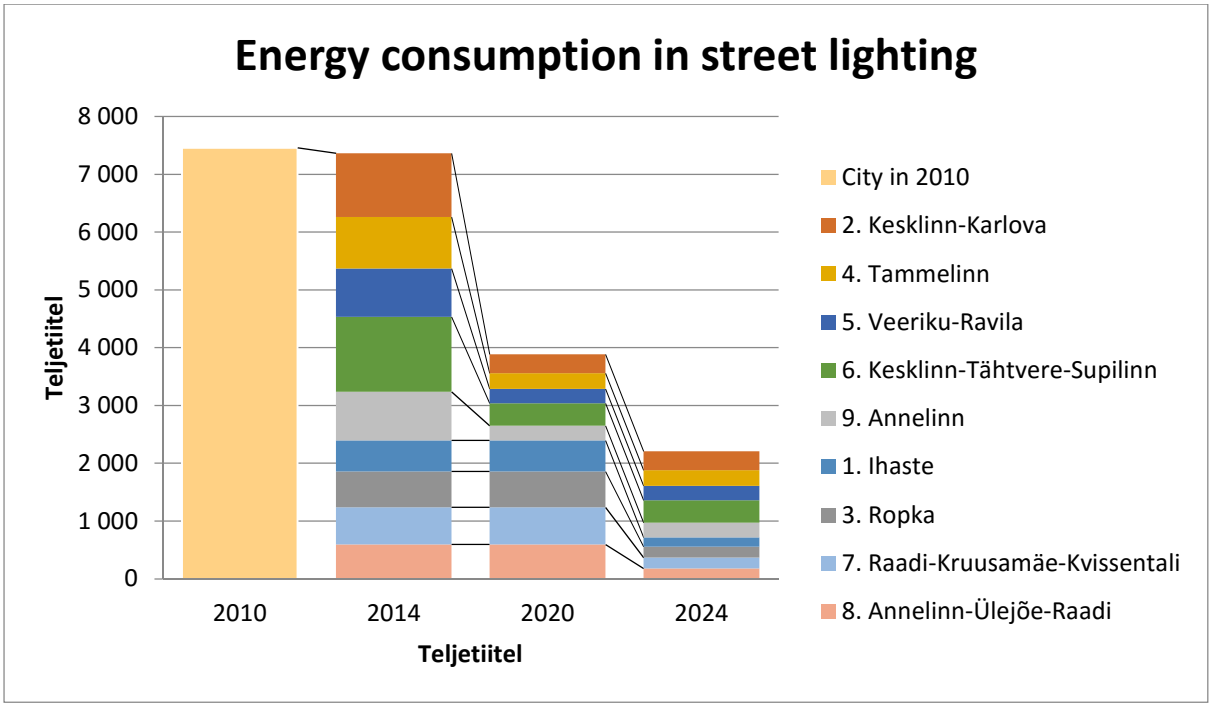


Diagram 3.5 Dynamics of Tartu street lighting energy consumption (no area info available for 2010)

Energy saving measures in street lighting to reach goal of 70% savings include:

- Dimming of LED lights
- Motion sensors to control the light intensity
- Decoupling smaller streets from main streets
- Reconfiguration of switchboards
- Optimal use of dimming and motion sensors in main and side streets
- Gathering citizen feedback on perceived comfort and security level on streets with dimming options and motion sensors.

3.3 Energy consumption in transportation

Total predicted energy consumed in transportation in 2020 will be 16,58 GWh of energy. The consumption will increase by 12% or by 1,4 GWh compared to year 2010. Energy consumption will increase both in public and city government transportation.

	2010	2014	2020	Abs. change 20vs10	Abs. change 20vs14	Rel.change 20vs10	Rel. change 20vs14
Public transportation	14 834	15 081	16 482	1 648	1 401	11%	9%
City Gov. Transportation	15	73	94	79	21	517%	29%
KOKKU	14 849	15 154	16 576	1 727	1 422	12%	9%

Table 3.4 Transportation energy consumption in 2010, 2014 and 2020.

The total distance traveled by public transportation vehicles in 2010 was around 3 600 000 km. The number is expected to increase to 4 000 000 km by the years 2020. The city is extending its public transportation network to connect neighboring parishes to the city. It is done to provide better service to people living in the area and to reduce private car use. The energy consumed in public transportation in 2020 is predicted to increase by 11% compared to 2010 or by 1,7 GWh.

Increase of annual public transportation kilometers is directly increasing public transportation energy consumption. To decrease carbon footprint of Tartu public transportation The City of Tartu, The Ministry of Economy and Estonian Environmental Investment Agency have signed a letter of intent to heave only gas busses in Tartu public transportation by the year 2017.

Energy consumption can be reduced by different measures depending on bus size, source of energy, line lengths, types of lines, number of busses, number of stops, distance between stops and other. It is not the purpose of this paper to optimize Tartu public transportation network.

The city government transportation has little effect on overall energy consumption. The quality of social services cannot decrease and the use of passenger cars will continue. The current gasoline diesel cars used by different departments of city government will be replaced by electric or CNG (biomethane) vehicles. The current property management situation will be reformed by the year 2020 and it will create demand for extra 3 to 4 vehicles-s. Overall number of passenger cars in Tartu City Government use will increase to 63.

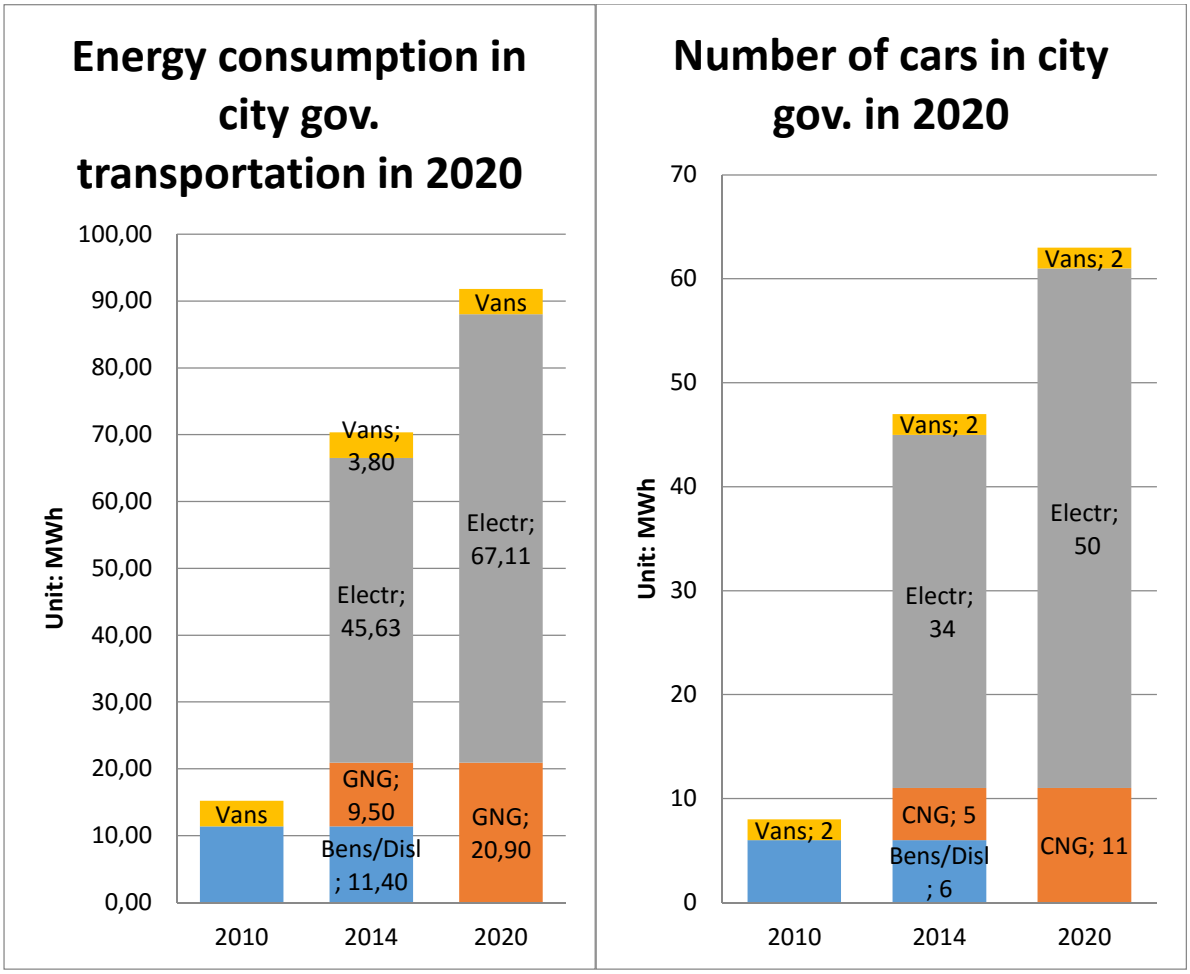


Diagram 3.6 Dynamics of city government transportation (unit: MWh) energy consumption and no. of cars

The energy consumption in city government transportation is expected to increase by 79 MWh to 94MWh. The increase compared to the year 2014 is 21 MWh.

Tartu City Government is planning to be first city in Estonia to introduce bike share infrastructure to the city. According to a modest scenario, 585 bicycles shall be used with around 40 sharing points, and according to calculations, 673 200 km shall be covered with these. 25% of this distance shall be travelled by bike instead of using a car, thus, car use shall reduce by 168,300 km per year, which, in turn, means fuel use will reduce by 16,830 l and CO2 emission by 33 t CO2 per year. Special access to city government officials during workhours to the bikes share program will be introduced to promote cycling for work related duties. The access will reduce city government energy consumption, promote cycling and sustainable transportation.

3.4 Other measures

Energy management system

Tartu City Government currently does not have an energy management system. The system should provide weekly or at least monthly data on energy consumed in public buildings and street lighting. The system would not save energy but it would enable for the city government to analyze its consumption, spot anomalies. The system would provide timely feedback on investments, renovations, changes or other activities made. It would also help to reduce impact of malfunctions in buildings that would otherwise be unnoticed. The development of energy management system is part of development of overall city property management system.

A pilot project for energy consumption surveillance is planned for 2016. The pilot project will include a number of municipal buildings. The list is not finalized but will include mostly newer buildings. Within the project a number of smart meters will be installed to provide the users with information about water consumption, heat consumption in heating and production of hot water, electricity consumption in lighting, ventilation and other functions.

The pilot project will provide the city government with experience on how to develop it's own energy management system within the new property management system. It will provide city government an experience on analyzing consumption data. And it will provide valuable data on consumption in specific buildings. It will also provide information for predicting energy consumption in upcoming new constructions or renovated buildings.

User education

User education is directed at higher level users of different public buildings. This includes directors and managers dealing with property management in their buildings as in staff at schools and kindergartens that is responsible for everyday maintenance of their buildings.

Tartu city government is reorganizing its property management and most the responsibilities will be lifted from the kindergarten staff. Meanwhile it is important to educate the staff on how to save energy. Not only to save energy as a manager of but also as a user of property. The task of organizing courses on energy efficiency to public building users is delegated to Tartu Regional energy Agency (TREA). TREA will create an overall introduction to building energy

efficiency and create building specific approaches in cooperation with public property managers. This will help to solidify sustainable behavior in public buildings and eliminate possible non-sustainable habits.

The user education becoming ever more important since new systems in buildings are getting more complicated. The user has to be able to spot if automated systems are operating correctly and report about malfunctions. The education will help to prepare the users for introduction of new technologies in public buildings.

Energy audit of sports facilities

Current paper has not analyzed the energy consumption impact of Tartu municipal sports facilities. The maintenance and energy efficiency is the responsibility of NPO Tartu Sport. Nevertheless the energy consumption trends should be analyzed to be able to make decisions for energy efficiency, reduce GHG emissions and reduce energy cost.

Creating city innovation strategy

City of Tartu defines itself in Tartu Vison 2030 as city of smart solutions, innovation and youth. Adaptation of innovation strategy and technology adoption tables as presented in project PLEEC WP3 results is a powerful tool to develop city innovation strategy. The strategy would improve adaptation of new technology into public services but also create a better urban environment.

Adaption of low-energy construction management system

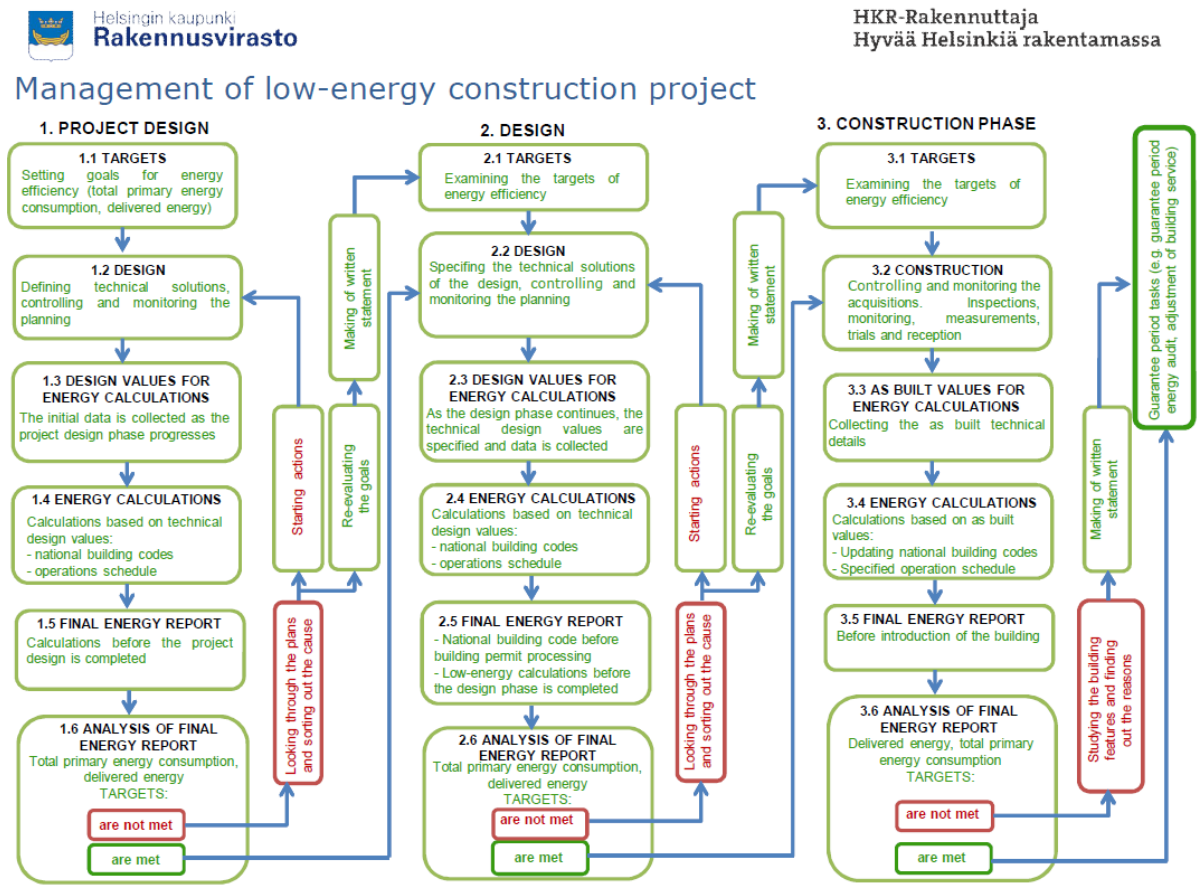
The low-energy construction management system is a routine that should help departments responsible for large property or infrastructure investments. The routine has been developed by City of Helsinki and successfully implemented. The system divides investment process into preparation, design and construction phase. It helps to set energy goals, asses the achievability of goals and actual achievement of goals.

A pilot project to test the management system is planned for 2016 for the design and construction process of new Mart Reinik School stadium building. Aim for the pilot is to test the system in cooperation with Tartu Regional Energy Agency (TREA) who will be acting in the role of energy consultant.

A building construction process is divided into 3 phases:

- Project design phase
- Design phase
- Construction phase

In project design phase initial energy consumption targets are set and upcoming building parameters are set. Initial energy consumption calculations are made according to the buildings parameters. If the goals are met then the project moves on to design phase. If the initial goals are not met then it is up to the project management team to decide if the parameters of the building or the initial goals should be changed.



Management system of low-energy construction projects

Actions in the design phase are mostly the same as in project design phase. The project has moved on to design phase with overall building parameters and energy consumption targets. New design values are developed, specific technologies are chosen, energy calculations are

made according to architectural and technological designs and final energy report is produced. If the initial energy consumption targets are met then the project moves on to construction phase. If the targets are not met then it is up to energy consultant's task to find the reasons for deviations. Then it is up to the project management team to decide if the initial targets should be changed or changes should be done to the designs of the building.

In construction process new energy calculations and energy report are done according to "as build" values since there can be deviations and changes to the design during the construction process. If the targets are met then the building moves on to guarantee period. If the targets are not met then energy consultant analyses the building and lists reasons for deviations. Then building moves on to guarantee period.

Green procurements

Purpose of green procurements is to reduce the negative impact coming from products or services on the environment. Current Estonian procurement legislation describes possibilities of procuring not for the best price of service or product but for best economical value. Best economical value means implementing criteria to valuate cost and quality or to include not only lower price but further maintenance costs but also environmental impact.

To reduce energy consumption in public buildings the green procurements should not only set minimum energy consumption standards on procured services or products. The procurements should also take into account positive impact on higher than standard efficiency. Future procurements should also take into account a products life cycle impact on environment.

A green procurement itself will not reduce energy consumption but it will support the process of lowering overall energy consumption.

Sustainable Tartu Website

There are a number of innovative and sustainable solutions in energy consumption and management around Tartu. The trouble is that the information is not systemized, regularly gathered and presented to the public. Estonian competition ability strategy "Eesti 2020" midterm report stresses the need for the public sector to take initiative and to be a role model in utilizing innovative and energy efficient solutions. For being a role model and to better communicate the utilization of innovative solutions Tartu City Government will start a "Sustainable Tartu" website.

The website is a logical continuation of Intelligent Energy Innovation Prize. The website is intended to gather innovative and sustainable solutions from Tartu region and to distribute the information to mainly Tartu citizens but also others that are interested. Website will be presented both in Estonian and in English. The website is divided into 6 sectors:

- Houses and buildings
- Transportation
- Street lighting
- Sustainable energy
- City development and research
- Events and courses

Input to the website is mostly provided by city government officials. Information about new public buildings and results of renovation works will be provided by Department of Municipal Property. Street lighting and transportation information is available from Department of Communal Services. Information about construction and renovation activities is available through the Department of Architecture and Construction and regular review of interesting activities will be made annually. Support for updating will be provided by Tartu Science Park and Tartu Regional Energy Agency. The public will be encouraged to provide information. Video and picture content will be created regularly to keep the website visually pleasing and easy to follow.

Project “SmartEnCity”

The city of Tartu is one of partners in project financed from Horizon 2020 The EU Framework Programme for Research and Innovation. In addition to Tartu the cities of Sondenborg from Denmark and Vitoria-Gasteiz from Spain are involved with the project. The project concentrates on residential building renovation, utilization of local energy sources, public services and sustainable transportation. Goal for the project is to create a replicable and sustainable city solution focusing on local energy resources.

The project in terms of Tartu City Government energy consumption is important due to the possibility to test a number of innovative solutions that can improve energy efficiency in public services.

Most impactful solutions tested in the project will help to reduce energy consumption in street lighting. 350 luminaries will be replaced with new LED-luminaries. The luminaries will be equipped with motion detectors and light intensity meters. The detectors will adjust the luminary intensity according to the activity on the street and the natural light conditions. This will provide additional energy savings for example in cases when there is a full moon and clear sky or when ground is covered by snow and light is not absorbed by the street surface. In addition road surface detectors will be installed to measure road surface condition. The luminary operation will be adjusted accordingly to road surface wetness to compensate for street surface light absorption. The following detectors will be installed in Tartu central area:

- 30 motion detectors
- 6 motion detectors with traffic cameras to analyze traffic
- 10 light reflection detectors
- 10 noise meters
- 5 air temperature, humidity and pollution meters

3.5 Responsibilities

The energy efficiency action plan activities described in current chapter are mainly connected to the work of the department of municipal property and the department of communal services since most of the assets that the consumption is created in belongs to the balance sheet of the departments. Additional responsibilities are set for other city government organizations:

Activities	**Responsible organization**
Building renovation	Dept. of municipal property
Street lighting renovation	Dept. of communal services
Public transportation	Dept. of communal services
Energy management system	Dept. of municipal property, TREA
User education	Dept. of municipal property, TREA
Energy audit of sports facilities	Dept. of municipal property, TREA
Adaption of low-energy construction management system	Dept. of municipal property,
Green procurements	Dept. of municipal property; Dept. of communal services, City gov. legal services.

Sustainable Tartu website	Dept. of municipal property; Dept. of communal services
ESCO	Dept. of municipal property; Dept. of communal services, City gov. legal services
SmartEnCity	Dept. of communal services

LISA 1. List of public buildings

Aadress	Asutus/ Kasutus	Netopind	Soojus, MWh 2010	elekter, MWh 2010	Soojus, MWh 2014	Elekter, MWh 2014
A.H.Tammsaare 10	Tartu Tähtvere Lasteaed	2556	682	44	656	58
Aardla 138	Tartu Lasteaed Hellik	3555,8	565	49	508	59
Aianduse 4	Tartu Variku kool	7395,9	886	142	749	147
Akadeemia 2	Tartu Kesklinna Lastekeskus	1432,5	321	49	191	28
Aleksandri 10	Tartu Lasteaed Sass	941,8	229	41	176	56
Anne 63	Tartu Hansa Kool	7446,5	837	148	704	182
Anne 65	Tartu Descartes'i Lütseum	7706,8	873	181	718	214
Anne 67	Tartu Lasteaed Krõll	2769,2	397	42	333	40
Anne 69	Tartu Lasteaed Poku	2753,9	475	36	365	36
Anne 9	Tartu Lasteaed Annike	2087,2	497	53	278	54
Annemõisa 1	Elamu	240,9	0	0	0	353
Annemõisa 4	Elamu	446,7	0	0	0	8
Ida 8	Tartu Lasteaed Lotte	1863,6	320	77	282	77
Ilmatsalu 24A	Tartu Lasteaed Meelespea	1072,3	204	44	181	39
J.Tõnissoni 3	Miina Härma Gümnaasium	5200,7	842	233	716	270
Jaamaõisa 22	Tartu Maarja kool (koos 2009 valminud juurdeehitusega)	1540,1	0	0	0	0
Jaani 7	Haldushoone	376	66	22	55	22
Kalda tee 40	Elamu	1928,4	322	47	326	48
Kalevi 52A	Tartu Lasteaed Helika	999,9	219	22	146	24
Kastani 139	Elamu	153,5	0	0	0	127
Kaunase pst 22	Päevakeskus Kalda, Tartu LA Sipsik	2730,2	198	122	174	176
Kaunase pst 23	Tartu II Muusikakool, Tartu Linna Keskraamatukogu filiaal, SAO piirkonnakeskus	3468,4	463	92	372	78
Kaunase pst 67	Tartu Lasteaed Triinu ja Taavi	2599,7	584	67	588	93
Kaunase pst 68	Tartu Annelinna Gümnaasium	7753,1	893	142	699	197

Kaunase pst 69	Tartu Lasteaed Kelluke	2565,1	685	31	475	37
Kaunase pst 70	Tartu Kristjan Jaak Petersoni Gümnaasium	7389,8	1 092	228	711	329
Kaunase pst 71	Tartu Kivilinna Kool	7214,9	991	228	603	216
Kesk 6	Tartu Lasteaed Karoliine	750	200	20	151	18
Kivi 44	Tartu Lasteaed Kivike	2112,5	483	34	305	35
Kompanii 3/5	Tartu Oskar Lutsu nimeline Linnaraamatukogu	4498,6	549	273	469	234
Kopli 1	Tartu Kutsehariduskeskuse koolihoone ja ühiselamu	26387,3	3 171	1 804	2 656	1 827
Kroonuaia 7	Tartu Kesklinna Kool	4589,2	565	115	553	136
Kummeli 5	Tartu Klaabu Lasteaed	2040,8	254	89	209	91
Küüni 3; Küüni 5	LV osakonnad	2121,3	304	125	263	116
L.Puusepa 10	Tartu Maarjamõisa Lasteaed	2695,6	566	49	504	72
Liiva 32	Tartu Hooldekodu	4377,4	1 269	647	1 187	594
Lille 9	Lille Maja	1009	157	25	133	22
Lina 2	Tartu Karlova Gümnaasium	4557,1	682	154	503	128
Lubja 14	Tartu Lasteaed Sirel	457	85	12	71	11
Lubja 7	Varjupaik ja eluruumid	1882,6	359	133	410	144
Lutsu 2	Tartu Mänguasjamuuseumi teatrimaja	896,2	195	58	150	64
Lutsu 4	Tartu Mänguasjamuuseum	199,6	0	0	0	0
Lutsu 8	Tartu Mänguasjamuuseum	705,6	190	100	142	84
Munga 12	Hugo Treffneri Gümnaasium	5400,1	777	263	600	257
Mõisavahe 32	Tartu Lasteaed Mõmmik	3441,1	442	39	366	37
Mõisavahe 67	Elamu	1941,5	315	4	319	5
Narva mnt 23	Tartu Linnamuuseum	1120	235	0	199	55
Nisu 2A	elamu	1282,8	0	0	243	67

Pepleri 27	Ärihoone	620,4	98	9	55	8
Ploomi 1	Tartu Lasteaed Ploomike, erakool Waldorfkool	2493,9	402	64	376	67
Puiestee 114a	Elamu	1446,4	179	3	192	14
Puiestee 126	Maarja kool	682,5	0	60	0	93
Puiestee 126B	Maarja kool	428	0	0	0	0
Puiestee 62	Tartu Kroonuaia Kool	3519,6	406	73	430	75
Puiestee 79	Elamu	1082,4	193	69	163	58
Põllu 11A	Tartu Kutsehariduskeskus, koolihoone	4871,7	684	262	318	262
Põllu 11B	Tartu Kutsehariduskeskus, õppekoda	1702,7	274	113	103	113
Põllu 11C	Tartu Kutsehariduskeskus, ühiselamu	2955,1	532	247	296	247
Põllu 11D	Tartu Kutsehariduskeskus, staadionihoone	97,8	0	0	0	0
Põllu 11E	Tartu Kutsehariduskeskus, abihoone	345,2	0	0	39	0
Raatuse 88A	Tartu Raatuse Gümnaasium	8234,8	1 019	151	960	147
Raekoja plats 12	Haldushoone. Äripinnad	2044,8	246	0	301	127
Raekoja plats 12	Ajutine hoidla	137,3	16	0	31	0
Raekoja plats 18	SA Tartu Kunstimuuseum	1047,3	202	0	158	0
Raekoja plats 1a	Tartu Linnavalitsus, SA Tartumaa Turism, Terve Pere Apteek OÜ	1637,5	250	71	219	64
Raekoja plats 3/Küüni 1	Haldushoone	2557	289	307	266	144
Rahu 8	Ropka perearstikeskus OÜ, Tartu Puudega Inimeste Koda MTÜ, elamu	4942	706	128	605	130
Ravila 43	Tartu Lasteaed Kannike	2570,4	676	35	634	56
Riia 25	Tartu Mart Reiniku Kooli algklasside maja	3592,8	575	83	441	77
Ropka 34	Tartu Lasteaed Piilupesa	3999,3	545	37	605	42

Ropka tee 25	Tartu Lasteaed Ristikhein	2178,6	394	46	467	50
Sepa 18	Tartu Lasteaed Rukkilill	805	230	33	216	30
Staadioni 34	Elamu	472	0	0	0	4
Staadioni 48	Tartu Linna pensonäride ühing "Kodukotus", Tehnikaringlus MTÜ	3046,2	727	110	378	13
Sõpruse pst 12	Tartu Lasteaed Pääsupesa	2724,9	499	64	466	69
Taara pst 8	Tartu Lasteaed Nukitsamees	927,1	132	13	125	15
Tamme pst 24A	Tartu Tamme Gümnaasium	6081,3	858	226	606	236
Tamme pst 43A	Tartu Lasteaed Tõruke	783	224	27	91	22
Tiigi 11	Tiigi Seltsimaja	657,7	154	17	134	15
Tiigi 25	Tartu Lasteaed Päkapikk	525,5	116	23	99	21
Tiigi 55	Tartu Laste Turvakodu	651,3	22	0	108	45
Tiigi 61	Tartu Lastekunstikool	779,4	120	0	110	24
Tähe 101	Arsis OÜ, Tähe Noorteklubi MTÜ, Muusikakoda MTÜ, Händikäpp MTÜ	737	154	0	122	17
Tähe 103	Tartu Forseliuse Gümnaasium	3933,6	560	110	452	90
Uus 54	Tartu Aleksander Puskini Kool	6862,4	713	134	661	209
Uus 56	Anne Noortekeskus	2155	421	59	355	35
Vaksali 14	SAO piirkonnakeskus, Tartu Nõustamis- ja Kriisikeskus MTÜ	343	90	12	66	15
Vanemuise 28	Tartu Lasteaed Midrimaa	1376,8	260	83	222	64
Vanemuise 33	Tartu Herbert Masingu Kool	2220	567	220	481	186
Vanemuise 35	Tartu Jaan Poska Gümnaasium	3329	485	141	361	130
Vanemuise 48	Tartu Mart Reiniku Kool	4872	621	117	446	108
Veeriku 41	Tartu Veeriku Kool	7252,5	796	147	730	146

Õpetaja 10	Tartu Lastesõim Mesipuu	589,2	145	18	129	16