South Transdanubian Region
South Transdanubian Regional Development Agency

MANERGY

SUSTAINABLE ENERGY ACTION PLAN
OF
THE MUNICIPALITY OF PÉCS

Program Central Europe - Project MANERGY
Paving the way for self-sufficient regional energy supply based on sustainable energy concepts and renewable energy sources

This document was created in the framework of the project titled “MANERGY – Elaborating of local energy strategies and self-sufficient regional energy-supplying models based on the renewable energy sources”.

The project is coordinated by the South Transdanubian Regional Development Agency and co-financed by the Central Europe Programme and the Hungarian Government.

Created by:

Lilla Csanaky – Energy Club
Orsolya Fülöp - Energy Club
Zsuzsanna Irmalós - Energy Club

Project manager:
Balázs Borkovits - South Transdanubian Regional Development Agency

Content

EXECUTIVE SUMMARY

The creation of possibilities of the sustainable energy management and the reduction of energy-import dependence is a particularly important challenge for the decision-makers of settlements. The energy consumption has a very significant role in the annual budget of the local-governments.

The efficient and environment friendly utilization of the local energy sources is indispensable not just for the reduction of costs, but contributes to make the living environment a better place to live and to raise the standard of living of people of Pécs.

In June 2013 Pécs has joined the initiative of the Covenant of Mayors, and with this the city leadership undertook that by 2020 the CO2-emissions will be reduced at least by 20% in the area of Pécs, in addition, a Sustainable Energy Action Plan will be elaborated. This document's main goal is to provide a guideline for the energetic investments in Pécs and with this, give help to the work of local decision-makers.
In the interest of this, the action plan contains suggestions in the terms of sustainable energy management to improve energy-efficiency, also contains suggestions how to use the energy sources. Through the interventions of the proposed actions, the City of Pécs can reduce the energy consumption and the greenhouse gas emissions – focusing on the sectors that are in the competency of the Municipality.

During the elaboration of the Sustainable Energy Action Plan of Pécs, the relating national, regional and local strategic plans were analyzed and the energetic aims of Pécs are in line with the goals established in the planning documents. The energetic efforts of the city forward the fulfilment of Hungary's international commitments.

The strategic goals of Pécs include:
- the reduction of energy consumption (on absolute value) through the expansion of energy-efficiency;
- the expansion of the rate of renewable energy sources;
- the reduction of the rate of fossil energy sources in the energy consumption of Pécs;
- the creation of diversified renewing energy mix;
- the general development and stimulation of local economy through the reduction of energy costs;
- the general development and stimulation of local economy through the attraction of investors into the city which use and operate energy-efficient and renewable energy source-based technologies.
- Awareness-raising campaigns to forward the social diffusion of the sustainable energy management.

The above-mentioned goals are reflecting on all the three elements (environmental, economical, social sustainability) of the definition of sustainability.

The annual energy consumption of Pécs was 2 011 714 MWh in 2011, the relating greenhouse gas emission was 554 3330 tCO2eq. Regarding the gross energy consumption, the residential buildings (49%) as well as facilities of the industrial and the service sector (30%) represent the biggest rate, but the function of traffic is considerable too (18%). The most important consumers are the facilities of service and industrial sectors (with 54% participation) in the electricity consumption. The residential sector (53%), the

facilities of service and industrial sector (28%) and the traffic (16%) are mainly responsible for the greenhouse gas emissions (latter can be linked to the energy consumption).

There are solutions to reduce the energy costs of the Municipality of Pécs among the propositions stated in the Sustainable Energy Action Plan, such as:

- establishment of an energy management system and an organization responsible for the energetics;
- Energy efficient modernization of public lighting and municipal buildings.
- Solar collector- and photovoltaic-based developments on public institutes.

The residential sector is the biggest CO2-emitter, so priority is given to the promotion of energy-efficient investments, solar collector- and photovoltaic-based developments (latter just in the case of village and condos) of the residential sector in the action plan.

The development of public traffic; to convert a portion of buses to CNG-powered ones and to supply them with biogas can also contribute to the reduction of CO2-emissions of Pécs.

The proposals of the action plan also contain the energetic modernization and solar energy investments of the facilities of the service sector, it also contain the operation of a biogas plant on the sewage treatment plant, and the establishment of a solar cell park with 7 MW power and awareness-raising concerning the sustainable energy management.

The implementation of the proposed action means: 158 733 MWh/year energy savings, 505 003 MWh/year renewable energy production and 186 040 tCO2eq/year reduction of greenhouse gas emissions. This means a 33.6% reduction compared to base-year 2011.

1 INTRODUCTION

The Municipality of Pécs decided to join the Covenant of European Mayors with the Decision 193/2013. (06.20.) and at the same time empowered the Mayor to sign the Accession Statement. The Accession Statement was signed on 25 June 2013, the Covenant accepted the submitted statement form and registered Pécs as a member of the Covenant[1]. This accession commits Pécs towards the climate protection and the rational energy management.

The Covenant of Mayors was established by the European Commission in 2008 and means the main movement of European local and regional Municipalities, which is committed itself voluntarily to improve the energy efficiency and the more intensive use of renewable energy on its own territories. The main goal with this commitment is to reach and exceed the 20% reduction of CO2-emissions by 2020 (that was targeted by the European Union). The Covenant of Mayors is the only movement, which mobilize the local and regional actors to reach the EU goals, so the European institutes declare the Covenant as the specific model of the multilevel governance. The initiative has 24 members from Hungary[2]; also the preparation of accession is in progress in the case of several municipalities.

With the accession to Covenant of Mayors the city leadership undertook, that it submits the Sustainable Energy Action Plan no later than one year after the accession and presents the actions how to reach the 20% reduction of CO2-emissions. It should be emphasized that the action plan gives more chances to obtain the EU Funds in the term of 2014-2020, so the Municipality can implement useful and inhabitant-friendly developments by the EU subsidy.

This document's goal is to present the energy-efficient and renewable energy solutions that help the Municipality to reach the planned 20% emission-reduction. The presented proposals of measures of the Sustainable Energy Action Plan are based on the Energy Concept of Pécs – latter was also created in the framework of the Manergy project in autumn 2013. The energy concept shows the geographical, social and economic positions of Pécs, also analyses the energy consumptions of different sectors, the related greenhouse gas emissions, determines the Municipality's aims in the field of the sustainable energy management and gives an overview about the national, regional and local planning documents which specify the development potentials of Pécs.

The proposals of the action plan were determined in line with the goals of the document titled "Energy Strategy of the Municipality of Pécs"[3]. The action plan shows the reachable energy savings through the relevant actions, the expected renewable energy products and the reduction of CO2-emissions, also determines the person who is responsible for the execution, additionally presents the expected costs of the investments and the related financing instruments. So the action plan can be the basis for the planning of municipal investments and creating the project proposals.

[1] http://www.eumayors.eu/about/signatories_hu.html?city_id=5951

[2] Hungarian members: Bogács, Budaörs, Budapest, Budapest IV. kerület (Újpest), Budapest XVIII. kerület (Pestszentlőrinc-Pestszentimre), Bükkaranyos, Bükkszentkereszt, Eger, Felsőnyék, Felsőtárkány, Hajdúszoboszló, Hatvan, Hernádnémeti, Martfű, Nagykanizsa, Nyékládháza, Ózd, Paks, Pécs, Sárospatak, Szerencs, Tab, Tiszaújváros, Tokaj

[3] Energy Strategy of the Municipality of Pécs, 2013, Blue Economy Consortium

2 ACTIONS

2.1 MUNICIPAL BUILDINGS, FACILITIES

2.1.1. EXECUTED ENERGETIC INVESTMENTS

In the framework of the project titled “Szemünk Fénye” the outdated light bulbs were replaced with newer lighting technology equipment in 109 municipal buildings in 2011. As a result of this modernisation 42% of energy savings can be achieved with the use of new light sources and luminaires, so the electricity consumption of the luminaires reduced by 884,5 kW. These institutions are modern from perspective of lighting technology, meaning that their further modernization is unnecessary and uneconomic.

Also in 2011 the insulation and heating modernisation of the Illyés Gyula Elementary School and Kindergarten were finished with the subsidy of the Environment and Energy Operational Programme. As a result of the investment, 10 cm insulation has been applied on the wall, the old windows were replaced with newer windows with better thermal transmittance (U=1,1 W/m^2K), additionally the heating system were renewed with double duct technology and 75/55 weather monitoring temperature difference.

In 2012 168 pcs of type ‘Sun Earth 180’ solar cell with Sin solar monochrystal were placed on the building of the Central-Transdanubian Regional Department of Water, with sum of 30 KW_p electric capacity. The produced electric capacity is taken over by the local electricity company (called E-ON) with a “buy-sell” settlement.

The handover of the buildings of the Szentágothai Research Centre were finished in 2012. There are medical, biological, engineering, laser physics and chemistry research in the institution (which is owned by the University of Pécs). Two buildings of the whole complex are supplied by a heat-pump system (115 wells in 100 m depth), while the heat is supplied by the local district-heating company for the „C” building.

As a result of the investments (finished after 2011) 385 MWh/year energy is produced by renewable energy sources, which takes out 83 tons CO2 – the SEAP table contains these data.

2.1.2. DEVELOPMENT OF ENERGY MANAGEMENT SYSTEM

Presentation of actions
The aim of developing the energy management system is to make the institutions’ energy consumption being traceable, comparable and evaluable. The systematically collected data significantly makes easier the planning and creating of projects, completing audits. The consciously planned developments are very necessary to avoid the parallelism.

Deadlines/timelines for the proposals of measures (starting and finishing), timing – steps, estimated duration
1. Assignment of responsible persons/teams/organizations
It’s necessary to establish a development-management and development-coordinating organization involving an energetic professional (who is employed by the Municipality),

which organization controls the energy management tasks of the Municipality and systematically (yearly/semi-annually) collects the data about the institutions. The energetic professional (who is employed by the Municipality) and the organization mainly participate in the evaluation of energy consumption data, the selection of buildings to renew, the planning of investments and the preparation of energetic projects. In addition their task is the residential and company counselling.

It is very important to ensure the eligible competency for the energetic professional to participate in development decisions, also in the related committees and establishments. It is also significant to regulate the framework and system of the information flow between the different (legal, financial, environmental, investment) departments and the organization (which is responsible for the energetic development).

Starting: 01 September 2014
Finishing: 31 December 2014

1. Data collection

The development of the energy monitoring system means a good solution, because with this the temperature of premises of the different institutions (schools, hospitals, etc.) can be controlled and their energy consumption can be monitored from the municipal's building.

However we do not have to wait until the completion of this, because the institutions can provide data about the energy consumption with filling a simple table.

It is very useful to collect the main energetic data (technical specifications, costs, etc.) of the completed investments in a common database.

Starting: 01 October 2014
Finishing: 31 December 2020

2. Information

It is worth making the information flow being two-way: at certain intervals the Municipality understandably (graphs with short descriptions) provides information to the institutions about the energy consumption. Also, a competition can be organised between the institutions on the grounds of specific data (i.e. kWh/m^2): the winner is the institution with the lowest specific data value.

Starting: 01 October 2015
Finishing: 31 December 2020

Person/department responsible for the coordination and execution

The organisation (which coordinates the energetic developments) can be created within the Technical Department, or rather within the General Technical Group. The Clearing House can help to collect the information, because this department has the energetic data of the most institutes.

Estimated costs, return on investment

The development cost of the energy management system moves on a wide scale. There will be no extra costs if the municipality uses the existing IT tools for data management. But it needs to calculate with extra costs if the Municipality decides to buy software which is expressly serves the register of building energy data.

Obtainable financial sources
The municipality can submit the application concerning the development of energy management possibly together with the modernization of buildings (i.e. to the call for proposals of the Rural and Settlement Development Programme)

Expected energy savings
This action does not mean direct energy savings. The development of energy management, assignment of the responsible person/organisation and the conscious planning are the basic conditions for the sustainable energy management.

Expected production of renewable energy
The action does not raise directly the production of renewable energy. However the development of energy management, assignment of the responsible person/organisation and the conscious planning contribute to the establishment of the mostly economic renewable energy investments.

Expected reduction of CO2-emissions
This action does not cause a direct reduction of CO2 emissions, but the consciously planned investments have a large contribution not just to the reduction of energy consumption of the institutions, but to the reduction of CO2-emissions.

2.1.3. ENERGY-EFFICIENT MODERNIZATION OF MUNICIPAL BUILDINGS

The consumption data of all institutions were converted to KWh in the interest of the correct aggregation. According to these data the electric energy means the 9% of the energy consumption of the municipal institutions, while the heating and the production of domestic hot water cover the remaining 91%. Most of the municipal buildings are supplied with district-heat; the gas boiler-based buildings represent a smaller proportion.

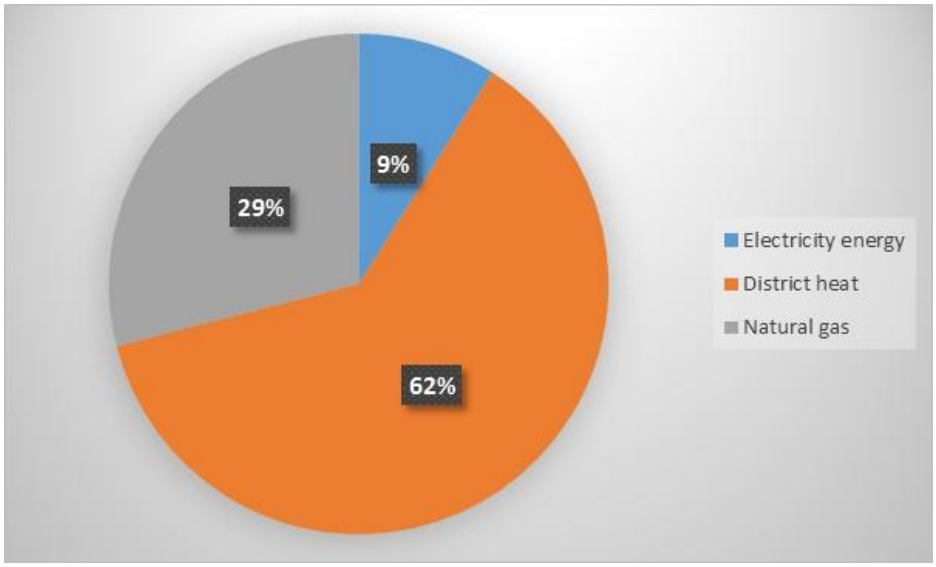


Figure 1: Proportion of energy consumption of municipal institutions in 2011.

In 2011 there was made an overall exploratory supervision on energy-loss in 108 municipal buildings in point of architectural and building engineering systems[4]. The analysis showed that only 15% of the buildings has the energetic classification that fulfil or exceed the eligible requirements, also 64% of the buildings were ranked as average or worse than average. There was established on the basis of the measurement of the institutions that most of the gas boilers are outdated (15 years old or older), so replacement of them is necessary. Just a few radiators were retrofitted with thermostat heads, but the setting is completed with weather-monitoring. The thermal energy usage of the buildings would be reduced by 54% with a complete renewal (thermal insulation, replacement of doors and windows). It is particularly proposed to replace the10-20 year old boilers with condensing boilers in the case of buildings which operate with gas boilers. With this action more than 20-25% reduction of natural gas consumption can be realised in the case of buildings that are determined in the exploratory supervision on energy-loss.

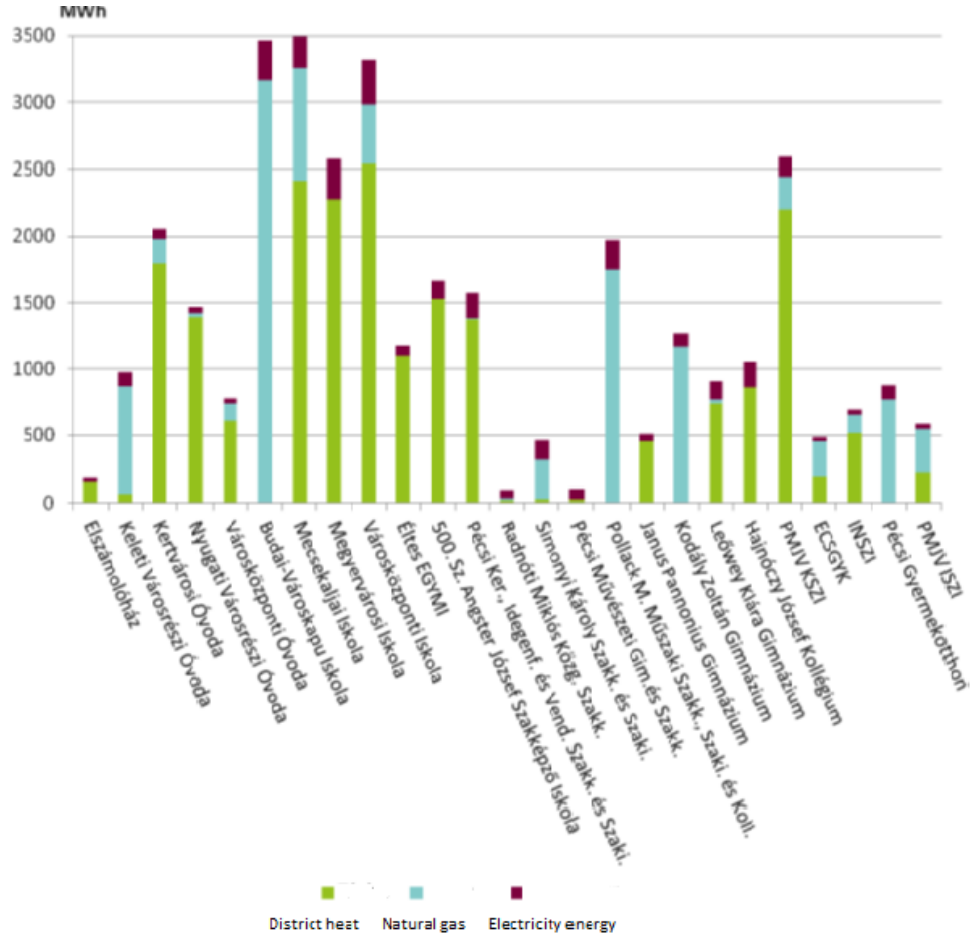


Figure 2: Energy consumption of public buildings in 2011[5]

The 2011 annual energy consumption of the municipal buildings (which are operated by the Clearing House) is shown in Figure 02. There are more institutes that have branch

[4] PBE Energiamenedzsment: Energetic waste excavation analysis of the municipal buildings in Pécs, November 2011

[5] Source: Clearing House of the Municipality of Pécs

organisations and buildings in different places of the city; this is the reason why just 25 institutes are presented in Figure 2.

We have to add that the energy consumption depends on more factors in the case of related institutions, like opening hours, the number of building users, the character of the institution etc. So institutions are just limitedly comparable with each other. It is practical to analyse the buildings separately – the graphs were created only just for demonstration.

According to the model calculations[6], the education and office buildings which are 25 years or older achieve just F-G ratings (on the energetic audit scale of I to A+) without modernisation. This was confirmed by the exploratory supervision on energy-loss in the case of public institutions of Pécs. This means annual 350 kWh/m2/year average principled energy-consumption: this much primary fuels need to be burnt (per m2) to heat up the institutions to 20 Celsius degree, to produce warm water and to operate different building technology systems (lightning, HVAC (heating, ventilation and air conditioning)).

However the (principled) calculated consumption is evidently different (whether significantly) from the real consumption, because the heat-up does not always carried out to reach 20 Celsius degree, also the average external temperature (which is determined in the calculation methodology) is different from the real data.

Presentation of actions

It is necessary to implement all energetic modernisation tasks in case of all the buildings named in the exploratory supervision on energy-loss, therefore thermal insulation, replacement of doors and windows and heating modernisation. The implementation of developments needs significant financial efforts from the Municipality because of the large number of the institutions, so it is worth starting the refurbishment with buildings that consume lots of energy – since more energy saving can be realised with the modernisation of these buildings. However there are some different cases: the outdated, malfunctioned tools (heating equipment, doors and windows), comfort level (feeling cold) give reasons to interfere, so all of these could be criteria in the selecting procedure.

Deadlines/timelines for the proposals of actions (starting and finishing), timing – steps, estimated duration

1. Planning and implementation of investments determined in the energetic analysis

The planning of investments and projects, selecting of contractors and the determination of technical content of the contracts require the involvement of an energetic expert.
Starting: 01 June 2014
Finishing: 31 December 202

2. Monitoring of effects determined in the energetic analysis

The effects of the finished investments are measurable if the colleague (who is responsible for the energy management) systematically monitors the trend of energy consumption. Also it is fortunate if this colleague informs the decision-makers and the city-council about the achieved results. This would boost further investments.
Starting: 01 June 2015
Finishing: 31 December 2021

[6] Optimization of requirements of building energetics. Energy Club, 2012.

3. Dissemination of results

It is important to inform the wider public about the achieved results for the purpose of awareness-raising, promoting investments and knowledge-sharing. The local and regional (example Délmagyarország, Pécs TV) media, same as the websites (www.pecs.hu, www.energiaklub.hu, www.toosz.hu), Facebook sites of Pécs and the Energy Club are capable for this.

Starting: 01 June 2015
Finishing: 31 December 2021

Person/department responsible for the coordination and execution

Preparing, planning and monitoring of investments: Technical Department, General Technical Team, Financial Department, City Development and Communal Branch Office.

Information, dissemination: municipal colleague assigned by the Mayor, example from the City Development and Communal Branch Office.

Estimated costs, return on investment

The proposed cost of all investments is 3.05 billion HUF (at 2011 prices). The payback period of the investments is different, but the average period is 24 years without subsidy.

Obtainable financial sources

The municipality can submit the application concerning to the modernisation of public institutes to the call for applications of the Environment and Energy Efficiency Operational Programme and the Rural and Settlement Development Programme.[7]

Expected energy savings

The heating thermal-consumption will reduce with 8947 MWh/year if the replacement of boilers will be finished by 2020.

Expected reduction of CO2-emissions

The greenhouse gas emissions will reduce with 3616 tons/year if the energy-saving modernisation of all municipal institutions will be finished by 2020.

2.1.4. SOLAR COLLECTOR INVESTMENTS OF MUNICIPAL BUILDINGS

Presentation of actions

It is worth installing the solar collectors on buildings, in which the demand for domestic hot water is continuous in the whole year. The implementation of the investment is cost-effective in the cases of the education and social institutes if the usage is continuous in summer too, because the long idle time does not help the solar collectors and might cause malfunctions. The installation of solar collector is proposed on those education institutes where a student hostel is operating too. Ideal installation places are additionally the buildings of the Children's Home of Pécs and the Integrated Social Home.

[7] Investors' Handbook: Proposals for the Energy Strategy of Pécs. Blue Economy Consortium Cluster, 2013.

Places:
- Éltes Mátyás Dormitory (60 people)
- Hajnóczy J. Dormitory:
  - Kodály Zoltán branch organisation (about 400 people)
  - Türr István branch organisation (175 people)
- Pollack Mihály Dormitory (87 people)

It is proposed to install 378 m2 of solar collector on the buildings to satisfy the total demand for domestic hot water. However in summertime (when solar collectors can satisfy the whole demand of domestic hot water) there are less people in the buildings, so a smaller system could be sufficient – this has to be decided separately in case of each building. The action plan calculates with the above-mentioned area, which means 180 solar collectors.

Deadlines/timelines for the proposals of actions (starting and finishing), timing – steps, estimated duration

The implementation of the projects could start directly after the acceptance of the action plan, but in case the financial opportunities are limited, it is worth waiting until the publication of the call for proposals of the Environment and Energy Efficiency Operational Programme and the Rural and Settlement Development Programme to allocate subsidy for the investments. So the timing of the solar collector investments depends on the availability of EU subsidy. It is worth starting to prepare the investment and to plan the systems before the publication of the call for proposals, so this is a good chance for Pécs to prepare a successful project despite a short submission term.

Starting: 01 September 2014
Finishing: 31 December 2020

Person/department responsible for the coordination and execution

A colleague assigned by the Mayor is responsible for the planning of solar collector investments and the monitoring of implementation. This colleague can be the employee of the Technical Department, the General Technical Team, the Financial Department or the City Development and Communal Branch Office. The coordinator of the projects could be the Financial Department.

Estimated costs, return on investment

The implementation costs of the solar collector systems are 150 000-200 0000 HUF per m2. This is a gross system price and contains all necessary material and constructing costs. The smaller systems are more expensive per unit, consequently larger systems are cheaper[8]. It is worth calculating with 200 000 HUF / m2 when proposing the costs of the SEAP, so the summarized investment cost is 75.6 million HUF.

Obtainable financial sources

The municipality can submit the application concerning the energetic modernisation of public institutes to the call for applications of the Environment and Energy Efficiency Operational Programme and the Rural and Settlement Development Programme.

[8] http://www.naplopo.hu/miert-napenergia/gazdasagossag-megteruelesi-ido

Expected production of renewable energy
About 550-650 kWh thermal energy can be produced in Hungary with the use of one square meter solar collector (taking into account a general system and average conditions). The geographical conditions of Pécs serve the utilization of the solar energy, so the expected production of renewable energy is at least 600 kWh / m2 / year[9]. The aggregate estimated production of the renewable energy is 226.8 MWh / year as a result of this action.

Expected reduction of CO2-emissions
The reduction of CO2-emission derives from the reduction of fossil energy which will be replaced with the solar collectors. The solar collectors will replace not just the district heat, but the gas boilers, so the CO2 reduction will be 109 tons / year.

2.1.5 PHOTOVOLTAIC INVESTMENTS OF THE MUNICIPALITY

The photovoltaic systems (which connect to the electricity grid) are implementable in the whole city, thanks to the well-developed electricity grid. It is important to keep in mind the roof orientation and the angle of it during the selection procedure of the installation places.

In consideration of the weather conditions and climate of Hungary, the ideal installation position is the South orientation and the ideal angle is between 30° and 40°. Practically the South-Eastern, South-Western orientation and the angle between 20° and 50° means an acceptable power loss, so it is worth the installation of photovoltaics even in these cases.

The other important aspect is the shading: just a 10% of particular shading results in 30-50% power loss. The roof condition and structure are also influencing factors in the implementation. It is worth renewing the roof if it is needed because of the photovoltaic lifetime. In some cases the supporting structure of the rooftop is not capable of installing the PVs, so in these cases it is very important to take into account the wind-load.

This document proposes several photovoltaic investments concerning the municipal buildings. The planned actions are shown in the next section.

Presentation of actions
Because of the effects of awareness-raising, we suggest firstly the PV installation on elementary schools and high schools (either of the municipal buildings). The so-called “buy-sell settlement” motivates the spreading of grid-connected PV systems, hereby the electricity supplier applies balance settlement, so the produced solar energy is deducted from the consumption in determined periods.
The law[10] allows yearly and semi-annual settlement periods. With this in mind, the installation of photovoltaics are also proposed in the case of elementary and high-schools, because the summer-term produced electricity is taken over by the electricity supplier, and also the investments (which are realized in the education institutes) can be tools for environmental awareness trainings.

[9] http://www.naplopo.hu/miert-napenergia/gazdasagossag-megteruelesi-ido
[10] 273/2007. Government Decree No. 273/2007 – Implementation of directions of electricity energy

Those schools were selected where the electricity consumption was the largest in the base-year 2011, so the installation of PV systems is proposed in the following institutes:
- Mecsekaljai Elementary School - Bánki Donát street. 2. (12 kW)
- Megyervárosi Elementary School - Aidinger J. street 41. (12 kW)
- Városközponti Elementary School - Megye street 15. (15 kW)
- 500. Sz. Angster József Vocational Training School - Rét street 41-43. (9 kW)
- Pollack Mihály Technical College and Student Hostel - Batthyány street 1-3. (12 kW)
- Pollack Mihály Technical College and Student Hostel - Jókai street 8. (9 kW)
- Kodály Zoltán High School - Dobó I. street 35-37. (9 kW)
- Radnóti Miklós Technical College - Eszetrgár L. street 6. (9 kW)
- Simonyi Károly Vocational Training School - Malomvölgyi street 1/B (15 kW)
- Art school of Pécs - Radnics street 9. (9 kW)
- Janus Pannonius High School - Mária street 2-4. (9 kW)
- Leőwey Klára High School - Szent István sqaure 8-10. (12 kW)
- Business, Tourism and Hospitality Technical College of Pécs – Rét street 10. (18 kW)
- Széchenyi István High School – Király street. 44. (9 kW)

It is proposed to install 636 photovoltaic panels on the above-mentioned 14 buildings, the peak performance of which is 159 kWp.

Deadlines/timelines for the proposals of measures (starting and finishing), timing – steps, estimated duration

The implementation of the projects could start directly after the acceptance of the action plan, but in case the financial opportunities are limited, it is worth waiting until the publication of the call for proposals of the Environment and Energy Efficiency Operational Programme and the Rural and Settlement Development Programme to allocate subsidy for the investments. So the timing of the PV investments depends on the availability of EU subsidy. It is worth starting to prepare the investment and to plan the systems before the publication of the call for proposals, so this is a good chance to Pécs to prepare a successful project despite a short submission term.

Starting: 01 September 2014
Finishing: 31 December 2020

Person/department responsible for the coordination and execution

A colleague assigned by the Mayor is responsible for the planning of solar collector investments and the monitoring of implementation. This colleague can be the employee of the Technical Department, the General Technical Team, the Financial Department or the City Development and Communal Branch Office. The coordinator of the projects could be the Financial Department.

Estimated costs, return on investment

When estimating the SEAP costs, it is worth calculating with a 1.98 million HUF investment cost (in the case of a 3 kW system), so by calculating with the current prices the action would mean a 101 million HUF investment. The payback period is 14 years referring to the total cost, assuming that we apply a balance-settlement. This return period can be significantly reduced by involving EU (or other external) subsidies.

Obtainable financial sources
The municipality can submit the application concerning the energetic modernisation of public institutes to the call for applications of the Environment and Energy Efficiency Operational Programme and the Rural and Settlement Development Programme.

Expected production of renewable energy
In the case of a 1 kW solar cell system it is worth calculating with 1150 kWh production in Baranya County. In the case of all the proposed buildings, approximately 183 MWh/year renewable energy production can be reachable.

Expected reduction of CO2-emissions
With the implementation of solar cell systems the electricity usage from the grid will be reduced. To estimate the proposed reduction of CO2 we have to calculate with the emission factor characteristic to the Hungarian mix of electricity (0.36 tCO_2eq/MWh). With the planned investments yearly 66 tCO_2eq reduction of CO2 emissions will be reachable.

Threats/risks
The correct installation of the above-mentioned systems is a very important condition so as to reach the expected energy production with the solar cells. Beside the optimal orientation it is necessary to select the correct angle to reach the maximum efficiency.

2.2 RESIDENTIAL BUILDINGS

There are 72 213 residential buildings according to the data of the census in 2011, but 10% of these buildings are uninhabited. The greater part of inhabited buildings is single-floored, also there are 3771 pcs of multi-storey condominiums and the average flat size is 67 m2. The greater part of apartments was built before 1990, mainly in the 60's, 70's and 80's, but more than 10 000 apartments were built before the World War II. The type of walling shows the amount of the building's energy usage, so according to these the predominance of the buildings which was built from bricks, hand blocks and prefabricated slabs can be concluded.
Without modernisation, these buildings will not meet the current building energy requirements, so it may be necessary to replace the doors and windows and perhaps to modernise heating systems – if it has not been carried out yet.

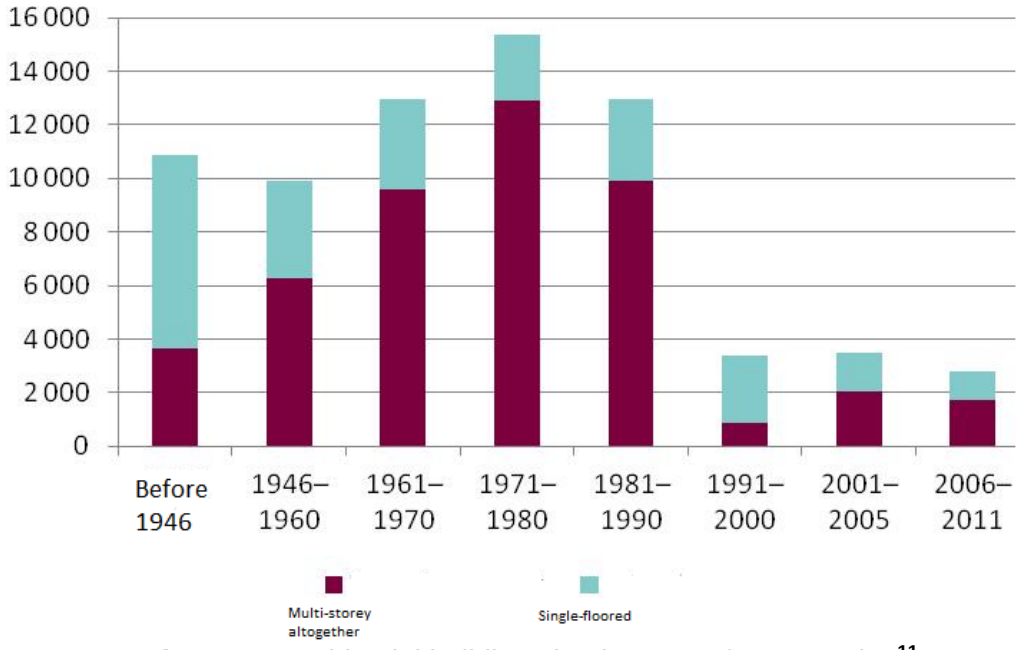


Figure 3: Residential buildings by the year of construction[11]

The energy consumption of the residential buildings represents 57% in the proportion of final energy consumption by sectors (without traffic), so in this sector the usage of renewable energy have a specific importance to achieve the 20% reduction of CO2 emission.

2.2.1 ENERGY-EFFICIENT MODERNISATION OF RESIDENTIAL BUILDINGS

Presentation of actions

The Municipality can help the modernisation of residential buildings with several methods like counselling, information about the call for proposals, so these methods induce the residential investments. The simplest form, when the Municipality systematically inform the habitants in the local media about the national, regional and even the interregional calls for proposals. The advanced method is to establish a local counselling office, where the experts can inform the habitants about the proposed refurbishments.

It is important to notice that that largest effect can be achieved by subsidies, which can be either repayable (loan) or non-repayable. It would be a good solution if the Municipality established a fund, which grants financial assistance (with low interest) for households, who would pay back the support in a determined time-period. In the following years, a part of the fund would be regenerated via the redemption of payments.

The panel buildings mean a different category. The masonry materials of these buildings are concrete panels and the buildings are supplied with district heat. The “Panel Programme” was launched to insulate and modernize the panel buildings, and this programme’s main goal is to help the refurbishments with national and municipal support

[11] Source: Census in 2011, Central Statistical Office

(both mean 33% financial support). There were 617 buildings insulated in Pécs until 2011: this affected 17 759 apartments and the related total investment cost was 7.4 billion HUF[12].

We have to manage differently the municipal rented flats, the refurbishments of which can be planned and implemented in the competency of the Municipality.

Deadlines/timelines for the proposals of measures (starting and finishing), timing – steps, estimated duration

1. Providing information about applications

Starting: 01 April 2014
Finishing: 01 January 2020

2. Establishment of a counselling office

Starting: 01 April 2015
Finishing: 01 January 2020

3. Establishment of a local/regional/sub-regional renewal fund

Starting: 01 January 2016
Finishing: 01 January 2020

4. Renewals of municipal rented flats

Analysis, calculation
Firstly it is worth making a technical analysis in the case of rented flats – if it is all about similar type-buildings, it is enough to make the calculation referring to the different types. Probably the calculation must be submitted if the investment will be implemented only by EU-subsidy.
Starting: 01 January 2014
Finishing: 01 May 2015

Planning of investments, preparing of applications and implementation of the projects
Planning of investments, preparing of applications, selecting of constructors, determining the content of contracts may require the involvement of an energetic expert.
Starting: 01 June 2014
Finishing: 31 December 2019

Dissemination of results
It is worth informing the wider public about the achieved results for the purposes of awareness-raising, promoting investments and knowledge-sharing. The local and regional (example Délmagyarország, Pécs TV) media, as well as the websites (www.pecs.hu, www.energiaklub.hu, www.toosz.hu), Facebook sites of Pécs and the Energy Club are capable for this.

Person/department responsible for the coordination and execution

As these investments will be realized among the population, the main responsible people will be the owners of these houses carrying out these refurbishments, reconstructions. The municipality can help the realization of these investments, if it sets up such an important office point, where it can inform the population about the impacts of these measures, the saving potentials, the cost of the investments, and payback period. The office can provide

[12] http://www.pecsma.hu/vezeto-hir/szunet-utan-ujraindult-a-panelprogram/

continuous information flow for the population about the available tenders, and can support them (either for free) in the application for these, or can offer mainly local professionals and companies who can take part in the implementation.
The replacement of old electric devices would be supported by the Municipality through organizing larger campaigns and collections.

Estimated costs, return on investment
Provision of information does not mean extra costs for the Municipality.

The cost of personal counselling depends on the opening hours of the office. Initially the energetic engineer can be the residential counsellor with one or two opening hours per week (see "2.1.2. Development of energy management system").

The refurbishment fund would mean extra costs for organising and coordination because of wage costs. The remaining sources would be obtainable from banks, savings banks, and EU-funds. So in these cases it would not be needed municipal sources.

Obtainable financial sources
Counselling services: the related sources are obtainable either from EU-funds (like Horizon2020), funds of other countries (like Norway Grants) or national funds (i.e. Green Source of the Ministry of Rural Development).

Refurbishment fund: for the establishment of the regenerating financial fund (to help the residential energetic refurbishment) the following funds are obtainable:
- "loan and subsidy"-mixed grant programmes of the EU, example ELENA and MLEI;
- European Energy Efficiency Fund;
- Programmes of the European Investment Bank.

The municipality can submit the application concerning to the refurbishment of municipal rented flats to the call for applications of the Rural and Settlement Development Programme.

Expected energy savings
If the energetic modernisation was implemented on 10% of the rented flats until 2020, the energy consumption of the city would reduce with 28 000 MWh. The replacement of the household appliances would mean additional energy savings: if the households replaced 20% of old (15-20 year old or older) refrigerators, the total electricity energy consumption would reduce with approximately 8558 MWh.

Expected reduction of CO2-emissions
In the case of energy-efficient refurbishment of 10% of residential buildings (until 2020) the greenhouse gas emissions would reduce with 4426 tons/year until 2020, also in the case of replacement of household appliances (until 2020) would reduce with 3080 tons/year.

2.2.2. SOLAR COLLECTOR INVESTMENTS OF RESIDENTIAL BUILDINGS

Before the base year of 2011, solar collector investments among the population had already been conducted. Within the National Energy-saving Program (NEP) 560 m^2 solar collector had been installed on 62 building between 2007 and 2009. The population mainly

preferred the sun collector systems, during this time only 1.7 kW_p PV has been installed. Through these investments the renewable energy was yearly approximately 337.4 MWh, and due to this, the emitted CO2 decreased with 94,4 tons.

Presentation of actions

Spreading of the utilization of renewable energies can also be expected in case of residential buildings. The solar collectors which can be used to cover the domestic hot water demand and probably the heating-assistance could mean an economical and relatively easily implementable solution to reduce the fuel-demand of private houses.

1-1,5 square meter sun collector per person can be used for the production of the significant proportion of the hot water demand. In yearly average, 60-70% savings can be reached, which is during the summer term nearly 100%, while during the winter term 30-40%.[13] The proposal of the Sustainable Energy Action Plan is to install $4m^2$ solar collector system on 10% of the private houses and to install $30m^2$ solar collector system on 100% of the condominiums. This affects 3150 private houses and 84 condominiums with the total surface of $11000m^2$ sun collectors.

Person/department responsible for the coordination and execution

As these investments will be realized among the population, the main responsible people will be the owners of these houses carrying out these refurbishments, reconstructions. The municipality can help the realization of these investments, if it sets up such an important office point, where it can inform the population about the impacts of these actions, the saving potentials, the cost of the investments, and the payback period. The office can provide continuous information flow for the population about the available tenders, and can support them (either for free) in the application for these, or can offer mainly local professionals and companies who can take part in the implementation.

Deadlines/timelines for the proposals of measures (starting and finishing), timings – steps, estimated duration

As the realization of the sun collector investments of personal houses are out of the municipality's scope of authority, it's not worth setting a very strict schedule.

Starting: 01 September 2014

Finishing: 31 December 2020

Estimated costs, return on investment

A $4m^2$ system can be implemented approximately from 600.000 – 1.000.000 HUF with all elements and the execution. The SEAP table does not include the costs of these, because these investments will not be financed by the municipality's budget.

Obtainable financial sources

The population could apply for these non-repayable grants for solar collector investments to the National Energy-saving Program (NEP) until 2008, and from 2009 to the Green Investment System (GIS). The latest call for proposal of GIS was available for households in 2013. Likewise the last couple of years, probably there will be a chance to allocate investment supports for the owners to install the sun collector systems in the term of 2014-2020.

It would be a good solution, if the municipality established a fund which gives an (low-interest) amount of support to be recovered for the particular parts of the households' sun

[13] http://www.naplopo.hu/miert-napenergia/alkalmazasi-terueletek/napkollektoros-rendszerek/melegviz-keszites

collector system installations - the households can re-pay this aid on a specified duration and on a specified debt payment. In the next years the part of the fund can be continuously regenerated via the repayments. To establish and organize this, it would require a high level of cooperation and serious efforts from the municipality; therefore it would have more chance to realize it on a regional level (with the cooperation of the South-Transdanubian Regional Development Agency).

Expected production of renewable energy
Beside the typical geographical characteristic of Pecs, at ideal orientation and implementation the reachable energy production of sun collectors can be 600 kWh/year/m^2. The proposed production of renewable energy could reach the yearly 6546 MWh, if the sun collector systems will be installed on 10% of the personal houses (on 4m^2 surface) , and on 5% of the condominiums (on 30m^2 surface) until 2020.

Expected reduction of CO2-emissions
In case of the proposed reduction of CO2 emissions, we can calculate with the following: the heat production (with is actually based on natural gas and electricity power) would be replaced in the case of residential buildings and condominiums and in this case the size of the proposed reduction of CO2 emissions will be around 1839 tCO2 eq/year.

2.2.3. PHOTOVOLTAIC INVESTMENTS OF RESIDENTIAL BUILDINGS

Presentation of actions
The other ways of the solar energy consumption are the photovoltaics which produce electricity. The grid-connected PV systems turned into a rapid spread also in the population due to the decreasing price of PVs. The spreading of the grid-connected PV systems are encouraged by the so-called “buy-sell” settlement, by which the electricity provider uses a balance-settlement, i.e. on a timely manner deducts from the consumption the value of sun energy produced to the grid. The law[14] defines monthly, semi-annual, yearly settlement period.[15]
The Sustainable Energy Action Plan calculated that until 2020 on the 10% of the private houses and on the 5-5% of the condominiums solar cell systems will be installed. We presumed a 3kW system on private houses, and 7kW (approx. 28 pcs) PVs in the case of condominiums, so it affects altogether approx. 3350 flats and altogether 7620kW_p power of solar cells.

Deadlines/timelines for the proposals of measures (starting and finishing), timings – steps, estimated duration
As the realization of the PV investments of private houses are out of the municipality’s scope of authority, it’s not worth setting a very strict schedule.

Starting: 01 September 2014
Finishing: 31 December 2020

Person/department responsible for the coordination and execution

[14] 273/2007. Government Decree No. 273/2007 – Implementation of directions of electricity energy
[15] 5.§. (5): The electricity supplier applies a yearly, half-yearly or monthly saldo-settlement if the relating residential solar power plant feeds the electricity grid. The settlement must be based on a contract between the parties.

As these investments will be realized among the population, the main responsible people will be the owners of these houses carrying out these refurbishments, reconstructions. The municipality can help the realization of these investments, if it sets up such an important office point, where it can inform the population about the impacts of these actions, the saving potentials, the cost of the investments, and the payback period. The office can provide continuous information flow for the population about the available tenders, and can support them (either for free) in the application for these, or can offer mainly local professionals and companies who can take part in the implementation.

Estimated costs, return on investment

A 3kW system can be implemented approximately from 1 960 000 HUF with all elements and the execution (a 7kW system is specifically a little bit cheaper). The SEAP table does not include the costs of these, because these investments will not be financed by the municipality's budget. The total cost of the needed investments would be approximately 4832 million HUF.

Obtainable financial sources

The population could apply for these non-repayable grants for solar collector investments to the National Energy-saving Program (NEP) until 2008, and from 2009 to the Green Investment System (GIS). The latest call for proposal of GIS was available for households in 2013. Likewise the last couple of years, probably there will be a chance to allocate investment supports for the owners to install the sun collector systems in the term of 2014-2020.

It would be a good solution, if the municipality established a fund which gives an (low-interest) amount of support to be recovered for the particular parts of the households' sun collector system installations - the households can re-pay this aid on a specified duration and on a specified debt payment. In the next years the part of the fund can be continuously regenerated via the repayments. To establish and organize this, it would require a high level of cooperation and serious efforts from the municipality; therefore it would have more chance to realize it on a regional level (with the cooperation of the South-Transdanubian Regional Development Agency).

Expected energy savings

Only with the solar cell investments no energy savings are attainable, if in the meantime our consumption habits are not changed, but some of the electricity (provided in the framework of a universal service) can be replaced and on the other hand we can also turn into energy producers, if the unused energy is fed back to the grid by ourselves.

Estimated production of renewable energy

Keeping in mind our country's geographical characteristic, in the case of 1kW solar cell we can calculate with a yearly 1150 kWh production. If 3kW of solar cell will be installed on 10% of the personal houses, and 7kW of solar cells will be installed on the 5% of multi-apartment buildings until 2020, as a result of this the proposed production of renewable energy will be altogether yearly 8763MWh.

Expected reduction of CO2-emissions

With the implementation of solar cell systems the electricity usage from the grid will be reduced. To estimate the proposed reduction of CO2 we have to calculate with the emission factor characteristic to the Hungarian mix of electricity (0.36 tCO_2eq/MWh). With the planned investments yearly 3155 tCO_2eq reduction of CO2 emissions will be reached.

2.3 BUILDINGS OF SERVICE SECTOR

2.3.1. PROMOTING ENERGETIC MODERNISATION

Presentation of actions

In case of the service sector, a 20% energy reduction plan can be a target until 2020. The municipality could have the same kind of role to inspire the target achievement, like in case of the residential buildings, mainly to help the implementation of investments with providing counselling and information.
The EU-funds will be obtainable for the companies and probably these funds will support energetic modernisation.

The reduction of heat consumption will be achieved with thermal insulation, replacement of doors and windows and heat recovery. The reduction of consumption of electricity will be reached with the replacement of outdated household appliances and older light sources.

Deadlines/timelines for the proposals of actions (starting and finishing), timings – steps, estimated duration

1. Providing information about applications

Starting: 01 April 2014
Finishing: 01 January 2020

2. Establishment of counselling office

Starting: 01 April 2015
Finishing: 01 January 2020

Person/department responsible for the coordination and execution

The Municipality directly is not responsible for the execution of this action (like in the case of energetic investment of residential buildings). However the Municipality can promote the investments of the companies mainly with counselling, awareness-raising or implementation regulatory instruments.

Estimated costs, return on investment

Provision of information does not mean extra costs for the Municipality.
In case of the personal counselling see: Residential Buildings.

Obtainable financial sources

The companies can submit the applications concerning the refurbishments to the call for applications of the Environment and Energy Efficiency Operational Programme and the Economy Development and Innovation Operational Programme.

Expected energy savings

If the companies will reach a 20% energy-reduction with the energy-efficiency investments until 2020, the energy consumption of the local enterprise sector will reduce with approximately 71 760 MWh and the consumption of electricity will reduce with 25 229 MWh.

Expected reduction of CO2-emissions
In the case of energy-efficiency investments of the companies the greenhouse gas emissions of the city would reduce with approximately 26 382 tons/year until 2020.

2.3.2. SOLAR ENERGY INVESTMENTS IN THE SERVICE SECTOR

Presentation of measures
In the last years more companies and hotels submitted applications for the calls for proposals of the Environment and Energy Efficiency Operational Programme to install solar collector/PV investments or implement geothermal energy systems. Until the first half of 2014 totally 230 kW_p PV systems were implemented and solar collector systems were installed on 219 m2 surface with the subsidy of the Environment and Energy Operative Programme.

According to the SEAP estimation the tendencies of the last years will continue and the current capacity of the PV and solar collector systems will be tripled until 2020. It means that in the next few years 460 kWp solar cell system will be implemented and also solar collector systems will be installed on 438 m2 surface.
Person/department responsible for the coordination and execution
The Municipality directly is not responsible for the execution of this action (like in the case of energetic investment of residential buildings). However, the Municipality can promote the investments of the companies mainly with counselling, awareness-raising or implementation regulatory instruments.

Deadlines/timelines for the proposals of measures (starting and finishing), timings – steps, estimated duration
The above-mentioned actions are out of the municipality's scope of authority, so it is not worth setting a very strict schedule.

Starting: 01 September 2014
Finishing: 31 December 2020

Estimated costs, return on investment
In case of the solar cell projects of the companies the SEAP table does not include the related costs, because these investments will not be financed from the municipality's budget. The total cost of the needed investments would be approximately 4832 million HUF.
The installation of approximately 500 kW solar cell systems would mean 330 million HUF, but it depends on the performance of the planned systems, because in case of the larger systems the specific installation cost (per kW) is lower.
The implementation of solar collector investments of the companies (which contained in the SEAP) would mean approximately 55 million HUF cost

Obtainable financial sources – aggregate amount of subsidies from the municipality and other sources
Between 2007 and 2013 the municipalities, NPOs and companies could submit applications for the calls for proposals of the Environment and Energy Operative Programme to install solar energy-using systems. Probably the companies would submit application for the calls for proposals of "Environment and Energy-efficiency Operational

Programme" and "Economy Development and Innovation Operational Programme" in the term of 2014-2020.

Estimated production of renewable energy
The main related goals of the SEAP are the installation of 460 kW performance solar cell systems, also the installation of solar collectors at least on 440 m2 surface. These actions result altogether in 792 MWh/year renewable energy.
As a result of the already implemented investments by the subsidy of the Environment and Energy Operational Programme (solar collector, PV and heat pump) the renewable energy production was raised with 957.5 MWh in the service sector.
As a result of the already implemented and planned investments a total value of 1750 MWh/year renewable energy production until 2020 is expected.

Expected reduction of CO2-emissions
With the implementation of solar cell systems the electricity usage from the grid will be reduced. To estimate the proposed reduction of CO2, we have to calculate with the emission factor characteristic to the Hungarian mix of electricity (0.36 tCO_2eq/MWh). With the planned investments, yearly 190 tCO_2eq reduction of CO2 emissions will be achievable.
As a result of the solar collector investments a 53 tCO_2eq/year reduction of CO2 emissions will be reachable.
As a result of the already implemented renewable energy investments, the CO2 emissions were reduced with a yearly 235 tCO2eq.

As a result of the already implemented and planned investments of the service sector a yearly 479 tCO2eq CO2 emissions will be expectable.

Threats/risks
The Municipality has no direct effect on the investments of the service sector, so it would be a risk.

2.4. PUBLIC LIGHTING

Presentation of measures
In base-year 2011 the 8637 MWh value energy consumption of public lighting represented 7% of the total municipal energy consumption (without transport). This is a significant proportion so it is definitely worth taking measures and allocating financial sources to carry out the modernisation of lighting.

Actually more than 2900 pieces of mercury and metal halide light sources are in use in Pécs, which do not only have higher power consumption, but these sources have inefficient lighting technical specifications, so in Phase 1, it is proposed to replace them with LED lamps.
The replacement of sodium light sources with LED sources is also proposed.
Actually 8326 pieces of compact fluorescent lamps are used in the public lighting, and it is proposed to install electronic add-ins to them, which make their temporal power control possible (the lamps can operate at 50% power level at dawn), by the help of which their power consumption can be reduced.

It is possible to install a so-called “intelligent controlling system” after the replacement of the outdated lamps with LED-lamps; the installed electronic units will:

- secure the reduction of energy-usage,
- provide information about technical condition,
- enable the zone-based power control (according to the needs of habitants and transport), so the CO2 emissions and light pollution value will reduce.

Deadlines/timelines for the proposals of actions (starting and finishing), timings – steps, estimated duration

It is worth implementing the conversion of public lighting to an intelligent network in the following 5 steps:

Phase 1: Replacement of outdated hydrogen and metal halide lamps with LED lamps.

Starting: 01 April 2015
Finishing: 30 September 2015

Phase 2: Retrofitting of technologically appropriate compact fluorescent lamps with electronic power control units.

Starting: 01 April 2016
Finishing: 30 September 2016

Phase 3: 2nd phase of conversion – the replacement of sodium lamps will be implemented in this action

Starting: 01 April 2017
Finishing: 30 September 2017

Phase 4: Retrofitting of lamps with intelligent controlling system

Starting: 01 April 2018
Finishing: 30 September 2018

Phase 5: Connection of public lighting with grid-connected solar energy systems

Starting: 01 April 2019
Finishing: continuously

Person/department responsible for the coordination and execution

The responsible person is the assigned professional from the Technical Department or General Technical Group.

Estimated costs, return on investment

The following costs were calculated at 2013 prices:

Phase 1: Replacement of 2914 pcs mercury and metal halide light sources
Cost: 330 million HUF.
Return: 3.1 years.

Phase 2: Retrofitting of technologically appropriate compact fluorescent lamps with electronic power control units
Cost: 137.5 million HUF.
Return: 4.56 years.

Phase 3: Replacement of 7976 pcs sodium lamps
Cost: 737.8 HUF.
Return: 5.1 years.

Phase 4: Retrofitting of lamps with intelligent controlling system
Cost: 217.8 million HUF.
Return: 7.6 years.

Obtainable financial sources
Public lighting modernization tender will be available in the fifth priority axis (Energy efficiency increasing, using renewable energy) of the Environment and Energy Efficiency Operative Programme (2014-2020).

Expected energy savings
Replacement of mercury, sodium and metal halogen lamps to LED light sources reduces lighting equipment's energy consumption by 1235.1kW. It means 5445MWh/yr reduction in electricity consumption. Another 25% is available by power control.

Expected reduction of CO2-emissions
The expected CO2-emission reduction is 1960 tCO2eq/year.

2.5 TRANSPORT

2.5.1 TRANSPORT MANAGEMENT SOLUTIONS

Public transport short and mid-term plans basically cover 5 areas. Plans are in the document called „Transport development plan of the City of Pécs and periphery" and in the feasibility study created to it. CO2-emission reduction is calculated based on „Guidance on the methodology for carrying out the Cost-Benefit Analysis: KÖZOP (Transport Operational Programme) subsidies, Public road development projects, railway development projects, public transport project", given by National Development Agency.

Introduction of action
1. **Revision and development of the local public transportation network and timetable**
The target in the first version is to develop a network of long transport lines so that the most parts of the city can be reached without transfer. The intention in designing city parts and routes is that main parameters (coverage, run time, density of runs) are at least on the same levels as the current ones. The first version prefers long route, change-free network structure. Later the network can make up the base of a metro bus system. The inter-suburban based network ensures easy traveling into the centre from each city area. Comparing to the current timetable, the new one means daily 500 km save in mileage, yearly it is close to 182 500 jkm. Supposing a 50 km/h average travel speed of a bus, their

CO2 emission is 476.7 g/km average so thanks to the decreasing public transportation mileage it results 87 tons of CO2 save per year.

2. Development of an East-West public transportation corridor in Pécs

The overall aim of the project is to motivate the usage of public transportation in the East-West orientation of Pécs. One tool to help is to enhance the preference of public transportation, ensure undisturbed proceeding in the traffic, increasing the quality of the service to be competitive with car transportation. Version I.: Implementing an East-West oriented bus corridor mainly by intervention of junctions and creating a bidirectional bus lane on one segment. This form counts with short-term feasibility. By implementing this version it is calculated that by 2020, the mileage will decrease by 1936 jkm/day caused by passengers that sit over from car. Assuming 50 km/h average speed of cars with an average 118.4 g/km CO2 emission, this action means a save of 83.67 tons of CO2.

3. Development of a North-South public transportation corridor in Pécs

The overall aim of the project is to motivate the usage of public transportation in the North-South orientation of Pécs. One tool to facilitate this is to enhance the preference of public transportation, to ensure undisturbed proceeding in the traffic, and to increase the quality of the service to be competitive with car transportation. Version I.: Implementing a North-South oriented bus corridor mainly by intervention of junctions, short junction bus-lane and implementation of a bus-lock. The corridor is to be implemented on the Siklósi way-Alsómalom street route, north to the Kanizsai Dorottya street (Maléter Pál street) node, all the way to the Rákóczi way crossing. Thanks to the shorter travel time, based on 2010 passenger count data, 156 passenger will change from car, this is modified by the passenger-count decrease without the project. It causes -320 km/day change in passenger car mileage resulting approx.18,83 tons CO2 yearly save by 2020.

4. Complex improvement of passenger information of the public transportation of Pécs

The overall aim of the project is to motivate the usage of public transportation. The tool is better information service to passengers, improvement of passenger information system on non-centrals and route-turns by showing planned timetable data dynamically. For this, there is no need to change or develop on-board units. In this version, in addition to keep the existing dispatcher centre, the on-board units are available to provide data without modification. So the dynamic information service improvement is based on systems currently owned by PK Zrt with minor fitting cost ordered. Improving passenger information systems also means increasing passenger count in public transportation, based on the planned data it results a 153 tons CO2 save yearly.

5. Improvement of Pécs public transportation station infrastructure

Next to the vehicles condition, passengers value the quality of the service by the stations' condition and equipment. Moreover, passengers expect the safe and possibly clean approach and use of stations. According to it, the aim of the improvement is to enhance waiting circumstances, comfort, and ensure clean and safe approaching of stations, thus raising public transportation quality. This can be done by attractive instruments that fit in the city image. The first version contains improvement of the most important, busiest stations. It is expected to cause 380 passengers to sit over to public transportation vehicles from cars. The expected decrease in CO2-emissions can be up to 34.14 tons per year.

Deadlines ordered to arrangements / schedules (start and finish)
The above described investments are long term proposals to be implemented in years. These help to solve problems whose instant solution can be done in the mentioned earlier schedules or the solution needs major investments in technology / infrastructure or needs drastic reshape of controlling.

Starting: 01 January 2016
Finishing: 31 December 2020

Person/department responsible for the coordination and execution
The document proposes Pécs Town of County's Government as project owner. Others involved:

- Pécs Holding Városi Vagyonkezelő PLC,
- Magyar Közút Nonprofit PLC (part of the road is government owned),
- Pécsi Közlekedési PLC (buses and other equipments),
- Pannon Volán PLC.

Estimated costs, return on investment
Estimated cost in 2010 rates is altogether 690.6 million HUF that contains the above described arrangements provisioned costs.

Obtainable financial sources
Provisionally, similar improvements can apply within the framework of the Közlekedés Operatív Program between 2014 and 2020.

Expected reduction of CO2-emissions
Implementing the planned innovations can result yearly 372 tons CO2 reduction.

2.5.2. BUS CONVERSION TO CNG-DRIVEN ONES

In year 2011, 169 vehicles, with an average age of 12 years, were used in the public transportation of Pécs. Some of them are Ikarusz makes, avg age is 20 years but 92 pieces – much younger – Mercedes buses are also working in the city. Local transportations greenhouse gas emissions reached 14 165 tons CO2eq/year in 2011.

Presentation of actions
Local government plans to use the biogas produced by the biogas factory that opens in 2014 for transportation purposes. The biogas factory's capacity is planned to be increased after the KEOP trend's reservation period. Thus the planned 70-80 buses can be converted to CNG-driven ones.

Compressed natural gas (CNG) is compound of liquid carbon hydrogens that can be used as vehicle fuel and for heating purposes. The engine fuel CNG is the same quality as the one used in homes for heating. Traditional gasoline engines can be converted to natural gas-driven ones by simple technical solutions.

Deadlines ordered to actions/schedules (start and finish), steps, estimated duration
The biogas factory's expansion can be done after the KEOP trend's reservation period.

Starting: end of 2019
Finishing: 31 December 2020

Person/department responsible for the coordination and execution
If the biogas factory will be improved, then Tettye Forrásház Zrt. will appoint people who will be in charge of project coordination and planning. Conversion of public transportation buses, or their purchase will be coordinated by Tüke Busz Zrt (it is owned by Municipality) sufficient department.

Estimated costs, return on investment
Based on US studies, the cost of a hybrid bus is around 500.000 USD, the buses work in Zalaegerszeg cost 70 million forint each. The expected cost depends on the scale of the capacity improvement and the purchased number of buses.

Obtainable financial sources
Provisionally, similar improvements can apply within the framework of the Transportation Operation Program between 2014 and 2020.

Expected energy saving
By implementing the investment, 2 million liter/year of fuel can be saved. The fuel consumption of diesel- and gas-driven buses with same performance and with same load is showing extremely similar values.

Expected reduction of CO2-emissions
Expected reduction of CO2-emission is 5472 tons/year after the implementation.

2.6. AWARENESS-RAISING, INFORMATION PROVISION

Information is needed due to multiple reasons and on multiple levels: once it is important that local people know the government aims, planned actions, facility-refurbishments, changes. On the other hand, there is a need for information, campaigns, action to take steps in their own lives.

Information provision can take place in many ways: a lot of people prefer paper-based, printed communication materials so maybe it is needed but looking at the cost and the CO2- emission it is better to produce them in a limited amount. The cheapest and most flexible information interfaces are thematic home pages, meaning the primary information source for the majority of the people. It is worth to utilize the local, well known, working communication channels (regional/county papers, governmental news pages etc.) e.g. presenting thematic articles, energy saving tips, reports, and articles about interesting initiatives. Thematic programs are able to get together businesses and local people and other economic actors. The experience is that non energy-specific programs welcome organizations to provide useful information to the visitors. These events typically attract more people than technical days, it is worth to concentrate on them when planning attitude shaping programs.

By joining to Covenant of Mayors, the city contracted to give opportunity to the locals to utilize possibilities in more efficient energy usage and provide information periodically via local press about the realization of Sustainable Energy Action Plan. It is a key to enhance social attendance in energetic and environment protection decision mechanisms, to get over possible resistance of people against key investments. In order to inform locals it is advised to hold a yearly residential forum about energy saving and climate change.

Next to shaping attitude, training is an essential part of widening knowledge of energetics.

Introduction of actions

1. Thematic article series, energy tips, reports of interesting initiatives
The cheapest and most flexible information interfaces are thematic home pages and facebook. Their drawback is that a part of the citizens, mainly the elderly are not users. In addition, it is worth to utilize local communication channels (county press, governmental news pages etc.)
Some organizations created a lot of documentary publications, web pages that can be taken over or linked to the city's homepage. If the government has resource for printing, the publications can be printed based on unique agreement and can be taken to households.

It is worth preferring the Pécs related topics, like preferring bike and pedestrian traffic, review of solar energy systems and showing effect of building modernisation.

Starting: 01 April 2014
Finishing: 31 December 2020

2. Programs
Thematic programs are able to get together businesses and local people and other economical actors. The experience is that non energy-specific programs welcome organizations to provide useful information to the visitors.

Starting: 01 April 2014
Finishing: 31 December 2020

3. Education
Programs and campaigns held in educational institutions along with direct savings, have a long term effect: the approach of the growing up, most sensitive generations will affect the attitude of the following generations. Civil organizations, educational, environment training organizations can be involved.

Starting: 01 April 2014
Finishing: 31 December 2020

Person/department responsible for the coordination and execution

The next departments of the Municipality can be involved: City Development and Communal Branch Office, Education and Cultural Branch Office, Nature and Human Resources Branch Office.

Estimated costs, return on investment

Educational materials to schools, kindergartens (approx. 1000 pcs): depending on material about 300-500 thousand HUF.
Documentary publication (printed, 5000 pcs): about 2 million HUF
One program / year: costs are different depending on type of the program (i.e. amplification).

2.7. ENERGY PRODUCTION

Gas and district heating consumption represents 98% of the total energy use of the municipality's institutions, meaning that the money spent on heating and hot water production is significant. The best way to lower the costs is the insulation of the buildings and the modernization of the heating systems. Also, the involved renewable energy sources are not only cheaper, but facilitate the decrease of CO2-emissions and has lower fuel and operation costs.

The conversion of the city's district heating system to a biomass based system had finished in the end of 2012. In the city of Pécs the Pétáv Zrt. provides the heating and hot water supply of approx. 31 thousand households and 1000 other users. In the base year (2011) there was already partly biomass combustion in the power plant. The fluidized bed boiler with 49,9 MWe power is operated with firewood cuttings, timber industry and agricultural by-products. The 35MWe performance block with straw-firing was installed by the end of 2012 so almost 100% of the city's district heating is on a renewable base.

As an effect of the investment, there has been a significant drop in CO2 emissions. As a consequence of this fuel change as of 2013 the CO2 emissions of the apartments supplied with district heating dropped by 135 thousand tons.

2.7.1. PHOTOVOLTAIC SYSTEM

The city of Pécs plans to establish a solar energy model park that has the following purposes:

- Decrease of electricity consumption by producing photovoltaic energy
- Decrease of CO2-emissions by creating a 7 MW solar park
- Lowering the costs of the public utilities with the increased income of the newly produced energy.

The city plans to establish a solar energy park with 7MW performance for maximum 5 billion Ft, for which the area of Tüskésrét has been assigned based on technological, economic and environmental aspects. For the planned investment, a feasibility study has been made. This area, owned by the city is classified as an industrial-economic area. The connection to the network is possible through a transformer in the close vicinity. To ease the authorization procedures and lower the investment costs, the installation is done on sites under 14 different land register references, where each 500 kWp performance solar cell parks will be installed. A total of 28 000 heavy duty solar modules with 250 Wp performance will be installed. The system is made out of PV modules on pillars either

screwed in the ground or pressed-anchored. The optimum performance is achieved with southern orientation and a 30-35° angle.

The small plant of 4 pc of 2.5MVA performance transformers is connected to a common bus-bar and then through a 22kV cable to the 22 kV bus-bar of the Kertváros (garden district) E.ON station.

Deadlines/timespan for proposal measures (beginning, ending), schedule – steps, estimated period of time

There are no fixed time frames assigned to the implementation, because the city is planning to implement the investment using tender funds which are launched in 2014.

After the start of the project until the plant is placed in service, a minimum of 16 month is required for the planning, authorization, implementation and connection to the network.

Person/department responsible for the coordination and execution

Primarily the appropriate specialist from the municipalities Engineering Department and Financial Department is responsible for the coordination of the investment and the preparation of the project.

Estimated costs, return on investment

The planned costs are made up of two bigger items, firstly the costs of the materials, machinery, equipment, the costs of the construction, secondly the connection to the network.
The first is 3 732 million forints gross, the connection cost is 1 268 million HUF. During the operation the costs of the maintenance and preservation are approx. 15 million HUF per year.
The time of return of the investment from the municipalities point of view primarily depends on which funds the implementation is established from, how is the proportion of the own financial contribution and the acquired funds.
From entirely own sources counting with simple return time it is 16.6 years.

Obtainable financial sources

The municipality is planning to cover the investment out of tender funds, likely from the Environmental and Energy Efficiency Operative Programme.

Expected renewable energy-production

Based on the data of the Pécs-Pogány weather station, the expected renewable energy production is 8070 MWh/year.

Expected reduction of CO2 emissions

The expected reduction of CO2 emission is 2898 tons/year.

Threats/risks

The predominant risk is the failure of the solar cells from mechanical and electrical point of view, furthermore the failure of the inverters and cables is possible.

2.7.2. BIOMASS/BIOGAS PLANT

In the city of Pécs, the 100% municipality owned Tettye Forrásház Ltd. is responsible for the sewage disposal, drainage and cleaning. More than 25 thousand m3/day wastewater is created by households and industrial companies. Since 2010 the local domestic liquid waste is disposed by the company as well. At the wastewater treatment plant the wastewater and the delivered liquid waste is cleaned biologically in accordance with the current EU regulations[16].

Presentation of actions

The Biomű-Baranya establishes a biogas plant on the waste-water treatment plant of the Tettye Forrásház to safely dispose of and to generate energy out of the anaerobe digestion of the pre-compressed sewage sludge generated on the plant and brought in from the regional waste-water treatment plants.

From the locally generated and collected sewage sludge, approximately 2.33 million Nm3/year biogas will be produced. After the purification, thermal- and electric energy in two combined cycle-power stations with each 375 kWh capacity is generated.

A substantial part of the sewage sludge generated in Southern Transdanubia is also safely disposed in the plant.

It has occurred in the municipality's plans that part of the produced biogas could be used to operate gas fuelled buses after purification though within this particular project there is no possibility for that. During the implementation, it was taken into account that on a possible later enlargement there should be a possibility to fuel the specially designed buses.

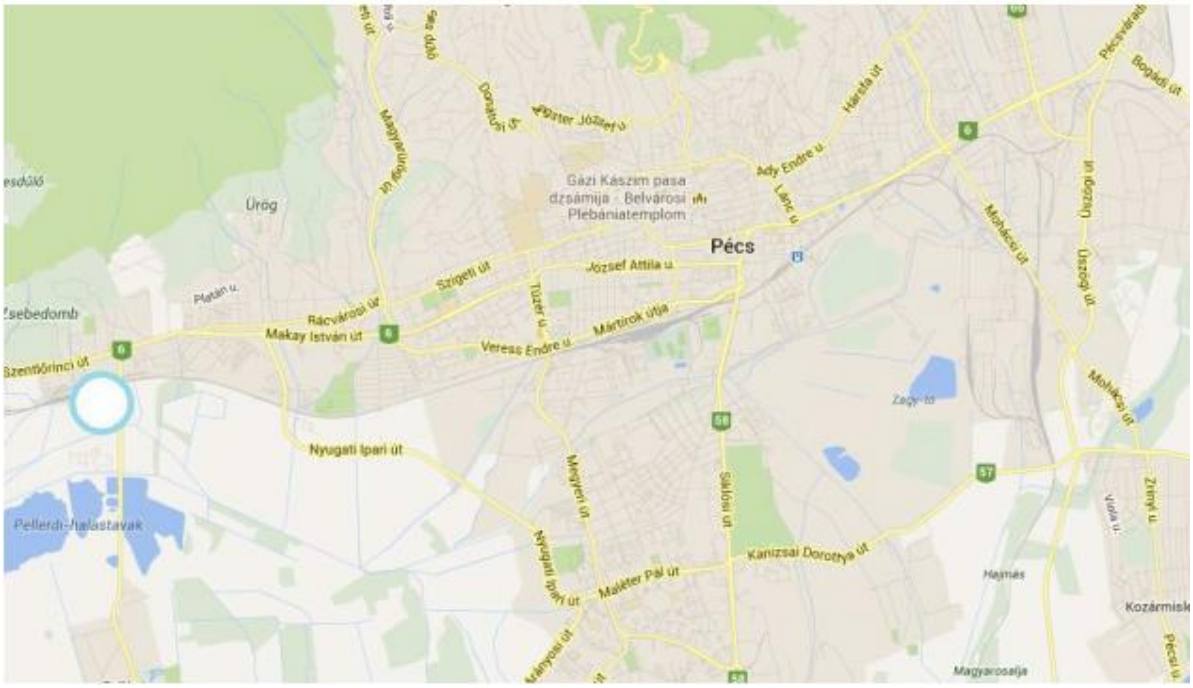


Figure 4: Location of the biogas plant.

[16] source: http://www.tettyeforrashaz.hu/index.php?mid=3

Deadlines/timelines for the proposals of measures (starting and finishing), timing – steps, estimated duration

- The Biomű Baranya project company was set up in February 2011.
- The feasibility study was completed and the related KEOP application was submitted in 2012.
- The KEOP-4.4.0/11-2011-0038 project titled The "Establishment of a biogas plant in Pécs" was supported with 925 562 500 HUF.
- November 2013: the foundation stone was put into place and the implementation began.
- The trial run was in the summer of 2014, and following this the commercial operation started.

Person/department responsible for the coordination and execution

The "Biomű Baranya" project company was set up in February 2011 for biogas production and to establish and operate a plant in Pécs suitable for joint thermal and electricity energy production. Members of the company are Wicha József private person (75%) and the WIS Investment and Commercial Plc. (25%).

Besides the ongoing developments using alternative energy, this project is a key investment in the middle- and long term strategy of the WIS Group – integrating with the cities and the WIS Plc's environmental management concept.

Estimated costs, return on investment

The eligible cost of the project is 2 142 550 000 Ft, which is founded in 46% from the obtained funds, the own contribution is ensured through a loan. According to the plans, the 1 billion own contribution on the biogas station shall return in 10-15 years, while the costs of the Tettye Forrásház (water supplier) deriving from the transportation of the sludge drop significantly.

Obtainable financial sources

For the implementation of the project, the project company won a tender with the "Establishment of a biogas plant in Pécs" project on the KEOP-4.4.0/11-2011-0038 Environment and Energy Operative Program with a 46% subvention.

Expected renewable energy-production

The biogas plant gives the exceeding part above the thermal energy for own use to the waste-water treatment plant in the quantity of 1.310 GJ/year, which is used for the heating of the offices and social building. The most part of the gas usage is replaced in this way.

The produced electricity decreased by own consumption is connected to the national electrical system and is sold through the KÁT in an estimated 4.379 MWH/year.

The system could provide the whole power supply of the premises below

- Waste water treatment plant
- Waste water pumping station on Megyeri Street

- Water source area in Pellérd
- Base engine room in Pellérd
- Main Office Building
- Water source area in Tortyogó
- Base engine room in Tortyogó
- Engine room in Kertváros
- 2 waste water pumping station

Expected reduction of CO2 emissions

As a result of the project and thanks to the prevention of methane emissions and the use of renewable energy, an emission decrease of 2731 tCO2eq/year of greenhouse gas is achieved.

3 MONITORING, PROPOSED INDICATORS

With the accession to the Association of Mayors the city committed to develop the Sustainable Energy Action Plan and report every two years about the execution of the actions to follow up the implementation.

The association requires a qualitative report every two years and a submission of a report supported by numerical data (Emission Inventory) every four years from accessing municipalities. The achievement of the related targets can be measured or estimated with the same methodology, the same statistical data on the base of the energy usage and CO2 baseline emissions registry for the given year (2016, 2018 and 2020). The notes regarding the preparation and submission of the monitoring report can be found on the webpage of the Covenant of Mayors.

Proposed indicators to monitor the implementation:

	2016	2018	2020
Municipality			
Number of insulated buildings (pcs)			
Volume of energy savings (%)			
Number of replaced boilers (pcs)			
Number of replaced electric devices (pcs)			
Volume of installed solar collector surface (m2)			
Power of installed PVs (kW)			
Electricity energy produced by PVs (kWh/year)			
Number of participants in awareness-raising campaigns (capita)			
Residential buildings			
Number of insulated buildings (pcs)			
Volume of installed solar collector surface (m2)			
Power of installed PVs (kW)			
Other investments which are using renewal energy (pcs)			
Public lighting			
Number of light			

sources involved to light-control (pcs)			
Number of light sources replaced with LED lamps (pcs)			
Volume of electricity energy savings (%)			
Industrial and service sector			
Volume of installed solar collector surface (m2)			
Power of PVs (kW)			
Reduction of electricity energy consumption (%)			
Reduction of thermal energy consumption (%)			
Transport			
Number of CNG vehicles (pcs)			
Change of passenger traffic in public transport (%)			
Increase of public transport (pcs)			
Renewed bus stations (pcs)			
Length of bicycle routes (km)			
Energy production			
Produced electricity energy by PV farm (kWh)			
Produced electricity energy and thermal energy of the biogas plant (kWh)			
Volume of produced biogas (Nm3/year)			

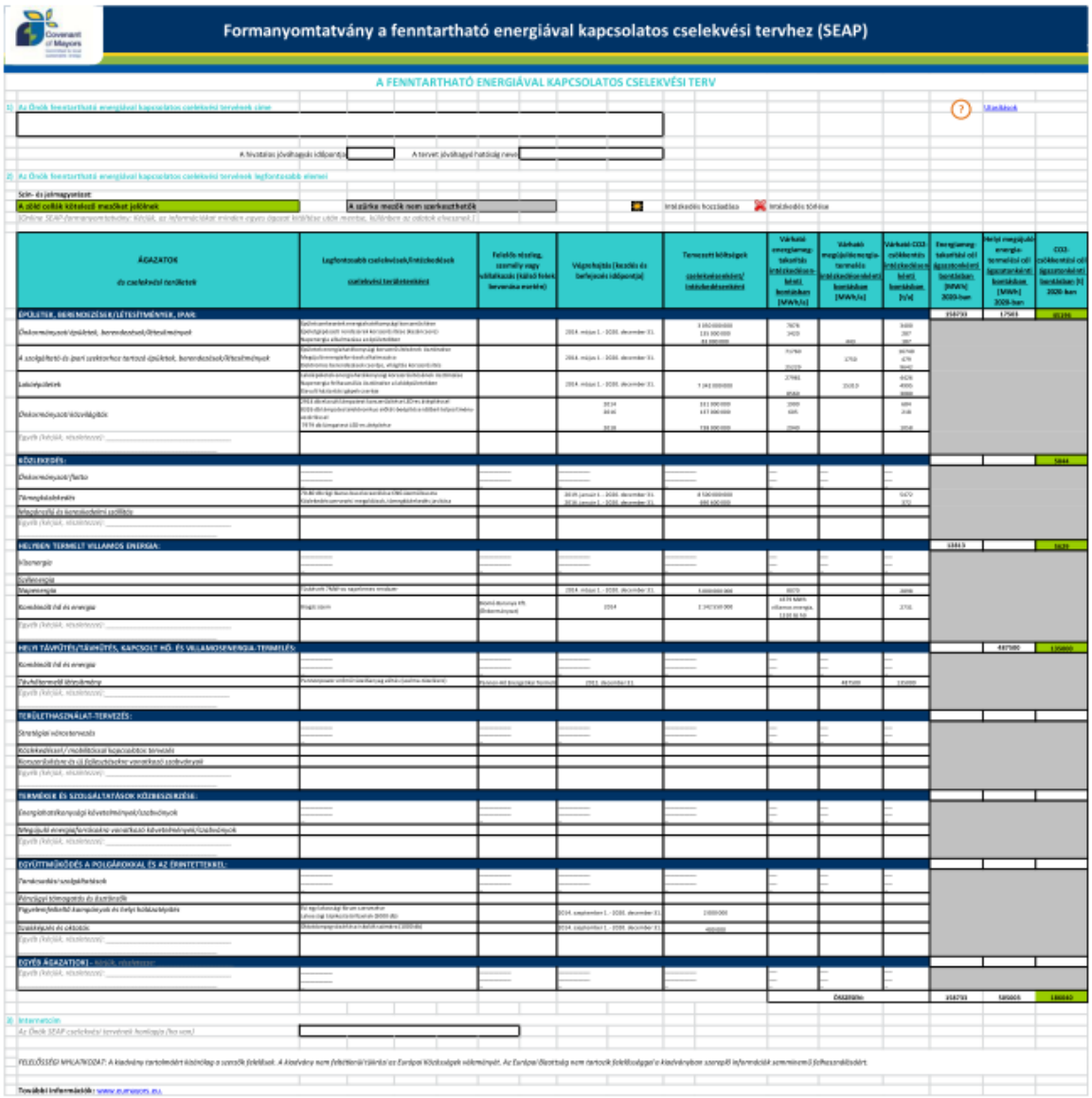
BIBLIOGRAPHY

1. PBE Energiamenedzsment: Energetic waste excavation analysis of the municipal buildings in Pécs, November 2011
2. Blue Economy Consortium: Energy strategy of Pécs, 2013.
3. Investors' Handbook: Proposals for the Energy Strategy of Pécs. Blue Economy Consortium Cluster, 2013.
4. Ernő Dittrich: Utilization of sewage sludge in Pécs (workshop_biogáz.ppt)
5. Optimization requirements of building energetic. Energy Club, 20012.
6. National Development Agency: Methodical Guide for cost-benefit analysis: "Transport Operative Programme" – subsidies, public road development projects, railway development projects, urban public transport development projects – COWI Hungary Ltd., September 2009.
7. COWI Hungary Ltd.: Long-term Transport Development Plan of Pécs and outskirts of it (Volume 1- 4); August 2010.
8. COWI Hungary Ltd.: Review and development of the local transport network and schedule in Pécs – Feasibility Study, August 2010.
9. COWI Hungary Ltd.: Establishment of the East-West public transport corridor in Pécs – Feasibility Study, August 2010.
10. COWI Hungary Ltd.: Establishment of the North-South public transport corridor in Pécs – Feasibility Study, August 2010.
11. COWI Hungary Ltd.: Complex development of the passenger information in the local public transport system of Pécs - Feasibility Study, August 2010.
12. Infrastructure development of public transport stations in Pécs - Feasibility Study, August 2010.
13. Supplying of data by the Clearing House the Municipality of Pécs.
14. Nr. 7/2006 order of the minister
15. Nr. 273/2007. Gov. Decree – Implementation of directions of electricity energy
16. http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php#
17. http://www.naplopo.hu/miert-napenergia/alkalmazasi-terueletek/napkollektoros-rendszerek/melegviz-keszites
18. http://www.naplopo.hu/miert-napenergia/gazdasagossag-megteruelesi-ido
19. http://www.terkepter.nfu.hu/
20. http://www.tettyeforrashaz.hu/index.php?mid=3
21. http://www.pecsma.hu/pecs-aktual/epul-a-pecsi-zolderomu/
22. http://www.pecsma.hu/vezeto-hir/szunet-utan-ujraindult-a-panelprogram/
23. http://www.cngport.hu/tudastar/a-cng-es-a-buszok.html

24. http://www.eumayors.eu/about/signatories_hu.html?city_id=5951
25. http://www.polgarmesterekszovetsege.eu/about/covenant-step-by-step-implementation%20reports_hu.html

LIST OF FIGURES

ANNEX I: DOCUMENT FORM OF THE SUSTAINABLE ENERGY ACTION PLAN (SEAP) – IN HUNGARIAN



Formanyomtatvány a fenntartható energiával kapcsolatos cselekvési tervhez (SEAP)

A FENNTARTHATÓ ENERGIÁVAL KAPCSOLATOS CSELEKVÉSI TERV