# Assets of Water Mills in Hungary

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## Abstract

Watercourses have been a great energy resource for thousands of years (Lewis 1997). Technical inventions have changed the role of water as an energy resource. The landscape preserved the former usage of watercourses as we can still find water mills.

In this research, we show the presence of water mills in Hungary. The main goal of the research is to show the possibilities to use water as an energy resource based on historical knowledge and the new technical improvements. We show which landscape characteristics make a place suitable for water mills. However, it is important that water mills change the landscape. We also answer the question how these elements can fit into greenways. There are examples of new functions like residential buildings, exhibition halls or community spaces. This helps to start to use water energy in a sustainable way and to give new functions for the old watermills.

Firstly, we review the types of water mills and the technical improvement in Hungary (Kádár 2010). Secondly, we summarize the history of water mills in Hungary (Kádár 2010). The main part of our research is to map the water mills in the country. As a resource, we used TÉKA (Land Value CT) to find existing watermills. Water has been used as energy source for long time in Hungary. Both streams and rivers have been used, geographical conditions determine the possibilities. With new inventions, these old wind mills can be important elements in the landscape again.

In our research, we mapped the water mills in Hungary. Historically, water was used as an energy resource much more in this country. Streams, rivers could provide a great opportunity to use renewable energy instead of fossil fuels. Water can be used as an energy resource that is more efficient, with new technical improvements. These developments provide a great opportunity to reuse these historical elements again and incorporate them into greenways.

## Introduction

Water is one of the commonly used renewable energy resource around the world. It has huge advantages: flexible and able to store electricity, however hydropower also means big dam power plants or run-over-the-river power plants (World Energy Council 2016). These huge power plants have a catastrophic effect on nature, including the landscape (Moran 2018). If we look back in time, water mills originally fit into the landscape, but somehow, they have been forgotten. Our research focuses on water mills in Hungary. We collected the existing buildings from TÉKA (Land Value CT). The cadastre only gives information about the location, but we did further research. We examine the locations: effects on landscape, the present condition of the locations, and possibility of grouping. We examine the relation of our data to see the possible connection with greenway planning.

## Background and Literature Review

Our research originally focused on renewable energy resources in Hungary. During the research, we realized that water mills have been given new functions so that they can be used for recreation or tourist purpose. The research has many different roots, in this section we make clear the background. As we started the research with the data of TÉKA, we describe the definition, former research and TÉKA. It is important to understand the technical background and the history of water mills. As hydropower is a renewable energy resource, we also give an overview of the importance of water power in the world and Hungary. Lastly, we give an overview about how water mills can be fit into the planning methodology of greenways.

The definition of landscape value is: "a natural value or landscape objects created by the human activity that is characteristic of the given landscape, which is important for society from a natural, historical, cultural, scientific or aesthetic point of view." (Nature Conservation Law 1996 Hungary) The research of landscape values started in Hungary in the 1970`s. Initially, the objects which were not protected by law belong to this definition (Csemez 1996). This changed over the time and landscape values are protected objects of the landscape and they are involved in the territorial planning. Collecting landscape values has its own official standard, in this case, data can be fit every level of design and planning (MSZ 20381 2009).

The TÉKA-project, which was the biggest project of Department of Landscape Planning and Regional Development is a database of the landscape value objects. It was financed by the EEA Grant and the project ran between 2009 and 2010. The database can be accessed at http://tajertektar.hu/. The department surveyed 431 settlements in Hungary and collected data of 15,014 objects. The database also includes existing data from other maps. Water mills are also included in this database as they are part of the industrial heritage.

Water mills have been used for many different targets. The definition of water mills gives the impression on the importance of this technology: "mill structure for grinding, grinding, peeling, cutting, sawing, forging, pipe drilling, ore, mineral crushing, etc. serve. They operated water-powered mill structures for pumping water at mines, etc." (Magyar Néprajzi Lexikon 1982). Hydropower has been used by human beings for thousands of years. The first mention of water mills occurred in De Architectura by Vitruvius from 1$^{st}$ BC (Vitruvius 2009), but probably the technique to use water to grind grain was invented before Romans. These inventions formed the landscape related to water courses. However, it also means water mills affected the agricultural landscape as this process made the `food industry` more effective.

The structure of the first water mills was very simple. That structure is called the horizontal water mill, where the millstones and the water wheels were parallel to each other. Despite being a simple structure, it went through a huge improvement in the medieval ages (Rynne 2015). However, the efficiency of the horizontal water mills was still very low, even with the improvements (Pongrácz 1967).

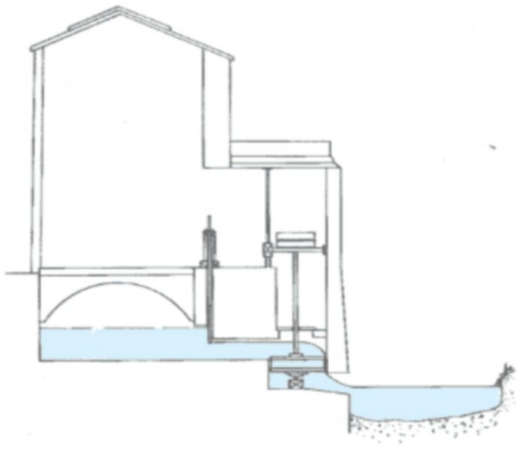

**Figure 1. Structure of Horizontal Water Mill (Molinos Nuevos 2019)**

In Hungary, the structure of the water mills is more complicated, because they always have a speed boost transmission part (Pongrácz 1967). There are three different types of water mills used in Hungary: ship mills, stream mills and river mills. As it is clear from the name "ship mill" is a floating platform on a river. It did not have big effect on landscape itself. As they floated, they cannot be landscape values as they changed their position. Stream mills are related to small watercourses and the level difference gives the gravitation energy to the water wheels. River mills are the origin of the dam power plants. (Magyar Néprajzi Lexikon 1982)

How many water mills are there in Hungary? Water mills have been very important in the food industry for hundreds of years. In this case there were quite a huge number of mills. Table 1 shows the number of water mills in Hungary from 1863 till 2010. Today we can find only 2% of the water mills in the country compared to the end of 19$^{th}$ century. Figure 2 shows the places of the water mills in Hungary.

| Year | Number of Water Millls |
|---|---|
| 1863 (Kádár 2010) | 13,474 |
| 1873 (Kádár 2010) | 17,249 |
| 1894 (Kádár 2010) | 15,417 |
| 1906 (Kádár 2010) | 13,425 |
| 2011 (TÉKA 2019) | 291 |

**Table 1. Number of Water Mills in Hungary**

**Figure 2. Water mills in Hungary TÉKA 2010.**

It is clearly visible that the number of water mills has decreased dramatically by now. In this case, it is very important to preserve these landscape elements. Giving new function or renovating the existing buildings are two ways to retain these landscape values. Water mills have gone through huge improvements from ancient empires until modern times. Nowadays, it has a huge impact on landscape to produce electricity. However, if we look at the history, it is possible to use this natural element in a sustainable way which fits the landscape.

Today, using renewable energy is getting more and more important. Most of the countries have pledged to increase the rate of renewable energy resources, as it is necessary to fight against the climate change (Paris Agreement 2016). These energy resources have been used for very long time: using wood for heating, using water and wind to grind grains, using the Sun to dry food, etc. However, these methods are not very efficient (Pongrácz 1967). We examine water, because in Hungary, there are many water courses, but water is not really used as an energy resource (Kádár 2010). However, water is the second most used energy resource in the world (Renewables 2018) and it can be a cheap way to produce electricity.

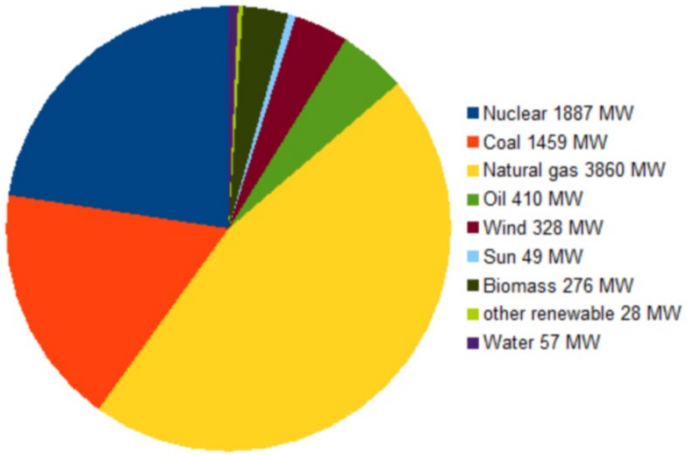


**Figure 3. Proportion of Electricity by Source in Hungary (authors` counting)**

Water is also important as a renewable energy resource with the consideration that some form of hydropower is dangerous for the environment. To understand that it could be a possible renewable energy resource for Hungary, we should also see the present situation. Figure 3 shows the Proportion of Electricity by Source. The proportion of water is very low, but as Table 1 shows, many of the wind mills disappeared, which objects could be a great possibility to increase hydropower.

Watercourses in Hungary do not have the geographical characteristics to build big hydropower plants. However, Hungary and Czechoslovakia planned to build Gabcikovo-Nagymaros power plant. Hungary stopped the investment because of protests, including some against the communist regime. Slovakia built the power plant with 570MW capacity causing ecological catastrophe (Lejon 1994). Hungary now buys electricity from this power plant, making the story even worse.

In the following, we discuss how this research is connected to greenways. According to Ahern (2002), the definition of greenway is: "Greenways are networks of land containing linear elements that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic or other purposes compatible with the concept of sustainable land use." (Ahern 2002) We analysed this definition related to water mills. The following points shows that water mills, as elements of greenways, can be used very effectively

- water mills are related to water courses which are linear element of the landscape,
- water mills are cultural heritage,
- water mills are used as hotels, restaurants, museums nowadays which are recreational aim, (Kádár 2010)
- the original usage, that of course formed the landscape, are compatible with the concept of sustainable land use.

It is clear from the definition that water mills are useful elements of greenways. However, this study changes the methodology, because we started from the landscape element and at the end, we define locations. What is the difference between our plan and thematic greenways? Water mills organise the greenway, not only as a main attraction, but they also can be restaurants, hotels etc.

**Goals and Objectives**

The main goal of our research is to assess water mills in Hungary and to find out how these buildings can be used now. The study uses a unique methodology: in landscape planning, we choose a site for our research. The starting point of our research is an element of landscape and at the end, we have a possible site of greenway. We show that elements with the same former function organise a greenway and provide all the important elements that a greenway should have. We also examine the effect of water mills on landscape to see the role in landscape changing. At the end, we show that water mills have a geographical feature organized in one system and the possibility to connect them as a greenway. We examined the difference with our planned greenway and the thematic road.

**Methods**

This research is the first step of a detailed research about water mills. The research follows these steps:

1. TÉKA - Land Value Cadastre: define the locations of water mills.
2. Find out that water mills can group linear way

3. Literature review: find exact information about the condition of the water mills.
4. Analyze historical maps to see how much effect water mills have on landscape
5. Show with Hungarian and international examples that water mills can be used as energy resource or can be given new functions
6. Show an example spot where water mills are able to organise the route of a greenway.

This research gives an overview of the present situation and also helps to find projects, which could be positive examples how water mills can be used today. The aim of this research is to give a new function or to produce energy in a more efficient way.

**Results**

At first, we looked for the relevant data in (TÉKA) database to define the existing water mills in Hungary. As a result, we found 291 existing water mills in the country. To define which of them could be used as a part of a greenway, we define geographical regions, mostly related to watercourses. Table 2 shows the defined regions and also some examples of the usage of the water mills.

| **Region** | **Relevant information – usage of water mills** |
|---|---|
| Stream Gyöngyös | 5 water mills produces electricity |
| Pinka | Working water mills, producing electricity |
| Rába | Producing oil with water mill, small power plants with dam |
| River Zala | From 35 20 still existing, Zalacséb – Mill hotel, Zalaegerszeg - flats |
| Moson and Sopron | Producing electricity; Mosonmagyaróvár – hotel, restaurant; Röjtökmuzsaj – grinding grains, hotel; Darázsfalu- family house |
| Pápateszér | Sulman-Sremmer Mill – producing electricity for the people living in the house |
| Pápa | Pápa – flats, Attyapuszta – hotel |
| Tributaries of Rába | Damonya – tiny power plant, |
| Region of Tapolca | Nagyvázsony – museum, Monostorapáti – hotel, Tapolca - hotel |
| Bakony | Csákvár – museum, research house; Sárkeresztes – wellness house; Kislőd – hotel |
| North side of Balaton | Csopak – restaurant, many private houses, |
| County of Somogy | Mike – warehouse |
| Völgység | Kárász – monument, Szászvár – livestock of sheep, Mecseknádasd – hotel |
| South of Mecsek | Borjád – Monument, Hird – restaurant, |
| Séd | Kádárta – warehouse, workshop; Medina – sport house |
| Öskü, Inota, Csór | Private houses, many ruin |
| Tata | Tata – mills connected to each other, |

| | |
|---|---|
| Gerecse, Pilis | Szentendre – warehouse; private houses |
| River Danube | Kvassay Flood Gate – Operating the Shipping, Bős-Nagymaros (Slovakia) – ecological catastrophe |
| Budapest | Víziváros – Museum, Nagybörzsöny – museum, |
| Börzsöny | Bodony – workshop |
| Mátra | Bag – Pub |
| Bükk | Eger – school, |
| Torna | Jósvafő – tiny power plant, |
| Hernád and Bársonyos | Gibárt, Felsődobsza, Kesznyéten, Hajmal – power plant, |
| Tisza | Túristvándi – miller conference |

**Table 2. Regions of Water Mills in Hungary (Kádár 2010)**

To group the water mills by geographical features is the most logical way. These results give the linear route of a greenway. Some of the new functions are very important in greenway planning:

- restaurant,
- hotel,
- pub,
- wellness house,
- museum,
- monument.

There are some regions which important to research further from the energy side. Gyöngyös, Pimka and Torna are relevant to produce energy in sustainable way. Rába, Tisza and Danube are the 3 rivers where the effect of bigger power plants appear. It is necessary to examine the landscape effects of small and big hydropower plants. It is important to note that the small power plants can be improved to be more efficient the production of electricity (Behari 2014).

Water mills can be used as parts of greenway by giving them a new function, protecting their old function or improving their efficiency. Water mills are also able to organise greenways, as they have characteristics which are determined by geographical conditions.

To understand what kind of effects water mills have on landscapes, we can examine historical maps. As an article is too short to go through all the places, we chose five water mills to show landscape changes. Those five places were picked, because we can show the relevant examples from the side of our research. Those water mills are the following:

- Pápateszér – Sulman-Sremmer Mill
- Tributaries of Rába – Damonya: tiny power plant
- Bakony – Csákvár: museum
- River Danube – Kvassay Flood Gate
- Hernád-Bvrsonyos – Gibárt: power plant.

Figures 4 and 5 show the differences between the landscape in Pápateszér. In the 18$^{th}$ century damming

lakes existed; however, mills were not on the map. In the middle of the 20th century all the mills can be found on the map, although they lost there importance. Sulman-Sremmer Mill is also signed on the map from 1941. This mill is very special, because the property owners transform the mill to produce electricity for the household (Kádár 2010).

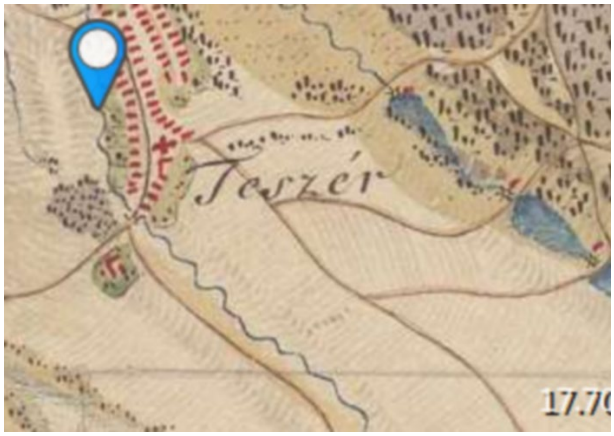


**Figure 4. Pápateszér 1782-85.**


**Figure 5. Pápateszér 1941**

Damonya is situated on the riverside of Csepregi. (Figure 6 and 7). We can find on the map of 1941 one of the mills. Originally there were 2 tiny power plant in the settlement. One of them is still operating with 25 kW capacity. As is visible from the maps, the settlement did not go through on any big changes. (Kádár 2010)


**Figure 6. Damonya 1782-85.**


**Figure 7. Damonya 1941**

Csákvár is situated in Bakony. At the end of the 18th the water mill, called Gurdi Mill, did not exist. In 1941 the maps shows that the mill is out of the settlement, which grew, but also kept the original settlement structure. The Gurdi Mill was ruined in 1950, but it was rebuilt in 2000, nowadays it is a museum and research house. (Kádár 2010)


**Figure 8. Csákvár 1782-85.**


**Figure 9. Csákvár 1941.**

Kvassay Flood Gate is situated in the south part of Budapest. (Figure 10 and 11.) It is clearly understandable that the landscape went through a huge change, but not because of the flood gate. At the end of the 18th century the sites were natural. In 1941, the 2 sides of the River Danube were a built up area. The Kvassay Flood Gate was built between 1910 and 1962. The flood gate was built firstly, the small power plant was built between 1956 and 1962. The object made it impossible to use ship mills (Kádár 2010).

**Figure 10. Kvassay Flood Gate 1782-85**

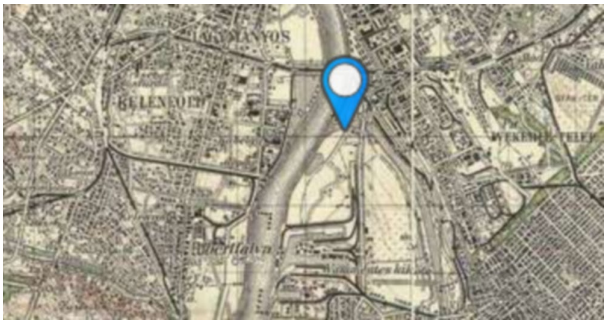

**Figure 11. Kvassay Flood Gate 1941**

Gibárt is situated on the river side of Hernád. It is a tiny little village and it is not really developed the settlement area between 18th and 20th century. According to a written memory the water mill was rebuilt in 1867, that means there were a water mill before that time. In 1903 a power plant was built on the place of the water mill and it still operates, but only as an industrial monument. (Kádár 2010)


**Figure 12. Gibárt 1782-85**


**Figure 13. Gibárt 1941**

The historical maps show that water mills were important objects, as most of them appeared on the maps. Water mills affected the landscape, but there is a need to research the intensity of the effect. To see how water mills organize a greenway we chose one of the groups. We chose Pápateszér, because we already had a detailed research about the settlement and its water mills, but it was not related to greenway planning. Figure 13 shows the locations of water mills in Pápateszér. According to the map we can organize 3 different greenways:

- Water mills from 1st to 14th: linear way
- Water mills from 18th to 25th: linear way
- Including all the water mills: circle.

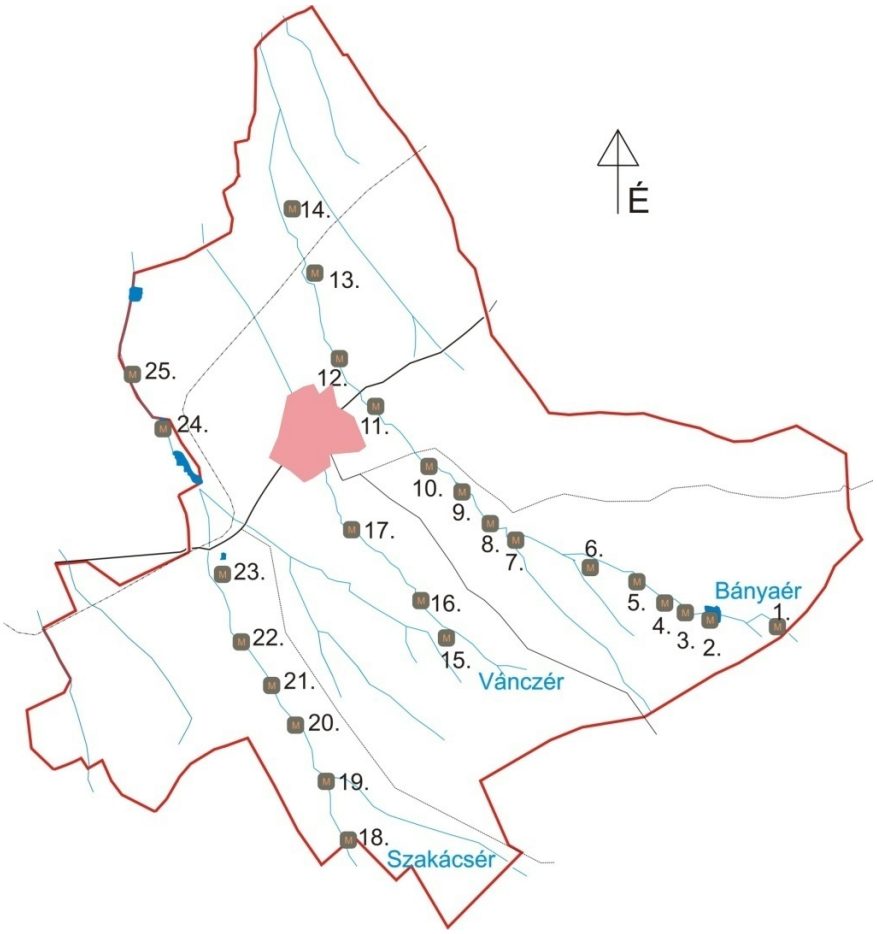


**Figure 13. Pápateszér water mills (Fülöp 2010)**

We examined the existing functions of the buildings to see how they can be used in the greenway.

| Number | Water Mill | Function |
|---|---|---|
| 1 | Halász-malom | Ruined |
| 2 | Fekete Mihály malma I. | Ruined |
| 3 | Fekete Orbán malma | Ruined |
| 4 | Fekete Mihály malma II. | Ruined |
| 5 | Horváth-malom | Ruined |
| 6 | Schulman-malom | Use as energy resource for the owner |
| 7 | Kuty József malma | Ruined |
| 8 | Zacsovics-malom I | Ruined |
| 9 | Kurics-malom | Inhabited |
| 10 | Kapcsándi-malom I. | Ruined |
| 11 | Gergely-malom | Ruined |
| 12 | Ledó-malom | Ruined |
| 13 | Bucs Kálmán malma | Ruined |
| 14 | Nikodém-malom | Ruined |
| 15 | Bögi-malom I. | Ruined |
| 16 | Bögi-malom II. | Ruined |
| 17 | Dobos-malom | Ruined, but the lake existing |
| 18 | Izsa-malom | Ruined |
| 19 | Eigner-malom I. | Ruined |
| 20 | Zacsovics-malom II. | Ruined |
| 21 | Fölber-malom | Ruined |
| 22 | Kutasi-malom | Ruined |
| 23 | Eigner-malom II. | Ruined |
| 24 | Kurali-malom | Ruined, bu the ruin still is in a good condition to visit |
| 25 | Kapcsándi-malom II. | Ruined |

**Table 3. Water mills of Pápateszér**

Most of the water mills are ruined in Pápateszér, however some still worth visiting: Dobos-malom which preserves the effect of water mills on the landscape. Another example is Kurali-malom, where the visitors can see the structure

of the mill. Schulman-malom could be an important step of a greenway, because the mill was developed by the owner of the mill. Some elements are missing; we saw above that water mills have gotten new functions, like hotels, restaurants or museums. In this area, the possibility is there, because even though most of the buildings are ruined, they still can be renewed.

**Discussion and Conclusion**

Water mills are a great landscape feature to include for sustainable design and greenway planning. We can give new function for the buildings, but also use the original function. It is important that there are water mills which are used in a sustainable way to produce energy. However, a lot of water mills are ruined, as 98% of water mills have disappeared, making it more important to protect the existing ones. They could be a solution for renewable energy production, and the size of the mill cannot cause any bigger problem in landscape. As we can define regions according to water courses, water mills give a great opportunity to organise greenways as tourist attractions or hydropower plants.

This study shows that starting a research project can give you a unique and surprising result. We started by investigating how water can be used as an energy resource in Hungary. At the end, we found out that water mills provide a great opportunity for greenway planning. Also, it is important to note that other landscape elements can organise greenways. TÉKA gives a very good resource to plan greenways in Hungary.

**References**


Ahern, Jack 2002 Greenways as Strategic Greenway Planning: Theory and Application Wageningen University, The Netherlands. p. 42

Behari, P.C., Bhardwaj, A.K. 2014 A Case Study of Improved Watermill Using Power Electronics Devices for Offgrid Power Generation. Research Journal of Applied Sciences, Engineering and Technology pp. 417-423

Csemez, Attila 1996 Tájtervezés-Tájrendezés. Budapest pp. 269-290.

Fülöp, György 2010 Pápateszér település fejlesztésének elindítása. Budapesti Corvinus Egyetem.

Kádár, Péter 2010 A vízimalmoktól a vízerőművekig. Budapest

Lejon, Egil 1994 Gabčíkovo-Nagymaros: Old and New Sins.

Lewis, M. J. T. Millstone and Hammer: the origins of water power 1997. University of Hull Press

Moran, Emilio F., Lopez, Maria Claudia, Moore, Nathan, Müller, Norbert and Hyndman, David W. 2018 Sustainable hydropower in the 21st century. PNAS, pp.11891-11898

Renewables 2018 Market Analysis and Forecast from 2018 to 2023 International Energy Agency

Rynne, Colin 2015 The Technical Development of the Horizontal Water-Wheel in the First Millennium ad: Some Recent Archaeological Insights from Ireland. The International Journal for the History of Engineering & Technology, pp. 70-93.

Vitruvius, Marcus Pollio 2009 Tíz könyv az építészetről. Szeged

World Energy Council 2016 Hydropower. p.12

Magyar Néprajzi Lexikon 1982. Budapest.

Pongrácz, Pál 1967 Régi malomépítészet. Budapest, pp. 57-84**.**

**Law, Agreement, Rule**

Nature Conservation Law 1996. Hungary

Paris Agreement of United Nations 2016.

Természetvédelem. Egyedi tájértékek kataszterezése. 2009. MSZ 20381

**Websites**

Molinos Nuevos (Museo Hidraulico) in Murcia, Spain. http://www.waterhistory.org/histories/murcia/ accessed February 4. 2019.

TÉKA http://tajertektar.hu/ accessed February 4. 2019.

**Historical Maps**

First Military Survey 1782-85. Hungary.

Military Survey Hungary 1941.