LOCALITY

AND THE

ENERGY RESOURCES

Edited by
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Acknowledgement

The editors, authors and all the other helping hands dedicate this book to the 60-year-old Klára Bank; as an acknowledgement in respect, honour and virtue of her invaluable work. We thank her for having been improving the field of Geography of Energy in the past decades and for motivating and supporting upcoming generations to gain competitive and recognisable knowledge in Earth Sciences.

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Publisher's Preface

Frugeo Geography Research Initiative defines its most essential field of research in the exploration of local values and directs a spotlight on reviewing their discovery of environmental impacts on, for example, habitats or physical and human communities. As a representation of our support to science, a serial publication—namely *Geographical Locality Studies*—has been brought to existence and this first issued number is titled *Locality and the Energy Resources*. It is an initiative and a step forward that carries out researches in our closest milieu, and it scientifically, yet comprehensively presents their geographical background. The purpose of the studies is, on the one hand, the meticulous cognition of and the familiarisation with the mankind's treasures; on the other hand, it is also a global publication with the purpose of having improvably efficient and essential knowledge of the physical, social and economic world that could be sustainably turned in every earthling's favour.

The spine of this first issue is made up by the energy resources which are the most important composite elements of the natural and, of course, the human spheres and their systems. Most types of the energy resources—in accordance with the scale of their utilisation—are renewing in a very slow period of time; however, our society is getting more and more addicted to a variety of electric equipment which demand higher and higher amount of energy. They, therefore, cause dependency in the population's life and palpable disorders in the environment, as well.

We believe that a happy life or a successful social integration is based on five pillars: locality, efficiency, sustainability, co-operation and independency. These terms are tightly wreathed and they strongly correlate with each other. By our articles, we aim to experiment by presenting locally achievable methods and solutions which can also be used anywhere else on the planet, or, at least, the ideas can be transplanted or adapted, or they can give birth to foundations for newer, more efficient and revolutionary techniques, technologies and developments. In the modern world, we cannot talk about total independency (we might not even need or want it), but we can achieve a sufficient state by seeing only simplicity and tangibility in everything that surrounds us.

This book and the foundation of the series, we can say, are already a success story which would have never come to life without the mutual effort of the editors and authors. Even the knowing can make us pleased that we have had the chance to work with well-known and acclaimed Hungarian researchers, and hopefully, by this publication, we can spread and strengthen their names and researches in the international ring of geographical sciences. This present co-operation, however, is not only an academic gathering to bring recognition to ourselves, but also to surprise one of our special friends: *Klára Bank*—a professor at the University of Pécs, Institute of Geography—who reached her 60^{th} birthday this February. By this book, we would like to erect a simple but long-lasting memory.

In the name of all our respectable colleagues, we wish a happy birthday to the professor and we hope you, dear reader, will find the following pages worth treading.

Shrewsbury–Pécs, 18 June 2013

László Bokor – János Csapó

Locality – Consumption – Innovation – Energy Efficiency

(By Way of Introduction)

The reader has an unconventional and unusual collection of studies in hand. Similar books previously published as acknowledgments—because of the authors' different areas of interest—were very diverse. Beyond that, the authors of the present publication try to shed light on topics which are useful in everyday practice. The subjects correlate to one concept, particularly connected to the research field of a celebrated person.

The relevance of this field of research in the new millennium is quite obvious, since we have to confront a number of strategic challenges, among which healthy food, clean drinking water and sustainable energy supply are the most important ones. In the energy sector, the next period will be the age of structural and paradigm shift on both the demand and the supply sides. Even today, many people live in the delusion of cheap and infinite supply of energy, but the current consumption patterns are not going to be sustainable in the future. In order to ensure our own and the forthcoming generations' needs, and also to maintain a liveable environment, a swift change of attitude in the energy field is imperative. The performance of the economy, social issues, investor confidence and social well-being also depends on the energy that is safely accessible and affordable. Therefore, one of the major challenges for our future is to address the energy-related issues.

There is no doubt about the actuality of the topic; the *European Union* has developed the *Europe 2020 Strategy* for the ambitious purpose to find a solution to the economic recovery and, at the same time, for future challenges. This also means that the growth should be socially inclusive and above all, more sustainable. Simultaneously, National Energy Strategy has been adopted which formulates the new energy development trends by outlining the Hungarian energy vision.

This is the energy strategy that has undertaken the 13 per cent increase of the share of renewable sources in *Hungary* in the last ten years and the establishment about 160 megawatts of electricity generating facilities from geothermal sources. However, this would require a number of improvements in *Hungary*, so it depends on the financial and technological support, as well. A good example for this is *Germany*, which compared to *Hungary*, receives almost twice as much support when it comes to geothermal energy; while the cost of the investment is not as high as we experienced. Moreover, *Hungary* has the best natural conditions in the area with no volcanic activity beneath the surface. Although, extremely costly methods are often involved; their competitiveness should be compared to other renewable sources. Beyond the low efficiency of operation, the utilisation of the so-called 'waste heat' generated during the production of electricity may not be neglected. Sooner or later, a significant number of investors appear in geothermal energy exploitation.

This is the strategy that has led the *European Union* and *Hungary* to co-finance the industrial-scale wind energy projects. This is typical of the doubts surrounding this issue that the *Hungarian* and also the *European Wind Energy Associations* organised a conference in 2011 titled *"Wind Energy in Hungary: full halt or a promising decade?"* However, *Hungary's* natural endowments are less suitable for the profitable operation of wind power plants; they did this in order to utilise the potential of wind energy and not to fall out of the *EU* subsidies because of the slow decisions and debates.

In the success of such strategies mentioned above, locality, mainly cities should undertake an emphasised role to achieve the targets. Highlighting locality has a number of reasons. It is obvious that because of different circumstances and conditions, different techniques mean the economical and practical solutions from region to region. However, this approach highlighted the role of cities—as the key centres to economic development and innovation—which are unique opportunities for the environmentally friendly and socially inclusive growth. In addition, we must find a solution for the issue of social exclusion in the cities; they are in urban areas where the greatest energy saving potential can be found. So the cities are engines of a conscious economic development.

Investments in the energy-efficient urban infrastructure create a thriving business and attract more people to the labour market. The higher levels of employment can help overcome the income-dependent and energy-wasting habits of consumers and provide the financial resources for the new, climate-proof growth. Thus, the cities represent both a challenge and a solution to climate change. A challenge, because the energy demand of the world's cities gives two-thirds of the total energy consumption, but also a solution, since, due to the dense urban network and compactness, cities have the opportunity to operate in an intensely energy-efficient manner. At the same time, the city is the first point of contact between citizens and public administration; the local actions are tangible and highly perceivable to the civilians—in this position local empowerment and confidence are indispensable. So the cities are not only the centres of consumption but also that of innovation.

However, a significant proportion of the alternative energy sources—through their rural development effect—can be connected to the areas located farther from the major cities. Through the retention of existing jobs or creation of new jobs, the appearance of new agricultural distribution channels, local taxes and plants settled in the countryside could increase local government revenues and facilitate the realisation of further developments. Local energy production which, therefore, can provide extra income for disadvantaged areas—through the creation of more liveable environment and indirect unemployment reduction—can also retain a population effect.

The present publication attempts to provide a starting point for those who are open to heed the recommendations and add their own experiences to it. However, the main target audience are the professionals and local communities active in the cities' management and urban or regional planning, leaders and decision-makers, officials managing processes, and professionals supporting their work. In fact, it is recommended to all those who are involved in the development of local, regional or sectoral planning, development of policies, implementations and professional preparation, and education at national or European level. Instead of permanent reference to the lack of funds, understanding approaches different from ours (even Asian) described in the book can be exemplary and strongly recommended for consideration, which may contribute to the practical and cost-effective management of problems and the change of attitude. We understand that the knowledge connected to the importance of energy awareness is expanding almost day-to-day. That is why we encourage all readers of this issue to adapt the information described here to the conditions of his/her own locality, complete it and contribute to the construction of this growing knowledge. We are asking them to use and propagate this knowledge, to explain the described information in this publication to others, to consider these guidelines and initiate further discussions at local and national levels.

Pécs, 18 June 2013

Róbert Tésits
Senior Lecturer, University of Pécs, Hungary

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The Energy Resources and Their Importance in the Local Environment

Abstract

This paper deals with the naturally occurring energy sources; introduces their physics and basics, accurately defines their terms and types, and assorts them into groups. It explains their importance in human history, reflects on their communal impacts of, e.g. settlement establishment and development, industrialisation and the formation of modern societies along with their consequences. It also shows methods and possible way-outs of their tight dependency and highlights the importance of locality and the possible co-operation in a widely globalised world.

Key words

Associative definitions of energy; Sustainability; Newly built settlements; Energy efficiency; Waste reduction; Local stability; Global integrity

„Most people spend more time and energy going around problems than in trying to solve them."

Henry Ford (1863–1947)

Introduction

It is, obviously, an interesting coincidence, yet a bit controversial and ironic that the introductory quote for this geographical serial publication's first study has been borrowed from that *Henry Ford*, who himself had significantly contributed to the emergence and development of the globalist perspective and its tightly associating 20th century's modern manufacturing sector. Its arrival onto the place of this study's introduction, of course, has no certain connections with the personal nature of the captains of industry; it, however, is increasingly mediated by its underlying message content, reflecting on the human way of *energy squandering* on all imaginable levels. In spite of that, it must be stressed that globalisation is not inherently wrong, but the local importance of global value of significance is being completely homogenised by many of today's political concepts of the social world and to top it off, the inhabitants—who live in and form these human systems—are made dependent from external and also unsustainable factors, therefore their local values could permanently be damaged.

Besides this, today's social complexity does not only have its weighty role in the global degradation of natural environment, but it also objectifies the humane values and all of its expressions by money are the benefit of a poorly structured globalisation. Moreover, one of its negative achievements is the individualistic lifestyle, which of its inorganic emotional spreading frequently results in making the weight of local spaces and their potentials unnoticeable. The modern man believes that one can live fully and independently solely, and that for its development, in addition, energy must be invested in exceeding their own capacity (even the working conditions expect this from them). Therefore, it is more likely that wrong and unsustainable decisions are born within an incohesive community which will eventually weaken all of the present social spheres even further.

This present study is not going to venture in making opinions on the negative impacts of globalisation on the social sphere; on the contrary, it is going to discuss the physical and human systems' basis-forming energy resources to make understand their nature, origins, natural connections and importance of utilisation in local dimensions, in accordance with the social sphere. After having clarified the definitions, the spotlight will be directed on, specifically, the energy resources to highlight their importance in mankind's social structure throughout its history. The aim of this study is to help understand the geographical energy systems in public interpretations and hence to present the tightening connections between the physical and human, and also the local and global spheres.

1. The bases in a nut-shell

Today's socialised man may doubt the otherwise obvious fact that human itself is part of nature, because most of the *Earth's* advanced-called societies already live in an artificially developed milieu where nature only has a subordinate role and the positive feedbacks are being cut down (HAJNAL, K. 2010). Human life is filled with, among other (mostly unnecessary) things, strange rules and laws, much paperwork, artificial and genetically modified foods, chemistry substances, and medicines. The natural contacts are being more increasingly weakened and almost everything that this world consists of can only be measured by money (e.g. GDP, GNP) (BOKOR, L. – SZELESI, T. 2011). Thus, for the social developments and their preservation, undoubtedly, the *Earth's* surface's naturally occurring processes (whether in a negative or a positive sense) play key roles. In the absence of nature and its given 'goods', the technological progression of currently on the highly-developed level of human societies would not have been possible.

At the dawn of humanity, most importantly, natural processes, physical interactions and earthly laws had fostered a rock-hard-long-standing relationship between humanity and nature. Man used only locally accessible and technically easily exploitable energy resources, for example solar energy and its closely related associates, such as wind energy, hydro energy and also—in accordance with the early harnessing purposes of biomass—a variety of timber produces were used straight for production (Solomon, B. D. 2010). However, the natural degradation of these resources, i.e. their recirculation into the physical systems, was also positive; there was no accumulation of useless by-products, waste or scrap. The manufactured goods served local interests; therefore, the demand supported life-sustainment.

By the beginning of the 18^{th} century, because of the impacts of the *Industrial Revolution*, the wide expansion of factorial use of coal resources, and also the results of the technical–technological development, a change had begun on a larger scale than ever before. This dominant type of fossil fuel (coal) resource, in almost all areas, directly or indirectly showed its impacts and contributed to the sweeping of electricity and its energetic utilisation (Daemen, J. J. K. 2009). However, this had also transformed the ways of energy devouring and its consumption structure which has established the most sensitive basis and structure of the present social world.

Fossil fuels are also naturally occurring and basically "renewables" (but in a much longer period of time). However, their continuous availability and exploitability—along with their current rate of consumption—is not constant and all of their uses have become a more widespread issue on environmental levels (e.g. global warming and climatic changes [Henson, R. 2008]). In fact, in the last several decades human has "rediscovered" the physical sphere's constantly and continuously available energy resources and, at present, is increasingly integrating them into their daily lives. According to the above mentioned facts, we are now going to discuss the logical system of energy resources—try to establish new aspects of their classifications and fulfil their definitions with new contents—starting with the *energy* itself which is not as simple as our regular wordy use would indicate …

2. Energy, energy bearer, energy source and energy carrier

In the title of this section, there have been words mentioned that are terms which we often encounter in a variety of media feeds. We are, more or less, aware of their meanings and it is also easy to realise that they are integrated parts of our lives. However, we seldom bother with nuances in their meanings and with the differences in their contents; but their distinguishing is important, especially, if they are checked from the point of view of geography. Whilst the majority of human beings can describe energy with an acceptable intellectual content, the differentiation between *energy bearer*, *energy sources* and *energy carrier* can hardly be understood, and they are often treated—also by experts—with synonymous meanings. Obviously, this does not mean that the terms' synonymous concept would raise doubts; however, their definitions can be fine-tuned, because synonyms do not always give the same meaning to different words and terms, which could easily result in misunderstandings (Bokor, L. 2010).

2.1. Energy

Everything that exists in our *Universe* is composed of either *matter* or *energy*. The co-operation of these two is essential, because energy is what makes matter change through time, which causes the shaping processes of our *Planet* (Strahler, A. H. – Strahler, A. N. 2002).

The term *energy* was first used by the 17th century's iconic astronomers, mathematicians, philosophers and physicists such as *Johannes Kepler*, *Sir Isaac Newton* or *Gottfried Wilhelm Leibniz*. However, it was first formally used as a technical term in modern interpretations in 1807 by *Thomas Young* (Crease, R. P. 2009). Contemporary physicists state that *energy* is one of the most common and basic science concepts (Bonifert, D. 1993) which, in a special sense, means the ability to do work (Breuer, H. 2002; Litz, J. 2005). It, in general terms, represents an opportunity for change because *the second law of thermodynamics* limits the work of thermal processes (Bonifert, D. 1993). Accordingly, it is not easy to define energy (it is not even our goal), but whatever it is, it seems to move with or within forms of matter (Strahler, A. H. – Strahler, A. N. 2002).

The energy is nothing more than stored "work or force" which is rereleased under appropriate conditions (Gulyás, J. *et al.* 1995). This appears in different forms, such as *thermal*, *electric*, *nuclear* and *mechanical* (Breuer, H. 2002). The forms of energy may be divided into three main groups: *kinetic energy, potential energy* and *chemical energy* (Strahler, A. H. – Strahler, A. N. 2002). The forms of energy may be traced back to one of the four *fundamental interactions of physics* (fundamental forces/interactive forces). The known fundamental interactions are: *gravitation*, *electromagnetism*, *strong nuclear* and *weak nuclear* (Holics, L. 2009).

2.2. Energy bearer and energy source

The *energy* itself is invisible, rather than a factual, objectified material. This is typically transmitted by the *energy source*. However, this is already a more evident material that is always a source of energy stored in a characteristic *energy bearer*. This latter principle may be anything, as everything is abundant in stored energy (so-called *subatomic energy*) that can be handled or seen (Eddington, A. 1935). From the point of view of, and in the earthly dimensions of our geographical approach, *Earth*, in this sense, is one of the biggest energy bearers. It bears different types of energy sources that may be objectified in materials (e.g. hard coal), or in the direct or indirect results of physical processes and phenomena that cannot be detected with a naked eye (e.g. wind). Its nature and manifestation vary by *geographic dimensions*, i.e. most of the energy bearers can conclude in the existence of more energy bearers. This *spherical structure* may include the whole lithosphere or a single mountain range that bears various *energy sources*. There can—for the modern society's needs and use—be *thermal energy* or *electric energy* transformed from *(Figure 1)*.

2.3. Energy carrier

The principal difference between the energy bearer and the energy source is that the source can be exploited for its electric power and thermal unit, but the energy bearer does not function as a source. The *energy carrier* is, according to *ISO 13600*, either a substance (energy form) or a phenomenon (energy system) that can be used to produce mechanical work or heat, or to operate chemical or physical processes (ISO, 2007). The energy carrier is a product that can be directly used in demand of energy, for example batteries, petrol.

Sometimes, it is very difficult to see the differences among the bearer, the source and the carrier. To make their terms clearly understandable, our approach has to be simplified: in this sense, the bearer is, for example, a mountain where the source (e.g. black coal) may be found; and the carrier is, for example, the electricity itself that is transformed (produced) from the source and is either directly used (for lighting homes) or stored for further use in a particular device (e.g. battery) *(Figure 1)*.

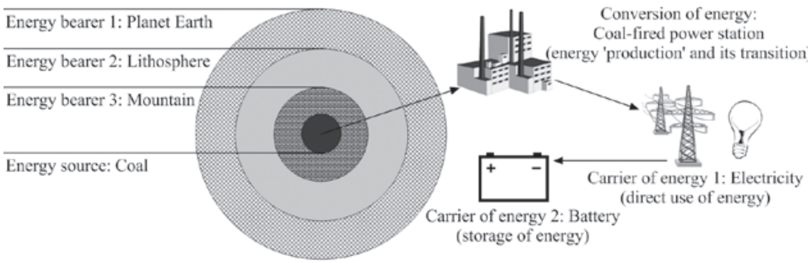

Figure 1 – A simplified example of the spherical structure of the energy Resources
Edited by BOKOR, L. (2013)

According to the above broadly explained terms and also to the clarification of physics along with the *law of conservation of energy*, the *energy in no processes can be created or destroyed; it can only be transformed from one form to another* (GAZDA, I. – SAIN, M. 1989; HUBER, T. M. 2010). The total amount of energy in a closed system remains constant over time. Within the system, energy can change its location and it can change its forms, as well. The system energy may be exchanged with the system's surroundings (BONIFERT, D. 1993).

In an open system—like the planet where we live or even our body—we can experience a so-called *wastage of energy* where the energy is transformed into an economically useless form. The process is also known as *Rudolph Clausius*'s term of *entropy*. In this sense, when a piece of coal is burnt, it will have no energy left to be exploited for human energetic purposes. The employed materials can be converted into different forms of energy to obtain electricity or heat, but the available amount of many of the *Earth's* materialistic energy resources is limited. The whole process may be drawn as a flow system in which matter, energy or both move through time from one location to another (STRAHLER, A. H. – STRAHLER, A. N. 2002). In this interpretation, this is the so-called *energy flow system* (open, closed or isolated).

This clearly shows that the term *production* is by no means, because energy is certain in a pre-given material or vehicle that cannot be produced but it can be transformed into types of energy (e.g. electricity) that can be utilised in the human environment *(geographical sphere)*. This transformation can be achieved by technological equipment such as a coal-fired power station. Therefore, terms as "production" could be dispensed with a general sense. However, the word "production" is strongly associated with the human *economic sphere* where energy development has principal importance, thus, the terms *energy production* and *consumption* are used to describe a series of social activities (e.g. transportation, heating and ventilation).

The electric and thermal energy are obtained by the conversion of specific materials or by harnessing the types of physical phenomenon. This specific thing is the so-called energy resource which types can be placed into three groups: *non-renewables* (non-constants), *renewables* (constants) and—considering the creation of a new group between the previous two that we are now going to mention for the first time and name it as—*sensitively renewables* or shortly *sensitives* (or semi-constants) *(Figure 2)*.

According to the ways of consumption, the energy sources can be:

a. *primary* (they can be used directly without modification, for example: black coal);
b. *secondary* (they are converted from primary sources, e.g. electricity from black coal generated by a power station. Having referred to *ISO 13600*, these are the so-called energy carriers);

c. *tertiary* (normally a "waste of energy" that comes to existence as a by-product of the secondary energy source, e.g. thermal pollution).

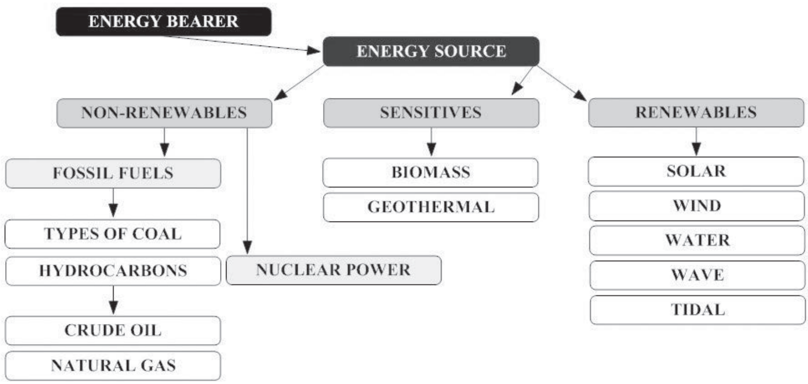

Figure 2 – The structure of energy resources
Edited by BOKOR, L. (2013)

3. The very first energy resources of humanity

The human's first source of energy was its own *muscle power* which was later complemented by those of the animals—e.g. *horse* or *bull power* (SOLOMON, B. D. 2010). However, in order for a living organism to be able to use its own power, a very important *external energy source* is required: according to historical information, human, who at the dawn of its evolution conducted fishing, hunting and berry gathering activities, found its first energy source in the form of *food* (VAN GINKEL, A. 1999). For living organisms, the energy for life is the process called *energy intake* which is operated by the *aerobic respiration* (respiration of glucose) (BECKETT, B. S. 1986) and can be clearly understood by the open flow system of energy. The energy of food for life, like most of the *Earth's* energy resources, originates from the *Sun* (STRAHLER, A. H. – STRAHLER, A. N. 2002). At this stage of energy utilisation, a link already appears among food, muscle power and also the *Sun*. This was accelerated by the discovery of *fire* (the most common chemical reaction in nature) which changed the human's habits in its roots. The custody of fire brought serious challenges into human life which, in all probability, contributed to the development of the first human settlements. If the fire guarding facilitated the establishment of the first settlements, it was also necessary that those settlings must have had a protective location (environmental factors) where the significant energy resources (e.g. water, wood, berries), for the human living, were also provided by nature. These are the so-called *local energies*. These settlements were mostly created in different landscapes that had a decisive encounter, e.g. mountain/hill meeting with alluvial plain/river or all of them together, and had a great influence on the development of agriculture (HAJNAL, K. 2010). Consequently, the settlements were mostly established on sites where the differently strengthened *locus* formed energy centres *(potential of energies),* and where these vital resources were given. This evolutionary progression also affected the development of settlements and the natural sphere had been transmitted into a *geographical sphere*.

4. Locality and the Energy Resources

The *geographical sphere* emerged from the encounter of the *natural* and *human spheres*. The latter is now independently shown as *social sphere*. The two are separated from each other, although it is very difficult to draw a line between them. Having set our focus on locality only, we can, more or less, talk about *geographical spheres* in plural. The society itself is also integrated into these spheres which of its most important basis components are, undoubtedly, the *energy resources,* and their day-to-day role show a greater significance in the survival of the currently advanced forms of societies (JUHÁSZ, Á. 2009).

While the natural sphere is an efficient and self-sustaining mechanism, the human sphere is increasingly moving away from nature and it tries to operate independently by adopting special rules, and attempts to exclude nature from this mechanism (HAJNAL, K. 2010). This also means that the inherent bond between the physical and the social spheres is being increasingly cut down. Therefore, a stable, effective and sustainable mechanism is tipping over for an unstable, inefficient and unsustainable state. Within this sphere, according to the needs of human society, today there is hardly any tool which, in some ways, is not in association with electricity. The buildings where we dwell, the vehicles that we drive, but in smaller dimensions mobile phones, laptops, GPSs and the recently expanding market of electric books and even electric cigarettes (!) are just few examples of the highly demanding devices of electricity in our spheres. To use these kits and gadgets, our world constantly requires the availability of electricity that must be continuously obtained from somewhere and from, somewhat, a specific source of material. In this context, a sustainable social milieu is unimaginable without the presence and usage of energy resources and this, most importantly, is the reason for our dependency in a de-facto dependent and limited natural/physical system.

In the recent centuries, the formation of industrial locations—primarily in connection with the conventional energy resources (e.g. coal and hydrocarbons)—initially at a local level, thereafter at a relatively wider area, have affected not only the local settlements but have also had their impacts on the development of vast regions. This type of energy production—based on trade (export and import) that reaches immense distances—has transformed many countries of our planet into "high-standard" communities. Nonetheless, the social-shaping processes of the 20th century, such as the boom in population growth and technical revolution, have had even worse impacts on those regions where the world economic production and competition were not guaranteed without the local presence of energy resources. Even though an area has significant local resources and reserves, it can hardly compete with cheap and concurrent types which results in import energy dependency (or sensitivity) and/or leads to the devaluation of a region. The consequences of this dependency mean constant import which makes the country's products expensive in the world market, and these are the countries of the planet which are the most vulnerable by the periodical economic or energy crises of the social milieu. These are the countries and regions where the life has become or can become difficult in the near future. These differences, of course, may show even worse distinction within a state's social sphere, too.

In the availability of conventionally utilised fossil energy resources, the importance of locality remains significant but their demand reaches global dimensions which can be seen in the developed countries like *Japan*. The latter forms one of the most important pillars of the world's economic centres. However, being in the central vein of this system's circulation without being noteworthy locally, it is not capable of exploiting usable resources to keep their industry or economy independent. In this case, there are no other possibilities but import; however, the conventional energy sources, regarding their extremely slow renewing period, are not suitable to keep up sustainable growth in a limited environment and physical sphere (HAJNAL, K. 2010).

It is then not surprising that, because of this sensitivity in energy demand and supply, the locality's role has been steadily increasing and the *renewable*, *sensitive* and *alternative energy resources* are highlighted in this context even more than ever before. The truth of the latter sentence is most valid for those countries which are protected and secured by archaically structured high-standard societies (e.g. most of *Europe's* countries) and are seeking alternatives, or in those regions which lack fossil fuels but could achieve astonishing development by setting their basis on local—especially renewable or sustainably maintained sensitive—resources (e.g. *Japan*).

5. Conclusion

The achievement in modernisation of the present world's energy consumption, locality and decentralisation should be given wider authority. This, of course, means that to bring off an efficient and secure energy production, the whole energy system must be installed on diversity formed by the variety of resources that are naturally occurring and given in a specific area of the natural sphere. The local demands, industry and economy, however, must be shaped by these natural resources that could then be integrated into the g*lobal sphere* as a working mechanism where co-operation has a major importance.

On *Earth*, there are still regions in existence that those basis of energy producing systems are fully (100%) established on only one source of energy; although, it requires another approach and angle to observe whether this resource makes the country dependent or independent. In the case of the electricity 'production' of *Bhutan*, this means exactly 100%, locally-sourced hydro energy which exceeds its own demands, so the country has enough potential to export electricity to the neighbouring *India* (Bokor, L. – Szelesi, T. 2011). In the opposite case, *Malta* and *Cyprus* are two extreme examples of those where the current fragile structures of economy are due to the majorly imported resources which make these countries fully dependent to the outer world. In *Bhutan*, there are even initiatives to exploit local renewable energy resources (such as wind and solar) approached by holistic methods (Pauli, G. 2010) but opposite to this fully independent country, there can hardly be seen a good example for local progressions in *Malta* or *Cyprus* which already has an effect on a wider European energetic instability, dependency and, therefore, vulnerability.

If—within a circle of cohesive society—the energy production were established on a multi-sourced basis and everything were locally used and integrated into this, and these sources were utilised by state-of-the-art equipment (importance of *high technology* must be highlighted) that were efficiently obtained in connection with the reduction of unnecessary wastage regarding sustainability, then a nearly independent state could be achieved within a flexible and complex community. By this system, a locally-based and stable circumstance could be granted that would also give the opportunity to widen the natural co-operation among the other localities. These local strategic points could, altogether, be integrated into a wider system and linked to other systems which could all contribute to the creation of a successfully sustainable global network that could help reduce or completely wipe out the unnecessary dependency *(Figure 3)*. In this context, by borderless, logical and responsible co-operation, the global connections would appear as *cohesive power points*. There are already similar examples for this sort of system that can be found in the co-operating networks of *eco-*

villages. Without working together every step that human tried to take forward, it would be sentenced to death. PAULI, G. (1998) describes this importance also as an example that arises to represent this positive energy flow: *"In nature, bacteria, enzymes, mushrooms, earthworms, insects, birds, bees, bats, rodents, deer, bushes, and trees—just to take a dozen living species in the forest—all depend on each other. It is only by co-operating in a tightly knit fashion that they have a chance of surviving, an opportunity to develop and generate an ever-improving system in which all evolve."*

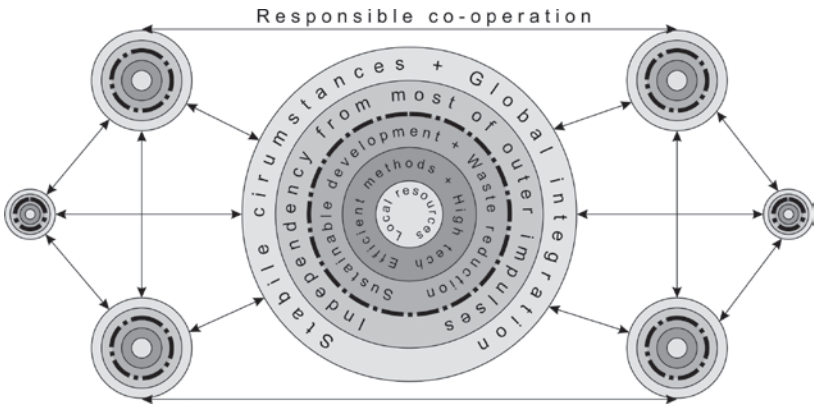

Figure 3 – The structure of a sustainable entity
Edited by BOKOR, L. (2013)

The creation of the system mentioned in the previous sentences is not impossible, however, at the moment, it may seem to be a utopian venture, because the majority of regions, micro-regions and their settlements (especially monster cities and their satellite settlements), and in the present vulnerable and instable social sphere, are being based on archaic and obsolete systems. Their, sometimes, overgrown collective population does not allow any reformer change or straightforward transformation to the local resources. Accordingly, this reflects on sensitive structural problems of the old settlements, which require complete transformation or even withdrawal and rebuilding from their roots by adapting new reforms in the traditional architecture and also in settlement planning for the sake of sustainability.

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The Importance of Holistic Approach in Energy Planning

Abstract

The challenges of energy management and planning are considered as technical and economic problems by the society including decision makers and engineers. This approach has proven to be insufficient globally. Therefore, in some European countries essential changes are afoot. In these procedures, they involve even several other disciplines (e.g. social sciences). Hungary is a conservative country in this regard. However, creating alternative energy strategies (Mathiesen, B. V. et al. [2009]; Kemp, M. [2010]; Munkácsy, B. [2011]) would be an important task to draw attention to, especially when it comes to the indefensibility of outdated methods. In this paper, some explanations and examples about the new approach will be shown and demonstrated.

Key words

Energetics; Holistic approaches; Non-technological principles; Well-being; Spatiality; Cross-sectoral interconnections

Introduction

Our time is the era of a global environmental crisis. The so-called developed civilisation has been proven to be underdeveloped from the point of view of its future. This problem can be described with considerable accuracy by the ecological footprint. According to this concept, the most significant problem is our extremely high carbon footprint which is connected to our fossil fuel based energy management (WACKERNAGEL, M. 2011). As the dominant economical paradigm, it does not take into account the environmental costs of this system; fossil fuel based technologies produce cheap energy with enormous environmental pressure. During the 20th century, our energy demand exceeded the potentials of fossil fuels; therefore, it seemed to be crucial to find alternative energy sources. The chosen nuclear energy has been also proven damaging in a very short time—considering not only the accidents but the whole life cycle of the technology. Taking it all round, our decisions on energy related topics will be made in the first decades of the 21st century which seems to be critical from the point of view of the next generations. It is high time to find sustainable solutions in this field and we must break away from the narrow-minded technological approach.

Results

The energy technology must be an integral part of the solution—for example as an instrument for improving efficiency—but it must not be the main issue in solving the energy problem. The holistic approach and changes in energy management require the involvement of other fields of engineering.

1. Technical aspects of energy planning – beyond the energy industry

Mining engineering, for example, has a traditional connection to energy management. In the future, due to the depletion of the stocks of fossil fuels and uranium ore (HUBBERT, M. K. 1956), this relationship will be more and more important. Collecting as much information as possible about the remaining stocks is indispensable for long term energy planning. In addition, the mining technology is also crucial, as it is an important factor of the most characteristic feature, called *Energy Returned on Energy Invested (EROEI)*. The problem we face now is that the overall *EROEI* figure is moving well down into single digits. It was around 100 in 1930, it had reached as low as 10 in some areas by 1990, while today that figure may approach 3 (Murphy, D. J. *et al.* 2011).

There are two other areas which have a long and traditional connection to energetics, namely *chemistry* and *physics*. Both disciplines have several direct branches to engineering, such as chemical engineering, nuclear engineering or thermodynamics engineering and so on. In a sustainable energy system, both chemistry and physics will keep their crucial roles, as these areas are connected to energy storage technologies which will have fundamental role in the future, due to the spreading of intermittent energy sources. Chemistry is more connected to electricity storage, for example in batteries or hydrogen storage solutions in chemical bonds. The significance of physics might be more outstanding, as it will have a more general influence on electricity and heat storage and transportation. Moreover, it will play an important role in the development of renewable energy technologies—mainly ambient heat, solar and wind energy. Getting a deeper insight into these disciplines would help understand the real possibilities in sustainable energy management.

Materials science, which also has a clear relationship with the above mentioned branches of knowledge, can provide information about the embodied energy of different products, for example that of buildings. There are great variations of construction materials all with different levels of embodied energy, but it is a fact that this kind of energy usage can be massively significant. Sixty studies of different buildings have been performed (Bribián, I. Z. *et al.* 2011) and found that the proportion of the embodied energy (in materials used and life cycle assessed) varied between 9% and 46% of the overall energy used over the building's lifetime when dealing with low energy consumption buildings, and between 2% and 38% in conventional buildings. These wide ranges in results are due to the variety of buildings, materials, the lifetime considered, and the geographic and climatic conditions. It is important to notice that in extreme cases the embodied energy can be almost the same amount as all the other energy usages throughout the lifetime. According to BRIBIÁN, I. Z. *et al.* (2011), as a general figure for the embodied energy of an average building area there may be used 1,600 kWh/m^2. This value is almost the same as the average yearly per capita electricity consumption of households in 2010 in the *EU27* (EEA, 2012). In other words, the embodied energy content of a 100 m^2 flat uses the same amount of energy as the per capita household electricity consumption during 100 years. The embodied energy of a car is estimated to be around 70–75,000 kWh per car (PARIKH, Y. *et al.* 1995; MACKAY, J. C. D. 2009)—which is comparable to ~45 years of energy consumption of an average *EU* citizen. Sadly, buildings and cars are just two out of our thousands of equipment and devices. Therefore, it is crucial to recognise the importance of resource efficiency from the energy consumption's point of view *(Figure 1)*.

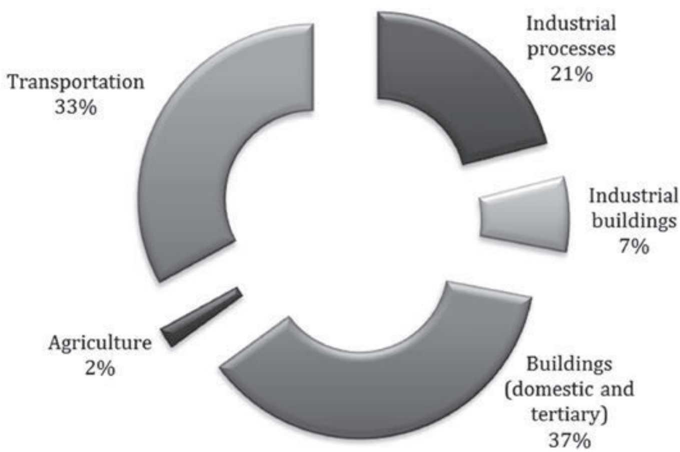

Figure 1 – Share of total energy consumption of the European Union

Source: EUROPEAN UNION 2010; Edited by BOKOR, L. (2013)

The role of *Architectural Science* is going to be more and more appreciated from the point of view of energy, as operating energy of our buildings cover approximately 44% of the whole energy consumption of the *EU* (EU, 2010). This fact can be seen in the background of the adoption of *Energy Performance of Buildings Directive* in 2010. This document requires member states to ensure that all new buildings built will have become a so-called 'nearly zero-energy building' by 2021. This rapid action would be important because suboptimal solutions in the building sector have resulted in unnecessary energy consumption over the decades.

Agricultural and forest engineering are also essential partners of the state-of-the-art energy management. These days, the biomass produced by these sectors—both as residues and direct energy plants—are considered to be one of its main resources. These are especially suitable for the energy system as they can be converted into several forms of energy and fuels can be stored easily. It means that it is controllable. It can be adjusted to meet the demand, taken as a whole. It can solve the intermittency problems, like those associated with wind and solar energy. Therefore, it will be more and more important in the future. At the same time, we need to learn more about its potentials in order to operate our recent system and plan our future energy ones.

Waste management is also tightly connected to energy issues. For instance, organic waste can be converted into biogas and can be utilised in heat and electricity production as well as in transportation. Therefore, it is more and more important to evaluate the potentials of this resource and use as much biodegradable waste as we can. From agricultural waste, 60–300 kWh power and 100–400 kWh heat can be produced per ton—depending on the type of source and technology. There are also existing technologies for household solid waste utilisation based on the separation of organic components. Its ratio can be 30–60% depending on the type of the living environment and season. Therefore, the diversion of these components from the landfill sites could easily double their lifetimes. This process has a connection to agriculture or even to forestry, as the by-product of anaerobic digestion, the sludge, generally after a composting phase, can be used as fertiliser.

On the other hand, we need to recognise that incineration (which is one of the most widespread procedures in the field of waste management and which is known as an energy production technology) ultimately means a huge loss from the point of view of energy. By this way, we lose all of the embodied energy of the materials. The concept of incineration is against the basic rule of waste minimisation and resource efficiency (*Directive 2008/98/EC* on waste [Waste Framework Directive]), as the operation of incineration plants requires a huge amount of waste material—that is converted into air pollution and slag. In this context, it is surprising that several European countries (e.g. *Sweden*, *Denmark*, the *Netherlands* and the *United Kingdom*) already have an overcapacity in this field. Nonetheless, constructions of new facilities are in progress (JOFRA, S. M. 2013).

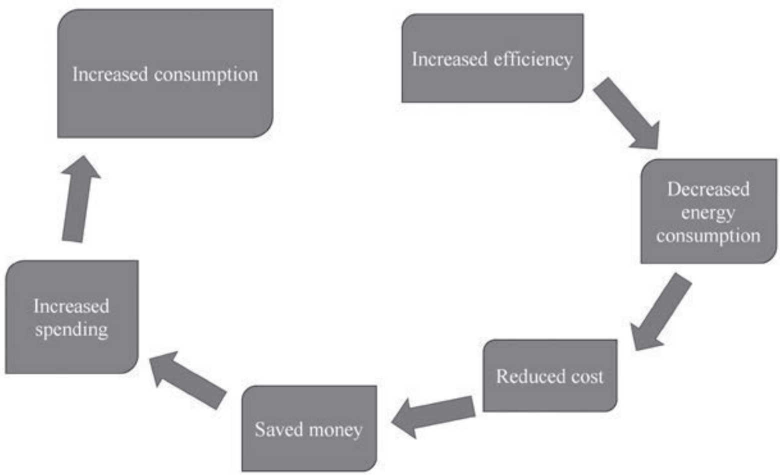

Figure 2 – Concept of rebound effect
Edited by MUNKÁCSY, B. (2013)

Water management is responsible for surveying and utilising the world's vast hydroelectricity potential. This area is particularly important, because the building and operation of hydropower stations—mostly the large facilities—can cause huge environmental burdens and social challenges. However, it can solve several problems of energy management. The most important advantage of this area is that it can contribute to the integration of other renewable energy applications, as the hydro energy can be controlled and stored easily. Due to these properties, hydroelectric power stations will be important elements of our future energy system *(Figure 2)*.

2. Non-technological factors of energy planning

There are several non-technological principles which already have serious impacts on energy planning. The most contradictory of them is *economic science*, as it has a detrimental effect on sustainability of the whole global system through:

a) belief in exponential economic growth (Boulding, K. E. 1966);

b) the unresolved problem of external costs of environmental pollution; and

c) incorrect evaluation of natural resources (Schumacher, E. F. 1973).

The above mentioned distortions result in a relatively low price of nuclear and fossil fuel based energies, which means a competitive disadvantage for renewable based energy and measures of efficiency. These discrepancies were recognised in the 1960–1970s; nonetheless, the economical mainstream has ignored them until today.

The other fundamental principle, which is already involved in energy planning, is *jurisprudence*. The legal regulation should have an important role in the energy transition, but decision making processes established on the aforesaid have distorted figures of economic calculations. This explains that legal regulation also appears as a drawback effect—see adversities of the *California Air Resources Board's Zero Emission Vehicle Mandate* in the 1990s (Dijk, M. *et al.* 2013) or the impossible battle against the increase of greenhouse gas emissions.

However, there are other unavoidable, *non-technological aspects* of energy management, as well; most of them being connected to the fact that energy services have been used by human beings. Their importance in energy planning is less recognised these days, but specialised studies have been dealing with their importance since the middle of the 19th century. According to *William Stanley Jevons* (1865), if there is an increase in efficiency in the use of a resource, its price can reduce leading to an increase of its consumption. Under certain circumstances, this phenomenon can actually increase the overall resource usage as opposed to reducing it. The *EU* financed and has just published a research on this *rebound effect* (MAXWELL, D. *et al.* 2011) *(Figure 3)*, concluding that the value of direct rebound effects for household energy efficiency is estimated in the range of 10–30% for developed countries. In commercial road transport, this value can be 30–80%, which highlights the importance of the human factor.

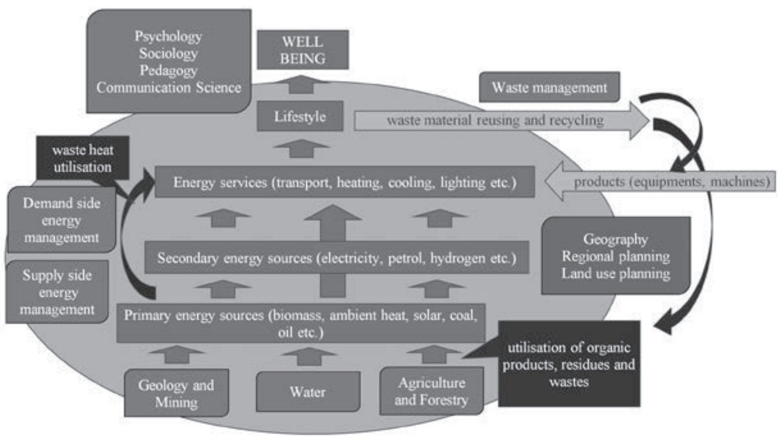

Figure 3 – Holistic approach of energy planning and management
Edited by MUNKÁCSY, B. (2013)

Beyond this whole concept, there is a fact that our ideas about "well-being" determine our lifestyle. However, our lifestyle is defined by the *amount and types of energy services* that are used by the society, or a community, or even a single consumer. Through the different energy services, this system is connected to the energy chain and, therefore, it has an effect on the consumption of energy sources and the environmental burden of our energy system (NORGAARD, J. 1998). Because of the above mentioned relationship, this issue is an interesting area of the *environmental sociology* that emerged in the early 1970s. There is also a special area of study, called *energy social science*, which deals with the social and behavioural aspects of energy use (LUTZENHISER, L. 1993). The *pedagogy* and its allied discipline, *psychology*, should have a tight connection to energy issues, as well. The formal education has a particular role, as staying half a day in schools, younger generations get important inputs at these institutions. Schools (and the families) should compensate the negative effects of the massive media campaigns of the consumer society which is a serious challenge these days. In order to meet this provocation, there are new areas in both fields, such as the *environmental or global education* and *ecological psychology*.

According to the previous paragraph, communication has a crucial role in the development of the environmental crisis. On the other hand, media and communication sciences have a responsibility and they should have a leading role in answering the questions raised.

3. The role of geography in energy planning

The changing role of geography should be remarkable, as it is a complex (social and natural science) discipline itself. This discipline will be more and more important, as the decentralisation of the energy system goes on. *Spatiality* is a crucial factor in sustainable energy production, due to the fact that renewable energy sources are dispersed in space. New methods of geography, as geographical information systems (GIS) are essential in the calculation of potentials, may be those either wind, solar or biomass technical energy potentials (MUNKÁCSY, B. – KOVÁCS, G. – TÓTH, J. 2007). International comparisons of capacities or production data can provide sufficient basis on estimations of socio-economical potentials (MUNKÁCSY, B. 2011) and contribute to create progressive national or regional energy strategies and plans.

Engineers generally have special knowledge in a narrow field, while geographers are more open and see a wider picture. Therefore, they can recognise the potential relationships (discussed in the first part of this paper) among the different sectors of environmental management in a given area. Thus, electric engineers cannot deal with architecture; agronomists do not deal with forestry. However, revealing the connections among these fields, sometimes, would be substantial within a geographical area, as energy and material flows do not consider the borders of different fields of knowledge. Recognising the possibilities in these kinds of connections might yield good results in energy and resource management, as well.

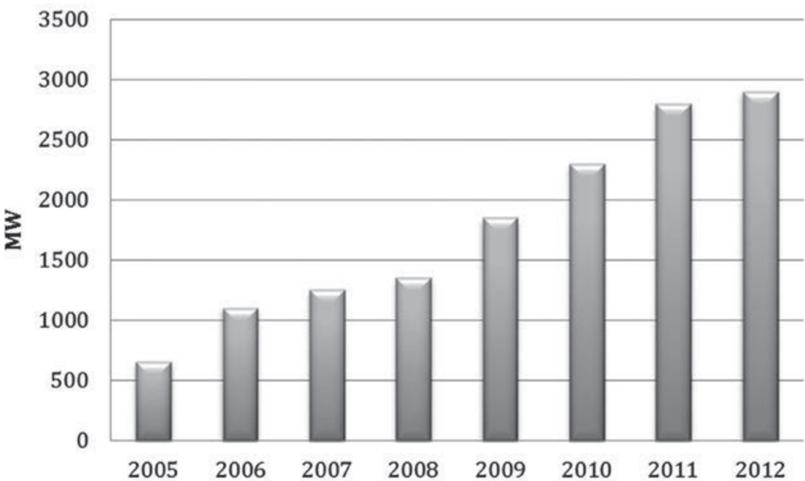

Figure 4 – Energetic capacity of biogas plants in Germany (2005–2012)

SOURCE: ERNST, R. et al. (2012); Edited by BOKOR, L. (2013)

For example, in *Germany* 2,200 MWp of biogas capacity was built between 2005 and 2012 *(Figure 4)*; 60% of them on bio-waste basis (ERNST, R. *et al.* 2012). It means not only a state-of-the-art waste processing activity, but also a highly efficient heat and power cogeneration, which is close to the consumers. Considering these developments in Germany, it is difficult to explain the necessity of a new nuclear power plant in *Hungary* which would produce electricity with a very low efficiency, while producing several types of radioactive waste and huge amount of waste heat.

Astronomical geography should also have an important role in energy related projects, namely in new building activities, as passive house planning and generally *passive solar energy applications* are based on the *Sun's* orbit. According to Farkas, I. (2010), heating energy consumption can be reduced by 15–20% with direct passive solar systems, and by 25–35% with indirect applications under Hungarian climate conditions. Planning new streets and plots, and creating new quarters in our settlements are very complex tasks, in which—account taken of the above—planners should consider this astronomical geography's aspect, as well.

Meteorology is one of the closest associating disciplines to geography. Without this scientific subject, it would be impossible to calculate potentials or install applications in the fields of harnessing of wind, solar and, moreover, hydro energy. Meteorology can also provide short time forecasts in order to enable power system operators to create the daily schedule of electricity production.

The energy efficient consumption is also connected to geography, for example "eco-routing". With intelligent navigation systems, we can save significant quantity of fuel. Experiments show that up to 33% of fuel savings can be achieved only by advanced route planning (Dhaou, B. I. 2011).

4. Conclusions

On the verge of the global environmental crisis, it is an urgent challenge to reshape our dramatically polluting energy sector worldwide. First of all, we need to remould our approach both to supply and demand sides of energy planning, in a way of giving up the narrow-minded technological and distorted economic attitude. The holistic approach needs to be the basis of the new energy planning procedures. There are three important tasks facing the experts and decision makers:

a) involving those disciplines which deal with the human factor of energy (sociology, pedagogy, psychology, communication science);
b) involving geography which can recognise and point out the possibilities in cross-sectoral interconnections in a given geographical area;
c) connecting the different engineering disciplines to each other.

After having solved the above indicated deficiencies, it would be possible to decrease the energy demand of the society and economy. Counting on "sufficiency" and moderate consumption are indispensable in order to set up a sustainable energy system, as the recent energy use could not be covered by renewable energy sources in a sustainable way (MacKay, D. J. C. 2009; Munkácsy, B. 2011).

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Energy Efficiency in Tourism – Towards a More Sustainable Travel Industry

Abstract

As the volume of this analysis is mainly focusing on the connection system and relationship between locality and energy utilisation or consumption, the present chapter concentrates on introducing the sustainable side of the tourism industry from a special perspective of energy efficiency.

It is not only important to investigate the purely economic and social factors of the travel and tourism industry, but as the branch develops, we have to take sustainable issues into consideration more and more strongly which, luckily, do not only derive from economic and environmental reasons. However, it seems that an increasing per cent of the travellers (tourists) are more and more aware of sustainability. A tourist accommodation, a catering place or whichever form of tourism enterprise seems to be more attractive for these conscious travellers when they can produce a new form of sustainable energy consumption and utilisation.

The paper intends to demonstrate these best practices of tourism concerning sustainable development and energy efficiency both from Hungarian and international perspectives.

Key words

Energy efficiency; Responsible tourism; Responsible tourist; Sustainable tourism development

Introduction

Tourism is, for many reasons, one of the most important industries of the 21st century. Just highlighting an important aspect from the many, in 2011 there were over 983 million international tourists travelling worldwide that generated some 1,030 billion USD (680 billion GBP) receipts (UNWTO, 2012). According to the latest statistics, at the end of 2012 there were over 1 billion international tourists! Tourism industry's total contribution to GDP is around 9% (direct contribution 6%), and its direct contribution to employment is around 6–7% which stands for 255 million employees worldwide. Global tourism contributes 5% of all the investments and also 5% of the total export (WTTC, 2012b).

We also have to stress that, in despite of the world economic backdrop, the analysed growth—between 3–5% in recent years, 2.7% in 2012—is continuous, although at different scale in the tourism macro and micro regions of the world. Long-term prospects forecast an even higher growth rate (around 4% annually) in the next ten years (*Figure 1*). By 2022, 10% of all the jobs will have been generated by tourism, employing 322 million people globally (WTTC, 2012a).

This continuous growth creates huge challenges not only concerning the "usual" social–economic perspectives (receipts, incomes, employment creation), but taking into account the state of the environment (both cultural and natural) and, of course, the sustainability (AUBERT, A. – BERKI, M. 2007; GYURICZA, L. 2008; HAJNAL, K. *et al.* 2008; BANK, K. 2009; AUBERT, A. 2010). It is also proven by the fact that transport—especially air transport—is responsible for the majority of energy consumption and associated carbon emissions from tourism-related activities. According to the estimations of the *United Nations Development Programme*, energy consumption that can be connected to tourism is 14,000 Petajoules (94% transport, 3.5% accommodations, 2.5% other transport related activities) (FERNANDES, E. – ROMO, Z. 2009).

In the following, we intend to collect examples on both the Hungarian and international scene where energy efficiency practices provides excellent examples of tourism development.

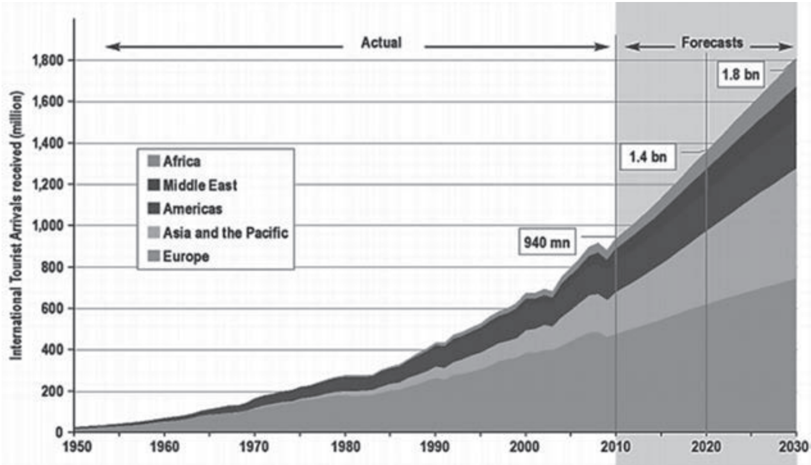

Figure 1 – Present tourism trends and forecasts
Source: UNWTO (2012)

Results

According to the research paper of the UNWTO (2012), the sustainable tourism is defined as "*Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities*". The guide of the UNEP-UNWTO (2005) defines 3 important aspects of sustainable tourism out of which we will stress the following definition in this paper: "*Make optimal use of environmental resources that constitute a key element in tourism development, maintaining essential ecological processes and helping to conserve natural heritage and biodiversity*".

1. Energy efficiency and tourism development

The tourism and travel industry can be connected to energy efficiency in almost every aspect and field of the industry. Among them, maybe tourist accommodations is the most concrete area of tourism, improving its energy efficiency, but many other aspects and fields can be connected to create a more sustainable industry, as well. The major factors are collected in the following figure *(Figure 2)*.

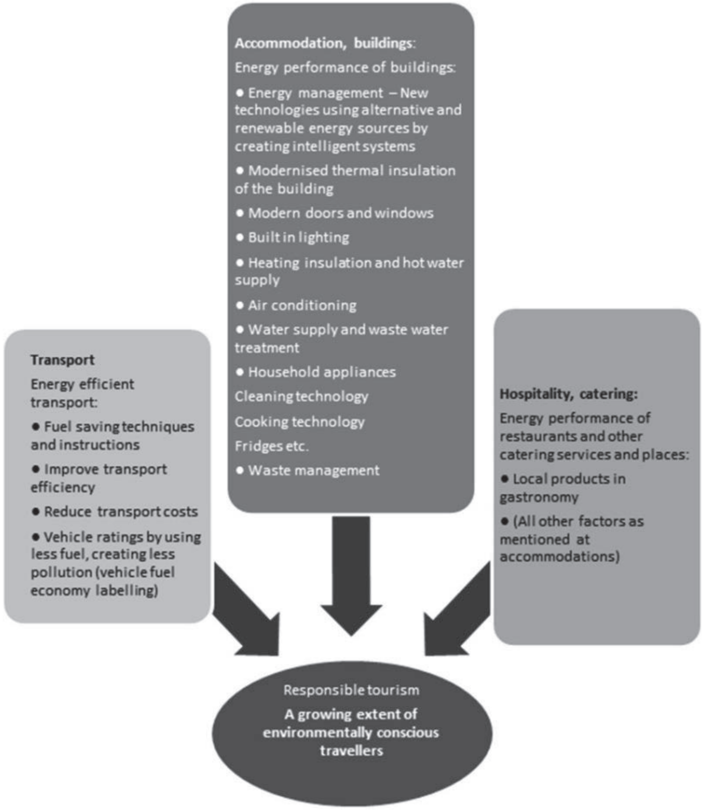

Figure 2 – Major fields of travel and tourism industry, concerning energy efficiency

Edited by CSAPÓ, J. (2013)

In the recent years, new initiatives have been born determining methods for the evaluation of tourism foot-printing or, in other words, the carbon footprints of destinations (BECKEN, S. 2001; WWF, 2002; DICK, S. 2007). These researches *(1)* analyse the energy consumption of the major components of tourism and catering; *(2)* provide methodology to determine carbon footprints of destinations, determine the specific areas of energy consumption and, of course; *(3)* provide useful and practical energy saving tips.

Just to give some examples:

- According to estimates, hotels could reduce their energy costs by 10–40% by using more efficient methods of energy consumption.
- 10–30% of laundry costs could be reduced by the option to re-use towels and bed linen for those guests who stay more than one night at the accommodation.
- Lighting: incandescent light fixtures can last 8–10 times longer than fluorescent ones (DICK, S. 2007).
- While energy costs in hotels usually represents about 6 per cent of the annual turnover, in the "best practice" establishments this expense factor has been significantly decreased to 1.5–2.8 per cent (HAMELE, H. – ECKARDT, S. 2006; PRATT, L. 2011).
- A 6% increase in investment in energy-efficient design and equipment can lower electrical consumption by 10 per cent (PRATT, L. 2011).
- Water-efficient design and operation can reduce consumption by 30% (NEWSOM, D. – SIERRA, C. 2008; PRATT, L. 2011).

Taking a look around the international scene, we have to say that the relationship between tourism development and energy efficiency is mostly dealt with in those destinations which belong to the so-called developed countries. In other words, these are the countries where social–economic background is as developed as their social need to maintain principles of sustainability.

We also have to take into consideration that the idea and introduction of the so-called soft tourism was first announced in 1984 in the *Chur Declaration of the Commission Internationale pour la Protection des Regions Alpines (CIPRA)* which provided the basis for the new approach to tourism and tourists. "*By soft tourism, CIPRA denotes a form of tourism which leads to mutual understanding between the local population and their guests, which does not endanger the cultural identity of the host region and which endeavours to take care of the environment as best as possible. Soft tourists give priority to using infrastructures des-*

tined for the local population and do not accept substantial tourist facilities harmful to the environment" (BROGGI, M. F. 1985).

This approach also brings forward another very important aspect of using and introducing energy efficiency in tourism in a greater extent or with a higher priority. It sheds light on the (changing) demand of tourists that can successfully influence tourism enterprises to be involved in the principles of sustainable tourism development. Those firms and enterprises which prove to be committed to energy efficiency can, first of all, significantly reduce their costs but, on the other hand, they can attract those responsible tourists—with an ever growing number, meaning a special increasing market segment—who are aware of energy efficiency. This attraction could also be marketed and advertised on different channels to the potential tourists, due to which the other service providers in tourism will be forced to be involved in a greater extent in energy efficiency.

A designed label or logo—energy label (just as eco labels work in ecotourism)—could be used for these marketing purposes which makes clear to the tourist that the certain firm—e.g. bus company, taxi company, airlines, hotels, restaurants—focuses special interest on sustainability and energy efficiency.

2. Selected case studies – Methods and practices

2.1. New Zealand

One of the most useful examples of tourism and energy efficiency policy on national level can be studied in *New Zealand*. In 2009, the *Tourism Industry Association New Zealand* published a selection of best practices in energy efficiency entitled: *Save Energy Save Money – Energy Efficiency in Tourism*. The document was created based on the opinion and practice of tourism operators on areas such as practical tips to save money and energy, government funding and services or fuel efficiency (TIANZ, 2009).

In their study, they provide useful topics on sustainability and efficient tourism development and also highlight exact ideas about energy efficiency when it comes to transport, lighting, appliances, heating and renewable energy:

- How to be a competitive and responsible tourism operator by running an energy efficient business;
- Future proof of the business—based on the fact that the visitors expect more and more sustainable enterprises and actions;
- Analysing the energy bill;
- Invest in an energy audit;
- Motivate and empower the staff (TIANZ, 2009).

2.2. Australia – model for water use and waste water management

The different regions of the world face different scale challenges of the natural resources. *Australia* is one of the best examples where water use and waste water management create a high level priority in tourism, as well. In this case study, we would like to mention the research and action paper of TAYLOR, M. A. P. *et al.* (2010) who created a modelling method for tourism demand and estimating costs of water provision and operation.

The majority of the consumed water in tourism is majorly used in garden and outdoors, bath and shower, laundry, kitchen and toilet (SA WATER, 2009). The research of the mentioned authors focused on the possible solutions to fund, provide and operate water and wastewater infrastructure in order to meet the ever growing demand of tourists. In order to achieve this, they identified the exact costs of visitors using the tourism infrastructure and created a forecast of how infrastructural developments should respond to the growing demand.

Finally, they created a GIS-based spread sheet model that included the previously mentioned future tourist demand in the analysed area and the estimation of the requirements for water and waste water infrastructure development with a special emphasis on the appearing costs. According to the researchers, this model can be easily used by the decision makers of local communities and governments (TAYLOR, M. A. P. *et al.* 2010).

2.3. European Union

It should also be highlighted that the *European Union*—and consequently its member countries—pay a special emphasis on energy efficiency in tourism. The most recent project (European SETCOM) that comprises 11 partners from 10 member countries was launched in 2008 with the co-finance of the *EU* programme called *Intelligent Energy Europe (IEE)*. The comprehensive programme's main aim was to raise awareness in energy related topics and encouraging the use of sustainable energy in tourism across *Europe*.

The Three Main Project Targets are:

1. "*Raise awareness of substantial energy topics among tourism companies, local administration and tourists in the participating communities.*
2. *Raise awareness of 'sustainable energy tourism' throughout Europe.*
3. *Set up energy action plans for the participating communities with realistic and clearly defined ways to improve energy efficiency and reduce GEG-emissions*" (IEE, 2011).

As one of the most important outcome of this project, the tourism companies of the cooperating countries were provided with useful tips and ideas how to reduce their energy costs and also best practices were presented to learn the techniques along with their general approaches. Due to this initiation, new energy saving ideas and measures were achieved and acknowledged (IEE, 2011).

3. A Hungarian best practice: The "eco farm houses"/eco accommodations (South Transdanubia, Hungary)

Among the attractions of village tourism, the values of rural heritage—so the material heritage of the villages, the tradition of keeping buildings which serves as an attraction and also as the framework of the supply—play highlighted roles. If we want to make the products of village tourism more adequate to the needs of the market and would like to introduce a new quality in this service, then we have to take into consideration the values of the countryside and their special characteristics, as well.

Since the autumn 2010, an accommodation network has started functioning in a new qualification system that has now become known as “Environmentally friendly guest caterer”, in other words “Eco-farm House”. The 32 guest caterers—in 20 settlements—who are signed by separate trademarks started to attract visitors to the villages which are placed around protected natural sites.

These eco-farm houses are found in the areas of the *Danube–Drava National Park* (9 settlements), in the *Eastern Mecsek Landscape Protection District* (5 settlements), in the *Western Mecsek Landscape Protection District* (2 settlements), and in the *Zselic Landscape Protection District* (4 settlements) (Szabó, G. 2006; Szabó, G. 2011) *(Figure 3)*.

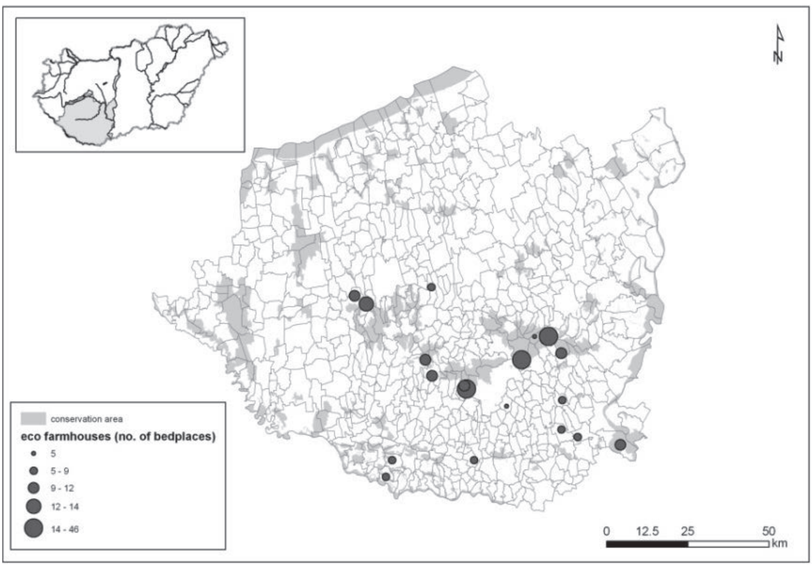

Figure 3 – The spatial allocation of eco-farm houses in South Transdanubia with special attention paid to the protected areas
Edited by Pirkhoffer, E. 2013

The eco-farm houses of the region can receive their accommodation titles by a qualification system created for the private accommodations and, within that, for the village guest caterers. The eco-farm house qualification system is regulated by the *2003/287 EU Commission Decision* on the quality of commercial accommodations and camps (2009/578/EC, 2009). One can receive the "eco brand" quality by fulfilling these requirements. The system, which is studiously elaborated only to commercial accommodations, determines 5 professional areas (energy saving, water saving, reflective functioning, waste decrease and visitor information provision) and the requirements for environmentally friendly establishment and functioning (SZABÓ, G. – CSAPÓ, J. 2012a; 2012b).

Following the *EU* regulations, *Hungary* has worked out the "Environmentally friendly product" trade mark criteria which are also related to the commercial accommodations. We also have to emphasise that no such state system has been created yet which would be able to create the "eco" qualifications for the private accommodations characteristic to rural tourism and, within that, village tourism. On the sample area of the *South Transdanubia Region*, by the promotion of the great project of the *Norwegian Civilian Fund* between 2008–2010, the *Village Tourism Association* of the *Baranya County* worked out and elaborated the experiences of the earlier mentioned systems, creating the qualification system and criteria for the "Environmentally friendly guest caterers" network called "eco farm houses". Based on this system, the organisation also completed the qualification of the eco farm houses (SZABÓ, G. 2011).

The elements—which, of course, should be accomplished—of the qualification system concerning energy efficiency are:

- The use of energy and water saving equipment and technologies;
- Only environmentally friendly cleaning supplies can be used;
- Compost and waste management is carried out selectively;
- Using renewable energy sources (as a special or added value);
- Using environmentally friendly heating system.

4. Summary

As we intended in this research paper, energy efficiency—coupled with sustainability and the appearance of responsible tourism and responsible tourists—is proven to be an important driving factor for tourism development. Energy efficiency means conscious energy consumption. The growing efficiency and the economic utilisation of energy sources results in the fact that we have to exploit far less natural resources, while we do not have to compromise the everyday comforts that we are used to.

The major benefits of the introduction and application of energy efficient techniques and methods in tourism are:

- Increased competitiveness of the sector;
- Reduction of environmental pollution;
- Increase in the energy security of the economy;
- Economic and employment spin-offs;
- Relatively quick reimbursement of the investments;
- Increasing efficient use of natural resources;
- Lower operating and maintenance costs;
- More environmentally friendly and efficient transport;
- Increasing percentage of renewable and alternative energy sources (Sookram, S. 2010).

It is also very important to accentuate that by the introduction and spread of the new technologies, tourism does not only benefit from an economic point of view but also from the behavioural changes of tourists who will be more and more aware of responsible tourism, principles of sustainability and, due to this phenomena, those tourism enterprises involved in energy efficiency can also benefit from the marketing aspects of their investments. One of the most realisable outcome or driving force of introducing new technologies and practices comes, first of all, from the direct increase of incomes, but also by introducing "eco labels" in tourism. The changing approach of the responsible tourists will increase the attraction of the tourism and travel enterprises with an energy efficient background.

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Traditional Energy – Free Solutions for Ventilation and Air-Cooling in Arid Tropical Areas of Asia

Abstract

Nowadays, more and more air-conditioning devices are installed to cool the inner spaces of dwelling houses and public buildings in the populous developing countries, mainly—within Asia—in India and in China. The need for such devices contributes not only to the growth of municipal and public electricity consumption and emission of pollutants, but it is also responsible for a negative self-generating process: the more greenhouse gases are released—as a result of air-conditioning—the warmer our environment becomes. Therefore, it is worth drawing attention to those traditional methods and architectural forms by which comfortable air conditions could be generated in the hot arid and semi-arid areas of our Planet—with respect to this study in South Asia. We can find several examples of such solutions in India and in the Iranian Basin, as well. Modern age architects have also started to discover the importance of these ancient methods and to apply them in their works. Although, widespread use of such techniques cannot be expected in the near future, the success of these innovative but low-key attempts achieved until now should be reported.

Key words

Air conditioning; Air pollution; Developing countries; Traditional air comfort improving; Traditional methods of architecture

1. The environmental and social effects of the spreading of air-conditioners

The serious consequences of the increasing rate of industrial and energy production, motorisation and, closely related to them, population growth and urbanisation—such as the negative climate changing effects of greenhouse gases accumulated in the atmosphere—have gained scientific certification in the last fifty years. The spreading of electric air-conditioning contributes greatly to the environmental damage occurring in the form of air-pollution through the emission of various gases in energy production or directly from the AC devices; although, this fact hardly has any impact on social awareness. The increasing need for these devices is well-marked by the turnover growth in the market of air conditioners that reached 13% between 2010 and 2011. Meanwhile, the amount of energy consumed by air conditioners put into the electrical system was 10^{12} kWh/year (COX, S. 2012). The total energy demand of air-conditioning is naturally enhanced by the AC equipment of motor-vehicles through their excessive fuel consumption.

It should be noted that global as well as regional aspects of the year by year observable consumption growth are conspicuous, as we have recently witnessed a remarkable spatial rearrangement in this regard, too. Nowadays, the "leading" role of the *United States of America* is still undoubted regarding both the number and energy consumption of air conditioners put in operation. Moreover, the amount of electricity used for air-cooling is higher than the whole current consumption of *Africa*; between the years of 1993 and 2005, this kind of current use had doubled, until 2010 it increased by 20%, moreover—and as a result of additional energy need of vehicles and buildings—almost 500 million tons more CO_2 has been emitted into the atmosphere (COX, S. 2012). However, the advance of economically developing countries with high population is more and more evident in this field, as well. Among them is *China* where only in 2010 50 million air conditioners were sold. According to the unanimous belief of forecasts, the number of climatised vehicles will have doubled by 2015, reaching 100 million. Furthermore, by 2020 preceding the *USA*, *China* will have become the first ranked in the use of electricity for air-cooling purposes (Cox, S. 2010), thus, by 2050 *China* will have been the most dominant state in current consumption for climatisation which, according to long-term prognoses, will have risen tenfold on global level by that time (Isaac, M. – Vuuren, D. P. 2009). Considering the future, it is more and more certain that, simultaneously with the overstocking of the local market, the developing, first of all *South* and *Southeast Asian* countries—of which India already excels—following *China* in the development of economy and in the rise of living standards with some time lag will be the great consumers of the post-2020 period (McNeil, M. A. – Letschert, V. E. 2008). The increasing demand for air conditioners in *India* has more reasons. On the one hand, it is a means indicating the status symbol of the vigorously expanding and strengthening middle class; on the other hand, there are also real needs for AC devices because of the higher indoor temperatures as a result of the new architectural design and building materials. The latters have replaced the traditional ones which have been adapted to the local climatic characteristics. It is supported by the data according to which the turnover of AC equipment has increased by 17% in the last three years in *India* (Dahl, R. 2013).

In connection with the environmental and economic effects of the spreading of AC devices, some geographical relations worsening the problem should also be pointed out. First of all, the economically developing countries are partly the most characteristic scenes of urbanisation and are predominantly situated in the tropical–subtropical regions of the *Earth*. It is convincingly demonstrated by the fact according to which 37 out of the world's 50 most populous agglomerations—among them 14 are in *China* and in *India*—can be found in the developing world and the ones with the hottest climate (30 out of 50) with the exception of 3—having their CDD (Cooling Degree Days) index higher than 1000—are also located in this group of states (Sivak, M. 2009), based on the country classifying system of the *International Monetary Fund* (IMF Online 2012). The CDD index is such a product of multiplication which is applied to express the rate of need for air conditioning, and one of its parts is the sum of the number of days with more than 18°C (64.4°F) mean temperature, while the other part is constituted by adding up the value domain of each day's mean temperature exceeding 18°C (64.4°F).

Considering the environmental effects of the spreading of electric climatisation, the type of the primary energy resources applied to generate electricity is not negligible either. In this regard, we should also take into account the spatial features of the types of fossil fuels and their roles in energy production, as they contribute significantly to the increase of exhaust emissions, but in a different degree. The difference between the material characteristics of coals and hydrocarbons—especially that during the oxidation of the latter, the amount of carbon gases emitted is fewer—has a well perceptible impact on environmental degradation. This rise becomes particularly significant if *China* and *India* are picked out of the group of developing countries on the basis of their population and economic potential as well as their climatic characteristics. In these two countries, about $^2/_3$ of the electricity is generated in coal-fired power stations (PROBÁLD, F. 2008; SZEGEDI, N. – WILHELM, Z. 2008).

As a result of the growing need for air cooling, more and more greenhouse gases are released into the atmosphere which, in connection to global warming, starts a self-generating process that increases the amount of electricity used for climatisation of buildings and the rate of air pollution onwards. The decrease of energy needed for heating, which is mainly based on hydrocarbons, is unable to compensate for the strengthening of this environmental impact. The population growth and the improvement of income conditions of the developing world have considerably contributed to this, as well. On the other hand, this also means that the cumulated energy need and greenhouse effect of heating and cooling is going to increase further in the coming decades (ISAAC, M. – VUUREN, D. P. 2009).

The increased demand for electricity—the degree of which is well demonstrated by the 2.0–2.5-fold rise of electrical energy used in the hottest months in *Delhi* between 2000 and 2009—is endangering, not only the environment but also the safe industrial and public power supply (WOLFRAM, C. 2012). For instance, *India* suffers from a day-to-day lack of energy in some places and times. Even 16-hour long power cuts can happen (COX, S. 2012) with which AC devices contribute to increasingly burdening the electrical grid.

2. Possible solutions to mitigate the environmental impact of air conditioning

If we wish to insist on the present habitual air-comfort level of cooled interior rooms also in the future and we would like to assure the cooling of inner spaces by air conditioners solely, there are theoretically two possible ways of solution strengthening each other's effect to keep back the concentration growth of greenhouse gases emitted into the atmosphere. One of them is to increase the energy efficiency of the devices and the other one would be the larger scale use of renewable energy resources.

The success of attempts to increase efficiency depends on the development and spreading of the optimum refrigerant of AC devices. In the most widely used and presently operating air conditioners, hydrocarbon derivatives pertaining to *Hydrofluorocarbons* (HFCs) are the materials applied as refrigerants in the cooling cycle. These were bound to replace the refrigerants of the older equipment namely *Chlorofluorocarbons* or *Freon* (CFCs, HCFCs) depleting the stratospheric ozone layer, after the so-called *Montreal Protocol*. The latter is an international agreement that constrains their production and circulation of them which came into force in 1989. Although, the decreasing process of the ozone layer concentration has been managed to stop and even reversed, the greenhouse effect of these chemicals (both the CFCs and the HCFCs) is still considered as a huge problem. When comparing the GWP (Global Warming Potential) of these hydrocarbon derivatives with that of CO_2, the former can be greater by 2–3 orders of magnitude. Their role in global warming is less significant than that of other greenhouse gases, but only because they are released in much lower concentrations into the atmosphere.

In the spotlight of these facts, it is undoubted that the key factor in the modernisation of AC devices is the replacement of old refrigerants by new ones with much lower GWP. But it seems that such an attempt will not lead to real solutions in a short term. With the increase of efficiency also in view, their technical efficiency is much lower than that of HFCs, not to mention their other problematic characteristics like inflammability, toxicity, ozone depleting effect and so on. Besides, the positive environmental impact of some possible improvements in energy efficiency would not prevail because of the increase in the CO_2 emissions as a result of the energy need for operating the more and more newly installed air conditioners (COX, S. 2010).

Optimistic and scientifically grounded analyses as well as scenarios regarding the future role of renewable resources in the process of energy production, like the Energy Report which has been made in the cooperation with *WWF* and *Ecofys* and was completed in 2011, slip out practically every day. Accordingly, it is possible that renewable energy resources could meet the energy demand of the *Earth's* whole population by 2050 (SINGER, S. ed. 2011). However, because of the real environmental risks and cost effectiveness problems, we cannot trust in the significant advance in this field in the near future, that is in the more efficient exploitation of the potential reserves lying in renewable energy sources. Consequently, in a short term at least, the amount of electrical energy coming from this kind of resources—approximately 750 billion kWh/year in the present time—will not increase notably.

In the spotlight of the above mentioned facts, putting a stop to the endless spreading of mechanised air cooling should really weigh up the possibility of making way for traditional, mainly free methods based on shading, ventilation and airing by means of which tangible results can be achieved in the reduction of air pollution level and relieving of energy dependency. This is not a doomed enterprise. The suppositions of scientific studies or surveys, according to which in spaces where continuous air movement by natural or artificial ventilation is ensured and the occupants of rooms are protected against the direct influence of sunlight anyway, the temperature tolerance limits are shown to increase and seem to be justified (Busch, J. F. 1992; Brager, G. S. – Dear, R. 2001).

3. Air comfort sense improving traditional architectural methods in India and in Iran

It is not a new recognition at all that in the arid and semi-arid climate areas of *Northwestern India* and the *Iranian Basin*, for instance, we can witness many long established technical methods which are also justified in the modern architecture. These methods help adapt to extreme weather conditions by the use of cooling and heat extraction potential of water, capitalising on the opportunities of shading techniques, strengthening the intensity of natural air movement as well as building and space shaping technologies adjusting to the thermal absorbing and radiative capacities of building materials.

Typical examples of utilising water for this kind of purpose are the stepwells, serving as public spaces. They are spread in the hottest and driest northwestern parts of the *Indian subcontinent*. Stepwells granted refuge from the heat not only to the local population, but—since these were often built along the major trade and military routes, too—as halting places and bases for replenishment of water resources, they also ensured refreshment for travellers (Wilhelm, Z. *et al.* 2008). Depending on language areas, these water sources are called *baori*, *baoli*, *baodi* or *vav*, *vaav*, *vavdi*. The water basins come to light in the towns of the *Indus Valley Civilisation*, the range of which is very comparable to that of stepwells today offer themselves spontaneously as the historical prefiguration of the baoris being formally similar to them. Nevertheless, the first typical well constructions used mainly for public purposes appeared only about in the middle of the first millennium CE in *Gujarat*. From here on, they were gradually gaining ground northward, in *Rajasthan (Figure 1)*, as well (Livingston, M. 2002).

The baoris could be utilised in various ways: they combined the functions of simple wells and masonry basins, i.e. water tanks being common in *India*, too. As round, square or polygonal-formed structures recessed as far down as the ground water level also enabled to store the rain water falling in a modest amount during the wet season. In some cases, the occasionally covered stepwells are tens of meters deep and have hundreds of square metres basic area. They consist of several

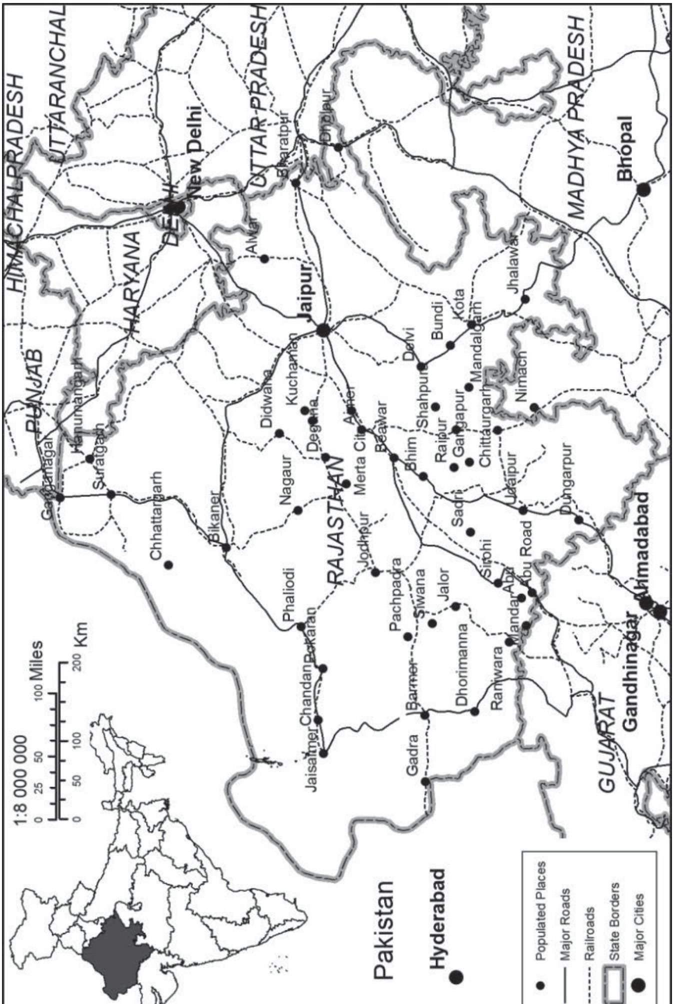

Figure 1 – Rajasthan in India

Edited by SZELESI, T. (2013)

stages among which steps running around the side walls or in the galleries provided interconnection to the water basin.

The steps—which either got under the water or emerged from it, depending on the fluctuation of the water level—ensured the approach of the actual water surface. The stepwells were suitable not only for providing continuous water supply, but these deep well buildings put up of thick stone blocks and storing a relatively big and cold water mass were pleasantly cool scenes for communal gatherings, as well. Additionally, as a result of the special cultic designation of water, they were supplemented by sacred roles, too, serving even in our days as sacrificial places of locally revered deities. One of the oldest and largest stepwells in *India* is the 20 metres deep and 13-storey high *Chand Baori* built during the 8–9th century CE in *Eastern Rajasthan*, which—even lacking its original functions—can be regarded as the model of a space formation adapting to climatic conditions *(Figure 2)*.

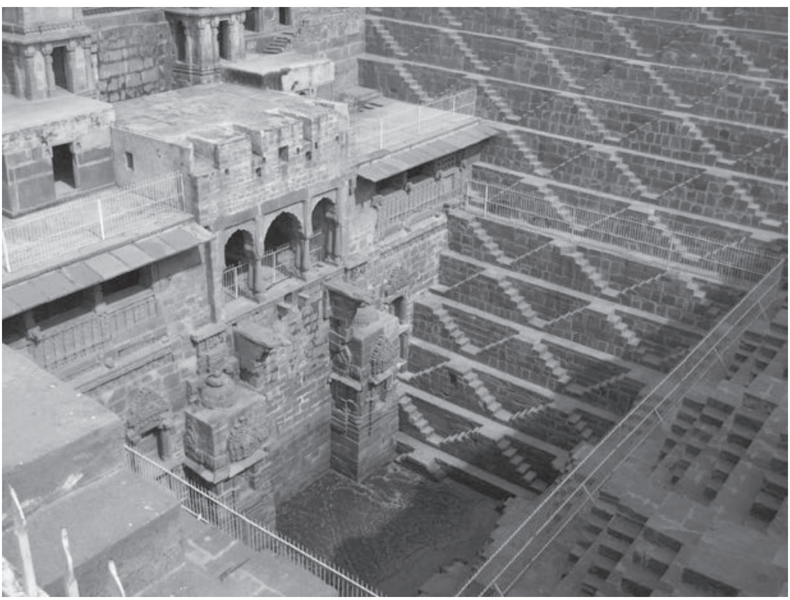

Figure 2 – Chand Baori, stepwell in Abhaneri village, Rajasthan
Photographed by Zagyi, N. (2012)

In relation to natural aeration, we ought not to forget about the architectural impacts of baoris marks of which are most evident among royal residences built in *Rajasthan* during the 17–18th centuries. In the case of these palaces enriched by *Mughal* stylistic details and placed next to water tanks or even gradually protruded into them, it was a generally established custom to apply such kind of structural and frontal elements by which the air temperature mitigating effect of water could be exploited. We can come upon maybe the most prominent examples of this in a small town named *Deeg*, near *Bharatpur*, on the annexes and pavilions of the local palace complex built by *Suraj Mal maharaja* in the 1730s which looks to and is partly situated above a water tank *(Figure 3)*.

Figure 3 – Gopal Bhawan, Suraj Mal's summer residence, Deeg Palace

Photographed by ZAGYI, N. (2012)

The natural air comfort enhancing techniques could be applied successfully not only in case of isolated structures, but they could also have a favourable influence on the climatic conditions of entire cities. In this regard, it counts as a key element to plan and form such kind of a layout which adapts to the changing angle of incidence of rays during the day. That means the correct orientation of road network and the right choice of the streets' width (GUPTA, V. 1985). The slightly wider lanes serving for through traffic are led in an east–west direction, whereas the far narrower passage-like joining streets are perpendicular to them, minimising the effect of direct radiation reaching the building surfaces and the streets encircled by them. In addition, the houses were built next to each other and face to face as closely as possible. The private balconies of the upper floors protruding from the street front wall-faces also increased the shadowing of the spaces between the houses. Besides window panes, the so-called jalis were also utilised to reduce interior air temperature. They are in fact *Sun's* rays breaking reticulated pierced stone slabs forming geometric or plant shapes and are widespread in the *Mughal* and *Rajput* architecture. The jalis are fit not only for screening, but they also substitute masterfully for the three functions of windows: they provide view, ventilation and light transmission at the same time (GUPTA, V. 1984). Furthermore, the jalis have gained such a vast popularity as impressive frontal decorative elements that important late medieval public and private buildings in *India* would have been inconceivable without applying this typical ornamental motif. In addition to a great number of other works, the artistically sculpted details of the *Amber Fort* built by *Raja Man Singh I* near *Jaipur* at the end of the 16th century; among them the wall-faces of the *Ganesh Pole (Ganesh Gate)* preserve a splendid memory of this *(Figure 4)*.

Another efficient way of reducing the temperature sensation is the air-flow routing by means of the so-called courtyard effect on the settlements that have been adapted to the tropical climatic conditions by applying traditional layout and building methods indicated above (GUPTA, V. 1981). Beyond the close location of the street façades, it was made possible by forming relatively spacious courtyards among the wings. Its operating mechanism is based on the physical properties of

Figure 4 – Jalis on the Ganesh Pole, Amber Fort, Rajasthan

Photographed by Zagyi, N. (2012)

the air maintaining the general circulation, that is its density changes depending on increasing or decreasing temperature, and it moves from a lower pressure towards a higher pressure one. Accordingly, the cooler and heavier air mass of the narrow well-shaded streets sinks, but the less dense air of the courtyards warmed by the direct radiation carries out an upward motion. From the point of view of the natural ventilation of the building interiors, the most important circumstance is that during the pressure equalisation the air getting in from the street through the loose textured front faces of the upper floors reticulated by jalis and crossing the residential spaces towards the courtyard creates transversal draught. The temperature of the inner courtyards and premises adjacent to them could be reduced by evaporation where financial opportunities as well as sufficient water resources were available to realise it. The cooling effect of water of fountains and shallow basins as well as channels existing in the inner courtyards of imposing residential buildings could be increased by the transpiration and shadowing of the vegetation planted there (LEHRMAN, J. 1980).

The right choice of building materials and structural forms improved the air comfort of the inner spaces, too, as they were fitted to the different heat absorption and emission properties and the diurnal temperature fluctuations of the individual house sections on the lower and upper storeys. The thick-walled, flat-fronted ground-floor rooms were massive block-like constructions, usually made of sandstone which slowly admitted the warmth of their environment and fairly delayed. Since they can also get rid of the thermal mass accumulated in them gradually prolonged in time, they are excellently suitable for stay in the daytime, but during the night they do not provide shelter for the residents of the houses. The exterior architectural forming of the upper storeys showed a completely different picture. On the whole, they were loosely structured, a few centimetres thick-walled building parts with carved and engraved decoration consisting of stone slabs reticulated by jalis and enriched by frontal elements protruding from the wall-faces which, contrary to the bottom floor, relatively quickly warm up, but during the cooling off in the evenings they are able to release the thermal mass accumulated in them in the daytime similarly fast. However, the late hours in the hottest months of the year are tolerable only in the open air; therefore, people gather on the roof level in the evenings and spend even their nights there. In areas which receive a significant amount of rainfall during the wet season, attachment structures, the so-called saywans consisting of discontinuous lath wall and thin metal roof sheet were erected which do not obstruct the withdrawing of thermal masses during the superficial radiation intensifying in the late evening and at night, however, they provide protection against the rain (GUPTA, V. 1981).

The natural ventilation realised through routed motion of air is also served by badgirs, the widespread windcatcher towers that have determined the urban landscape since the early antiquity in the *Iranian Basin*. These towers built next to residential buildings and vaulted reservoirs are usually four, but occasionally six or eight-sided constructions that are connected by their foundations to the buildings desired to ventilate and on their top depending on the direction of wind and the mode of operation on one or more sides openings can be found which make the capture and departure of air possible. Badgirs open only on one or on two opposite sides were used where wind typically blows in the same direction; while in regions, where the direction of wind is changeable, windcatcher openings were normally formed on both sides. Inside the badgirs open on more sides, wind channels are located appropriate to the numbers of the windcatcher openings which are separated from each other by a dividing unit named shaft stretching down from the top of the tower till the residential levels.

The windcatcher towers utilising the kinetic energy of wind and the vertical motion of air as a result of change in temperature are suitable for three kinds of working methods (A'ZAMI, A. 2005). The most common is the primary function of badgirs based on the capture of wind. In this case, the tower extending upwards catches a high energy air beam through its opening which faces the direction of wind and this retaining its weight starts to move downwards in the given flue and then reaching the residential levels enters the airspace of the building. From the living spaces, the air gets out through the opposite side counterpart of the windcatcher opening and its wind channel respectively. It is possible, because the wind passing around the tower in contrast with the compressive force exerted on the opposite side displays a suction effect at the opening located in the direction of the windflow, but with its back to that, so it can sniff the air out from the building through the connecting flue. The air current captured into the badgir and exhausted through it provides a mild draught in the premises of the house.

The windcatcher towers, where it is possible, are connected with the essential accessories of irrigation doing along pediments of arid and semi-arid areas, called *qanats* in *Iran*. These are nothing else than slightly sloping artificial tunnels, one end of which is drilled into the groundwater collecting layers of mountain ranges, and the other one joins the irrigated lands through a surface channel. Utilising qanats, the evaporation of water flowing in them can be prevented. The qanats are hollowed out through shafts which are located in roughly equal distances and sunk in vertical direction. The badgirs linked with these water delivery tunnels possess only one opening situated on the leeward side. The warm airflow entering the air transport system through the vertical shafts of the qanats and passing the cold water tunnels turns chilly noticeably, then gets into the buildings built over the qanats via the pipes leading to their basement premises. It leaves the living spaces through the aperture of the badgir as described above, by the means of the suction force of wind blowing along the top of the tower. It is also helped by the upward streaming airflow which gets warm in the building. The most efficient air conditioning can be achieved by the use of qanat connected windcatcher towers, since the air stream arriving through the irrigation tunnels and departing across the badgirs not only ventilates but also cools the inner spaces.

The badgirs can also be utilised in case of windless weather, then the convective reversal of air resulting by its changes in temperature is used to maintain the air motion. In the daytime, cooler air enters the buildings through their northern, shaded frontal apertures and also moves down across the flues of the windcatcher towers shadowed, as well. It is then pulled out by the air current warming and rising up in the southern wind channels of the badgirs exposed to the direct radiation of the *Sun*. A different current system operates at night as the external air cooling down and getting heavier as a result of the thermal absorption of the strong terrestrial radiation that moves downwards in each flue of the windcatcher towers. At the same time, thermal masses of the premises get warmer by the end of the day coming out through the apertures of the houses; they ascend and so take over the airflow arriving across the wind channels of the badgirs.

4. A possible solution: contemporary use of conventional ventilation methods

Some technical designers in present days are already inspired by the natural architectural methods of climatisation not requiring additional energy resources outlined above. Fortunately, in the last years and decades a number of constructions, making use of passive ventilation and heat tempering procedures, have sprung up worldwide, out of which we would like to draw attention to two Indian public buildings in conclusion.

The building of *Torrent Research Centre*, a pharmaceutical institution located in the *Ahmedabad–Gandhinagar agglomeration*, the economic, cultural, administrative and scientific centre of *Gujarat*, which was built on the basis of *Nimish Patel* and *Parul Zaveri*'s plan and had been completed by 1999 can be considered as one of the most eminent contemporary examples of air comfort improvement that is implemented by the use of windcatcher towers. In this construction, a method has been introduced which combining the ventilation of trapped air and the heat extraction effect of water increases the efficiency of air conditioning. The essence of the procedure called *passive downdraught evaporative cooling (PDEC)* is that the air current got into the aeration system through the wind channels of the towers is led across a microscopically vaporised fine rain. The research site of the Torrent Group in *Ahmedabad* consists of six blocks out of which four uses PDEC-technology based climatisation only. Due to this method, on the one hand, the indoor air temperature compared to the outdoor one is 12–13°C (53.6–55.4°F) lower and the diurnal temperature fluctuation is not more than 3–4°C (37.4–39.2°F). On the other hand, by means of PDEC, the efficiency of the ventilation is so high that the building can provide continuous occupation for even 600 persons in contradiction to the 150–175 planned in advance. Besides, the cost-benefit calculations based on the experiences of the operation now show that the additional capital requirements of the PDEC system as a consequence of the significant fall of the power consumption recovered within one year. Moreover, even the investment costs of the whole construction project can be returned in 15 years (Thomas, L. – Baird, G. 2006; Palacios, D. 2007).

One of the newest modern-day adaptations of the formal solutions of the traditional Indo-Islamic architecture serving passive aeration and air cooling is the educational centre of the 5, the institute playing a leading role in fashion and design training in *India* which has been dreamed in *Manit* and *Sonali Rastogi*'s architect studio and was opened in 2008 in *Jaipur*. The creators have based their architectural conception on the ancient methods of air comfort improvements presented above. Out of them, they gave all their attention to apply jalis to shade and baoris to cool air (Archdaily Online, 2009). The most prevailing detail of the conspicuously closed, introverted compact building situated in an industrial park, approximately 20 km (12.4 mi) far from the centre of the seat of the hot and arid *Rajasthan* is the perforated pattern metal frame placed around about 1.2 m (3.94 ft) in front of the façade which looks as a modern but less expressive reminiscence of the ancient stone-carved jalis. This structural element provides not only for filtering light rays, but it also serves to enclose a thermal buffer zone around the exterior wall front which delays the heat effect of the solar radiation *(Figure 5)*. The water reservoir being equivalent to a baori has been formed through a several metres step-sided lowering of the ground level *(Figure 6)*.

This recessed area would be able to create a pleasant microclimatic environment even by itself as a result of its temperature which compared to that of the surface of earth is lower. Its effect can be further enhanced by evaporation, in the case of proper use of the water basins, shading of the wings protruding into the courtyard and the ventilation of air currents creeping in diagonally from the open pavement level of the house.

The author's generally positive impressions obtained during his visit of the building in October 2012 have been overshadowed a little only by the fact that he discovered a series of equipment looking like AC devices in the thermal buffer zone behind the metal jali screen *(Figure 7)* and he did not find even a drop of water in the basins destined to fulfil the functions of a baori.

Figure 5 – Metal jali skin on the Pearl Academy of Fashion, Rajasthan
Photographed by Zagyi, N. (2012)

Figure 6 – Courtyard of the building of Pearl Academy of Fashion imitating a stepwell
Photographed by Zagyi, N. (2012)

Figure 7 – Thermal buffer zone with AC looking devices, Pearl Academy of Fashion
Photographed by ZAGYI, N. (2012)

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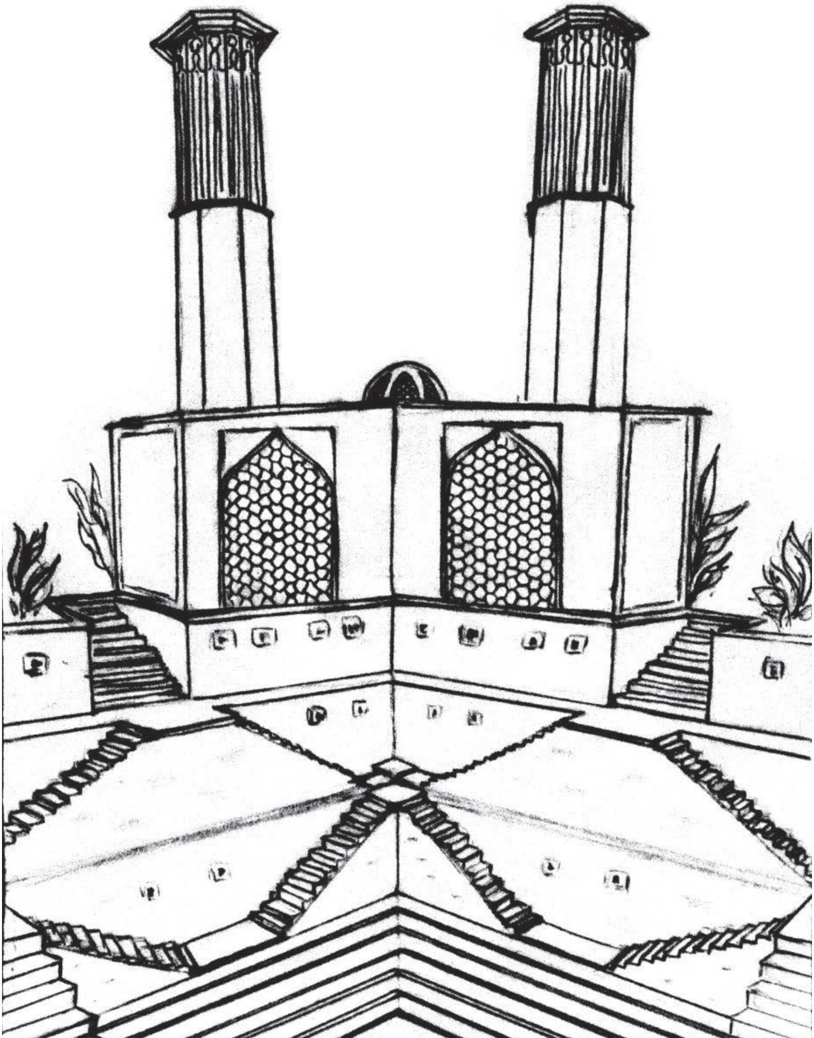

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Water as a Natural Resource, Cultural Heritage and Tourism Attraction in India

Abstract

The present study aims to discuss a social heritage that is based on a commonly utilised natural resource. The natural resource, in this case, is the groundwater and the infrastructure is the groundwater exploiting facility. This type of infrastructure is much more than a simple well or water extracting facility: it is part of the social heritage. This heritage appears through those wonderful stepwells out of which, luckily millions can still be found in the dryer, northwestern parts of India. As everyone knows, India is outstandingly rich taking into consideration its tourism attractions. Its natural and manmade attractions are incomparable. These attractions, at the same time, are exploited with an extremely low efficiency. Compared to other countries outstanding in tourism or in other aspects of world economy, the country significantly lags behind in terms of the international inbound tourism. In addition to the presentation and a more effective marketing of the stepwells of India—as well as the broadening of the tourism supply—the visitors could come to know such a traditional, sustainable water management method which, with its breath-taking art implementation, draws attention to the importance of the planet Earth's ever decreasing natural resources.

Key words

Sustainable water management; Cultural heritage; Tourism; Natural resources

Introduction

Although, *India (Figure 1)* is the *Earth's* second most populous country and the seventh largest by land area, it is not listed among the most well-known and most popular tourist destinations. *China* and *India*

Figure 1 – Map of the 28 states and 7 union territories that form India

Edited by WILHELM, Z. (2013)

have very similar aptitudes, both from natural and cultural aspects; however, in 2011, nine times more visitors (57,581,000) arrived to *China* than to the *Land of Gandhi*. Compared to *Europe* and its most important touristic countries, *India* also shows a rather huge fallback. In 2011, *Austria* was visited by 3.5 times more, *Hungary* more than 1.5 times, but still, *Denmark,* which is not a so important touristic destination, was visited by more tourists than *India (Figure 2)*.

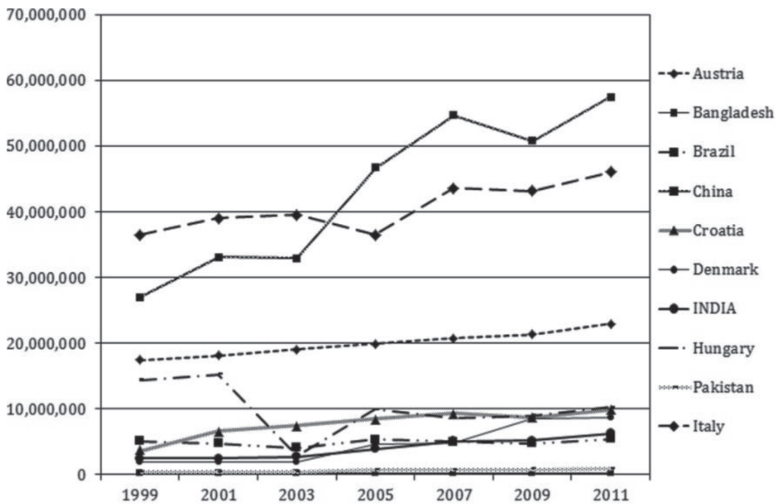

Figure 2 – Total number of foreign visitors in selected countries between 1999 and 2011 *(In the case of Bangladesh, Denmark and Pakistan data are available only until 2010.)*

Source: ATKearney (2008); NationMaster (2008); UNWTO (2012); Edited by Wilhelm, Z. (2013)

Looking at the pure numbers of tourism statistics, a better overview can be obtained, if the number of international visitors are ranked per unit land area (e.g. number of people per km²), i.e. the specific number of visitors *(Table 1)*.

This statistical parameter is an important index of nations of large land area, as these types of countries likely have heterogeneous physical environment or natural attractions. *India* belongs to this latter type of countries: the physical environment here is characterised by a large-scale heterogeneity. In *India,* the spectacular peaks of the *Himalayas*, large alluvial plains as well as vast tropical sandy beaches can be found. Compared to large countries of similar environmental characters, *India* (0.84 visitor per km^2) has more international visitors per a square kilometre than *Brazil* (0.48 visitor per km^2), but has four times fewer than that of *China* (3.44 visitors per km^2), and almost five times less than the *USA* (4.10 visitors per km^2). If the number of visitors is projected to one local resident, then even worse touristic statistics can be found than in the case of the previous index, mainly compared to the similar European indices and values. However, in general these latter values are somewhat better than those of the neighbouring countries.

Table 1 – Selected tourism related statistical data of India and other selected countries (2008)

Source: ATKEARNEY (2008); CIA (2008)

Country	**Area (km^2)** (1 km^2 = 0.386 mi^2)	**Population (2008)**	**International visitors (2008)**	**Population / International visitors**	**„Visitor density" (visitor/km^2)**
India	3,287,590	1,148,000,000	5,367,000	0.005	1.6
China	9,596,960	1,330,045,000	53,049,000	0.04	5.5
Hungary	93,030	9,931,000	8,814,000	0.89	94.7
France*	547,030	60,876,000	78,449,000	1.29	143.4
Croatia	56,542	44,92,000	9,415,000	2.1	166.5
Austria	83,870	8,206,000	21,935,000	2.7	261.5
Denmark	43,094	5,485,000	4,503,000	0.82	104.5
Italy	301,230	58,145,000	42,734,000	0.73	141.9
Brazil	8,511,965	19,1909,000	5,050,000	0.03	0.59
Bangladesh	144,000	153,547,000	467,000	0.003	3.2
Pakistan	803,940	167,762,000	823,000	0.005	1.02
USA	9,826,630	303,825,000	57,938,000	0.2	5.9

*Without French Guyana, Guadeloupe, Martinique, and Reunion.

Nevertheless, *India* has internationally well-known „trade-marks", such as the *Himalayas*, the *River Ganges* and the *Bengal tiger (Panthera* *tigris tigris)*, or man-made edifices like the *Taj Mahal*. Despite the apparent secondary role of the Indian tourism, the touristic sector is one of the most important income sources of the country. In 2004, this sector provided the second largest income preceded by the gem export. It is also noteworthy that, compared to the number of visitors in 1947 (the year of independence), the number of foreign tourists has increased by 151-fold *(Table 2)*.

Table 2 – Changes of the number of foreign visitors in India
Source: Khullar, D. R. (2006)

Region	1951	1961	1971	1981	1991
North America	3,628	33,268	62,027	107,410	153,502
Central/South Asia	63	1,833	3,441	11,157	11,819
Africa	268	17,701	24,716	45,278	62,127
Australia	247	2,903	13,931	26,993	30,535
Western Europe	8,088	18,552	104,081	331,326	514,541
Eastern Europe	170	5,482	7,912	27,855	46,073
West Asia	772	4,766	9,822	93,036	118,530
South Asia	1,711	18,027	27,999	539,846	590,621
Southeast Asia	1,146	12,431	31,788	65,179	78,966
East Asia	768	4,841	13,885	35,267	67,793
Stateless	38	-	1,393	863	3,001
Total	**16,829**	**139,804**	**300,995**	**1,279,210**	**1,677,508**
Region		**1999**	**2000**	**2001**	**2002**
North America		334,869	432,305	417,747	441,780
Central/South Asia		37,988	23,131	31,413	18,591
Africa		136,595	94,523	104,106	84,892
Australia		101,237	67,567	66,336	63,617
Western Europe		807,885	875,908	821,112	730,466
Eastern Europe		59,893	49,764	42,568	41,197
West Asia		110,806	95,580	99,051	93,341
South Asia		624,945	673,917	672,133	630,653
Southeast Asia		142,358	148,513	142,614	150,302
East Asia		125,108	147,674	130,809	116,053
Stateless		244	8,912	9,393	13,487
Total		**2,481,928**	**2,617,794**	**2,537,282**	**2,384,364**

Everything is true in *India*. Even its opposite is true. This statement is also valid for tourism. By analysing the latter statistics, certain factors can be found that shade the increasing trend of the latter numbers. If we analyse the visitors according to their country of origin, we find that the majority of international visitors come from the neighbouring countries (*Table 2* and *Figure 3*). Furthermore, the primary goal of the trip is family reunion and visiting relatives. However, due to the large number of foreign Indian Diasporas, from this latter aspect, countries like the *UK* are the major countries of origin. Half of the *Western European* visitors, i.e. 15% of the total number of foreign visitors come from the *UK*. Other 15% of all visitors come from the *USA*.

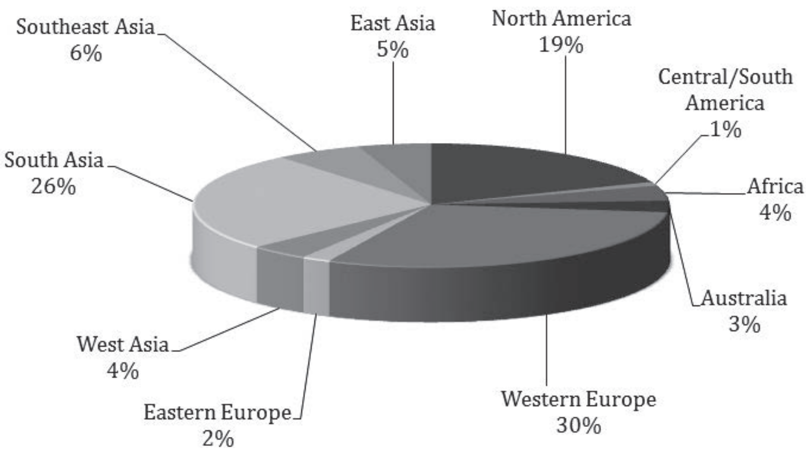

Figure 3 – Percentage of international visitors according to their countries of origin in 2004

Source: KHULLAR, D. R. (2006); Edited by WILHELM, Z. (2013)

Although, *India* has less than 0.5 per cent of the total number of visitors worldwide, several positive and promising trends in the Indian tourism have been observable since 2000. Obviously, in a country with more than 5,000 years of history, the primary destinations of foreign visitors are historic, architectural and religious attractions. *India* is abundant in attractions of these types. There are 29 sites in *India* that are listed on the *UNESCO's World Heritage* list (2012); 34 more sites are expected to join this list in the very near future. However, over the past few years, touristic attractions and destinations have become more diverse in *India*. Today, there is plethora of trekking, mountain climbing, rock climbing, skiing, paragliding and caving, and ecotourism opportunities in the majority of *India*. At the same time, less active holidays are also available on the tropical beaches.

Table 3 – Temporal trends of economic growth in India (%)

Sources: Panagariya, A. (2008); The World Bank (2012);** India in Business (2012)*

Year	Growth	Year	Gr.	Year	Gr.	Year	Gr.
On 1993–94 prices				*On 1999–2000 prices*			
1951–52	2.3	1969–70	6.5	1987–88	3.8	2000–01	4.4
1952–53	2.8	1970–71	5.0	1988–89	10.5	2001–02	5.8
1953–54	6.1	1971–72	1.0	1989–90	6.7	2002–03	3.8
1954–55	4.2	1972–73	–0.3	1990–91	5.6	2003–04	8.5
1955–56	2.6	1973–74	4.6	1991–92	1.3	2004–05	7.5
1956–57	5.7	1974–75	1.2	1992–93	5.1	2005–06	9.0
1957–58	–1.2	1975–76	9.0	1993–94	5.9	2006–07	9.2
1958–59	7.6	1976–77	1.2	1994–95	7.3	2007–08	9.8*
1959–60	2.2	1977–78	7.5	1995–96	7.3	2008–09	3.9*
1960–61	7.1	1978–79	5.5	1996–97	7.8	2009–10	8.5*
1961–62	3.1	1979–80	–5.2	1997–98	4.8	2010–11	10.5*
1962–63	2.1	1980–81	7.2	1998–99	6.5	2011–12	6.2**
1963–64	5.1	1981–82	6.0	1999–2000	6.1	2012–13	5.0**
1964–65	7.6	1982–83	3.1	2000–01	4.4		
1965–66	–3.7	1983–84	7.7	2001–02	5.8		
1966–67	1.0	1984–85	4.3	2002–03	4.0		
1967–68	8.1	1985–86	4.5	2003–04	8.5		
1968–69	2.6	1986–87	4.3	2004–05	69		

The extremely high economic development of the country *(Table 3)* has also generated a significant business and conference tourism. The Indian version of health tourism has also dramatically increased over the recent years. Private hospitals and health care centres with their expertise, promptness and prices attract a large crowd of foreign visitors. Physicians, who studied and trained in *Europe* or in the *USA*, provide state-of-the-art medical services at incredibly low costs. For instance, a bypass surgery costs a mere £500 in *India*, while patients pay ten times more for the same surgery in the *UK*. While hip replacement costs £6,600 in the *UK*, the same surgery is completed for only £860 in *India*.

Today, about 20.5 million people are employed in tourism and tourism associated industries in *India*; this number equals 5.6 per cent of all employees nationwide. By 2015, an estimated 25 million directly and 40 million indirectly employed people will have worked in tourism. The efficiency of tourism is reflected appropriately in the following statistics: 1 million rupees each invested in the tourism creates 89 new employment opportunities; this number totals only 44.7 in agriculture and only 12.6 in the general industry (KHULLAR, D. R. 2006).

1. Man-made heritage, based on natural resources

Today, following the pre-industrial and industrial phases, human development experiences a new socio–economic phase, commonly named as the post-industrial phase. During the post-industrial phase, the mutual interaction between the physical and social environment strengthens and approaches an ideal equilibrium, i.e. the socio–economical space, i.e. the geographical environment becomes total (TÓTH, J. 2001). In this context, in the socio–economic space, the increasingly broadening (in number as well) natural resources play special roles. For instance, history of crude oil extraction started in 1859, only 154 years ago; hence, it is an essential part of our everyday life without which we would be almost non-functional.

Consequently, natural resources are embedded in the socio–economic space. They are part of the physical environment, but without social demand they are non-interpretable. Natural resources are primarily important for our economic activities, but, obviously, they are essential and crucial for our everyday existence. Their exploitation usually requires a substantial infrastructure. Their utilisation demands the active involvement of the local residents and, in general, the society. However, local communities are not prerequisites for their exploitation *(Figure 4)*.

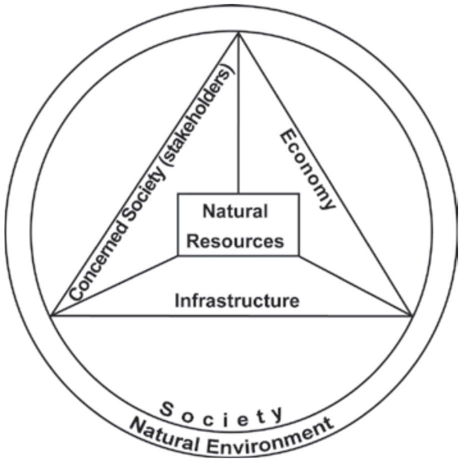

Figure 4 – Functional location of natural resources in the socio–economic (geographical) space
Edited by WILHELM, Z. (2008)

The present study aims to discuss a social heritage that is based on a commonly utilised natural resource. The natural resource in this case is the groundwater; the infrastructure is the groundwater exploiting facility whose type of infrastructure is much more than a simple well or water extracting facility; it is a part of the social heritage.

Water is the most characteristic substance on *Earth*. Undoubtedly, this is the most unique natural resource that is provided by our planet. Despite its unambiguous importance, water management is often erroneous. Water availability for human consumption continuously decreases. In addition, average water quality is worsening at the same time. Thus, maintaining appropriate aquifer qualities is a strategic and unavoidable project of the present and the near future.

In *India*, both water scarcity and excess water are characteristic and observable throughout the year. Thus, appropriate water management is extremely important. Consequently, local residents developed expertise in water harvesting, water drainage and various preventing techniques to mitigate economic and life loss due to excess water (WILHELM, Z. 2008a).

Water budget of *South Asia* primarily depends on the monsoon. With the exception of *Sri Lanka* and *the Maldives*, in the majority of *South Asia*, 70% to 90% of the total annual precipitation is received by the summer monsoonal rains. Besides the monsoonal rains, the northern part of the studied region receives a considerable amount of rainfall from the westerly cyclones, as well. Despite the well-known consistent behaviour and onset of the monsoon effect, monsoonal rains show a considerable spatial and temporal variability. Long-term temporal variability depends on the thoroughly studied *El Niño anomalies*. Out of the 22 documented draught-impacted years between 1871 and 2002, 11 years were affected by the *El Niño effect*. In all the seven most characteristic *El Niño*-affected years, between 1901 and 1990, annual total precipitation was below the long-term average (KUMAR, K. R. *et al.* 2003).

When and where available per capita, water is considered as a pronounced difference that is observed among the individual countries of the studied region. However, it is noteworthy that per capita consumption varies to a large degree among the individual countries. Nonetheless, each country has considerable liquidity water reserves *(Table 4)*. Surface waters are primarily available over the period of monsoonal rains (June to September), however, their majority flows unutilised to the oceans. Water flow of Indian rivers varies considerably throughout the year. The ratio of water flow between dry and wet seasons in the *Brahmaputra river* is 1 to 4, in the *Ganges* 1 to 6, in the *Godavari* 1 to 10, and in the *Narmada* 1 to 12 (WILHELM, Z. 2001).

This high-degree dependence on the extremities of natural resources put water into the focal point of the economic life. No other region on *Earth* owns as many religious beliefs associated with water as *India* does. The importance of water was also noted in the cultic world of the previous residents of the area. In the life of the early civilisation along the *River Indus (Harappa Culture)* reservoirs, pools were tagged with sacral meaning, just like in the case of the *Large Spa of Mohenjodaro*. In the southern states of *India*, where the *Dravidic* language is widely used, early settlement structure has been maintained. These settlements include pools and spas surrounded by churches or church complexes in their downtown area (WILHELM, Z. 2008b).

Table 4 – Annual per capita freshwater availability and consumption in South Asia, 2002 (m³) *(1 m³~1000 litres)*
Source: MONIRUL QADER MIRZA, M. – AHMAD, Q. K. (2005)

Country	Availability	Consumption
India	2,158	612
Pakistan	3,250	1,269
Bangladesh	19,210	217
Nepal	7,623	154
Bhutan	120,405	13
Sri Lanka	2,642	573

The apparent religious demand of the collection and utilisation of available water is naturally based and is perceived as an economic force. The economic success of *India*—simultaneously with the so-called green revolution, population increase and the adaptation of the western lifestyles—has unambiguously reflected in increasing water consumption over the past decades. Household water use increased six times between 1990 and 2000, while industrial water use doubled over the same period (MADARI, D. M. 2007).

Increasing water demands are also present in agriculture. Agricultural employment and profitability is primarily determined by the presence or absence and utilisation efficiency of the available water (*Figures 5* and *6*). Excessive groundwater usage has dramatically decreased the level of groundwater tables at several locations in *India (Figure 11)*, since—in despite of the traditions—water used for irrigation purposes is primarily obtained from wells. The only exceptions are the poorly financed small farms where water for irrigation is based on the traditional tank system (traditional Indian reservoirs are called tanks). Due to the increasing water use and increasing impact on the environment, conventional water harvesting and utilisation techniques need to be revitalised. Consequently, studies on the revitalisation of such water management techniques have been undertaken. From another point of view, but with a similar goal like in *Europe*, studies of water management problems are as similarly vivid on the *Indian subcontinent* as on *the Old Continent*.

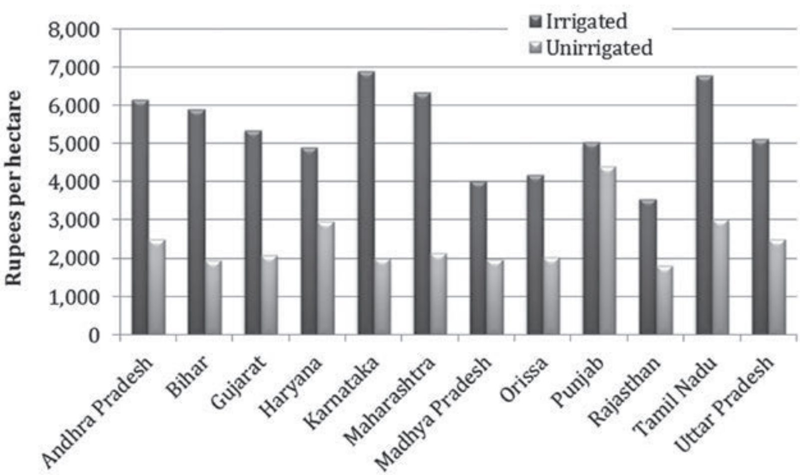

Figure 5 – Differences in income* between irrigation and dryland farming in selected states of India

Source: Briscoe, J. – Malik, R. P. S. (2006); Edited by Wilhelm, Z. (2013)
** 100 Indian Rupees (INR) = 1.21 Pound Sterling (GBP) (23.04.2013)*

Based on both literature and field works, the author documented and studied more than 50 conventional water harvesting and water managing methods in *India*. In this paper, he provides a relevant technique for the edited book on sustainability; this water harvesting technique is predominantly employed in the states of *Rajasthan* and *Gujarat* and is called *vav*, *vavdi*, *baoli, baori* and *bavavdi*. The word by word translation of the word in English is stepwell.

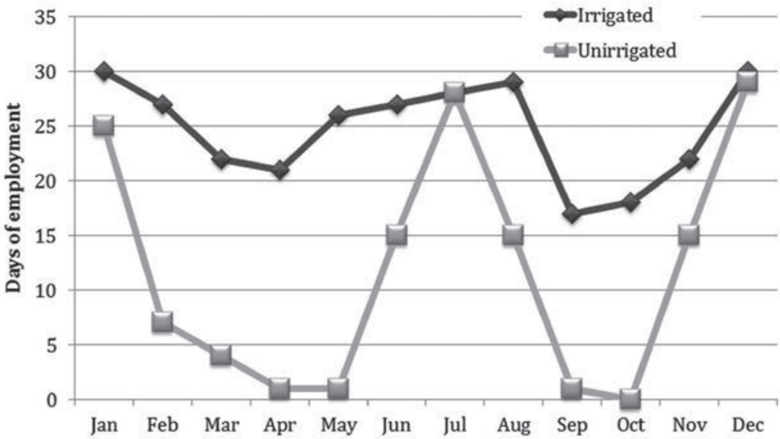

Figure 6 – Average monthly number of days of employment of agricultural day-workers on irrigation and dryland farms
Source: CHAMBERS, R. (1988); Edited by WILHELM, Z. (2013)

2. Stepwells (vav/vavdi/baoli/bavadi)

Conventional stepwells in *Gujarat* are called *vav*s or *vavdi*s, while their name is *baoli* or *bavadi* in *Rajasthan* and in *Northern India*. Wells of this type were built by noblemen partly for strategic and partly for humanitarian reasons. They are non-religious edifices with water being available for everyone. Wells of this type were decorated with statues and inscriptions indicating their social and artistic relevance. Location of stepwells showed the purpose of their use. If the well was situated in a settlement or at its margin, it was a location of public meetings and gatherings. If the well was found between settlements along a trading route, it functioned as a rest area. Several stepwells are found along military and trading routes.

The city of *Patan* can be found 130 km (80.8 mi) northeast from the metropolis of *Gujarat* which is primarily visited by tourists due to its fantastic stepwell, the *Rani-ki-vav (Figure 7–8)*. The settlement preserved the capital rank of an ancient *Hindu kingdom* for a long period of time. In 1024 A.D., however, it got under the Muslim occupation and lost its significance. This change of power structure, however, did not inhibit the construction of the sensational stepwell which was first put in practice in 1050. Through time, the maintenance of the well was more and more neglected and it was completely silted as a consequence of which it was preserved in an excellent quality and was only excavated again in the 1980s.

The vav of the city of *Adalaj*, also in *Gujarat* (19 km/11.8 mi north from *Ahmedabad*), is much younger *(Figure 9)*. It was first put into practice in 1499; its erector was *Queen Rudabai*. The well itself is 5 floors deep and, like the *Rani-ki-vav*, it is decorated with breath-taking carvings and art implementations, as well. The year 1499 was written with golden letters in the book of the stepwell architecture in *Gujarat*, since the *Dada-Hari-van* reached completion in *Ahmedabad (Figure 10)*. About 200 m (0.22 mi) away, there is another stepwell, as well (the well of *Mata Bhavani*) which is now used as a Hindu temple.

The demolition of the spatial structure of the stepwells was considerably enhanced by the increasing agricultural activities. These public wells are extremely valuable in the eyes of the public. They create not only access to natural resources, but, at the same time, serve as public meeting points and locations for information exchange. Simultaneously, they are living museums of conventional water extracting facilities. Unfortunately, the groundwater table has been decreasing significantly since the beginning of large scale agricultural activities. Due to the decreasing volume of local aquifers, many of the stepwells lost their water entirely and were completely dried out. Consequently, they lost their original function. Today, communal water supply is widely available in *India*, thus, residents rather use taps than trek to the magnificent edifices of stepwells. Furthermore, nowadays several *baoli*s simply function sadly as garbage depositories.

In *India*, where several-thousand-year old buildings are integral and common parts of the landscape, little attention is paid to the remaining, artistically valuable stepwells. Likely, an international collaboration is needed to direct the attention of local residents to these undeservedly neglected architectural values and to appropriately manage stepwells as their real cultural heritage. Many of the stepwells

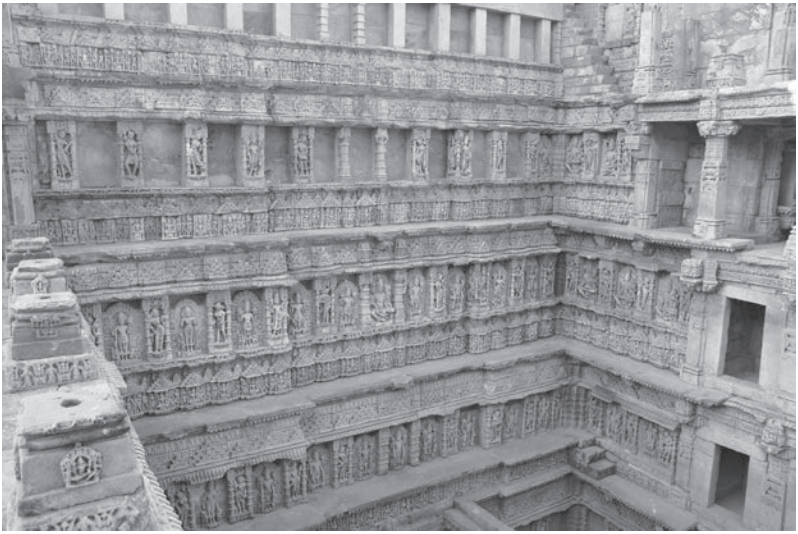

Figure 7 – One of the ornate lateral walls of the Rani-ki-vav of Patan
Photographed by WILHELM*, Z. (2009)*

Figure 8 – Some from the thousands of stone sculptures of the Rani-ki-vav
Photographed by WILHELM*, Z. (2009)*

Figure 9 – Some details of the underground world of the Adalaj-vav
Photographed by WILHELM, Z. (2009)

Figure 10 – The sink building of stepwell of Dada-Hari-vav in Ahmedabad
Photographed by WILHELM, Z. (2009)

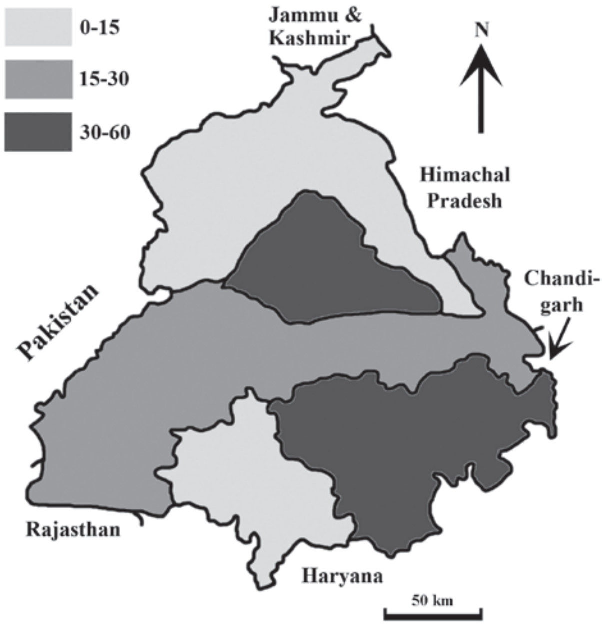

Figure 11 – Drop of groundwater table (%) in Punjab between 1966–1996
Source: Kaur, D. (2007); Edited by Wilhelm, Z. (2013)

could potentially function as touristic attractions. By changing their fundamental role, stepwells could function just like many years earlier: they could generate income and could provide and supply life.

3. Summary

In this article, the author have shortly analysed the tourism positions of *India* on the international market from which he has pointed out that this is rather weak compared to its supply and opportunities. Moreover, he has demonstrated the peculiar role of water as a natural resource on the sub-continent. Since water takes place in the focus of the social-economic life in *India*, it has been extremely appreciated over history. As a result of this appreciation, these work-of-arts were born that of their functions were the provision of water to people. That is how these wells (stepwells) have also become a part of cultural heritage (*Figure 12.*). The *Rani-ki-Vav* of *Patan* has been on the tentative list of the *UNESCO World Heritage* since 1998. When it obtains the title, it will certainly serve as an outstanding example for exhibiting a traditional and sustainable water management method and together with other stepwells, it can contribute to the broadening of the tourism supply in *India* by increasing the income in the tourism industry.

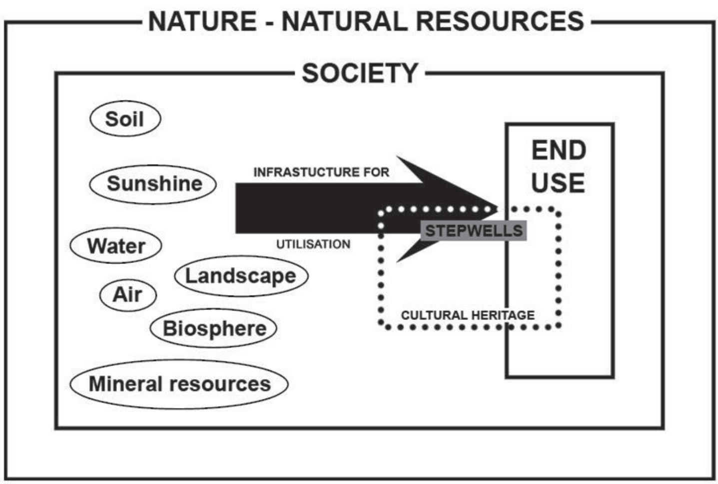

Figure 12 – The possibilities of social–economic exploitation of water as a natural resource (the location of stepwells)

Edited by WILHELM*, Z. (2013)*

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'Geodrawphy' of Bhutan: A Nature-based Holistic Society in the Himalayas

Abstract

In this paper, we discuss Bhutan's geography that particularly deals with its energy resources, energy production and supply. But beyond this challenge, there is a more effective silhouette of the advantage for publishing this paper originally in Hungarian language (Bokor, L. – Szelesi, T. 2011). At that time, we believed it was a stop-gap for our academic profession, especially in Hungary. Now, we have realised that the internationally available information about Bhutan's geography of energy is generally too vague. Therefore, for this revised version, we have updated all the relevant data and written a comprehensive guide to Bhutan, this time in English. Our work is meant to present a little bit of this Asian kingdom, but also introduce an example of the sustainable and competitive holistic economy and its social progress. As these are kind of key fields for the further development in Bhutan, our aim is also to demonstrate their importance and provide examples that could also be adopted locally anywhere else on the planet.

Key words

Holistic society; Blue economy; Sustainable local development; Geodrawphy

Introduction

This study has been written as more of a reform experiment. With it, we would like to call the attention of the professional geographer's audience and also reach the average reader and introduce *Bhutan*, by using comprehensive and up-to-date international literature and resources. Our goal is, moreover, to observe —by using physical geographical bases and specific human geographical spectrums (energetic at present)—and also to introduce unusual examples of nature and environmental awareness to the *Western World* in the instance of the *World's* most spiritual country.

Situated within the eastern chains of the *Himalayas*, the *Vajrayana Buddhist Bhutan—in Dzongkha* it means the *Land of Thunder Dragon (Druk Yul)*—is among the *Earth*'s relatively small and young democratic countries. Its territory covers 38,394 km^2 (14,824 mi^2), and its total population between 1998 and 2002 was estimated to 1.8–2.3 million by the *United Nations* (SZEGEDI, N. 1998; BROWN, C. E. 2002). However, the official *Bhutanese Census* in 2005 exposed that the total number of inhabitants was as little as only 634,983 (BROWN, L. *et al.* 2007; NSB, 2009). (According to the CIA WORLD FACTBOOK [2013], the total population is now growing and is estimated to 725,926.) In Asian dimension, primarily spatially and population-wise, it is doubtlessly a small political entity; and as a landlocked country, it is wedged between two bordering giants. Its neighbours (*China* and *India*) like joiner's clamp vice it by their sizes (e.g. by areas and by populations) and also by the dynamics of their economic growth (WILHELM, Z. 2010). As a *Himalaya*n country, it is located at high altitude where the young arcs of mountain contours fall apart from the great alluvial plains of *Brahmaputra*.

1. The basis of the Bhutanese society

There has not remained much and known about *Bhutan's* early history because in the old capital, *Punakha*, a fire devastated the city in 1827, and the ancient records had all been perished. In the 17–18th century, the country broke into several feudal states, but the anarchic conditions had only ended when *Ugyen Wangchuck*, the governor (Penlop) of *Trongsa*, defeated his political enemies and united the country, following the civil wars of 1882–1885. In 1907, he was unanimously chosen and elected as the hereditary king (inherited) of the country. From this moment, *Bhutan*—like *India*—slowly went under British control, but was only dependent on its foreign affairs. By the 1960s, the country itself developed independently and—even then and after the *Indian independency* was achieved—remained an isolated state. Its opening to the world—especially to *India*—began by the Chinese occupation of *Tibet*, when, in 1959, *China* claimed the part of the *Bhutanese Kingdom* (JACOBS, D. 2005).

By the end of the second millennia, it had functioned as a hermit state, as an absolute monarchy. The end of that era was official by the abdication of King *Jigme Singye Wangchuck* on 14 December, 2006 in his son, *Jigme Khesar Namgyel Wangchuck*'s favour. *Bhutan's* political system developed from an absolute monarchy to a constitutional monarchy. By this step, the country moved onto the path of modern democracy with the adumbration of conscious goals placed on natural bases and holistic approach of economic growth (GALL, T. L. 2004).

Bhutan's economic activity, with regard to the *Western World*'s concept (GDP), belongs to one of the *Earth's* underdeveloped regions. The present estimated data of GDP (purchasing power parity) is circa 6,500 USD per capita, 47% for literacy, 35% for urbanised population, and 44% for agrarian workers (CIA, 2013). These data present *Bhutan* as a poor and an economically backward, agrarian country; however, in their own interpretations, their country is an independent and sovereign and, when it comes to its natural and historical treasures, it is infinitely rich and in human spirituality it is one of the *Earth's* most colourful and blissful formations of society. As the local inhabitants emphasise: *Bhutan* is the "Country of Happiness" which they put in opposition to the *Western World*'s GDP and measure their life with the GNH index (Gross National Happiness). The latter shows the quality of life and the non-economy-based standard of life (NORBU, U. P. 2012). They intend to preserve this by not copying the wrongly structured

"Western" economic models and consumer habits and they do not place into trade their traditional values into trade (for example, the country's first TV programme supply started just in 1999 with quite a few resistance against it). As a protection of the country's natural treasures, the number of tourist visitors allowed to enter the country is maximised at an annual rate (LAMA, M. P. 1998; SZEGEDI, N. – WILHELM, Z. 2008). It is the *Earth's* first country which has fully adopted *Gunter Pauli*'s concept of *Blue Economy* (transpose purpose of maximum efficiency and self-regulating processes of nature into the economy) and highlighted its future's economic development by the guidance of that (PAULI, G. 2010a; 2010b).

2. The natural environment as one of the most important pillars of culture and energy economy

The employment of energy resources forms inherent components in today's social–economic systems. Its main nature is that the *Western World*'s economic–material–financial society—by the aims of profit-orientation and the subordination of nature—pursues only a continuous economic growth (HAJNAL, K. 2010). This system is, however, sensitive to energy (just as to the energy resources)—primarily to electricity or heat—which are the most important components of all producing equipment, like water to a fish. Therefore, it is not a miracle and it is not even surprising that the *European* and *North American* statistical publications find *Bhutan* as an underdeveloped and backward agrarian country (SZEGEDI, N. 1998; BROWN, C. E. 2002). However, this Himalayan state is also identified as the land of secrets and mysteries (HAGGETT, P. 2002). In the *Western World*, if anything appears in this relation (thus, by its economic-development measurer, based on the GDP, is 'underdeveloped'), assuming that on one's mental map, it is marked by white, thus, it is *terra incognita* (which is an undiscovered territory) from what—like a mediaeval curse—everyone has to be feared of, or, at least, be kept refrained from.

Figure 1 – Bhutan's shaded relief conditions

Edited by SZELESI, T. - BOKOR, L. (2013); Meteorological stations are according to NHMS (2013)

However, the blank white spots of the mental map can be coloured, thus, Bhutan can be re-drawn and re-characterised by, principally, four distinct shades similarly to the classically defined environmental zones by KARAN, P. P. (1987). The technic can now be called geodrawphy:

grey, white, blue and green. These are 'elements', from which the chains in our brains can slowly be broken: sedimentary rock formed young mountain ranges (grey; e.g. *Great Himalayan Range – Figure 1*);

- their snow-capped summits that go above 7,000 metres (23,000 feet) in heights (white; e.g. the official top of the country *Gankhar Puensum* [7,570 m/24,835 ft]);
- from those, melt waters born huge rivers (blue; e.g. rivers in the *Brahmaputra*'s catchment area [for example *Manas Chhu*, also known as *Lhobrak*]);
- the southern barriers of all of the above mentioned ones, as low-level mountains, sub *Himalayan foothills* (e.g. *Siwalik*), basins and alluvial plains (e.g. *Duārs*) which are the main sources of the 70.5% forestation of *Bhutan* (green).

From the point of view of geography of energy, the most important is to exploit those energy resources which are locally available in a particular area and can be compatibly used by the aim of today's sustainable development. This is the philosophy of *Blue Economy*, too (PAULI, G. 2010a). In the world, there is everywhere at least one such type of source, but their majority differs in their employable amount of quantity and quality. In some countries—especially there where the basis of the economy is established on conventional fossil energy sources and the locally exploitable natural energy sources are small in their available amount—a tight dependency has developed on the import of energy sources. In these countries (like *Hungary* or the *United Kingdom*), the new and sometimes expensive energy production methods and equipment are not easily adoptable. On the contrary, in those countries where nature provides *Canaan* of exploitable energy resources (for example hydropower in *Austria*, in *Norway*, or in *Switzerland*), the occasional struggle from financial or energy crises, their dependency and import sensitivity are only affected by the pursuit of their constant economic growth. Nevertheless, the so-called renewable and sensitively renewable energy sources (e.g. solar, wind, water biomass and geothermal energy—*see pp. 14–29*) could maximally be able to contribute to their electric energy production and partly also to their primary energy supply.

Two of the above mentioned three *European* countries are *Alpen* and one is mountainous *Scandinavian*. All of them bear huge amount of renewables and relatively small amount of fossil resources (yet this does not apply to *Norway*). *Bhutan* is part of the *Himalayas*. If we started our analysis by having mentioned and known this fact only, it would already be highlighted that this relatively small *South Asian* country owns the *World's* largest amount of energy resources and reserves. Luckily, this type of energy sources is not fossil-based …

3. Primary energy structure

… because *Bhutan* has no known *hydrocarbon resources* (neither crude oil nor natural gas). Therefore, there has not been installed any assisting infrastructure either (e.g. oil refineries) (Fraser, N. *et al.* 2001; Tshewang, K. 2007). The ready-to-use raw materials (such as oil products) are imported principally from *India* (CIA, 2013; IEEJ, 2009).

The country's *coal* properties are having the same limitations as the hydrocarbons. However, in opposite to those, there is a small hard coal reserve exploitable in *Southeast Bhutan* (*Bangtar*, *Chenangri* and *Deothang*) where mines are still in operation. The size of the entire coal reserves is estimated to 1.96 million tons. This potential, however, is relatively small and to cover its needs, *Bhutan* imports coal from *India*. Regardless of the size of the reserve, sometimes coal is also exported mainly to *Bangladesh.* However—according to their bilateral agreements—it is then exported back to *India* (Fraser, N. *et al.* 2001). The minor amount of coal is used in the local factories (e.g. in the areas of chemical industry and used as coke in iron making and steel production). As opposed to Szegedi, N. – Wilhelm, Z. (2008), they never use coal for electricity production.

There is no support of *nuclear energy* in *Bhutan*, therefore, there has been no power station installed either.

The three paragraphs earlier mentioned "ready-to-use import energy resources", according to Tshewang, K. (2007), mean primarily *hy-*

drocarbon products, such as diesel oil, petrol, kerosene, liquefied petroleum gas (LPG) and specific greases. Diesel oil and petrol are used in transportation, whereas kerosene is majorly used for domestic purposes to heat in the urban areas and to produce a small amount of electricity for lighting houses in the rural households. LPG is also normally used in homes in gas cylinders. Imports of petroleum products have been gradually increasing in recent years, because the continuously improving quality of paving brings more vehicles onto the roads. (According to NSB [2009; 2012], in 2004, there were altogether 26,740 (governmental and privately) owned vehicles in the country, whose number went up to 40,659 by 2008, and at the end of 2011 the total number reached 62,697.) This is the only major issue that makes the country dependent on import of crude oil (100%) *(Figure 2)*.

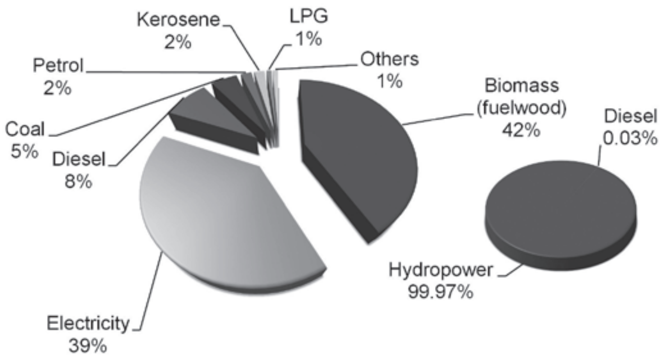


Figure 2 – The overview of Bhutan's primary energy supply in 2005 (left) and its electricity production (right) in 2012

According to TSHEWANG, K. (2007) and NSB (2012), edited by BOKOR, L. (2013)

Moreover, *Bhutan* also endeavours to do free of fossil fuels in transportation, for which it tries to contribute by developing and using biologically and locally produced energy sources (PAULI, G. 2010b).

Biomass is not yet supported as an energy source for electricity production. There are no biomass power stations in operation either. Biomass has no role in the structure of electricity production; however, its share is significant in primary energy supply due to the high percentage of forestation (70.5%) in the country. The traditional biomass utilisation is majorly represented by the burning of wood (and animal roughage similarly to *Nepal* [Wilhelm, Z. *et al.* 2010]) which is primarily used for domestic purposes (approx. 90%), e.g. in cooking and heating of homes.) The annual firewood is the largest use of energy derived from a solid fuel and it has the highest rate in *Bhutan* among the *Earth's* countries (725 thousand tons/year). The estimations show, however, that this amount will probably increase in the future (IEEJ, 2009). The majority of the country's woodland is protected. At the moment, the total per cent of land covered by Protected Areas, Biological Corridors and Conservation Areas sum up to 51.44% of *Bhutan* (MOAF, 2013). In case of a further success of the *Blue Economy*, the currently separate areas might turn into a country-wide national park.

As everywhere else on *Earth*, biomass is primarily used for heating purposes, and the hydro power is utilised for electricity production. *Bhutan's* hydro energy potential is huge, thus, it is one of the most consistent energy sources that guarantees continuous supply for the entire country and even beyond its borders.

4. A strong relationship between the electricity production and renewable energy resources

Electricity occupies 39% of primary energy forms in *Bhutan*. According to data from the *2005 Census* and the *Statistical Yearbook of Bhutan 2012 (Figure 2)*, 99.97% of electric energy was obtained from domestic resources that make *Bhutan* a unique state in the world. Its top ranking is due to the fact that the country is situated among the chains of the *Himalayas* providing inexhaustible supply of hydropower which has become part and parcel of its culture through centuries and it is now the basis of the *Bhutanese* economic growth (Zürcher, D. – Choden, K. 2004). The amount of hydropower is enormous, but its utilisation is still low. Therefore, the country has its own necessary energy resources available for an economic boom right away; sources can be regarded as the precursors of an environmentally conscious process of industrialisation (Wilhelm, Z. 2010).

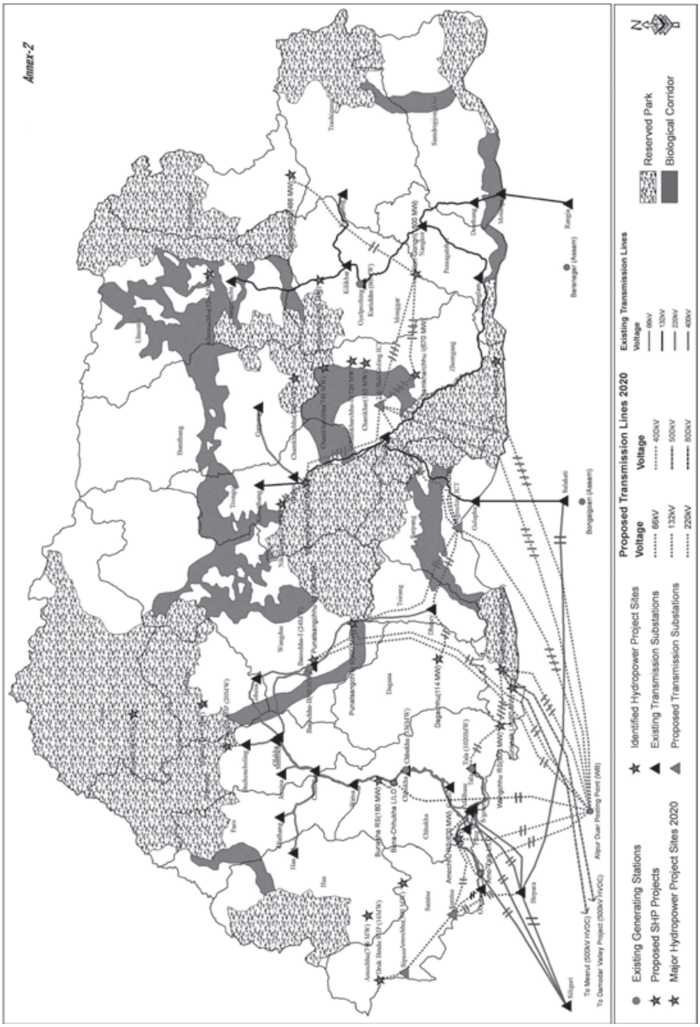


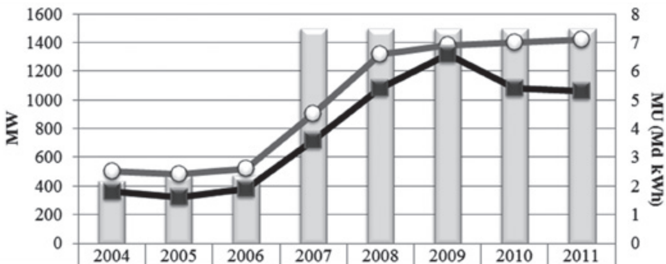
Figure 3 – Existing and proposed power transmission infrastructure by 2020

Source: With the permission of the Ministry of Economic Affairs, Department of Energy, Bhutan Received from TSHEWANG, K. (01.10.2011)

The process of electrification in *Bhutan* began in 1966, when the first 256 kW diesel generator (miniature heat power station) was built in *Phuentsholing*. Then, in 1967, the first low-powered 360 kW hydro-power station was established in the capital city *Thimphu.* Until the middle of the 1980s, electric energy production was supported by grants from *India* and *Japan*, and the country also had diesel power stations and low-powered hydroelectric power plants for domestic production. Between 1986 and 1988, two turbines of the *Chhukha* power station (with 336 MW installed capacity) started to operate. This was the only hydroelectric power station until 1990 providing 82% of all Bhutanese electric energy. In the spotlight of an economic boom after 1990, more hydroelectric power plants were planned; however, projects were carried out only after 2000 with faster installations: *Kurichhu* (2001, with 60 MW installed capacity) → *Basochhu I.* (2002, 24 MW) → *Basochhu II* (2004, 40 MW) → and *Tala* (2006, 1,020 MW) *(Figure 3)* (TSHEWANG, K. 2007; IEEJ, 2009; NSB, 2012).

As a result of the instalments, by the end of 2011 the total installed capacity of hydroelectric power stations had reached 1,488.1 MW (a total of 1,497.29 MW with other plants like diesel generators); however, according to TSHEWANG, K. (2007), there is still an estimated 23,500–30,000 MW of theoretical potential which could be exploited from the country's hydro reserves. Until 2020, experts have agreed to increase the total installed capacity by hydroelectric power plants up to 10,000 MW as the currently developing *India's* needs for energy means a perfect opportunity for energy export. Hydroelectric power seems to be the basis of an oncoming and future Bhutanese economic growth and development which will fundamentally move the country from a backward position to a highly developed state.

The total amount of *Bhutan's* electric energy is generated by hydroelectric power stations, which is sufficient for domestic needs, so that, a significant amount of power is exported to *India (Figure 4)*. In 2011, 7.1 billion kWh of electric energy was generated in *Bhutan,* and 5.3 billion kWh was exported, mainly to *India*. This amount of energy is equal to 74.7% of all the domestic production (NSB, 2012). The distribution of electricity supply was designed according to the establishment of power plants, the efficacy of production and the needs of buyers' markets. The distribution in 2011 included transmission lines of 400 kV (74 kilometres), 220 kV (219 kilometres), 132 kV (345 kilometres), and 66 kV (311 kilometres) *(Figure 3).* The fast process of development is obvious: in 2004, 40 cities and 1,064 remote villages were electrified. In addition, 71 cities and 1,934 remote villages were provided with electricity in 2008. Currently, there are altogether 3,194 settlements where electricity is distributed to (IEEJ, 2009; NSB, 2012). However, the country is not lagging behind and is not in poverty regarding its domestic consumer needs. The country has recently embarked on the drive to provide "electricity to all by 2013" with the taking charge by the first democratically elected government in 2008.



	2004	2005	2006	2007	2008	2009	2010	2011
Installed capacity (MW)	437.82	477.82	477.26	1497.36	1497.29	1497.29	1497.29	1497.29
Production (Md kWh)	2.5	2.4	2.6	4.5	6.6	6.9	7	7.1
Export (Md kWh)	1.8	1.6	1.9	3.6	5.4	6.6	5.4	5.3

Figure 4: Indices in Bhutanese energy production between 2004 and 2011
Edited by BOKOR, L. (2013) based on data obtained from National Statistics Bureau (2009 and 2012)

The system of the electricity supply distribution will certainly be further developed as *India's* rapidly increasing need for electric energy consumes a growing amount of hydroelectric power. As a consequence, experts are already planning further establishment and development of hydroelectric power plants, and the expansion of the electricity supply distribution is in question *(Figure 3)*.

5. ... beyond forests and rivers

In energetic systems, the two (biomass and hydroelectric energy) mentioned forms of renewable energy sources play an important role. Although, they have been proven to be indispensable for the development; according to UDDIN, S. N. *et al.* (2007), they have also been found vulnerable due to climate change and environmental degradation. Bearing this in mind, it is worth investing in other renewable possibilities, since *Bhutan* has more energy sources such as solar energy, wind power and some other types of bioenergy.

Making use of energy of the *Sun* in *Bhutan* is significant considering the country's traditions (it means the passive utilisation: suitably orientated houses or preserving food such as fruits and meat products). There are some already installed solar cells which are now able to generate sufficient power for low-energy buildings and institutions (schools, buildings of monastic orders and transmission towers of radio stations) in remote villages (FRASER, N. *et al.* 2001). In 2009, 0.3 MW of power was generated by installed solar cells (IEEJ, 2009).

Although, *Bhutan* has wind power plants in the neighbourhood of *Jakar* (*Bumthang* region) and *Wangdiphodrang* (*Wangdue* region) *(Figure 1)*, there have not been prominent attempts to make use of wind power for energetic purposes so far. Relying on wind energy in the future, higher altitude areas give fruitful prospects. These elevations are in connection with the current major meteorological stations in operation (NHMS, 2013. – *Figure 1*) which constantly convey weather information. Regarding windy conditions, these areas in *Bhutan* are the best choices for building wind power plants. There is no accurate and detailed mariners' card available for these areas, because professionals plan to create them experientially with the newest technological innovations by taking land conditions and natural relations into consideration (PAULI, G. 2010b).

Facilities for the production of biogas (one of the forms of biomass) are proper all over the country and there are some established industrial units. The vast majority of these units are situated in the southern, above the sea level areas of lower heights including *Sarbhang (Sarpang).* In addition, there are also some units in the region *Punakha (Figures 1).* On a daily basis, units produce only 2–9 m^3 (70.6–317.8 ft^3) of gas sufficient for basic public purposes such as illumination (instead of using kerosene) in predominantly remote villages. As the production of biogas gradually expands, a significant decrease in the import of hydrocarbon is expected.

Despite the fact that the country has appropriate natural endowments, the use opportunities for geothermal energy are not so good and the methodology is still unknown.

6. Conclusion

We have, limitedly, showed *Bhutan* from its energetic possibilities. We really think that all the fields well reflect how inhabitants of the *Kingdoms of South Asia* try to live in harmony with nature which clearly appears in their everyday life and activities. Conditions for the development of energetic systems are defined by surrounding mountain chains that can be considered as the basis of Bhutanese culture and its attraction to nature. Characteristics of Bhutanese society and economic structures are in a strong relationship with the country's mountainous site. The latter is regarded to have an important natural value and is the ground of Bhutanese culture, as well. Also, geographical conditions provide the essentials for joining the international economy.

Bhutan can, with good reason, be proud of its self-reliance and its practically total independence. The country makes every effort to maintain these values with all kinds of economy-boosting political measures which are effectuated through environmentally conscious and viable strategies. Nevertheless, *Bhutan* does not give out its natural and cultural values; all the economy-boosting measures are carried out in the light of remaining the happiest country in the world with its ever-smiling population. All these features are, in our view, exemplary, and *Bhutan* is determined to demonstrate them to the *Western World* countries that think that *Bhutan* is situated in a poor and underdeveloped region *(Kingdoms of South Asia)* according to local GDP information. However, the opposite is true: *Bhutan* is a developing country.

Bhutan is probably not an economic great power in the sense that western countries are, but can be famous for its pure way of thinking and circumspection. *Bhutan* is also the *World's* last paradise whose population demonstrates societal development relying on its natural values. We can, frankly, say that *WesternWorld Countries* should take *Bhutan* and its development as an example …

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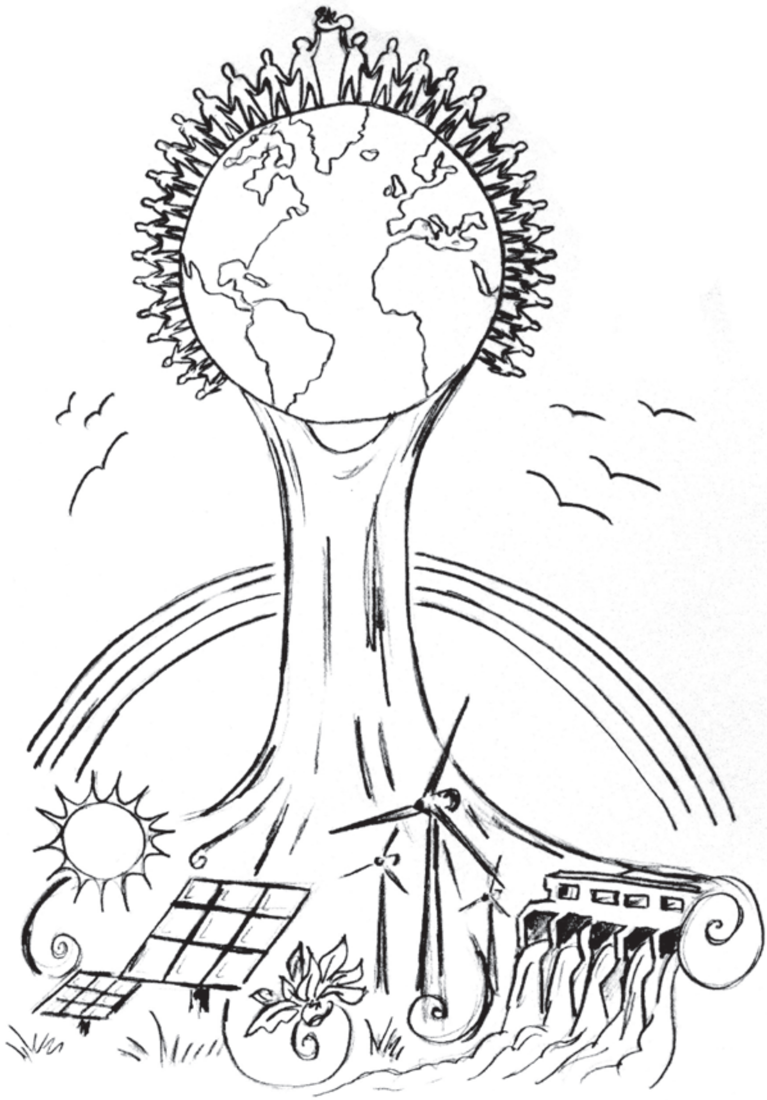

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The Feasibility of Micro-regional Autonomous Energy Systems

(using renewable energy sources for regional development)

Abstract

The current and the future situations of the utilisation of renewable energy sources are contradictory. As a consequence of the present economic crisis, investments in this field are in decline all over the world. One of the most advanced bio-Diesel plants of Europe, in Orosháza, has been out of order for four years. Hungary's first biomass electric power plant, created as a Japanese–Hungarian investment in Szakoly, went bankrupt only after a few months of operation and is still out of use. In the long run, the "One Europe–One Market" idea is not very attractive for investors. In December 2012, the chairman of the Hungarian Renewable Energy Association resigned. His reasons: the use of renewable energy has lost its importance in Hungary, as the government only focuses on nuclear power and the usage of natural gas. We must all prepare for the changes in our own area, and small communities should draw their own energy strategies. This primarily means building local energy supply systems. The annual amount of 6 million tons of unused biomass, solar- and geothermal energy offers a sound foundation for such plans. In this respect, the country has great potentials. In this study, an attempt is made to draft the optimal ways of development.

Key words

Hungary; Renewable energy resources; Energy policies; Local solutions

Introduction

Hungary is located in *Central Europe*. With 93,000 km^2 (35,919 mi^2) of land covered, the country lies in the middle of the *Carpathian Basin*. Due to its central location, the country plays a significant role in energy transport in the direction of the neighbouring countries and *Western Europe* (e.g. transmission lines of electricity, natural gas and oil pipelines are running through the country). *Hungary* purchases 65% of the total primary energy resources from *Russia*. In the last few years, the country has set a target. It aims to get independence from the imported energy sources. This goal increased the utilisation of the renewable energy sources, the development of the nuclear energy and the further usage of existing oil, gas and coal reserves. The exploration of the geothermal energy has a significant role in the energy efficiency action plan. The possibility of uranium mining is genuine and is now under exploration by an Australian company.

Nowadays, several research centres are dealing with sustainability models for micro-regions. Old local communities that have disintegrated and fallen apart by now are to be re-constructed. No sustainable economy may exist without a powerful and sustainable local infrastructure. Out of the public supply and utility systems (e.g. energy, communications, water, sewers, flood defence, information networks), energy supply receives most of the attention. Public reactions to energy issues are sometimes extreme and the opinions may easily infiltrate into media and even politics. Moreover, there may be social uproars or riots that are instigated by political forces from the background as well as profit-hungry business enterprises. Energy management is an extraordinarily complex technical and financial activity that integrates a wide range of sciences: for example geology, geography, mining, chemistry, physics, meteorology, economics, law and even sociology. All of these areas are amalgamated with the special competences of the trade. Energy production and energetics in general are like football: everybody claims to know a lot about it. Undoubtedly, selecting a method for heating, operating a car or lighting the house requires a series of personal, individual decisions. Most often, it is the owner of car or the house who makes a decision; selecting central heating, stove, electricity or oil heaters (like most detached houses in *Germany* do). It is possible to continue the list with a variety of other examples. On the other hand, energy politics has to contribute to economic growth, fight against climate changes and efforts aimed at reducing the dependence on foreign energy sources. Individuals and communities alike strive to reduce the dependence, wishing to find an economic and effective solution. One of the most common objectives of renewable energy sources is that they are very often incompatible with the changing demands on the consumers' side; e.g. wind, solar energy, water and tidal power.

1. Hungary's renewable energy resources

Based on our experience, there is a lot of hostility and indifference towards renewable energy sources in *Hungary*. This is partly a consequence of experience and support. A logical, supportive government decision often generates a whole new industry. Such is the case in *Germany* where they offer an amount equal to 156 HUF (0.42 GBP) for every kW supplied to the national grid from household photo-electric panels. In *the Netherlands*, the respective amount is 160 HUF (0.43 GBP), whereas in *Hungary* it is only 22 HUF (0.06 GBP). The differences are considerable. Within the *EU*, *Hungary* is at the end of the line in terms of supporting the use of alternative energy sources. A simplification of the official procedures would be a great step forward (e.g. at the moment, 45 different official permits and licences are required for installing wind power generators). When the new price for re-supplied energy was introduced in *Germany*, 7,000 MW new solar panels were connected to the system in 2012. When there are good potentials and capital for the use of renewable energy, it appears to be simple. That is, however, not the case. There are several towns and villages in *Hungary* where readily available thermal water of 70°C (158°F) or nearly 90°C (194°F) is simply drained to sewers and rivers (e.g. *Tiszacsege [Figure 1]* has a population of 10,000 and its well yields 800 m^3 [~800 thousand litres] of hot water a day (73°C/163.4°F), 99% of which is unused and simply flows into *River Tisza*.) It would be worth surveying the degree of utilisation of the thermal wells in *Hungary*; in *Szabolcs–Szatmár–Bereg County* it is estimated at 5%. Some of them only need 3 hours of rest after thirty years of continual operation to reset to their original water output.

Figure 1 – Hungary and the settlements mentioned in this paper
Edited by SZELESI, T. (2013)

A relatively small country such as *Hungary* is unable to do a lot for the reduction of global CO_2 emission, particularly when large countries like *India*, the *Republic of South Africa*, *Russia* and others do virtually nothing in the struggle against climate change. The world-wide ”Earth Protect” programme, which is a joint objective of mankind, is apparently not important to the countries mentioned. This is a business where we pay the bills (especially *Europe*), but others draw the profit. Our fight for increasing the share of renewable energy sources may, therefore, appear to be a wasted effort.

Hungary does not have a comparative advantage in terms of green energy. Today, it is clear that the 10% share of bio fuels is not realistic.

”Manufacturing” bio fuel may lead to the extermination of forests, starvation and the result of the analysis of physiological effects is also negative; ethanol is more harmful than traditional fuel. The most modern bio-Diesel factory in *Europe*, at the industrial park of *Orosháza*, has been unused for four years. The first bio-mass power station (20 MW) in *Hungary* was created as a Japanese–Hungarian joint venture in *Szakoly* in *Szabolcs–Szatmár–Bereg County*, had to be closed down after a very short period of operation. No continual supply of fuel was organised and finding the market for the generated heat did not receive due attention either. The awkward debates and discussions about the power station (based on straw as fuel) planned to be created in *Szerencs* are the signs of these sad conditions. Despite all these, it is our conviction that economic and independent energy supply organised at a regional or sub-regional level is indispensable for overcoming the relative poverty of the area and for creating a better and healthier environment. It is, therefore, justified to say that *Hungary* is extremely rich in renewable energy resources. It is, however, equally justified to claim that it is also poor, as the geothermal and other potentials are only utilised to a very small extent.

In the northwestern part of *Hungary*, biomass appears to be the most suitable and also most economic for introducing energy supply systems for small settlements. There are good examples for such energy supplies; in *Pornóapáti* (a village of 700 inhabitants in *Vas County*) a central heating power plant has been established and the local households are all connected to it. There are large forests near the village and waste from forestry and carpentry work is purchased and used as fuel heating the power station. The waste is ground to small and uniformed parts to make it suitable for the furnaces. The local government established a limited liability company for this particular purpose (organising heating production for the local community). The company purchases the raw material, pays the price to the suppliers and sells the heating energy and hot water to the end users. The local government, however, owns and runs a profit company which pays VAT after its turnover. This is an exemplary initiative.

The most difficult problem, in connection with such heating power plants tailored to small settlements, is that the raw material supply has to be very carefully planned and organised for years forward; production and transportation of the fuel have also to be calculated and contracted well in advance. Only then it is possible to guarantee the sustainability of the system.

The most economical solution—and the best way of avoiding any legal disputes that may arise later on—is that the fuel is grown on a land owned by the local government or the power company itself. When the land is leased or rented, there are usually legal disputes arise. When a farmer offers a land for use, it may appear to be useful and advantageous initially, but later when new lands are involved for growing fuel crops, the initial lease contract may generate disputes.

Unfortunately, there has been no considerable change in terms of use of the forestry and farming side products in the past 20 years. Regrettably, there is a lot of resistance against the transformation of the district heating and hot water supply systems in *Hungary*. The main reason is that the systems were originally constructed with a very low efficiency level, as energy was cheap when it was supplied by the *Soviet Union*. As the efficiency of these systems is low, the cost of hot water used is very high for district heating. The number of district heating centres in *Hungary* is 93; the respective figures in *Austria* and *Slovakia* are 588 and 500. In the *Czech Republic*, the population of which is, similar to the other two nations, smaller than that of *Hungary*, there are 650 district heating centres. In *Denmark*, 63% of households are connected to the district heating system, whereas in *Hungary* the figure is only 17%. Therefore, it should follow *Denmark's* example. In a country which is smaller than *Hungary* compared to its size and population (5.2 million), there are 450 district heating systems and, as it has been mentioned previously, the proportion of households connected to the system is 63%.

It is also noteworthy that the first district heating system in *Europe* was created in a small town in *Denmark*, more than 85 years ago. Experience, therefore, suggests that the best heating system is district heating as it is constructed at the highest technical–technological level.

A look at the sources of energy used for district heating in the *European Union* reveals interesting facts. The share of renewable energy sources is the highest in *France* (27%). In *Hungary*, it is not more than 8%, while even in *Finland*, where people live in small settlements scattered around the country, it is 11.6%. Interestingly, the share of renewable energy sources in the district heating system is also high in *Italy* with 18.4%. Another noteworthy indicator of the development level is the use of waste as an energy source. *Denmark* is in a leading position with 22.5%, while in *Hungary* 0% is the amount of waste used as fuel.

2. Solar energy

Hungary has excellent potentials for the use of solar energy. It is, perhaps, the process of global warming that explains the record number of sunny hours in 2012. In *Csongrád County* and around the city of *Békéscsaba (Southeast Hungary)*, the number of sunny hours per year was 2,300–2,645, a remarkable growth from the previously measured 1,800-2,100 hours of direct sunshine a year. (In *Rome* the average is 2,500 hours/year, in *Copenhagen* it is 1,680 hours/year.)

Fortunately, sun collectors began to spread in *Hungary* in the early years of this millennium. The market for solar energy equipment is in prosperity. The *Ministry of National Development* offers support to the population for the purchase and installation of solar energy devices through various applications. In these, there are more than 800 companies registered as contractors. Unfortunately, there is no domestic manufacturing industry for the production of solar collectors and, since *Duna-Szolár* went out of business ten years ago, sun batteries are also imported.

From an energy utilisation's point of view, the use of solar collectors is the most popular in *Hungary*. The investment required for a detached house with a family of four is 1.2 million HUF (3,240.00 GBP). The solar collector provides hot water and also serves as an additional heating device. The return period of the investment is 8 years. The equipment supplies 70% of the hot water used by the family and also contributes to heating. After several decades, 90% of the material of the collectors is recyclable. When the solar collector system is also used as an additional heating device, it is possible to save 25–30% of total heating costs. The sun collector is most economical when used with low-temperature heating systems (e.g. wall or floor heating).

It is a sad fact that solar battery systems are not yet popular in *Hungary*. The reason for that is that most families lack the financial resources required for the installation of such systems, despite *Hungary's* excellent potentials. The complicated *Sun*-following systems produce 45% more energy per average than fixed installations. The major disadvantage of these systems is that they need permanent maintenance personnel, as they are exposed to the weather and gale-force winds can sometimes cause damage to them. Solar battery systems have a great future and if a good solution is found for supplying the energy that is generated into the mains, the system will be very economical in the long run. A fix-installed kWp solar battery system in *Hungary* is able to generate 1,150 kWh of electric power per average. In order to install a 1 kWp solar energy system, a surface area of 6–7 m^2 (64.58–75.35 ft^2) is required when a crystal module is applied. For the same performance, the thin film systems need 11 m^2 (118.40 ft^2).The performances of the two systems are identical, but the latter is considerably cheaper. In order to supply energy to the mains, inverters are necessary, as the DC produced by solar cells is to be converted into 230 V AC. Moreover, there is hardly any loss at certain new inverter types (their efficiency is 98%). These systems are primarily profitable at solar battery installations that produce some surplus power.

In *Hungary*, such systems are purchased from foreign sources, primarily from *China*, *Germany* or *Japan*. The solar collectors reach the end users through wholesale companies. Quality complaints are usually the consequences of the inexperienced personnel installing the systems. There are also incorrect business enterprises in the market of solar collectors and batteries. In several towns and smaller settlements successful systems have been installed. In *Szarvas*, for instance, 50% of the town's electric power consumption is covered by solar energy. The solar energy park of *Újszilvás* is a real success story. The settlement, located in *Pest County*, has a population of 2,800. A Sun-following solar power plant has been installed. The system provides electric power for local government institutions. The construction of the system cost 628 million HUF (1.8 million GBP), 70% of which was provided by government funds. A speciality of the system is that a rotating machine always adjusts the collectors towards the *Sun* to provide the highest possible efficiency.

In *Újszilvás*, geothermal energy is used for heating 90% of local government buildings (primary school, day cares, cultural centre and the town hall). This is a dual-utility system. Water of 33°C is available which is used for heating. The water returning to the waterworks is cool (16°C/60.8°F). It is treated and supplied into the water mains for the community as drinking water. It is, therefore, not necessary to press the water back to the ground, as it is required by law in the case of low-temperature thermal waters. Except for the kitchen of the canteen, no natural gas is used at all. The local government saves an annual of 10–12 million HUF (~30,000 GBP).

3. Geothermal energy and the use of Earth's heat

Hungary has exceptionally good potentials in geothermal energy, as the geothermal gradient (Celsius/km) and the density of heat streams on the surface (kW/km^2) are much higher than the global average (25°C per km of depth/1°F per 70 ft of depth). In terms of the use of thermal waters below the temperature of 100°C (212°F), *Hungary* is only second to *Iceland*. There are 1,164 active thermal fountains in the country, several of which have water output of 3,000 litres/min. Despite the fact that the *Carpathian Basin* is not an active volcanic or tectonic region, thermal water and steam reservoirs of 150–350°C (302–662°F) enthalpy have been found.

In the plains, for example in the vicinity of *Nagyszénás*, outbursts of dry steam of 200°C (392°F) can be found. The steam comes from layers between 2,500–3,000 metres (8202–9842 ft) deep. Near *Hódmezővásárhely*, at the deep well codenamed HÓD-I, a pressure of 960 atm was measured at the depth of 600 m (1,968 ft). In spite of these advantageous potentials, the use of geothermal energy is negligible. The 3.7 PJ of utilised geothermal energy is not more than 3.5% of the primary energy use. A lot of the thermal water is used for balneological purposes, but energetic use is still low on the priority lists. *Hungary* does not have a geothermal electric power station, no refrigerating storehouses based on thermal water and the use of underground thermal water reserves for district heating is insignificant. The related legal regulations are contradictory and the problems of storing and pressing the water back to the water storing geological layers are varied and serious. The heat pump systems are not very well spread in *Hungary* yet. It is only worth constructing geothermal electric power stations when water of 105–110°C (221–230°F) is available. Despite the good potentials, geothermal energy does not play an important role in district heating in *Hungary*. There have been, however, some progresses attempted, as there are encouraging initiatives in *Mosonmagyaróvár*, *Kapuvár*, *Szentes*, *Makó*, *Szeged*, *Hódmezővásárhely*, *Csongrád*, *Veresegyház* and *Kistelek*.

4. Biomass

A comparison of heating value of black coal, brown coal, coke, lignite, natural gas, regular petrol, gas in cylinder and tank out of the fossil energy sources, and also wood shred, wood pellet, wood briquette and hay to the heating value of wood reveals the following *(Figure 1)*: the most economical fuel at current market prices is hay, as the price of a MJ is only 0.42 HUF (0.001 GBP) Wood briquettes are next with a price of 0.86 HUF (0.002 GBP) preceding lignite (1.8 HUF/0.005 GBP). The fourth is black coal, as it costs 5.2 times more than hay and 2.5 times more than wood shred *(Figure 2–3).*

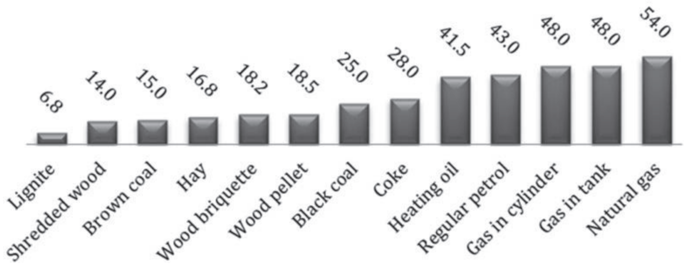

Figure 1 – Average heating values of various energy resources (MJ / kg)
Source: GERGELY, S. (2010; 2011); Edited by BOKOR, L. (2013)

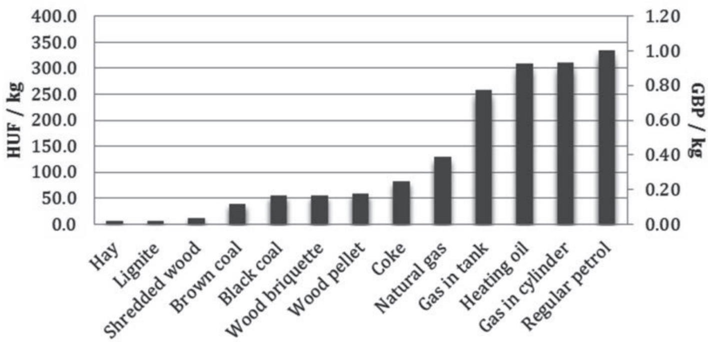

Figure 2 – Average prices of various energy resources (HUF/GBP / kg)
Source: GERGELY, S. (2010; 2011); Edited by BOKOR, L. (2013)

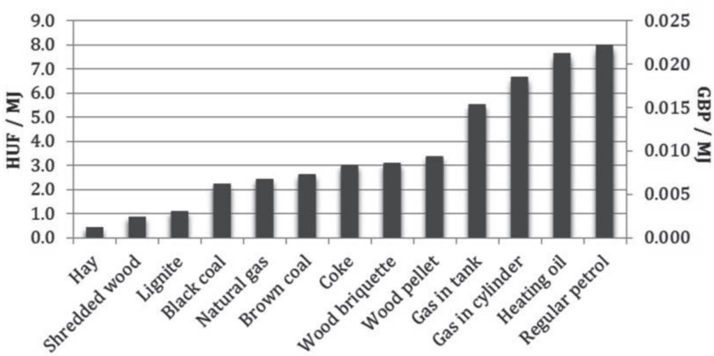

Figure 3 – Average prices of various energy resources (HUF/GBP / MJ)
Source: GERGELY, S. (2010; 2011); Edited by BOKOR, L. (2013)

In *Hungary*, the most important fuel for common heating purposes is natural gas. It retails at a price 5.7 times higher than that of hay and 2.8 times higher than that of wood shred. Lignite also appears to be an attractive fuel, but there are other problems with that. Wood contains no sulphur at all, whereas the sulphur content of lignite is 2.5–4%. The ash content of hay is a mere 4–6%, of wood it is 3–6%, but lignite contains more than 50% of ash. There have been hay power plants in *England* for decades, e.g. the one at *Sutton* near *Cambridge*, supplying power for 80,000 people.

The research literature suggests that it is only worth using wood pellets or wood briquettes under special circumstances and for special demands. In *Hungary*, the utilisation of biomass appears to be the most advantageous and economical type of renewable energy source in the future. *Hungary* has a highly developed agriculture. Therefore, the utilisation of green energy appears to be a priority in the future (in addition to geothermal and solar energy). Unfortunately, the majority of the machinery, appliances and equipment necessary for the utilisation of renewable energy sources are manufactured outside *Hungary*. At present, everything is imported. It is logical and necessary to organise the domestic manufacturing base. Since energy supply systems are planned for sub-regional purposes, there are usually seven important aspects to be taken into consideration. These are the following:

1) source of supply (where the energy is purchased from),
2) transport,
3) distribution,
4) consumption,
5) selling the energy to the end users,
6) risks in supply,
7) environmental risks.

The heating works of villages (small, multi-purpose power plants) work most effectively when they are based on locally available energy sources, because in this way it is possible to shape the most advantageous energy production system. Wood, as fuel, plays an important role. Using wood pellets and wood briquettes is only economical at already existing boilers, e. g. when there is no adequate storage facility for wood shred. Pellets and briquettes are not the ideal fuel for village district heating centres, as the net energy output may be reduced by as much as 10–25%. Firewood, waste from orchards, vineyards, wood processing plants, forestries and energy plantations may be considered as source of economical fuel. The optimum fuel supply is to be planned in accordance with the needs and specific purposes of the small power plants.

5. Conclusion

Given these facts, it can be said that firewood from the forestries may serve as the prime raw material for shredding. It is possible to mechanise the process of wood shredding. It appears to be logical to include the shredding machinery into the small power plant itself. In this way, the most suitable raw material can be easily and readily produced on the spot. Thus, it is also possible to prevent quality complaints and price debates with suppliers. A 0.5 MW village heating plant needs 1,875 tons of wood shred annually. When all factors are considered, the results suggest that areas of 70, 93 or 140 hectares are needed for the energy (wood) plantation in order to supply and operate a 0.5 MW village district heating centre. If hay is used as a fuel, it is needed to calculate with fields of 140, 186 and 279 hectares. The hay of the grain crop grown in the fields would serve as fuel. (The author's calculations suggest that 5,583 people produce 500–560 tons of communal waste. If that waste is used as fuel, several settlements must join forces and selective waste collection ought to be organised.)

It is a well-known fact that the use of fossil fuel does not have any considerable area development effect. On the other hand, the area development effect of renewable energy sources is definitely positive, as seen from some of the processes described above. The positive effects apply to employment, research development, the work of SMEs and industrialisation. Renewable energy sources have highly positive effects on living standards and human resources.

According to the 2020 energy action plan, *Hungary* has to achieve the average of 13.6% of renewable energy resources in the total energy consumption. At present, the renewable energy in the Hungarian energy balance is only 8.8%. When it comes to the latter, the traditional wood usage is the most important. The others are solar, geothermal and wind energy which account for only 3% of the renewable energy usage. According to the author, if the government does not support this development, *Hungary* will not be able to reach the action plan's goals.

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Energetic Parameters of the Wind Directions

Abstract

The objective of this study is to assess whether changes in the surface pressure field over Europe are reflected in the statistical structure and the inner definiteness of the wind energy field over Hungary, despite the specific pressure field of the country. The investigated energetic parameters are: relative frequency, relative energy content, mean velocity and mean length of time of wind directions. The investigation was carried out for two time periods (1968–72, 1991–95) at three meteorological stations which are on nearly the same geographical latitude, but their orographic environment differs from each other.

Key words

Relative frequency; Relative energy content; Mean velocity and mean length of time of wind directions; Characteristic, non-characteristic and prevailing wind directions; Linear correlation

Introduction

The rise in global surface air temperature, due to the increase of the atmospheric concentration of greenhouse gases, has probably induced a redistribution of the surface pressure field. According to SCHÖNWIESE, C. D. *et al.* (1994) and MEYHÖFER, S. *et al.* (1996), this process has occurred in *Europe*: in the winter half-year, the average values of surface pressure, converted to sea level, increased in the south and decreased in the north of the continent between 1961 and 1990. In the summer half-year, however, there were no significant changes. On the other hand, METAXAS, D. A. *et al.* (1991) and BARTZOKAS, A. – METAXAS, D. A. (1996) found that the average intensity of influx of cold air masses in summer, coming from the north and northwest to the southeast of *Europe*, had increased. Therefore, according to their investigations, the summer circulation system is also changing, as a consequence of the redistribution of the surface pressure field in summer, as well.

The spatial distribution of annual and monthly average sea level pressure fields in *Hungary* is due to the so called "basin character". Roughly in the middle of the *Great Hungarian Plain*, a pressure minimum can be found. This is caused by strong warming in summer and the frequent passing through of the Mediterranean cyclones in winter (DOBOSI, Z. – FELMÉRY, L. 1971). The aim of the former investigations (TAR, K. 1998a, 1998b, 1999, 2001; MIKA, J. *et al.* 1999; TAR, K. *et al.* 2000, 2001; MAKRA, L. *et al.* 2000a, 2000b) was to decide whether or not the observed changes in the pressure field over *Europe* could be detected in the statistical structure of the wind field over *Hungary*, despite the specific pressure field over the country.

In this paper, the useful properties of some energetic parameters of wind directions and the change in time and space of stochastic relationship between these parameters are analysed.

1. Database and research methods

The database consists of hourly wind direction data and wind velocities of three meteorological stations—*Debrecen, Budapest* and *Szombathely*—between the periods of 1968–72 and 1991–95 measured at

10 meters. These stations are about on the same geographical latitude, but their orographic environment differs from each other *(Figure 1).*

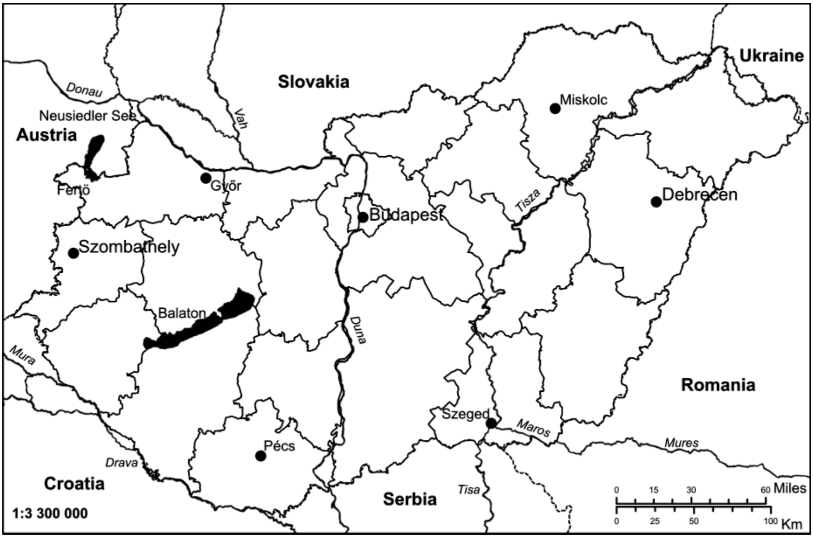

Figure 1 – Locations of the meteorological stations in Szombathely, Budapest and Debrecen
Edited by S*ZELESI, T. (2013)*

The investigation was carried out for the two complete periods and for the subsets of those. The subsets were produced by two methods: *(1.)* by the differentiation of natural seasons and *(2.)* by defining the macrosynoptic-type groups from *György Péczely*'s macrosynoptic-types. As opposed to PÉCZELY, GY. (1983), the central type is handled separately on the base of its obviously different air flow characteristics. According to this, the following categories and centres are used: Meridional Northern (MN), Meridional Southern (MS), Zonal Western (ZW), Zonal Eastern (ZE) type groups and anticyclone centre (A) and cyclone centre (C) types. The base of the classification is the place of the cyclone or anticyclone centres relative to *Hungary*. The types that govern the weather of *Hungary* can be grouped in as cyclonal type group (CG). Anticyclonal type group (AG) can be defined similarly. For the classification of the individual days, the macrosynoptic codes of PÉCZELY, GY. (1983) and KÁROSSY, CS. (1998) have been used. The sizes (the length of days) of the macrosynoptic-types/type groups for the two five-year-long periods are shown in *Table 1*.

Table 1 – The number of days of the various type groups (days) and their length relative to the whole length of the period (%) in the two complete 5-year-periods

	1968–72		1991–1995	
	days	%	days	%
MN	301	16.5	401	22.0
MS	529	32.4	434	23.8
ZW	429	23.5	390	21.4
ZE	348	19.1	235	12.9
A	134	7.3	269	14.7
C	22	1.2	97	5.2
Σ	1826	100.0	1826	100.0
AG	1187	65.0	1259	68.9
CG	639	35.0	567	31.1
Σ	1826	100.0	1826	100.0

It is evident that the difference between the number of days of the type A is about two times larger than that of the type C, and the frequency of the days in the AG-type group is higher by 4 per cent in the second period. Based on this, we can conclude that the wind velocity and wind energy in this period decreased. Stagnation or a small increase occurs in a few cases only in *Debrecen* (winter, ZE, A). The largest decrease is in *Szombathely*: in the MN, MS, ZE and CG-type groups and in type C, the decrease is above 1 m/s. The spatial average of the decrease is the largest in the type C, and then the MN, MS and the CG-type groups follow.

2. Energetic statistics of the wind direction

In the following, the relationship among relative frequency (%), relative energy content (%), average velocity (m/s) and the average length of time of the wind directions are going to be investigated. The relative energy content of a D wind direction for a sub-period (season, type, type group) can be determined by the mean specific wind power, namely with the equation,

$$P_{f1}(D) = \frac{\rho}{2}\sum_{j=1}^{k}\frac{f_{Dj}}{N}v_j^3$$

where f_{Dj} is the frequency of the speed of the D wind within the (v_j-0.5Δv, v_j+0.5Δv) interval, k is the number of intervals and N is the number of days of the time period, respectively. If P_{f1}, denoting the mean specific wind power of time period, is independent of the wind directions then the ratio

$$p(D) = \frac{P_{f1}(D)}{P_{f1}}$$

is equal to the relative energy content of the given D wind direction. The average velocity of this direction is:

$$\overline{\mathrm{v}}(\mathrm{D}) = \sum_{\mathrm{j=1}}^{\mathrm{k}}\frac{\mathrm{f_{Dj}}}{\mathrm{N}}\mathrm{v_{j}}.$$

The value of the last parameter strongly depends on the height of the anemometer. This height is regularly 10 metres in the meteorological stations, but the measure of the wind speed can happen on lower or higher levels. In these cases, the height correction is achieved by the following equation:

$$v_h = v_{10}[0.233+0.656\lg(h+4.75)]$$

where v_h is the measured wind speed on h≠10 m and v_{10} is the calculated wind speed on 10 m. The average length of time of the wind directions can be determined by the distribution of hours with the same wind direction (MEZŐSI, M. – SIMON, A. 1981).

3. Characteristic and non-characteristic wind directions

In this and the following subdivisions, the relationship between the relative frequency and the relative energy content of wind directions in a special case will be investigated.

To decide which are the wind directions with significant definite frequency—i.e. it is not random that they are present in a given place at a given time— the statistical test for hypothesis of probability evenness has been used (VINCZE, I. 1975). This can be applied to the problem as it follows: in a given ε probability level, we can determine a critical interval with h_1 and $h_2>h_1$ borders. If there is, at least, one D wind direction with f_D frequency, so that $f_D > h_2$, we cannot consider the distribution of the wind direction to be even. In this case, D is called a characteristic wind direction (CWD), otherwise, it is a non-characteristic wind direction (NWD) on 1-ε probability level (TAR, K. 1991a, 1991b). The values of h_1 and h_2 are (VINCZE, I. 1975):

$$h_1 = p_0 n - u_\varepsilon \sqrt{np_0(1-p_0)}$$

$$h_2 = p_0 n + u_\varepsilon \sqrt{np_0(1-p_0)}$$

where p_0 is equal to $\frac{1}{16} = 0.0625$, as we used 16 wind directions, n is the number of cases (24*number of days), u_ε satisfies the equation

$$2\Phi(u_\varepsilon) - 1 = 1 - \varepsilon$$

where $\Phi(x)$ is the distribution function of the standard normal distribution. Let be ε=0.0027; i.e. the small value used by PÉCZELY, GY. (1957) for the efficiency of the test. In this case u_ε=2.98.

If f_D is given in %, then the limits of the critical interval are $H_1=100h_1/n$, $H_2=100h_2/n$. The value of H_2 changes between 6.6 (whole period) and 9.4 (type C in period 1968–72), so we can say, it moderately depends on the number of cases.

We can determine the total and the mean relative energy content of the characteristic and non-characteristic wind directions by the way written previously. CWD_e and NWD_e denote the relative energy content of one characteristic and non-characteristic wind direction, respectively; i.e. the mean relative energy contents.

Table 2 – Relative energy contents (in %) of one characteristic wind direction (CWD_e) and one non-characteristic wind direction (NWD_e)

	Debrecen				Budapest				Szombathely				mean			
	1968–72		1991–95		1968–72		1991–95		1968–72		1991–95		1968–72		1991–95	
	CWD_e	NWD_e	CWD_e	NWD_e	CWD_e	NWD_e	CWD_e	NWD_e	CWD_e	NWD_e	CWD_e	NWD_e	CWD_e	NWD_e	CWD_e	NWD_e
year	10.1	4.0	8.5	4.9	11.7	3.0	12.3	3.5	13.2	0.9	11.9	0.6	11.7	2.6	10.9	3.0
winter	12.7	2.5	10.9	3.4	13.2	2.1	12.8	3.3	12.3	1.5	13.5	0.6	12.7	2.0	12.4	2.4
spring	11.6	3.8	7.6	5.4	9.2	4.0	11.8	3.7	14.0	1.6	22.3	0.9	11.6	3.1	13.9	3.3
summer	9.8	4.1	8.3	5.3	15.3	2.1	13.0	3.2	25.9	1.7	21.7	1.1	17.0	2.6	14.3	3.2
autumn	13.1	4.0	8.7	4.8	10.3	3.1	12.2	3.5	13.5	0.6	13.3	0.8	12.3	2.6	11.4	3.0
MN	15.3	3.2	10.1	4.5	27.5	1.3	19.5	1.8	23.4	0.5	18.0	0.9	22.1	1.7	15.9	2.4
MS	7.2	5.5	7.4	5.4	7.7	5.6	8.7	5.2	14.7	1.2	13.6	0.5	9.9	4.1	9.9	3.7
ZW	14.2	3.6	9.3	4.8	16.6	1.5	19.6	1.8	11.7	2.0	14.2	1.5	14.2	2.4	14.4	2.7
ZE	17.8	1.0	17.9	2.4	12.5	2.5	13.7	2.9	42.9	1.0	18.8	0.6	24.4	1.5	16.8	2.0
A	10.0	5.0	9.5	4.8	8.1	5.6	6.1	6.3	11.7	3.8	11.7	3.0	9.9	4.8	9.1	4.7
C	9.3	5.2	12.1	4.3	29.1	1.0	17.7	2.4	42.2	1.1	31.2	0.5	26.9	2.4	20.3	2.4
AG	11.3	3.2	8.9	4.7	11.7	3.0	10.9	3.5	13.1	1.0	11.9	0.6	12.0	2.4	10.6	2.9
CG	12.3	4.2	9.9	4.6	13.6	2.9	12.6	2.5	13.2	0.8	13.3	0.7	13.0	2.6	11.9	2.6

In *Table 2,* the values of the three stations in both 5-year-periods in the cases of the whole database (year) and the different sub-periods are presented. The most remarkable feature of the table is that there is only one case (type C, first period) when the minimum value of NWD_e is not in *Szombathely*. Regarding the CWD_e, we find that yearly maximum value of this is in *Szombathely* in the first and in *Budapest* in the second period, but its minimum value is in *Debrecen* in both periods. The seasonal values are orderly small: the maximum value occurs in *Szombathely* except in the winter in the first period. In the second period, the minimum values occur in *Debrecen* in every season, but their time changes in the first period. The orographic environment probably has a stronger influence on the investigated phenomena due to the general decrease of the wind velocity. In the type-groups of macrosynoptic-types and the two central types, we can say that the maximum values of CWD_e can never be spotted in *Debrecen*, but the minimum values are not evident in every case. The picture is more orderly only with the differentiation of anticyclonal (AG) and cyclonal (CG) type-groups: the maximum is in *Szombathely* in the second period, whereas the minimum is in *Debrecen* in both periods. The reason for this is that the circulation system of macrosynoptic-types and type groups is influenced in a stronger way by the barometric formations as by the orography (but their effects decrease from west to east as in the cases of any weather events in *Hungary*).

For a more exact investigation about the temporal and sub-periodical changes, different averages for the three stations are determined *(Table 2)*. It is evident from these that in the seasonal case of CWD_e, the summer maximum and spring or autumn minimums are highlighted in both periods. Its values decreased in the second period except in spring. In the case of four type-groups and the two central types, the maximum of CWD_e is in the type C, its minimum is in the type A and the order of type-groups is ZE, MN, ZW, MS in both periods. In the type-groups AG and CG, values of CWD_e change like in the central types, but with significantly smaller differences. Only the values in the MS and ZW groups do not decrease in the second period. The values of NWD_e also have a little annual course (maximum in the spring, minimum in the winter in both periods) and we can see differences in the sub-periods (maximum in the type A, minimum in the type-group ZE in both periods) and certain increase in the second period.

Definite orographical differences are shown when it comes to the significance of the relationship between the average wind velocity of sub-periods and the energy content of one characteristic wind direction (CWD_e). The value of linear correlation coefficient is not significant in *Debrecen* in both periods, but it is positively significant at the other two stations. The reason for this is the stability of wind directions (TAR, K. – SZEGEDI, S. 2002): the weak winds are unstable, they are disordered, i.e. the number of characteristic wind directions and so they have less energy in these places. The average wind velocity of sub-periods decreases by the geographical altitude in the first period with the exception of zonal type-groups. On the other hand, the minimum wind velocity is, in all cases, in *Budapest* in the second period.

Table 3 – The ratios of energy content of one characteristic and one non-characteristic wind direction (CWD_e/NWD_e)

	Debrecen		Budapest		Szombathely		mean	
	1968–72	1991–95	1968–72	1991–95	1968–72	1991–95	1968–72	1991–95
year	2.5	1.7	3.9	3.5	14.7	19.8	4.4	3.6
winter	5.1	3.2	6.3	3.9	8.2	22.5	6.3	5.1
spring	3.1	1.4	2.3	3.2	8.8	24.8	3.7	4.2
summer	2.4	1.6	7.3	4.1	15.2	19.7	6.5	4.5
autumn	3.3	1.8	3.3	3.5	22.5	16.6	4.8	3.8
MN	4.8	2.2	21.2	10.8	46.8	20.0	13.2	6.6
MS	1.3	1.4	1.4	1.7	12.3	27.2	2.4	2.7
ZW	3.9	1.9	11.1	10.9	5.9	9.5	6.0	5.3
ZE	17.8	7.5	5.0	4.7	42.9	31.3	16.3	8.5
A	2.0	2.0	1.4	1.0	3.1	3.9	2.1	1.9
C	1.8	2.8	29.1	7.4	38.4	62.4	11.0	8.5
AG	3.5	1.9	3.9	3.1	13.1	19.8	5.0	3.6
CG	2.9	2.2	4.7	5.0	16.5	19.0	4.9	4.6

In *Table 3,* the ratios CWD_e/NWD_e from *Table 2* are presented, it can unambiguously be stated that the maximums of these are in *Szombathely* in both periods except for the type-group ZW. The occurrence of extreme values does not show regularity in the seasons and types/type-groups. Therefore, we counted the orographical averages ('mean' column in *Table 3*). In the seasonal case, the maximum of these is in the summer in the first period and in the winter in the second period. The minimum is in the spring in the first and in the autumn in the second period. Now, the four type-groups show uniformed pictures: the maximum of ratio CWD_e/NWD_e is in type-group ZE, its minimum is in type-group MS in both periods. The value of this ratio is greater in type C from the central types, but this difference is not reflected in the corresponding (AG and CG) type-groups.

4. Wind directions with extreme energy content

In the meteorological literature, the most frequent wind direction is called the prevailing wind direction. This direction is entitled to this because BACSÓ, N. (1959) proved that the largest mean wind velocity belongs to this or a very close wind direction. For the objective determination of the prevailing wind directions of macrosynoptic-types, a statistical test was worked out by PÉCZELY, GY. (1957). His test produced one direction in the majority of cases, two directions in a few cases from one data by days (06 GMT) with the distinction of eight wind directions only.

The test described in the previous section is available to select the prevailing wind directions with another condition. We use a parameter which includes the two features of the prevailing wind direction: large frequency and large average velocity. As we also know from the previous sections, this parameter constitutes the energy content of wind directions. In our previous papers (TAR, K. 1991a, 2001; TAR, K. – VERDES, E. 2003), we defined the prevailing wind direction as the characteristic wind direction with the largest energy content. In these papers, we investigate some features of this direction. The most general result of our investigations supports the energetic definition of prevailing wind direction and does not conflict with the traditional one, mainly in the macrosynoptic-types. In *Table 4,* the wind directions and their energy content are shown which meet the condition mentioned above. With the further analysis of the table, our aim is to show the space and time change of the (energetic) prevailing wind direction.

The distributions of the two periods differ from each other markedly. The frequency of N and S directions strongly decreased in the second period because of the benefit of NE direction. The frequency of direction with W component increased with the exception of NW, so their distribution became more even.

The second conclusion from *Table 4* reflects the effect of orographical differences, too. The prevailing wind direction changed in all cases in *Debrecen*, but it did not change in the seasons and the type-group AG in *Budapest*, and it changed only in three cases (ZE, AG, A) in *Szombathely* in the second period.

Table 4 – The energetic prevailing wind directions and their relative energy contents (in %).

	Debrecen				Budapest				Szombathely			
	1968–72		1991–95		1968–72		1991–95		1968–72		1991–95	
	prev. dir.	ener.cont.	prev. dir.	ener.cont.	prev. dir.	ener.cont.	prev. dir.	ener.cont.	prev. dir.	ener.cont.	prev. dir.	ener.cont.
year	N	21	NE	15	NNW	19	NNW	24	N	57	N	43
winter	N	24	NE	15	NW	31	NW	29	N	65	N	45
spring	N	16	NE	15	NW	23	NW	22	N	53	N	41
summer	N	31	NE	18	NNW	34	NNW	34	N	50	N	46
autumn	S	18	SW	12	NW	27	NW	25	N	57	N	40
MN	N	40	NE	16	NW	40	NNW	31	N	60	N	47
MS	S	27	NE	12	ESE	10	NNW	16	N	56	N	38
ZW	N	20	SW	16	NW	32	NNW	28	N	46	N	49
ZE	NNE	30	NE	36	E	25	ENE	24	N	70	NNE	53
A	S	20	NE	14	ESE	10	S	11	S	23	NNE	35
C	SW	17	SSW	13	NW	45	NNW	31	N	49	N	65
AG	N	25	NE	20	NNW	24	NNW	26	N	55	NNE	38
CG	S	19	SW	14	NNW	25	NW	26	N	59	N	52

We made the change of the prevailing wind directions numerical in the sub-periods by the subtraction of their values in degrees. The difference was positive when the direction of the change was N–E–S–W (i.e. anticyclonal, clockwise). The absolute value of the difference was less than 180° or equal to this. It can be found by the average values that the negative changes are dominant in all three stations. If we do not take into account the 0 values for the averages, then we get unambiguous orographical differences: the absolute value of the change is the largest in *Szombathely* (37° from 3 cases), followed by *Budapest* (11° from 7 cases) and finally there is *Debrecen* (5° from 13 cases).

The energy content of prevailing wind direction also changed: it decreased in the majority of cases. The maximum value of decrease is in

Debrecen in the type-group MN (–24%), in Szombathely in the winter (–20%) and in the type-group MS (–18%). By the spatial averages, the largest decreases are in type-group MN (–15%) and in the winter (–10%).

Table 5 – The minimum energy wind directions and their relative energy contents (%).

	Debrecen				Budapest				Szombathely			
	1968–72		1991–95		1968–72		1991–95		1968–72		1991–95	
	min.en.dir.	ener.cont.	min.en.dir.	ener.cont.	min.en.dir.	ener.cont.	min.en.dir.	ener.cont.	min.en.dir.	ener.cont.	min.en.dir.	ener.cont.
year	SE	1.0	SSE	0.8	SSW	2.2	SE	1.2	E	0.1	SE	0.1
winter	NW	0.9	SE	0.7	SW	0.8	SE	0.7	E	0.0	SE	0.0
spring	SE	1.0	SSE	1.0	NE	1.1	SE	1.0	E	0.1	SE	0.2
summer	SSE	1.7	SSE	1.0	NE	1.3	SSE	1.3	E	0.2	ESE	0.1
autumn	ESE	0.4	SSE	0.4	ENE	0.8	NE	1.4	E	0.1	ESE	0.2
MN	SE	0.3	SSE	0.7	SSE	0.2	SE	0.7	ESE	0.0	SE	0.1
MS	NW	1.0	SSE	1.0	NE	0.8	NNE	1.7	E	0.1	SE	0.2
ZW	E	0.2	ESE	0.3	ENE	0.2	NNE	0.3	E	0.1	ESE	0.1
ZE	WNW	0.3	WSW	0.3	SSW	0.7	SSW	0.5	E	0.1	SE	0.2
A	ESE	0.8	NNW	0.8	ENE	1.7	NNE	1.6	E	0.3	ESE	0.2
C	E	0.6	NNW	0.9	NE	0.2	SE	0.9	ENE	0.0	SE	0.0
AG	SE	1.0	SSE	0.6	SW	1.4	SE	1.5	E	0.1	ESE	0.2
CG	ESE	0.8	SE	0.9	NE	0.6	SE	1.1	E	0.1	SE	0.1

From the point of view of the wind energy utilisation, the wind direction with minimum energy content is remarkable, too. They are called energetic weak winds and they can be seen in *Table 5.* The distributions differ from each other markedly in the two periods which appear mainly in a positive turn of 45°. It is also seen from *Table 5* that the direction of weak winds changes in the second period with the exception of two cases. Considering the direction of changes, orographical differences offer: the dominant changes are negative in De*brecen*, positive in *Budapest*, but positive changes are visible only in *Szombathely*.

5. Correlation analysis of energetic parameters

We determined the measure of stochastic connection among the energetic parameters given in the previous section for characterisation of inner definiteness of the wind energy field. This connection is presumably linear. We counted the linear correlation coefficient by sub-periods and investigated the significance of these; the number of significant connections depending on time and space. We only compared the unfamiliar subsets. We can investigate exactly six connections at a given station and in a given sub-period. We find six significant correlation coefficients in the majority of cases in *Szombathely*, mainly in the first period, since the number of these decreased in the second period. For example: there are altogether 86 and 76 significant correlation coefficients in the first and second period which constitute about 80 and 70 per cent of all possible cases in type-groups MN, NS, ZW, ZE and type A and C, respectively. We can see the details by stations in *Table 6*.

Table 6 – The relative number of significant correlations (%) in different periods and sub-periods

		Debrecen	Budapest	Szombathely	mean
seasons	1968–72	66.7	66.7	100.0	77.8
	1991–95	50.0	54.2	91.7	65.3
	diff.	–16.7	–12.5	–8.3	–12.5
anticycl.+cycl.	1968–72	66.7	83.3	100.0	83.3
	1991–95	58.3	75.0	100.0	77.8
	diff.	–8.4	–8.3	0.0	–5.5
zon.+	1968–72	69.4	77.8	91.7	79.6
merid.+	1991–95	58.3	69.4	83.3	70.4
centr.	diff.	–11.1	–8.4	–8.4	–9.2

The unfamiliar subsets, which are investigated together, are the seasons, type-groups AG and CG (anticycl.+cycl.), the above mentioned four type-groups and the two central types (zon.+merid.+centr.). According to the table, the greatest number of significant correlations is in type-groups AG–CG, whereas the least number is in the seasons in both periods. The measurement of decrease is reversed. The decrease has an orographical course which appears mostly in the seasons: it is the greatest in *Debrecen* and the least in *Szombathely*. The reason for the decreases is obvious, since the significant correlations in the first period became non-significant. There are altogether 21 cases; the connection of the mean length of time with the other three characteristics appears in more than half of these cases.

Table 7 – The number and relative number (%) of non-significant cases of different energetic characteristics of wind directions

(r.fr.: relative frequency, r.en.: relative energy content, a.vel.: average velocity, a.l.t.: average length of time)

	year	seasons	anticycl.+ cycl.	zon.+ merid.+ centr.	Σ	%
r.fr.-r.en.	0	4	1	8	13	2.8
r.fr-a.vel..	3	14	6	14	37	7.9
r.fr.-a.l.t.	0	1	0	2	3	0.6
r.en.-a.vel.	0	0	0	0	0	0.0
r.en.-a.l.t.	1	6	1	6	14	3.0
a.vel.-a.l.t.	4	15	6	20	45	9.6
Σ	8	40	14	50	112	23.9
possible	36	144	72	216	468	
%	22.2	27.8	19.4	23.1	23.9	

The study of non-significant cases provides useful information, too. In *Table 7,* we give this data by the reduction of the periods and stations in different sub-periods. It can be seen that the least, fewer than 20%, non-significant correlation is in type-groups AG–CG. However, the greatest number is about 28% that occurs in the seasons. It follows from the definitions and their obvious but complicated relationships that there is the least non-significant connection between the relative frequency and the average length of time, and between the relative energy content and the average velocity.

6. Conclusion

The most general result of our investigations is that the value of wind direction's energetic parameters and the ratio of their significant connections are dependent on the orography, too. In addition, it has a decreasing tendency in time, respectively. The most non-significant connections are between the average velocity and average length of time, or between the relative frequency and the average velocity of the wind directions. Based on our results, the inner definiteness of the wind field became weaker in *Hungary* which requires more prudent selection of the place in the procedure of the utilisation of wind energy.

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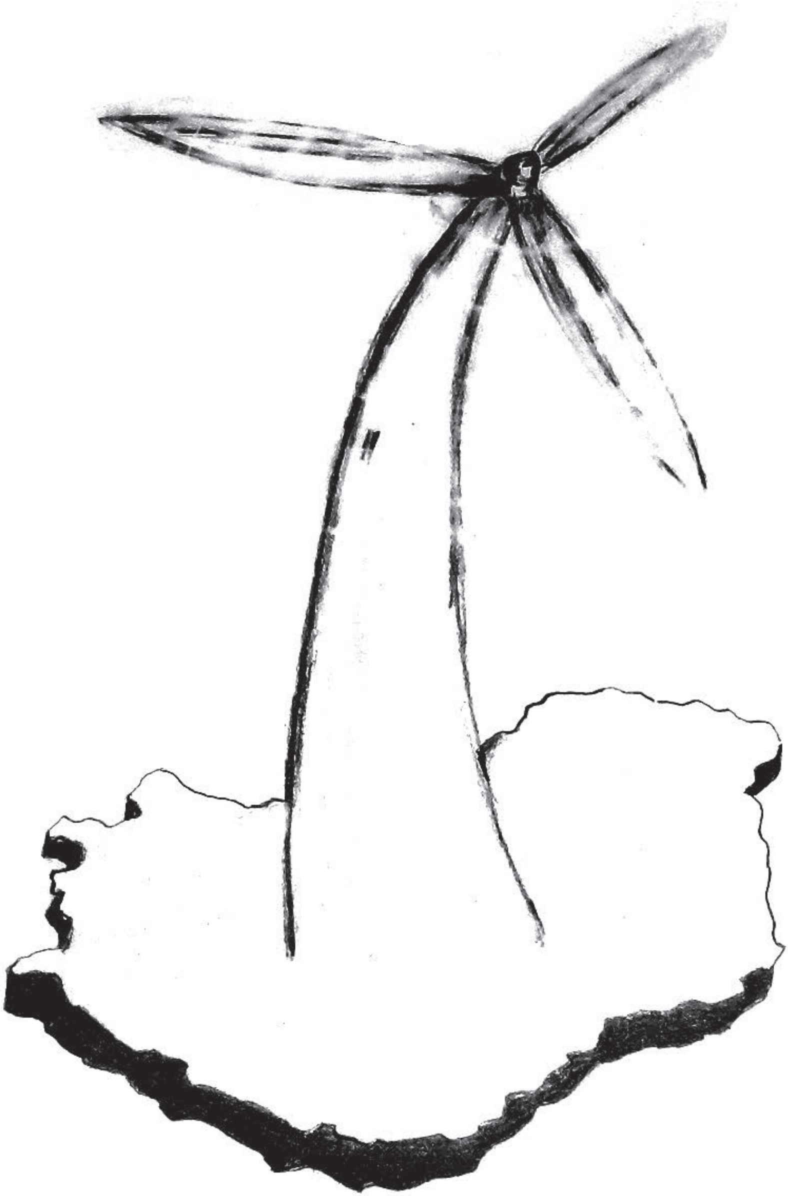

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Realistic Potentials of Wind Energy Utilisation in Hungary

Abstract

After the demonstration of the present situation of wind energy utilisation in Hungary, those policies are analysed that determine the economical harnessing of the wind energy potential. The following aspects are examined: climatic and climate change of Hungary, facilities in Hungary's geography and land use. The relevant research is based on the last 10 years and examines the possibilities in science and science policies which are shown in greater detail. Finally, the possibilities in energy policies are investigated on the basis of Hungary's Renewable Energy Action Plan 2010–2020.

Key words

Wind energy; Hungary; Potentials in climate and climate change; Geography and land use; Science and energy policies

Introduction

In December 2011, there were 172 wind turbines in operation in *Hungary* with a total installed capacity of 329.3 MW. 90% of these are located in the northwestern part of the country. The annual electric power output of these stations is over 600 GWh. According to *Figure 1*, approximately 29% of this capacity was installed in 2010. *Hungary's* total exploitable wind energy potential is an estimate of 532.8 PJ/year (IMRE, L. 2006). This paper summarises the realistic potentials of economical wind energy utilisation in *Hungary*.

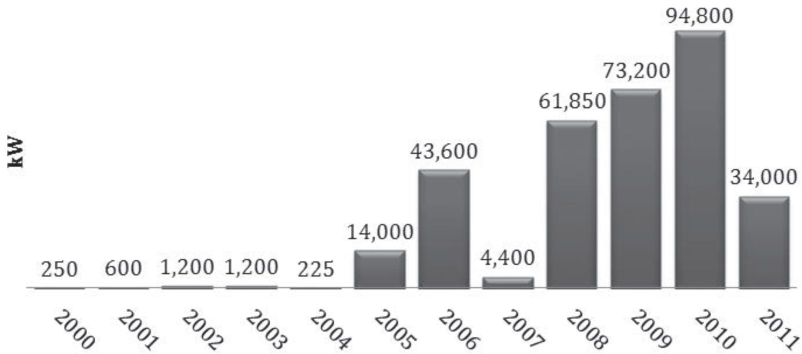

Figure 1 – Annually installed wind energy capacity (kW) in Hungary between 2000 and 2011

Source: Hungarian Wind Energy Association (MSZET, 2011); Edited by BOKOR, L. (2013)

1. Climatic potentials of Hungary

Hungary's climatic conditions demonstrate winds of far less strength that of those in *Western Europe*, but the number and distribution of old windmills indicate, unambiguously, that there is harnessable wind energy potential in the *Carpathian Basin*. Most windmills were built between 1866 and 1885. Wind conditions in the southern part of the *Great Hungarian Plain* were most suitable for installing windmills of smaller height with a typical capacity of about 20 kW. Thus, the location of former windmills defines those regions, where the utilisation of wind power is economical with high probability (KEVEINÉ BÁRÁNY, I. 2000).

The wind-climate of *Hungary* indicates that other parts of the country are also suitable for wind energy utilisation. According to the examinations by BARTHOLY, J. *et al.* (2003) and RADICS, K. *et al.* (2010), the yearly mean wind speed in *Hungary* is between 1.5–3.8 m/s at a 10-metre height *(Figure 2)*.

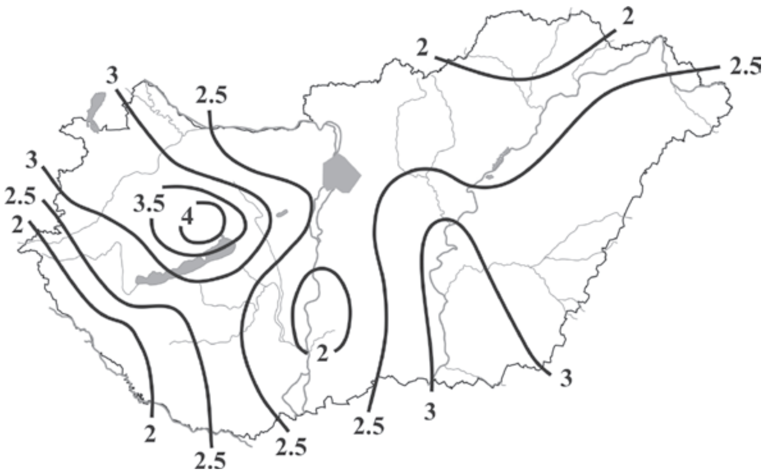

Figure 2 – The yearly mean wind speed at 10 m in Hungary
Source: BARTHOLY, J. et al. (2003)

These mean wind speeds are greater than 3 m/s in about 70% of the country's territory and they show great geographical differences at this height. The most and least windy parts are the northwestern and northeastern parts of *Hungary,* respectively. This is shown in *Figure 3* which represents the geographical distribution of wind speeds of more than 5 m/s at 10 m height.

The maximum of relative frequency is in the middle of *Transdanubia* (21.6%), its minimum (less than 4%) occurs in the axis of *Northeast* and *Southwest Hungary*. The longest duration of wind speeds is between of 1–3 m/s and between 1,500 and 3,000 hours/year.

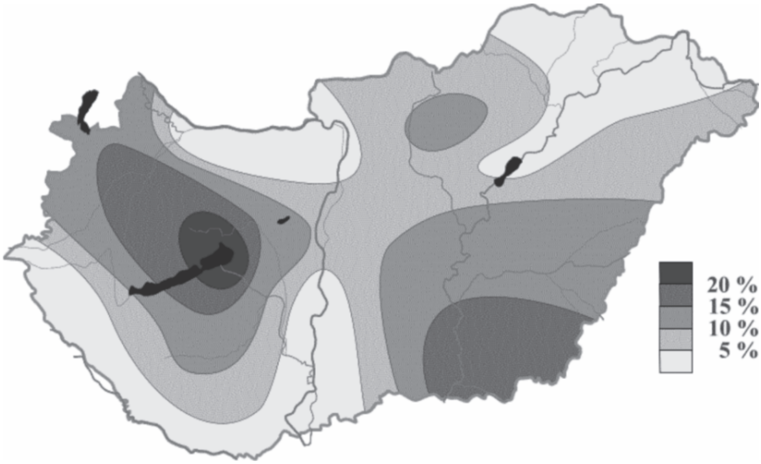

Figure 3 – Spatial distribution of wind speeds of more than 5 m/s measured at 10 m height

Source: RADICS, K. et al. (2010)

Since the cut-in wind speed of wind turbines working in *Hungary* is 3–4 m/s, the statistics of wind speeds, that are greater than this figure, is very important. According to our former research results (TAR, K. – RÓZSAVÖLGYI, K. 2008; TAR, K. *et al.* 2011), there is no orographic difference in the daily distribution of the probability of hourly wind speeds of more than 3 m/s. For example, the maximum of this probability occurs at about 13–14 o'clock and, accordingly, the daily distribution of continuously changing temporal probability results in an increase of electricity production until 17–18 o'clock.

There are neither orographic nor height-separations when it comes to the mean length of those intervals that have the wind speed of more than 3 m/s every hour. The length of these intervals determines the monthly mean specific wind power between 38% and 69%. The monthly mean specific wind power is more sensitive to the changing length of these intervals in mountainous regions than in flat plains.

The changes of potential wind energy in different parts of the day—which is proportional to the cubed wind speed—causes an important problem for the transmission system operation. It is necessary to supply the missing amount of electricity from other sources. According to *Figure 4–5*, the daily distribution of hourly cubed wind speeds may show a 12-hour or a 24-hour period.

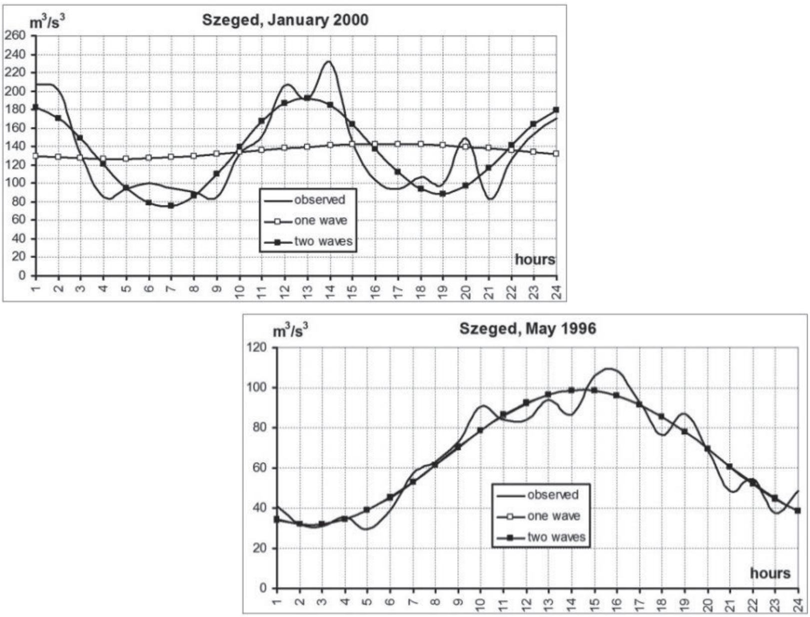

Figure 4–5 – Complex (12-hour period) and simple (24-hour period) changes in daily cubed wind speeds that are proportional to the specific wind power

Source: TAR, K. (2006; 2007)

The frequency of the wave with 12-hour periods increases during the winter, early spring, and autumn months, that is for the major part of the year. Thus, significant daily alterations in wind energy are to be expected, with minimums in the morning and afternoon, and maximums during daytime and at night. There are no daily changes in wind energy, where the 12-hour wave is random because it is dominated by the daily cycle with a single maximum around midday. The most favourable days for the transmission system operation are those, when there is no significant daily variation. Following the above case, the number of these days should be relatively small. The proportion of those months, where the daily average wind energy shows neither the daily nor the 12-hour period, is only 2%.

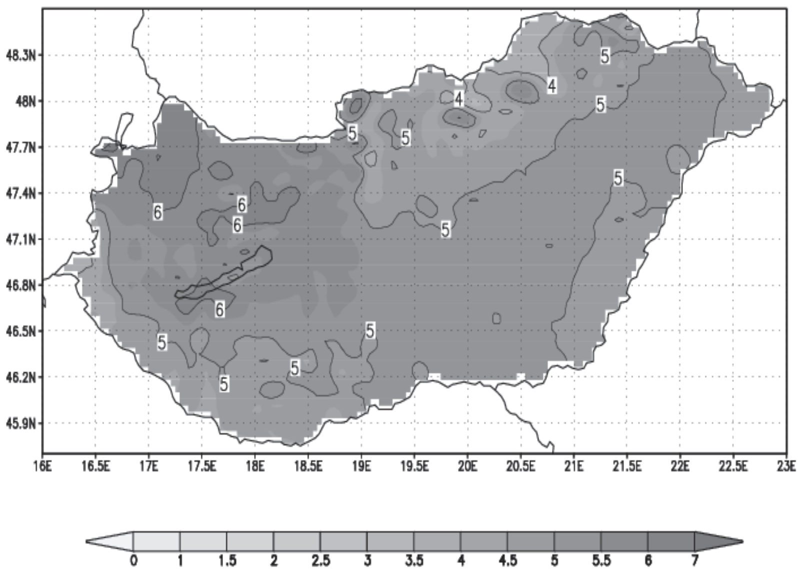

Figure 6 – Average wind speeds at 75 m height calculated by the dynamic downscaling between 1961 and 1990

Source: Szépszó, G. – Horányi, A. (2009).

Apart from the application of wind forecasts with high space-time resolution, the careful selection of the site of wind turbines is also necessary for economical operation. The selection of the optimal site can be achieved with the help of wind maps showing the mean wind speed or the mean specific wind energy during a particular time interval. In the course of a national research project, one of the important tasks of the *Hungarian Meteorological Service (OMSZ)* was to draw high-resolution wind maps that show the wind climate of the lower 100-metre-layer of the atmosphere on the historical basis in the past.

OMSZ provided more solutions to this problem. The dynamic downscaling of numeric models enables modelled wind fields near the ground to accurately reflect real stream conditions. This technique enables the production of wind direction and wind speed data at different points and heights where measured information does not exist, otherwise (SZÉPSZÓ, G. *et al.* 2006, SZÉPSZÓ, G. – HORÁNYI, A. 2009). The dynamic downscaling is never exact because it is just the best available simulation based on the laws of the atmosphere. Nevertheless, in our opinion, the produced 5 km resolution wind climatology (wind direction and speed) provides better results than the maps derived from ground-level measurements *(Figure 6)*.

2. Potentials in the change of Hungary's climate

According to the investigations of MIKA, J. (2001), it can be concluded that the decreasing barometric gradient, the increasing frequency of anticyclones and the decreasing frequency of northerly and westerly flows would result in a decrease of wind speeds and wind energy.

This result is also supported by one of our own investigations, although it covered only a short period with regard to climate change (TAR, K. *et al.* 2002). The frequency of cyclonic and anticyclonic macrosynoptic weather situations, after *György Péczely,* was determined during between 1968 and 1972, and 1991 and 1995. These situations specify atmospheric stream conditions in *Hungary*. It was found that the number of cyclonic situations, namely which have utilisable wind speed, decreased by 4% during the second period. In the case of some Hungarian weather stations, the impact of this decrease on the mean specific wind power was also investigated. The deficit was 40% for the whole period, its maximum occurred in the summer (48%), and its minimum in the winter (36%).

Based on the hourly wind speeds of the above mentioned periods, the monthly relative wind energy, i.e. the monthly proportion in percentage of the yearly sum was determined. According to *Figure 7*, the relative wind energy follows the 'traditional' yearly distribution of the wind speed: in Budapest, maximums in March, July and November; and minimums in September were detected between 1968 and 1972. However, significant changes occurred between 1991 and 1995 compared to the previous interval: extreme values changed and the third maximum in the summer, which is very important with respect to irrigation, disappeared. These are the consequences of significant alterations in the yearly distribution of the wind speed which can be likely due to the changes of atmospheric flows as a result of climate change.

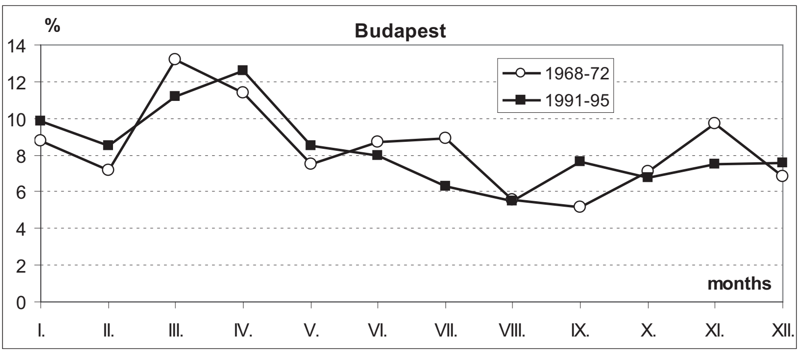

Figure 7 – Annual changes in monthly relative wind power in Budapest

Source: TAR, K. et al. (2002)

However, the results of a research-team, which has analysed ground-level wind speeds for the past three decades, show that decreasing wind speeds in the last 30 years are primarily due to the increase in vegetation covering the *Northern Hemisphere* (LÁZÁR, I. 2011). As a result, the surface of the ground has become rougher which hinders the air flow. The team has analysed the data of weather stations and found that average wind speeds on the *Northern Hemisphere* are weaker by 10% than 30 years ago. Ranking the causes, the researchers concluded that the vegetation cover accounts for 60% of the wind speed decrease. Consequently, VAUTARD, R. *et al.* (2010) states: their results are explained by global warming only by 10–50%.

In contrast, the *2007 IPCC report* says that westerly winds have become stronger in medium latitudes on both hemispheres since 1960 (ÉGHAJLATVÁLTOZÁS, 2007).

Theoretically, the investors and operators of wind turbines may worry about the decrease in wind speeds, but researchers are not able to answer the question of to what extent this phenomenon affects the wind energy utilisation in its industrial size. Ground-level wind is measured at 10 m height, so these data are used by researchers as well. However, the rotor of wind turbines is at 50–100 m height, and there is little data on air flows at this height in all parts of the *World*.

There is no direct reference to the change of the wind speed in the *Carpathian Basin* either in the above mentioned paper or in the IPCC report. According to MIKA, J. (2009), *Hungary's* wind energy will rather decrease in the future, despite the fact that the downscaling of macro-regional climate models do not show significant alteration in wind speeds.

3. Potentials in Hungary's geography and land use

The main factors in installing wind turbines are the following:

- wind conditions which mean the prevalence of permanent, strong winds that should be checked by wind energy measurements;
- environmental aspects: an area that is wide, open and free of obstacles and other surface roughness and statically possesses adequate soil conditions;
- technical factors: sufficient quality of roads, grid connection opportunities;
- environmental protection factors: noise effect, shadow effect, bird migration routes, etc.

The latter ones are the most complex; in fact, areas that are not recommended for installation or are forbidden can be deduced from these factors. These are:

Installation not recommended or forbidden:

- areas of ecological networks (protected natural areas, their buffer zones, natural areas, and ecological corridors);
- biotopes, feeding and nesting areas of protected wild animals and their migration routes;
- biotopes of protected plants and plant associations;
- protected landscape areas, areas of unique landscape values;
- areas affected by international agreements and laws (e.g. Ramsar, Natura 2000, Bio-sphere reserves)

Areas recommended for installation:

- large, contiguous agricultural areas (farmlands);
- industrial areas;
- areas degraded by open-pit mining or other factors.

Based on various statistical yearbooks, HUNYÁR, M. *et al.* (2006) identified the total area of lands that are unsuitable with high probability for installing high capacity wind turbines. Results are shown in *Table 1*.

Table 1 – Areas unsuitable for wind turbine installations

Source: HUNYÁR, M. et al. (2006)

Land category	Area (km²)
Interior area of settlements	6,650
Water surfaces	1,753
Protected areas	8,573
Yards, vineyards, orchards	2,880
Forests	17,468
Railroads	3,949
Roads	2,205
High and Medium voltage transmission lines	15,419
Areas 400 metres above sea level and steep slopes	1,860
Total	**60,758**
In percentage of Hungary's total area	**65.3 %**

4. Potentials in science and science policies

Technological development, which is closely linked to the results of scientific research, can be observed in the change of the capacity of wind turbines. In this respect, the past 25–30 years have shown that doubled axis height and rotor diameter resulted in a 2.5 times capacity increase, while a three times change resulted in 4.3 times change in the capacity. If this tendency goes on, then by 2020, there may appear wind turbines with the 20 MW nominal capacities.

The role of science is also important. By choosing the location of high capacity, electricity generating wind turbines require serious consideration of climatological, technical, economic, social, and environmental factors. A review of the Hungarian meteorological literature shows that Hungarian meteorologists are aware of their responsibility when it comes to exploration and exploitation of atmospheric resources (SZÉPSZÓ, G. *et al.* 2006; SZÉPSZÓ, G. – HORÁNYI, A. 2009).

The results of wind climate research for energetic purposes are summarised in a paper written by TAR, K. – PUSKÁS, J. (2011). Nevertheless, there is still a lot to do in the area of detailed and accurate exploration of *Hungary's* wind energy potential in short and long-term forecasts.

During the exploitation of renewable energy, currency, acceptance and government subsidies are among the most important social factors. Research in the currency and acceptance of renewable energy has recently become the topic of socio-geographic research, and so far, the results have been encouraging (KOVÁCS, T. – PATKÓS, CS. 2011; TÓTH, J. – TÓTH, T. 2011; TÓTH, T. – KAPOCSKA, L. 2011; TÓTH, T. *et al.* 2012). The main conclusion of an extensive research conducted in the valley of the *River Hernád* with respect to wind energy is the following: *"... real substantive knowledge is minimal. Traditional sources of information (electronic and print media) do not provide a full range of knowledge on this topic. Residents should be given correct, authentic and comprehensive information which fulfils their needs as its best. Municipal leaders may play an important role in the actual implementation and information transmission process."* (TÓTH, T. *et al.* 2012).

Education is one of the key factors of success. Given the fact that the present geography textbooks used in elementary and secondary schools underrepresent the current state of renewables, PAJTÓKNÉ, T. I. (2012) introduces her own electronic toolkit developed for geography teachers and students. Moreover, it also gives examples on how to diversify the teaching of geography and other natural sciences with the knowledge of renewable energy sources.

With respect to the government subsidies, the paper by GÁCS, I. (2010) and BÜKI, G. (2010) comes to the following conclusion: *"During the exploitation of wind energy, electricity is produced which substitutes primary energy. Substituted primary energy in the Hungarian national grid can be fossil fuels (gas, coal, lignite) and nuclear energy, but because of various aspects (primarily due to the high percentage of natural gas in the structure of primary energy use), this results in the substitution of natural gas. However, the hectic electricity production of wind turbines due to wind speed fluctuations decreases the efficiency of power plants working in the network. Due to the compensation for the alternating electricity production of wind turbines, the electricity system requires a higher reserve capacity. This results in a significant decrease in the efficiency of fossil fuel power plants. Primarily, this occurs at night when the electricity demand is low. Rapid and significant changes in load increase the frequency of unstable working conditions in traditional power plants which decreases their annual average efficiency and results in more fuel consumption and greenhouse gas emissions."* (GÁCS, I. 2010, BÜKI, G. 2010).

"The savings on primary energy usage, chiefly the substitution of natural gas, provides the basis for the promotion of wind energy. Energy saving is also related to the reduction of carbon-dioxide emissions. This reduction in emissions means 2–2.5 HUF/kWh (0.007–0.009 GBP/kWh) an advantage in the present electricity system. The amount of money or part of it can be transferred to wind energy producers. In a grid equipped with more modern and more efficient gas power plants, this figure is reduced by one-third. However, a 30–40% increase in profit could be achieved by setting up pumped-storage hydroelectric power stations, but in this case (at least), the additional profit should be used to finance the construction of the power plant … More subsidies for wind turbines would be justified only if large scale wind turbine production was present in Hungary which would result in new jobs." (GÁCS, I. 2010).

Meteorologists carry out researches on wind climate and also hope that these conditions will be fulfilled soon, and that the installation of wind turbines will continue with its past dynamics. It is an encouraging sign that the foundation stone of a new wind energy generator house factory was laid on 15 October 2010 in *Tiszaújváros*.

5. Potentials in energy policies

In this respect, wind is the most authentic source in *Hungary's* Renewable *Energy Action Plan 2010–2020*. The following paragraphs contain the edited version highlighting those parts of this document which refer to wind energy.

"Wind energy is an extremely environmentally friendly, modern energy source (with practically no CO_2 *emissions) which could represent one of the key elements of energy supply in the future. It is, however, a non-controllable, weather-dependent technology. Thus, the proliferation of wind energy is inhibited until the time energy storage can be ensured in an economical manner by the controllability and capacity of the electricity system. The national target for 2020 is thus aligned to the limit of the electricity system's controllability which is, to our present knowledge, capable of receiving wind energy up to an approximate total output of 740 MWe."*

"Based on surveys conducted in the past few years, locations have been identified that provide economically sufficient place for the installation of larger wind turbines with respect to nature conservation and environmental protection. According to this, Hungary's total wind power potential reaches several thousand MWe." (According to Imre, L. [2006] this is 6,489 MW.)

"In addition to larger wind energy parks, the National Renewable Energy Action Plan also factors in the spreading of smaller wind turbines (with an output of a few kW) and dwarf turbines which could generate power for the network periodically and primarily play an important part in the local autonomous energy supply. Based on experts' estimates, these can be expected to emerge at a total electricity output of approxi-

mately 10 MWe until 2020. Based on this, a realistic target of 750 MWe can be set for the creation of wind energy capacities by 2020.”

“According to the Hungarian Electricity Act (article 7 – (2)) on January 1, 2008, connecting wind turbines to the grid requires formal application. The first request for tender in wind energy appeared in 2009 in the capacity of 410 MW. (Decree of the Ministry of Transport, Communication and Energetics, no. 33/2009. (VI. 30.). The frequency of tenders’ occurrence depends on the controllability and safe operation of the electricity system and on the changes in technical limits which may enable the installation of the additional wind power capacity based on the results of the periodic audit of the electricity system.”

“The primary goal of the priority axis ‘Increasing the use of renewable energy’ within the Hungarian Environment and Energy Operational Programme is to generate a favourable change in the structure of Hungary’s fuel consumption, i.e. to promote the shift from fossil fuels to renewable energy. Within the construction of thermal energy and electricity, the following measures are supported: biomass usage, production and usage of biogas from green waste, exploitation of geothermal energy, installing heat pump systems, using solar and hydro power, installing wind turbines without grid connection, setting up or modernising community district heating systems using renewable energy, and preparing renewable solid fuels (e.g. pellets, briquettes). Taking the limited wind energy receiving capacity of the Hungarian electricity system into account KEOP (Environment and Energy Operational Programme) currently supports the installation of only low-capacity (max. 50 kW) wind energy parks.“

6. Epilogue

“Based on large and world-wide sources, with respect to costs, the maturity of technology and limited environmental impacts, it can be stated that the use of wind power for the fulfilment of an ever growing percentage of electricity demand has a promising future in those countries that are willing to make investments.” (OLÁH, GY. *et al.* 2007).

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Local Geothermal Energy Sources in Csongrád County, Hungary: A New Way for a More Sustainable Energy Supply

Abstract

Szeged and Csongrád County are among the lucky few territories which are well supplied with potential energy resources. Numerous hydrocarbon fields are found under the city itself as well as in its vicinity. The resources have been extensively exploited for local public and economic purposes. At the same time, the abundance of potentially available thermal waters found in the geological layers underneath opens up new possibilities for multi-focal usage as well. Geothermal energy offered by these local resources is unfortunately not fully exploited yet. Industrial usage of thermal waters still prevails, followed by balneological and touristic purposes. Excellent examples are the recently constructed or developed, well-equipped, thermal bath complexes found in and around the city (Algyő, Mórahalom and Makó), many of which have also gained increasing international reputation and visitors across the borders. This present study discusses the potential areas where thermal waters could be more widely used in Szeged touching upon the modern geothermal cascade systems already installed and running in some of the neighbouring settlements.

Key words

Geothermal energy; Thermal waters; Exploitation; Southern Great Plain

Introduction

Social and economic changes accompanying the change of the regime in 1989–1990 resulted in significant transformations of energy production and consumption in *Hungary*. There is a constant decrease in local production parallel to an increasing import from the 1990s onwards *(Table 1)*. This unfortunate trend directed the attention of professionals to the utilisation of the new type of energy resources.

Table 1 – The energy budget of Hungary (1990–2010) (in PJ)

Source: KSH (Central Statistics Office) STADAT

Year	Production	Import	Total	Export	Change in	Total
1990	634.1	653.5	1,287.6	70.8	13.1	1,203.7
1995	575.0	617.5	1,192.5	98.8	9.1	1,084.6
2000	485.2	665.4	1,150.6	82.8	12.7	1,055.1
2005	428.0	873.6	1,301.6	140.8	7.5	1,153.2
2010	460.6	770.4	1,231.0	134.6	9.7	1,086.7

Hungary has largely run out of conventional energy sources in the past few decades. Black coal mines were shut down in 2005, with ongoing mining focusing on the exploitation of lignite and brown coal reserves alone. While natural gas production could meet the domestic demands in 1980, today it can only account for 26% of the total needs. The remaining is imported. Oil production has seen an even larger decrease by ca. 35% in the past 10 years. The country's nuclear power station contributed to the national electricity production by 172 PJ in 2010, providing for 42% of the local demands. This resource provides for 15% of the total domestic energy demands. If we consider the energy policy and status of the *European Union*, there is an obvious dependence on imported energy to varying degrees which fundamentally affects the safety as well as the price of supply. In 2006, the rate of dependence on the imported energy supply was 54% in the *EU-27* (the index is given by the ratio of net import and usage in per cent). In *Hungary*, the same index was 62.5% assigning it to rank 14 among the *EU* countries.

The negative influences of burning fossil fuels on the environment are clearly known. Recent policies of the *EU* are thus calling for and supporting a larger reliance on renewable energy sources. According to the 2009/28/EC policy of the *European Parliament and Council*, *Hungary* has to gain at least 13% of its energy demands from renewable sources by 2020. This value was only 7.4% in 2007 and has not changed much since then.

1. Geothermal energy

Hungary boasts of an outstanding potential in geothermal energy sources, especially in the area of the *Great Hungarian Plain* due to its unique geological endowments ranking it among the leading countries. This is clearly evident from the exploitation numbers and with a second rank among renewable energy production after biomass. In the past ten years, a rapid increase in utilisation of this type of energy has been witnessed *(Table 2) since it is* a reliable and environmentally friendly resource.

Table 2 – Energy derived from renewables by type (1995–2010) (in TJ)
Source: KSH (Central Statistics Office) STADAT

Name	1995	2000	2005	2010
Electricity from hydroelectric	587	641	728	677
Electricity from wind power	0	0	36	1,922
Wood and other solid waste	31,095	29,295	43,535	63,756
Geothermal energy	3,600	3,600	3,627	4,130
Biogas	0	6	297	1,516
Heat from solar energy	0	0	81	225
Electricity from solar energy	0	0	0	3
Renewable communal waste	1,085	1,218	1,382	2,229
Biofuels	0	0	214	5 947
TOTAL	**36,366.8**	**34,759.8**	**49,900.1**	**80,405.2**

Despite the high investment costs, the running costs are extremely low. Furthermore, as this type of resource is a local one, it can significantly enhance economic development of the rural, economically disadvantaged regions. Cheap running costs offer significant savings for the local governments. Balneological uses, on the other hand, can contribute to tourism development. The geothermal industry opens up new employment possibilities along with training needs (Bobok, E. – Tóth, A. 2010).

A moderate estimate of the local geothermal potential is 100–110 PJ annually. This would provide for ca. 20% of the annual heating demands. In other words, ca. 10% of the primary energy demand could be met via the sufficient exploitation of this energy resource. The number of exploited thermal wells in 2007 in *Hungary* was 971, 33% of which were used for balneological purposes. 43% of the wells are exploited for heating purposes in local agriculture, various branches of the industry as well as to ensure public hot water and heating demands. Roughly 25% of the working wells are run by waterworks (Szanyi, J. *et al.* 2009).

The first thermal water wells were established in the second half of the 1950s. Due to a relative economic upheaval and positive policies of the period, exploitation flourished in the 1960s. Non-productive oil wells deepened in the same period which meant a further impetus, as it can be seen on the example of *Zalakaros*. There was a significant decrease following the stagnation in the 1970s, when a relative increase in recent market demands brought about a second upheaval in utilisation. Formerly, used waters were driven into rivers, lakes and canals. According to a bill passed in 2004, these waters must be pumped back in case of the newly established wells *(No. LVII Act of 1995, modified in 2003 on Water Management)* (Ágoston, B. *et al.* 2008) This policy is in line with the expectations of the leading experts of the field as increasing usage of the thermal waters puts greater and greater pressure on the reservoirs with a limited storage. In order to ensure increased production in the heat transfer, cooled waters are to be pumped back to allow reheating and some other types of renewable utilisation. Several well-known examples for this type of technology are known locally and internationally as well (Szanyi, J. – Kovács, B. 2011.). The geothermal public utility system of *Hódmezővásárhely*, which was opened in 1998, is one of such examples, where the used waters are pumped back into a sandstone reservoir.

2. Geothermal energy exploitation in the Southern Great Plain Region

The region of the *Southern Great Plain* has an outstanding potential for geothermal energy as sandy layers of the *Upper Pannonian* and *Pleistocene* age, acting as potential reservoirs, are the thickest here. These layers render as number one among domestic thermal water reservoirs. The temperature of productive waters increases with the depth of the established wells ranging between 50–60°C (122–140°F) at a depth of 1,000 m (3,280 ft), 90–100°C (194–212°F) at a depth of ca. 2,000 m (6,561 ft) and 110–120°C (230–248°F) at 2,500 m (8,202 ft) (SZANYI, J. – KOVÁCS, B. 2010). The referred extraordinary hydrogeological endowments allowed for a wide-scale utilisation of thermal waters in the area studied *(Figure 1)*.

Figure 1 – Major 'geothermal settlements' of Csongrád County
Edited by SZELESI, T. (2013)

a. Roughly one-third of the exploited thermal waters are used in agriculture for local horticultures and animal farms acting as major users. The annual usage of this agglomeration ranges between 8–10 million m³ (282–353 ft³/1 m³~1000 litres) of waters with temperatures between 70–100°C (150–212°F). Two major centres are known in *Szentes* and *Szeged*, where the heat transferred from thermal waters is used for heating greenhouses, animal farms as well as for servicing communal buildings. The *ÁRPÁD-AGRÁR Horticultural PLC.* of the city of *Szentes* is one of the largest complexes in *Europe* using such renewable energy resource. Its predecessor, the *Árpád Horticultural Cooperative* started exploiting this resource as early as from 1960. Today, 20 producing wells ensure heating supply of 60 ha for greenhouse complexes and plastic foil tents. In addition, the gained energy is also used for heating poultry farms and concomitant service buildings. Greenhouse and plastic foil tents provide the growth of various off-season vegetables and groceries such as green peppers, tomatoes, cabbages, lettuce, and cucumbers. The other company, the *FLORATOM Ltd.*, established in 1992 in *Szeged* uses the same type of energy for heating 22 ha of greenhouse complexes which primarily produce peppers and tomatoes. 15% of the total capacities are used in floral industries with gerbera being the main type of flowers grown. The company' predecessor, the Liberation Cooperative, has exploited this energy source from 1959 onwards.
b. Balneological and therapeutic utilisation of thermal waters is long-standing in our study region. 24% of total thermal water production goes to spas and thermal baths. The first wells, yielding waters of 30–50°C (86–122°F), were established during the last century, many of which were granted the status of therapeutic waters. A 944 m (3,097 ft) deep well established in the vicinity of the public steam bath in *Szeged* in 1927 yielded waters of 49°C (120.2°F). The thermal spring of the Anna well was granted therapeutic status in 1929 and 1967, respectively. The

recently renovated *Anna Thermal Bath and Spa* complex is one of the largest and most visited wellness complexes of the city of *Szeged*, offering a wide-range of wellness and therapeutic services. The *Napfényfürdő Aquapolis Spa Complex* opened in 2009 on the other side of the *Tisza River* is the other such highlight of the town. In addition, several modern spa complexes have been opened in the region including the ones of *Algyő*, *Mórahalom* and *Makó*. The key importance of these complexes in local tourism industries is well known. The most recently established spa complexes of *Hódmezővásárhely* and *Csongrád* act as end users of the newly established geothermal cascade systems, where the produced waters after an initial heat transfer and cooling to 30–40°C (86–104°F) are used for balneological purposes.

c. Only 6% of the referred energy types are used in public heating. They are mainly concentrated in the area of *Csongrád* County. The first such measures were taken in *Szeged* and *Szentes* in the 1960s.

3. Potential uses of thermal waters for public heating in Szeged

Geothermal energy for public heating of trade and service providers as well as local citizens was first used in the *Odessa district* of the city. The first thermal water well with a depth of 1,900 m (6,233 ft) yielding waters of 90.5°C (194.9°F) was also established there in 1962. The gained heat was initially used for heating local daycares, preschools as well as various communal buildings in addition to 196 public apartments. Within two years, another 800 users were introduced into the system. So far, the cooled waters have been driven to the *Tisza River*. From 2013, however, the used water must be injected back to the reservoir (Kothencz, T. 2012).

The first complex of a production and injection well in the city of *Szeged* was established in 1983 by the courtesy of the *Central Mining Development Institute*. After a long intermission, a new, high productive compressor was installed in 1994–1995 from *PHARE* subsidies. This well system provided the heating and hot water demands for

3,300 apartments in the residential complex of *Szeged-Felsőváros* between 1995 and 1998. In that year, due to the unfavourable running conditions, the injection was shut down. Today, the producing well yields 50,000 m^3 (1,765 thousand ft^3/1 m^3~1000 litres) thermal water for heating (KOTHENCZ, T. 2012).

Learning from the problems of the past uses, today there are two possibilities for thermal water utilisation in public heating. One is the updating of the available infrastructure and the other is the establishment of the multi-step heat transfer cascade systems. The establishment of the latter is profitable only in those areas where there are substantial market demands. The enormous public buildings of the downtown area as well as the condos of the adjacent residential complexes would be most suitable for such establishment. Numerous pros are present, including a local presence of the energy source granting independence from imported energy as well as being perceived as a long-term stable supply. Moreover, this would also result in reduced pollution and heating costs. In the long run, the system offers ca. 60% savings compared to systems based on gas burning.

In 2007, an extensive study conducted by the *Geothermal Coordination and Innovation Foundation of the Department of Mineralogy and Geochemistry*, *University of Szeged* as part of an *INTERREG II. Project*, was assessing the potential uses of geothermal energy in the buildings of the university. Proposals were made for the establishment of two cascade systems. The first is located in the downtown area and composes a producing well of 2,200 m (7,217 ft) depth yielding waters of 90°C (194°F) where two concomitant injection wells would provide for the heating of 9 downtown university buildings. The second, made up of a producing injection well, established in *Újszeged*, would provide the heating of 6 university building complexes in addition to the city's stadium and public pool. The expected turnover period of the investments with substantial state subsidies is 9 years. However, once this plan is realised, heating costs would be reduced to roughly half of the present value.

While *Szeged* is still stuck in the phase of planning, some nearby cities have decided to move on providing functioning examples of such systems. The geothermal public utility system of *Hódmezővásárhely* was inaugurated in 1998, after five years of construction. The system is made up of two subunits, a producing and a heating unit. Two producing wells with a depth of 1,300 m (4,265 ft) provide hot water for 2,800 apartments and 10 public buildings. The heating subunit is composed of three producing and two injection wells with the depth of 2,000 m (6,561 ft) and water of 80–86°C (176–186.8°F). Two insulated heating pipe circles were established of 6,500 m (21,325 ft) total length transporting hot water to the apartments. The end user of the cascade system is the public bath, where the cooled waters with the temperature of 27–30°C (80.6–86°F) are injected back into the reservoir. The producing cost of 1 m^3 (35.3 ft^3/1 m^3~1000 litres) of hot water for public use in the traditional system was ca. 1.60 EUR (1.35 GBP), now it is only ca. 20 euro cents (0.17 GBP). In case of heating, the costs were cut back to one third of the original (Ágoston, B. *et al.* 2008). The system is being continuously extended by the adding of new public buildings. A significant achievement, besides its greenness, is complete independence from imported energy.

Learning from the example of *Hódmezővásárhely*, more and more settlements have realised the benefits offered by this new type of energy. The city of *Mórahalom* inaugurated its own cascade system in 2010 following two years of construction using *EU* subsidy, as well. The system is composed of a single pair of producing and injection wells and accessory pipes with heat transfer centres. The gained energy is primarily used in public buildings for heating and will surely cut back running costs besides offering a lesser degree of dependence on fossil fuels. The geothermal cascade system of *Csongrád* was reopened in 2012 following a substantial expansion and update of the previously shut down system. The rejuvenated producing well with a depth of 2,000 m (6,561 ft) yields waters of 82°C (179.6°F) provides heating for the most important public buildings and facilities (schools, healthcare centre) in addition to 500 apartments and the public bath as the end user of the system.

4. Summary and discussion

The utilisation of geothermal energy has several advantages with respect to the technology, the outstanding economic value and importance. These are rooted in several factors, such as the independence from price increases of other energy resources like fossil fuels, the mass of potentially available resources and environmentally friendly usage. Thermal waters have been widely exploited for ca. 50 years in the area of the *Great Hungarian Plain* for not only balneological purposes, but also industrial and agricultural usage, as well as public heating. The use of geothermal energy for heating has been more and more widely propagated. An economic run can be achieved only in case of larger public buildings as well as residential complexes.

The geothermal public utility system in the city of *Hódmezővásárhely* dates almost a decade back and as such offers sufficient information on the potential pitfalls of such systems in public heating for other cities. Acknowledging these experiences, more and more towns decided to introduce it into their own system of public utilities. Classical examples are the towns of *Makó*, *Csongrád*, *Szentes*, *Kistelek* or *Mórahalom*. Thermal waters are used as a renewable energy source since the excess heat is utilised with used waters pumped back into the original reservoir. The region has a good potential of know-how in the field of geothermal energy exploitation based at the University of *Szeged*. The presently ongoing projects are aimed to evaluate the benefits and pitfalls of establishing a geothermal cascade system in the city of *Szeged*. The leading expert in the field, *János Szanyi* considers the establishment of 5–6 subsystems to be necessary for meeting the heating demands of public buildings and residential complexes in the town. With this, approximately one third of the total usage of natural gas for heating could be substituted following a full payback of investment in 10–12 years (DOBAI, T. 2012).

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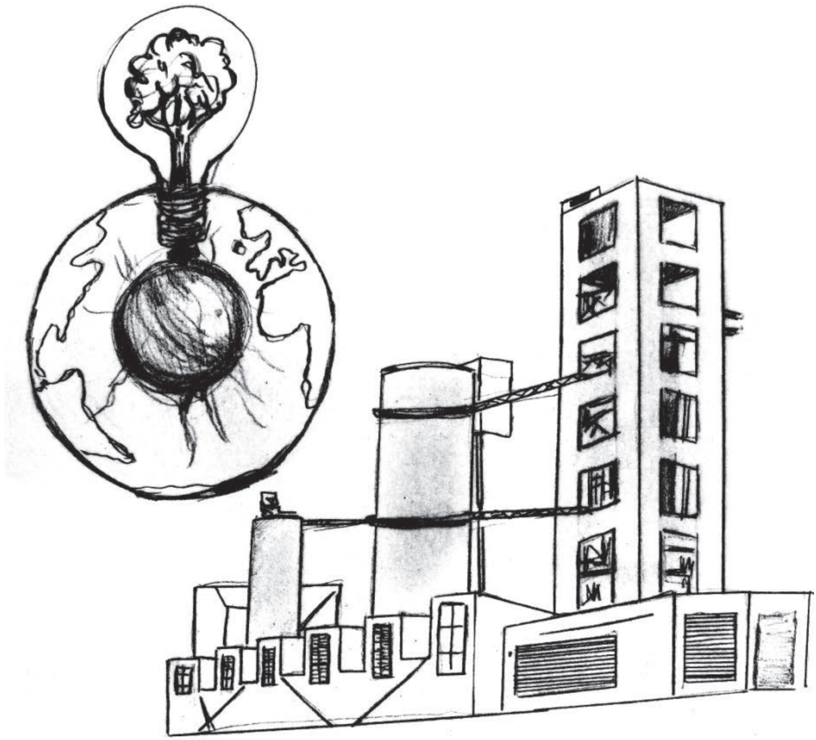

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The Functioning of the Cement Factory in the Rural Area of Királyegyháza, Hungary

Abstract

A real state-of-the-art cement factory has been recently built in Baranya county, in Királyegyháza, Hungary. The study intends to give a thorough overview on the impacts of the new plant. It is a typical rural area without large employers and industrial plants where agriculture has the strongest tradition. The investors and also the majority of the local community expect large economic and social benefits from this investment. The operator related to the regional waste management program aims to achieve sustainability and rational energy utilisation by involving local human resources, basic commodities, the ratio of the utilised fossil energy sources and the planned biomass which can be optimised. Environmental issues are also investigated, as the plant is still deeply committed to environmentally friendly production while the investment and the operation itself is continuously criticised by green movements.

Key words

Cement industry; Energy utilisation; Waste management; Sustainability; Locality; Human resources

1. Human geographical relations of the micro-region

The cement factory of *Királyegyháza* was built in the area of the *Szentlőrinci micro-region*. The *Szentlőrinci micro-region* composes a spatial, administrational unit with one town and 19 parishes (*Figure 1*). When it comes to its size, population (approx. 15 thousand persons) and the number of the settlements, it can be considered among the smallest in the country. Its position is peculiar, since it is situated between the most backwardly positioned *(Sellyei)* and the most dynamically developing *(Pécsi)* micro-regions. According to the *218/2012. (VIII. 13.) Government Regulation*, from 1st January 2013 the *Szentlőrinci district* basically covers the same area as the micro-region, but it is enlarged by one more settlement.

According to the *67/2007 Parliamentary Decision*, the micro-region was qualified to a lagging position (KSH, 2007), based on the measured complex social, economic, infrastructural and employment indicators. The micro-region consists of 11 settlements lagging by social–economic viewpoints and 15 suffering from unemployment which largely exceed the Hungarian national average. Therefore, based on the categories of the *National Regional Development Concept*, it is backward from social–economic points of view (SZENTLŐRINCI KISTÉRSÉG, 2008). It is a typical rural area with disintegrated countryside structure where *Szentlőrinc* provides 45% of the micro-region and 6,848 inhabitants at present. Three settlements may be classified as the most developed ones, namely *Szentlőrinc*, *Bicsérd* (1,008 inhabitants) and *Királyegyháza* (915 inhabitants), which concentrate nearly 60% of the spatial unit's population (KSH, 2012). 60% of the settlement substance belongs to the micro and dwarf villages out of which numerous settlements have only one road in and out of the settlement.

The area is divided in half by primary route no. 6. The landscape is dispersed north and south from this structural axis differ. On the north, the afforested foothills of *Zselic* and *Mecsek* are situated where the transport expansion of the settlements is on a nominal level. South from the main road, the villages with a more advantageous social–economic situation are allocated on the plain landscape. They are traditionally and dominantly involved in agriculture, with *Királyegyháza* belonging to this category, as well (KECZELI, L. 2011).

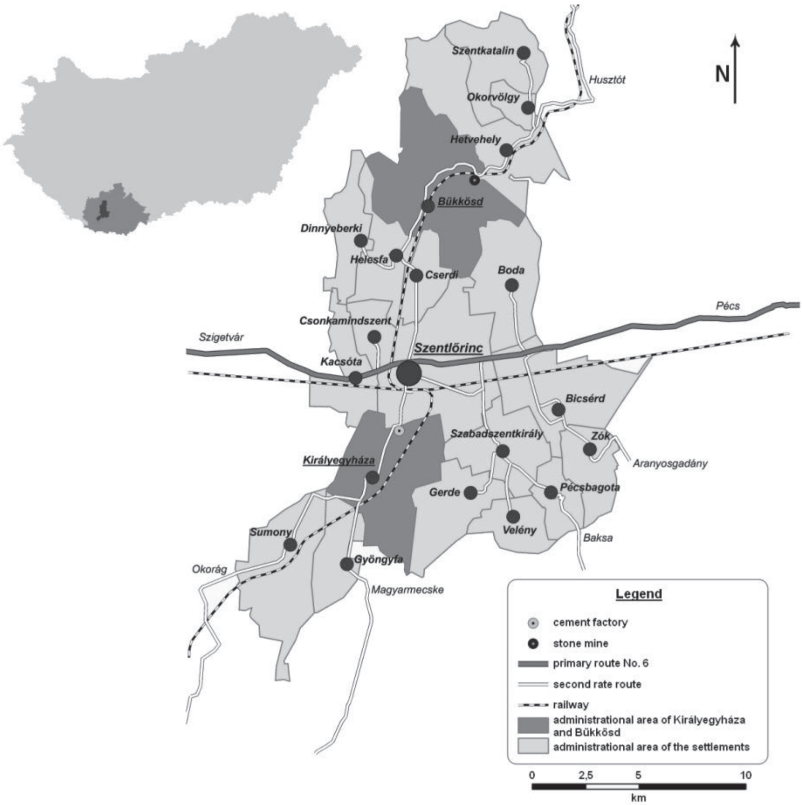

Figure 1 – The micro-region of Szentlőrinc
Edited by KECZELI, L. (2013)

2. The circumstances of the Királyegyháza cement factory's construction

The planning period of the cement factory was an era full of conflicts. The initiation per se was also a peculiar phenomenon since in *Europe* no new cement factory had been built in the last 30 years (CE-

MENTVILÁG, 2011b). The first steps were carried out by the *Strabag Co*. in 2003. The original location in factory plans was *Bükkösd* referring to the limestone mine as a basic commodity base. The settlement is located along the meeting point of the *Mecsek* and *Zselic* slopes in an afforested, scenic environment in the so called *Green Valley ecological corridor*. The neighbourhood takes pains over the preservation of natural values and the notion of environmentally conscious settlement development. Therefore, it was expected that the firm would be directly affected by the hostility of the locals and the civilian organisations. One of the movements' leaders was *Zöld Völgyért Egyesület* (Association for the Green Valley). Several referendums were carried out unsuccessfully in order to start the investment. Although, the third referendum was successful and was valid from the point of view of settling the cement factory to *Bükkösd*, at that time the investor was looking for some new locations. In 2007, he announced that the object was going to be built on the administrational area of *Királyegyháza*.

The leading part of *Bükkösd*, concerning the building of the cement factory, ended, but they could not avoid the industrial investment since the stone mine provides raw material for the factory in *Királyegyháza*. Moreover, from an environmental point of view, the mine, which should be enlarged 10 times the previous size, may be much more controversial: even though the cement factory was built with the most modern technology, it has significant effects on nature and the environment. In respect of the village of *Hetvehely*, it will perhaps be facing the enlargement of the bordering mine, but it can also be advantageously considered on every account that the environmentally sensible region has been decontaminated since the incriminating effects of the cement factory (KECZELI, L. 2011).

Even before the launch of the construction, the investor was positive about the environmental charging impacts of the factory. *Strabag* asserted on numerous forums that it was going to be the possibly most modern cement factory in the world with the most innovative production technology carrying out the production process in a closed system. It is evident that today, in the case of construction, such works (e.g.

strict domestic and international rules, standards and limit values) have to stand the proof. This means that the emission rates of the occurring polluting materials, theoretically, are minimal and by far under the threshold limits. The highest rates are performed by the floating dust concentration which is continuously scrutinised by the environmental monitoring system. The latter measures emission values 5, 10 and 15 kilometres (3.1, 6.2 and 9.3 mi) away from the firm *(Figure 2)*.

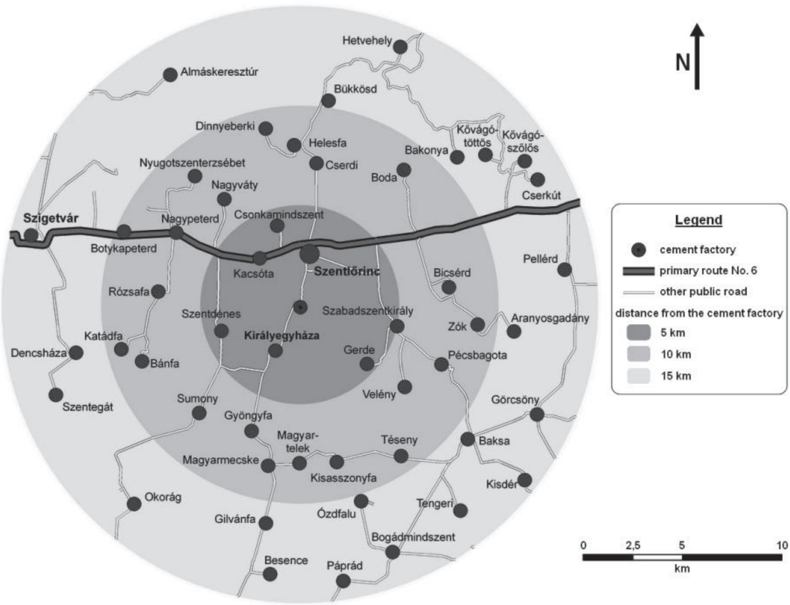

Figure 2 – The environmental monitoring area of the cement factory
Source: V-Med Bt. (2005); Edited by Keczeli, L. (2013)

Although, according to the reports, the emission of the air polluting materials is hardly perceptible; one has to consider other factors during the functioning, as well. Noise pollution is present mainly around the stone mine where limestone is excavated with blasts; light pollution can be experienced mainly in the case of the cement factory since, during nightshift, the luminous factory can clearly be seen miles away.

From a visual point of view, the mine is a serious landscape scar which significantly reduces the aesthetic quality of the landscape in its closest environment. Moreover, the factory is an intense land shaping and land changing object with concrete towers emerging from the earlier more monotonic plain areas *(Figure 3–4)*.

Figure 3–4 – Views of the cement factory in Királyegyháza as of 2012
Photographed by Keczeli, L. (2012)

From environment and social points of view, the transport of the raw material, the finished product and the connected heavy traffic are very emphatic factors. Since the exploited lime stone and clay should be passed 15 kilometres (9.3 mi) away to *Királyegyháza*, they had to find the most optimal and effective way of transportation. Raw material is conveyed by railway. An industrial gorge was connected from the mine to the *Budapest–Pécs* railway line which cuts *Bükkösd* into two parts. From there via *Szentlőrinc*, the carriages are transported on the *Szentlőrinc–Sellye* line. However, with an industrial branch, the raw material is transported onsite. With this, the road section between *Királyegyháza* and *Bükkösd* was practically exempted from a significant amount of traffic. On the contrary, the transport of the finished product is more problematic since the extension of the M60 motorway has not been finished and the latter was one of the most important settling factors for the cement factory. The investor lobbied very hard to effect this planned infrastructural and economy invigorating development in the area, because they needed it as a transport connection to the motorway. They intended to transport the finished material both by railway and road.

Due to the above mentined, the inventor had to find another solution to avoid joining the main road through *Szentlőrinc*. It is obvious that it was neither in the interest of *Strabag* nor the population of *Szentlőrinc* or its leaders, because the heavy traffic passing through the settlement and the enhanced road quality destruction would cost too much. Presently, heavy traffic is drifted to main road 6 in a way that the building contractors created an industrial road out of a former dirt road leading as far as the outskirts of *Szentlőrinc (Tarcsapuszta).* From there, for a short section the road continues to *Szabadszentkirály* where it joins main road no. 6.

By the end of the construction period, there had been a change in the ownership relations. It is well known that *Strabag* had never owned an independent cement factory and, based on its profile, the firm adepts much less at making basic commodities instead of applying them. Perhaps this is the explanation for the fact that the world's greatest cement making firm is the French *Lafarge, which owns* 150 factories altogether, has created a Central European cement holding in the latter years. The holding consists of 5 firms, comprising 4 factories in the neighbouring countries of *Hungary* and the factory of *Királyegyháza* with a 30% ownership of *Strabag* and 70% of *Lafarge* (KONYÁRI, T. 2010). The termination of the era of ownership relation changes and personal fluctuation more or less overlaps with the deliverance of the 70 billion HUF (198.5 million GBP) investment in the autumn, 2011 (CEMENTVILÁG, 2011b). At this time in 2013, the entire cement factory fully belongs to the *Lafarge group*.

3. Cement production with secondary fuels

When the campaigns, dealing with environmental charging and harmful effects on human health, were relatively put down and the majority of the local population accepted the circumstances of the investment, the *Lafarge Cement Magyarország Kft. (Ltd.)* was perceived as a new development. The latter is now fanning the flames again. It was a redeemed and innovative method in the foreign factories of the firm to use secondary fuels to overshadow the utilisation of coal based fuels as much as possible which would ultimately decrease the ecological footprint. By this procedure, the original production technology is altered. According to the *314/2005 (XII.25) Government Regulation*, there is a need for a new admission from the *Environment Protection Advisory Board of South Transdanubia* (Dél-dunántúli Környezetvédelmi Felügyelőség). The factory in *Királyegyháza* started the authorisation procedure in April 2012, during which one had to stand the proof of extremely rigorous directions. First, the *Preliminary Consultation Documentation* had to be handled in based on which no excluding factors appeared in order to modify the admission, as it was also supported by the *1571/2012 regulation* of the EPABST. Following this, the *Authorisation Documentation* was carried out and handled in. Moreover, a detailed environmental impact assessment was also created. Its first point includes the topic of noise protection related to the construction and operation phases. The second point contains the protection of the air clearness and the third point of the document deals with the topic of waste management.

"In the member states of the European Union, the cement industry proved in practice that instead of the conventional fossil fuels, the utilisation of secondary fuels (primarily waste material) significantly contribute to sustainable development by decreasing greenhouse gases (such as carbon dioxide)"—this can be read on *page 9* of the impact assessment. According to the study prepared by the *Cross-roads Foundation* (Válaszúton Alapítvány), the solution would be the so-called eco-cement or geopolimer, for which a lower temperature oven is needed due to which the polluting material emission from the fuels is decreased by

two thirds. According to the study, hazardous waste and rubber should not belong to the scope of alternative fuels, since 17 types of heavy metals get into the environment (SZUHI, A. 2007).

According to the plans, the *Lafarge factory* in *Királyegyháza* would like to cover the need for the secondary fuel mainly from the *Mecsek–Dráva Waste Management Programme* where one of the outputs is the so-called light fractioned waste material. They primarily use non-utilisable paper, plastic and grinded rubber sparing the sewage disposal and the environment. Besides the assorted and treated waste, biomass could be used as well, with the exception of timber produced with forest clearing. The latter should be produced locally and remain as agricultural waste (e.g. corn-stalk, energy grass and other plant waste). With this development, the neighbouring farmers and entrepreneurs were given new possibilities, as well. The secondary fuel would be transported on public roads to the area of the plant and would be located in a closed container at the south, southwestern part of the factory from where the material would be brought to the system with a closed conveyer-belt. The need for public road transport would increase from the present 120 lorries to more than 160 (LAFARGE, 2012).

The maximum annual production of the cement factory is 1,130,000 tons, the minimum is 840,000 tons. This latter amount of finished products would be produced, if their product was portland cement only. 75% of the production would be loose, while the remaining 25% would be sacked cement (TOTAL KFT., 2012).

The traditional fuel for the turning out of the cement is coal and petrol coke (82,500 tons per year), natural gas (1,000,000 m^3 per year/1 m^3~1000 litres) and the pyro-coke (5,000 tons per year). This latter material is made during the pyrolysis of car tyres and plastic wastes when a very small carbon deposit-like particle is created with a heating value of 30–32 MJ/kg. Natural gas is used to start the burners and for fuel as well (TOTAL KFT., 2012).

According to the data shown in *Table 1,* the grinded concrete waste and car tires would display twice as much than the formerly annually applied coal and petrol coke. The allocation of the car tires would be solved in an open container built on the area of the firm, in which 360–400 tons could be settled at once.

Table 1 – The utilisation of secondary fuels by types of waste groups
Source: TOTAL KFT. (2012)

Waste group	Amount (thousand tons/year)	
	minimum	maximum
Grinded concrete	23	152
Biomass	0	102
Car tyre	0	5.5
Total	23	259.5

The change of fossil fuels to waste could even be decreased by 20% of the price of the energy needed for cement manufacturing. While the price per ton of the original materials is between 30–39 thousand Forints (87.00–110.00 GBP), the waste materials are under 30 thousand (less than 87.00 GBP). Lafarge aims to decrease the manufacturing costs by firing waste, decreasing carbon dioxide emissions and contributing to the monitored utilisation of those materials which cannot be recycled. The firm has aspired to decrease the manufacturing costs due to the decreasing utilisation of cement from 2008 as a consequence of the lack of investments (SZABÓ, Y. 2013).

Despite the social forums and dialogues propagating the environmentally friendly green technology, the local population expressed their objections almost immediately when they were informed about the utilisation of waste material as fuel. In *Szentlőrinc,* they started to canvass for signatures, and in the forums, those are regularly giving forth to their voice. Among them are also family doctors, who object this plan and fear for the health conditions of the local population. Namely, as a consequence of waste firing, the health risk for tumour illnesses within 5 km (3 mi) radius of the factory would be increased between 1.46–2.68 persons, exceeding the internationally accepted, value of 1 (SZABÓ, Y. 2013).

4. Employment and economic change

Based on the disseminated information, the factory employs 130 employees and directly contributes to the employment of further 300 persons (Cementvilág, 2011b). In the spring of 2011, the mayor of *Királyegyháza* reported that the firm employed 34 persons from the settlement and a further 10–15 increase was expected. *Szentlőrinc* contributes to somewhat the same number of employment with 30 persons, but an increase is expected there, as well, by 40–50 employees (Grím, F. *ex verb.* 2010). From the point of view of local employment, it is a negative phenomenon that—in relation to the agrarian settlement and the industrial great scale investment—the supply and demand meet in a much smaller scale than previously expected. In this case, the demand should be monitored in a much wider scope, mainly in the county, but, in certain cases, regional perspectives should be given, as well. It is a very important question whether the labour force prefers the local or the skilled one. Although, the positive aim is to employ as high ratio of the local workforce as possible, such a modern and professional firm requires skilled human resources with adequate education and qualification which is only scarce in the reviewed settlements (Keczeli, L. 2011).

The construction was such a great scale investment that in the later years 3,500 workers were involved in the construction, from the local as well as from the county and the country's environment altogether. They were employed by the sub-contractors (Cementvilág, 2011a). In *Szentlőrinc* and its surroundings, 200–400 non-local construction workers were accommodated in the different periods which resulted in serious advantages and goods in the micro-region with multiple effects. It is enough to consider that the employees—to pay for the accommodation, shopping and entertainment—spent a major part of their income locally. The planned and expected production values in the short and long run, and the production multiplier effects can greatly transform the region's economic construction (Keczeli, L. 2011).

Parallel to the plans and the opportunities, however, we can list numerous weaknesses and threats, as well, which should be considered to stay realistic. Basically, it can be reported about the region that the agrarian feature dominates due to its natural endowments. The mean arable land value of the micro-region is the highest after the *Mohácsi micro-region* in the county. The sectoral share of the economy reflects a much less modern position. The 12% employment ratio in agriculture is more than double of the national average and almost double of the county average. This is one of the most important indexes of the region's rural characteristics. The greatest agrarian settlements are *Bicsérd*, *Szabadszentkirály* and *Királyegyháza*. Unfortunately, food processing is practically missing in the micro-region. The quality and characteristics of the micro-region's agriculture is negatively affected by the fact that the industrial firm allocated on 60 hectares and the surrounding areas are, for the present, empty. In the long run, another 60 hectares of industrial area (120 hectares altogether) of excellent soil are withdrawn from agricultural production. The representatives of the secondary sector are present mainly by small and micro ventures and 60% of them are concentrated in the town. The ratio of people employed in the industry is 33%. The micro-region lacks great employers. We can only highlight the cheese factory in *Kacsóta* and the cement factory which can apply a considerable number of labour force.

The town of *Szentlőrinc* and its closest area have never had any important large-scale industry. There are only few small and medium sized firms that can be found in the town. Traditionally light industry prevails, namely shoe & clothes industry and also craftsmanship, out of which numerous ventures have already become bankrupt. There are some unique firms in the region, as well, such as the *IKR Agrokémiai Kft./Ltd.* netting chemical fertilisers. On the contrary to industry, tertiary sector has a relatively highlighted position with a 55% ratio, but lagging behind the national average. From the employees' point of view, it is an important characteristic of the micro-region that *Pécs* has an extremely strong pulling effect. A good example of this is that more than 50% of the employees of *Szentlőrinc* are not locally employed, but primarily commute to *Pécs* (Geopólus Bt. és Tímár és Társa Kft. 2005a; 2005b).

Cement production started in the second half of 2011. Optimists explain this as a first step of economic progression. The firm could generate real regional development, if the overlaying logistical services employed a further significant number of local workforce and the modern industrial firm came into being; adumbrating the earlier agricultural façade. However, we also have to add that 'one swallow does not make a summer', so a cement factory itself could not provide the key for the economic development of the region, since a complete vertical development is needed for that. The network of ventures correlating and being built next to each other—relying on local and human resources—could result in a complex boom and later economic impacts could exceed the region. In default of this, negative factors can be projected; e.g. such baulking threats which—considering the economic façade of the region—may even develop harmful effects, as well.

The earlier regional development concepts of the micro-region and today's development direction demonstrate similarities. It is a strategic program proposal to industrialise the micro-region by settling down green field industrial investments and to create an industrial park and a logistical sub-centre which would primarily be connected to the town. They mainly emphasise the opportunities provided by the cement factory, the technology industry development (applying environmentally friendly innovations) and the interconnection of the *Szentlőrinc–Királyegyháza* industrial–transport axis. The industrial park could primarily be the site for processing industry ventures, where numerous enterprises, which function in the town presently, could move to (Geopólus Bt. és Tímár és Társa Kft. 2005a; 2005b).

5. Conclusion

The owners of the plant propagate the venture as it brings "a sustainable economic profit" to the area (Cementvilág, 2011a). Its future façade is the question of the next years or decades. We can see three kinds of clearly identifiable ways of development. The agrarian space will remain admitting to an industrial profile which is coequal with it. The relationship of the agrarian production will be strengthened with the cement factory by the production of biomass fuel. In the second scenario, the dominance of the primary sector could be completely underplayed, and the secondary and tertiary sectors would take up the majority of the employees. According to the third version, based on the negative tendencies of the world economy, the unsuccessful economic structural change would result in a state, where the original, agricultural façade, which is at present behind the times, dominates further on. This could also be perceived as an advantage with technological innovations and the settling down of food processing industry taking place. For the objective draw of the conclusions, we can frame an advantageous and a disadvantageous general aspect, as well. Based on the positive point of view—considering the modern production—the so far minimal environment charging effects could be accepted by the majority of the local population with adequate and correct information provision. The expected economic development can really be felt in the middle and long run. According to the negative approach, the microregion is exposed to significant environment charging effects which are further strengthened by the factory's changing energy utilisation and the possible growing risk of illnesses. The economic advantages will have only slight efficiency and so, due to the present global tendencies, we also have to take into account that the experienced development will lag behind.

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Social Conflicts in the Shadow of the Paks Nuclear Power Plant

Abstract

Since the use of nuclear energy has become a possible global solution for the replacement of traditionally used fossil energy resources, it affects the public realm in Hungary, as well. The aim of this paper is to provide an insight into social aspects of constructing and operating of the nuclear power station in Paks, which is the only plant of this kind in Hungary. Social aspects will be analysed according to two types of phenomenon—NIMBY and PIMBY, which reveal people's level of disagreement and protest (NIMBY), or their approval and participation (PIMBY). In the light of the presented results, as well as of the global nuclear energy tendencies, the attitude of the people towards the recent proposals for nuclear repository in the Southern Transdanubia Region will be considered.

Key words

Nuclear power station; NIMBY phenomenon; Nuclear waste repository; Social conflict

Introduction

Providing long term energy supply for *Hungary* is nowadays a top priority issue which is characterised by bargaining in the background and the clashes of strong lobby interests. Moreover, the forecasts of depleting fossil fuel reserves have been published since the 1960s. There has been an on-going dispute on the ratio of fossil and renewable energy sources and the process of "reducing" the usage of the conventional sources of energy (e.g. coal, crude oil and natural gas). The question of nuclear energy plays an important role in the public discourse, especially in issues relating to the safe operation of a nuclear power station and the transport and storage of the accumulated radioactive waste. The case of the power station in *Paks* is no different, as the social conflicts of the indigenous local and the newly arriving settlers began as early as at the beginning of the construction. Later, they affected the field of politics and brought about serious changes in the once quiet town on the banks of the river *Danube*.

Contrary to the examples of *Germany* or *Austria*, Hungarian people do not overwhelmingly reject nuclear energy, although it is not clearly supported either. It is no wonder that the society is so divided on the issue of nuclear energy supply, as there are many well-known pros and cons of this type of energy source. Amongst the arguments against nuclear energy, we find *Chelyabinsk*, *Three Mile Island*, *Chernobyl* and the recent disaster in *Fukushima*, plus several other accidents that occurred in radioactive waste repositories. In the Hungarian context, it is also worth mentioning that in the period between 1991–2003, there were 380 incidents requiring investigation and that occurred in the *Paks Nuclear Power Plant*; 18 of them were classified as malfunction (VÁMOSI, B. 2012). Nevertheless, this power station is one of the major employers in the *Southern Transdanubia Region*, and as such, it is important for the people living in *Paks* and its vicinity, especially when it comes to the significantly high incomes provided for the local budget.

This study analyses the conflicts that have occurred in investments and constructions (the NIMBY phenomenon) in the context of the social-environmental conflicts related to the *Paks Nuclear Power Plant*.

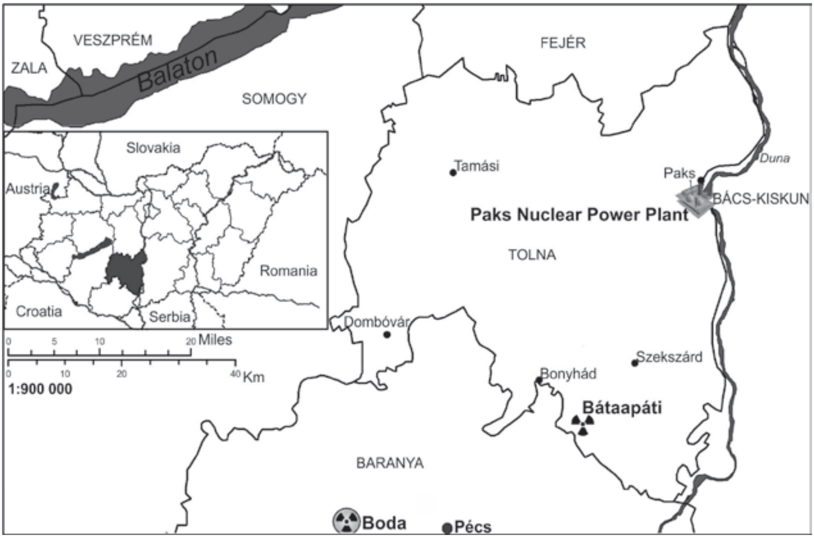

Figure 1 – Paks Nuclear Power Plant and nuclear waste repositories in South Transdanubia Region
Edited by Szelesi, T. (2013)

1. The NIMBY phenomenon

It is a well-known fact that people usually do not like having a dangerous or hazardous power station in their neighbourhood. This is called the *NIMBY phenomenon* ("Not In My Back Yard"). Although, citizens do acknowledge that certain factories, power stations, industrial and military establishments, and landfills have to be constructed in a country, they reject to have them built in their vicinity. A more extreme form of this phenomenon is evident when the residents doubt the rightfulness of the construction and reject the idea itself. This is often called the *BANANA phenomenon*, meaning "Build Absolutely Nothing Anywhere Near Anybody". In connection to NIMBY, the issues of personal involvement and the related personal risks appear, manifesting in protest and rejection as the common goal. Usually, this rejection formed into collective action is not willing to accept any compromise until the developer abandons the site or compensates in a timely and adequate manner. The amount of the compensation is primarily calculated with an economic approach after the cost-benefit analysis. This takes into account the financial status, the natural environment, the infrastructure of the construction site and the living conditions of the residents. The investor offers a viable compensation for these values which is considered enough to eliminate the expected resistance of the residents. O'HARE, M. (1977) warns that the calculations usually do not appropriately emphasise the psychological effects which may be just as important as the financial solutions. Significant elements to this include the possible metaphysical appreciation of the habits; the existence of the feeling of an extended private sphere which perceives the effort to modify the environment as a violation of the personal sphere; the exaggeration of risk perceptions; transformation of the protest against constructions into a demonstration against power station and the defiance that is apparently without a cause. O'HARE also examined how rational individual actions are transformed into irrational community stand-ups, in which different opinions are not formed along community interests, but as a mass of individual suggestions without convergence. The researcher called this the "multi-person prisoner's dilemma" suggesting that an unwanted construction may be performed even with a rejection rate of 90%, if the remaining 10% persuades the majority, claiming that it is in the community's interests. It is even more so when the minority is made up of the distinguished members of the town or the district, or the municipal government supports it.

The main reasons for the NIMBY behaviour are (KRAFT, M. E. – CLARY, B. B. 1991):

- distrust of the investing corporation or its representatives;
- lack of information, signs of secrecy;
- benefits and possible negative consequences of the construction do not compensate each other
- inherent conflicts in the local traditions;
- negative memory of similar constructions.

To understand environmental conflicts and the NIMBY behaviour, the theories of McAdam, D. (1986) on the expansion of movements and mobilisation shall be examined, as they may provide answers to what is behind the collaboration in environmental cases. The researcher distinguishes among low risk, low cost activism and participation requiring high costs, efforts, time or involving high risk. The first one articulates general goals, rejects presumably harmful future constructions (such as a nuclear waste repository, a cement plant, etc.) in a certain municipality and tries to regulate these efforts at a legislative level and present them as concepts. It, therefore, articulates and submits petitions to decision-makers, collects supporters, publishes articles and organises street gatherings. In case of the low risk action, it is usually the activists of the movement or organisation that perform the activities with the aim to inform or persuade the contacted people (residents, "people on the streets") or pre-defined social groups (students, professionals, politicians, etc.). In connection to high risk participation, we may mention specific involvement when the community is formed to halt a construction near its housing, school, workplace or any other site with emotional bonds to these people. In these cases, the movement consists of loose organisational ties because identity is not formed by loyalty to an organisation or a vague ideology but by personal bonding and the fear of possible future hazards. Such movement alliances are usually active as long as the problem exists, then their activity is dissolved or suspended. They may still serve as an example to other initiatives.

Snow, D. – Bendford, R. D. (1988); Krauss, C. (1994); Shemtov, R. (2003) and others agree that the NIMBY is a local network of individuals and groups that serves as a connecting medium between global and local protests. The arguments of the protest may be related to local specialities and may be supported by general thoughts that reinforce and back the group's demands. The networks are usually not formed without a history; familiarity and common interests are the foundations of trust. However, not all initiatives reject the possibility of a compromise due to their conflicts of interest. The parties usually consider each other more of an enemy and less than just an opponent. The behaviour of local politics fundamentally influences the possible radicalisation of the NIMBY group. In case of the politicians in a decision-making position, they turn their backs to managing social will, they do not participate in finding the proper solutions and are unable to mediate between interests. Therefore, a legitimacy crisis may evolve. The initial protests may expand to other areas and form alliances that would not work out under “ordinary” circumstances. It is also possible that after the movement’s initial successes, a larger, more general organisation is created that may take up a political role to reach its goal(s) (Krauss, C. 1994). According to Gore, A. (1993), the NIMBY symptoms are the beginning of a healthy tendency, since they make the decision-makers understand that the “backyard” is virtually the home of all mankind.

Based on the goals, NIMBY initiatives may be classified according to the following seven types:

1. Protests against the construction of landfills, waste storage facilities and incineration plants.
2. Protests against the construction of high-voltage wires, transformers, oil and natural gas pipelines near residential areas.
3. Protests against the construction of power stations, especially nuclear power plants.
4. Protests against the construction of polluting factories, facilities emitting radiation, mining complexes, industrial and military facilities.
5. Protests against the construction of public buildings causing noise (ambulance, police and fire services).
6. Movements for a clean environment (proactive activities for cleaning the settlement or residential area, or keeping it clear).
7. Movement for a secure alternative, a safe future.

The directions and tools of single issue initiatives may change during the protest-negotiation process. While the original goal remains intact, the expansion of the protest group enables the influx of new interests at a local level and also at a regional or national level considering the initiative as a whole. The rhetorics also changes in many cases. It adjusts to the system of aims and possibilities. The initial "direct rhetoric of aims", i.e. halting the construction and resistance, overwhelms the communication of the protesting individuals and community. The discourse may later gain extra value as a result of highlighting the protection of environmental values and taking advantage of the "vulnerability course". The aim of the latter is to present the protesters as toys in the hands of corporations, industrial giants and politics and, therefore, gain support from the public. The research of SNOW, D. – BENDFORD, R. D. (1988) proves that the appropriate rhetoric depends on the social status of the protesters, their income status, educational background and trust index. The NIMBY is most successful where the participants of the initiative are middle class or upper middle class individuals with good connections to politicians (SHEMTOV, R. 1999).

Green organisations and networks usually appear as actors of the NIMBY conflicts, on the side of the opponents of the construction, and they work to overstate the expected risks. REPHANN, T. J. (1996) created the typology of the protests against certain constructions, in which he emphasised the responsibility of the greens. He argues that in NIMBY, the greens appear as generators of the conflict and not take the role of mediators. They highlight the dangers but fail to provide an alternative. For the sake of completeness, we have to add that in some cases, the local community protests against the placement of the possibly polluting plant or they may tolerate it for the sake of the expected compensation. The residents hope that the profit from the construction (such as local business taxes) will exceed the negative effects. This phenomenon is called "Put In My Backyard" (PIMBY).

The participation of individuals, non-governmental organisations, and movements in environmental and environment-related cases may be classified according to the following four categories. On different ends of the scale, we find protest (e.g. rejection) and cooperation, controlling activities. The actual means of participation depend on the given case and the choice of the participants themselves.

1. Protest (in compliance with the laws [legally] or defying the laws [illegally])
   a) against a planned or already operating project (prevention);
   b) against pollution itself, demanding the termination of the polluting activity, an inspection of the case and the punishment of the culprit;
   c) against the development policy of the government or the local government (pressure).
2. Participation in the cases related to development projects, in the framework provided by the laws in force: elaboration of strategies, concepts; participation in steps of public policy decision-making (especially in regional and municipal development, rural development and other policies)—the task of enforcing environmental and sustainability interests.
   a) The role of interest articulation: the development of specific interests and needs, raising issues to be discussed.
   b) Providing information and communication.
   c) Expertise and advice: the demand for defining present and future needs and directions.
   d) Innovation: development of new solutions, approaches; suggestions for the transformation and "improvement" of operating systems (energy, transport, education, healthcare, social care, tax policy, participation forms, development policy)
   e) Conflict management:
      - exploration of the power relations and interests of the affected actors;
      - information and involvement of the affected groups, development of communication channels;
      - creation of compensation mechanisms;
      - the making of complex impact studies (Horváth, M. T. – Szirmai, V. 2000)

3. Partnership based on the permanent cooperation in the work of the government/local government. A primarily advisory and informative role that presumes loyalty, expertise and social familiarity; secondarily in relation to providing public services. Cooperation with pre-defined organisation or with ones selected, created by the governmental body or work group, committee that is created as a permanent or temporary expert group and provides recommendations related to policy preferences.
4. Legal proceedings: the non-governmental organisation participates in the approval process of the planned construction as a client and creates legal obstacles to hinder the realisation of the project. The pillars of the right for community participation have the right to receive information, engage in the freedom of expression and have the right of appeals (as independent parts of client's rights). The need of citizens to participate in administrative proceedings is considered important for the community (which has increased in the last two decades). It is almost naturally transformed into certain rights of client's rights, however, without the demand of the affected parties (Pánovics, A. 2011; Fülöp, S. 2012; Gajdics, Á. 2012). An elementary dilemma of participating in administrative and other decision-making proceedings is to harmonise an early and well-informed participation. If the decision-maker only focuses on early participation, the residents and their organisations might not have adequate information to judge the planned project. However, if they wait until all the required information is available, the developer is usually financially and morally committed to an alternative of the project, and the decision-makers may also theoretically decide on a possible decision, therefore making only formal participation in the process.
5. Monitoring role: monitoring of projects, especially concentrating on (e.g. environmental, economic) sustainability aspects (watchdog function). It is the duty of the non-governmental organisations to trace and measure the results of a certain policy.

It is important to have an effective and transparent monitoring system, which ensures that the policy/programme realises its goals, and that the aspects of sustainability are enforced (with regard to each aspect of sustainability).

The framework of a participatory democracy provides the opportunity of participation; laws and negotiation mechanisms ensure that opinions, objections and suggestions are articulated and mediated towards decision-makers and the society in an institutional form. The effectiveness of this process greatly depends on the degree of the mentioned openness and trust which are preconditions to the negotiation process. Without this, cooperation may turn out to be an empty formality, significantly decreasing legitimacy and the public approval of decisions.

2. Social conflicts in Paks

The search for the site of the nuclear power plant planned in *Hungary* started in 1966, and the final decision to choose the most suitable place on the right bank of the *River Danube*, south of *Paks* was made in the autumn of 1967. The construction plans had been finalised by 1968 and the landscaping works were carried out during the following year. The swiftly commenced work came to a halt in 1970 because the expected costs of the construction exceeded the original plans. Moreover, the national decision-makers were already hypnotised by the prices of cheap hydrocarbons and, therefore, turned to the development of coal and gas power plants. The original contract was concluded with the participation of the *Soviet Union* in 1955. It was amended to finish the first 440 MW-unit in ten years, only in 1980. Not much later, the economic changes and the sharp rise in oil prices (the 1973 oil crisis) made it clear to the competent bodies that the country's energy needs would not be satisfied without constructing a nuclear power plant. This became even more obvious when the construction of the *Gabčíkovo–Nagymaros Waterworks* failed. In 1973, the halted landscaping works continued and in the same year, the construction of a new housing block also began (Sipos, T. 2010).

The village of *Paks* lacked adequate human resources as well as the workforce and expertise required to build a nuclear power station. By the time of laying the cornerstone of the construction in 1975, several thousands of people had to be settled in the settlement on short notice. The mass of new inhabitants was settled outside the town at an external site that previously served as an agricultural area near the village. After the housing blocks were constructed (in 1973), the area was named *'Lakótelep'* (Housing estate). The lifestyle of the residents in the *Lakótelep* was isolated from the original residents of *Paks*, spiritually and spatially. The workers for the construction arrived from *Tatabánya*, *Pét*, *Ózd*, *Dunaújváros* and were used for urban infrastructure which provoked aversion from the "old" residents of *Paks* who were also suspicious about the lifestyle of these newcomers.

After the construction, the hierarchy of the local community has also significantly changed. Before the construction of the nuclear power station, the leaders of the local (primarily agricultural) community were on top of the political elite of *Paks*—comprising of chairmen of agricultural cooperative, heads of the canned food factory and school headmasters. After the power station was built, the chief engineers moving to *Paks* took their positions. This change did not only affect the municipality's highest political levels but also the lower levels of the system. Original residents could profoundly evaluate the shift in powers by stating that they had become second class citizens of their own town, contrary to the newcomers that arrived to participate in the construction project. This standoff remained intact on the levels of local council leaders and other higher political positions. Consequently, this enabled an "alien" (meaning that he was not born or educated in *Paks*) to be selected as a political leader of the community on numerous occasions (Barkóczi, Cs. 2012).

In the first period, most of the power station employees were not connected to *Paks* at all, except through their jobs. Till the mid-1980s, the *Lakótelep* looked like a ghost town on weekends, as the residents usually used the period between working days and the weekend to commute between *Paks* and their hometowns/villages. In this situation, the city leadership aimed to create a community place that could “naturalise” the worker communities of the *Lakótelep* in *Paks* and forge them with the original residents of the settlement. The element required to create a common *Paks* identity. The secure social cohesion was found in sports. The basketball, judo and football associations were developed and they became key factors of success in the 1990s. While social conflicts eased at the end of the 1980s (and practically disappeared by the 1990s with the expansion of work opportunities), other problematic issues started to arise in connection with the nuclear power station. Every one of the citizens has at least a relative, friend or a close acquaintance that works at the nuclear power station, so it can be declared that the plant breathes together with the town. This is why it is plausible that 91% of the town’s residents agree to having the facility, while only 2% disapproves it, according to a survey conducted in 2012 (NAGY, R. 2012).

3. Issues of the nuclear waste repository

Compared to other parts of *Hungary*, issues causing public resistance occurred very early in the *Southern Transdanubia Region* (in the last years of the 1980s). These issues also provided a framework of the appearance of non-governmental organisations dealing with environmental protection issues. The landfill in the village of *Garé* was the first environmental case in the region that mobilised large numbers of the local population. In the 1980s, nearby residents complained about the deterioration of the water quality in the wells and spotted an increase in animal deaths. The conducted inspections discovered that a part of the metal barrels containing liquid waste were damaged, and the radioactive waste escaped to the nature. After some contradictory water examination results and debates, it was proved that the contamination reached the aquitard and entered the groundwater. The landfill was later closed down, but environmental damages remained significant. After the fall of socialism, the coal and uranium mining industry in *Tolna* and *Baranya* counties collapsed, the mines were eliminated, but recultivation efforts are still unfinished to date. There is new information on a possible reopening of these mines, initiating civil associations. *Hungary's* only nuclear power station is situated in the region—in *Paks*—and this factor still raised questions about the amount of radiation and the transportation of the created nuclear waste.

The analysis of the issues related to the establishment of the nuclear waste repository can be approached from the already discussed NIMBY and PIMBY phenomena; and the risks, dangers and perceptions of dangers articulated toward the decisions on construction. Research shows that the opponents of nuclear waste repositories articulate concerns regarding health, safety, the economy, the environment and the technological and decisive processes (Szántó, R. 2008). The problem of placing the by-product created by the operation of nuclear power station (nuclear waste) is of high risk and requires long and increased attention. The plans for placing low and medium level activity waste had already caused social, political and environmental conflicts before the transition to democracy. According to plans publicised in the mid-1980s, the waste was intended to be managed via the *Council for Mutual Economic Assistance (COMECON)* by transporting the accumulated waste to an area outside of *Hungary*. Due to various reasons, this concept later failed, and the management of the *Paks Nuclear Power Plant* realised that the waste had to be transported and placed somewhere inside the country (Szíjártó, Zs. 2010).

Followed by this, geological explorations and drillings were conducted at numerous possible sites and later reduced to a handful of possible alternatives. The research and the authorisation processes already began in the late 1970s, but neither the public nor the residents of the affected area were informed about the necessity of the repository. That was typical of the socialist government behaviour of the era. After inspecting and rejecting some possible locations, the decision to build the nuclear waste repository in the area of *Feked–Véménd–Ófalu* was made in 1983 (Balogh, J. *et al.* 1990). Apart from the requested physical geographical features, the region met the expectations as it was a priority for the location to be in the vicinity of the creation of the nuclear waste. The power station only published the plans of the nuclear waste repository four years later and declared them to be final facts not only mere plans. Unsurprisingly, the residents voiced their outrage, not only because of the risks the construction involved, but also because of the secrecy of the planning process. Moreover, the protests against the *Ófalu project* were complex and incorporated many interests and emotional-mental imprints (SZIJÁRTÓ, ZS. 2008), including the *Chernobyl disaster* in 1986 and the "secrecy" surrounding it.

The conflict that erupted is interesting in many aspects. The experts of the power plant and representatives of the government did not understand the fundamental reasons of the rejection perceived from the residents. Therefore, no communication space could be created to solve the conflict. On the other hand, the civil cooperation had no pattern, no case on which the locals could have built their resistance. It is, therefore, safe to say that they gradually "learned" how to protest.

The social composition of the protesters showed a very mixed picture. Residents were mostly employed in agricultural sectors and were mainly driven by emotional motivations. Their fear of the unknown and the concern that the construction would completely overturn the traditional lifestyle of the village was more than evident. The younger generation of residents played a very important role in radicalising the protest, as they grew up in the more liberal, less authoritative *Kádár regime*. As the country was nearing its transition to democracy, the role of publicity increased. The press also paid attention to the case and entered the conflict arena, mostly by providing neutral information.

With the increasing media attention, a new group of actors appeared in the conflict. Its motivations were similar to those observed in the case of the *Gabčíkovo–Nagymaros Waterworks*. A loosely organised group consisting of intellectuals appeared on the scene, especially in the area of *Ófalu* and *Pécs*. Its members were teachers, doctors and other groups of intellectuals who declared that they were willing to represent the interest of the villagers. It can be stated that the help of this group was not motivated by emotional factors, but by only one (more or less typical for all social groups) thought: protest against the government and the form of decision-making. They recognised that, in relation to an environmental conflict, they could criticise the communist government with less risk, as they did not directly argue with the political elite. They only reflected on the legal irregularities and the possible shortcomings of the construction process, and system anomalies, (the fact of secrecy).

Newly formed opposition groups (such as *Fidesz* [Alliance of Young Democrats] and *MDF* [Hungarian Democratic Forum]) recognised that the protest against the nuclear waste repository was a springboard to strengthen and promote the developing parties, since the conflict powerfully echoed in the media, and their messages were easily spread via TV, radio and the press. The case was also an important catalyst for the new non-governmental organisations, associations and experts (VÁMOSI, B. 2012). Due to the deep crisis of the political-economic system, the government could not risk another conflict and completely passed the responsibility to the *Paks Nuclear Power Plant*. The power station tried to compensate the village, especially in the form of infrastructural developments (such as the construction of a doctor's office and service apartments, the establishment of a guest house, and contribution to the renovations of roads and a school building). This "gesture" did not work. After the enduring negotiations, the villagers felt that they were being bribed. The residents articulated this opinion at the public hearings and in the media very loudly. The then almost unknown concept of unemployment could not influence the possible acceptance of the compensation, as the nearing crisis of the transition to democracy was alleviated by the prosperous local agricultural cooperatives. After publishing the plan of the repository in 1987 and the increasing protests, the power station gradually lost its prestige and reputation. The case was finally closed with a political decision of the ruling party in 1988 by not issuing a building permit for the area of *Ófalu*.

Until 1997, the low activity radioactive waste of the *Paks Nuclear Power Plant* was placed in the *Radioactive Waste Treatment and Dis-*

posal Plant in the village of *Püspökszilágy*. However, the facility was filling up and a new location had to be found for the hazardous material. For choosing locations to dispose low and medium activity radioactive waste, the affected authorities were examining the whole territory of the country from 1993 to 1996, and the research included the municipality of *Bátaapáti*. From 1994, it was a selected target and in early 1997, the decision was made to start detailed explorations in the vicinity of *Bátaapáti* by providing complete public access to all of the related data. Surface geological exploration ended in 2003 with the affected authority deciding that the *Bátaapáti* site was geologically appropriate for the indefinite placement of radioactive waste. During the preparation for the "waste repository", the NGOs cooperating in the cases of *Garé* and *Ófalu* "came together" again. But since the village received a significant amount of development tenders financing other incomes, and the project provided employment to about 50 locals, the protesters received no significant public support.

In Hungarian practice, compensations play a significant role in influencing decision-making in environmental issues. Compensation is a frequently used tool to persuade the citizens of the settlements and the local governments facing financial hardships. For example, landfills are typically constructed in villages with a small population and low sources of income. *Bátaapáti* was one municipality meeting these criteria. It is situated in a valley, in a regional cul-de-sac with high levels of unemployment. Disadvantaged villages with high levels of unemployment, low incomes and scarce resources of the local government are usually happy to receive the offered projects for the related economic advantages and the projected developments (KISS, G. 2012). Surface geological exploration was finished in *Bátaapáti* in 2003, and a local referendum was organised on 10th July, 2005. With participation rates of 75%, the construction of the repository was supported by 91% of the residents, thus the results confirmed and also provided legitimacy for the construction. The works on the nuclear waste repository lasted from 2005 to 2012 with a budget of 68.5 billion HUF (app. 199 million GBP). The region was compensated with an annual

1million euro (850,000 GBP) beginning from the operation of the plant and divided among the villages and settlements of the region. The municipality's sewage and gas network was constructed and the three kilometres long road leading to the village was also built. The cultural centre was renovated and an old traditional estate was transformed into a community building. When the local post office closed, the village purchased the property and reopened it as a "tele house" with public internet access (GLIED, V. 2009).

Explorations related to constructing a high activity nuclear waste repository have been on-going in the *Mecsek Hills* since 1989. According to the geological examinations, the area of *Boda* in the *Western Mecsek* is appropriate for establishing a repository in the 2020–2046 term. The findings of the poll conducted in *Boda* during 2011 by the *Public Limited Company for Radioactive Waste Management*, show that 27% of the residents would completely accept the planned repository, 40.3% would only decide upon receiving the results of the required examinations and 32% would reject it (RADIOAKTÍV HULLADÉKOKAT KEZELŐ KHT., 2011). A new movement is currently undergoing against the reopening of uranium mines and the construction of the repository in *Boda*, called *"NeMecsek" (Not onto Mecsek)*.

4. Conclusion

Surveys made in the past decade have shown that the Hungarian society does not reject the operation of *Paks Nuclear Power Plant*. However, the proposed expansion sets new questions about the financing of the investment and necessity. The need for the expansion of the nuclear power plant—which currently provides 43% of the Hungarian electricity supply—is also queried. After the disaster in *Fukushima*, *Japan*, the *German government* announced in 2011, that by 2022 all the German nuclear power plants will have been shut down. Moreover, similar decisions have been made about the withdrawal by the Italian, Swiss and Japanese governments, too. The German decision and the Italian referendum in 2011 made clear that decisions against nuclear energy could be formed by not just energy and financial considerations, but also by emotional and political motivations. That can be seen in those countries where the anti-nuclear attitude of the society is high and the political elite can achieve success by making similar decisions.

In 2003, *Greenpeace* organised a protest action in *Paks* against the lifetime-extension (prolongation). The group, which demonstrated without permission consisting of Austrian, Dutch, Turkish, Slovakian, Romanian and Hungarian activists, chained itself to the entrance of the nuclear power plant. They could not achieve success and the action remained without an echo. It is not the nuclear energy security risks which are primarily mentioned concerning the expansion of the plant. It is rather the costs of the planned construction of new blocks and the restart of the uranium mining in the region of *Pécs*, which are in the forefront of the related debates.

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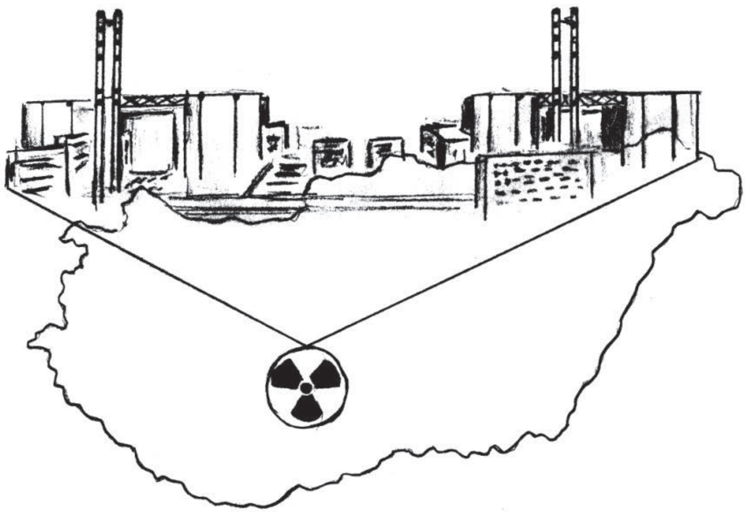

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We provide place and opportunity for publications to researchers, although we do accept only outstanding papers; therefore, a published work in one of our upcoming books has to bear high standards, must be well-researched, well-illustrated and well-written in an engaging style that can call the attention of anyone who reads it. It must be something interesting, topical and must contribute to the development of any geographical (scientific) disciplines.

Our books will cover many different types of geographical subjects; therefore, we try to encourage and approach anyone who acts on the fields of Earth or Environmental Sciences, too.

The subsequent numbers of *Geographical Locality Studies* will offer a wide range of titles where, we believe, every geography researcher will find the best that suits him/her and have the opportunity to contribute to it. For the upcoming titles and publishing possibilities, please keep an eye on our regularly updated website (www.frugeo.co.uk) or contact us (info@frugeo.co.uk).

In order to an article get published, the author(s) will need to follow our instructions and must achieve the expected standard of Geographical Locality Studies.

1. Manuscripts have to be prepared by

- one individual author, or by
- two co-operating authors.

2. They have to be written in

- British English, and
- majorly, in Passive mode.

3. The following types of papers are considered for publication:

- Original articles in basic and applied research
- Critical reviews, surveys, opinions, commentaries and essays

4. The papers have to have

- Abstract
- Introduction
- Aims of the study
- Research methods
- Results
- Discussion
- Conclusions
- Acknowledgements
- Reference list or/and bibliography

To keep our standards and quality high and also to ensure the books will surely be published and distributed, we charge a certain amount of participation fee which is broken down into three groups:

- *Group A* is for an Academic, who already has a PhD degree.
- *Group B* is for a PhD Student, or for a Candidate of PhD (PhD Aspirant).
- *Group C* is for an MSc/BSc Student, or for a researcher with MSc/BSc degree

Group	£	Ft	€	$
A	100.00	35,000	110.00	140.00
B	75.00	26,000	85.00	110.00
C	50.00	17,500	55.00	70.00

We expect the fee paid in *Pound Sterling (Great British Pounds)*, although the payment can be made in different currencies, as well, through our secure website by using *PayPal* (prices shown in this table above in other currencies are informative only).

The fee covers and guarantees that

- every paper will be read by professional and fully independent reviewers (peer reviewers);
- they will be proof-read;
- the authors will be given as much extra help as possible;
- the book will be published;
- the book will be available in a print copy as well as online;
- it will be distributed and
- every participant will receive a copy at no extra fee.

The authors must bear in mind that the fee is

- non-refundable and
- it can only be paid by one author individually or as a share by two authors together.
- We do not accept papers with more than two authors.

The above prices are for individual papers that are written by one or two authors. We do not accept works written by more than two authors. Participants only need to pay when the Editors have read and approved the first version of the submitted document and have confirmed and reserved a place for the authors in our book. However, papers will not be published, if we do not receive the fully completed articles by our set deadline. If the authors miss the last day of submission, the opportunity to publish in our book and the participation fee will either be lost.

Frugeo GRI membership

Everyone who joins the GLS project and pays the fee, regardless of the group and the amount, **will automatically become the member of the Frugeo Community** for a 1-year-period (the membership is worth up to £50.00) which will give the opportunity to all the participants to request services (e.g. translation, proof-reading) from Frugeo GRI for a discounted rate (30% off all services except for subsequent participation fees).

Amazon.co.uk voucher prize draw

We would also like to encourage our participants and make them motivated; therefore, every time a new number of GLS is published, all the participating authors will be given the chance to win our top-prize of **£100.00 Amazon.co.uk gift voucher** (or 2 x £50.00, if the article is written by two authors). All the manuscripts that we will accept in our book will go through the editors and peer reviewers who will independently and individually score them. The best one and its author(s) will receive our gift voucher via e-mail that can be used on www.amazon.co.uk.

If you would like to be considered for our offer or if you have questions regarding the publication possibilities or the GLS project, please contact us instantly.

We look forward to hearing from you!

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