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FROM WASTED LAND TO MEGAWATTS: HOW TO CONVERT BROWNFIELDS INTO SOLAR POWER PLANTS (THE CASE OF THE CZECH REPUBLIC)

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Abstract

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This article deals with the issue of brownfield redevelopment for the needs of solar energy projects from different perspectives. Attention is first paid to a brief characterisation of the data and information available both for brownfields and for solar energy projects in the Czech Republic. Then there is description from the most important results of GIS analysis, which (based on a comparison of aerial images from different years) identified the previous uses at the 127 solar power plants with an output of over 1 MWp in the South Moravian Region. The results of the quantitative analyses are accompanied by knowledge from a qualitative survey conducted on selected actors participating in this kind of brownfield regeneration for solar energy development. The conclusion contains proposals which could contribute to the more intensive future use of brownfields for the needs of solar energy in the Czech Republic (a similar process to what has already successfully been realised in Germany). The research results can be inspiring not only for the Czech Republic but also for other EU-member counrties where brownfields have not been re-used for the needs of solar energy projects or where brownfields have been used in this way only marginally.

Keywords: Brownfields, solar energy, regeneration, Czech Republic

INTRODUCTION

Following the re-introduction of a market economy after 1989, the Czech Republic has undergone a complicated transformation period, accompanied by substantive changes of political, economic, social and other structures. The transformative changes of the 1990s led to further changes in the next decade, influenced particularly by deepening globalization trends and the accession of the Czech Republic to the European Union in 2004. Radical modification of sociopolitical conditions in the Czech Republic had not only a positive impact (e.g., gross domestic product growth, a more effective economy, increased life expectancy, etc. Tvrdoň *et al.*, 2012) but also some negative impacts such as the bankruptcy of certain companies, unemployment growth, and the emergence of significant numbers of brownfields, defined in the National Brownfield

Regeneration Strategy (Národní strategie regenerace brownfieldů 2008: 3) as underused, neglected real estate (plots, objects, plants) with a possible presence of contamination, having their origins in previous industrial, agricultural, residential, military, or other activity. Klusáček *et al*. (2011), Klusáček *et al*. (2013), Novosák *et al*. (2013), Frantál *et al*. (2013), Vojvodíková *et al*. (2011), Hercik *et al*. (2011, 2014), Kunc *et al*. (2014a, 2014b), Frantál and Nováková (2014), Martinát *et al*. (2014), Sun and Jones (2013), Alexandrescu *et al*. (2014), Slach *et al*. (2013) or Navrátil, Pícha, Hřebcová (2010) have, among others, dealt with the subject of brownfields from a variety of perspectives.

In the period 2005–2007 the CzechInvest agency conducted a survey which identified 2,355 brownfields with a combined acreage of 10 362 ha within the territory of the Czech Republic (Vyhledávací studie 2007: 1). Surveys of regenerated brownfields in the Czech Republic to date (e.g., Brownfield Regeneration in the South Moravian Region, 2011) have shown, in agreement with the ABC model (Ferber, 2006), that brownfields are most often regenerated in attractive locations (e.g., city centres, core development areas with good connections to main transportation routes, etc.) and the least often in unattractive locations (e.g. outside settlements, on peripheries, etc) (Frantál *et al*., 2013; Doleželová *et al*., 2014). Brownfields with a low potential for commercial usability usually do not attract private investors and consequently continue to deteriorate; their regeneration depends much on the decisions of the public sector.

One of the alternatives for brownfields with low usability is their possible use for the development of alternative energy sources. In this context it is key to mention that the Czech Republic, as an EU member, has accepted an obligation to increase its share of renewable energy sources to cover 13% of final energy consumption by the year 2020 (Národní akční plán České republiky pro energii z obnovitelných zdrojů, 2010). The fact that a significant portion of brownfields may have an unstable subgrade is important in this context, because it makes them most likely candidates for the development of solar power plants, which – unlike other renewable sources (such as wind parks – see Cetkovský *et al*., 2010) – do not have such stringent demands on subgrade stability. This makes even some former landfills usable for the construction of solar power plants. In the context of solar power plant construction, possible contamination is also irrelevant. Thus landfills might be re-used for energy purposes both by the generation of electricity from material contained within (via biogas) (Martinát *et al*., 2013a) and by coverage with solar panels.

Brownfields are already fairly intensively used for the development of solar power plants in some other countries, such as the USA (Riberio, 2007 or Adelaja *et al*., 2010) or Germany (Solarparks auf Brachflächen in Thüringen, 2010). Brownfield-based solar power generation is in the public interest for several reasons: (a) it offers a new use for brownfields with regeneration challenges, (b) it supports renewable energy development, and (c) it improves the public image of renewable energy sources because the development of alternative energy sources on brownfields usually does not spark intensive local NIMBY-type protests, unlike power generation projects of similar scope on greenfields, which often lead to open landscape acquisiton (Frantál, Kučera, 2009; Frantál, Kunc, 2010 and 2011; Martinát *et al*., 2013b).

RESEARCH GOALS AND METHODS

The first goal of this study is to bring an introductory characterization of the selected data and information related to both solar energy development and to brownfields in the Czech Republic. The second goal is to analyze the extent and types of brownfields which were used for the development of part of the 127 solar power plants with an output over 1 MW in the South Moravian Region case-study area. The third goal is to identify the principal problems and obstacles which had to be overcome by the selected actors participating in the past in brownfield regeneration during the realization of brownfields-based solar power plant projects in the Czech Republic. The fourth goal of this article is to create proposals, which could help to improve the situation in future, and thereby indirectly initiate a broader discussion of the topic within the Czech Republic, where sub-optimal policy incentives in the recent past enabled the unregulated growth of solar power plants. These facilities have unfortunately usually been built on greenfields (usually on arable lands), which was one of the main reasons for criticism of solar energy development among Czech stakeholders.

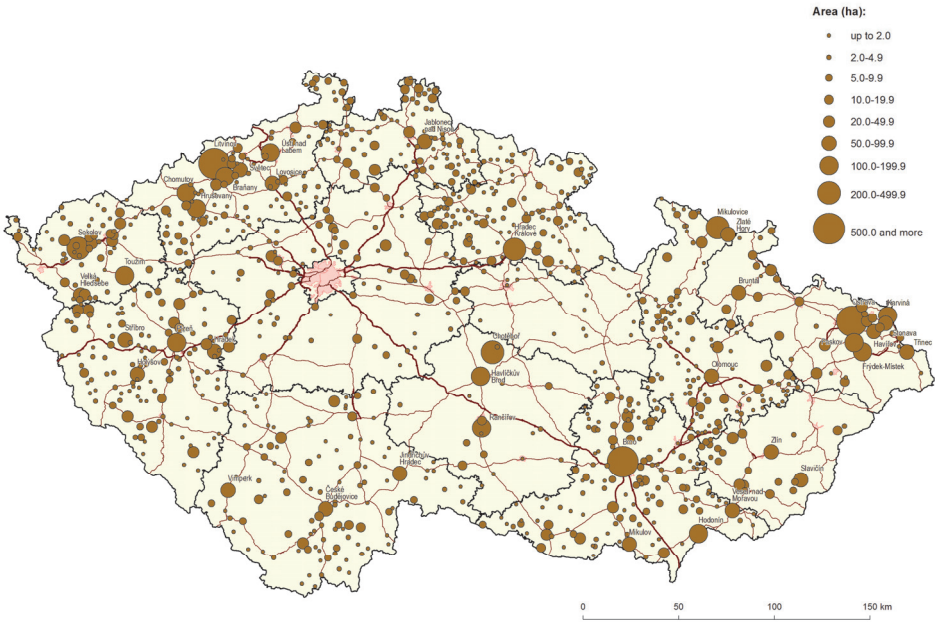
The first part of the quantitative research, which is based on selected available data and information related to both brownfields and solar energy projects combines data and information from different sources (for example the CzechInvest Agency, the Energy Regulatory Office, the Czech Statistical Office, the Czech Hydrometeorological Institute), was used as starting point for the identification of the case study area (the South Moravian Region). The second part of the quantitative research is based on GIS analysis of aerial images from different years of the 127 solar power plants with an output over 1 MW in the studied region. The actual land-use was identified based on the map application Consultation of the Cadastre of Real Estate, which was created by Czech Office for Surveying, Mapping and Cadastre. The most intensive development of solar power plant construction in the Czech Republic happened in the period 2008–2010, and therefore attention was paid to analysis of aerial images from the years 2003, 2006, 2009, and 2012. These aerial images are part of a data archive of aerial images available at The Silva Tarouca

Research Institute for Landscape and Ornamental Gardening. The quantitative research was supported by qualitative research conducted during two quarters of 2013 by means of semi-structured interviews with seven representatives of companies which had successfully realized solar power plant projects on brownfields in the South Moravian Region in the past. The research sample containing seven projects comprised one project realized on brownfields previously used for the mining of raw materials, two on brownfields with an original industrial use, three on brownfields with an original agricultural use, and one on a landfill. In keeping with the wishes of the respondents, the results of the qualitative research have been discussed anonymously – i.e., without mentioning specific persons related to the studied brownfields sites.

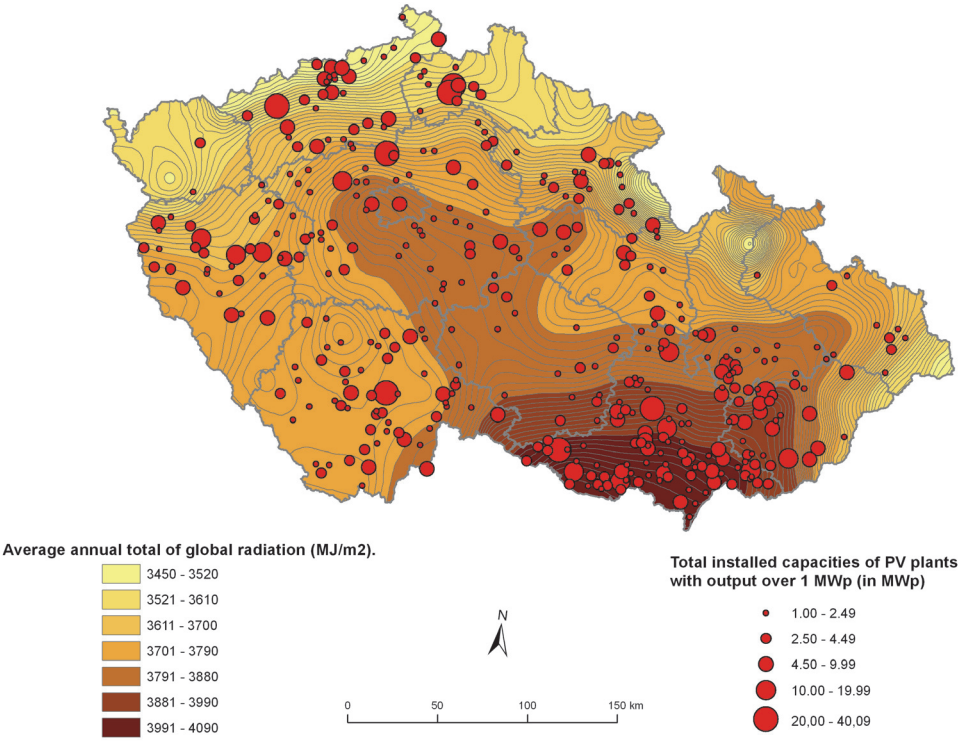
Brownfields and Solar Energy in the Czech Republic – a Brief Characterization of Studied Phenomena

There are different types of information related to brownfields and solar energy in the Czech Republic but there does not yet exist an official database or list of solar energy plants built on brownfields. Therefore attention is firstly paid to selected data and information available both for brownfields and for solar energy projects. Concerning the brownfield data, within the period 2005–2007 a large survey on the evidence of brownfields in the Czech Republic was carried out, organized by the CzechInvest Agency, which asked that such evidence be collected by regional administrations (in area outside of Prague). On the basis of the CzechInvest Search Study, 2 355 brownfield sites were identified in the Czech Republic, covering an area of 10,3 thousand hectares, with circa 14% of built-up areas comprising 1 412 hectares (Vyhledávací Studie, 2007). However this study cannot be used as a reliable source of data for our analysis for the following two reasons: (a) a very incomplete dataset – different regions provided CzechInvest with different quantities and qualities of data; the Vysočina and the Pardubický Regions located in the central parts of the Czech Republic in particular included just a very limited sample of brownfields (see Fig. 1); (b) missing data – the CzechInvest Agency Search Study did not include post-mining brownfields, did not collect information for Prague, and collected only brownfield sites with a minimum area of 1 hectare. CzechInvest admitted that the total number of brownfields in the Czech Republic is much larger, estimates from 2004 being in the range of 8,5–11,7 thousand brownfield sites covering an area of between 27–38 thousand hectares (Národní strategie regenerace brownfieldů 2008). The available brownfields databases at the national level (National Database of Brownfields 2008), regional level (for example Liberecký Region database, 2013 or South Moravian Region database, 2013), and municipal level (for example Brno brownfields 2013) usually have marketing purposes (i.e., they should present the brownfield sites to potential investors in particular), and they cannot be perceived as complete lists of all brownfields in the studied territories.

There are also different types of data and information relating to solar power plants in the Czech Republic but here there is a crucial



1: *Spatial distribution of brownfields in the Czech Republic (according to the Search Study of the CzechInvest Agency – dataset of 2 355 brownfields)*
Source: CzechInvest (data), own elaboration



2: *Spatial distribution of solar power plants with an output over 1 MWp in the Czech Republic (state 1st September 2012)*
Source: Energy Regulatory Office, Czech Statistical Office, Czech Hydrometeorological Institute; authors' own processing

methodological problem in that there is no available information about the geographical location of individual solar power plants or their size and spatial extent. Unfortunately, data from the Energy Regulatory Office provides information only about the number of licenses and installed capacities at the level of cadastral areas. The spatial distribution of solar power plants with an output over 1 MWp (see Fig. 2), where it is necessary to presuppose large areas in hectares, and that they are usually ground-mounted, show the spatial contrast between the eastern and western parts of the Czech Republic. In the eastern part of the Czech Republic (Moravia), large solar power plants are spatially concentrated in the areas with the highest intensity of global radiation, and it is necessary to presuppose that many of these projects are occupying very good and fertile agricultural land in the Moravian lowlands. To the contrary, in the western part of the Czech Republic (Bohemia) the spatial distribution of large solar power plants does not correlate with areas where global radiation is the most intensive, and many large projects were created in Northern Bohemia, where there is the lowest level of global radiation in the Czech Republic (see also Hofierka *et al.*, 2014). It is also clear to see that the highest concentration of large projects, where it is necessary to presuppose ground-mounted systems covering larger sites, is located in the South Moravian Region. This is the reason why this region was selected as the case study area for a more detailed GIS analysis by means of aerial images analyses. Moreover there is a quite large occurrence of different types of brownfields in this region, and thus it is expected that the re-use of agricultural brownfields is especially covered by solar power plants.

Large Solar Energy Plants With an Output of Over 1 MWp on Brownfields in the Case-study Area of the South Moravian Region

In this part of the research attention is paid to the sample of the 127 large solar energy plants with an output of over 1 MWp registered on the territory of the South Moravian Region by the Energy Regulatory Office. The detailed analyses by means of GIS are based on the comparison of aerial images before the solar power plant was created, and after. The GIS analysis showed that 12 of the above-mentioned group of solar power plants cover areas comprising two different original types of land use, and that is why the total number of areas included for land-use analyses was 139 sites (see Tab. I and Fig. 9 for their spatial distribution). The analyses conducted on 127 large solar energy plants located on 139 areas identified that the studied solar projects covered a total area of 790.7 hectares. The majority of projects (about 80%) are located on arable land or on different types of agricultural land (for example one of the studied solar power plant is officially still

located on vineyards, but vineyards is not operating in reality).

The solar power plants located on brownfields covered in total 91.4 hectares, which is 11.6% of the total area. The brownfields for the purposes of these analyses were defined as lands economically deprived by previous industrial, agricultural, mining, or other kind of use. From these brownfields the largest share was held by brownfields with a former agricultural use (see example in Figs. 3 and 4) – a not very surprising fact, because during the earlier centrally planned economy (1948–1989) there was support for very intensive agricultural production in the South Moravian Region, and after the return of a market economy many large agricultural cooperative farms faced serious economic problems (Věžník and Konečný, 2011; Svobodová and Věžník, 2011). The advantage of post-agricultural brownfields is that they are located in small municipalities where there is usually no interest in a different kind of regeneration, as the commercial potential of agricultural brownfields is usually quite low (Klusáček *et al.*, 2013; Skála *et al.*, 2013). Also the existence of such types of brownfields could be perceived as a barrier to the attractiveness of municipalities for tourists (Navrátil *et al.*, 2009, 2012, 2013). The re-use of other types of brownfields were identified less often – there are four solar power plants on post-industrial brownfields (see example in Figs. 5 and 6), two large solar projects on former manipulating areas (parking spaces, open-air storage grounds), one solar power plant on a post-mining brownfield (see Figs. 7 and 8), and one project located on a landfill. It is an interesting fact that there were three large rooftop-mounted projects installed on roofs of new industrial buildings but these projects were not calculated among brownfields because they were not ground-mounted. However from the environmental perspective it is necessary to mention that rooftop-mounted constructions on large buildings and objects are environmentally friendly as well.

The results of the GIS analyses of the 127 large solar energy plants located in the South Moravian Region show that the proportion of solar energy projects situated on brownfields is relatively low. In this context it is necessary to emphasize that these projects were conducted despite the Czech government not offering any systematic financial incentives or other kinds of support for the realization of such brownfield redevelopment. In contrast, the purchase price of energy from alternative sources in neighboring Germany is graduated depending on whether the power plant is located on rooftops, on agricultural land, or on land with usability challenges such as brownfields or contaminated plots. Unfortunately, brownfield-based solar power plants in the Czech Republic are supported in exactly the same way as greenfield-based projects. The majority of solar power plant projects to-date were therefore realized on greenfields, which did not require the expensive and complicated remedial

I: *Previous use of large solar energy plants with an output of over 1 MWp in the South Moravian Region*

Previous use of areas	Number of areas	Area (hectares)	Share (%)
Agricultural brownfields	14	65.5	8.28
Industrial brownfields	4	13.7	1.73
Mining brownfields	1	1.4	0.18
Manipulating areas (parking spaces, open-air storage grounds)	2	8.6	1.09
Landfill	1	2.2	0.28
Brownfields in total	**22**	**91.4**	**11.56**
Arable land	100	605.9	76.63
Arable land, permanent grasslands	4	30.2	3.82
Arable land, other areas	3	19.9	2.52
Permanent grasslands	2	9.4	1.19
Permanent grasslands, other areas	1	13.7	1.73
Orchards	1	6.7	0.85
Vineyard	2	5.6	0.71
Other areas – sport areal	1	2.3	0.29
Rooftop mounted project installed on the large industrial buildings	3	5.6	0.71
TOTAL	**139**	**790.7**	**100**
South Moravian Region			
Number of solar energy plants with output over 1 MWp			127
Number of areal of solar energy plants with output over 1 MWp in GIS			139
Total area of the solar energy plants with output over 1 MWp (ha)			790.7

Source: Energy Regulatory Office; authors' own processing

3, 4: *An example of a solar power plant located on agricultural brownfileds in Dubňany (a municipality in the South Moravian Region, Czech Republic) – state in 2003 (left) and 2012 (right)*
Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening
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5, 6: *An example of a solar power plant located on industrial brownfields in Hodonín (a municipality located in the South Moravian Region, Czech Republic) – state in 2003 (left) and 2012 (right)*
Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening
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7, 8: *An example of a solar power plant located on mining brownfields in Omice (a municipality located in the South Moravian Region, Czech Republic) – state in 2009 (left) and 2012 (right)*
Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening
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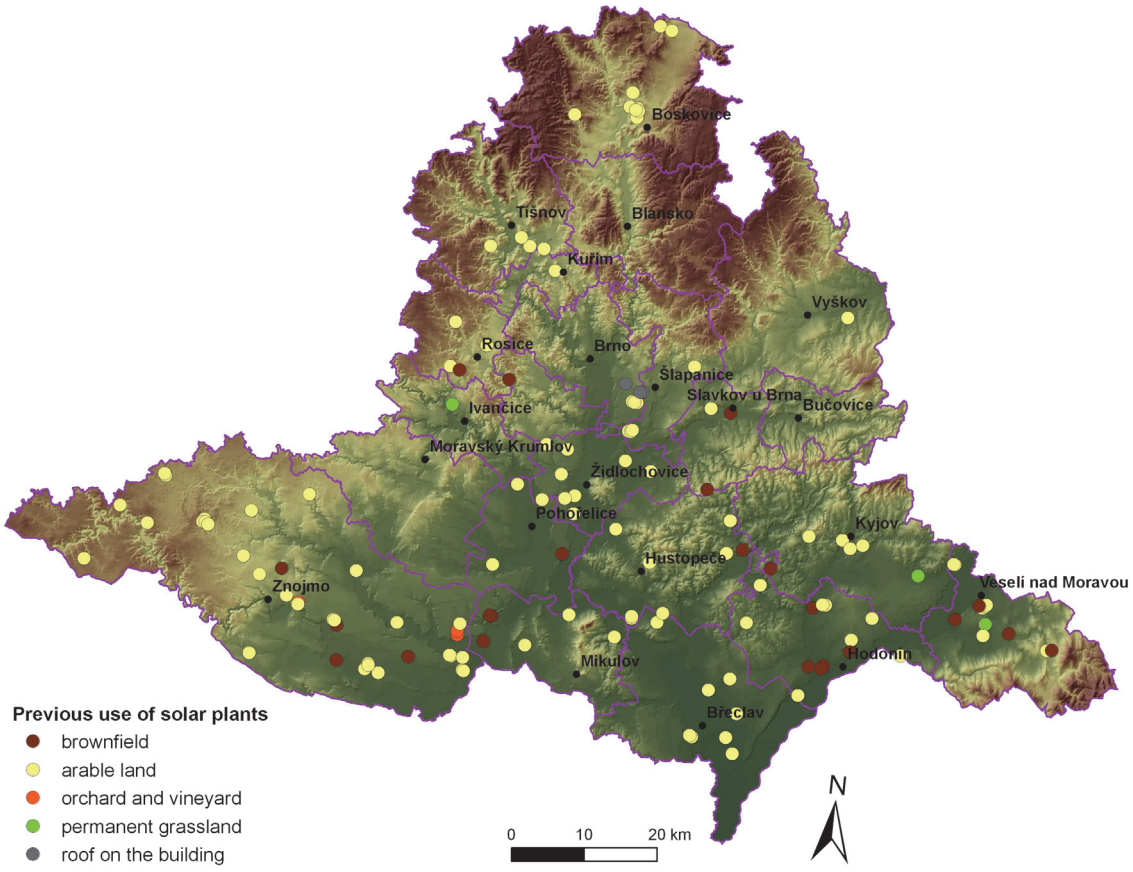
measures or subgrade stabilizations often necessary for brownfield projects. This is probably the main reason why the number of brownfields utilized for solar power generation in the Czech Republic remains very low in comparison with Germany, and why even the issue itself has not attracted significant interest among the general public or experts yet.

RESULTS OF THE QUALITATIVE INTERVIEWS WITH SELECTED STAKEHOLDERS

The introductory part of the interview aimed at identifying the reasons why the investors decided to invest finances into brownfields as opposed to greenfields. Three investors emphasized the suitability of the plots' technical parametres (e.g., slope, subgrade quality, etc.), two others emphasized clear ownership relations in the sense that the immediate and uncomplicated purchase of the land was possible because of a limited number of owners with whom it was easy to negotiate. One of the investors, who had already owned the plot prior to the solar power boom of 2007–2009, had decided to take the opportunity, as construction of a power plant appeared to him an ideal solution for increasing the economic value of the plot. It is notable that one of the investors preferred brownfield realization on the grounds of the ecological views of the company, although a greenfield construction would have been less expensive. The next part of the interview focused on speculation as to how the brownfield would have been used had the solar power plant not been built there. The majority of interviewed persons agreed that the brownfields had hardly any other potential commercial uses because of their location on the outskirts of settlements or entirely away from them. If they had not been used for solar power generation, they would probably have completely deteriorated or been put to minor provisional uses without more any substantial regeneration (activities such as a used car lot, scrapyard, etc).

The respondents further commented on the obstacles they needed to overcome in connection with project realization. The respondents pointed out not only the expected technical challenges (e.g., subgrade leveling and fixation, demolition of decrepit buildings, dangerous waste liquidation, removal of naturally seeded plants from plots that were not used for a long time, etc.) but also administrative obstacles, such as the fact that agricultural brownfields (e.g., former agricultural cooperatives' animal production sites) are still registered as agricultural land resources, and their prices are not commensurable with the fact that these are problematic, depressed areas with the possible occurrence of all kinds of burdens. Four representatives of companies that have realized greenfield-based solar power plant projects in addition to the brownfield-based ones stated that greenfield-based solar power plant construction in the Czech Republic is much easier and less expensive than on brownfields, primarily because it



9: *Spatial distribution of previous uses of large solar energy plants with output over 1 MWp in the South Moravian Region*
Source: Energy Regulatory Office; authors' own processing

does not require investments into complex remedial measures. Part of the respondents identified as an obstacle to solar power generation development also an a priori negative attitude on the part of some officials, who refused to grant the necessary permits and did not distinguish whether the solar power plant would have been built on land registered as agricultural or in a brownfield location.

Another theme was the impact of the realized projects on local community development and the attitudes of local inhabitants to the projects. In six cases the land was owned by the investor; only in one case was it leased from the municipality, which realized income from the lease. The number of jobs created in association with solar power plant operation in the 7 locations under study was minimal, as this type of energy generation does not have substantial demands for a workforce to operate them (simply activities such as regular checks or the occasional mowing of grass). The attitude of local inhabitants towards brownfield-based solar power plants varied greatly – on the one hand they were accepted without objections where the solar panels were installed outside of the settlement proper, whereas solar power plants built in the immediate vicinity of settlement structures provoked frustration and annoyance on the part of the public. The argument that the power plant provided a use for land that did not have any other adequate present use did not convince the critics among the local populace. Local criticism may also be linked to a predominantly negative attitude to solar power generation in the Czech Republic at large, which is supported by some media and politicians (see for example Přibil, 2013).

The last part of the interview concerned possible measures to help a more intensive future use of brownfields for the development of solar power generation in the Czech Republic. A majority of respondents expressed the opinion that this topic is closely associated with government incentives, which are rather unpredictable in the Czech Republic. Whereas in the period to the end of 2009 legislative mistakes and errors in the system conditions enabled a boom of solar power plants, which were by and large built on greenfields, the year 2010 brought an actual stop state, where only the construction of rooftop-mounted generation units up to 30 kW was permitted. A majority of respondents showed a detailed knowledge of the situation in Germany; in their opinions, the adoption of regulatory tools similar to those already used in Germany could help the situation in the Czech Republic. Some respondents were rather critical in this regard, blaming the absence of any long-term energetic strategy on the part of the Czech Republic for this situation; among other factors, the monopolistic position of the company ČEZ was also perceived to be a big problem. According to a majority of interviewed company representatives, brownfield-based development of solar power generation is practically impossible under the current conditions in the Czech Republic.

CONCLUSIONS – DISCUSSION OF RESULTS AND PROPOSALS

The recent dynamic increase in solar power plant construction in the Czech Republic was realized mostly on greenfields – according to Dvořák *et al*. (2012) altogether 90% of new solar power plants were built on agricultural land, with a total acreage of about 4000 hectares. Our research conducted in the South Moravian region identified that majority of large solar power plants with an output of over 1 MWp were built on arable land (76.6%), and only small part of projects were created on brownfields (11.6%). Some of the realized projects have been criticized in the media for various reasons – for example because of the magnitude of expenditures and project size (e.g., the solar power plant Amun.Re in the Ralsko-Mimoň location – see Býma, 2011) or because of the controversial location of the project (e.g., the solar power plant Mostkovice, built in the immediate vicinity of a cemetery – see Havlík, 2010). A further decline in the media image of solar power generation was caused by articles emphasizing the development of solar power generation as the cause of increasing costs of power for both household and commercial end users (e.g., Klímová and Farghali, 2010). Even some representatives of the government executive have joined this criticism – for example the Prime Minister of the Czech Republic has called groups of solar power entrepreneurs "solar barons" and subjected them to a harsh critique (Wirnitzer, Hron, 2013).

Based on the results of both the quantitative and quantitative research activities, it is possible to mention that there are several obstacles necessary to be overcome in order to achieve a more intensive future use of brownfields for the needs of solar energy development in the Czech Republic:

1) Change in political support – the approach of Czech political representatives is very different from that of German political representatives. While German Chancellor Angela Merkel one day after the tsunami destroying the Fukushima nuclear power plant (2011) made a statement to the press pointing out that the events in Japan had made her re-think the security measures of Germany's nuclear power plants, and the German government then decided to phase out its nuclear power plants by 2022 and to move from fossil and nuclear fuels to renewable energy sources (Henze, 2013), the Czech Prime Minister Nečas emphasized a few days after this same disaster that new blocks in the nuclear power plant in Temelín would be created (Vláda ČR, 2011). Naturally political support in the Czech Republic, which depends on election results, can be changed in the future especially in the case of German energy policy, with its massive investments into renewable energy sources, being

successful, which could overcome the criticism from selected Czech political representatives who traditionally support the classic centralised energy sources such as coal and nuclear power plants (Chlebná, 2011; Kopecký, 2013; Marek, 2013) and oppose the new and decentralised renewable sources.

2) Improve the image of brightfields among Czech stakeholders – while German brochures dealing with "best practices" related to brownfields regeneration emphasize temporary use as a very useful instrument for the improvement of the image of such sites and as a catalyst for new investment (Kalberer *et al*., 2005), and also pay attention to photovoltaic power plants on brownfields (see for example Solarparks auf Brachflächen in Thüringen, 2010), Czech brochures of "best practices" pay attention to fully regenerated brownfields and ignore the issue of the solar and other renewable sources on brownfields (see for example Brownfields regeneration in the South Moravian Region, 2011; Brno Brownfields, 2013). In spite of the fact that there has not been any systematic financial or political support for the creation of solar power plants on brownfields in the Czech Republic as yet, a few projects developing solar energy on brownfields have been conducted, and can be used as best practices in Czech conditions – see Fig. 5–14.

3) Prevent the misuse of future subsidies – if Czech energy policy is changed in future, and if financial incentives supporting the development of solar on brownfields are approved in the Czech Republic, it will be necessary to prevent the misuse of these public investments and to decrease the risks of corruption. According to the Corruption Perceptions Index (2012), the Czech Republic was in 54th position among the countries of the world, and in this context it is necessary to expect that the danger of misuse and tunnelling of subsidies is quite high in the Czech Republic. Current information about non-regenerated brownfields in the Czech Republic is available in the form of brownfields databases, which were created at the national level by the CzechInvest Agency (National Database of Brownfields, 2013), at the regional level by some regional authorities (see for example the Database of Brownfields for Liberecký Region, 2013 or South Moravian Region Database, 2013), and at the municipal level by some large municipalities (see for example Brno Brownfields, 2013). In our opinion, all these types of existing brownfields databases are not reliable enough for serious decisions about public support related to the development of solar energy on brownfields, because these databases of brownfields are strongly influenced by different methodologies and by subjective decisions of actors collecting the data and information for these brownfields databases. In our opinion, the creation of a reliable, complete, and widely accepted brownfield database is a kind of utopia not only under the conditions of the Czech Republic but under those in other EU countries as well (see the examples of publically available brownfields databases from neighbouring countries on Tereny poprzemysłowe i zdegradowane, 2013 or Brachflächen in Leipzig, 2013), because there are very different definitions of brownfields across different countries and these definitions are changing over time as well (Oliver *et al*., 2005; Frantál *et al*., 2012). Moreover, there is a danger, if decisions about subsidies for the development of solar energy on brownfields is related to any of the official state, regional, or municipal brownfield databases, that some greenfields could be intentionally or non-intentionally formally declared as brownfields and that the subsidy program will be misused again. Therefore in our opinion every future applicant interested in obtaining subsidies for this kind of re-development should create an application specifying in detail why the site can be defined as a brownfield, how long the brownfield site or a part thereof was abandoned, whether there is contamination of soil and underground water, how much money was invested in the demolition of buildings and decontamination activities, what the land-use was before and after the completion of the project, showing through detailed aerial maps and images from the different years (see for example Fig. 3–9), what the share of built-up area was before start of project, the capacity of energy production from solar and renewable sources, and other accompanied and important information, which can be checked by concrete and objectively-measurable indicators. All projects approved for subsidy and financing from public sources (both the national incentives program of the Czech Republic and EU structural funds) should be publicly available on the Internet to increase the transparency of the decision-making processes and to decrease the risk of corruption. In other words, it is necessary to search for objective methods for preventing any kind of misuse of subsidies that could definitely damage the image of solar and renewable energy among different groups of Czech stakeholders. Naturally, detailed aerial and satellite photographs, for example, which often offer detailed resolution of approximately 20 centimetres, can be very useful and effective tools (see for example the plan for the use of satellite images for controlling the solar business available on idnes, 2013) for decreasing the risks of future misuse of public funds and related corruption.

The authors believe that the above mentioned proposals can be inspirational not only for the stakeholders in the Czech Republic but also for stakeholders in other selected EU member countries which are dealing with the occurrence of neglected, abandoned, and sometimes polluted sites, intensive development of solar and other kinds of renewable energies, and where the concept of the development of solar energy on brownfields has not been systematically supported yet. We

believe that more intensive implementation of the studied concept can not only contribute to the improvement of the environment and to the redevelopment of presently neglected and abandoned sites and properties, but that it can also start a new economic and social re-development in the many municipalities and regions dealing with structural changes and shrinking trends. If there is to be a new phase of solar energy development in future, public support should be given to environmentally friendly projects (roof-top mounted projects or projects on wasted or deprived lands, the so-called brownfields), and development on different kinds of non-deprived open landscape (arable lands, permanent grasslands, orchards) should be strictly regulated.

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