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Towards a solar cadastre – a review of global solutions

W kierunku katastru solarnego – przegląd rozwiązań światowych

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Abstract

Climate change is causing humanity to think increasingly about moving away from traditional energy sources, which are one of the causes of the greenhouse effect. The sun is of particular interest as a source of clean energy. The interest in solar energy causes that increasing number of people start to discuss the need to implement registers that gather information about the energy potential of specific parts of the space we live in. In addition, there is also a talk of simultaneously registering solar energy installations. Since, in the age of globalisation, the compilation of such databases should be standardised, the authors attempt to answer the following research questions in their presentation: (i) what information should be contained in databases that collect information on solar energy generation; (ii) what functionality should tool for recording and sharing this data have? These were answered by reviewing and analysing solutions worldwide.

Keywords: solar energy, geoportal, solar cadaster, solar potential map, ranking
Słowa kluczowe: energia słoneczna, geoportal, kataster solarny, mapa potencjału słonecznego, ranking

Introduction

The U.S. Energy Information Administration (EIA) forecasts a global increase in household energy consumption of 65% between 2018 and 2050 (EIA, 2021). The main influence on that will be: (i) increasing population; (ii) improved living standards in countries outside the Organisation for Economic Co-operation and Development (OECD), which will raise income and increase demand for appliances and personal equipment; (iii) urbanisation.

Such a large increase in demand for energy will, of course, force an intensification of energy production. This in turn will result in an even more significant impact of energy on the environment in which we live than at present. It is a well-known and very disturbing fact that energy production increases our standard of living in terms of various conveniences, but at the same time it causes degradation and destruction of the natural environment, and thus has a negative impact on our health. This has to do with the fact that the global energy industry is dominated by fossil fuels, the combustion of which to produce energy emits large amounts of carbon dioxide and dust into the atmosphere (World Figures, 2021).

It is believed that it is almost impossible to match energy-related measures that are intended to simultaneously increase comfort and refrain from degrading the quality of environment. Reconciling that contradiction will only succeed if comprehensive measures are taken including: (i) efficiency in the use of energy produced; (ii) replacement of fossil fuels with those that are less threatening to the environment, i.e. non-fossil fuels and nuclear fuel. The first type of action requires the implementation of new technological solutions which will prevent energy losses during its transmission or require less energy to be consumed in the operation of electrical equipment. The second, on the other hand, fits into the trend of sustainable use of resources and consists, among other things, in the significant development of the energy branch connected with the use of renewable energy sources (RES).

Solar cadastre as a renewable energy source – Global overview

On the spectre of a growing climate crisis, and even increasingly forecasting ecological catastrophe, humanity is beginning to think with growing interest about replacing existing energy sources with renewable ones. In 2019, about 11% of the world's primary energy came from renewable technologies (World in Figures, 2021), and in 2020 renewable energy consumption increased by 2.9 EJ, or 2.9×10^18 J (BP, 2021). China was the largest

contributor to this growth. This was followed by the United States of America, Japan, the United Kingdom, India and Germany. The European Union (EU) as a whole, on the other hand, recorded a share of energy from RES of 19.7% in 2019 (Eurostat, 2021). The target for the EU is 20% in 2020 and at least 32% in 2030 (European Commission, 2021). The European continent is to be the first in the world to be climate neutral by 2050 (European Green Deal, 2021). Certainly, the values come from many different sources, mainly sunlight, wind, water, rain, tides, ocean waves, geothermal heat and energy from biomass (various plants or plant-based materials). The above-mentioned statistics include, among others, energy from salinity or temperature differences in the seas and oceans, and even rotting agricultural waste. Of particular interest, however, is solar energy, listed first. This is because the sun constitutes the most abundant source of renewable energy. Approximately 86 PW (0.086 EJ) per second reaches the Earth's surface, which is about 4500 times more than humanity needs (about 600 EJ/year).

The interest in solar energy leads to a growing discussion about the need to implement registries that collect information about the energy potential possessed by specific parts of the space we live in (Hilling and de Lange, 2010; Lanig et al, 2011; Kanters et al., 2014; Desthieux et al., 2018). Additionally, the need for simultaneous recording of solar energy installations is also mentioned (Mainzer et al. 2014; Desthieux et al., 2018). In addition to quantitative attributes, these databases should of course also contain comprehensive spatial information about their location. Since, in the era of globalisation, the compilation of such databases should be standardised, the authors in their presentation will try to answer the following research questions: (i) what information should be contained in databases that collect information on solar energy generation; (ii) what functionality should tool for recording and sharing this data have? It was possible to answer these questions by reviewing existing solar cadastre solutions. In the world, the name is often assigned to geoportals containing information about energy potential, thermal potential and solar energy installations. Based on this overview, the authors have created their own rough framework for a solar cadastre, which they plan to develop in the future.

Thirteen portals containing data on solar energy were analysed. including realised for the area of Switzerland (Portal ... Switzerland, 2021) and the following cities, regions or agglomerations: (i) Amsterdam, the Netherlands (Portal ... Amsterdam, 2021); (ii) Boston, United States of America (Portal ... Boston, 2021); (iii) Calgary, Canada (Portal ... Calgary, 2021); (iv) Grand Genève, Switzerland (Portal ... Grand Genève, 2021); (v) Graz, Germany (Portal ... Graz, 2021); (vi) Hannover, Germany (Portal ... Hanover, 2021); (vii) Hessen, Germany (Portal ... Hessen, 2021); (viii) London, United Kingdom (Portal ... London, 2021); (ix) Munich, Germany (Portal ... Munich, 2021); (x) San Francisco, United States of America (Portal ... San Francisco, 2021); (xi) Vienna, Austria (Portal ... Vienna, 2021);

(xii) Wroclaw, Poland (Portal ... Wroclaw, 2021). Based on the analysis, the information that should be made available in such portals and the most desirable features they should have were identified. The total number of selected features and functions is 19: (i) estimation of the energy potential of roofs; (ii) estimation of the thermal potential of roofs; (iii) estimation of the energy potential of facades; (iv) estimation of the energy potential of open space; (v) land use classification and planning restrictions; (vi) 2D view; (vii) 3D view; (viii) estimation of the area that can be covered by PV panels or the number of panels that can be installed; (ix) estimation of the cost of installing PV panels; (x) inclusion of details such as: slope or shape of roofs, existing solar infrastructure, tree canopy etc. (xi) consideration of the effect of shading; (xii) assessment of efficiency, i.e., (xii) assessment of efficiency, i.e., the expected profit from the energy produced – e.g. (xii) evaluation of efficiency, i.e. the expected profit from the energy produced, e.g. monthly income; (xiii) estimation of the payback time for the construction, operation and maintenance of a photovoltaic installation; (xiv) information on the optimal tilt angle for panels placed on flat surfaces; (xv) data on carbon offsets; (xvi) possibility to create one's own profile, which will help to take into account any requirements regarding the planned solar energy infrastructure; (xvii) possibility to draw on the roof to indicate the most desirable location for a photovoltaic installation; (xviii) possibility to provide data on the existing photovoltaic system; (xix) possibility to select a map background – base map, orthophotomap, etc.

Summary and conclusions

Based on the specified features of the analysis, a ranking of the reviewed portals was created. More than half of the points were obtained by six of them: for Switzerland and for Amsterdam, Boston, Hanover, Hesse and London. However, none of them has all functionalities mentioned by the authors and if they were evaluated on a standard school grading scale, they would deserve at most a plus rating of "sufficient". This does not mean, however, that they do not fulfil their basic role. All portals analysed inform their users, at least at a basic level, about the energy potential of roofs in a 2D view. Most of them also contain information about the shape of the roof and existing infrastructure and shading. They thus represent a great seed for a multifunctional solar cadastre.

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Streszczenie

Obserwowane zmiany klimatu powodują, że ludzkość coraz intensywniej myśli o odejściu od tradycyjnych źródeł energii, które są jednym z powodów efektu cieplarnianego. Szczególnym zainteresowaniem, jako źródło czystej energii, darzone jest Słońce. Zainteresowanie energią słoneczną powoduje, że coraz częściej zaczyna dyskutować się o potrzebie wdrożenia rejestrów gromadzących informacje o potencjalne energetycznym jaki posiadają konkretne fragmenty przestrzeni, w której żyjemy. Dodatkowo, mówi się także o jednoczesnym zewidencjonowaniu instalacjach służących do pozyskiwania energii solarnej. Ponieważ w dobie globalizacji, sporządzanie takich baz powinno zostać ujednolicone, Autorki w swoim wystąpieniu próbują odpowiedzieć na następujące pytania badawcze: (i) jakie informacje powinny zawierać bazy danych, w których zbierane są informacje dotyczące wytwarzania energii słonecznej?; (ii) jakie funkcjonalności powinny mieć narzędzia do ewidencjonowania i udostępniania tych danych? Odpowiedź na nie była możliwa dzięki przeglądowi i analizie rozwiązań stosowanych na świecie.

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