International Cartographic Association
Association Cartographique Internationale

The design of a location-based mobile service with augmented reality to capture perceptions of coloured photovoltaic scenarios in rural and urban environments

Catherine Emma Jones [a,b,*], Alexander Skinner [a,b], Malte Helfer [a,b]

[a] *Department of Geography and Spatial Planning, University of Luxembourg. Catherine.jones@uni.lu, alexander.skinner@uni.lu, malte.helfer@uni.lu*

[b] *Institute of Advanced Studies, University of Luxembourg*

* Corresponding author

Keywords: Solar Energy, Augmented Reality, Social Acceptance, Energy Transition. Photovoltaics

Abstract:

Current fossil fuel production sites are traditionally placed out of sight but as the move to renewable energy systems progresses, our social, spatial and temporal processes related to energy production evolve. Decentralised energy production is leading to new visible land and cityscapes. It is currently estimated that fossil fuel production infrastructure takes up ~0.3% of land surface in small to medium-sized countries. For countries such as Luxembourg this is expected to increase to around 6% as renewable energy production from wind and solar become more dominant. This shift in energy production landscapes is leading to more visible energy production infrastructure which will in turn impact our relationship and attachments to places. Thus, as part of the SolarZukunft project, we hypothesise that photovoltaic installations that fit with the look and feel of the local land or cityscapes will improve social acceptance and reduce the impact of our place attachments. To realise such a hypothesis we are faced with several significant challenges: (1) how to develop coloured patterned PV panels that are camouflaged within their surroundings but yet maintain their energy yield (2) how to demonstrate to all community stakeholders what their potential new energy environment could look like in the future and to evaluate their perceptions of this transition.

In the SolarZukunft project, we test our hypothesis, using an interdisciplinary approach. Firstly, we work alongside physicists who are exploring the development of colour photovoltaic (PV) at different resolutions using liquid crystals. Secondly, we are evaluating the results directly with stakeholders and citizens by scaling up the findings by designing geographical visualisations for our real-world scenarios and presenting the results using digital models and augmented reality tools. A spatial-data framework integrates the scaled-up, pre-existing and new experimental colour PV data directly from the physics lab. Data concerning PV coloured panels, resolution and efficiency are adjusted to the scale of the neighbourhood using in-situ mapping simulations based on location-based services and augmented reality. These tools are then used to model the perceptions and attitudes of participants towards coloured photovoltaic scenarios in rural and urban environments.

In this paper, we discuss the conceptual design of a location-based mobile application that integrates augmented reality that will be used to evaluate perceptions towards the scaled-up results of the colour PV lab experiments. The app is designed in such a way as to enable all stakeholders to visualise future energy scenarios that combine rooftop and facade PV installations at a neighbourhood scale in three different land/cityscapes: rural, urban and peri-urban in Luxembourg. The app is designed so that participants can compare different neighbourhood scenarios. The first scenario is a baseline black PV scenario using a simulation that makes use of commercially available PV panels with that of a coloured PV scenario. Whilst, the second scenario is comprised a mix of colour-black PV installations that maximise the energy yield potential for the neighbourhood based on a design derived from a collaborative 3D participatory mapping workshop held with stakeholders. Then using place-based theory alongside a social acceptance evaluation framework that integrates a decision-making framework (derived from AHP) the tool will be used to assess what variables matter.

We extend existing research that applies augmented reality and mixed reality in the domain of solar PV/energy by evaluating optimal scenarios for colour PV installations that will support roof and facade installations that return a maximal neighbourhood energy yield. This article presents the prototype application that is developed to provide users with an immersive experience of different neighbourhood scenarios and explores how we capture their preferences towards cost, aesthetics, and yield using an underlying decision-making framework. This tool will provide valuable insights into the relative importance of aesthetics compared to other factors in the decision-making process. Such a holistic understanding will inform the development of tailored strategies to effectively communicate the benefits of renewable energy systems while addressing community concerns and preferences.

Abstracts of the International Cartographic Association, 7, 64, 2024.
European Cartographic Conference – EuroCarto 2024, 9–11 September 2024, TU Wien, Vienna, Austria.
https://doi.org/10.5194/ica-abs-7-64-2024

Acknowledgements

This research has been funded by the Institute of Advanced Studies, University of Luxembourg as part of an Interdisciplinary Project called SolarZukunft: a collaboration between the Department of Geography and the Department of Physics and Material Sciences. (https://solarzukunft.uni.lu/).