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Reflections on the use of large-scale tangible participatory mapping at scientific outreach events: a case study exploring public perception of traditional and coloured photovoltaics in Luxembourg.

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Abstract:

We reflect on the usefulness and impact of a large-scale tangible participatory mapping activity, drawing on experience from its usage at a national scientific outreach event. The activity was designed to raise awareness of the solar energy transition and gather public perceptions about traditional versus coloured solar panels versus. We gathered perceptions for three types of built environments using an imagined town in Luxembourg called *Solartopia*. The map was a mashup of three case study locations used in our broader SolarZukunft project, ensuring representation of urban, peri-urban, and rural built environments. Using Lidar data from the national mapping agency, we 3D-printed real buildings at a scale and created a giant tangible map that could be walked upon (3m*4m). We designed a flexible 15-minute workshop activity with six tasks that targeted different abilities, age groups, and interests to ensure it was appropriate for intergenerational participants. The tangible participatory maps sparked curiosity, encouraging participants to observe, interact and reflect. The map fostered simultaneous, multi-group collaboration between researchers and participants, while the visual and tactile elements provided a multi-sensory active learning experience. The creativity and imagination inspired by the map and the tasks suggest an element of social contagion to the diffusion of ideas.

Keywords: Participatory Mapping, Scientific Outreach, Tangible Maps, Idea diffusion, Solar Energy Transition, Citizen Science.

1. Introduction

In this paper, we reflect on the usefulness and impact of a tangible participatory mapping activity. Designed for large-scale public events focused on scientific outreach, this activity supports data collection on the perceptions of solar energy and coloured photovoltaics/solar panels (PV) in complex urban environments. The aim of the activity was to explore and develop understanding of solar energy transitions in the wider public and raise awareness of the potential for colour photovoltaics in urban contexts. We chose a small stakeholder event alongside a large science event to conduct our activity. This is because science outreach, especially when conducted as part of the organisation of coordinated public events, alongside hands-on interactive and participatory activities, can improve the level of public involvement, engagement, and interaction with ongoing scientific research practices (Hipkins, 2010; Stylinski et al., 2018). Thus, as efforts to communicate to the public, the work of scientists based in Luxembourg, the National Funding Agency of Luxembourg organises an open call for their bi-annual Researchers' Days, it is described as a unique platform for researchers to present their work to a large audience, via hands-on experiences, interactive workshops, experimentation, or by holding question and answer sessions (FNR, 2024).

The event is organised over 3 days, the first two days dedicated exclusively to high school students, whilst the third and final day, held on a Saturday, welcomes members of the public, and is particularly attractive to intergenerational families and those with young children. Attendance numbers are regularly in excess of 5000 visitors, which, for a small country such as Luxembourg with a population of just under 700,000 is classed a large-scale event.

Luxembourg University has only just turned 21, and the notion of public engagement in science and even participatory and citizen science aimed at dialogue the wider population is still in its infancy. It represents an area of research practice that has significant potential and events such as Researchers' Days help to close the gap between researchers and the public. These events offer

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playful discovery of scientific concepts, inclusion in participatory research and generally encourage a greater appreciation of the role of science in everyday life. These interactive events provide educational opportunities to spark curiosity in science (Clark et al., 2016). Enhancing not only public appreciation for science in the next generation but can also encourage critical thinking, whilst building the foundations required for informed decision-making on scientific issues that impact society today. Presenting creative ways to explore the challenges linked to the UN sustainable development goals, such as climate change, its associated sustainability transitions, health inequality, or those linked to technological advancements and their impact on society such as AI and robotics (UN, 2025).

2. Outreach, Participatory Mapping and Citizen Science

A significant purpose of these large-scale scientific outreach events is to nurture and encourage active participation via the creation of opportunities for individuals, families and/or school groups to engage, collaborate, and contribute to local scientific initiatives (Bucchi and Trench, 2021). In this context, citizen science is a meaningful approach that immerses citizens in the research process. In the literature, citizen science is conceptualised as either a tool to support data collection, analysis and dissemination, as a method for improving scientific literacy (Queiruga-Dios et al., 2020) in activities such as crowdsourcing or as a research methodology that embeds citizens into academic research by recognising their expertise and transforming them into researchers (Vohland et al, 2021). We adopt the conceptualisation of citizen science as a tool, focussing particularly on the practice of crowdsourcing and participatory mapping. We support active participation in our research via analogue interactive mapping activities that enable the sharing of ideas and provide us with a tool(s) to gather understanding on the topic of solar energy.

2.1 Participatory Mapping

Since participatory mapping practices involve local communities and members of the public as well as local stakeholders in the collection, analysis, and visualisation of geographic data, it ensures that their knowledge and perspectives are incorporated into, for example, planning decisions (Brown, et al., 2018). It is a relevant tool to gather perceptions. Indeed, the use of participatory mapping is widespread across many research fields including urban and neighbourhood planning (Torun et al., 2024; Casonato and Vedoa, 2020; Hasanzadeh et al., 2023), environmental and ecosystem management, noise and air pollution monitoring (Forrester et al., 2015), public health (Douglas et al., 2020), disaster management (Reichel and Frömming, 2014), cultural heritage preservation (Álvarez and McCall, 2019) or energy planning (Chilvers et al., 2021; Calvert and Jahns, 2021; Muller et al., 2022). Its power as a technique lies in its ability to enable collaboration with all demographic groups of citizens and is especially effective in engaging hard-to-reach marginalised communities (Lung-Amam and Dawkins, 2020) due to its ability to leverage local knowledge and thus support the acquisition of non-traditional, contextually and culturally specific data (Fagerholm and Käyhkö, 2009). Non-traditional spatial data, that are often rich in detail and context are thus acquired by the direct mapping of local phenomena by citizens and/or stakeholders and can be used to articulate, emotions, cultural practices, feelings or perceptions, giving voice to the unheard or poorly known local spatial sensibilities (IFAD 2021; Brown and Raymond, 2014).

It is both a visual and interactive tool that requires neither complex language nor high levels of reading literacy, (Denwood, Huck and Lindley, 2022) but depending on the technique used, it does require spatial cognition. It can assist crowd-sourced data collection in an easy manner, depending, of course, on the interface and medium in which the data are collected (digital versus analogue). It is tool widely adopted in development studies and other research areas linked to societal inequality because of its unique ability to overcome the socio-educational barriers that arise because of language, literacy and cultural differences (IFAD 2021; Denwood, Huck and Lindley, 2022). Given the multilingual nature of Luxembourg with its three official languages, its strength for facilitating engagement where cultural differences are present comes to the fore.

Furthermore, the general power of maps lies in their visual accessibility. It has long been said that carefully drawn maps are powerful tools for communication and representation that are able to convey complex spatial information in a way that is simple to understand (Monmonier, 2018). Especially since the rise of smart phones and car navigation systems, mapping apps have become a ubiquitous part of our day-to-day life. This means maps and mapping are available to a broader audience (White and Stephenson, 2014). Thus, their inclusive nature and mass appeal, combined with an appropriate mapping medium, make them not only more accessible but also better suited to supporting intergenerational contributions from children, adults, and the elderly alike (Brown et al., 2018)

Given that there is no one size fits all when it comes to the implementation of participatory mapping, a variety of techniques have been adopted. Ranging from analogue methods such as annotating or drawing on a paper map, to sketch mapping in mud (Denwood et al, 2022, Corbett, 2018) to the development of digital technologies such as the implementation of online web mapping services (eg Brown et al., 2018) or the development of apps with integrated location-based services (Oyana, 2017). This choice between analogue and digital methods for participatory mapping depends upon a an array of interconnected factors which include: (1) the type of data being collected; (2) the characteristics and needs of the participants who are collaborating in the process (3) the institutional setting (4) the situational context and (5) the environmental context as well as the

(6) the digital literacy of participants and availability of technology. (Denwood et al, 2022; Fagerholm et al., 2021).

2.1 Topical aims and objectives

Despite extensive work across Europe to model social acceptance of renewable energy, very little research has been conducted at the scale of Luxembourg. Energy security, dependence, and vulnerability have recently emerged as important social and economic factors that are impacting quality of life in Luxembourg. Driven by multi-level perspectives associated with global and local exogenous pressures such as increase in price, instability from war, climate change, and local cost of living crises. Social acceptance of the energy transition is determined by a complex array of social, cultural and political understandings of place, that results in either active or passive acceptance or passive rejective and active resistance (Upham, Oltra and Boso, 2015).

Our research project SolarZukunft, is an interdisciplinary project focused on solar energy. It is a collaborative project combining geographers and physicists. Our objective is to design and develop coloured PV using inkjet printing techniques that integrate liquid crystal technology and then to simultaneously evaluate the societal acceptance of the colours produced in the lab. We evaluate such acceptance pathways using both participatory mapping processes and hybrid geospatial technologies. Described in this paper is a participatory mapping workshop that, whilst originally designed for a 2-hour stakeholder workshop, was adapted to explore attitudes towards standard PV and colour PV amongst citizens at large scale outreach events which encourage engagements of 10 to 20 minutes.

2.2 Methodology

When designing participatory activities to be conducted in Luxembourg, we must first be mindful of its situational context. It is a small country of approximately 650K people, located in the heart of Europe, sharing borders with three other countries. It has three official languages, French, German and Luxembourgish with a widespread use of English as a common second language. It has a strong history and culture of supporting immigration – and more than 48% of the population do not have Luxembourgish nationality. This makes for a diverse multilingual and multicultural environment that adds a layer of complexity to any participatory project conducted. Workshops need to be mindful of this socio-cultural-linguistic setting and plan/adapt accordingly. In the context of large-scale outreach activities, we must be conscious that participants span different generations and thus our activities should account for such dissimilarities as well as encourage inclusive participation across diverse educational backgrounds and abilities (Denwood, Huck and Lindley, 2022). Given the scale of the event, the enormity of the building and purpose of the event, where participants should not feel they are being lectured to, we chose a participatory mapping event using a giant, walkable map with 3D buildings.

2.3 Workshop description

For the public day, we designed the 6 components to the workshop activity, targeting different abilities/age groups and interests which could easily swap in and out accordingly, to a maximum time of 10-15 minutes. For the school days, since we had only one age cohort, the activity was less flexible. We started by welcoming participants and giving a short introduction to project, where they were told that if we were to meet the energy needs of the country, we would need to cover between 6-8 % of all the land. Participants were then asked to look at the map and identify the most densely populated areas and say which parts of the map they thought represented urban, rural or suburban environments. Participants where then asked to walk around map and identify the building that they thought had the most potential for solar panel installations followed by the place with the least potential. They were then told about some of the factors that influence where we put solar panel installations and how there are different types of installations that support more imaginative practices. We explained more about the project and the development of colour PV by our physicists and then in a fourth step they were asked to choose a location on the map where they would like to put colour PV. The fifth and final step was to ask them to design their own colour PV panel and place it anywhere on the map where they would like to see it installed. Lastly, we demonstrated the impact of solar panel placement on facades using a model fitted with solar panels and interactive microcomputer with a light sensor (circuit playground express) When direct light shone on the panel the 10 NeoPixel lights shined in different colours, see figure 1. This was combined with a quick demonstration of our app – so it helped bring to life what the role of colour PV in the built environment could look like.

During the public day, we had two extra activities (1) each building was given a demographic profile (long term renters with low income, mixed ownership apartment blocks etc) participants were asked to identify the policies that they would prefer to see implemented to enable solar panel installations to meet the complex needs of the population.

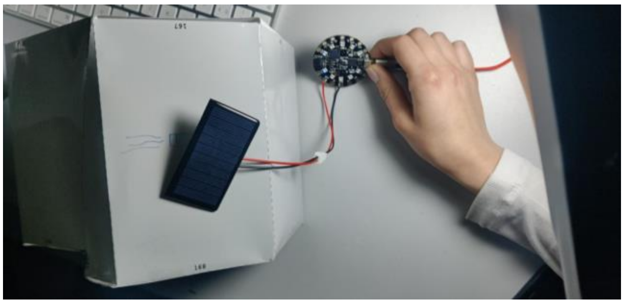

Figure 1. Demo of solar panels using micro-computer light display

We completed these activities with adults (mostly parents or grandparents) whilst the younger generation designed their solar panel. Our last activity, a

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standalone activity, asked young children to use origami to cut out and colour and add solar panels.

2.4 Iterative design and development of the participatory map

A giant tangible map (3m by 4m) was the central feature of our activity, providing a multisensory experience with sight, movement and touch. To construct our tangible map for the 3D participatory activity, we started with our 3D building models. The first iteration of the activity was designed for a stakeholder workshop for 20 participants, held a year previously. We used an origami method to develop real life scaled 3D models of buildings in two of our case study areas. The ACT2BIM dataset provided 3D models for buildings, created from high resolution LiDAR (horizontal accuracy of ±3 cm, and vertical accuracy ±6 cm). The building objects were exported as a Sketchup file to give us a 3D view of the buildings. The scale of the buildings was modified to that of our base map so that each building was scaled down to a scale of 1:250m and then imported into Pepakura Designer (a software tool that converts 3D models into 2D templates) used to create paper models by flattening the objects. It marks the folding lines and assigns numbers to guide assembly (see Figure 1). These templates were then printed. Our project intern and a handful of students painstakingly folded and built the models. The map design process is illustrated in figure 2. We used these original proof of concept models for two stakeholder workshops but for a large-scale event it was necessary to rethink because the paper models were rather fragile, and it was not easy to reset them for new workshops.

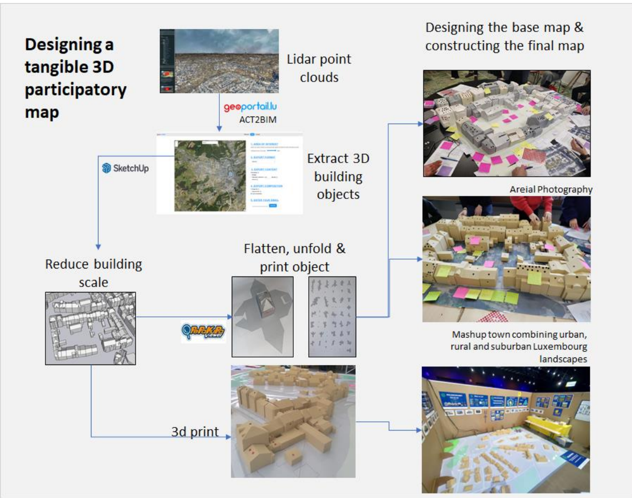

Figure 2. Overview of method for designing a tangible (scaled) building model for participatory mapping.

Given the overall goal of the SolarZukunft project is to explore perceptions in different landscapes: urban, suburban and rural. The paper prototypes were so time-consuming to make it wasn't feasible to do it for our three case studies. At the large-scale event we wanted to ensure participants had an overview of the case studies and not only spent the majority of their time looking at one locality. Thus, we created an imagined place called *Solartopia* - a mashup of our three case study locations. Using photoshop and the original building footprints and street layouts of our localities. We combined other key features commonplace in a Luxembourg town, a park, cultural centre, church, industrial building, forest, fields. A standardised colour palette for basemaps inspired by OpenStreetMap was applied (see figure 2). The original SketchUp models were exported and sent to the 3D printers.

The basemap was set up with North facing up and because of the orientation of the booth, the spotlights provided a convenient metaphor for the midday sun. An analogy that was particularly helpful for discussions on orientation and shade, see Figure 3.

3. Findings

Several reasons motivated our choice to integrate 3D models into the participatory mapping process. Firstly, our topic, solar energy, is very much related to the spatial attributes of the physical environment, and we felt that it would be helpful to have a visual, interactive and tangible representation of place where participants could evaluate the scale, compactness, roof complexity and form of the streetscape under investigation. As we believed this would help identify potential technical barriers/solutions such as shading, orientation, size of roof etc. Secondly, we felt using representations of Luxembourg's built environment provided a focal point to explore local knowledge and expertise directly linked to our situational contexts. Our hybrid town of Solartopia, offered a sense of familiarity without inherent bias/ preconceptions that might exist for our specific case study localities.

In the next section, we draw on reflections taken from a debrief meeting and logged observations by the researchers during the event to consider how the participants interacted with the map and its models. The purpose is to begin to understand the value of tangible participatory mapping. We describe our observations of participation and analyse interactions from a qualitative perspective to develop insights that can be further evaluated in a follow-on comparative study.

3.1 Reflections on the use of tangible 3D maps

In large scale events, understanding the scale of the building and the scale of the space is important. It took place in a concert all with a capacity of 6500, where each atelier was divided into 5m*5m booths. Thus, the requirement for a giant map. The walkable scale of the map created an **enriched physical-sensory experience** providing immersive and constructivist learning opportunities as when participants walk through the town they could discuss with others, make observations from different viewpoints, analyse the spatiality of the town, as well as touch the models. This was particularly evident when deciding which building had the most solar potential. With such a hands-on and tactile challenge participants embodied the activity; the tasks which required interaction with the map encouraged visual and kinetic approaches to thinking and learning. We observed participants walking

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through the map, observing, pointing, bending down to look more closely at buildings and discussing before making their decisions. The physicality of the interactions helped them to build a closer connection to the space (see figure 3.) Encouraged by the physical and sensory experience afforded by the large-scale map. Since it is widely known in the literature, for example, in Cochrane and Corbett (2018), community members must contribute their own experiences, information and ideas about a place and by facilitating participants to build connections to the space, this was more likely.

Figure 3. Tangible participatory map of Solartopia and sample interactions

Large scale maps reveal small areas in lots of detail, this meant participants with a simple scan around the floor could visually scale the town and its models and making sense of the place from a holistic, bird's-eye perspective. The scale of the map, its walkable nature and our incorporation of 3D buildings into the participatory mapping process helped participants to quickly **visualise and build spatial relationships** which **developed spatial awareness** of the town which on a screen would require more computer interactions (Zoom in/out, pan etc) than just observation.

The act of walking on the map meant participants could physically experience the space, it could be embodied. This combined with the 3D perspective of the buildings, made it easier for participants to appraise important spatial concepts relevant to the topic of solar energy such as: size, height, volume of building, and their spatial arrangements including concepts of adjacency and proximity. The 3D perspective encouraged participants understandings of spatial concepts such as distance between buildings, how near or far different types of buildings were in the different neighbourhoods (rural, urban, suburban), exploring notions of building density and compactness were perhaps easier. When asked to identify which parts of the map were urban / rural participants could see that the rural properties had bigger building footprints that were located further apart from each other. They were able to judge that urban environments had higher buildings and were closer together, so facades would be impacted by shading from other buildings and roofs were smaller.

We observed when asked to identity buildings with the most/least potential there were able to **evaluate the spatial relationships** since the impact of building heights, roof complexity and size as well as the spatial distribution of buildings that contribute to shadowing. By observing the map as they walk, they were able to observe roof complexity and size, building orientation and potential shadowing. Thus, leading to an exploration of the role the built environment plays in solar energy decision-making. Such observations would be more difficult in a 2D map.

One successful factor of participatory mapping is the act of collaboration. **Enabling collaboration** during the mapping process has many benefits including: the better support and inclusion of local knowledge and data quality, as well as the promotion of social learning (Brown and Kytta, 2018). Tasks were designed to be completed in small groups but required one selection, thus the group needed to reach consensus through discussion. We observed how the map facilitated collaboration in two ways. Firstly, groups of people such as small groups, friends or a family, together with the researchers could be on the map and discuss their collective ideas and express their individual perspectives. This is indicated by the gathering around buildings, pointing, observing and discussing between each other. We were also able to have multiple groups working with the map simultaneously. Indeed, the model buildings on the map provided a focal point for discussions and exchange of ideas (see figure 3). The 3D buildings helped the groups of participants to mentally and collectively analyse and interpret the map and its spatial data. We propose this led to a **shared learning experience**.

The 3D map modelled a real building which was a supportive tool to overall spatial cognition. It was easy to visualise the building dimensions, shape and spatial relationships. A particular strength of the **visual impact** of the map lies in its ability to encourage participants to visually assess the role of the buildings in their surrounding environment. Participants were able to conduct their own line of sight analysis by observing what can be seen from where. The tangible representations encouraged the collection of perceptions as groups of people engaged in discussion, pointing to and observing specific buildings and spaces that they felt were more supportive or problematic to the implementation of photovoltaics. Take the church and the school campus as examples. The public buildings drew strong positive responses in support of installing photovoltaics (and not just on the roofs) but given the cultural significance of the church, which was clearly identifiable on the map due to its familiar form, we observed many in-depth discussions about the use of its roof and facades as possibility for energy production. Polarising participants either strongly in favour or emphatically against. The visual impact of the map also served as a focal point, sparking people's curiosity and drawing them towards the activity and helped us to start a conversation and with this curiosity we were able to motivate active participation.

3.2 Reflections on spatial trends and perceptions of photovoltaic implementations in different environments

The activity involved asking participants to use stickers to map their perceptions on the 3D map. After the two school days we reset the map by removing all the interactions. This was a strategic decision to support the organisation of data collection and ensure a distinct and unbiased set of perceptions were collected between the two groups (students vs public) to ensure the public group contributed, independently of the exclusively younger group of participants. This helped ensure a less biased set of data were collected. Secondly, resetting the map avoided visual clutter from the considerable number of contributions that were gathered. Making it more inviting, less intimidating and giving the overall impression that their contributions were necessary. This approach meant we could explore if there were any differences between the different groups.

3.2.1 *Perceptions of solar energy*

Perceptions across both groups align with traditional understandings of the spatial placement of solar energy, in that expectations in both rural and urban environments are that if implemented, they should be on south facing roofs. When it comes to solar implementations on facades (both colour or traditional black panels) there are few expectations in rural areas and a minority of data points indicating they could be implemented on south facing facades in urban environments. Unexpectedly, we observed 80% of all contributions shared on day 1 & 2 and 75% of contributions on day 3 were located in urban environments. Indicating perhaps an *openness* to urban environments becoming decentralised energy producing landscapes. Across both participant groups we also observed a desire for public buildings such as schools, municipal buildings and cultural centres to become energy producing installations.

3.2.2 *Cultural expressions with colour PV*

In the second part of the activity, participants were tasked with designing and situating a colour PV panel. Mid-morning on day 1, one participant drew an image of their national flag and placed it on a roof in an urban environment. Thus, using the PV panel as a medium to express their cultural identity via the incorporation of traditional symbols of identity. These symbols can be powerful socially constructed representations of family heritage. This creative expression of identity resonated with subsequent participants. Leading others to adopt the same idea (with flags from Mali, Morocco, Poland, Portugal, Germany, Brazil…) these contributions represented twenty percent of all customised coloured panels designed on day 1 and 2. For day 3, after we reset the model, no flags were drawn. We also observed that 1 in 3 of the contributions on day 1 and 2 represented images that depicted art, symbols of building use such as a stained-glass window on a church, a book on a panel located on the cultural centre/library, flowers or natural landscape scenes on facades in urban environments. On the public day, creativity was different with much fewer pictures or images, no flags with a propensity for a colourful grid or one colour block (predominantly situated on roofs).

4. Discussion

4.1.1 *Potential Social contagion and the diffusion of ideas*

We are conducting qualitative research and need to be cautious of over generalisation. However, we would like to contemplate the form of contributions in our participatory map and consider using the lens of social contagion within the theoretical framework of the diffusion of ideas to consider the contributions. Social contagion theory describes the seemingly spontaneous process for which our thoughts, emotions and behaviours are influenced by those around us and lead to the rapid spread of attitudes, sentiments and behaviour in a similar manner to disease contagion (Riggio, 2023). The diffusion through the group is spontaneous. General examples of this in contemporary society include the spread of panic in a crowd, the imitation of behaviours such as speeding or the spread of trends on social media (such as ice-bucket or dance challenges). We observed the rapid spread of one simple idea throughout the schools' days. An initial participants' design that expressed their cultural identity illustrated to others, of a similar age, how sustainable technology such as coloured PV could be imagined as a form of representing one's personal and cultural symbols. This original idea spread, sowing the seed of creativity to other participants who replicated this expression of personal identity through the process of echoing spontaneously the behaviour of others. From the perspective of idea diffusion where a novel idea (or niche technology) gains momentum and becomes more and more widely adopted sparked by one initial idea, copied by their friend/ neighbour and then replicated by strangers observing the map and adopting the concept. People's thoughts, emotions and behaviours can be strongly influenced by the people around them, ideas spread throughout social network. Interestingly, on the third day, when the map was reset, not a single participant had the idea to use the panel to represent their cultural heritage and personal identity. Thus, reinforcing the importance of having an early adopter who adopts a technology/ idea and acts as the seed for social contagion in the spread of idea. It is important in the solar energy transition to encourage and showcase community champions/ building examples that advocate for the technology and can be the seeds that support the spread of ideas. The differences observed between the two groups highlight how one simple creative idea can collectively influence the behaviour of subsequent participation in strangers disconnected personally from the initial people who sparked the behaviour.

Reflecting on the diffusion of ideas and the creativity observed during the workshop, which began with a single participant and then spread across the various participatory groups, we can draw parallels with broader themes of technology adoption and the social acceptance of solar energy within the urban built environment.

The process of adopting new technologies or new policies, such as PV panels, often follows similar patterns of idea diffusion and social contagion. Our workshops raise awareness of the emerging colour PV technology demonstrating to early adopters its creative potential. The spread of imaginative solar panel designs on the map somewhat mirrors the influence of social networks in technology adoption and behaviour change and indicates the potential for visually appealing and aesthetically integrated panels in the spread of social acceptance for decentralised urban solar energy systems. Without the original social contagion (the initial concept idea), the diffusion process of panels as expressions of cultural identity did not occur. Suggesting that this is indicative of the importance of solar energy champions, policy innovators and the application of flagship buildings in urban environments to encourage passive acceptance that can lead to active adoption in the sustainable energy adoption process. We think this indicates the strategic importance of early adopters and the role of visible demonstrations in spreading innovative concepts and niche technologies to support their integration into the wider socio-technical system. We propose that local authorities and public buildings have considerable potential to be at the forefront of this transition by assuming the role of community champions and creating flagship coloured PV buildings. Our findings justify the next stage of the project where we are developing an AR app to demonstrate what real streetscapes will look like with colour PV and provide citizens and policy makers with the potential to interact with different colours and build passive acceptance.

4.1.2 *Limitations of tangible models in participatory mapping*

From our observations and experience we can attest that tangible 3D models offer numerous advantages in the participatory mapping process, they also come with certain limitations. The process of their creation is complex, time consuming and expensive and so is only justifiable if the models are reused multiple times. Our models are rich in many architectural details, but they are still limited. There are no windows on our models. So, whilst they provide a useful overview of the physical environment and enable general discussions, they do not capture specific details. This is a compromise we felt comfortable with as we were not asking participants to plan specific environments but were exploring general perceptions and attitudes. Interpreting 3d models requires a different spatial cognition to 2D maps, thus for some participants it is possible they found it difficult to interpret and orientate themselves. We did observe a few participants struggling with the concepts of direction/orientation which manifested in the choice of north facing roofs and facades as most suitable locations for panels. This point requires further investigation to determine if it's a general symptom of reduced spatial cognition in society or if it's the readability of the 3d map. Our final remark, on the limitations of the methodology is associated with the logistical challenges. Both the base map and the models took up a lot of space, as it's important to design for the space/scale of the event. Transporting and storing large 3D models can be challenging and reusing the base map was dependent upon participants willingness to take their shoes to walk on the map (we observed the school kids could slip their shoes on and off much whilst the adults on day 3 much preferred to keep their shoes on). From the perspective of the map as a data collection tool, the models required photographing after each day, and the data painstakingly logged. This is effective but the process of digitising the data is time consuming (like all analogue to digital map transformations).

5. Concluding Remarks

This paper reflected on our experiences and observations from a national scientific outreach event, where we designed and used giant participatory mapping practices to explore perceptions of the solar energy transition in different built environment landscapes of Luxembourg. Our reflections indicate that tangible participatory maps spark curiosity, encouraging participants to observe, interact and reflect. The scale of the map encouraged group collaboration amongst family and friends. Whilst the visual and tactile elements of the maps encouraged a multi-sensory physical experience which supported active and constructive learning in multi-cultural contexts. Thus, the tangible map was suitable for such large public events. How participants used creativity and imagination with the map was indicative of the potential the role of social contagion as a mechanism for influencing behaviour and provide a source of contemplation on how niche technologies, such as coloured photovoltaics could be more widely accepted as part of the energy transition. The large-scale map provided a realistic and hands-on representation of the local built environment using a hybrid representation of urban, peri-urban and rural landscapes. This supported the collection of public data on perception and ensured the solar energy concepts which we were discussing were less abstract and more relatable to participants. Such authenticity is an important part of participatory mapping processes as it facilitates personal connection to the topic. Our reflections on the workshop indicate a lot of potential in the use of tangible large-scale maps for this topic and beyond as well as offering further ideas future study to validate our observations in a more quantitative manner.

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