Dr Eleonora Nicoletti

Senior Lecturer in Architecture and Environmental Engineering

Towards Solar Facades as Participatory Public Art

An Introduction

Funded by the Arts and Humanities Research Council (AHRC), part of UK Research and Innovation (UKRI), under the Design Accelerator scheme (Grant Ref: AH/X003574/1)

21/06/2023

An Introduction to the Project

Context, aim, activities, participation, outputs, questions and contact details

Project Lead

Dr Eleonora Nicoletti

Senior Lecturer in Architecture
and Environmental Engineering

School of Architecture and Environment

College of Arts, Technology and Environment

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Area of Expertise

- Architectural Design
- Environmental Design
- Facade Design
- Architectural Technology
- Computational Design
- Participatory and Design Research

Research Focus

Visual Design of Solar Facades

Context: Photovoltaics and Buildings

Diego Delso, delso.photo, License CC-BY-SA

Delso, D. (2019) *Powerhouse Brattørkaia, Trondheim, Noruega, 2019-09-06, DD 27* [photograph]. At: Wikimedia Commons [online]. Available from: go.uwe.ac.uk/Powerhouse [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA4 (No modifications)

Limelightpower (2010) *Colorado Court BIPV* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/ColoradoCourtBIPV [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA2

Building-Applied vs Building-Integrated Photovoltaics

Brown, E. (2012) *Solar panels on a roof - Northfield* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/SolarRoofNorthfield [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Pessar, P. (2018) *Balenciaga Miami Design District* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/BalenciagaMiamiBIPV [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Project Aim

To facilitate and improve the implementation of Building-Integrated Photovoltaic (BIPV) technology for façade retrofit applications in Bristol by considering the local community's views on the visual design of solar facades for the art-rich landscape of the city.

La Citta Vita (2011) *Solar facade* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/SolarFacade [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA2

Activities: Co-Design Workshops and Exhibition

Tulloh, E. (2015) *Co-design workshop* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/CDW [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

O'Neil, A. (2010) *Entrance to the Tobacco Factory theatre in Bedminster - geograph.org.uk - 2232255* [photograph]. At: Wikimedia Commons [online]. Available from: go.uwe.ac.uk/TF [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA2

Why take part?

You can…

- Learn about the opportunities for the building integration of photovoltaics
- Express your thoughts and help us understand the local community's views
- Contribute to reimagining Bristol for the renewable energy transition
- Influence future decisions on the building integration of photovoltaics in Bristol
- Meet notable Bristol artists and learn about their distinctive, creative approaches

We are interested in your perspective!

Participating in the Workshop

You can take part by…

- Considering the provided information about participating in the project, and asking questions
- Signing the consent form given to you, and keeping the information sheet
- Attending the presentations introducing the project, solar facades research and BIPVs, and asking questions about the presented content

~ 90 minutes

- Taking part in a small-group discussion
- Writing down your preferences for the visual design of solar facades, and completing some general demographic questions
- Seeing the artists at work as they start visualising ideas through sketching

~ 30 minutes

You do not have to take part, and you can withdraw within 7 days by writing to the Project Lead:
Eleonora.Nicoletti@uwe.ac.uk

Participation Principles and Expected Outputs

Participation Principles

- Voluntary participation
- Secure data handling
- Anonymised information
- A safe space for creative expression
- No sensitive topics, no special category personal data
- No significant risks

Expected Outputs

- Artworks by the artists working with Upfest
- A public exhibition with an online questionnaire
- Reports to the funder (AHRC)
- Academic publications (e.g., design guidance, peer-reviewed scholarly articles and conference papers)
- Public talks, lectures and presentations
- Media communications and advertising

Approved by the Faculty of Environment and Technology (FET) Faculty Research Ethics Committee (FREC).

If you decide to participate you will be given a copy of the Participant Information Sheet and your signed Consent Form to keep.

Questions?

Dr Eleonora Nicoletti

Email: Eleonora.Nicoletti@uwe.ac.uk

Solar Facades: An Introduction

An overview of research and principles for the visual design of solar facades integrating photovoltaics

Researching the Design of Solar Facades

- Nicoletti, E. (2022, December). ***Photovoltaics potential for façade renovations***. Paper presented at PowerSKIN 2022, TUM School of Engineering and Design, Technische Universität München. Available from: https://uwe-repository.worktribe.com/output/10196804.
- Nicoletti, E. (2022, August). ***Potential strategies for enhancing solar architectural skins***. Paper presented at International SEEDS Conference 2022, University of the West of England, Bristol and online. Available from https://uwe-repository.worktribe.com/output/9720912.
- Nicoletti, E. (2022, January). ***Design strategies for visually engaging solar skins: Between dynamic displays and energy generation***. Paper presented at Sixteenth International Conference on Design Principles & Practices, University of Newcastle, Newcastle, Australia. Available from https://uwe-repository.worktribe.com/output/8687397.

PhD Research

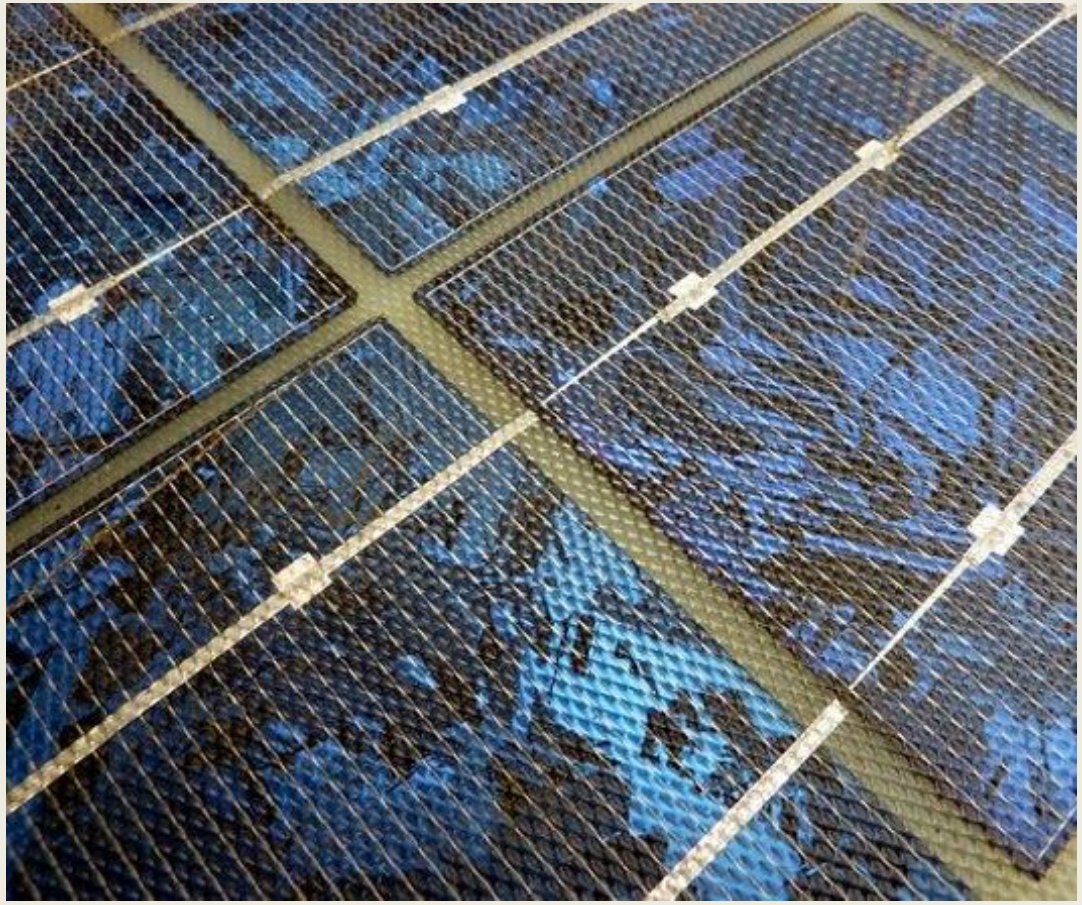
- Nicoletti, E. (2020). ***Design of Effective Solar Architectural Skins for Visual Engagement***. PhD, University of Brighton. Available from: https://cris.brighton.ac.uk/ws/portalfiles/portal/24289039/Eleonora_Nicoletti_PhD_Thesis_Final_Copy_Redacted.pdf.

Solar Roof or Façade?

Chance, T. (2007) *BedZED* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/BedZED [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Photovoltaics (PVs) for the Building Envelope

- Semiconductor materials (e.g., silicon)
- Generating electrical energy from sunlight
- Modularity (solar cells, panels, arrays)
- Performance depending on multiple factors (e.g., irradiance, temperature, extent of the active PV area)
- Trade-off between energy generation efficiency and other functions of the building envelope
- Continuing technology developments



Sandberg, A. (2009) *Solar cells* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/SolarCells [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Photovoltaics (PVs): Crystalline vs Thin Film PVs

Open Grid Scheduler / Grid Engine (2011) *Solar cell panel* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/SolarCellPanel [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CC01

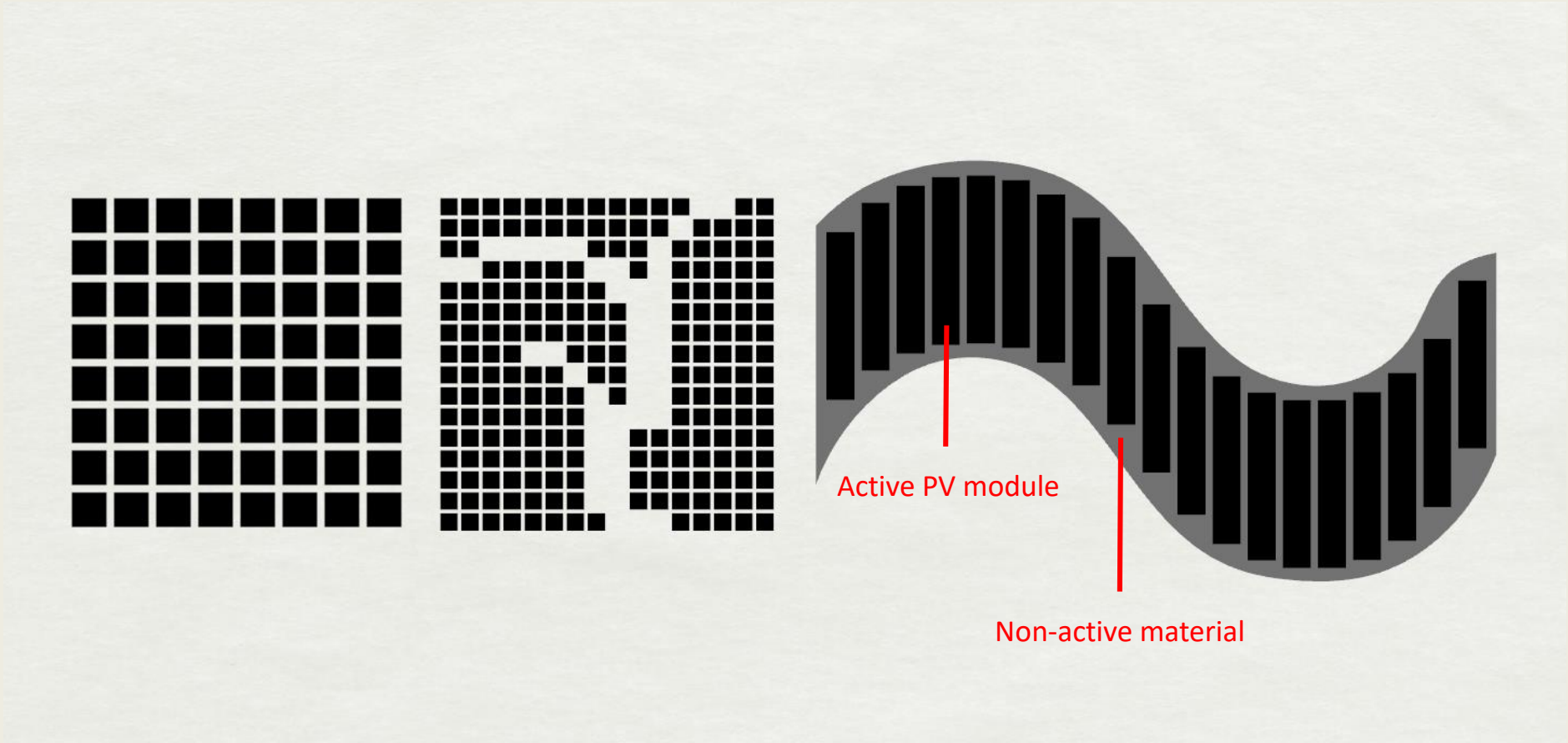
Fields, K. (2008) *Thin Film Flexible Solar PV Ken Fields 1* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/ThinFilm [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA2

Visible or Invisible PV Integration

Brown, M. (2009) *Heron Tower cladding* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/HeronTower [Accessed 18 June 2023]. Licence: go.uwe.ac.uk/CCBY2

White, P., BRE (2011) *WDtransparent PV_5250* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/TransparentPV [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYND2

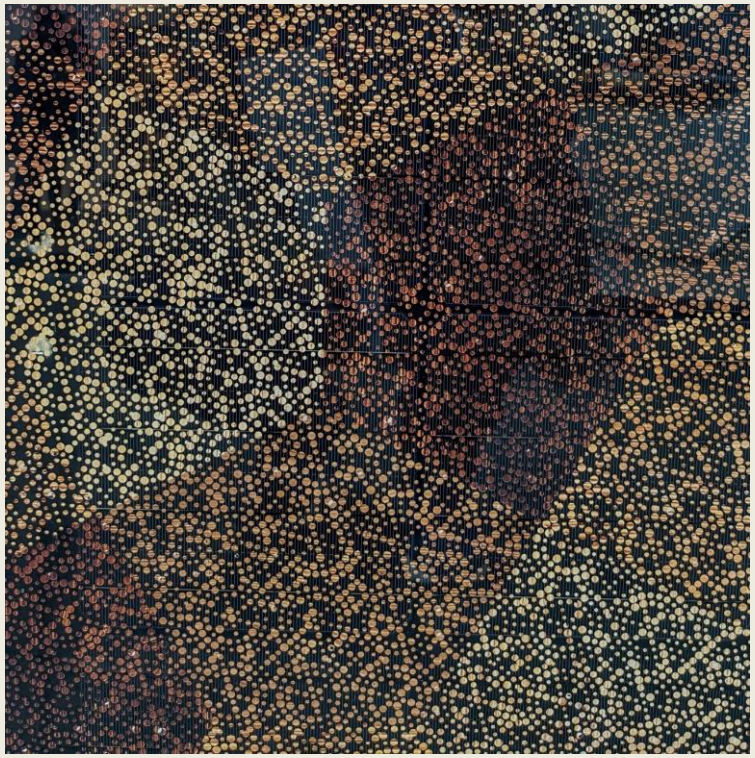
Modularity



Composing visual designs through modular configurations and the integration of active and non-active elements

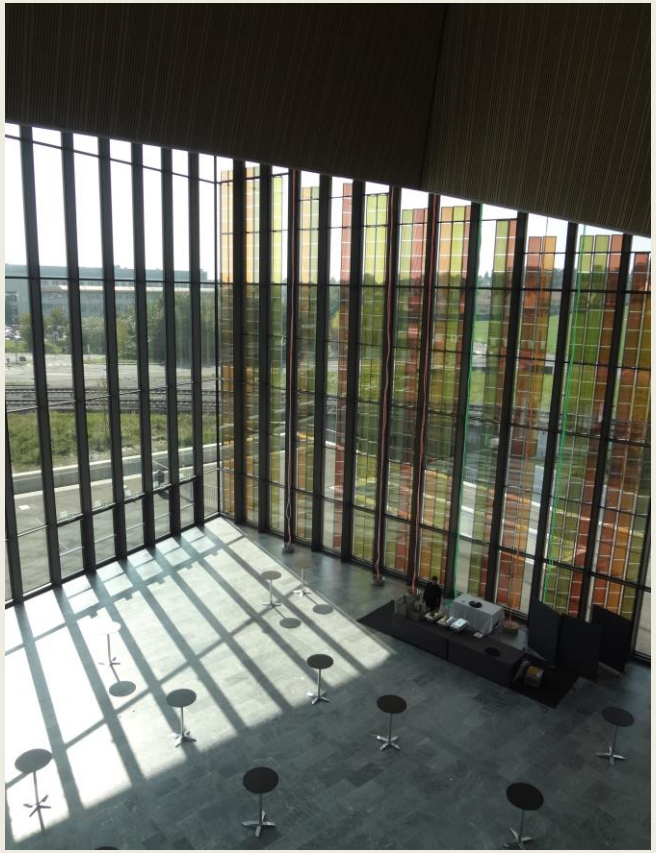
Visual Design with Established PVs

Hall, S. (2016) *Solar Decathlon Window by Sarah Hall* [photograph]. At: Wikimedia Commons [online]. Available from: go.uwe.ac.uk/SarahHall [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA3



Traparker (2022) *Close-up of the dots on the front cover of a BIPV glass* [photograph]. At: Wikimedia Commons [online]. Available from: go.uwe.ac.uk/BIPVglass [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA4 (No modifications)

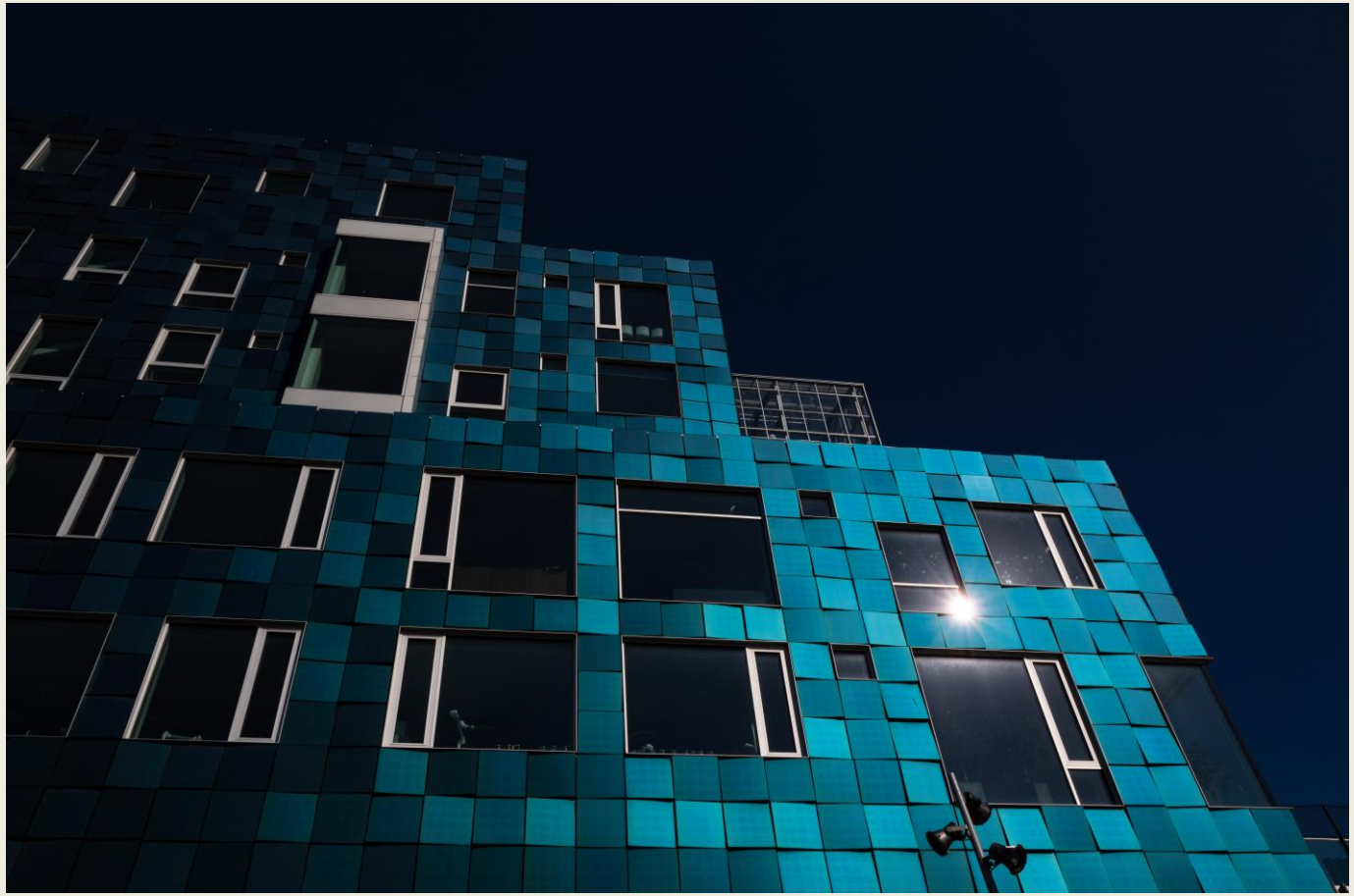
Visual Design with 3rd Generation PVs



MHM55 (2014) *SwissTech Convention Centre Campus 02* [photograph]. At: Wikimedia Commons [online]. Available from: go.uwe.ac.uk/SwissTech [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA4 (No modifications)

Frostdawn (2015) *Belectric cell* [photograph]. At: Wikimedia Commons [online]. Available from: go.uwe.ac.uk/BelectricCell [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBYSA4 (No modifications)

Blending in?



Nygaard, S. (2019) *Copenhagen International School* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/CIS1 [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Standing out?

Theisohn, P. (2017) *La Seine Musicale* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/LaSeineMusicale [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Towards Visual Concepts for Solar Facades

Location-Related Factors
(e.g., geography, climate, culture, economy, regulations,…)

- Outdoor environment (e.g., street, square,...)
- Building (e.g., commercial, cultural,…)
- Visual Content (e.g., image, pattern)
- Economic factors (e.g., lifecycle costs)

Possible Design Variations

- Visual strategy (e.g., motion illusion)
- Skin Morphology (e.g., scale, modular configuration,...)
- Visual Quality (e.g., colour, transparency, reflectivity…)
- Solar technology (e.g., absorber, substrate, and performance enhancement strategy)

Nicoletti, E. (2020). *Design of Effective Solar Architectural Skins for Visual Engagement*. PhD, University of Brighton.
Available from https://cris.brighton.ac.uk/ws/portalfiles/portal/24289039/Eleonora_Nicoletti_PhD_Thesis_Final_Copy_Redacted.pdf

Solar Facades: Some Visual Design Principles

- PVs may be integrated into different parts of a façade, e.g., glazing or cladding, in areas with a higher solar potential
- When integrated into facades, PV modules may be visible or not
- PV modules may contribute with their standard colour and/or in combination with non-active elements to forming visually engaging designs displaying, e.g., images or patterns
- BIPV products can vary in module shapes, sizes, and visual qualities to resemble traditional building envelope materials or display, e.g., images or patterns and visually dynamic effects
- There is a trade-off between effective appearance and energy generation but there are continuing technology developments (e.g., towards higher-efficiency solar cells, or lifecycle, optical, and thermal performance enhancements)

Solar Façades for Bristol

Identifying facades of existing buildings in Bedminster, that offer opportunities for photovoltaic energy generation, through photography and solar potential analysis

Solar Facades for Bristol

Minimal impact on the building's exterior appearance or the 'amenity of the area'

The Town and Country Planning (General Permitted Development) (England) Order 2015. (SI 2015/596). Available from: https://www.legislation.gov.uk/uksi/2015/596/ [Accessed 10 May 2023]. Licence: go.uwe.ac.uk/OGL3

What does this mean to the people of Bristol?

Brown, M. (2013) *ARYZ street art Bristol* [photograph]. At: Flickr [online]. Available from: go.uwe.ac.uk/ARYZ [Accessed 17 June 2023]. Licence: go.uwe.ac.uk/CCBY2

Bedminster: The West Street Area

Restrictions on PV Installations

- Conservation areas
- World Heritage Sites
- Listed buildings
- Scheduled monuments

The Town and Country Planning (General Permitted Development) (England) Order 2015. (SI 2015/596). Available from: https://www.legislation.gov.uk/uksi/2015/596/ [Accessed 10 May 2023]. Licence: go.uwe.ac.uk/OGL3

Identifying constraints from planning data

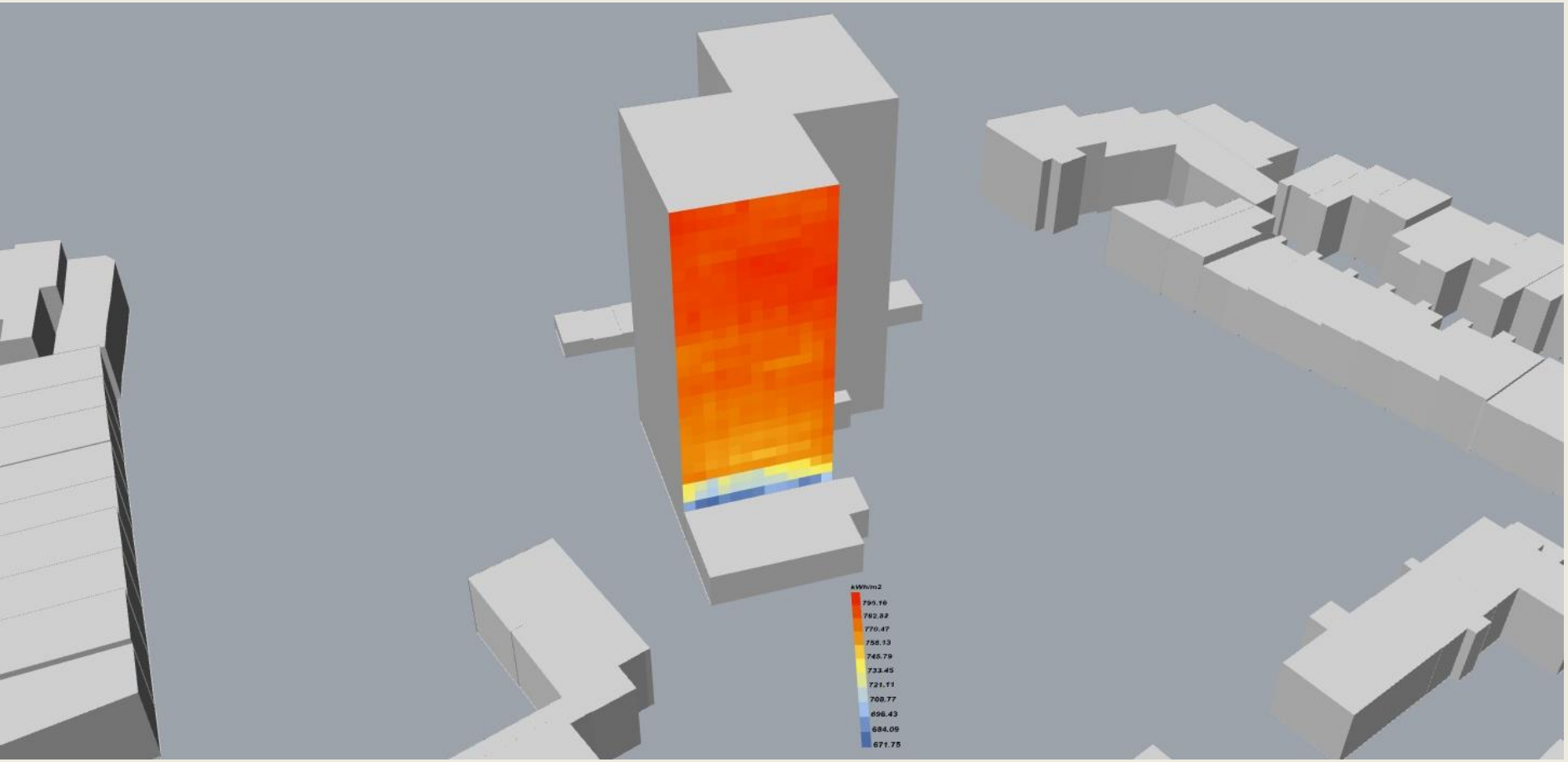
planning.data.gov.uk (n.d.) *National map of planning data*. Available from: https://www.planning.data.gov.uk/map/?dataset=conservation-area [Accessed 10 May 2023]. Licence: go.uwe.ac.uk/OGL3

Google Earth image capturing the Bedminster area around West Street

Buildings with Large South-Facing Facade Areas

Google Earth images capturing large multi-storey buildings in Bedminster near West Street

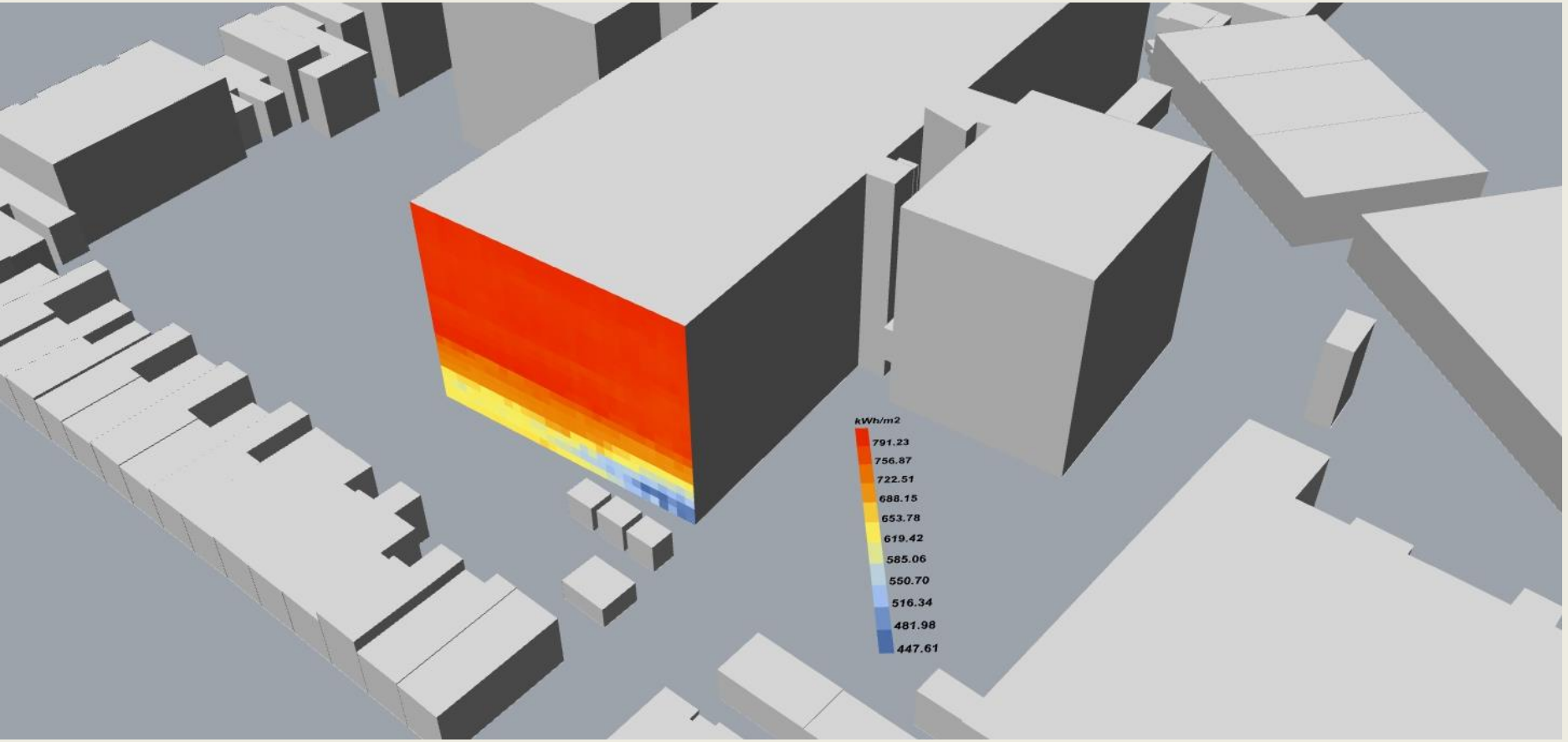
Considering Fire Safety



Analysis of solar radiation on a South-facing façade of a high-rise building in Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and Ordnance Survey Data

Photo capturing the analysed South-facing façade of a high-rise building in Bedminster

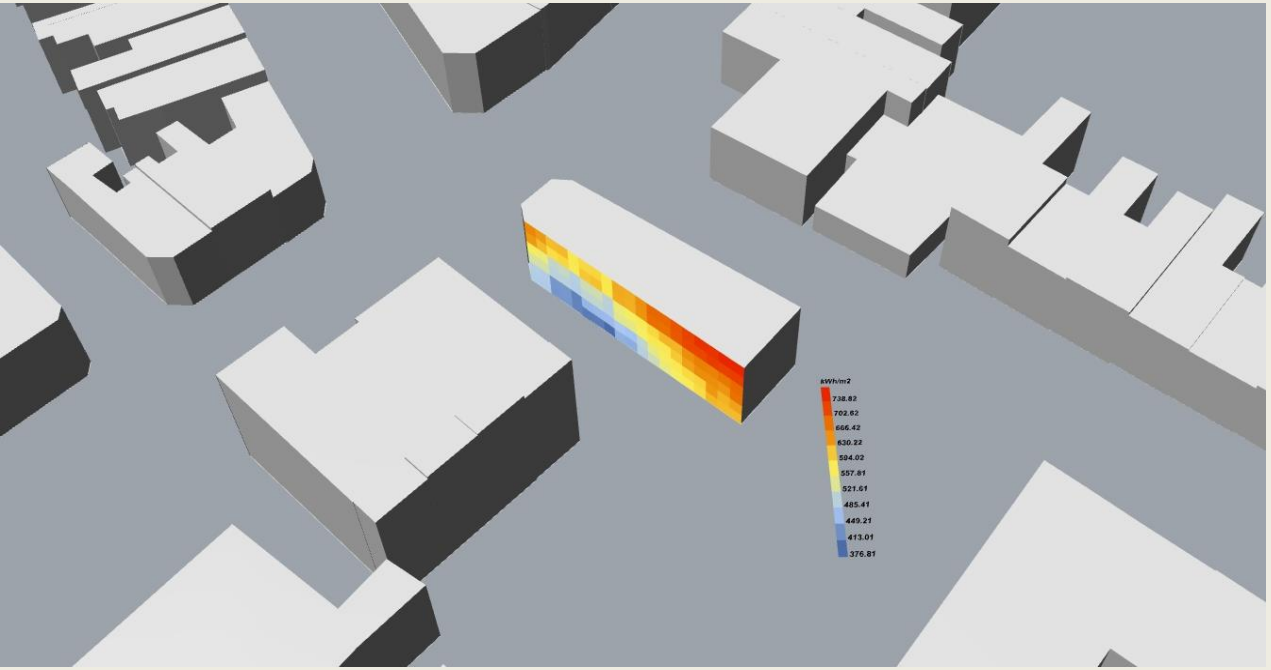
Considering Fire Safety

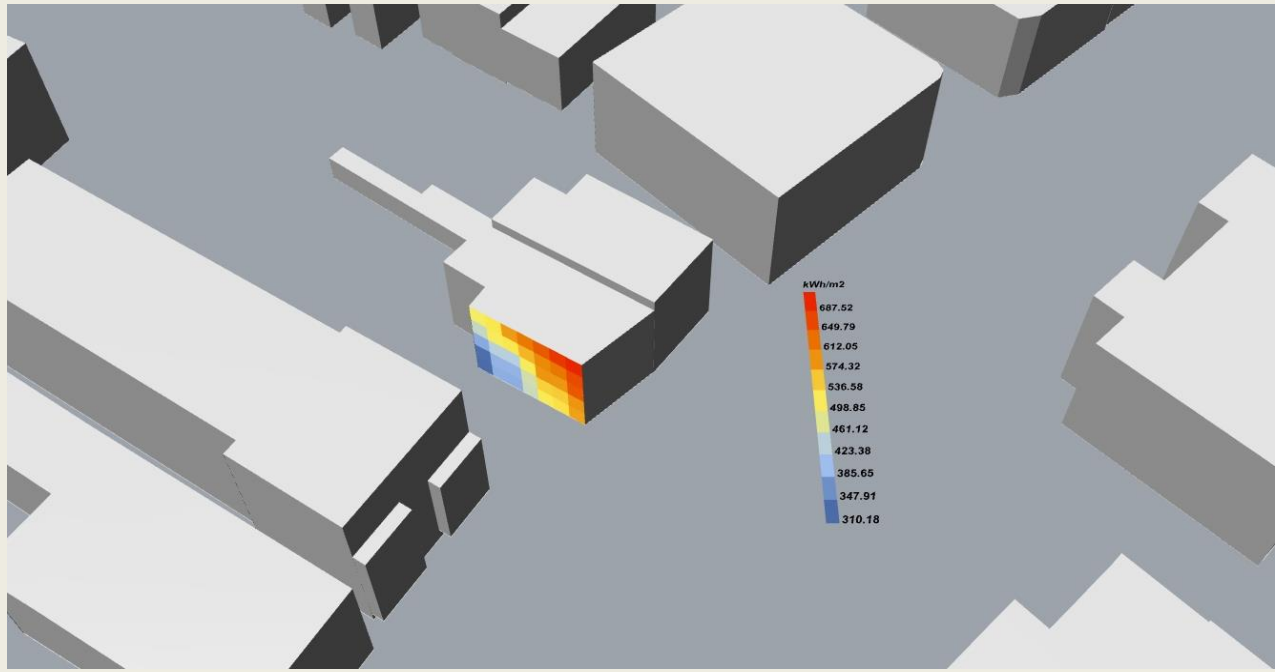


Analysis of solar radiation on a South-West-facing façade of a multi-storey building in Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and Ordnance Survey Data

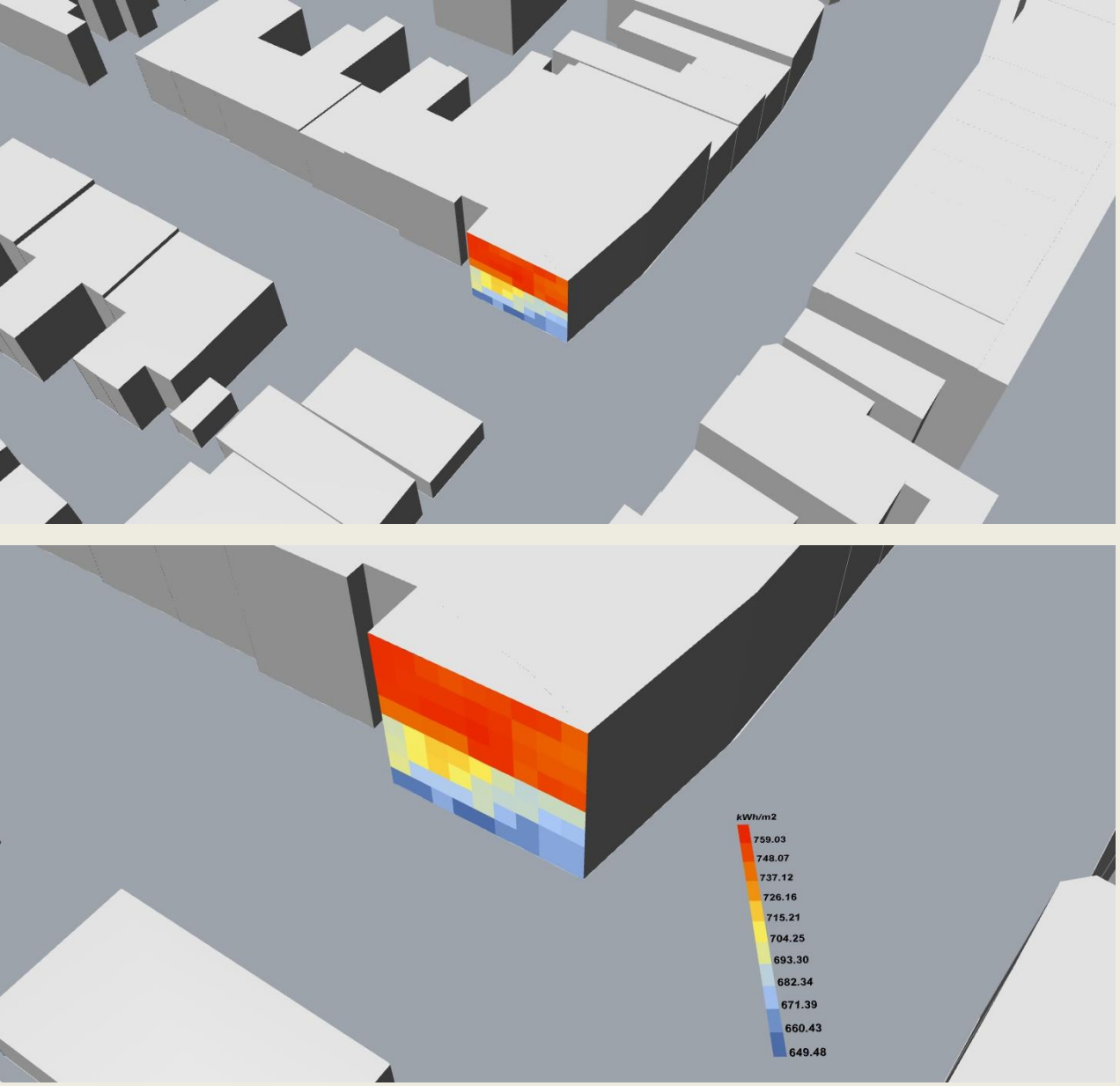
Photo capturing the analysed South-West-facing façade of a multi-storey building in Bedminster

Solar Potential of Facades in the West Street Area



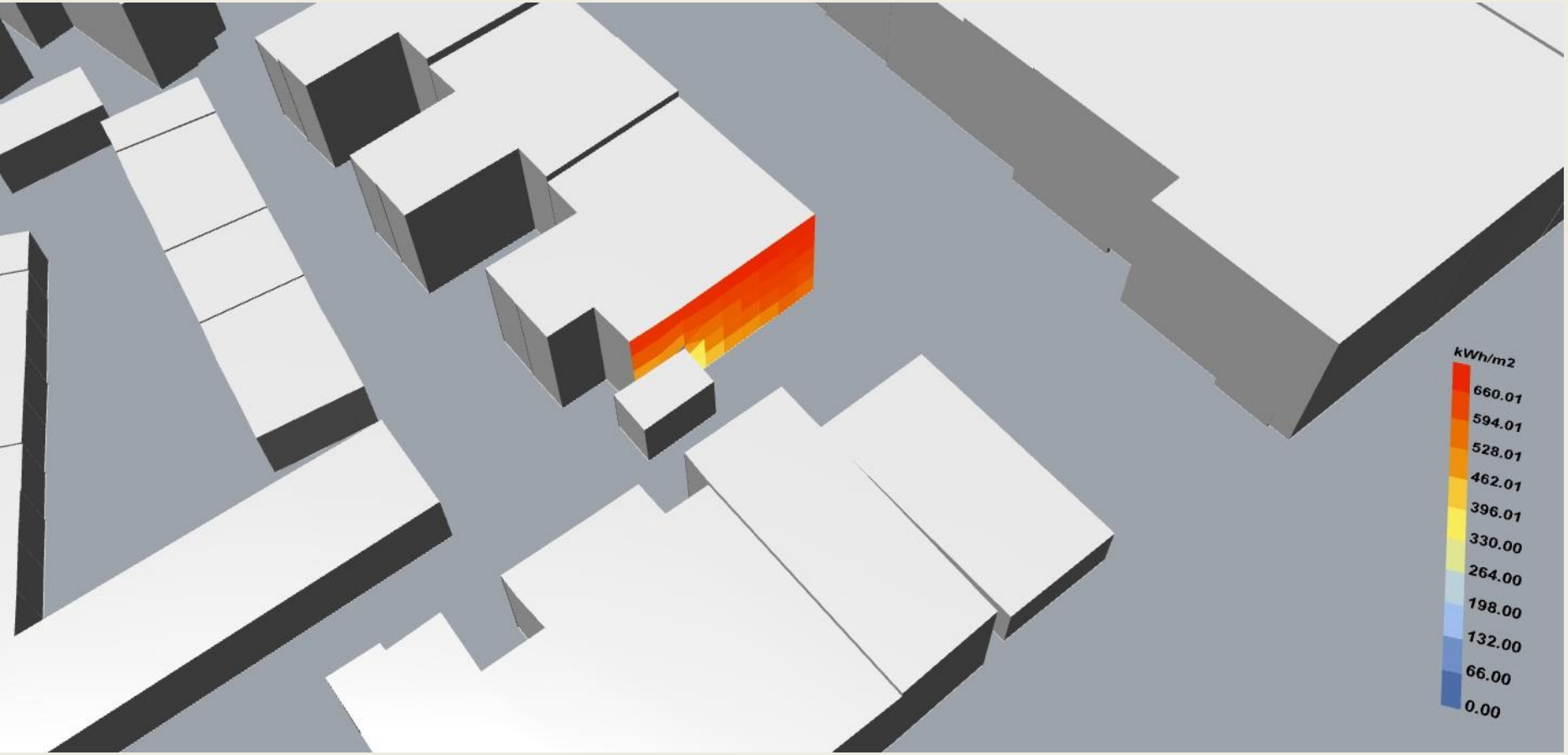


Analysis of solar radiation on South-West-facing façades of two buildings in the West Street area, Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and Ordnance Survey Data



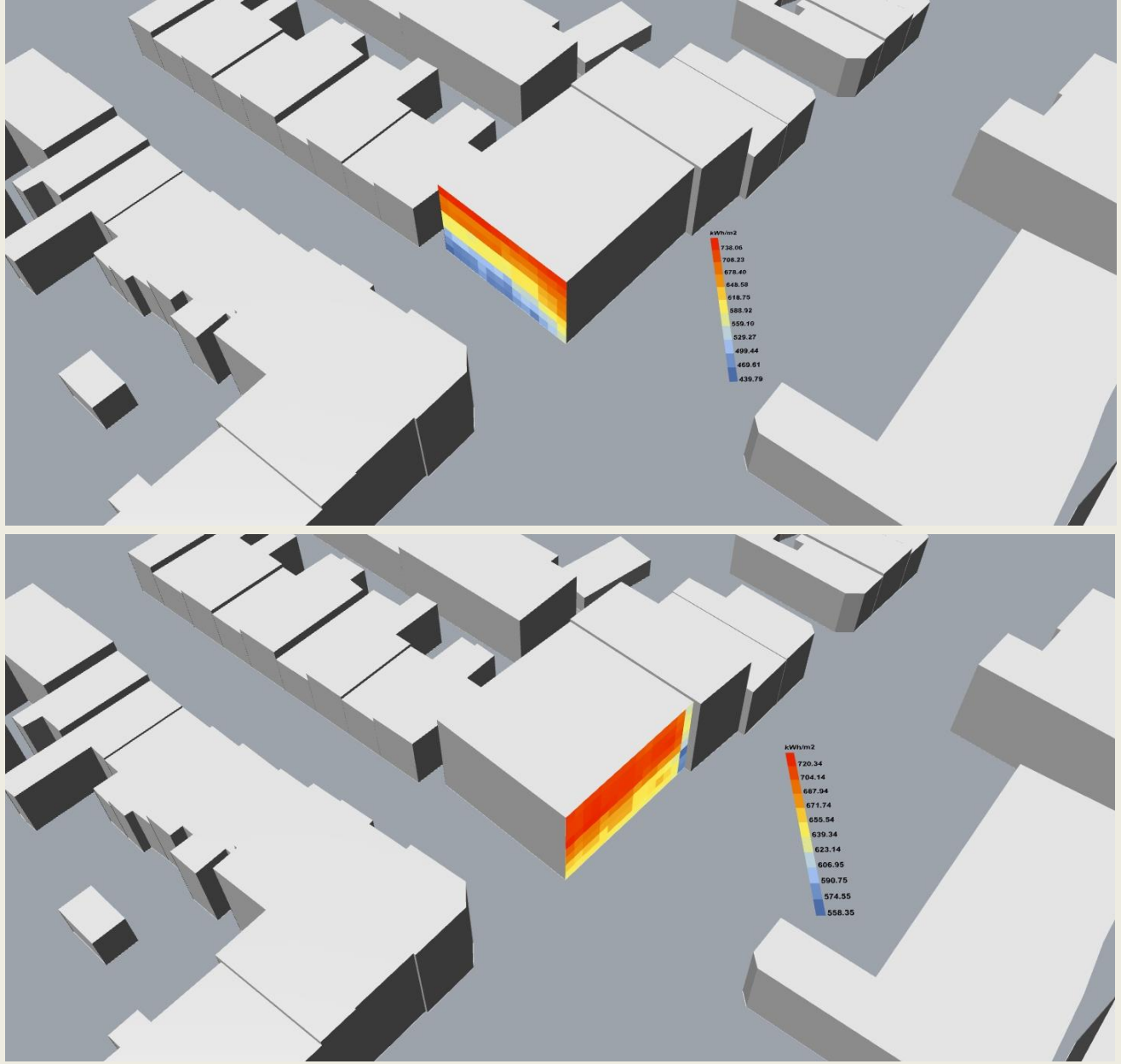
Analysis of solar radiation on a South-West-facing façade of a building in the West Street area, Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and OS Data

Photo capturing the analysed South-West-facing façade of a building in the West Street area, Bedminster



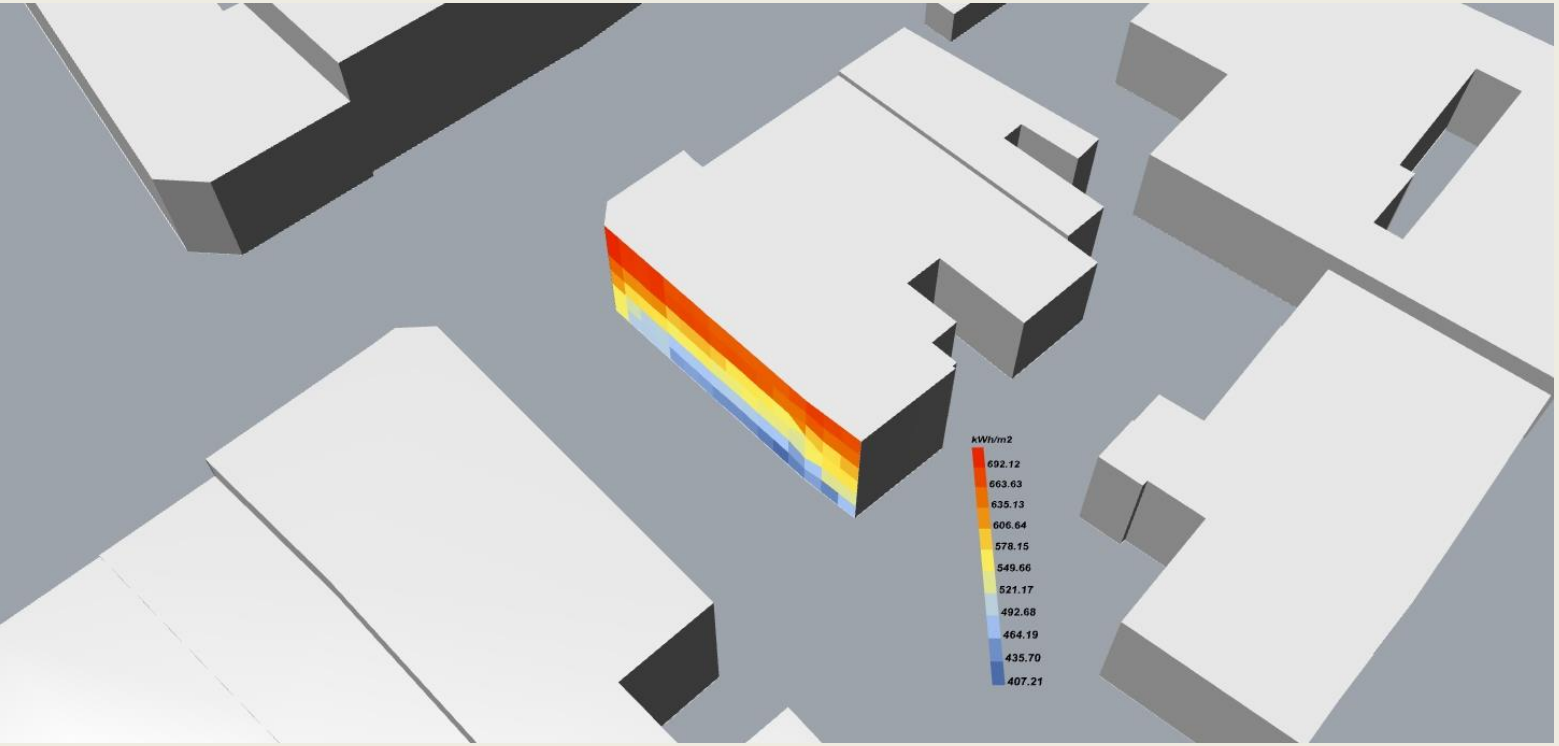
Analysis of solar radiation on a South-East-facing façade of a building in the West Street area, Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and OS Data

Photo capturing the analysed South-East-facing façade of a building in the West Street area, Bedminster



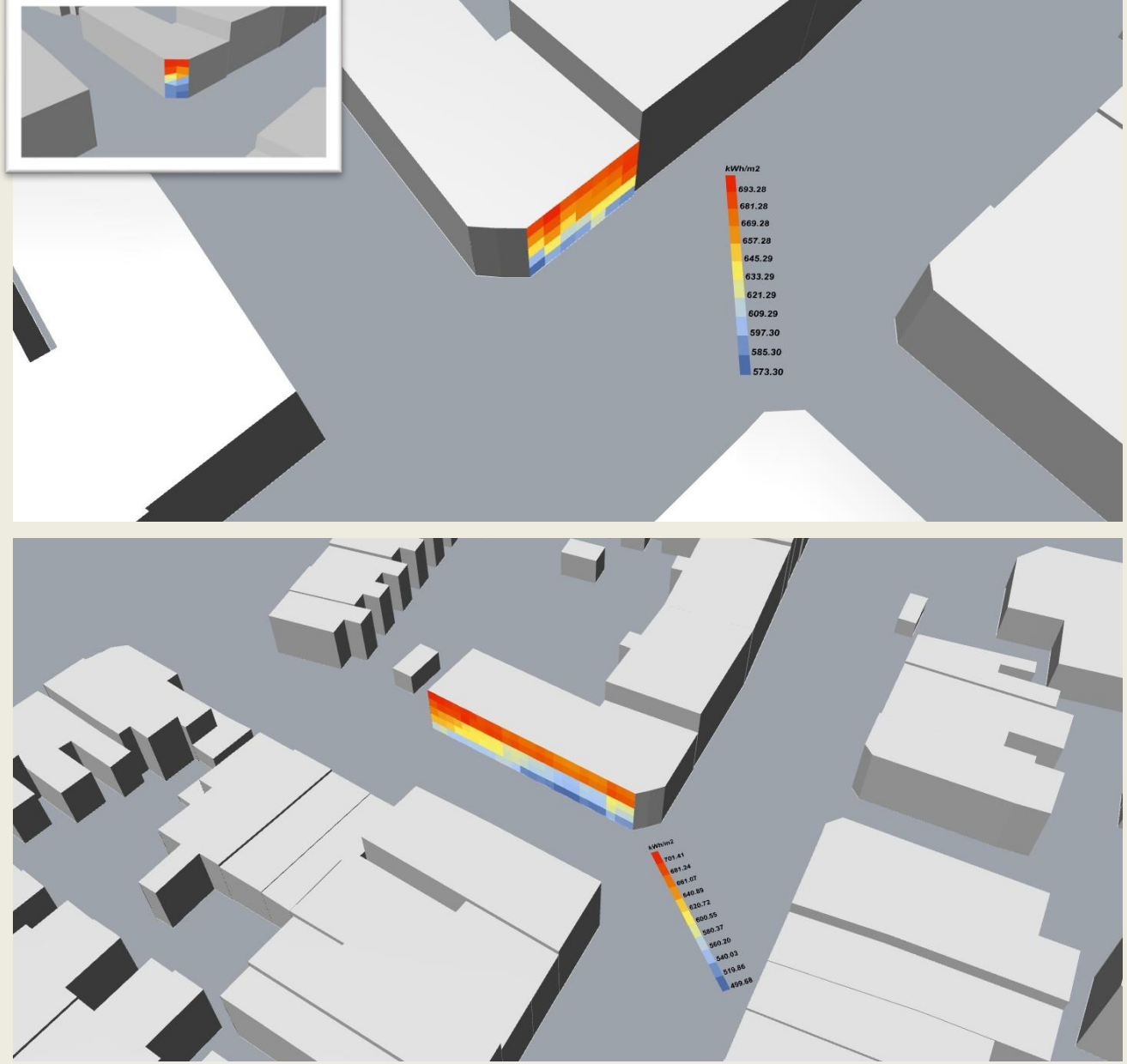
Analysis of solar radiation on South-West- and South-East-facing façades of a building in the West Street area, Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and OS Data

Photo capturing the analysed facades of a building in the West Street area, Bedminster



Analysis of solar radiation on a South-West-facing façade of a building in the West Street area, Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and OS Data

Photo capturing the analysed South-West-facing façade of a building in the West Street area, Bedminster



Analysis of solar radiation on South-, South-East- and South-West-facing façades of a building in the West Street area, Bedminster, using Ladybug software by Mostapha Sadeghipour Roudsari and OS Data

Photo capturing the analysed facades of a building in the West Street area, Bedminster

Selected Facades





Photos capturing the selected building facades in the West Street area, Bedminster

Your Perspective

Bristol is characterised by a strong presence of street art.

If photovoltaics were installed on building fronts in Bristol, how would you like to see them integrated into the facades of existing buildings?

You are invited to consider particularly facades in the Bedminster area.

In other words, what impact do you think BIPVs could have on the appearance of local buildings and the urban area?

E.g., you may prefer...

- Not to have PV facades at all
- Solar facades juxtaposing PVs and street art
- Solar facades with a traditional appearance, integrating PVs invisibly
- Solar facades integrating PVs invisibly and displaying particular types of visual content (e.g., nature-inspired images, geometric patterns,…)
- ...

Questions?

Dr Eleonora Nicoletti

Email: Eleonora.Nicoletti@uwe.ac.uk