



(Biophilic Interior Design, 2019)

RSA Case Study Report

How can the concept of biophilic smart windows help ‘future-proof’ homes and create a sustainable, age-friendly environment?

RSA Brief 6 – Home Sweet Home

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Word Count: 2017

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Introduction:

In the following investigation, I will be exploring how windows in the home can be adapted to convert new and existing buildings to be significantly more 'future-proof' and sustainable through the use of biophilic design and smart window technology. The '14 patterns of biophilic design' helps outline how and why we connect with nature through the use of different theories and design approaches (Browning, Ryan and Clancy, 2014). These patterns of design combined with current smart technology have the potential to create a more sustainable and inclusive space in new and existing homes.

The RSA (Royal Society of Arts) brief, 'Home Sweet Home', discusses how we need to "harness age-friendly design to future-proof homes" (RSA SDA Competition Pack 2020-21, 2020). We can define 'age friendly design' as "supporting the attitude towards an inclusive society which meets the needs of all age or ability" (Sedgewick, 2020). This indicates that my design concept needs to be all-encompassing to allow both the younger and the elderly to understand and utilize this concept to its full capabilities. Creating an age-friendly design concept also contributes to improving upon the sustainability aspects through meeting the needs of today's generation without compromising the needs and resources of the future generation (Sustainability, 2020).

Aims:

- Investigate the feasibility of electrochromic windows in residential homes for different age ranges
- Discover how biophilic design can help increase sustainability and support age-friendly design
- Explore new technology or features that can be implemented into the windows for a greater sense of connection with nature

Objectives:

- Analyse data collected from the general public on their understanding of electrochromic windows and whether this technology would be useful in their home.
- Discuss how we can implement biophilic windows into new and existing homes without compromising the ease of use.
- Obtain information on new technologies through existing research and how this can be applied to windows.

Methodology:

As a main source of primary research, I propose to create an online survey focusing on educating people on electrochromic glass and creating a series of questions, both opened and closed, that are designed to gain insight into an individual's perspective of smart windows in their home. Through this survey I can attain information on how often they use their windows on a daily or weekly basis, what features would appeal to them and if an automated or manual control of the window is preferred. I can also delve further into the sustainability, mental health and productivity aspects through creating questions which targets the individuals understanding of how they connect with nature and if biophilia would improve upon these aspects. Some questions may ask of people's current mental wellbeing in order to understand the effects of biophilic design; therefore, it is crucial to consider the sensitivity of the questions and offer an option to not disclose this information.

In addition, secondary research will be conducted as a means of understanding and analysing the individual components required to make electrochromic glass function. This research will provide the necessary information needed to assess the feasibility of this technology in conjunction with other up-to-date technological advancements. Further research can identify the key aspects which will ensure the design concept is age friendly, sustainable and incorporates several practices of biophilic design.

Findings:

The set of survey questions below was created to identify which rooms people would prefer smart windows and how this functionality would impact on their personal mental well-being and productivity. Additionally, I was able to attain information on how they prefer to be woken up and whether a wallpaper technology would support this. From figure 1, you can clearly see a diverse range of responses from all age brackets further supporting my conclusion to be representative of all age-ranges. Figure 2 and 3 show that the bedroom and living room are the most feasible places to use smart windows for various reasons since these rooms either have “the most sunlight” or some people value “more privacy” in the bedroom. Figure 4 and 5 was intended to attain information on the aesthetic and control on the smart windows, which as the figures show, at least 63.6% of respondents would prefer smaller window frames alongside an app/switch controlled smart window. Figure 6 and 7 justifies the feasibility of smart windows in the home since 86.7% of responses believe in reducing their energy costs and would actively look for this technology to be implemented into new homes. Further into this survey, I intended to understand how nature and biophilic design can impact on people in order to achieve my second aim. The results show that there is a significant proportion of people who believe incorporating nature into the home can increase their productivity and mental well-being. However, 33.3% of participants responded with maybe, which may mean they could still potentially find biophilic design beneficial but are unaware of the impact it could perhaps have on themselves. A critical question in this survey was how people prefer to be woken up, to which 50% of people prefer to let natural light filter into the room (as shown in figure 10); thus, supporting the feasibility and sustainability of smart windows incorporated with one of the patterns of biophilic design, ‘diffusion of light’ (Browning, Ryan and Clancy, 2014). Lastly, in figure 11, it’s clear that a significant proportion of people are unsure whether a wallpaper feature implemented into the glass panes would appeal to them. In contrast to this, 46.7% of people are certain this feature would appeal to them which as figure 2 shows would be either in the bedroom or living room.

Figure 1.

What age group are you in?

30 responses

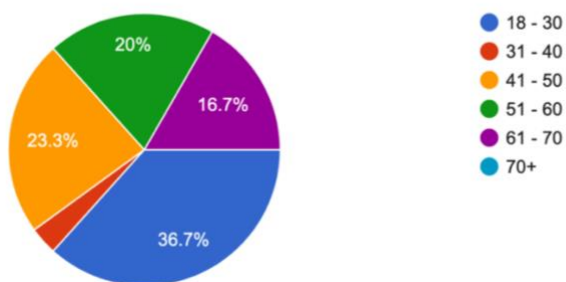


Figure 2.

Which room would you find smart windows most useful?

30 responses

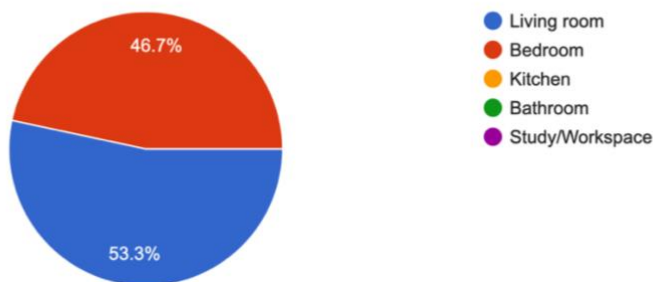


Figure 3.

Which room would you find smart windows most useful?	Why did you choose this room?
Living room	different control of light for various situations
Living room	The most communal room of the house
Bedroom	Quicker to go to bed
Bedroom	Because its more important to get the right amount of heat/light when trying to sleep.
Bedroom	This is the room I must value my privacy
Bedroom	Most private room
Living room	As it is the most common room used when people come around to your house and say if you decide to use the TV, it may allow less light to enter the room compared to blinds, curtain etc, which leave a reflection or allow light to come through on the screen.
Living room	
Bedroom	I have a street facing bedroom, with my tv facing this window, sometimes I get paranoid people are watching into my room from the street
Bedroom	I spend most of my time in my bedroom, and am quite picky with the amount of light and heat entering my room when working/relaxing etc.
Living room	This room gets the most sun light
Living room	Room most time is spent in
Living room	It's the largest with more windows
Bedroom	To have black out atmosphere during the night
Bedroom	To control light levels
Bedroom	
Living room	Overlooks garden
Living room	This room gets the most sun light
Living room	It's the room with the largest window
Living room	Lots of light issues due to the glare from the sun pm.
Bedroom	The concept will allow you to switch between transparency, tinted and blackout easily
Bedroom	The concept will allow you to switch between transparency, tinted and blackout easily
Bedroom	The concept will allow you to switch between transparency, tinted and blackout easily
Living room	Spend most time in it
Living room	Spend most time in the living room
Living room	Spend most time in thete
Living room	It has the largest windows and doors
Living room	Room most time is spent in

Figure 4.

Would you prefer the window frames to be smaller in order to let more light in?

30 responses

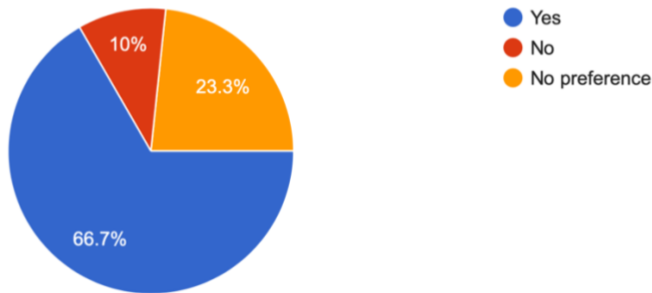


Figure 5.

What form of control would you prefer to use for these smart windows?

30 responses

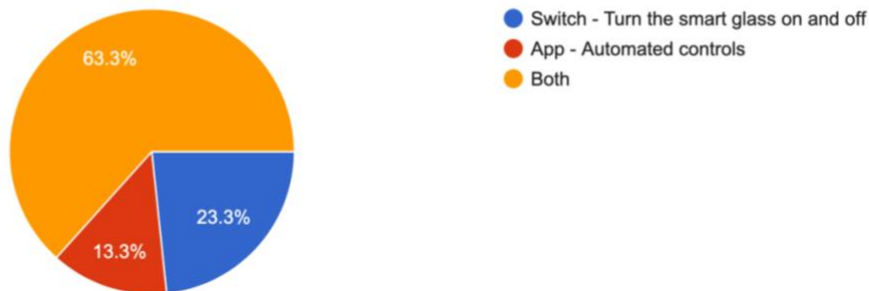


Figure 6.

Smart windows can save up to 20% on your energy usage, would this affect your choice of windows?

30 responses

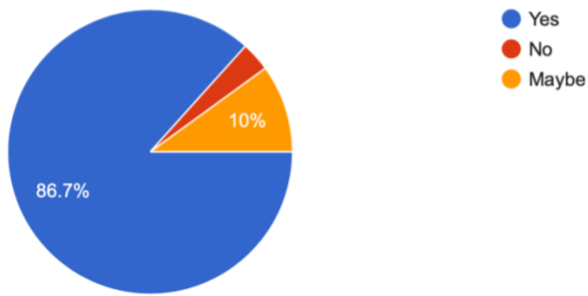


Figure 7.

When purchasing a property, would a house that is fitted with smart windows be more appealing to you?

30 responses

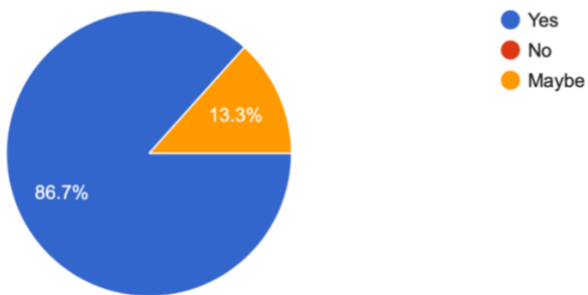


Figure 8.

Do you feel that having nature included in the structure/design of the home will improve your mental well-being?

30 responses

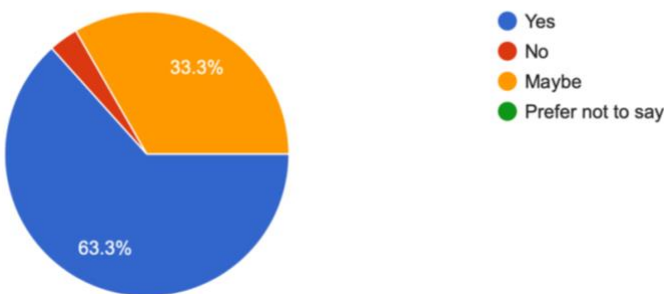


Figure 9.

Do you feel that having nature included in the structure/design of the home will improve your productivity?

30 responses

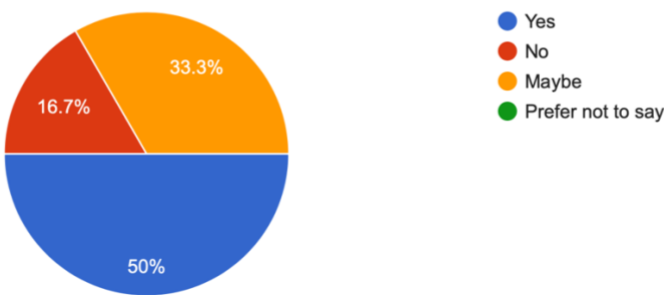


Figure 10.

How do you prefer to be woken up?

30 responses

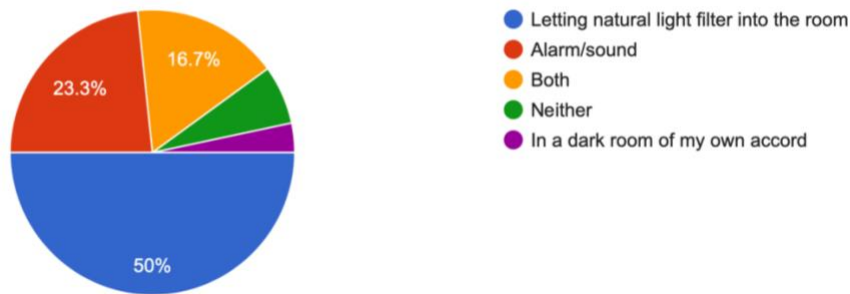
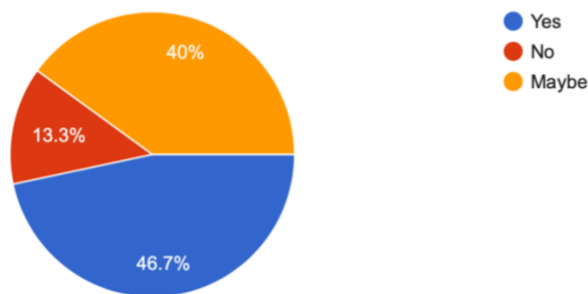


Figure 11.

Would a wallpaper feature built into the smart windows, particularly in rooms with no TV's, appeal to you?

30 responses



In order to understand how smart glass technology and its components work in conjunction with one another, I carried out secondary research through the use of articles, videos and books. Currently, it's estimated that 10-25% of energy is lost through the windows of residential buildings (Cannavale, Ayr, Fiorito and Martellotta, 2020), which consequently suggests that glazing and window technologies need to be mainstreamed in order to help combat climate change and increase environmental sustainability. The term 'smart glass' can be derived by 3 of the main technologies; electrochromic, polymer stabilized liquid crystal (PSLC) and Suspended Particle Device (SPD) (Elhamid, 2015). In this report I will refer to the electrochromic aspect of this technology.

Electrochromic windows are manufactured with different materials and products in-between the two panes of glass. These materials are as follows and in order of production (Bonsor, n.d.);

- Glass panel
- Conducting oxide
- Electrochromic layer (such as tungsten)
- Ion conductor
- Ion storage
- Conducting oxide
- Glass panel

When a voltage of 3-5 watts (Ways and Ways, n.d.) is applied to the conducting oxides, this "drives the ions from the ion storage layer, through the ion conducting layer and into the electrochromic layer" (Bonsor, n.d.). The ions and consistent electrical charge are crucial in maintaining the opaque or black-out state; however, the electrical charge alone is not strong enough to attract the ions to the electrochromic layer. Therefore, the ion conductor, storage and the conducting oxides (plus an electrical stimulus) is fundamental to the function of electrochromic windows. Studies conducted in the European climates show evidence of savings up to 34% in temperature control and 29% in electrical energy costs causing a beneficial impact on the user's mental well-being and productivity status (Electrochromic Glass for Energy Efficient Buildings | WFM Media, n.d.).

A relatively new technology commonly known as OLED (Organic Light Emitting Diode) is responsible for the innovation of transparent TV's since each pixel can provide its own source of

light resulting in a transparent electrical panel (*Transparent OLED Screen / Transparent Display / Pro Display, n.d.*). This form of technology combined with the approach of biophilic design and electrochromic windows can revolutionise the smart window industry.

Discussion/Analysis:

From the survey conducted, we can clearly infer that there is a significant need for smart windows to be implemented into future as well as existing homes. This is reinforced in figure 7 with over 85% of the respondents would find smart windows (which can be made from sustainably harvested timber with aluminium cladding) more appealing than standard uPVC windows. It is also clear that the implementation of nature, whether it's through forms of biophilic design or incorporating real plants in the home, has a fundamental impact on both their well-being and productivity. These two sets of data suggest that biophilic smart windows could further support an individual's well-being whilst adhering to the need of technological advancements in glazing or windows as a means of reducing energy costs (as shown in figure 6 to be a substantial aspect of the home to improve) and future-proof homes.

As figure 10 shows, 50% of people prefer to wake up to the natural diffusion of light into a room which could also allude to the significant impact biophilia or nature has on an individual's increased productivity as shown in figure 9 with 50% agreeing to this. I believe the wallpaper feature, which 46.7% support in figure 11, can perhaps be incorporated into smart windows through the use of OLED technology and aid diffuse sunlight into the home. Thus, improving upon the user's productivity and well-being since it adds several 'patterns' of biophilic design to the home (*Browning, Ryan and Clancy, 2014*). An article states, "artificial representations of nature aren't as good as the real thing, but they are beneficial" (*Kellert, Heerwagon and Mador, 2011*). This aids the concept of a wallpaper feature having measurable impacts on a user's mental ability and attention levels. Suggesting that biophilic smart windows is a key steppingstone to future proofing homes.

However, electrochromic windows incorporated with OLED technology to increase biophilia in the home has the potential to increase the cost per square metre considerably. Currently, there is electrochromic films which provide a much cheaper alternative and can transform existing uPVC windows to have this technology but doesn't provide the full experience and functionality of fully integrated electrochromic windows (*Woodford, 2020*). This could suggest that in order to increase the economic sustainability of producing biophilic smart windows, interest and research in this technology needs to become more mainstreamed in order to innovate new ways of producing this technology at a lower cost. Appendix 1 further shows that interest over time fluctuates considerably, although, it is predicted to increase entering into 2021. This may suggest an opportunity to demonstrate the concept of biophilic smart windows to maintain this interest going forth. 86.7% of my respondents would find smart windows appealing and at least 50% of people believe nature or biophilic design can positively impact on their mental well-being and productivity. This means that socially and environmentally, this concept is sustainable, but interest and awareness of this technology can improve the economical sustainability of producing and marketing this concept and aid future-proofing homes.

Conclusion:

In conclusion, the concept of biophilic smart windows can significantly improve the social and environmental sustainability in the home through improving an individual's well-being and productivity levels. To achieve this, the biophilic windows would efficiently diffuse light, and provide

a visual connection to nature by implementing OLED technology into the interior glass panel of electrochromic windows. The combination of these two technologies helps future-proof homes to keep up with the technological advancements present in new and existing homes such as Amazon Alexa, Google Home, Philips Hue bulbs and more.

To help increase the levels of sunlight in the desired rooms, the width of the frames can be reduced which as figure 4 shows, 66% of people would support this design consideration. The window frames could be made from sustainable composites such as aluminium clad frames with sustainably sourced engineered timber, thus providing greater thermal and environmental sustainability and retaining a strong, durable frame similar to traditional uPVC windows.

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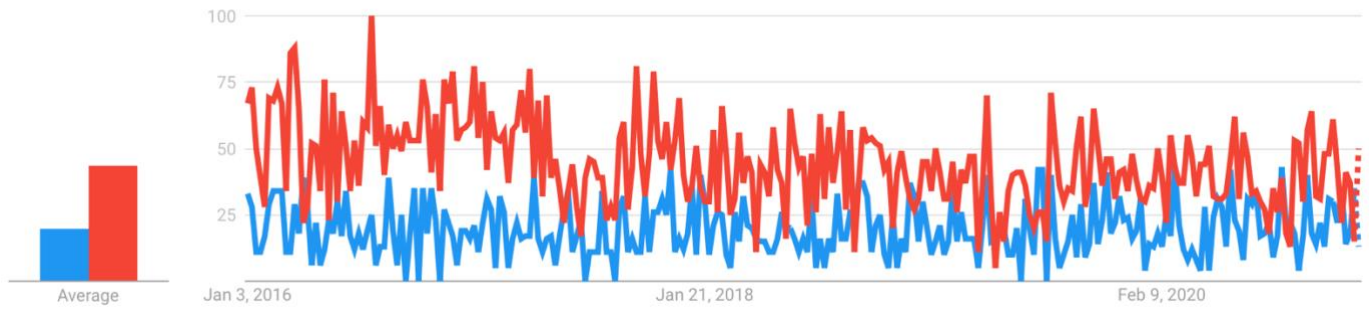
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Appendices:

Appendix 1: Interest over time for the terms 'smart glass' (BLUE) and 'smart windows' (RED)



Appendix 2: Survey Questions

Biophilic smart windows

This survey will be a source of research for my case study report. I'm currently researching how smart glass windows and the concept of Biophilic design (meaning nature in the design) can be a key stepping stone in future proofing and improving sustainability in our homes.

Smart glass allows the user to turn their windows on and off by switching between transparent, tinted and complete black-out glass at a flick of a switch. This obviously limits the amount of light and heat that can enter your home and the benefit means no blinds are needed.

I hope to combine this technology with the theory of Biophilic design (adding a sense of nature into design) to make the product more environmentally sustainable and evaluate its impacts on the home and the user compared to traditional uPVC windows.

What age group are you in?

- 18 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70

Which room would you find smart windows most useful? *

1. Living room
2. Bedroom
3. Kitchen
4. Bathroom
5. Study/Workspace

Why did you choose this room?

Long answer text

Would you prefer the window frames to be smaller in order to let more light in? *

- Yes
- No
- No preference

What form of control would you prefer to use for these smart windows? *

- Switch - Turn the smart glass on and off
- App - Automated controls
- Both
- Other...

Smart windows can save up to 20% on your energy usage, would this affect your choice of windows? *

- Yes
- No
- Maybe

When purchasing a property, would a house that is fitted with smart windows be more appealing to you? *

- Yes
- No
- Maybe

Do you feel that having nature included in the structure/design of the home will improve your mental well-being? *

- Yes
- No
- Maybe
- Prefer not to say

Do you feel that having nature included in the structure/design of the home will improve your productivity? *

- Yes
- No
- Maybe
- Prefer not to say

How do you prefer to be woken up? *

- Letting natural light filter into the room
- Alarm/sound
- Both
- Neither
- Other...

Wallpaper features

Modern TVs show a scenic image when idle or set to show. This allows the user to have a static or slow moving image of nature to improve the atmosphere and feel of the room.

Would a wallpaper feature built into the smart windows, particularly in rooms with no TVs, appeal to you? *

- Yes
- No
- Maybe



Appendix 3: snapshot of public post made on LinkedIn with survey attached



Lewis Ainsworth

Looking to apply my Computer-Aided Design skills and passion for archite...

1m · Edited ·



I'm conducting research for my university project on smart windows & Biophilic Design and how they can be a stepping stone in 'future-proofing' homes. If you could take the time to fill in the survey attached, that would be greatly appreciated

<https://lnkd.in/dhy8cC9>

[#university](#) [#project](#) [#biophilicdesign](#) [#smartbuildings](#)

Biophilic smart windows

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* Required

What age group are you in?

18 - 30

31 - 40

Biophilic smart windows

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