

# Can energy efficient windowless buildings be livable?

DOE SSL R&D Workshop 2022

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# Outline

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- Virtual (artificial) Windows
- Windowless Buildings?
- Advances in display technology
- Summary

# “Artificial” Windows



<https://www.neonny.com/moving-sky-led-mega-panel>



<https://www.skyfactory.com/products/SkyView/>

# Artificial Daylight

## COMING SOON - IRIS

A circadian illusion of nature featuring location-specific, sunrise-to-sunset biomimicry.



Morning

[www.skyfactory.com](http://www.skyfactory.com)

Evening



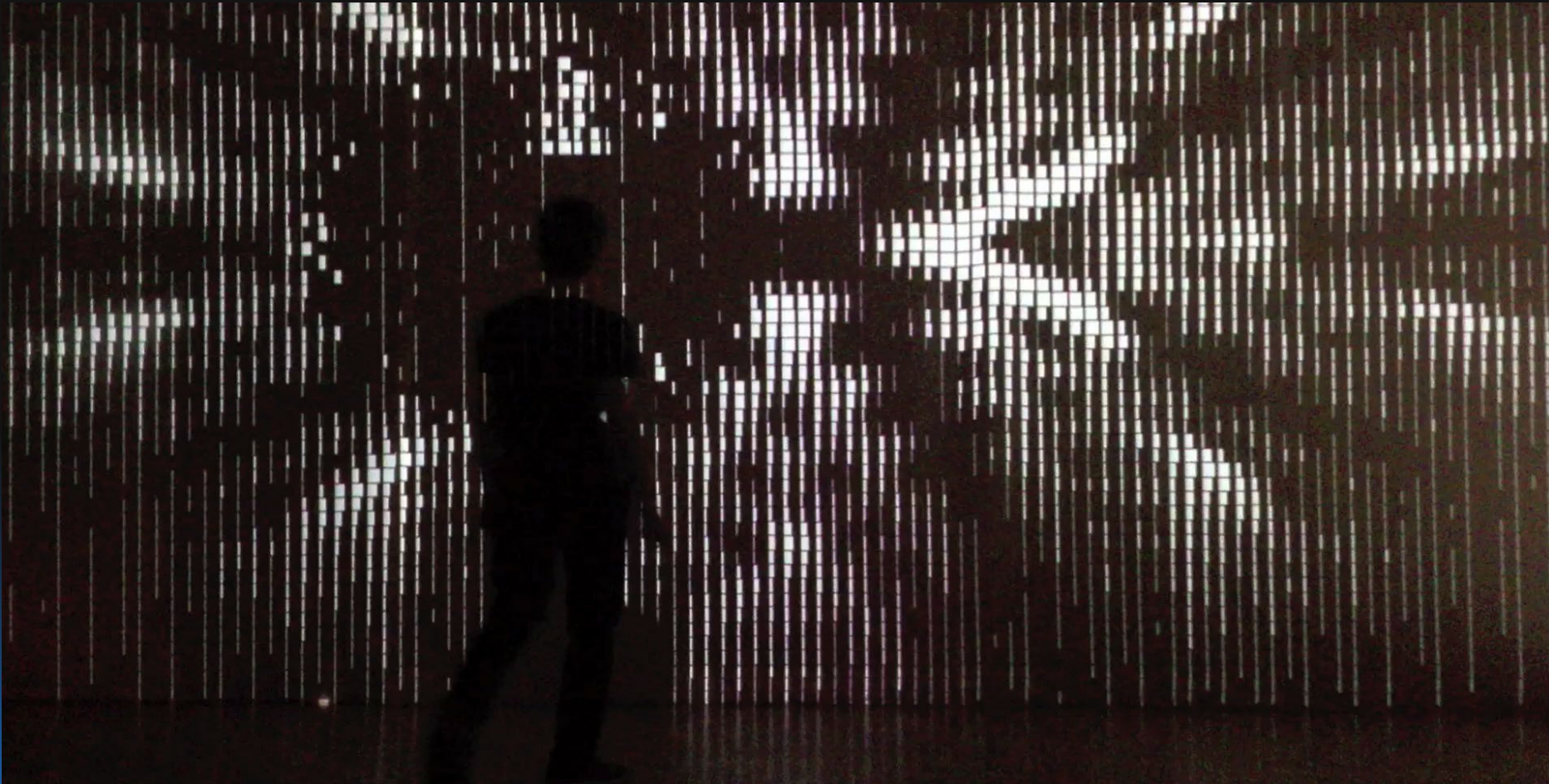
# LESA Virtual Window Project



- Installed in 19 ICUs, with St. Peter's Hospital Albany NY
- Patients liked virtual windows better than existing windows in ICUs that had them
- Limited research on patient performance with virtual window

# Interactive “Windows”

CASE Center for Architecture  
Science and Ecology



# Future Office?



# Windowless buildings are not a new idea...

🔒 Requires Authentication Published by Penn State University Press 2021

## **Chapter 6. Frank Lloyd Wright's "Windowless" Buildings for SC Johnson Company and the Air-Conditioned Tower**

From the book *Air-Conditioning in Modern American Architecture, 1890–1970*

*Joseph M. Siry*

<https://doi.org/10.1515/9780271089256-011>

“... by the 1930s the development of air-conditioning systems in the United States had given rise to the idea of a “windowless office building...”



...but it is conventionally regarded as a bad idea

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# NIGHTMARE OF THE WINDOWLESS DORM ROOM

*Charlie Munger, a Warren Buffett crony, donated two hundred million dollars to a university for a gigantic new dorm. The catch: no windows. How did guinea pigs in a similar Munger housing experiment fare?*

THE  
NEW YORKER

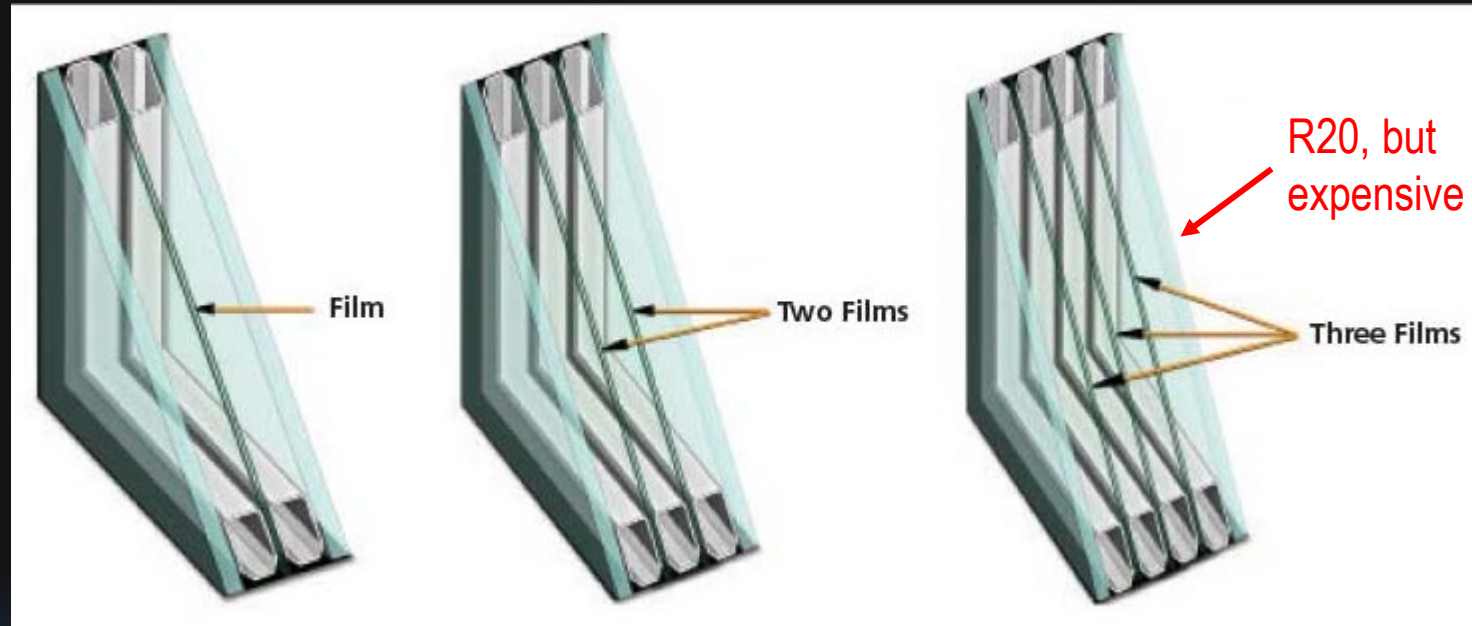


By Charles Bethea

November 13, 2021

Is it time to challenge the notion that windows in buildings are essential to human health and wellbeing?

# Advanced Window Technologies



<https://www.constructioncanada.net/windows-versus-walls-debunking-the-energy-myth/>

- “Superwindows” could save \$10B in energy costs annually

<https://newscenter.lbl.gov/2018/06/06/super-window-could-save-billions-in-energy-cost>

Lawrence Berkley National Laboratory estimated 34% of commercial building energy use in the US is window-related (LBNL--60146, 928762, (2006) doi: 10.2172/928762)

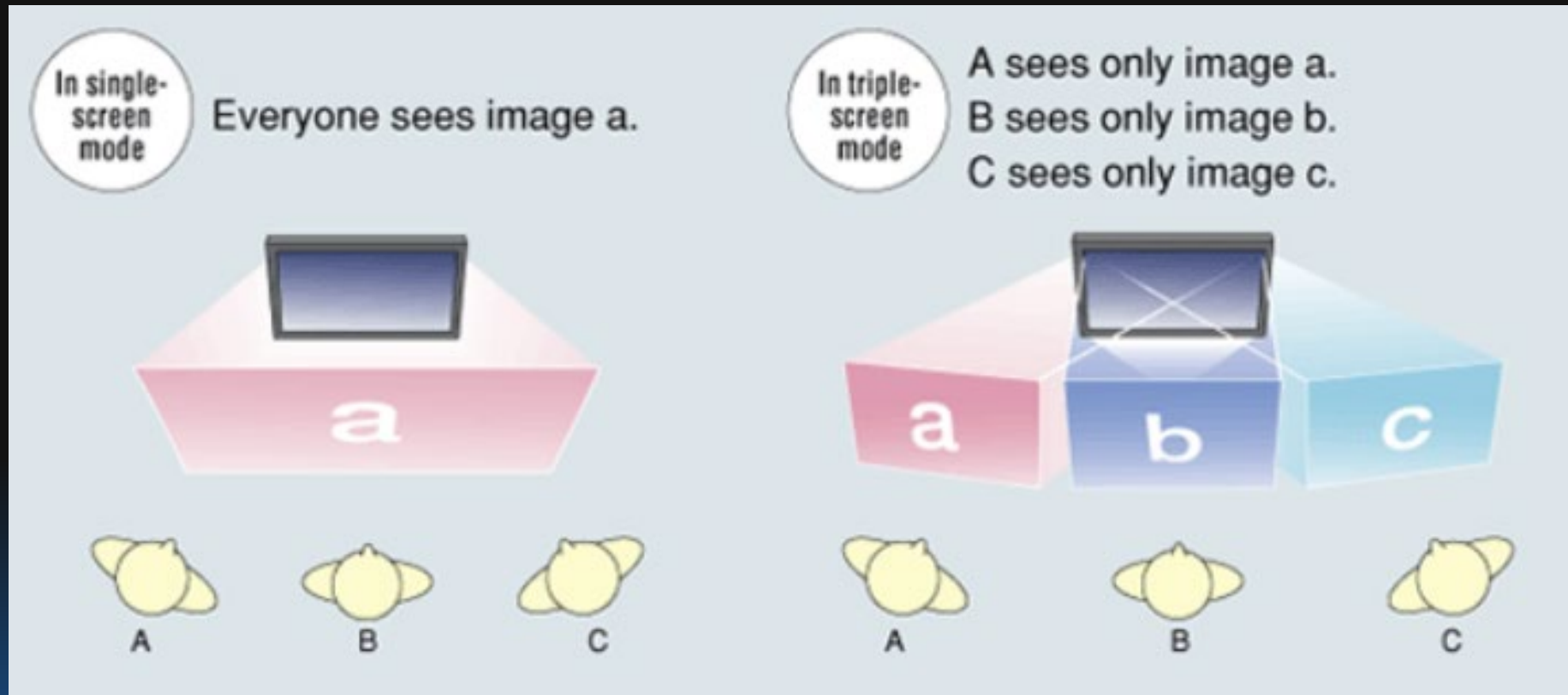
# Enter HDR Displays

- A normal TV puts out around 100-300 nits of brightness, (nit comes from the Latin for 'to shine')
- An HDR TV can, in theory, deliver up to 5000 nits
- The current Dolby standard for HDR supports up to 10000 nits
- Daylight on a clear, sunny day is 10,000 to 12,000 nits



Could an 8K  $\mu$ LED HDR TV be convincing enough to pass as a window or skylight?

# Better virtual windows coming?



<https://global.sharp/products/device/about/lcd/dual/index.html>

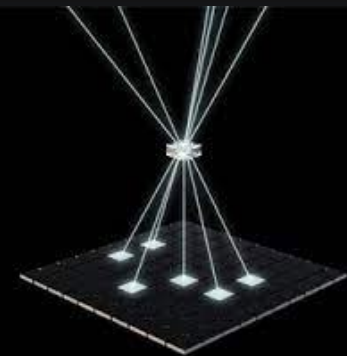
# Responsive virtual windows?



## ECHO'S DIRECTIONAL PIXEL TECHNOLOGY

The patent pending ECHO technology is a light field display that works by selectively directing the light from its pixels directly to the eyes of the viewers. By utilizing eye-tracking techniques, ECHO's directional pixel technology will even be able to emit differentiated light to multiple viewers at the same time, essentially making it possible for each viewer to see their own unique content.

Additionally, the ECHO technology presents unique power reduction capabilities by only emitting the precise amount of light needed to target the eyes of the viewers.



# Immersive Virtual Environments?

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## Building and Environment

journal homepage: [www.elsevier.com/locate/buildenv](http://www.elsevier.com/locate/buildenv)



ELSEVIER

## Immersive virtual environments for occupant comfort and adaptive behavior research – A comprehensive review of tools and applications

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# Summary

- Windows are a significant source of building energy loss
- Windowless buildings could be about 30% more energy efficient
- Advanced display technology:
  - Low energy consumption?
  - High quality virtual windows?



# Acknowledgements

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## LESA Industry Members

## LESA Faculty and Students

Lighting Systems that  
**THINK™**

<http://lesa.rpi.edu>