

HEALTHIER FACADES:



INCREASING
VALUE AND
TAPPING INTO
THE LUCRATIVE
WELLBEING
MARKET

INCLUDES MEASURES
TO HELP REDUCE
CORONAVIRUS RISK



Public Domain Image: CDC/ Eckert, A. & Higgins, D. (2020), SARS-CoV-2, <https://ro.wikipedia.org/wiki/COVID-19#/media/Fisier:2019-nCoV-CDC-23312.png>, CC BY 3.0 Image: Bobac (2014), https://en.wikipedia.org/wiki/Sustainable_architecture#/media/File:Harvard_University_of_Design_Central_Design_Building.jpg, CC BY 3.0

BIOSUSTAINABLE DESIGNS

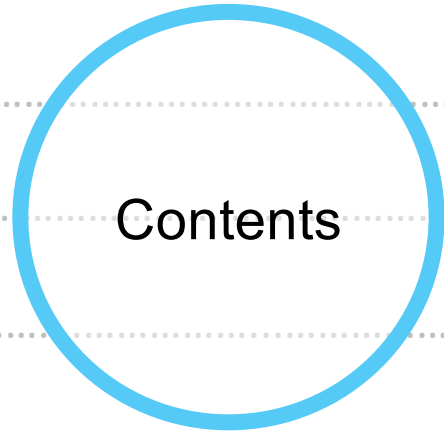
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HEALTHIER FACADES: INCREASING VALUE AND TAPPING INTO THE LUCRATIVE WELLBEING MARKET

Includes Measures to help Reduce Coronavirus Risk

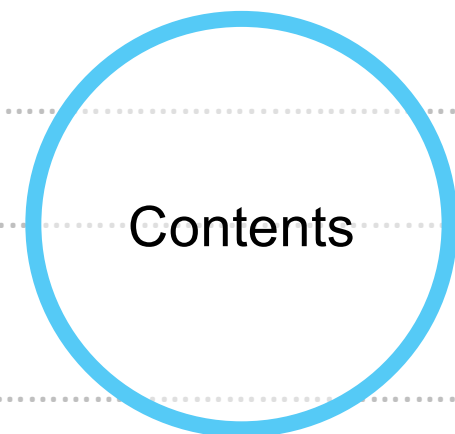
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HEALTHIER FACADES: INCREASING VALUE AND TAPPING INTO THE LUCRATIVE WELLBEING MARKET

Includes Measures to help Reduce Coronavirus Risk

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Healthier Facades: Increasing Value and Tapping into the Lucrative Wellbeing Market (Includes Measures to help Reduce Coronavirus Risk) can also be viewed as a video. The majority of the materials herein were presented by the author at ZAK World of Facades Virtual Festival of Facades on 10 September 2020.



Executive
summary

The \$4.5 trillion global wellness market is worth 3 times more than the world's pharmaceutical industry. As the design of the built environment can greatly affect wellbeing, tremendous opportunities exist for the building industry to become far more involved in this lucrative market.

[From critical literature review undertaken for this work, it is suggested that:](#)

- Biologically optimising exposures to light can help improve immune system functioning, fertility levels and cardiovascular health whilst potentially reducing cancer risks.
- Improved facade design may help significantly reduce the likelihood of infection from pathogens, including SARS-CoV-2, the virus responsible for COVID-19.
- Increasing occupants' contact with nature can create further substantial benefits. These include providing opportunities to aid food security, helping reduce buildings' energy requirements and improving general wellbeing.

Other benefits are also proposed. As we address the new normal, those creating healthier buildings will achieve significant competitive advantage.

Isaac Jamieson, PhD, DIC, RIBA, ARB, DipAAS, BSc (Hons) Arch, MInstP.

WHY HEALTHIER FACADES ARE NEEDED

People spend 90% of their time indoors

(WHO 2014, US EPA 2018).

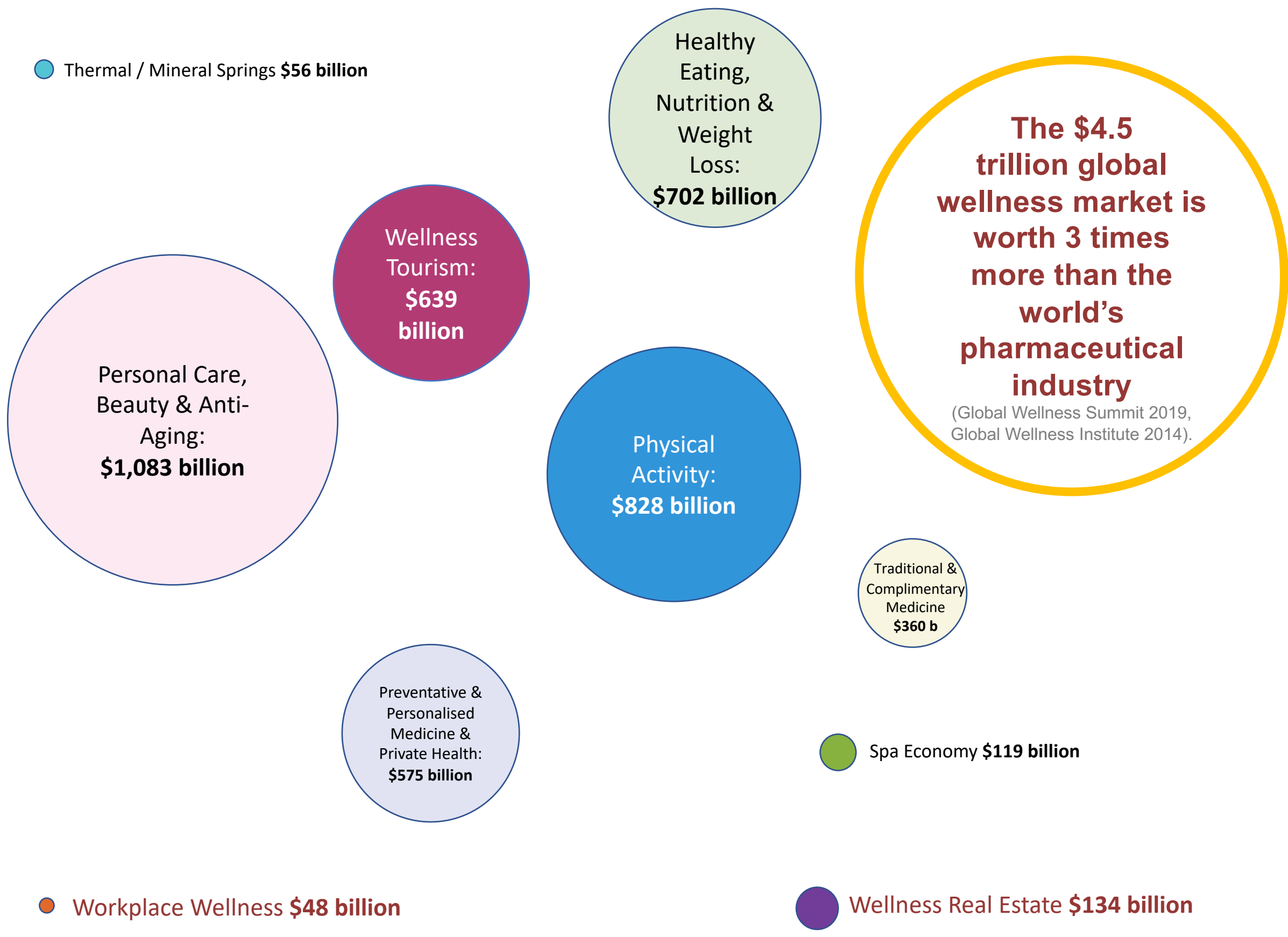
Many developers, designers, employers, health professionals and officials are unaware of the effects of facade design on health, wellbeing and productivity.

One Central Park, Sydney, New South Wales, Australia. Designed by Jean Nouvel.

- Facades that optimise exposure to Nature and natural phenomena can help reduce stress and increase wellbeing.
- Improved facade design can also help reduce likelihood of infection from pathogens.

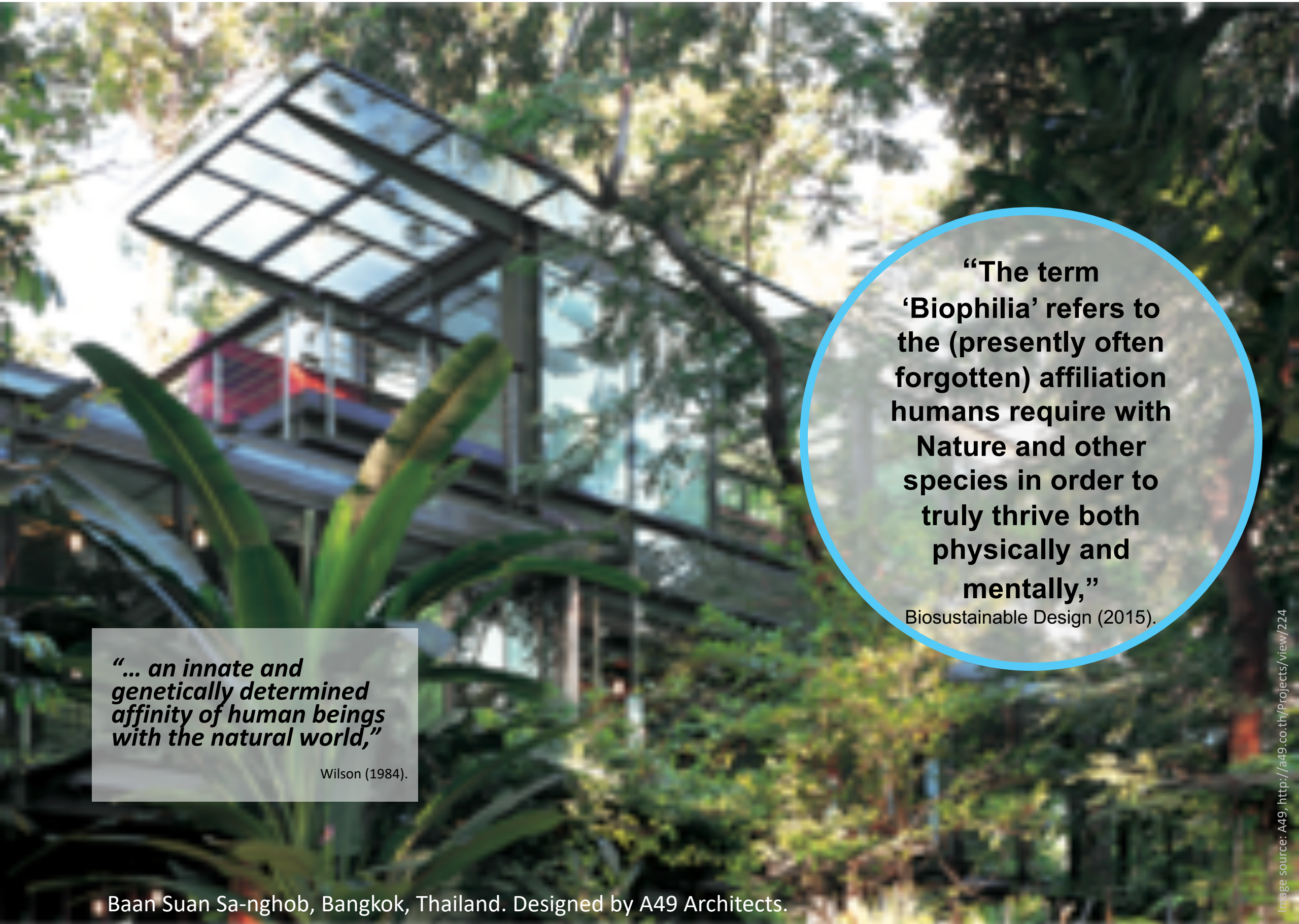
Creating healthier building facades can create numerous ‘Win/Win’ situations.

GLOBAL WELLBEING MARKET VALUE



The building industry presently makes up a tiny part of this market, with Wellness Real Estate being worth \$134 billion, and Workplace Wellness \$48 billion. These figures can be much improved.

BIOPHILIA



“The term ‘Biophilia’ refers to the (presently often forgotten) affiliation humans require with Nature and other species in order to truly thrive both physically and mentally,”

Biosustainable Design (2015).

“... an innate and genetically determined affinity of human beings with the natural world,”

Wilson (1984).

Baan Suan Sa-nghob, Bangkok, Thailand. Designed by A49 Architects.

“... the passionate love of life and of all that is alive”

Fromm (1973).

BIOPHILIC DESIGN AND BIOLOGICAL RESPONSES

Biophilic Design Pattern	Biological and Psychological Responses		
	Stress Relief	Cognitive Skills	Sensitivity, Atmosphere, and Preference
Visual Connection with Nature	Lowering blood pressure and decreasing heart rate	Increasing work engagement and concentration	Positive effect on spatial preference
Non-Visual Connection with Nature	Lowering systolic blood pressure and relieving stress	Positive effect on cognitive skills	Promoting mental health and psychological composure
Dynamic and Diffuse Light	Increasing comfort, happiness, and productivity	Positive effect on increased concentration	Improving spatial preference and perception
Connection with Natural Systems	Relieving stress	-	Changing the perception about environment and promoting health
Biomorphic Forms and Patterns	-	-	Increasing preference for view
Material Connection with Nature	-	Lowering diastolic pressure	Promoting relaxed feeling
Complexity and Order	Relieving psychological stress	-	Increasing preference for view
Prospect	Relieving stress	Reducing boredom and fatigue	Improving ability to perceive comfort and safety
Refuge	-	Improving concentration and ability to perceive safety	Improving ability to perceive stability and safety

Source: Park & Lee (2019).

With regard to facade design, biophilic design measures can include the provision of biophilic elements on the facades that individuals will look through, and also on the facades that they will look out upon.

IMPACT OF VIEWS WITHIN HOSPITALS

Views can reduce stress and medication needs while enhancing recovery.

Views of Nature:

- Shorter stays, fewer complaints, lower medication (Ulrich 1984).
- Reduced stress and less health-related complaints from hospital staff (Verderber 1986).

Views of Brick wall:

- More painkillers, anxiety & post-surgical complications (Ulrich 1993, 1984).

No Windows:

Postoperative delirium twice as high in ICUs without windows (Wilson 1972).

The economic benefit of letting patients view nature is \$93 million/year in US alone (Terrapin Bright Green 2012).

DESIGNING IN RESILIENCE: RETHINKING FACADE DESIGN

The inclusion of extensive vegetation can help:

- Improve air quality.
- Aid biodiversity.
- Lower temperatures, provide shade and reduce energy costs.
- Increase wellbeing.

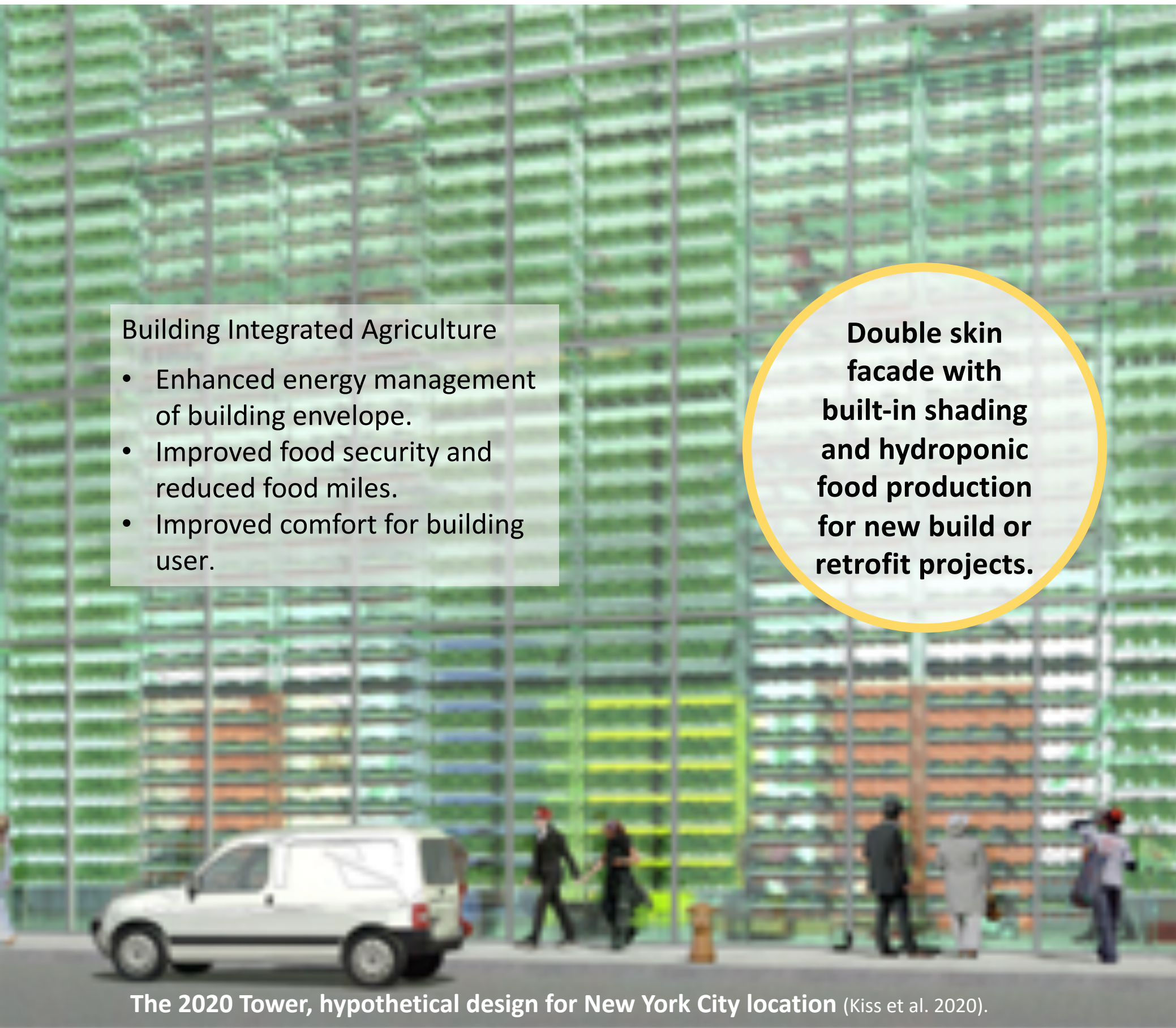
Food crops can also be grown on facades to aid urban food resilience.

EDITT Tower, Singapore. Proposed design by TR Hamzah & Yeang

Illustration courtesy of Ken Yeang.

Increasing our connection with nature can create numerous benefits.

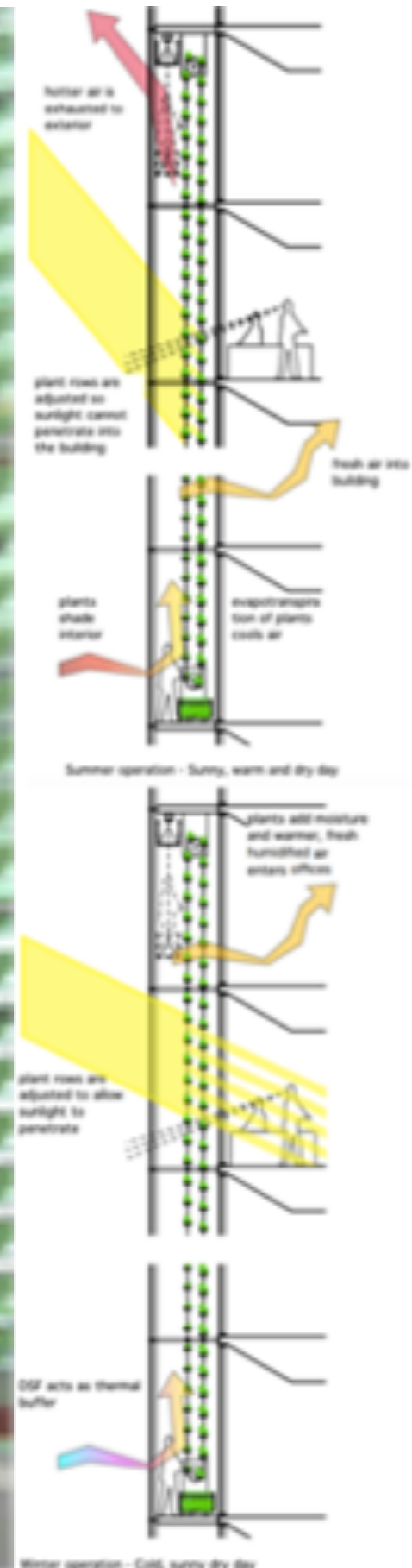
FACADE FARMS: VERTICAL INTEGRATED GREENHOUSES



Building Integrated Agriculture

- Enhanced energy management of building envelope.
- Improved food security and reduced food miles.
- Improved comfort for building user.

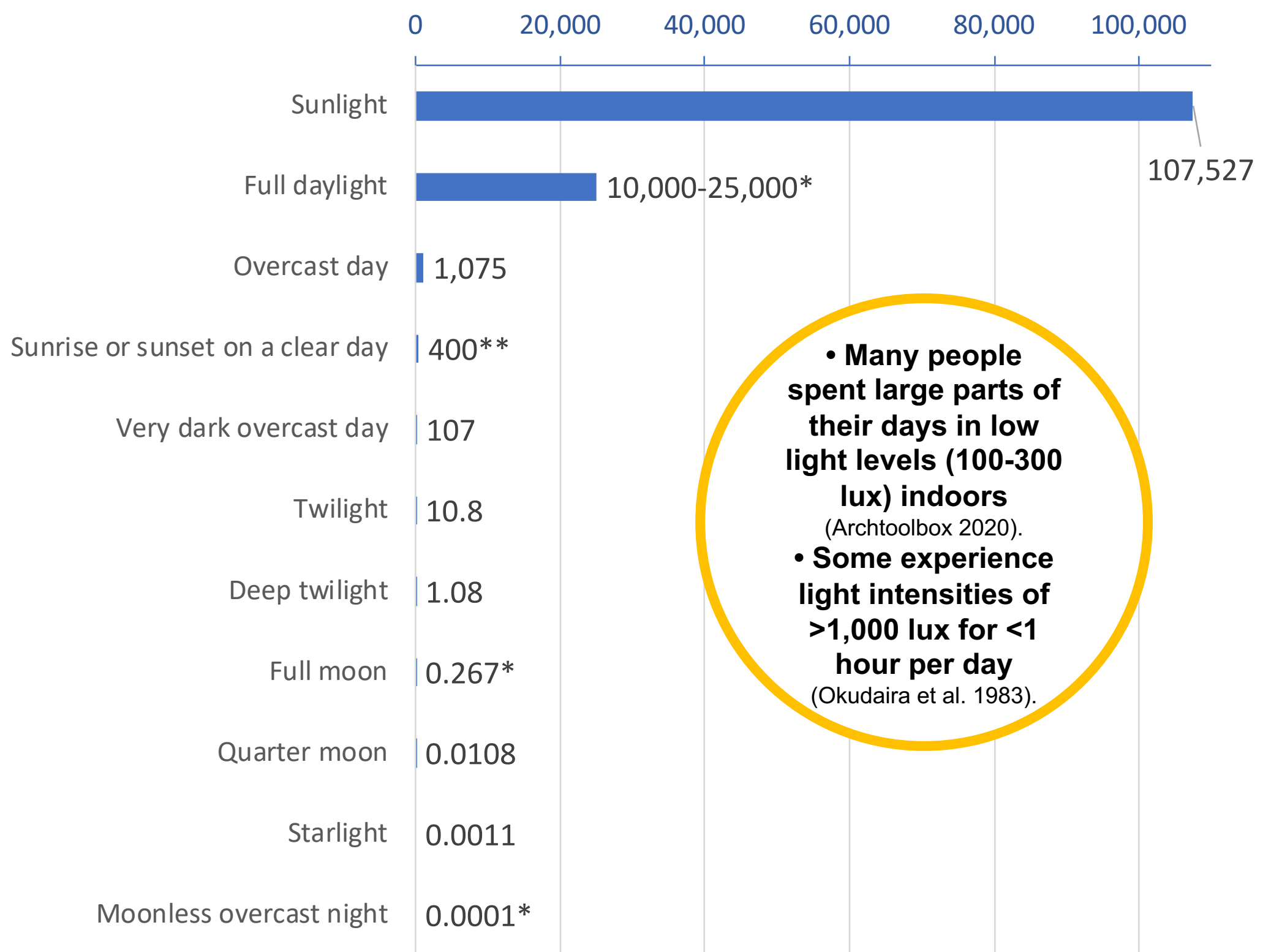
Double skin facade with built-in shading and hydroponic food production for new build or retrofit projects.



The 2020 Tower, hypothetical design for New York City location (Kiss et al. 2020).

“Waste heat exhausted from buildings can be used to heat greenhouses, and the carbon dioxide rich air actually helps those crops grow more quickly.” Kiss et al (2010).

NATURAL LIGHT LEVELS



Common outdoor light levels as found in nature

Sources: The Engineering ToolBox (2014), *Schlyter (1997-2009), **ILO (2014).

Many individuals would benefit from improved light exposures.

The exposures individuals' receive when indoors should be biologically optimised.

LIGHT AND CARDIOVASCULAR HEALTH



**The
Cardiovascular
disease market is
predicted to be
worth \$146.4
billion by 2022
(GBI Research
2016).**

CCO Image: PublicDomainPictures (2013). https://cdn.pixabay.com/photo/2013/02/21/19/10/mother-84628_960_720.jpg

“Cardiovascular diseases ... are the number 1 cause of death globally, ...”

- **They cause around 31% of all deaths** (WHO 2020).

Exposure to intense full-spectrum light can help provide protection against heart attacks. Typically, light levels indoors are far below those shown to decrease risk.

EARLY-MORNING LIGHT EXPOSURE, WEIGHT CONTROL AND COVID-19 RISK

Early morning exposure to natural [unfiltered] daylight >500 lux is correlated with lower body mass index (BMI), a measure of body fat (Reid et al. 2014).

Obese individuals	
Increased risk of being COVID-19 positive	>46.0% higher
Increased risk of hospitalisation	113%
Admission to intensive care unit	74%
Death from COVID-19	48%

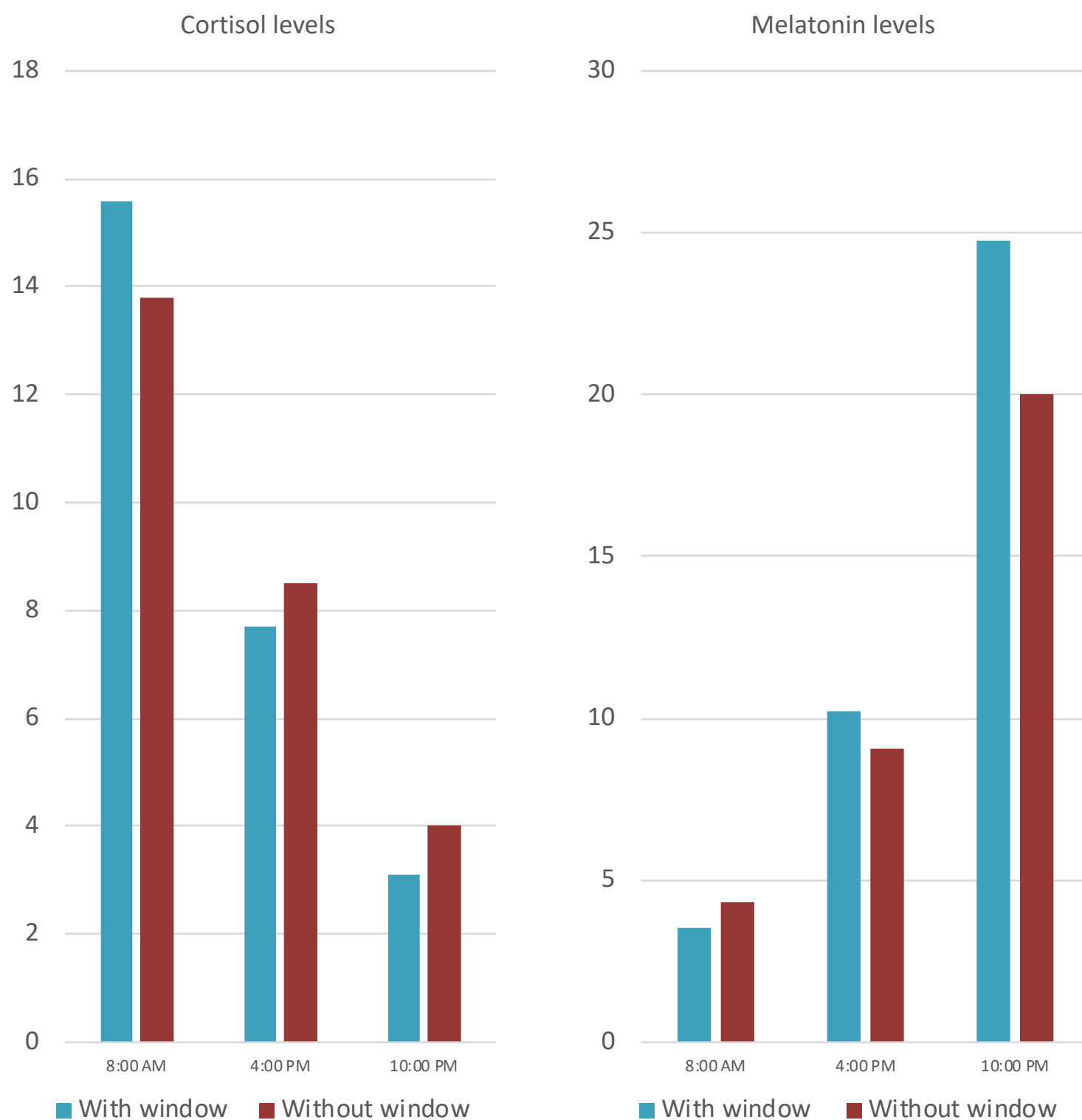
Source: Popkin et al. (2020).

The global weight loss and obesity management market was valued at US\$ 170.0 billion in 2019
(Coherent Market Insights 2020).

- Obesity increases risk of dying from COVID-19 by 48% (Popkin et al., 2020).
- Facades should be designed to help optimise light exposures.

LIGHT EXPOSURE, IMMUNE SYSTEM FUNCTIONING AND MOOD DISORDERS

Inadequate exposure to daylight is associated with raised levels of cortisol and reduced levels of melatonin at night, which are associated with poor sleep quality and depressive symptoms.



Additionally, improved nighttime melatonin levels “... has emerged as a top candidate for protection against an array of different viruses, including the coronavirus.”
Anderson & Reiter (2020).

Redrafted from: Harb et al. (2015).

Improved exposure to natural light during daytime can reduce likelihood of poor sleep and mood disorders. It can also help immune system functioning.

LACK OF NATURAL DAYLIGHT AND DEPRESSION

- Depression is the world's top cause of ill health and disability (Jezard 2018).
- Around 4.4% of the world's population suffers from depression (WHO 2017).
- Their numbers increased 18.4% between 2005 and 2015 (Vos et al. 2016).

The anxiety disorders and depression treatment market is expected to be worth USD 20.97 billion by 2025
(PharmiWeb.com 2020).

Inadequate exposure to natural light during daytime is associated with higher risk of depression (Brown & Jacobs, 2011).

DAYLIGHT AND PATIENT WELLBEING

- **Shorter recovery time:** Average length of stay 16%-41% shorter in SE rooms (receiving early morning Sun) than NW rooms (Choi et al. 2012).
- **Increased pain relief:** Patients receiving greater sunlight exposures required 22% less medications (Walch et al. 2005).
- **Reduced agitation:** Exposure of dementia patients to 2,500 lux in the morning reduced their agitation levels (Lovell et al. 1995).

“The increased levels of fatigue reported in the general population during the COVID-19 lockdown may in part be due to inadequate light exposure.”
Dr Isaac Jamieson

Khoo Teck Puat Hospital, Singapore. Designed by CPG Consultants in collaboration with RMJM.

Image: Dr Sirinath Jamieson

Additionally, reduced levels of fatigue have been reported in chemotherapy patients receiving increased light exposures (Liu et al. 2005).

DAYLIGHT AND WORKFORCE PERFORMANCE

Light levels indoors are often very low Benefits of daylight

[partial list]:

- **Offices:** 10-25% better mental function, memory recall & task performance.
- **Call centres:** Calls handled 6-12% faster.

Sources: Heschong Mahone Group (2015), Loftness et al. (2009), Pierson (1995).

Staff working next windows are more physically active & typically sleep 46 minutes more at night (Boubekri et al. 2014).

A lower error rate has also been noted in prescription-dispensing at higher light levels: 2.6% at 1,500 lux versus 3.8% at 450 lux (Buchanan et al., 1991).

CREATING HEALTHIER FACADES [PARTIAL LISTING]

- Take design measures to improve light levels and allow light deeper into the building.
- Where possible allow windows to be fully openable.
- Create stronger connections with nature.

Passive day lighting strategies can collect sunlight and daylight and distribute it where needed without requiring specialist equipment.

Project: EDITT Tower, Singapore. Proposed design by TR Hamzah & Yeang

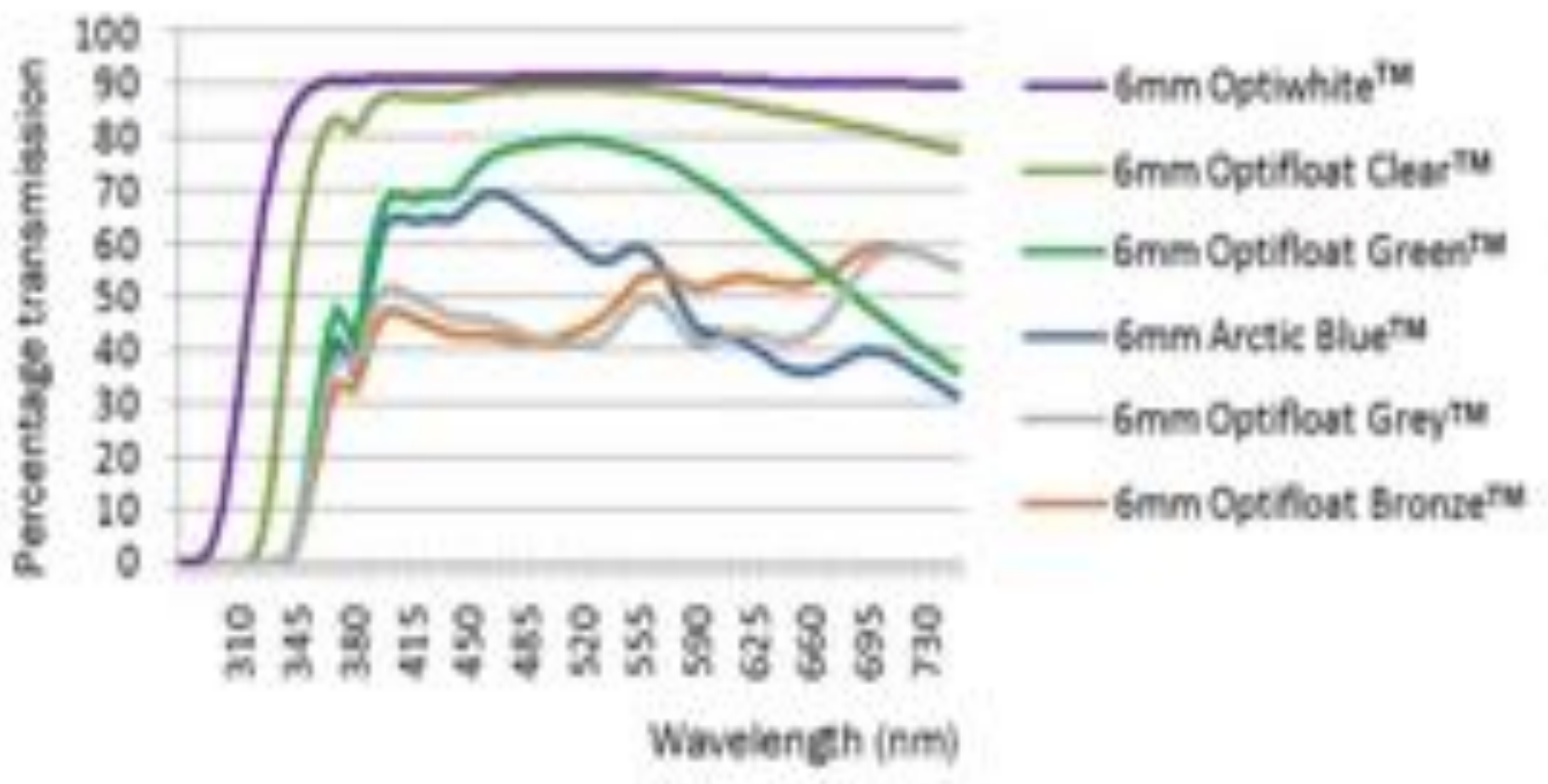
Illustration courtesy of Ken Yeang.

Substantial economic benefits can be created by using either passive or active strategies to improve light exposures and connections with nature.

SPECTRAL TRANSMISSION THROUGH GLAZING AND WELLBEING

The type of glazing specified can have a marked effect on the quality of light that we receive when indoors.

Spectral transmission of different glazing types.



Data supplied to author by Pilkington Group Limited (2009).

Specifying bio-friendly glazing formats which also allow higher transmissions of microbicidal wavelengths can help reduce infection risks.

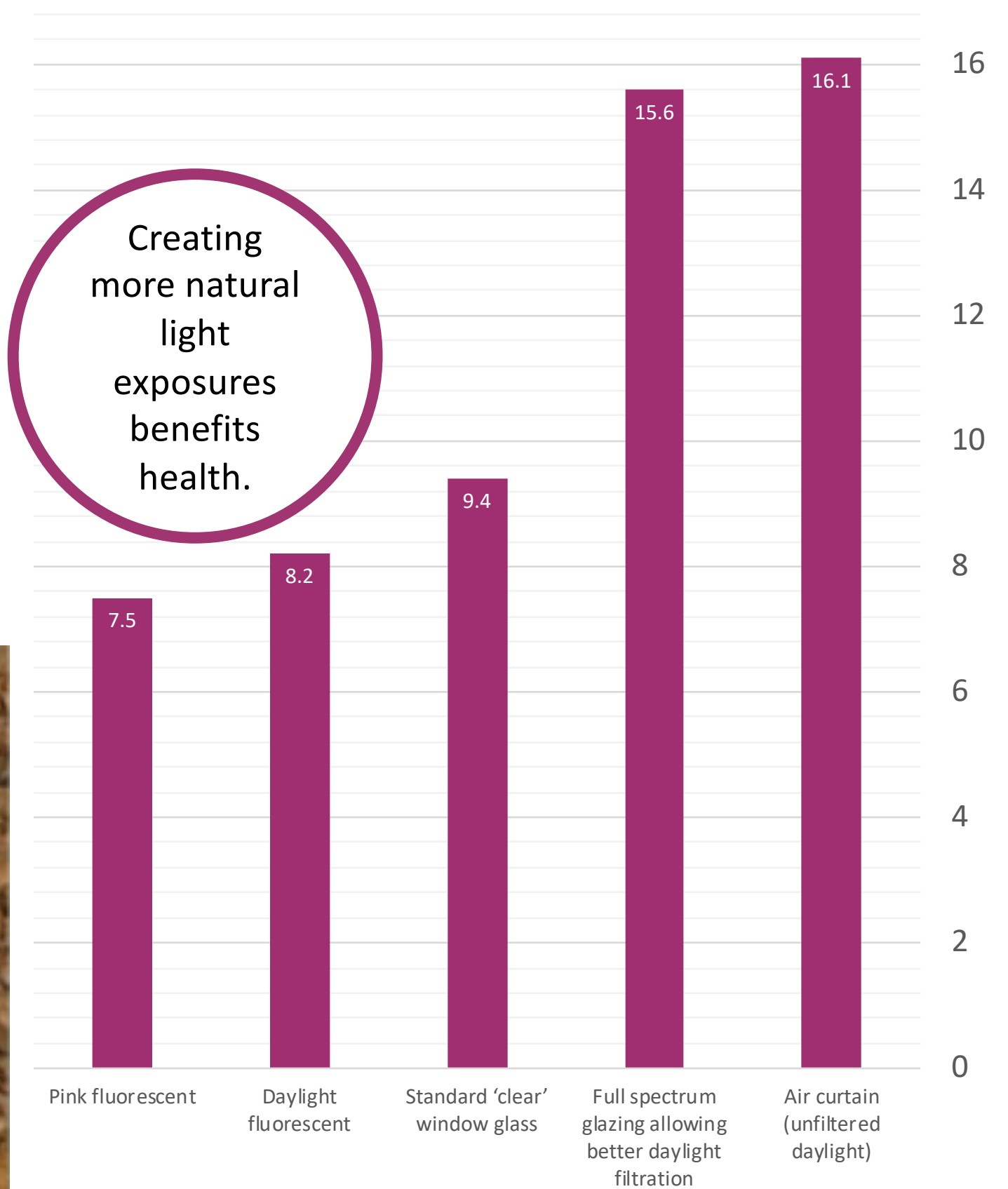
EFFECTS OF MAL-ILLUMINATION ON HEALTH

ANIMAL TESTS

Past research investigated the effects of different light exposures on average life expectancy of C3H mice, a strain of mice widely used in cancer research (Ott 1973).



Average period before death from tumours (months)



Optimising light exposures can greatly help improve health and wellbeing, and can often be undertaken at low cost / no cost.

SUNLIGHT, GLAZING AND PATHOGEN GROWTH

1877: Sunlight and microbial-growth in solutions in test-tubes were exposed to light that passed through different types of glass:

- Sterilisation effect from sunlight using either **deep-blue** or ordinary [**clear**] **window-glass** [both of which transmit natural violet- and blue-light].

Microbial-growth occurred with:

- **Red glass** [which blocked natural violet- and blue-light completely].
- **Yellow glass** [which blocked all violet- and some blue-light].

Source: Downes & Blunt (1878).

Sunlight can help prevent pathogen development
(Downes & Blunt 1878).

Many of the microbiocidal wavelengths in sunlight and daylight are heavily screened by standard types of glazing.

ACTION OF DIFFERENT LIGHT WAVELENGTHS ON PATHOGENS

Colonies in areas exposed to either infrared (IR), red, orange (O), or yellow (Y) light wavelengths germinated as readily as those in the area kept in darkness.

Ward (1893).

IR Red O Y Green. Blue Violet UV

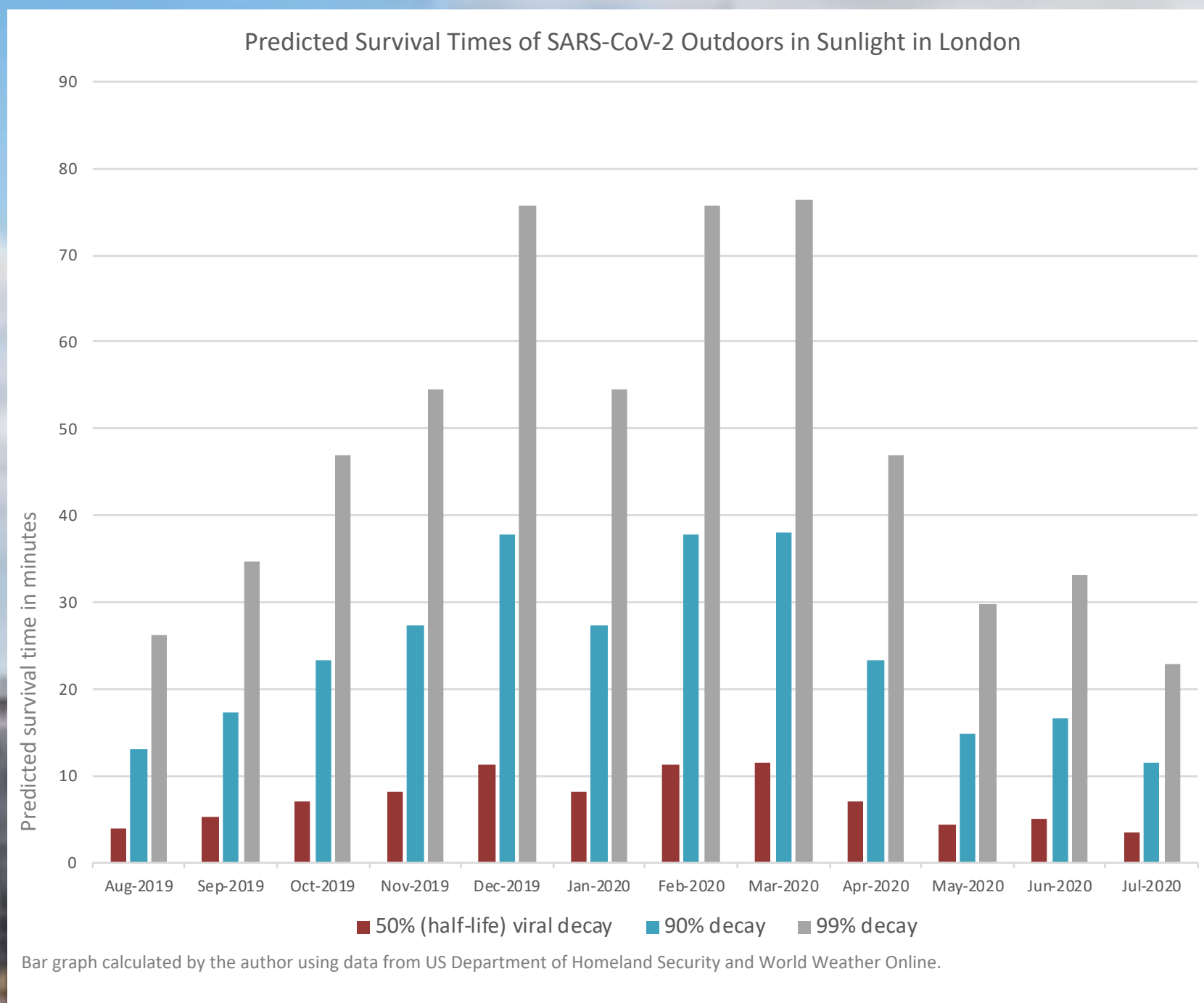
Anthrax spores on a plate exposed through a slot for 5 hours to solar spectra of different wavelengths in August 1893 and incubated 48 hours.

UV wavelengths were greatly reduced in intensity by the plate glass cover used.

Image source Ward (1893).

“The maximum effect is in the blue and blue-violet (BV), where nearly every spore has been destroyed, and the area appears cleared of colonies” Harry Marshall Ward (Ward 1893).

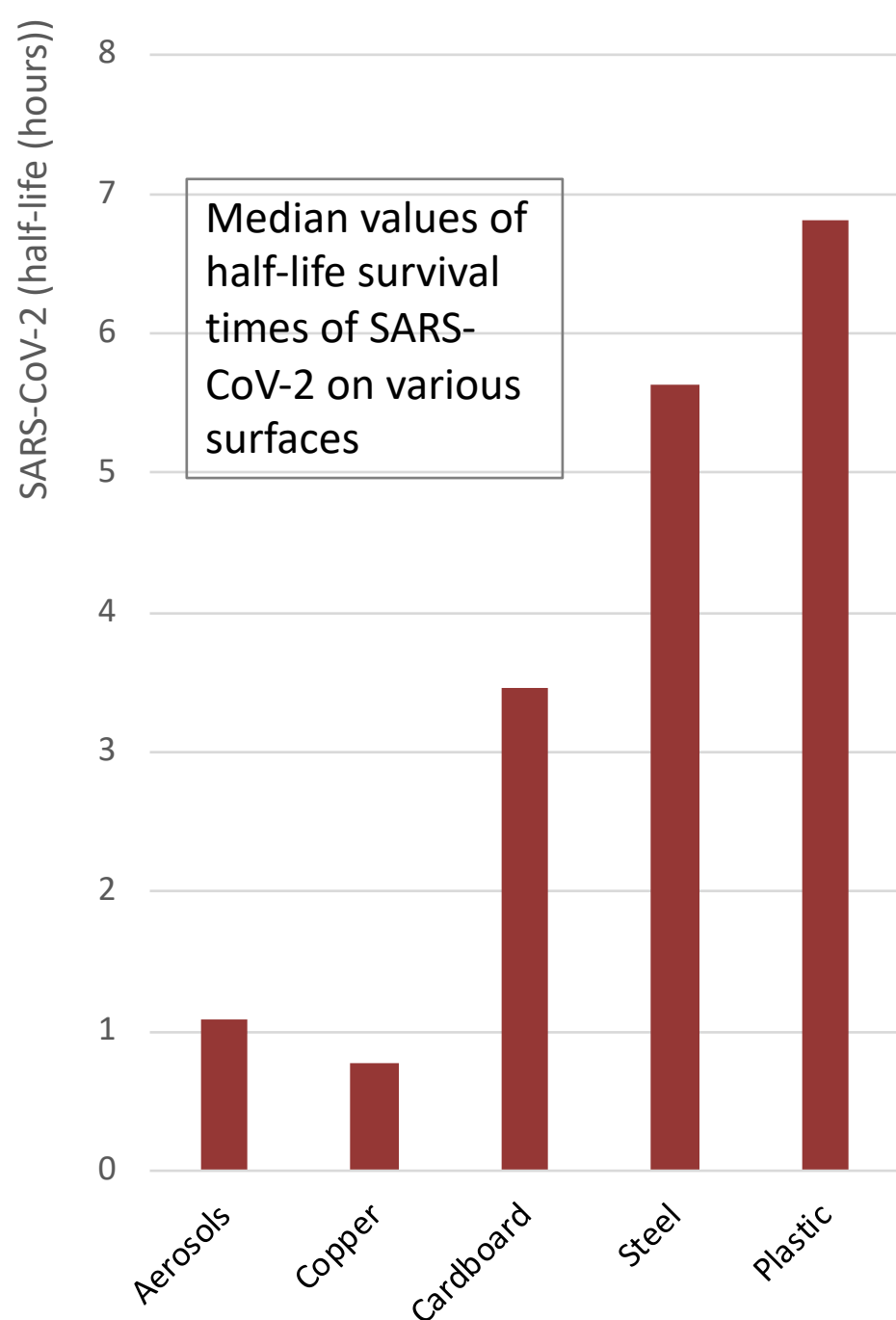
THE EFFECTS OF SUNLIGHT ON AIRBORNE DECAY OF SARS-CoV-2



Optimising indoor exposures to sunlight and daylight can reduce infection risks.

In addition to time of year, cloud cover and pollution levels may further influence the survival times of pathogens (Mims 2005, 1996).

STABILITY OF SARS-CoV-2 VIRUS IN AEROSOLS AND SURFACES INDOORS



Source: van Doremalen et al. (2020).

Aerosols

SARS-CoV-2 remained viable in aerosols throughout the 3-hour duration of the experiment

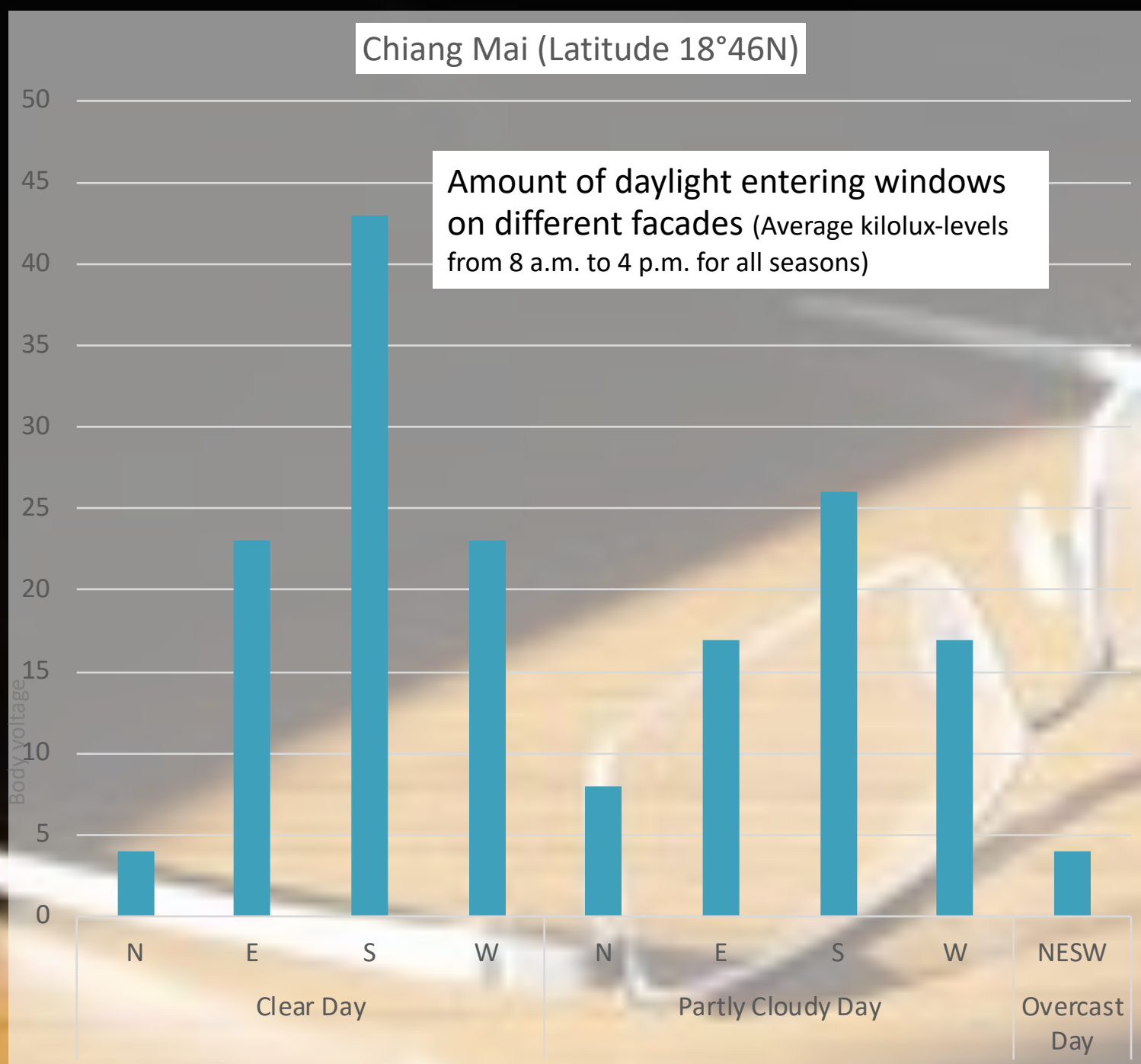
“SARS-CoV-2 was more stable on plastic and stainless steel than on copper and cardboard”
van Doremalen et al. (2020).

Surfaces

- Copper: no viable SARS-CoV-2 reported after 4 hours.
- Cardboard: no viable SARS-CoV-2 reported after 24 hours.
- SARS-CoV-2 was more stable on plastic and stainless steel than on copper and cardboard.

SARS-CoV-2 can persist for multiple days on nonporous surfaces and survive for 28 days when kept in darkness (Ridell et al. 2020).

AVERAGE AMOUNTS OF DAYLIGHT RECEIVED INDOORS

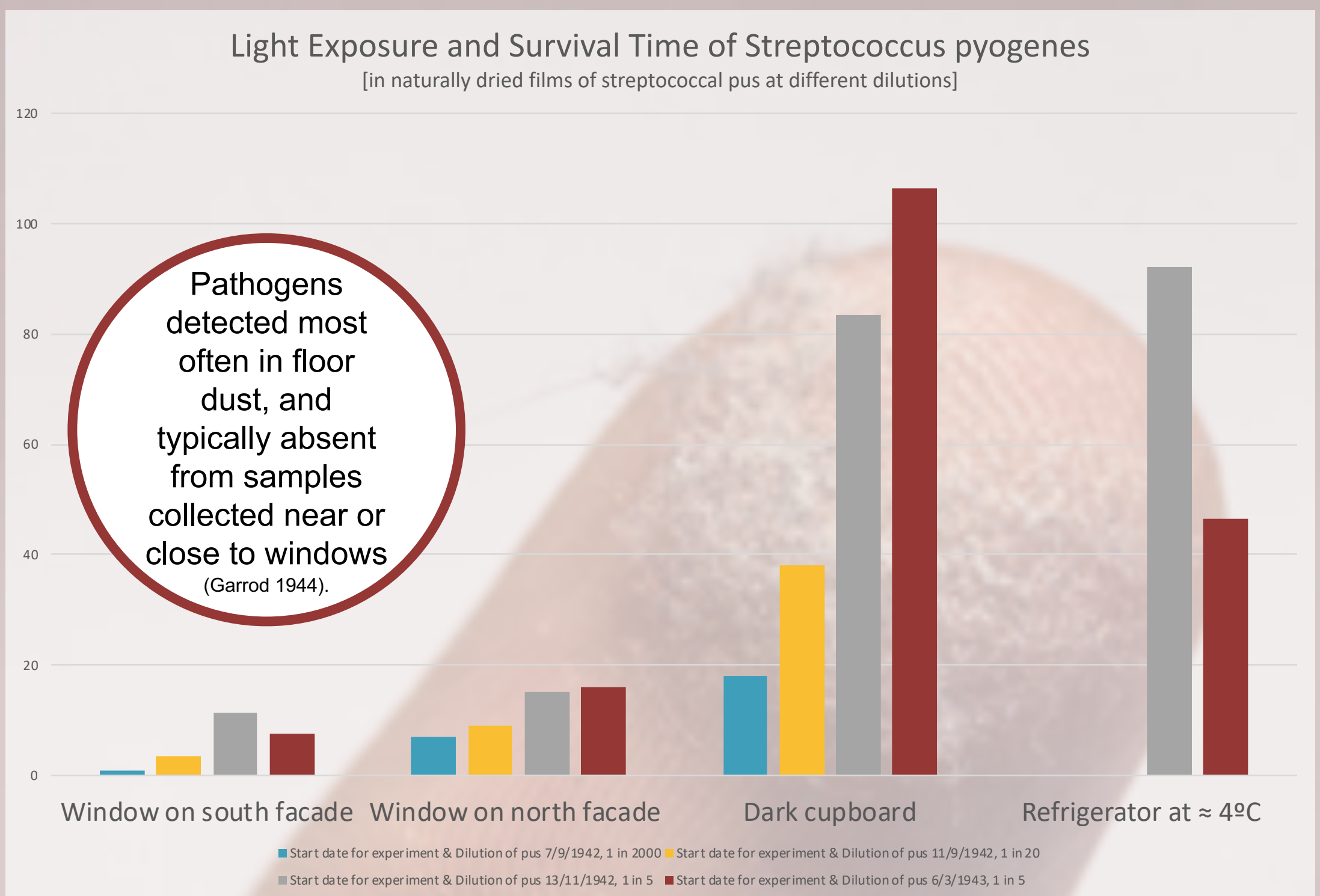


Retabulated data: Sersen (1990).

Facade orientation can often greatly influence the daylight levels received indoors.

The amount of daylight pathogens are exposed to can greatly influence their survival times.

EFFECT OF FACADE ORIENTATION AND PATHOGEN DILUTION ON SURVIVAL TIMES OF PATHOGENS COLLECTED FROM FLOOR DUST



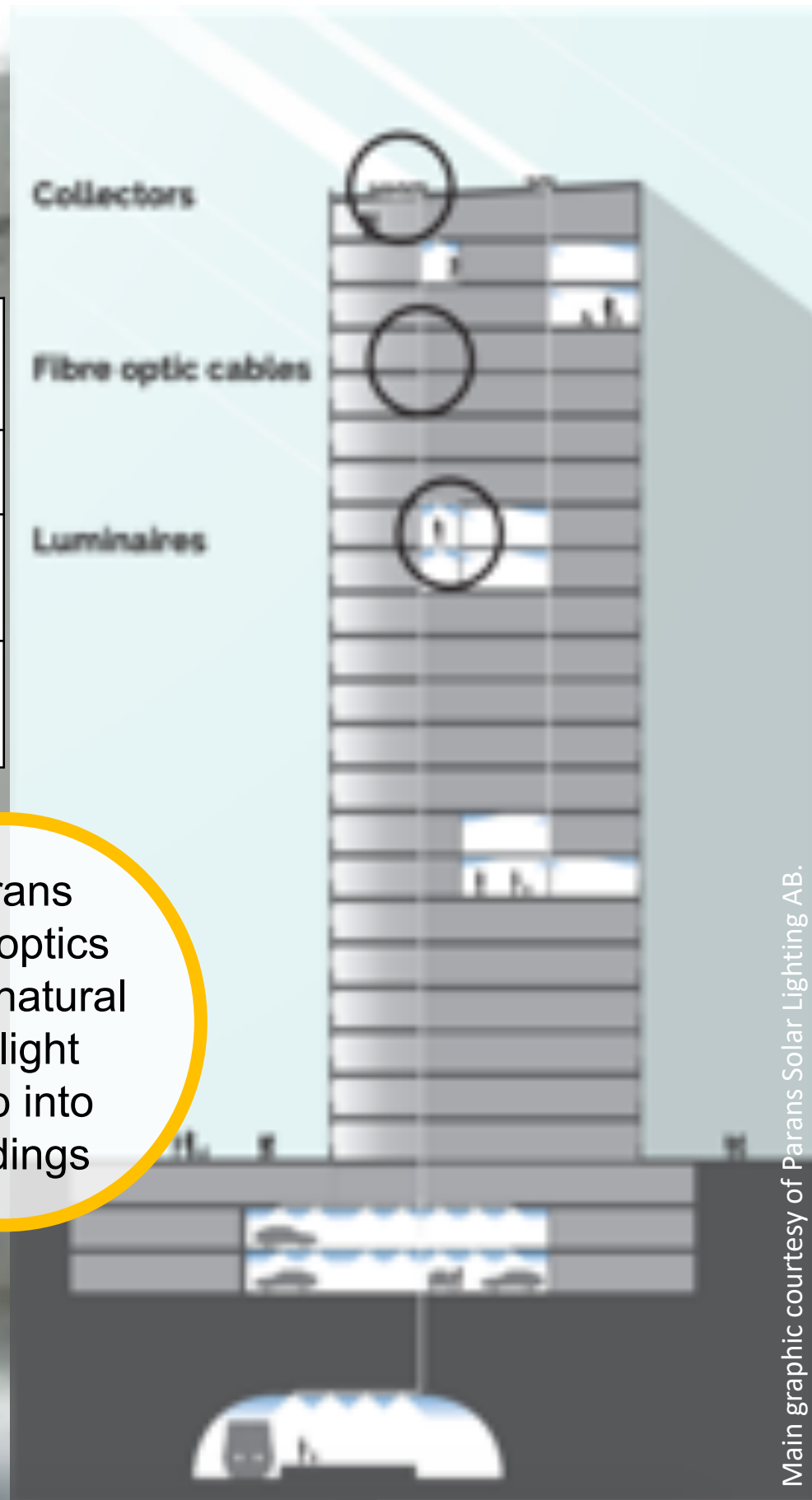
CC0 Image: Ocrum, A. (2016), Domestic dust on a finger, https://en.wikipedia.org/wiki/Dust#/media/File:Hausstaub_auf_einem_Finger.jpg

Increasing daylight exposures within buildings can help reduce the pathogen load that they contain.

EFFECT OF LIGHT EXPOSURES ON PATHOGEN VIABILITY

Results of sampling floor dust from well-daylit or poorly-daylit hospital wards for Haemolytic Streptococci (Garrod 1944).

Location	Negative samples	Positive samples	Percentage positive
Ground floor patient wards [with poor levels of daylight]	21	55	72%
First floor patient wards [receiving good levels of daylight]	27	6	18%



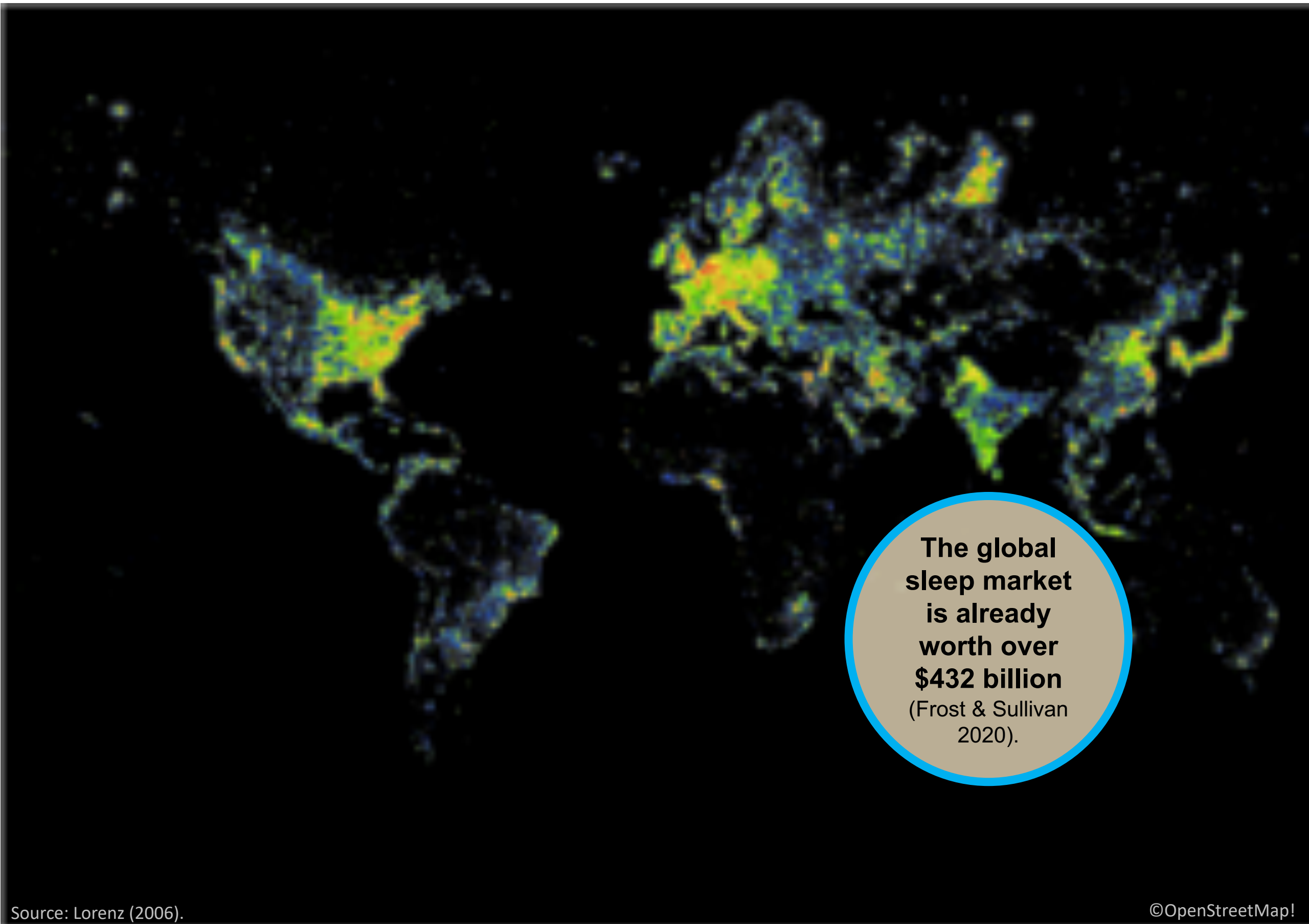
Parans fibre optics allow natural sunlight deep into buildings

Main image courtesy of Parans Solar Lighting AB.

Main graphic courtesy of Parans Solar Lighting AB.

Increasing daylight exposures within buildings can help reduce the likelihood of infection. It can also aid general wellbeing.

LIGHT POLLUTION AT NIGHT AND WELLBEING



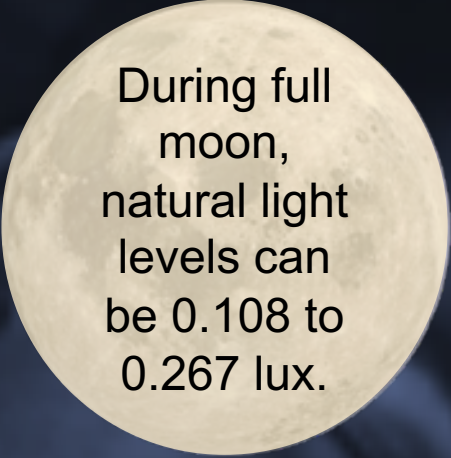
Light pollution is a threat to Nature and Humans (Drake 2019).

LIGHT AT NIGHT, DEPRESSION AND OBESITY RISKS

On moonless overcast nights, light levels in nature can be 0.0001 lux.

- Exposure to artificial light at night of ≥ 5 lux when sleeping is associated with increased depression risk.
- Exposure to ≥ 3 lux when sleeping is associated with increased obesity risk.

Source: Obayashi et al. (2016).



During full moon, natural light levels can be 0.108 to 0.267 lux.

Facades can be better designed to prevent the creation and ingress of light pollution at night.

LIGHT AT NIGHT AND FERTILITY

The fertility treatments market is worth **\$14.87 billion**

(BusinessWire 2020).

- Reduced nighttime melatonin levels can compromise fertility and embryo viability (Fernando & Rombauts 2014).
- Prolactin, which also influences fertility, can be suppressed by exposure to light at night.
- Prolactin levels also regulate male fertility (Gill-Sharma 2009).

“Overall, infertility is on the rise with 1 in 6 couples wishing to conceive being diagnosed as infertile” Ravitsky & Kimmins (2019).

LIGHT AT NIGHT AND HUMAN CANCERS

The cancer therapeutics market is worth over **\$182 billion** (BCC Research 2019).

- Increased risk of prostate and breast cancers is associated with high exposure to blue-enriched light at night (Garcia-Saenz et al. 2018).
- Immune system function is also compromised by light at night.

The knowledge already exists to enable us to create healthier more bio-friendly facades at all times of day.

HEALTHIER FACADES: INCREASING VALUE AND TAPPING INTO THE LUCRATIVE WELLBEING MARKET

IN SUMMARY:

- We need to address the new normal in the design of the built environment.
- We have the ability to do so.
- Adopting more innovative bio-sustainable approaches to facade design can help create numerous 'Win/Win' situations and increase the building industry's presence in the Global Wellbeing Market.

WORKING TOGETHER WE CAN CREATE THE SOLUTIONS WE NEED.



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