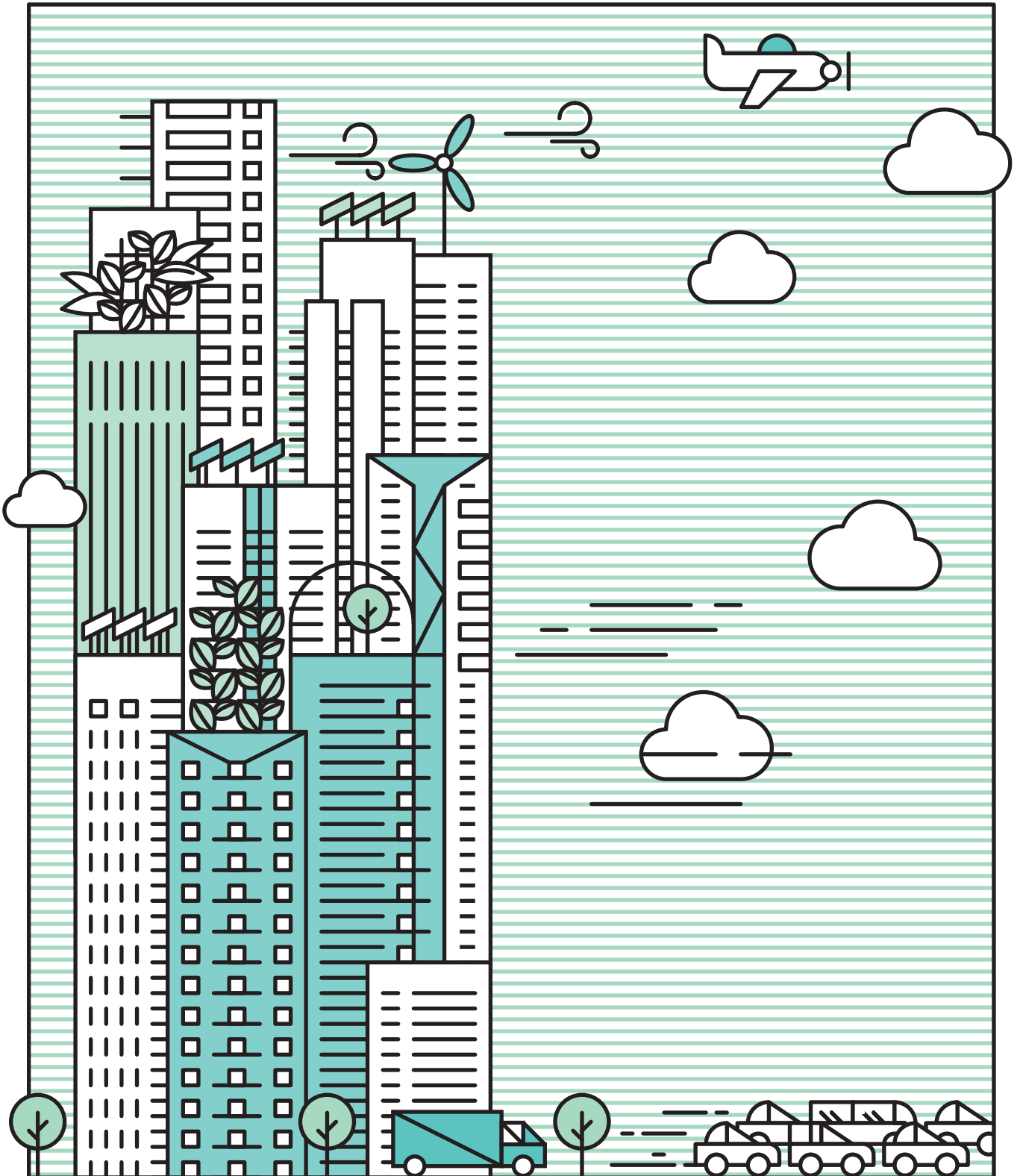


# Design for Polluted and Toxic Environments

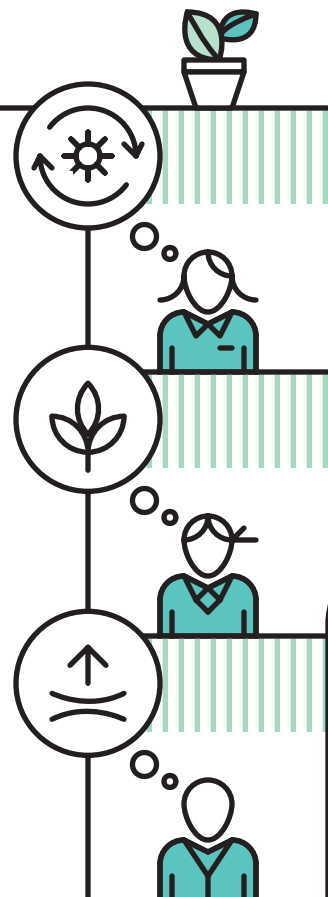
Exploring opportunities to address air pollution via design and architecture.



# A Breath of Fresh Air

Can workplace and building design help filter polluted air?

For design to be an effective tool in the fight against air pollution, we need to look beyond filtration and focus on energy conservation, clean energy generation, and resilience in building design.



## WHAT WE DID

We conducted a comprehensive review of existing research and information on the topic of air pollution in China, including current trends aimed at addressing this urgent issue. After collecting this information, we identified specific target areas and ways in which we felt design could address air pollution problems, both indoors and outdoors. We determined several locations in Asia with the greatest opportunity, then created experiments to test our designs. By tracking and comparing fine particulate matter (PM2.5) data for our experimental sites with other meteorological data from the region, we were able to determine trends from year to year. We also used surveys to gain insight into the effect of air pollution on people's daily lives and health.

## THE CONTEXT

The World Health Organization has set the allowable AQI (Air Quality Index) level at 50; it is not unusual for Shanghai residents to experience levels over six times that amount. Many commuters wear particulate masks on their way to and from work, and even while working on days when AQI levels rise above 300. Pollution in China is an urgent problem that not only affects indoor air quality and occupant health, but also contributes to increased energy consumption to filter and circulate indoor air, reduced natural daylighting due to heavy smog, and decreased productivity and overall well-being among workers.

As our clients continue to seek LEED certification for new projects, addressing issues of daylighting, energy consumption, and ventilation is an ongoing challenge in such heavily polluted environments. Local economies and communities also suffer as people remain reluctant to breathe outside air, and become less willing to leave their homes and workplaces.



PM 2.5

PM2.5 levels signify the fine particulate matter content of air, specifically particles that are below 2.5 microns in diameter, small enough to lodge deeply into the lungs or be absorbed by your skin, hair, and ultimately bloodstream.

## THE RESULTS

Concerns about air pollution are part of daily life in China.

In a survey we conducted with 150 residents, respondents stressed both the significant challenges air pollution adds to their daily lives, and expressed a feeling of helplessness about solving the problem—when asked if there was anything they could do to improve air quality, 4 of 5 respondents said no.

53%

of people discuss air pollution at least once a week.

72%

of people feel air pollution is the issue that affects their daily life the most.

74%

of people wear a mask at least once a week or more.

80%

of people don't believe the air is getting better.

81%

of people claim to suffer from respiratory illness related to poor indoor air quality.

Air pollution isn't just a respiratory issue; it has broad-reaching effects.

Contaminated air not only affects respiratory health but also contributes to decreased daylighting. Smog clouds concentrate and dissipate over hours, days, and seasons, and our designs need to not only provide clean indoor air, but also be able to respond to fluctuating levels of daylight. Interestingly, while it was originally believed that pollution in Shanghai was worse in winter months due to increased coal burning, through analyzing meteorological data, we determined that it was also due to a seasonal change in wind direction.



Traditional air filtration helps building air quality, but also compounds broader issues via increased energy consumption.

The importance of dramatic energy reduction and clean energy generation in building design may be one of the biggest takeaways from our research. Significant amounts of energy are consumed to filter air. Our own research shows a 7 percent increase in energy consumption in commercial office buildings (COBs) with the addition of air pollution filtration systems, even in those that achieve LEED Platinum certification. COB energy demand accounts for 60 percent of the total energy demand in metropolitan cities. If 7 percent is added to the existing 60 percent, it only creates a larger problem if that energy is 70 percent supplied by coal, as it is in China. Personal home filters are even worse, adding 1,280 grams of pollutant an hour at the energy source, while filtering only 62 grams in that same hour.

Much of the energy consumption and pollution in China are due to U.S.-owned and other foreign-owned industry.

In thinking about energy conservation, those living outside of China should also consider the impact of buying goods that are manufactured in China. A recent study conducted by Peking University and UC Irvine found that 24 percent of pollution on the U.S. West Coast can be linked to manufacturing U.S. products in China.



**WHAT THIS MEANS**

We can't rely on air pollution reduction; we need to design buildings to address this issue now.

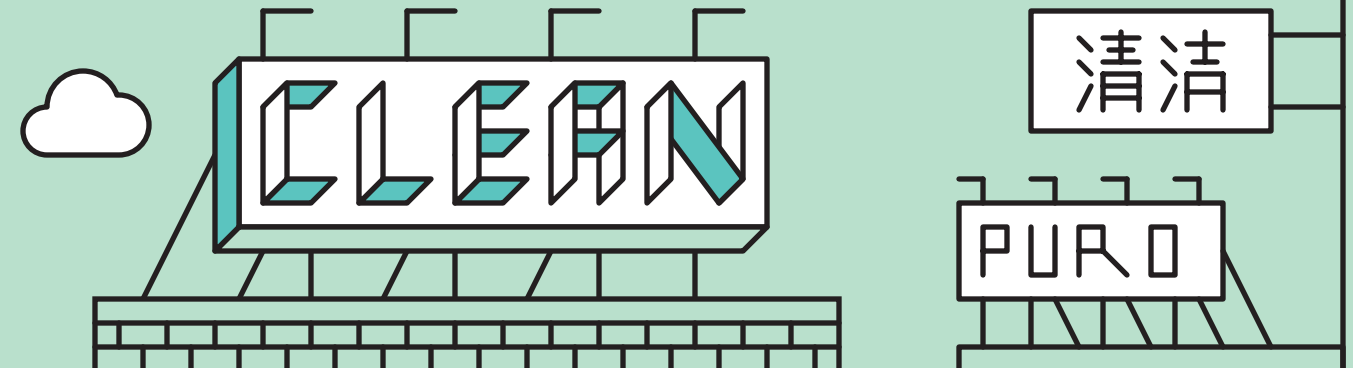
Reducing air pollution is absolutely necessary, but it is not something we can take for granted. We must continue to design buildings to withstand high levels of pollution. In China, the carbon cap will not be put into effect until 2030, which is more than a decade away. Even after the carbon cap, pollution migration still remains a major threat as countries such as Iran, Pakistan, Bangladesh, and Mongolia continue to be big polluters in the region, with their pollution often drifting over to China.



**CLEAN DESIGN**

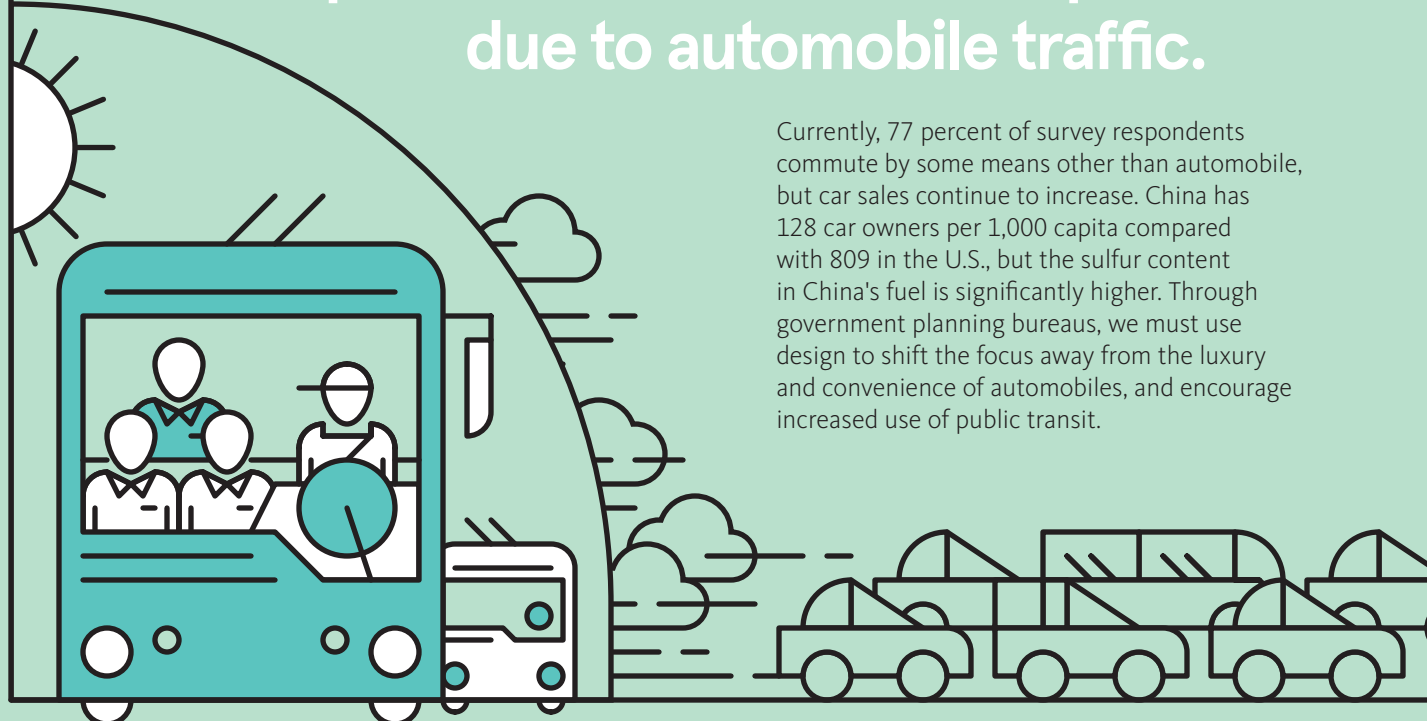
Public education must emphasize that air pollution is a problem not unique to China, and that it can be resolved.

Our research also uncovered a general lack of understanding about the topic of pollution—the sources of pollutants, what it means to talk about particulate matter, and how pollution has changed historically—not just in China, but in other major cities as well. By instead emphasizing cleanliness and the idea of “clean” design, we can simplify conversations to express the benefits of a pollution-free environment to our clients, colleagues, and communities.



We must continue to encourage the use of public transit and reduce pollution due to automobile traffic.

Currently, 77 percent of survey respondents commute by some means other than automobile, but car sales continue to increase. China has 128 car owners per 1,000 capita compared with 809 in the U.S., but the sulfur content in China's fuel is significantly higher. Through government planning bureaus, we must use design to shift the focus away from the luxury and convenience of automobiles, and encourage increased use of public transit.



**PERSPECTIVES**



In the 13th century, King Edward was the first person to try to ban the burning of coal in England. A consensus was not reached, and even today we are still arguing over coal as a source of energy.

**WHAT'S NEXT**

It remains a tremendous challenge to reduce indoor air pollution while also reducing energy consumption within a building. It is vital that we take the lead in designing buildings throughout Asia that address both issues simultaneously.

## Team

Dan Winey, Ray Shick, Kyle Mertensmeyer, Clifford Champion, Ryan Choe, Tom Ford, Danielle Gharst, Russell Gilchrist, Ningning Guan, Yangchao Ni, Amber Sun, Hai Tran, Vickie Wang, Weiwei Wei, Brad Wilkins, Zang Wu

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As architects, designers, planners, and consultants, we partner with our clients on some 3,000 projects every year. These projects can be as small as a wine label or as large as a new urban district. With more than 5,000 professionals networked across 46 locations, we serve our clients as trusted advisors, combining localized expertise with global perspective wherever new opportunities arise. Our work reflects an enduring commitment to sustainability and the belief that design is one of the most powerful strategic tools for securing lasting competitive advantage.

Gensler's Research Program supports research investigations important to our firm, our clients, and to the ongoing learning and development of Gensler professionals. Research projects are practitioner-led with involvement across the globe. Our teams bring thought leadership to the table as we seek to solve our clients' and the world's most pressing challenges by creating high-performance solutions that embrace the business and world context in which we work, enhance the human experience, and deliver game-changing innovation.

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