

Every breath we take – transforming the health of China's office space

JLL presents a white paper on how to achieve good indoor air quality
in the workplace, in partnership with PureLiving China

Research Report | December 2015



仲量聯行





Opportunity knocks

In the modern business world, people in China are spending more time indoors than outdoors. At work, employees from 90 percent of the country's industries are clocking in overtime hours on a weekly basis¹. Meanwhile, outside of the office, the air in China is a serious problem. Air pollution in China contributes to some 1.6 million fatalities in the country annually, according to the findings of a scientific study released earlier this year by Berkeley Earth, which also attributed 17 percent of the country's mortalities to the bad air. While the number of premature fatalities linked to the air that we breathe indoors is difficult to quantify, we know that spending time inside, in places where the air is not properly managed, also exposes us to harmful levels of outdoor pollution – and the ubiquitous PM2.5. The real danger is that 75 percent of PM2.5 – or particulate matter sized 2.5 microns or smaller – finds its way into our buildings from outside². PM2.5 penetrates deep into our lungs, enters our bloodstream, and has sobering long-term health implications. Consequently, pollution remains at the forefront of public health concerns in the country and continues to be a focal point of China's 13th Five-Year Plan (2016-2020), with targets curbing reliance on coal-fuelled power – a chief source of PM2.5 – reaffirming the Chinese government's deep commitment to the “war on pollution”.

As pollution continues to strongly influence China's plans for the future, indoor air quality is a critical issue that deserves greater attention, especially given that high public awareness of pollution is dramatically changing people's expectations toward health. Moreover, pollution is no longer primarily a concern among just expatriates working in China; everyone has major reservations about the bad air. In just a short time, the general public has gone from complete ignorance to world-leading levels of knowledge on air quality indexes, and this is especially true in major cities like Beijing

and Shanghai. The average Beijinger, for example, is well versed on PM2.5, unlike residents of other world capitals in developed countries where pollution is not of huge public concern. Experts have surmised that PM2.5 levels in Beijing are currently even worse than those experienced in Los Angeles during its peak pollution decades from the late 1940s through to the 1960s³. In developing countries presently, however, it is India and Pakistan that suffer the highest PM2.5 concentrations in the world⁴. Though China is not that far behind these countries, it is head and shoulders above in both awareness and policy, making it best-positioned to act on indoor air quality in a global context so that other industrialising nations can follow.

A decade ago, tobacco smoke was targeted as the main culprit of bad air in office buildings around China. Although legislation has done well to put an end to smoking in most Tier I city offices in recent years, cigarette smoke was previously only masking the PM2.5 in the background. Unlike PM2.5, tobacco smoke is a form of point-source pollution – it has a strong odour and is highly location-specific – making it relatively easy to identify and eliminate from offices. Nowadays, however, concerns have shifted to non-point-source pollution, namely PM2.5, which comprises the bulk of China's ambient air pollution and is harder to eliminate. In fact, PM2.5 from the burning of fossil fuels can travel hundreds of kilometres to infiltrate office buildings of all shapes and sizes. While flushing out poisonous compounds off-gassed from office furniture and construction materials (volatile organic compounds or VOCs) and keeping carbon dioxide levels low are also key components to achieving good indoor air quality, these pollutants are tied to indoor sources and building construction. Therefore, for the purpose of this paper, we focus heavily on PM2.5, given its lack of analysis relative to the China office market. We also emphasise PM2.5 as a concern, given that pollution poses a problem that is increasingly becoming important for workplace retention and commercial space selection.

1. China Labour Market Report Analysis. Beijing Normal University; 2014. (www.cnki.net).

2. Wallis, Raefer. RESET Certified Video. December 2015. (v.youku.com/v_show/id_XMTQwNjQ5MDE0OA.html?from=y1.7-1.2).

3. Makinen, Julie and Smith, Doug. Beijing's Smog Makes Los Angeles Air Look Good. September 10, 2014. Los Angeles Times. (www.latimes.com/world/asia/la-fg-china-la-smog-stats-20140910-story.html).

4. Outdoor Air Pollution Database. May 2014. World Health Organization. (www.who.int/entity/quantifying_ehimpacts/national/countryprofile/aap_pm_database_may2014.xls?ua=1).

Considering that environmental reform in China is a long-term endeavour, we can all take proactive measures now to improve indoor air quality and create office space that employees will want to work in – and choose over others. In this white paper, we explore how sound investments in indoor air quality today can improve office space for tomorrow and beyond, giving employers an important edge needed in China to attract and retain top talent in the increasingly competitive marketplace – where companies are only as strong as their people. Though our findings are far from providing all of the answers to indoor air quality problems, we have looked at the outside air in China and assessed how it is of concern to both landlords and tenants in the office market. Supported by data analysis and anecdotal evidence, we address issues surrounding the subject of indoor air quality and offer solutions on how the situation at work can be better managed.

Our key takeaways include:



Indoor air quality affects daily business operations and company growth.



Good indoor air correlates with nearly twice the level of productivity compared to average air quality and is increasing in significance for talent attraction and retention in China.



Good indoor air quality can be achieved by following the 3As (Assess, Act, and Assure).



Assess: Test your office space to identify current problems and design a solution to fix them.



Act: Install effective and efficient equipment to clean the air in your space; mechanical systems have the greatest impact on PM2.5 reduction indoors.



Assure: Implement controls that maintain clean indoor air on an ongoing basis, such as on-demand automation and continuous monitoring.



Get the indoor air quality of your space accredited by a trusted certifier to validate your results and leverage the marketing benefits.



Investments in indoor air quality help to differentiate office buildings from competitors, better enabling them to retain value in any market.



Pollution in China is not just a Beijing problem – or even a North China one – it is far-reaching and affects the entire country.

Indoor air quality affects daily business operations and company growth.

China's future economic growth will largely depend on transitioning to a service-oriented economy, which requires improving productivity – what economists refer to as Total Factor Productivity. This all starts with the individual worker. Uncomfortable working conditions arise from poor indoor air quality. Stuffy air, for example, has been known to cause people to feel unwell or sluggish. Likewise, particulates have a negative effect on workers, especially after prolonged exposure to heavy concentrations. Lower productivity, whether it is from reduced efficiency or increased absenteeism, hurts how companies run their day-to-day business. Moreover, the knock-on effect weakens the productivity of others around them who rely on their output to carry out tasks. Not only may others have to pick up the slack, but more employees may also become worried and distracted from their work. In extreme cases, these disruptions lead to increased turnover, as disgruntled and concerned employees seek opportunities elsewhere; this causes instability for companies and a loss of momentum in the market as firms are forced to redirect energy and resources on recruitment. Given that retention is projected to pose even greater staffing challenges for employers in China going forward, it is not an issue to be taken lightly⁵. Meanwhile, although employee turnover rates in China are improving, they still remain generally high, particularly in retail, high-tech, consumer goods, and insurance, giving employers good reason to be cautious of losing their top talent to competitors⁶ (see Figure 1).

Figure 1: Voluntary Turnover Rates in China

Industry	Voluntary Turnover Rates		Trends
	2012	2013	2013 vs 2012
Retail (Chain Store)	30.9%	30.9%	–
Hi-tech	24.0%	23.2%	↓
Consumer Goods	19.5%	19.0%	↓
Insurance (Life)	19.2%	20.7%	↑
Pharma	18.5%	17.7%	↓
Real Estate (Tier 1)	17.5%	16.5%	↓
Insurance (Non Life)	17.2%	15.7%	↓
Engineering	17.0%	13.2%	↓
Auto Parts (Tier 1)	16.9%	13.0%	↓
Logistics	16.7%	15.4%	↓
Medical Device	16.1%	13.1%	↓
Machinery (Tier 1)	14.3%	10.5%	↓
Sourcing	14.1%	11.1%	↓
Chemical	12.9%	10.7%	↓
Auto Vehicle (Tier 1)	7.0%	4.1%	↓
China Overall	18.9%	14.3%	↓

Source: Aon Hewitt's Long-term Trends Reshape China Talent Landscape Report. 2014.

5. Retention: Is it Getting Enough Attention? Hays. 2012: Shanghai, China. (www.hays.cn/cs/groups/hays_common/@cnl/@content/documents/digitalasset/hays_088412.pdf)

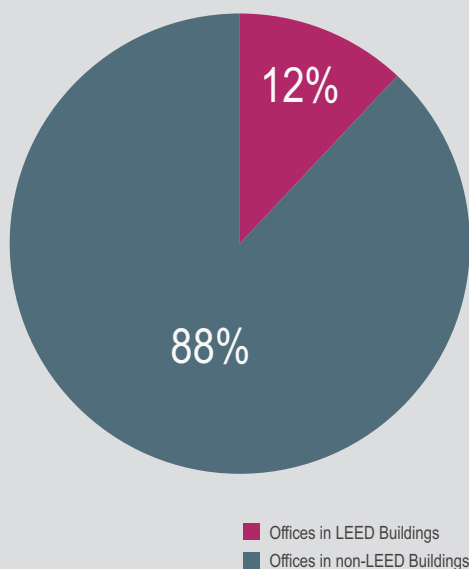
6. Long-term Trends Reshape China Talent Landscape. Aon Hewitt. HR Connect – Asia Pacific. Vol. 7, Iss. 3, 2014. (www.aon.com/apac/human-resources/thought-leadership/asia-connect/Attachments/Talent-2014Vol7Issue3-Reshape-China-Talent-Landscape.pdf)

LEED without lead on indoor air quality

Widely credited as a leader of sustainable practices in building construction, LEED certification has helped raise awareness on green issues to advance building design and functionality. However, without mandatory requirements directly influencing the indoor air quality of a building, LEED as a certification standard should not be confused as a guarantee of good indoor air quality, especially in terms of managing PM2.5 levels. While there is a set of guidelines for indoor air quality that are fairly stringent, the optional credit emphasises VOCs and can be fulfilled by flushing air through the space. This can make LEED unreliable in terms of its ability to vouch for good indoor air quality in the China office context. For example, JLL and PureLiving China research found that 12 percent of the worst-performers in terms of PM2.5-reduction indoors were offices in LEED buildings (see chart below). Therefore, paying more to be in a LEED-accredited building does not guarantee better air.

However, the new LEED Dynamic Plaque, which moves from a design-rating only approach to a continuous performance measurement, is aimed at addressing some of the loopholes in the certification process. While indoor air quality requirements are once again optional, the credit applies a rolling-points system, which is good enough for most markets, but perhaps not granular enough for a heavily polluted market like China where more is required.

Offices with the Worst Reductions in PM2.5



Note: Includes bottom 25% of tested spaces in terms of PM2.5 reductions.

Source: PureLiving China Certified PM2.5 Audits (2013-2015)

Good indoor air quality starts with good design and selection of construction materials and mechanical systems, and then relies on continuously checking and maintaining air quality.

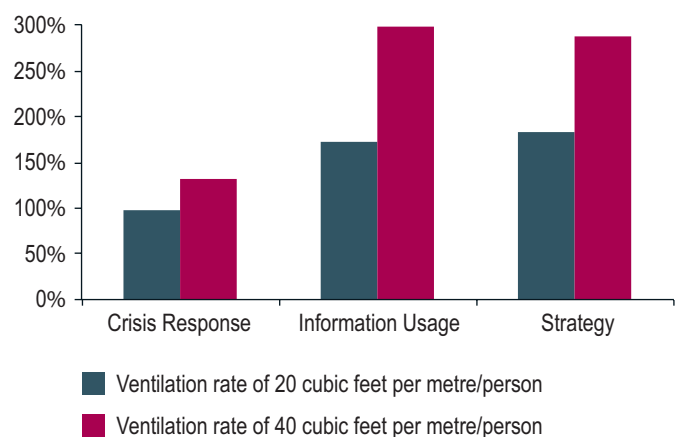
The Chinese government is increasingly recognizing the need to protect health both indoors and outdoors and is getting help from institutions like ours to create standards which direct smart building and design.

Dr Li Jingguang

Shanghai Research Institute of Building Science

While the benefits of a healthy workspace can be difficult to measure in terms of directly correlating gains, new research from Harvard University indicates that working environments with better ventilated clean air helps raise the level of productivity for analytically intensive tasks by as much twice that compared to just average air quality⁷ (see Figure 2). The study is significant because it suggests that air quality has far more of an impact than previously thought, according to previous seminal research from 2003 and an examination of some two dozen studies in 2006, which only linked better airflow to improved productivity for repetitive tasks such as typing speed, and not by more than 11 percent⁸. Furthermore, instead of relying on performance of rote tasks, the study measured performance on standardised tests assessing analytical skills such as judgment and processing, which are more relevant to professional services firms.

Figure 2: Productivity Increases in Analytical Tasks

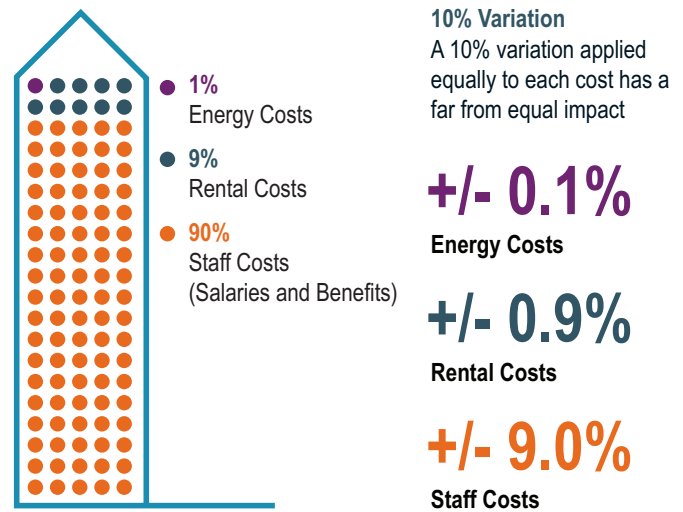


Source: Harvard T.H. Chan School of Public Health's Center for Health and the Global Environment Report. 2015.

Productivity gains from good indoor air are especially significant given that staffing costs make up the majority of a company's operating costs.

A simple cost-benefit analysis (see Figure 3) illustrates the potentially large cost-savings that employers can achieve by locating their firms in a building with proper air filtration, an important driver of air quality in offices. Staffing costs, by way of salaries and benefits, consume up to 90 percent of the operating costs, while rents and energy account for just 9 percent and 1 percent, respectively. Investments in improving air quality can pay for themselves in as little as three to six months through increased productivity, reduced sick days, and lower health insurance premiums⁹. Though technologically advanced buildings with filtered fresh-air systems tend to be higher rent buildings, these properties typically only demand marginally higher rent than the market average. Therefore, a small premium in office rent could go a long way in creating bigger cost-savings for companies. With greater productivity leading to better performance, employers have the most to gain.

Figure 3: Typical Business Operating Costs



Source: World Green Building Council's Health, Wellbeing & Productivity in Offices Report. 2014.

Developer aims to offer “peace of mind” with upgrades

With corporate offices currently undergoing air quality testing to customise solutions for effective PM2.5 reduction indoors, Kerry Properties has started to explore how to implement mechanical system upgrades across its mixed-use developments in mainland China to improve indoor air quality at its projects.



“Ensuring a safe and healthy environment for our customers and tenants is our top priority. With air quality an increasing topic of concern, we want to make sure the air quality in our office buildings is clean, safe, and healthy,” said Bryan Gaw, an executive director of Kerry Properties Limited.

Apart from shielding people from the hazardous elements outside, the goal for Kerry Properties is to deliver “peace of mind” to all guests once they step into a Kerry Centre project. Included in the company's plans is the installation of real-time air quality monitoring devices – focused on tracking live PM2.5 levels – so the public can see for themselves just how safe the air inside is.

Given the current state of pollution in China, providing a safe indoor environment is not only the responsible thing to do, but also follows the Kerry philosophy. “If the ability exists to make a difference, then we should look at how to benefit our customers – because as a developer, we are always striving to create communities that get people to come together in a more sustainable way,” Gaw said.

Now is the time to act, he added, pointing to improving technology with lower costs now available in the market, growing awareness on how bad air in China is affecting indoor environments, and people's rising awareness and demands for healthy spaces due to heightened concerns over health.

Yet even beyond productivity and growth, in this day and age of pollution in China, employers also need to pay more attention to risk management, and we believe that there is a greater role for indoor air quality to play in this to come. Simply put, employers who provide clean air at work are sending a clear message to staff: they care about their well-being. Not only is this highly likely to motivate staff to stay longer and work harder, a healthy workplace further supports a work environment that is more conducive to employee engagement. This is particularly critical in China, where only 6 percent of employees are engaged at work compared to 29 percent of employees in the United States and Canada, which share the largest percentage of employees in the world who are engaged while on the job¹⁰ (see Figure 4). Moreover, Chinese workers who are engaged in their jobs are more likely than those who are not to say that they are satisfied with their health – and this is important for workplaces as higher satisfaction with personal health has been proven to lead to lower absenteeism, reduced healthcare costs, and greater productivity¹¹.

Considering that the country has one of the worst employee engagement figures in the world, employers in China would arguably benefit the most from anything that encourages employee engagement. Yet while all of these reasons support the call to action, perhaps the real highlight for employers in China is that the provision of good indoor air quality for staff at work is not just in their best interest, but also well within their reach.

When it comes to creativity, WPP tends to think outside of the box in every aspect.

Taking extra steps to create a healthy and safe working environment for staff is one of our innovative moves as an industry leader, and one step ahead in corporate responsibility.

James Woodburn
Head of Real Estate
WPP Asia Pacific

Indoor air quality is important to our people, and air quality monitors installed at our new Shanghai premises gives management confidence that this new office space represents a high quality, healthy and sought after work environment for our people.

It has also provided unprecedented transparency and access to air quality data. The user-friendly online portal displays real-time air quality results per floor, including a comparison between indoor and outdoor readings.

We are now exploring options for installing indoor air quality monitors in other offices in China.

Douglas Johnson
Corporate Responsibility Manager
PricewaterhouseCoopers

Figure 4: Global Employee Engagement Rates

Region	Engaged	Not Engaged	Actively Engaged
United States and Canada	29%	54%	18%
Australia and New Zealand	24%	60%	16%
Commonwealth of Independent States and Nearby Countries	21%	60%	19%
Western Europe	18%	62%	21%
Southeast Asia	12%	73%	14%
Central and Eastern Europe	11%	63%	26%
Middle East and North Africa	10%	55%	35%
South Asia	10%	61%	29%
Sub-Saharan Africa	10%	57%	33%
East Asia	6%	68%	26%

Note: Totals may not equal 100% due to rounding.
Source: Gallup Employee Engagement Study. 2013.

10. Crabtree, Steve. Worldwide, 13% of Employees are Engaged at Work. October 8, 2013. (www.gallup.com/poll/165269/worldwide-employees-engaged-work.aspx?version=print).

11. Yu, Daniela, and Srinivasan, Rajesh. Employee Engagement Increases in China, but Still Very Low. February 20, 2013. (www.gallup.com/poll/160190/employee-engagement-increases-china-low.aspx).

Good indoor air quality can be achieved by following the 3As (Assess, Act, and Assure).

Though the actions taken by employers to improve indoor air quality in a new or old building will differ, the process undertaken to get there will be the same. While many employers have a tendency to cut corners at some stage of the process, believing that budgetary requirements will be beyond their reach, this is perhaps unwise. Skipping over a step could lead to serious repercussions – the circulation of dirty and dangerous air – that could prove much costlier and painful to fix at a later date. It is also important to note that not all undertakings to improve air quality are necessarily costly. Moreover, as companies face added pressures to run on lower operating budgets to increase their competitiveness in the market, we expect more employers in China to place greater emphasis on finding better balances between achieving good indoor air quality, energy-efficiency, and cost-savings.



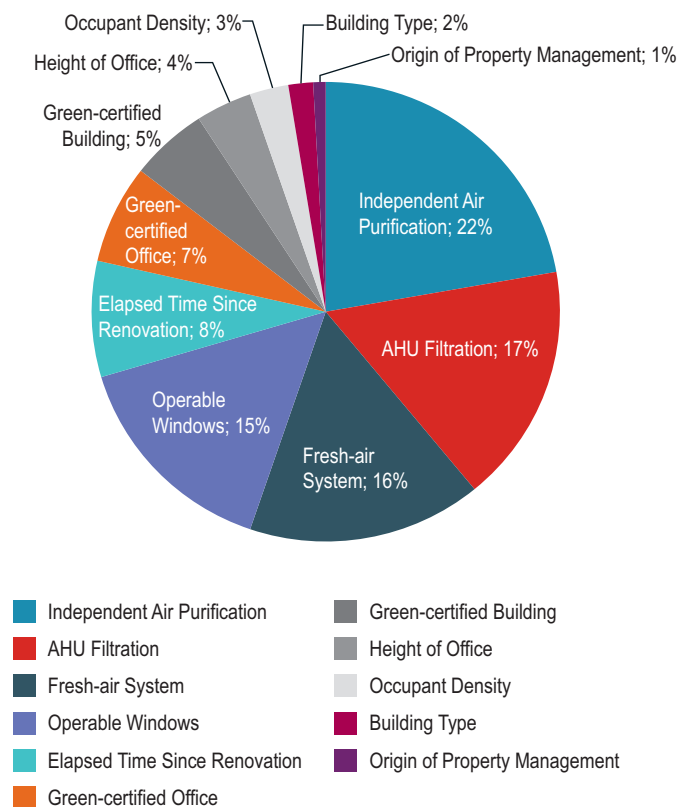
Assess your workplace situation.

When considering a space for lease, tenants should be proactive in asking landlords about what has been done to provide good indoor air quality in the building. For example, does the office tower have a fresh-air system in place, and is it kept on during all operating hours? Is there a centralised air filtration system? The more tenants asking these questions, the better, as it motivates landlords to consider these specifications when they do upgrades. It also applies pressure on them to change their property management practices. Yet even if a landlord assures you of excellent air quality, it is not possible to detect the indoor air quality of a space solely by relying on their responses. Even in cases where the landlord has answered truthfully, the differences in design, operation, and maintenance can produce different outcomes. Therefore, performing due diligence is important. Having air quality tested not only provides a snap picture of the situation, but also helps to form the basis for a solution to improve the indoor air quality of the space in question. For the best results, PM2.5 auditing should be conducted by a credible third party, not only before occupation as is most commonly done, but actually prior to fit-out commencement to ensure that solutions can be implemented during the fit-out period (or afterwards as a retrofit). This assessment is critical to knowing how to act. For example, is the existing system acceptable and just in need of a filtration upgrade? Is better maintenance required? Or what kind of air purification should be added if the current system cannot be upgraded? As the industry develops further, pre-testing before signing a lease agreement should be adopted as an industry standard.

Act on that information.

With a sample of 100 data points collected at some 50 commercial offices around the country in Beijing, Shanghai, Chengdu, and Suzhou from indoor air quality testing carried out from 2013 to 2015, our partner for this paper, indoor environmental quality consultancy PureLiving China, considered almost a dozen factors contributing to indoor air quality. This helped us determine what has the biggest impact on PM2.5-reduction indoors. Surprisingly, while several factors, including building height, occupant density, and green certification had little correlation with the reduction of PM2.5 indoors, statistical analysis revealed that as a group, mechanical systems, specifically the heating, ventilation, and air conditioning (HVAC), and filtration functions, make the most meaningful contributions to cleaner indoor air at offices in China (see Figure 5). Therefore, these should be the prime focus of efforts to improve the air where we work.

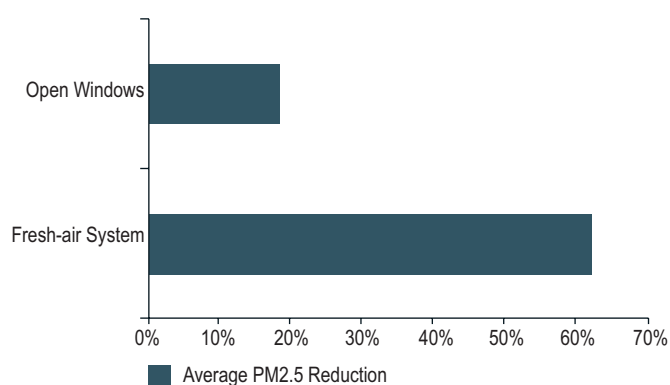
Figure 5: Relative Impact of Factors on PM2.5 Reduction



Source: PureLiving China Certified PM2.5 Audits (2013-2015)

Improving the indoor air quality of an office can be as simple as ventilating the space with fresh air from an open window; this helps to dilute air contaminants such as carbon dioxide and VOCs. This works in other countries, even in cases where tobacco smoke is an issue. However, because China's outdoor air is typically heavily polluted, opening a window brings pollution into the breathing space. Since open windows do not flush out PM_{2.5}, buildings that rely on opening windows for ventilation achieve only minor reductions in PM_{2.5} concentration. Given that open windows offer zero filtration, this method only works on blue-sky days. Therefore, many office towers rely on a fresh-air system to ventilate the air within their building. Buildings that use mechanical systems for ventilation typically incorporate at least some type of filtration, however, varying filter grades will impact the degree to which the equipment will be effective (see Figure 6).

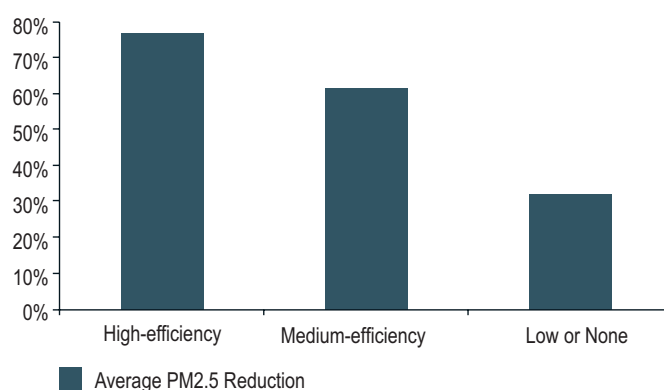
Figure 6: Building Ventilation Comparison



Source: PureLiving China Certified PM_{2.5} Audits (2013-2015)

The easiest way to purify the air is to exploit existing equipment and retrofit particulate filtration media into existing air handling units (AHUs) of a central HVAC system. AHUs utilising high-efficiency filters deliver large amounts of purified air at a minimal cost, while AHUs operating without a filtration mechanism will be largely ineffective in reducing PM_{2.5} levels (see Figure 7). Note that HEPA (ultra high-efficiency particulate air) filters – while suitable for portable air purifiers – are too restrictive of airflow to enable the functioning of the HVAC system, which requires slightly more porous filters to achieve the necessary balance between airflow and the capture of particulates.

Figure 7: Impact of AHU Filtration Efficiencies on PM_{2.5} Reduction



Note: There is a system called MERV that standardises filtration efficiencies.
Source: PureLiving China Certified PM_{2.5} Audits (2013-2015)

The importance of performance-based standards

In the near future, we shall see a conversion of the market to performance-based standards. This will be driven in part by employees whose access to real-time information has already begun to surpass that of employers. As consumer-grade air quality monitors continue to flood the market, air quality in the workplace will increasingly be tested and challenged at any and all times by employees. This is an opportunity to create better employee-employer engagement for mutually beneficial outcomes. Performance-based standards based on real-time measurements will become imperative not only for attracting talent, but also maintaining trust and employee satisfaction. Although standards will continue to evolve quickly, several key components of what they will determine has already become apparent: from determining the grade of monitor being used to how and where these devices are installed. Currently, the RESET Certified Standard is the only third-party system to address these questions.

“Our industry is rapidly becoming transparent and performance-based. Whereas this trend is led by governments in the energy and water sectors, it is almost entirely led by individuals in the air quality sector.

This trend is moving at consumer speed within an industry that is traditionally slow and conservative. Those in real estate who are equipped with the proper knowledge, and respond quickly, will have much to gain.

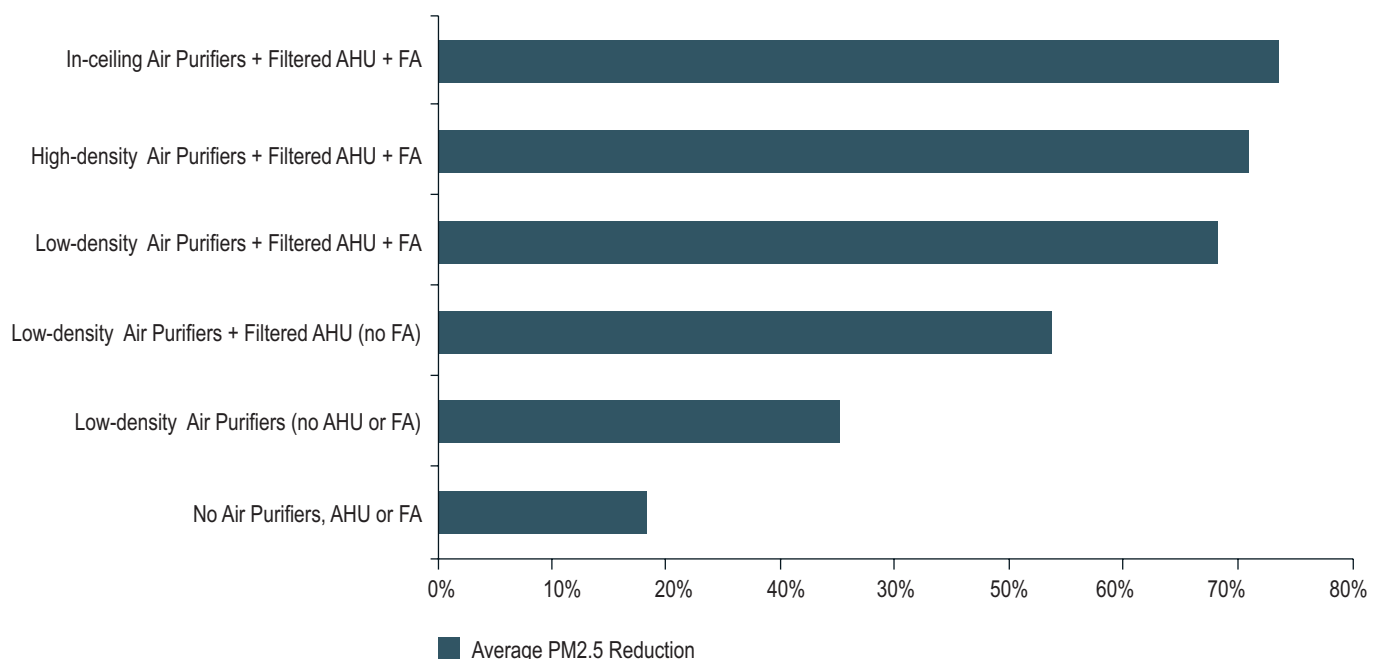
Raefer Wallis
Founder and CEO of RESET

Unfortunately, retrofitting the central ventilation or air conditioning system is not always an option because of the negative impact on airflow, or the landlord's unwillingness to allow modifications. Therefore, many tenants assume that control over their environment is beyond their reach. However, it turns out that companies can in fact significantly benefit from installing independent purifiers that filter the air within the tenant's space. Depending on the size of the space or the time permitted for the upgrade, different methods can be used to filter the recirculating air.

For large spaces where installing a central filter is not possible, independent air purification is necessary. There are two ways to approach this. One is the use of portables, which can be highly effective, but carries cost, maintenance and human error drawbacks. Meanwhile, in-ceiling solutions are the most effective and cost-efficient. The in-ceiling approach has been found to be significantly more effective for big areas compared to portable air purifiers at floor level due to their high capacity and therefore sweeping coverage area. In-ceiling systems can also be spaced apart without any airflow obstructions from furniture. This allows for evenly distributed filtration at a faster rate and minimal sources of interruption. By comparison, portables are frequently found turned off, without a filter, with a dirty filter, or with a filter incorrectly inserted – all forms of human error that make it difficult for the machines to work as designed. Portables are also often misplaced within an office, with objects blocking their air intake and output, and this, too, handicaps their effectiveness. The results of our analysis (see Figure 8) demonstrate which combinations of mechanical systems generate the best results in terms of reducing PM2.5 levels indoors. A combination of in-ceiling purification, AHU filtration, and a fresh-air system is most likely to lead to the best possible outcome.



Figure 8: HVAC and Filtration Combination Efficiencies



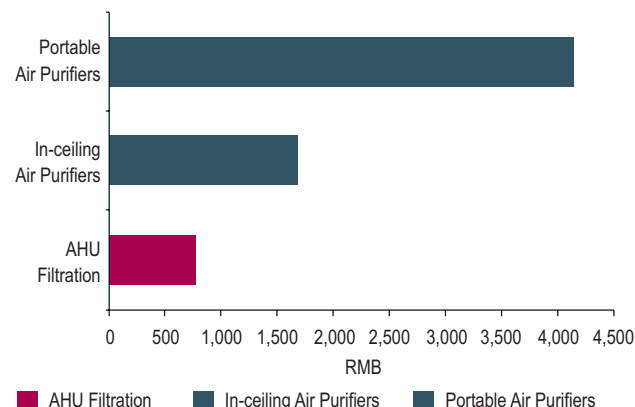
Note: Medium-efficiency filters applied to AHU Filtration. High-density portables = > 1 per 50 sqm while low-density portables = < 1 per 50 sqm. FA = Fresh-air System. AHU = Air Handling Unit.

Source: PureLiving China Certified PM2.5 Audits (2013-2015)

The use of mechanical systems (which is anything besides opening the window) is most compelling when extreme spells of pollution hit. Figure 9 shows the actual recorded PM2.5 levels in a 1,000-sqm Grade A office in Shanghai during a historic “airpocalyptic” episode in December 2013. This is the true stress-test of the equipment. By using in-ceiling air purifiers to filter the recirculating air, the company’s office effectively achieved a 93 percent-reduction. Indoor PM2.5 levels never exceeded 40 micrograms per cubic metre while outdoor levels soared up to 570 micrograms per cubic metre. The outdoor Air Quality Index (AQI) reading at the time was off the charts, but the indoor equivalent only reached the low 100s at its peak.

While portable filtration units are quicker to set up and cheaper by the unit than ceiling units, more portables are required to cover a larger space. Therefore, portables are most suitable for smaller rooms (typically working best in spaces smaller than 20 square metres in size) or temporary offices requiring flexibility in deployment. While in-ceiling units take comparatively longer to set up, their installation is still relatively quick, and they can be hidden with drop ceilings to reduce their visibility and distraction to employees. While the capital investment required for these systems is more upfront per unit than portables, they offer greater longer-term cost-savings due to lower maintenance costs and higher coverage per unit (see Figure 10).

Figure 10: Relative Cost for Mechanical System Filtration Options (per 1% PM2.5-reduction over 3 Years per 1,000 sqm)



Note: Medium-efficiency filters applied to AHU Filtration.

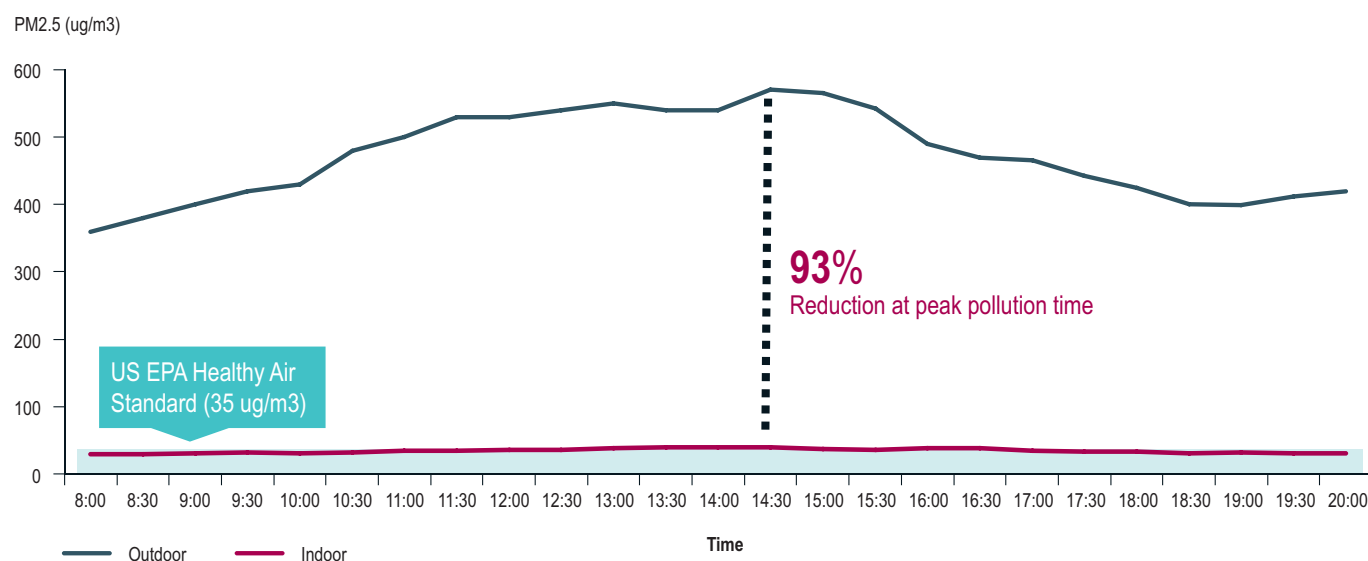
Source: PureLiving China

M Moser Associates has always focused on creating corporate workspaces that are not just attractive and energy efficient, but ones that people can be comfortable and productive in.

As we see more clients interested in indoor air quality and health, we believe designing workspaces with people in mind at the forefront brings tremendous values to the business.

Elaine Fang
Sustainability Advisory Services
M Moser Associates

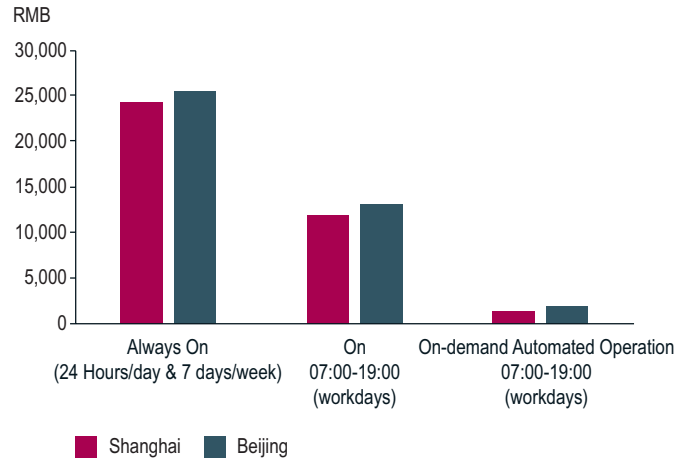
Figure 9: December 2013 Shanghai “Airpocalypse” – PM2.5: Outdoor vs. Indoor



Source: PureLiving China

Meanwhile, on-demand automation is the latest tool in the market. Strongly preferred for its ability to reduce human error – or mistakes commonly made when it comes to manually operating purifiers, such as cleaners accidentally turning units off on “good days” and people fighting over the control switch without understanding how the machines work. On-demand automation is also highly efficient and energy-saving as pre-programmed functions enable air filtration systems to respond to real-time air quality readings and turn on or off according to actual conditions, which helps to streamline the consistency of good indoor air quality (see Figure 11). Because the machines do not need to be kept on at all times, on-demand automation also lowers operating costs through energy savings (see Figure 12). Therefore, we expect interest in on-demand automation to grow as the number of employers investing in better indoor air quality rises.

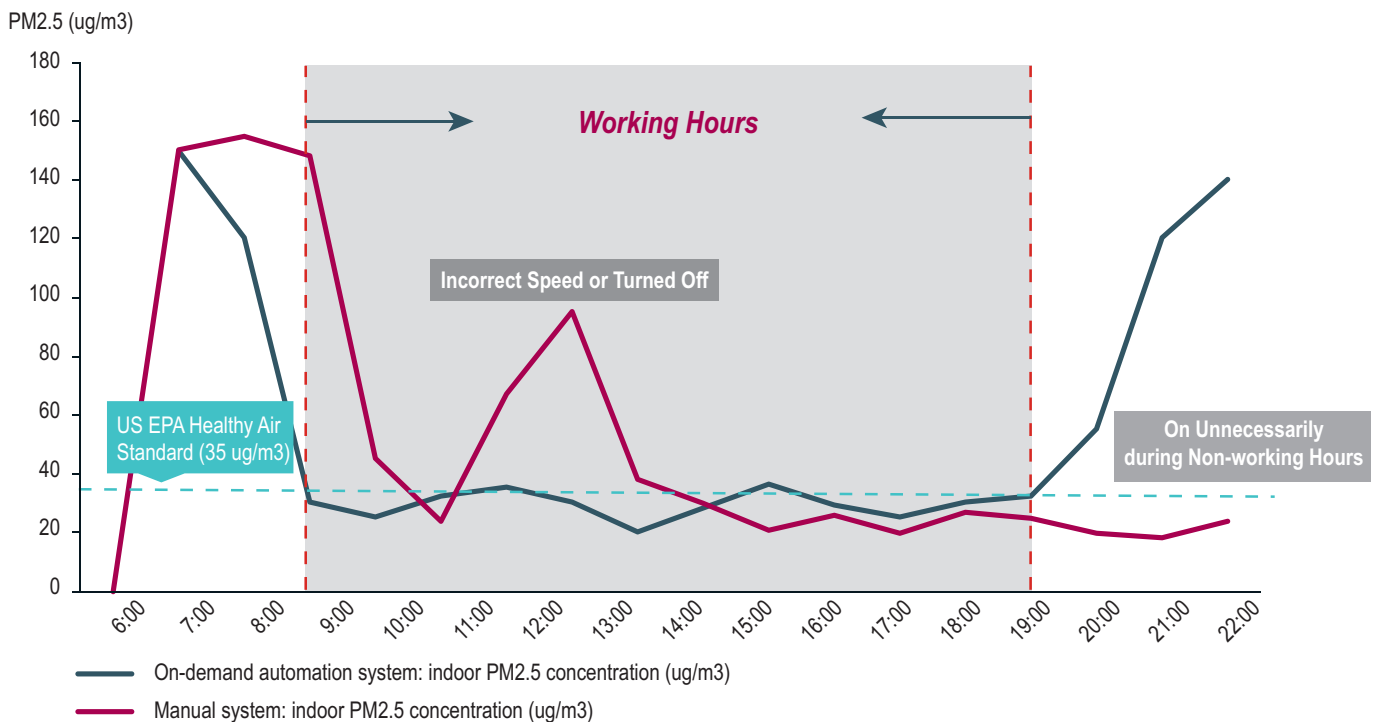
Figure 12: Annual Energy Costs per 1,000 sqm (RMB)



Note: On-demand automation calculation based on pre-programming that turns machine off once outdoor PM2.5 levels drop below 75 ug/m3.

Source: PureLiving China

Figure 11: On-demand Automation vs. Manual Operation: PM2.5-reduction Trend



Source: PureLiving China



The key selling point of RESET for the China office market is that it grades the indoor air quality of a space based on the results of a three-month period of continuous monitoring which pays close attention to PM2.5 levels.

Assure that good air quality is maintained by continuously monitoring your accredited space.

Many landlords and employers mistakenly assume that once the installation is complete, there remains nothing left to do. In fact, the real work begins after a designated system is up and running. The ability of employees to track air quality in real-time with indoor air quality monitors and mobile apps is rapidly driving the industry toward performance-driven solutions, putting more pressure on employers to provide safe air during working hours. This is also exerting more pressure on landlords, as tenants expect their buildings to deliver consistently good indoor air quality.

The next step is monitoring to validate and fine-tune performance of the equipment, as well as improve training and communications among the staff operating the machines. Best of all, automated operations allow both landlords and employers to take care of all of this while getting the most out of their system. Industry certifications such as RESET (www.reset.build) or WELL (www.wellcertified.com) help protect occupant health with specific requirements for criteria affecting indoor air quality. Not only do these accreditations provide a road map and standard for creating healthy spaces, they provide marketing benefits and recognition for those who make the effort and achieve real results. Dedicated to the overall comfort and well-being of occupants, the WELL accreditation takes on a holistic approach, demanding a series of requirements that include strict standards on factors affecting indoor air quality. The RESET

certification differs from WELL in that it primarily concentrates on indoor air quality with a focus on PM2.5, and because of this, it is arguably the most relevant to the China market and others where pollution poses challenges. Starting at the design phase, RESET considers the indoor health of a space by drawing from a database categorising the safety and/or risk of some 104,000 materials – a key element of the equation, but beyond the scope of this paper.

The key selling point of RESET for the China office market is that it grades the indoor air quality of a space based on the results of a three-month period of continuous monitoring which pays close attention to PM2.5 levels. Certified spaces are subsequently tracked with a real-time monitoring app online that conveniently enables indoor air quality conditions to be displayed publicly for employees to follow. With certified, live readings and metrics, the app offers a high degree of transparency for operations teams to continuously improve indoor air quality. Equally important, the app, along with similar apps that track indoor air quality in real-time, offers employees high visibility of air quality conditions in their workspace.

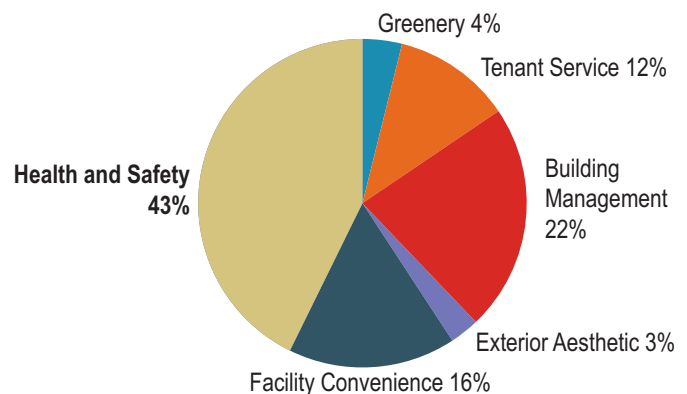
Additionally, real-time monitoring apps are a powerful feedback tool in holding both landlords and tenants accountable for the indoor air quality of their space on a regular basis. It ultimately encourages both sides to work together to make certain that problems are rectified quickly as they arise, further helping to minimise interruptions to good indoor air quality.

Investments in indoor air quality help to differentiate office buildings from competitors, better enabling them to retain value in any market.

While employers have numerous reasons incentivising them to act quickly, it should also be recognised that landlords, too, have a very persuasive case to be proactive in leading the market. As more landlords consider HVAC upgrades, making the right level of investment in system upgrades will be essential. Under-investing has been the case historically and should be avoided. However, over-investing from an insufficient assessment of the situation is also to be avoided. The bottom line is that office towers with good indoor air will only be more appealing to tenants. Buildings without good indoor air quality will provide tenants with less incentive to sign or renew their leases, particularly in older buildings where tenant leases are nearing expiry. In the worst-case scenario, tenants will move into buildings with cleaner air. Even buildings with very high occupancy are still susceptible to losing tenants. Today, office buildings with good indoor air quality are able to differentiate themselves from competitors. Later, as more buildings upgrade their systems, those with the best equipment (specifically fresh-air systems and AHU filtration) will be able to maintain their relevance

to the market. This will help properties with good indoor air quality to be more resilient in periods of economic downturn or slow growth due to their long-term market viability, according to the results of a 2013 Beijing Tenant Survey (by Building Owners and Managers Association (BOMA) China) indicating that health and safety are a priority for building satisfaction (see Figure 14).

Figure 14: Most Important Criteria for Building Satisfaction


















Source: 2013 Beijing Tenant Survey by BOMA China

What lies ahead

There is evidence that strict government pollution controls in China are working. Beijing observed humble improvements in PM2.5 levels in 2014 compared to 2013, and this trend is expected to continue in 2015. However, experts believe that it will still be decades before outdoor pollution levels in China fall to those of mature markets. Due to the alarming conditions in China, pollution has become a mainstay of daily conversation all over the country. As a result, routine habits such as wearing protective masks, using air purification machines at home, and checking mobile apps for real-time outdoor readings on air quality before planning activities outside have become commonplace for millions of people nationwide. Perhaps, the tipping point for people in China, public pressure on the government to put an end to the haze has been mounting ever since the "Beijing Airpocalypse" in January 2013. The Chinese government's most recent pledge to combat pollution as part of China's 13th Five-Year Plan (2016-2020) illustrates that leaders are focused on the issue, but the reality is that there is no immediate solution to the problem.

China's Energy Policy Outlook

	12 th Five-Year Plan (2011-2015)	2013	2014	National Air Pollution Plan (2013-2017)	National Energy Plan (2020)
Coal Power					
% of Energy	~ 65	66-67	64.2	< 65	< 62
Non-Fossil Fuel Power					
% of Energy	11.4	9.8	11.1	13.0	15.0
Gas Power					
% of Energy	7.0	5.9	> 6	9.0	> 10

Curbing Coal Usage and Increasing Reliance on Non-fossil Fuels

Source: Greenpeace Beijing's New Normal Presentation. 2015.

Pollution in China is not just a Beijing problem – or even a North China one – it is far-reaching and affects the entire country.

When people think of pollution in China, Beijing automatically comes to mind. Following the “Beijing Airpocalypse” in January 2013 – when PM_{2.5} concentrations soared to more than 22 times the level deemed safe by the World Health Organization¹² – media headlines have largely focused on Beijing. The attention has since put the capital under constant scrutiny for its bad air, yet Beijing is far from experiencing the worst air in the country. In fact, several other cities have also experienced their own “airpocalyptic” episodes. While some places are worse off than others are, the reality of the situation is that the bad air in China directly affects nearly every pocket of the country (see Figure 15). As a region, the corridor that extends south-west from Beijing, meanwhile, suffers from the highest concentration and largest sources of pollution in China,

according to data collected from some 1,500 ground stations in and around the country in 2014¹³. Considering the vast reach of pollution in China, complacency, whether in Beijing or not, would be unwise.

Pollution presents numerous challenges for China. With regards to its bearing on indoor air quality, topical clinical research in China is limited, but is expanding quickly as awareness has grown exponentially in just the last few years.

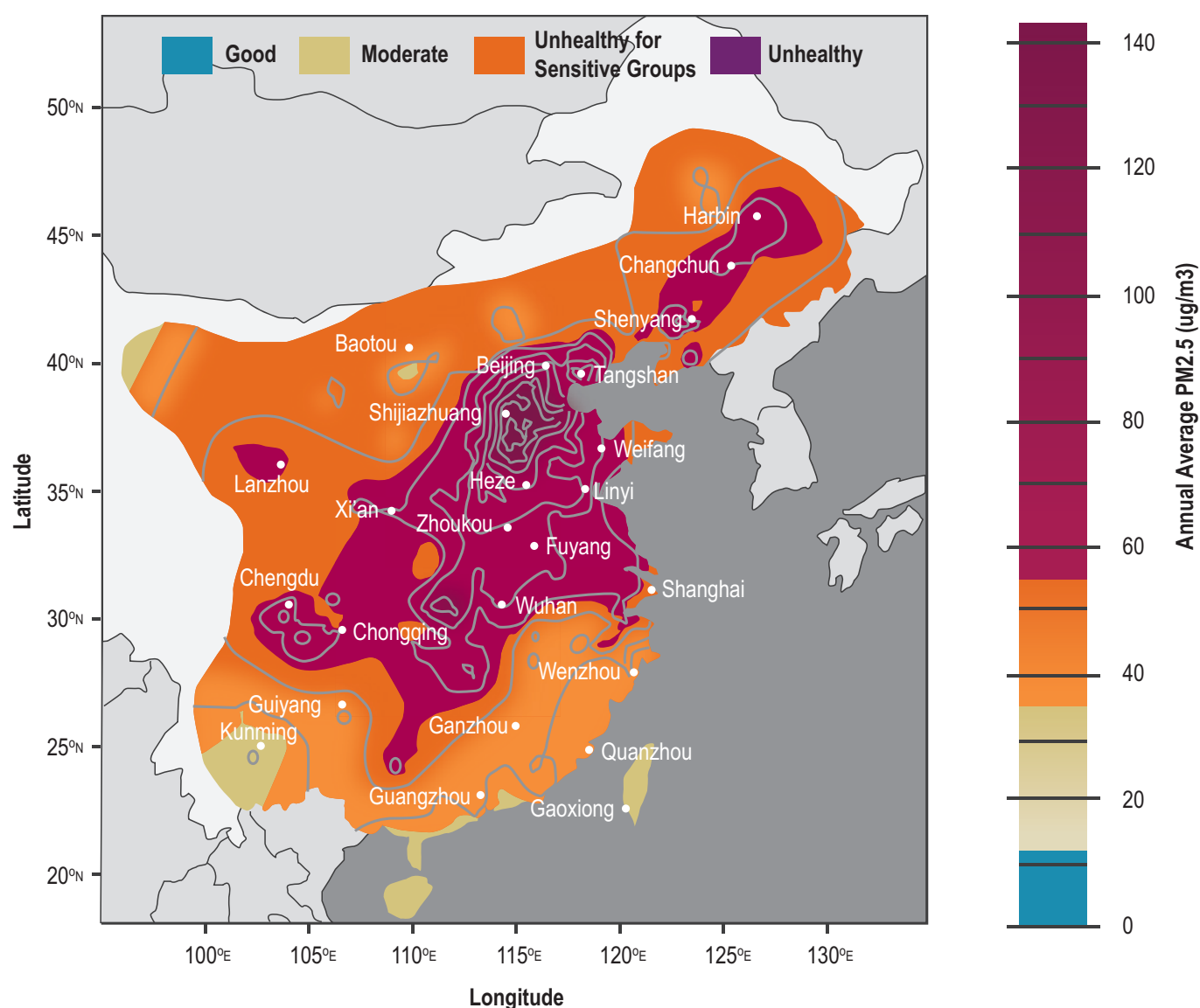
Moreover, contrary to popular belief, the impact of unpleasant and unhealthy conditions on productivity is as pronounced in China, if not more than overseas studies indicate.

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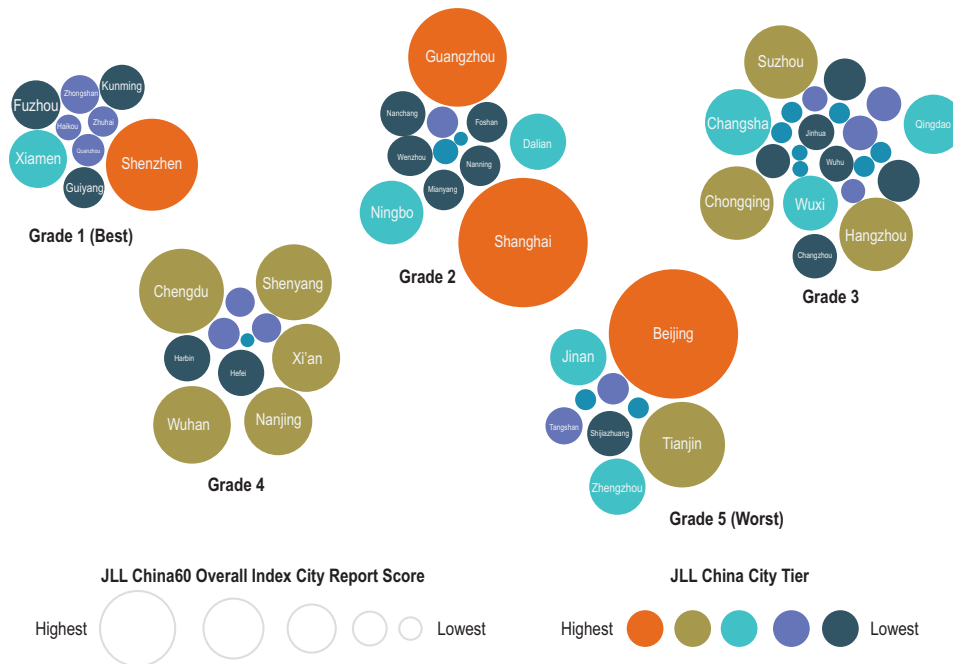
Figure 15: Air Pollution in China



Source: Berkeley Earth's Air Pollution in China Study. 2015.

12. WHO caps PM_{2.5} exposure at 25 micrograms over a 24-hour average.

13. Rohde RA, Muller RA (2015) Air Pollution in China: Mapping of Concentrations and Sources. PLoS ONE 10(8): e0135749. doi:10.1371/journal.pone.0135749 (berkeleyearth.org)

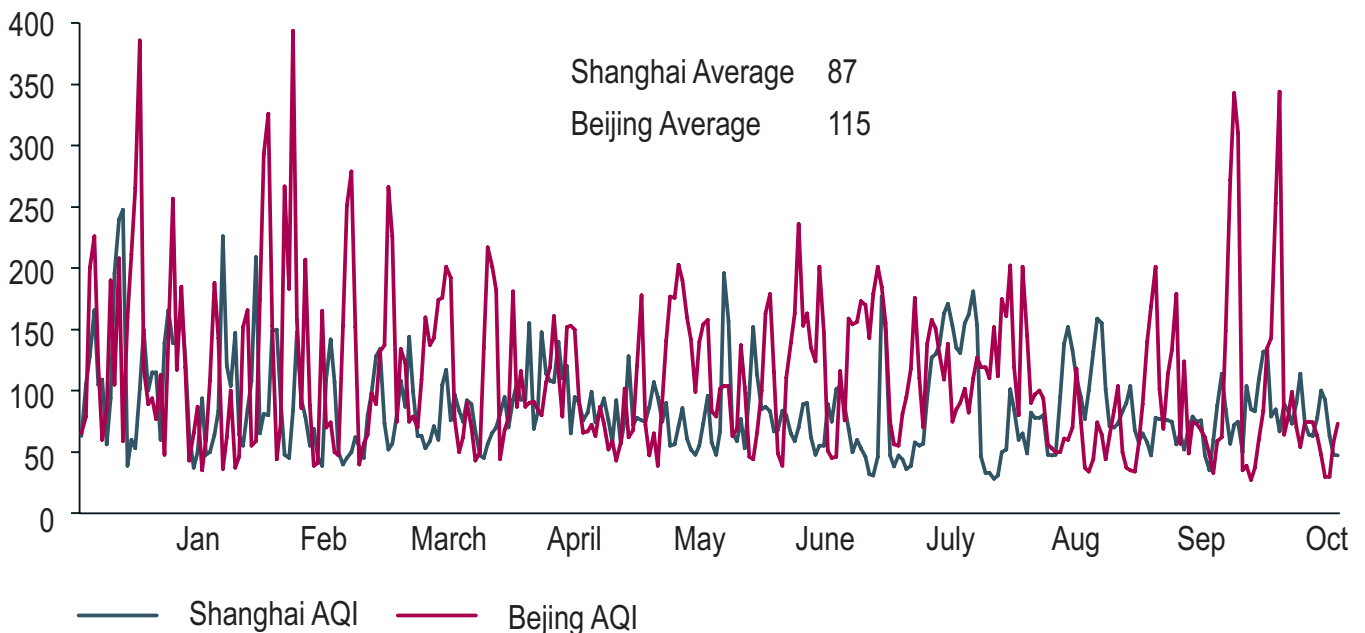
Figure 16: Air Quality Index Group Categories for 64 Cities in China

Note: Grade 1 refers to the best group; Grade 5 refers to the worst group. The best city's annual average AQI was 43 according to the Chinese standard, while the worst was 170.

Source: Ministry of Environmental Protection of China, JLL China60 Report (www.jll.com/china60)

JLL's own analysis of full-year 2014 air quality statistics separated 64 major Chinese cities into quintiles according to their annual average China AQI readings (see Figure 16). The groupings rank the relative severity of cities across China and illustrate that while coastal cities enjoy some reprieve from the sea breeze, air quality levels rapidly deteriorate as one moves inland a few dozen kilometres.

Yet for all of the times that Beijing is put in the hot seat for pollution, it is fair to say that the pollution peaks are high in the capital. When comparing China's two main cities, Beijing frequently has more "bad air" days than Shanghai (see Figure 17). While this hardly means that Shanghai is immune to the situation, this fact does add more weight to the argument for landlords and tenants in Beijing – comprising one of the most influential markets in the country – to act sooner rather than later and set the tone for the country.

Figure 17: 2015 Air Quality Index (from January to end-October)

Note: AQI refers to the Chinese Air Quality Index.

Source: Ministry of Environmental Protection of China

Healthy buildings foster development of truly innovative cities by helping thwart “brain drain”

It is no secret that innovation is a key measure to further enabling China to compete globally. For the nation to push ahead as a legitimately innovative force, however, it will require top talent. Yet, as China's most highly educated and skilled residents move abroad, seeking so-called greener pastures in developed countries, where healthier living and cleaner air are part of the draw, the need to better manage China's pollution is undeniable. In 2013, the number of Chinese residents overseas totalled 9.34 million people, almost double the figure in 2000, underlining the extent of the country's “brain drain” deficit (see chart below).

Given rising health complaints and surging health care costs, the move toward sustainable development in China will be a key component for helping re-route citizen outflow patterns in the future*. Increasing difficulties in attracting and retaining top talent will effectively impede economic development and competitiveness among global counterparts. Thus, at a time when swelling numbers of people are leaving and relatively few are arriving, the importance of a healthy office market – capable of not only protecting China's brightest minds, but also of attracting top talent from elsewhere – is arguably more critical now than ever.

Population Inflows and Outflows for China



Source: Center for China & Globalization's Annual Report on Chinese International Migration. 2014.

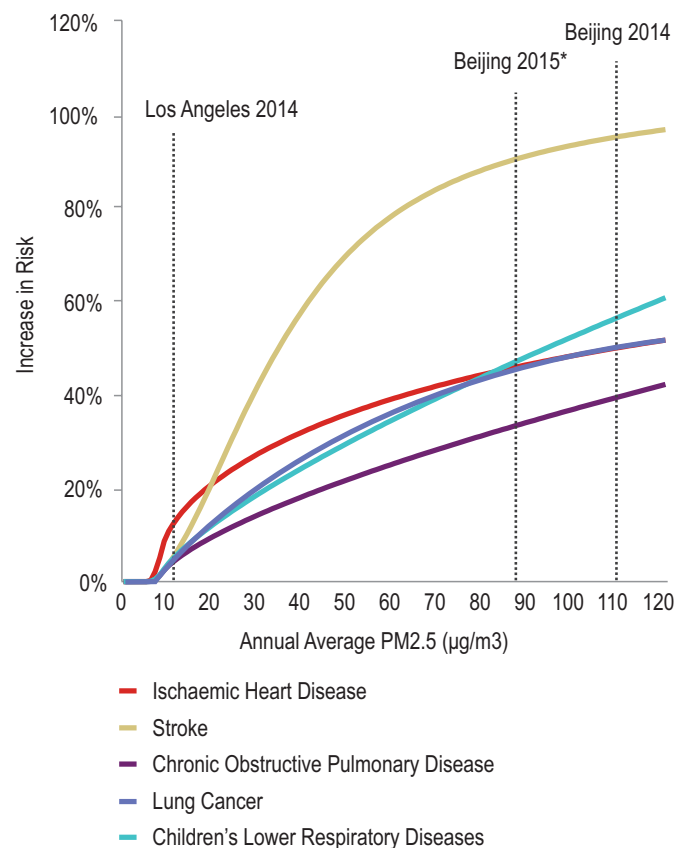
* Annual Report on Chinese International Migration: 2014. Center for China & Globalization.

While pollution is harder on the young and old, it does not discriminate, and therefore, after lengthy amounts of exposure to the bad air, everyone will suffer in some form or another. From 2000 to 2012, cancer rates and incidence of diseases linked to air pollution have increased significantly for both men and women in China¹⁴. Considering that urban residents in China spend an average of 87 percent of their time indoors¹⁵, improvement in indoor air quality will have a tremendous potential gain for public health, for which costs are expected to continue rising¹⁶.

Moreover, the direct impact of particulate matter on health shows a disturbing reality, with residents in China subject to extremely high risk of heart disease, stroke, pulmonary disease, lung cancer, and children's respiratory diseases (see Figure 18). Using Beijing as a case study, we see that even though the city's annual average PM2.5 figure is expected to improve modestly from 2014 to 2015, it is still exponentially greater than that of Los Angeles – the most notoriously polluted US city. This shows the polar gap between both cities and underscores the serious public health issues facing Beijing.

Therefore, without sincere and effective actions taken to reverse these trends soon, it will only be a matter of time before the toll on China's workforce overburdens the market and has far-reaching implications which worsen the situation. With this in mind, it would be in the best interest of the market as a whole to move swiftly to provide more breathable working spaces.

Figure 18: Increase in Risk of Death from Air Pollution-related Diseases



*Note: Forecast as of October 2015 (Greenpeace Beijing's New Normal Presentation).

Source: Greenpeace, Global Burden of Disease, and the US South Coast Air Quality Management District

14. China Statistical Profile. World Health Organization. January 2015. (www.who.int/gho/countries/chn.pdf?ua=1).

15. China's Ministry of Environmental Protection. Exposure Factors Handbook of Chinese population: Adult Edition. Beijing, China: China Environmental Science Press, 2013.

16. The Innovation Center for Social Risk Governance in Health associated with Fudan University; 2015. (srghealth.fudan.edu.cn/a/news/2015/0603/264.html).

Clean office air is hard to come by

Throughout the second half of 2015, JLL Research inspected PM2.5 levels in 160 office buildings in Beijing, of all grades, located in the urban area. While not a thorough, scientific testing process like that used by professional testing companies such as PureLiving China, where tests are conducted over multiple days with sophisticated sensors, the JLL Research team spot tests are a quick snapshot and an indication of the situation using consumer-grade tools. (Also, off-gassing and other indoor air issues are a different discussion not covered here.)

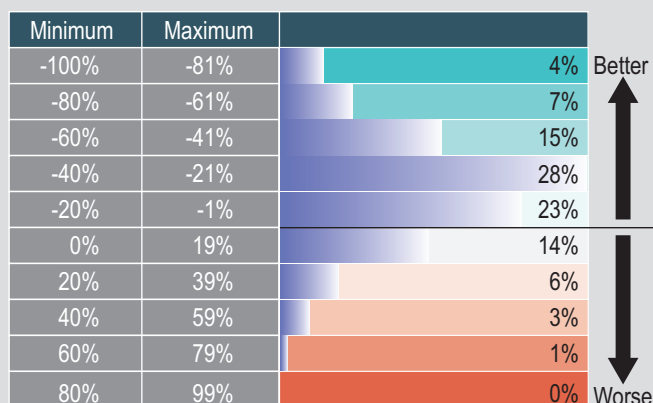
JLL took spot measurements in five locations: outdoors, which establishes a baseline, followed by the lift lobby, office corridors, stairwells, and washrooms. Buildings tested on days with outdoor baseline PM2.5 readings below 20 micrograms per cubic metre were removed (relatively clean days), leaving 145 buildings for analysis.

Ninety percent of office buildings in Beijing are not achieving a substantive reduction in PM2.5 with their current systems.

We compared the indoor readings with outdoors. A substantive means at least a 60 percent reduction in PM2.5 readings over ambient outdoor levels. This means that the vast majority of the buildings we tested are unlikely, with the exception of low-pollution days, to be able to maintain indoor PM2.5 levels within a safe range. Only about 4 percent of buildings achieved drastic reductions of 80 percent or more. It is these state-of-the-art buildings that set the example for others to follow.

While many buildings (about half) achieved slight or moderate reductions in PM2.5, they are defenceless against elevated levels of pollution. For example, a 20 percent reduction of a high PM2.5 level is still an undesirably high level. Similarly, a 40 percent reduction is still not satisfactory. In the first 10 months of 2015 in Beijing, 81 days were considered unhealthy, with an AQI over 150. This is approximately one out of three days. On these days, it would take a 60 percent to 80 percent reduction indoors to reach levels equivalent to a nice, blue-sky day. In spite of this, even a small reduction is a start.

Office Working Area PM2.5 Level vs. Outdoors*



*Days with outdoor air over 20 micrograms per cubic metre.
Source: JLL Research

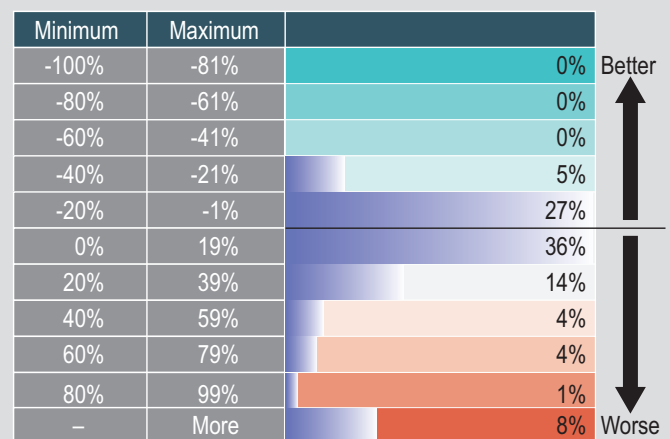
Some buildings have worse air quality indoors than outdoors.

Some buildings achieve no improvement at all. In fact, about one-quarter of all buildings surveyed showed worse air quality in indoor working areas than outdoors. Reasons could potentially include air intakes drawing from parking garages, or insufficient fresh air intake. Limited fresh air intake could cause a build-up of particulates. In a handful of extreme cases, indoor air was 50 percent worse than outdoor air, which needs to be addressed. The key point about PM2.5 levels is prolonged, extended exposure. While brief exposure is acceptable, long-term exposure – where people work daily – is where the damage is done.

Washrooms and stairwells are often worse.

We repeated the analysis with measurements taken in washrooms. In these areas, circulation is often not ideal, and in some buildings, tobacco smoke can also be a factor. A third of washrooms sampled had air quality worse than outdoors. Also, more than two-thirds of washrooms have higher PM2.5 readings than the working areas, and almost 10 percent of the buildings had washroom readings that were double that of the working areas.

Washroom vs. Working Area*



*Days with outdoor air over 20 micrograms per cubic metre.
Source: JLL Research

JLL also investigated stairwells, which are usually much less climate-controlled. They are also prone to particulate build-up and tobacco smoke in some buildings. We considered 122 buildings with accessible stairwells. While PM2.5 in almost a quarter of office building working areas exceeded outdoor levels, this number nearly doubles in stairwells. However, given that occupants spend little time in stairwells and washrooms compared to working areas, it is the working areas that should remain the focus for PM2.5 reduction efforts.


Leading by example

While we cannot change conditions outside, we can all play a part in controlling the situation indoors, which also happens to be where we spend the majority of our time working. In the interim, this means that the onus will increasingly be placed on landlords and employers to be proactive in providing effective and sustainable solutions to safeguard people from the major health risks that come with the bad air. Additionally, the weight of this burden is only likely to come down harder as more employees demand that the welfare of their health be taken seriously in the workplace.

With everything that there is to gain, we are cautiously optimistic that more market-movers will act and lead the pack with the delivery of sensible indoor air quality solutions. Though currently the skies are far too often grey, there is a real opportunity here for the office market to responsibly chart the path ahead and set an example for other markets. As public intolerance over environmental issues continues to grow, people are only likely to become more reluctant to spend their time in places with poor indoor air quality – and this resistance is eventually likely to spill over to other sectors, such as retail and entertainment. Also, as retail sales growth slows and malls

counter this by emphasising dining and leisure, indoor air quality will become all the more important as crowds gravitate toward clean air space. Thus, legitimately certified spaces with ongoing real-time monitoring results available to the public will have better odds of coming out on top, specifically as the detrimental health effects of pollution become even more apparent and people ask more of both employers and retailers.

In this paper, we have examined the subject of indoor air quality, with a dedicated focus on its relation to pollution in the China office market within the context of commercial real estate. Considering that pollution is an ongoing concern, however, our intent is not to be overly conclusive, but rather to help provide a better understanding of the bigger picture and how the issue is growing in significance for companies operating in China. We have also presented practical options that are available in the market that can help improve the situation – now. While more landlords and employers in the office market are increasingly getting on board, the reality of the situation is that the number of players currently acting to achieve good indoor air quality at their spaces continues to make up the minority, when in actuality, the pursuit of clean indoor air should really be a mainstream priority.



We cannot change conditions outside, but we can all do something to control the situation indoors, which also happens to be where we spend the majority of our time working.

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Special thanks to JLL Research's **Linda Yu** in Beijing for writing and compiling the paper and PureLiving China's **Amber Liu** in Shanghai for leading the data collection.



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