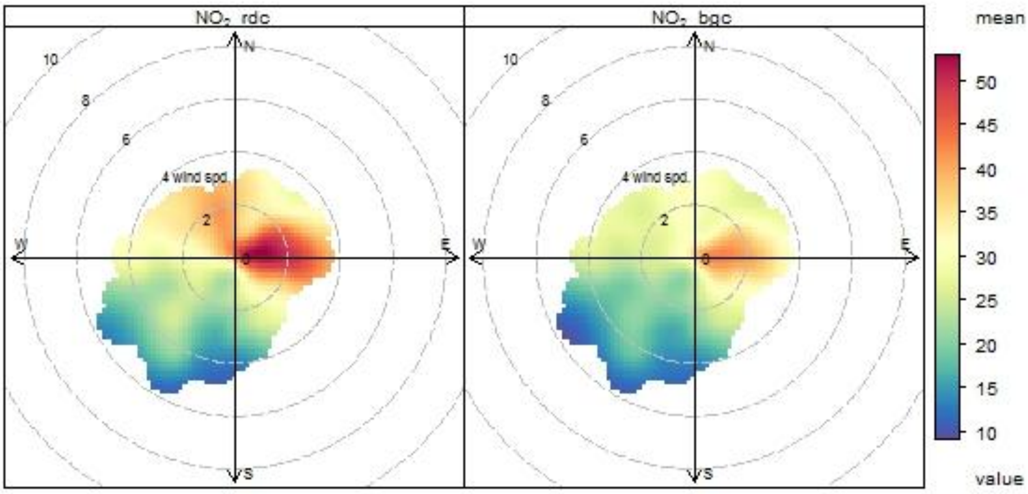



**Figure 8: Bivariate polar plot of the $NO_2$ (ppb) concentrations at the roadside site (rd) and playground site (bg) by wind speed and direction**

The pattern for $PM_{10}$ was more complex with sources evident to the east/north-east at mostly lower wind speeds and an additional source to the south-west at high wind speeds. The source to the east/north-east is likely to be the same as for $NO_2$ and hence due to traffic emissions from the various roads that surround the monitoring stations. The source seen to the south-west at higher wind speeds is due to emissions a further distance away. This could possibly be also due to traffic emissions from the Old Brompton Road, other $PM_{10}$ generation activity such as construction work or sea salt from marine sources often associated with these high wind speeds from the south west.

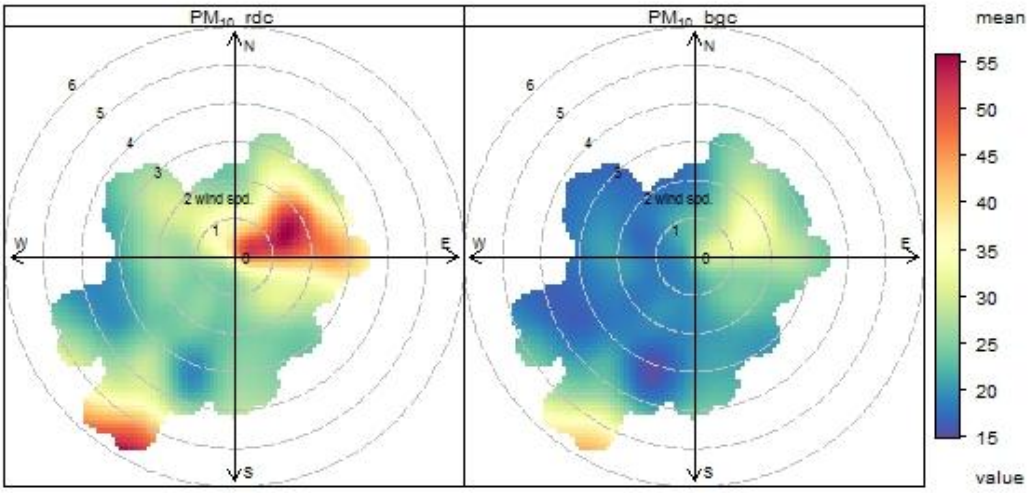



Figure 9: Bivariate polar plot of the $PM_{10}$ ($\mu g/m^3$) concentrations at the roadside site (rd) and playground site (bg) by wind speed and direction

## 3.4 Concentration difference between roadside and playground

Figure 10 shows monthly box and whisker plots of the daily mean concentration difference in % for $NO_2$ and $PM_{10}$, respectively. Also indicated is the between sampler uncertainty calculated using the co-location data.

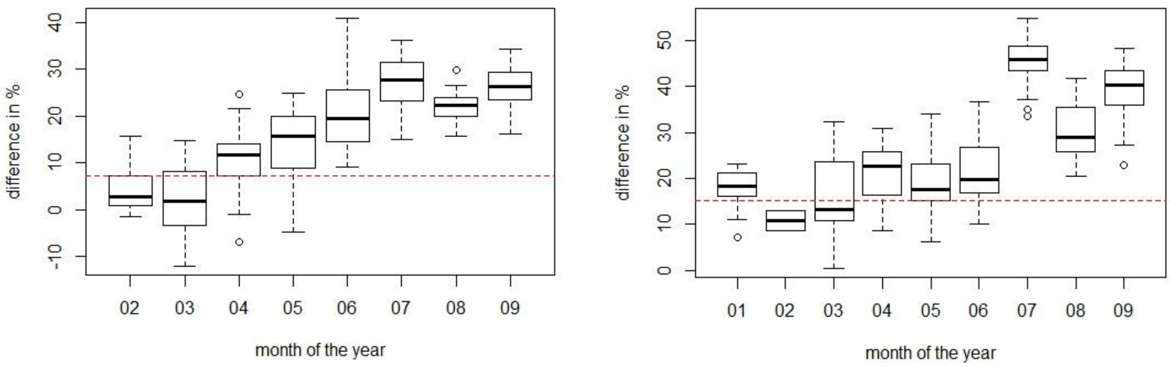



Figure 10: Monthly box and whisker plot of daily mean $NO_2$ (left) and $PM_{10}$ (right) concentration difference (%) in comparison to the daily between analyser uncertainty (dashed line)

For the first two months the $NO_2$ concentration difference between the two sites was on average 3% and increased to 10% in April. For $PM_{10}$, the initial three months showed an average difference of 16%. This difference likely reflects the slightly greater distance from the traffic emissions of the playground instruments as well as the immature green screen which blocked the transport of some of the pollutants into the playground (Figure 11). Importantly, this was smaller than or around the instrument uncertainties for both pollutants, which was 7.2% for $NO_2$ and 15.2% for $PM_{10}$.

As the ivy starts to grow, however, the concentration difference between the two sites increases above level of instrument uncertainty to an average of 24% for $NO_2$ and 38% for $PM_{10}$ from July to September 2014. The trend in the effect of the ivy growth is clear in the $NO_2$, increasing at approximately 5% per month. The trend is less clear in $PM_{10}$, suddenly increasing in July. $PM_{10}$ is likely to be influenced more strongly by background concentrations which in turn are influenced by episodic event. The resuspension of material from the ivy screen itself may at times impact on $PM_{10}$ concentrations measured on both sides of the screen. It is also possible that the effect on $PM_{10}$ is higher as the ivy screen filters. Encouragingly, the effect of the screen is broadly similar for both $NO_2$ and $PM_{10}$.


**Figure 11: Green screen on installation (left) and after growth period has started (right)**

## 3.5 Temporal variation in $NO_2$ and $PM_{10}$ concentrations

The diurnal and weekly variation of the pollution concentrations were plotted for the spring term period, which was before a significant concentration difference was found due to the ivy screen (07-01 to 11-04), the summer term, which was after a significant concentration difference was found (28-04 to 22-07) and during the period when the ivy screen had fully matured (23-07 to 30-09; Figure 12 and Figure 13).

The $NO_2$ concentrations show a clear diurnal cycle with a pronounced morning and evening rush hour, especially during the first period of analysis. The concentrations remain elevated throughout the day. The lowest concentrations can be found in the early morning hours. There is also a clear weekly pattern with Saturday and Sunday showing lower concentrations than weekdays.

When comparing the three periods, it is noticeable that the $NO_2$ concentration difference between the sites increases as the screen matures. Initially, during the summer term, the background concentration drops as the screen thickens and only increases slightly even though the roadside concentration increases during summer.

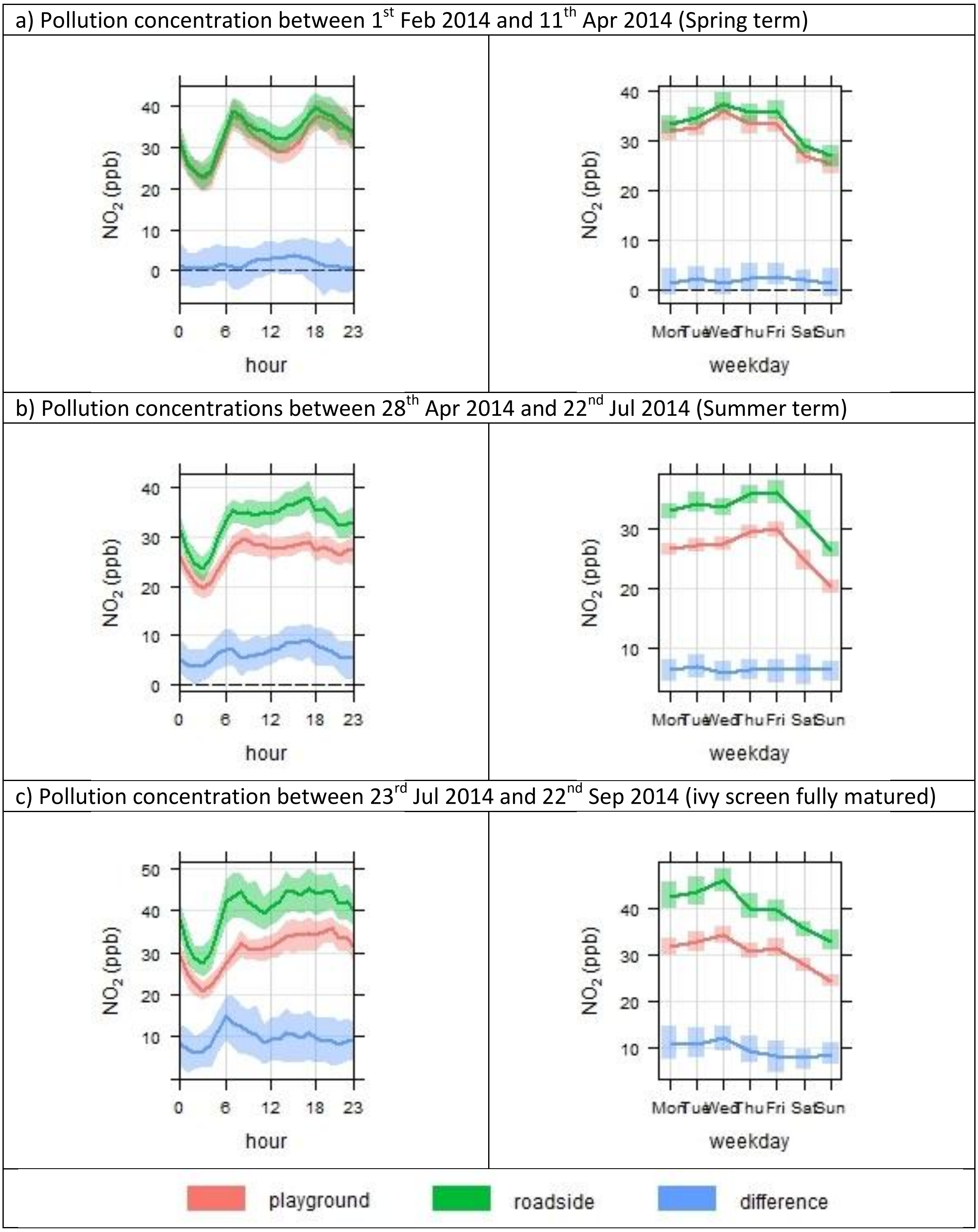



**Figure 12: $NO_2$ diurnal and day of week plots**

The diurnal pattern of $PM_{10}$ is less pronounced than that of $NO_2$. There is a clear rise during the morning rush hour and then the concentration stays elevated during the day. There is no clear pattern over the weekly cycle as they seem to differ in each period analysed. It is possible that a few days with high concentration have a marked effect on the concentrations overall.

When comparing the three periods a similar pattern can be seen for $PM_{10}$ compared to $NO_2$, with the background concentrations initially dropping compared to the roadside and staying lower in summer when concentration increase at the roadside.

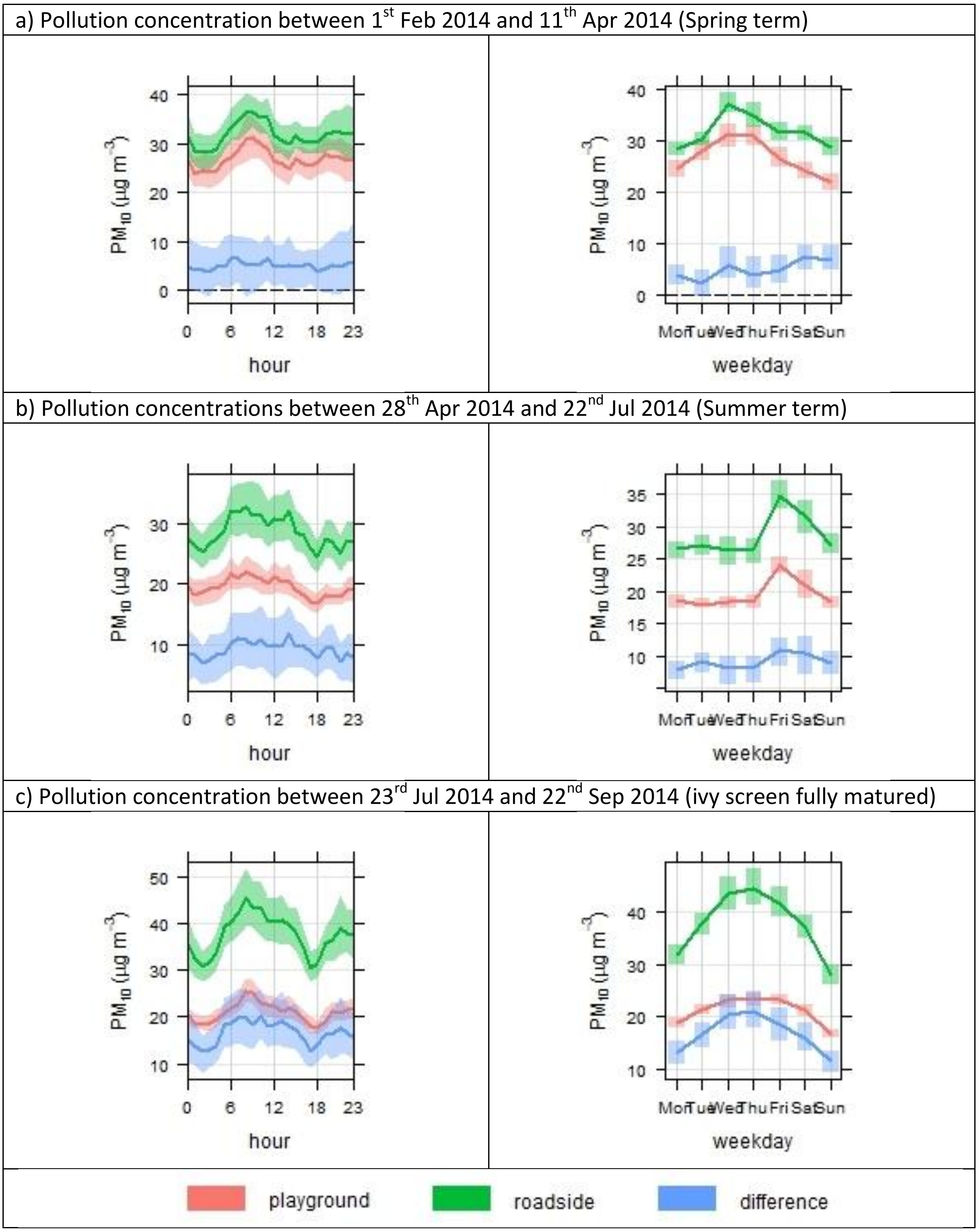



**Figure 13: $NO_2$ diurnal and day of week plots**

Examining the diurnal variations, it is clear that both $NO_2$ and $PM_{10}$ concentrations are higher during the daytime when children are in the school and playground. In order to quantify the effects the screen has on the exposure of the children, the pollutant concentrations in the three periods were calculated for daytime hours (09:00-16:00) of weekdays only (Table 3). A clear trend can be seen to the concentration difference as the screen matures, with a fully matured screen leading to a concentration decrease of 36% and 41% for $NO_2$ and $PM_{10}$, respectively, at the playground side of the screen. Again these are broadly consistent with each other, showing that $NO_2$ and $PM_{10}$ are reduced to a similar but slightly greater degree for $PM_{10}$, possibly due to the filtration effects.

| | Roadside Site | Playground Site | Difference | |
|---|---|---|---|---|
| **$NO_2$ in ppb ($\mu gm^{-3}$)** | | | | |
| spring term | 39.7 (75.8) | 31.1 (59.4) | 8.6 (16.4) | 22% |
| summer term | 41.5 (79.3) | 28.1 (53.7) | 13.4 (25.6) | 32% |
| mature screen | 50.3 (96.1) | 32.3 (61.7 | 18 (34.4) | 36% |
| **$PM_{10}$ in $\mu gm^{-3}$** | | | | |
| spring term | 37.1 | 31 | 6.1 | 16% |
| summer term | 30.4 | 21.1 | 9.3 | 31% |
| mature screen | 43.1 | 25.5 | 17.6 | 41% |

**Table 3: Roadside and playground pollution concentrations during school hours (09:00-16:00) for the spring term, summer term and after the ivy screen has fully matured**

# 4 Conclusions

$PM_{10}$ and $NO_2$ were measured either side of an ivy screen to assess the efficacy of a green screen to prevent the transport of vehicle emissions from the nearby road into the playground. The experimental design included periods of co-location which allowed both an assessment of uncertainty in the measurements so that any effect of the ivy screen could be deemed significant, or not. Furthermore, this allowed any biases between instruments to be corrected to ensure that any efficacy derived was independent of individual instrument anomalies. The consistency between pre and post trial co-location assessments and the high correlation of determination values demonstrated that this was a robust approach.

Highest $NO_2$ concentration could be observed during September and overall the annual mean air quality objective would not have been met on either side of the screen for $NO_2$ assuming that the analysis period is representative of the entire year. There are $PM_{10}$ episodes in March and September/October with the average concentration being below the annual mean objective; this is with the significant caveat that the PM10 measurement methodology is not equivalent.

$NO_2$ and $PM_{10}$ source directions are aligned with the road axes suggesting that pollution levels were generally highest when emissions were either recirculated from the A3220 (northbound) or blown along the road from sources on northbound A3220, old Brompton Road and southbound A3220. There was an additional source in south-westerly direction at high wind speeds for $PM_{10}$.

The screen was found to be an effective pollution barrier once the ivy had started growing and a significant impact could be seen once the screen had matured. The ivy screen led to a decrease in the $NO_2$ concentrations on the playground side of the screen by 24%, this was higher than the measurement uncertainty of 7% and was therefore significant. The decrease in the $PM_{10}$ concentrations on the playground side of the screen was 38%; this was higher than the measurement uncertainty of 15% and was therefore significant.

Comparing school hours independently a reduction in $NO_2$ concentrations of up to 36% and a reduction the $PM_{10}$ concentrations of up to 41% was found. This demonstrates that the screen is very effective during daytime hours, when both emissions and exposure are highest.

The reductions in $NO_2$ and $PM_{10}$ concentrations are broadly similar; the $PM_{10}$ reductions are slightly higher than those for $NO_2$ once the green screen has fully matured. This may illustrate slightly different effects that the screen is having on gases or particles. As the $NO_2$ concentration is lower than the $PM_{10}$ the gas may be passing through the screen while the particles are being filtered by the increased foliage.

Although it is clear that the screen has a significant effect in preventing the transport of pollution from the roadside into the playground, further work would be required to assess the impact of the screen at greater distances from the road.

# 5 References

Barratt B., Carslaw D.C., Fuller G., (2012). Characterisation & trends in air quality within the Royal Borough of Kensington & Chelsea. Client: Royal Borough of Kensington & Chelsea

Carslaw D.C., Beevers S.D., Ropkins K., Bell M.C., (2006). Detecting and quantifying aircraft and other on-airport contributions to ambient nitrogen oxides in the vicinity of a large international airport. *Atmospheric Environment*, 40(28), 5424-5434.

Carslaw D.C., (2013). *The openair manual*; open-source tools for analysing airpollution data.

European Parliament and Council, (2007). Regulation (EC) No 715/2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information.

Hill A. C. (1971). Vegetation: a sink for atmospheric pollutants. *Journal of the Air Pollution Control Association*, 21, 341–346.

Horak Jr., F, Studnicka, M., Gartner, C., Spengler, J.D., Tauber, E., Urbanek, R., Veiter, A., Frischer, T., (2002). Particulate matter and lung function growth in children: a 3-yr follow-up study in Austrian schoolchildren. *European Respiratory Journal*, 19, 838–845

Kelly, F. J., & Fussell, J. C. (2011). Air pollution and airway disease. *Clinical and Experimental Allergy*, *41*(8), 1059 – 1071

Sternberg, T., Viles, H., Carthersides, A., Edwards, M., (2010). Dust particulate absorption by Ivy (Hedera Helix L.) on historic walls in urban environments. *Science of the Total Environment*, 409, 162-168.

WHO, (2003). Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide. Copenhagen, World Health Organization.

# MOBIPANEL

# MOBIPANEL

## THE LATEST GENERATION IN VERTICAL GREEN

MobiPanel is an innovative and sustainable system for living walls on existing buildings and new developments. The latest generation in vertical green from Mobilane, specially developed to make future-proof and sustainable construction even more accessible. This unique modular system, with its interchangeable plant cassettes in two sizes, makes it possible to give a sustainable and vibrant appearance to both flat and curved walls.

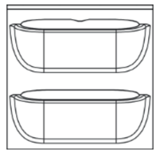
## FLEXIBILITY IN DESIGN AND CHOICE OF PLANTS

The system has been developed with circularity in mind. All its components can be disassembled, reassembled and recycled. The system is made up of corrosion-resistant profiles that can be installed both horizontally and vertically, depending on the format and layout of the backing wall. The profiles provide the bearing structure for the plant cassettes measuring 40 x 40 cm and the quarter-cassettes (pixels) of 20 x 20 cm. The plant cassettes are fitted with two spacious slots for plants of varying size. This flexibility allows great variation of design and choice of plants.

## GREEN APPEARANCE THROUGHOUT THE YEAR

Vertical greenery with a vibrant appearance is really easy to create with MobiPanel. The plant wall stimulates biodiversity, while purifying the air and regulating heat. The automatic irrigation system ensures that the plants receive the correct quantity of water and nutrition throughout the year. This means that the green wall remains a real eyecatcher in the urban environment, offices, parking garages, hospitality sector, etc.

## MOBIPANEL MATERIALS



Cassettes, pixels and cover: The cassettes, pixels and cover are made of fire-retardant EPP (B-s2, d0). This material is light, UV-resistant, breathable (for good root growth) and can be fully recycled.

Profiles: The omega profiles are made of high-quality and extremely corrosion-resistant Magnelis steel. The punched-hole pattern is suitable for both vertical and horizontal installation of the profile.This provides space for passing water pipes and electricity cables through with ease. In addition, this allows use on both flat and curved backing walls.

Planting: The plants used in the pre-cultivated cassettes in the MobiPanel system are grown at the Dartplant production site under “On the way to PlanetProof” certification. This independent certification proves that the plants for the MobiPanel facade have been produced more sustainably and are therefore a better choice for nature, climate and animals. The online Mobilane PlantGuide gives an overview of selected plant species that are recommended for planting on the MobiPanel facade.

hedera screens

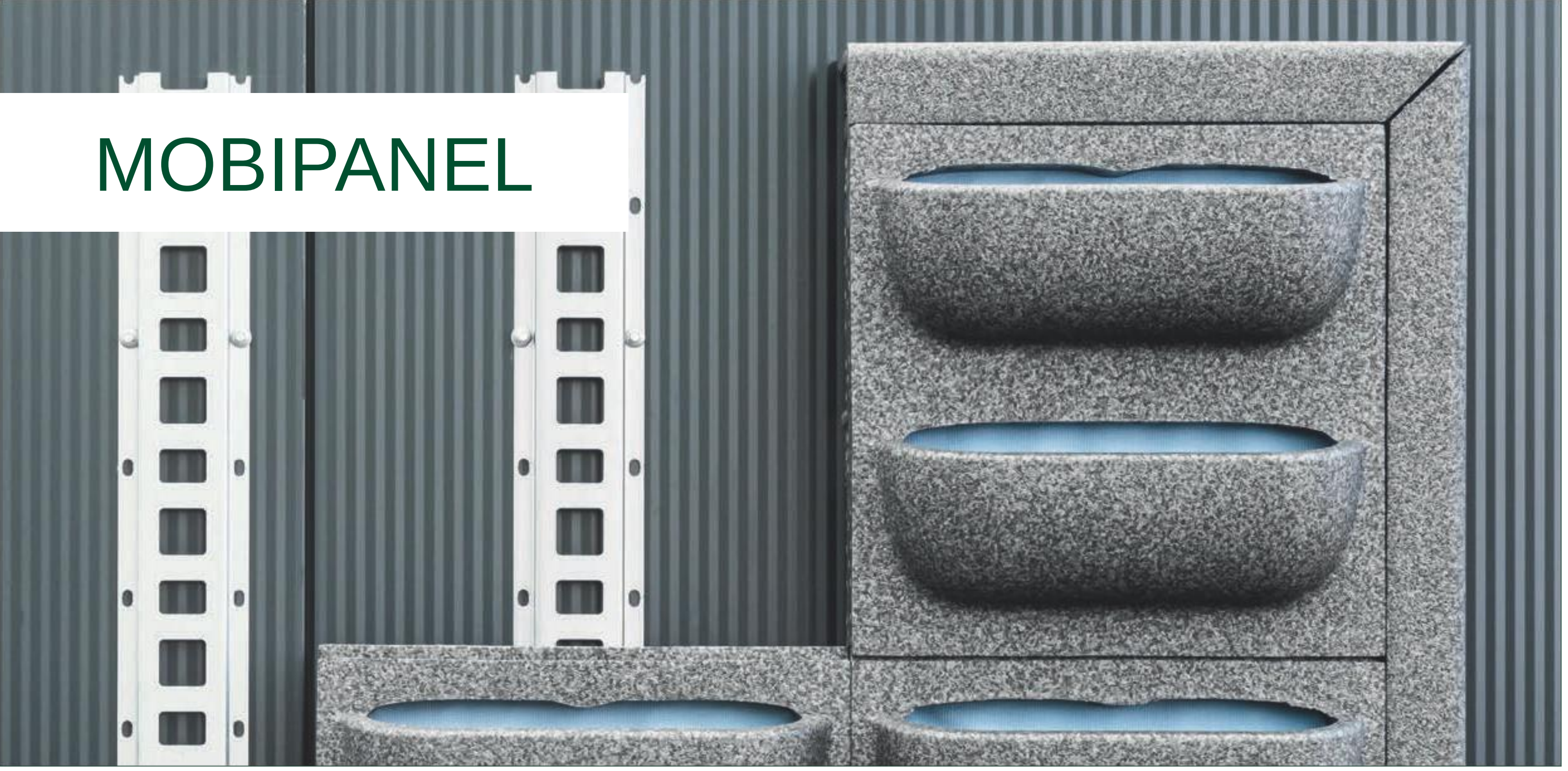
# UNIQUE FEATURES

- Suitable for flat and curved walls
- Suitable for various wall types including certain types of sandwich panels
- Interchangeable plant cassettes in two sizes (40 x 40 cm and 20 x 20 cm)
- Economical water consumption
- Complies with fire classification B-s2, d0
- Reusable and fully recyclable
- Equipped with automated irrigation and drainage system
- Lightweight and space-saving
- Modular system
- Easy to install against new and existing facades and walls

# BENEFITS

- Contributes to greening the living environment
- Boosts air quality by absorbing fine dust particles and generating oxygen
- Promotes biodiversity
- Raises property values
- Dampens noise and insulates
- Captures rainwater
- Provides an immediate green effect

# MOBIPANEL



For the outdoor green facade system MobiPanel automatic watering is carried out by means of an irrigation system. Water consumption varies from season to season and depends on the climate and type of planting. Account should be taken of a maximum water consumption of approx 4 litres per m²per day in hot periods. Mobilane can also optionally offer maintenance contract.

## PLACING AND WATERING

| | MobiPanel |
|---|---|
| Indoor | ● |
| Outdoor | ● |
| Watergift | |
| Manual | |
| Tank | |
| Irrigation system | ● |

## BUILDING PLAN

In most cases, the installation can be directly fitted to any back wall by means of the supplied fasteners; as long as the Magnelis omega profiles hang level. The correct distance between them is shown on the supplied building plan specification for the project in question, this must be adhered to. The irrigation system is then connected and activated, after wich the cassettes (with planting) can be placed on the profiles.

## DIMENSIONS

- The system is made up of cassettes measuring 40 x 40 cm and pixels of 20 x 20 cm.
- The omega profiles and covers have a standard size of 120 cm for efficient transport. They can be custom-made for large projects.

## WEIGHT

- Maximum system weight when fully planted: 40 kg/m².

## WALL TYPES

Low weight and intelligent design make MobiPanel suitable for greening most types of existing and new facades and walls. For example, backing walls of concrete, stone, sandwich panels, timber frame, etc.

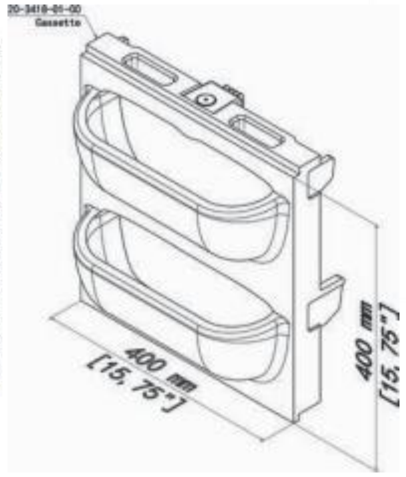
## CAPILLARY ACTION

An automated irrigation system provides water and nutrients to the MobiPanel green wall. An irrigation pipe along the top of the wall supplies water to the cassettes and pixels. Each cassette and pixel is fitted with microfibre textile with capillary action to ensure even distribution of water in the cassette. All the plants receive the correct quantity of water and nutrients in this way. Extremely efficient and low water consumption is the result.

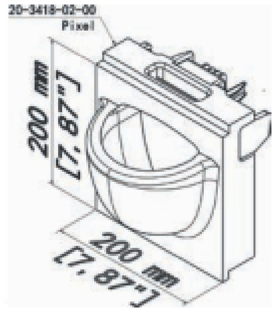
## CASSETTE

Each plant cassette has two slots providing space for 6 to 8 plants per cassette, depending on the size of the plant pots. The spacious slots provide a great deal of flexibility and plant choice. They also offer the plants more space for the roots to ensure healthy growth. Plenty of space for roots contributes to plant quality; the plants remain healthy even with large variations in temperature.

CASSETTE




PIXEL




Air chambers behind the capillary matting ensure a good supply of air to the roots. This contributes to optimal plant growth and quality. By using pixels, systems can be tailormade to fit precisely and can be used in all designs, including those with unusual dimensions.

## WIND LOAD AND VENTILATION

A static load calculation is available for the MobiPanel system, both for attaching the cassettes to the profiles and for attaching the profiles to the backing wall. A separate calculation is available for carrier sandwich panels.
Proper ventilation of the living wall is ensured by the gap of 38 mm between the rear of the cassettes and the wall.

## THERMAL INSULATION

Living walls contribute to the thermal insulation of a building. They heat up less in the summer and lose less heat in the winter. In addition, living walls contribute to cooling the urban climate as a result of evapotranspiration from the greenery.

## RECOMMENDATION

It is recommendable to involve Mobilane as early as possible in the design and construction process to ensure optimal design for the technical requirements, such as the irrigation system and the piping and cabling.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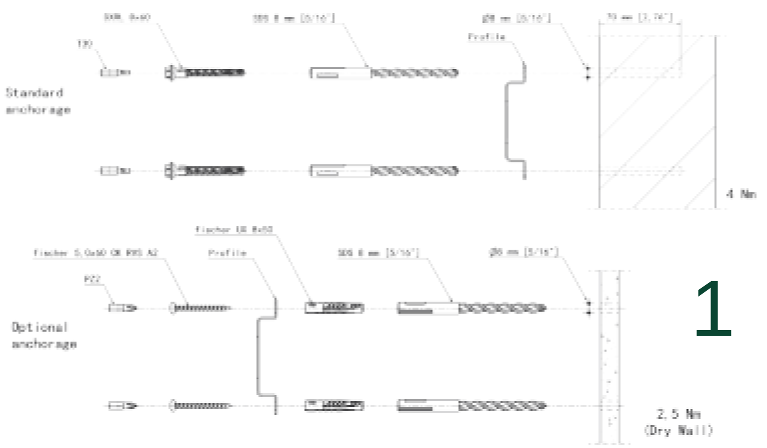
# INSTALLATION



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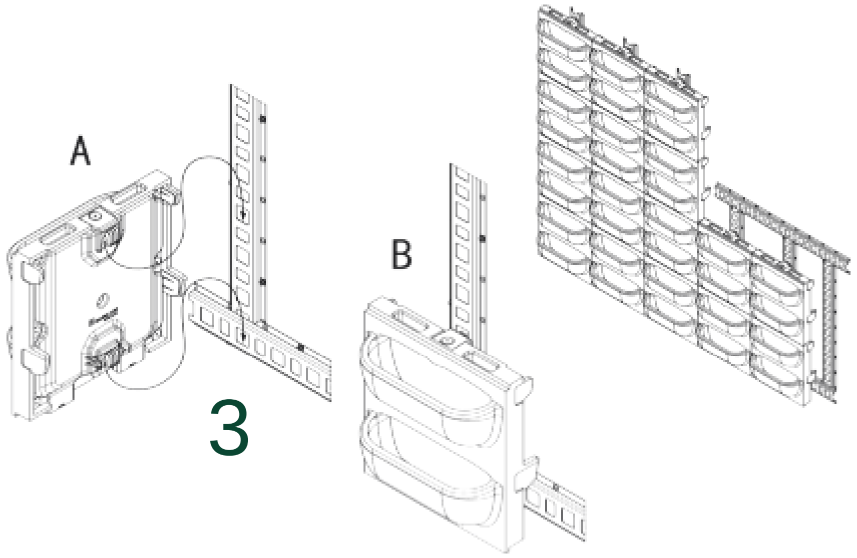

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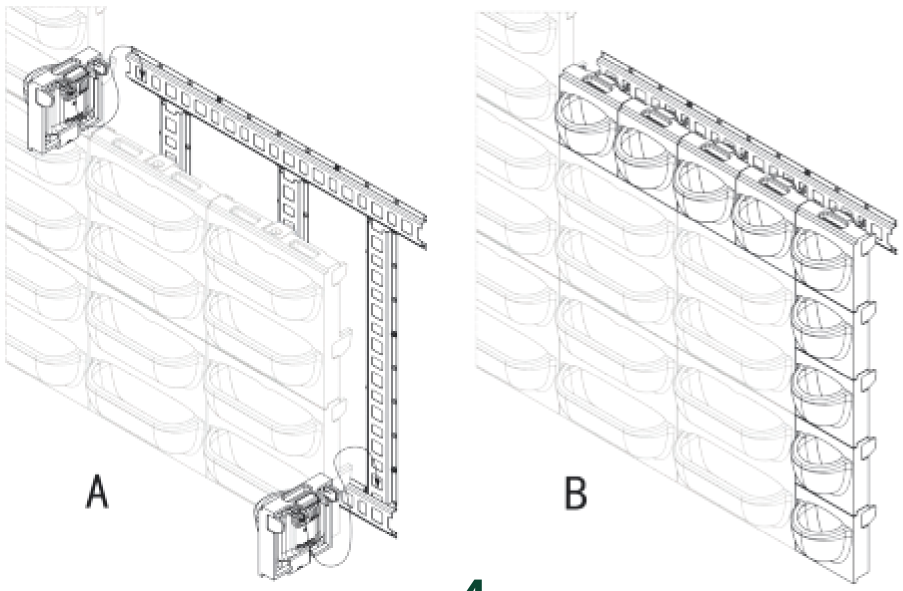

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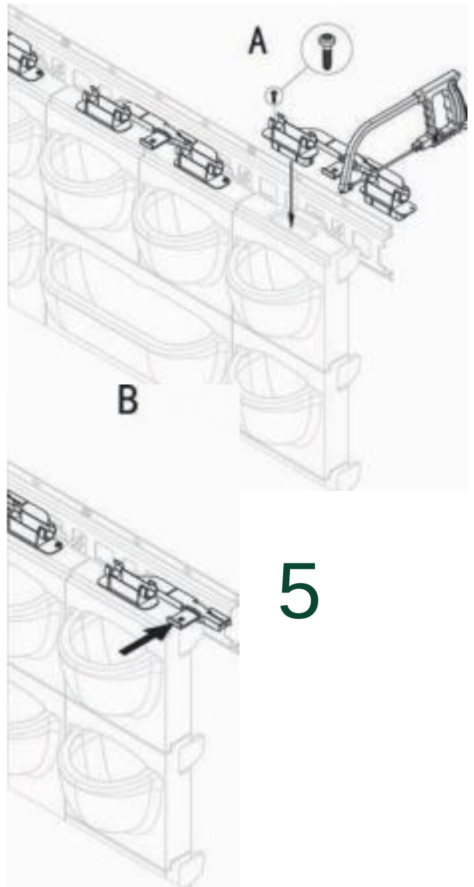

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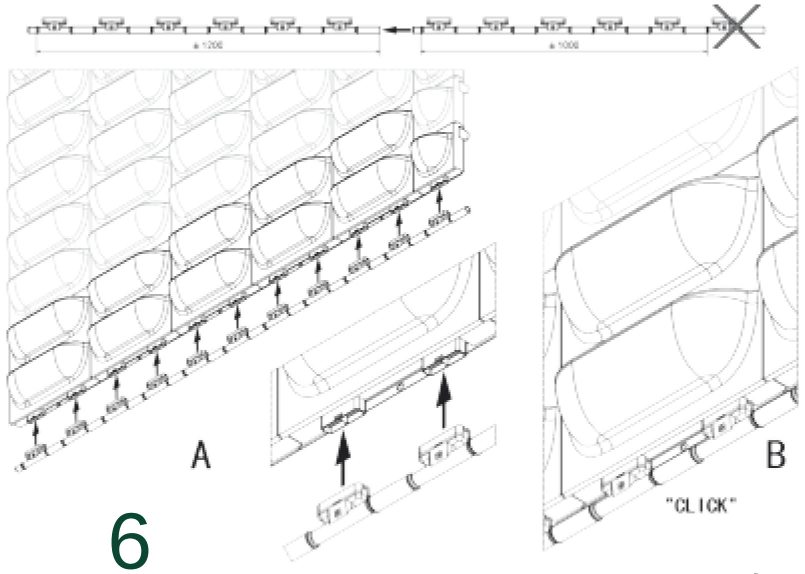

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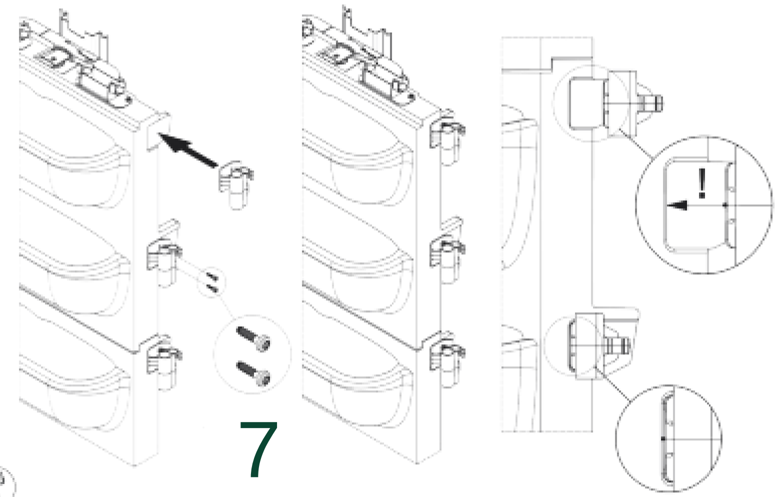
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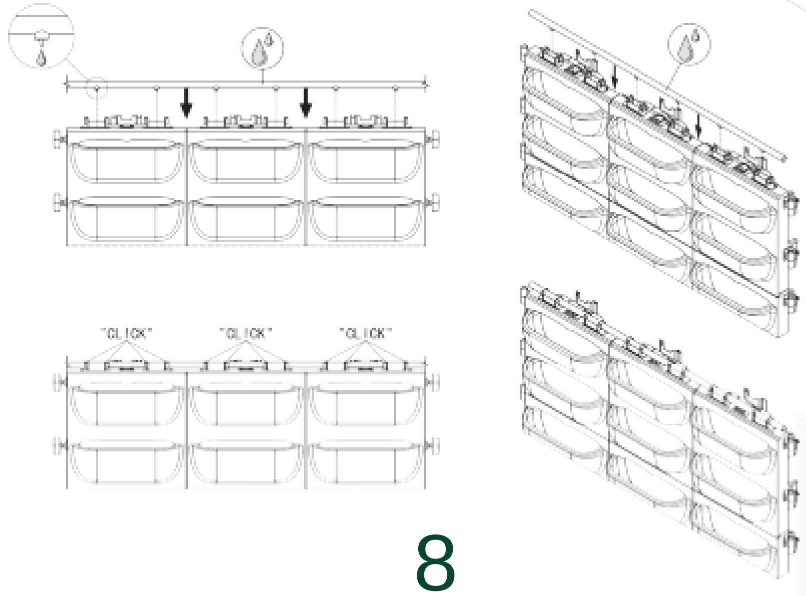

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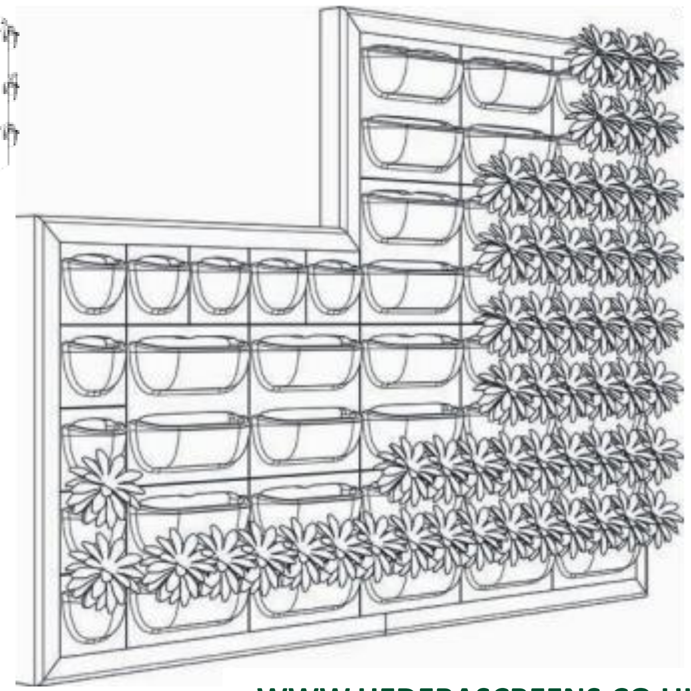
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# MAINTENANCE

The maintenance of a green facade consists of pruning, replacing bad plants, identifying and controlling any diseases and pests. The frequency of maintenance depends on the types of plants, season, and the associated growth of the planting. Maintenance of a green facade is very important for ensuring optimum appearance and a healthy green facade.

## 1. PRUNING

For the protection of the green facade, it is essential that the wall is well maintained and the planting is pruned. The wall should be pruned about twice a year, depending on plant type. This should be avoided in colder seasons and nesting periods. The planting in the green facade must be pruned in order to keep it’s optimal design, giving the planting light and space grow to grow and bloom again. The green facade is pruned by means of an (electric) hedge trimmer or pruning shears.

## 2. CONTROL OF DISEASES AND PESTS

During inspection visits, the presence of diseases and pests us also carefully considered, and treated if necessary. This happens biological as much as possible. For example, nematodes are used in the control of vine weevil larvae.

## 3. ANNUAL IRRIGATION SYSTEM CHECK

The irrigation system should be checked regularly. Mobilane offers a suitable irrigation system with integrated nutrient supply for every green facade. Every green facade is different and requires appropriate adjustment. For example, it is important that a wall on the north does not get as much water as a wall on the south, because a wall on the south will consume more water in summer than a northern wall. Many variables are under monitoring to ensure that the green facade has a healthy appearance all year round.

## 4. NUTRITION

Non-ground-based systems such as Mobilane’s MobiPanel, having no connection to the ground, require a permanent and a responsive needs-adapted water and power supply. The MobiPanel facade vegetation system used an irrigation system in which continuous nutrition is added to the water to give the green facade the perfect appearance and keep plants healthy.

# PARTS

CASSETTE

OMEGA PROFILE

DRIP ASSEMBLY

PLASSON END CAP
20 MM

PLASSON ELBOW
20MM

PLASSON T-PIECE
20MM

PIXEL

HOSE BRACKET

DRIP LINE

DRIPPER

COVER

INTERMEDIATE COVER

DRAIN HOSE