EVAPO+ Green Wall

Evapo-transpiring wooden vertical greening

Figure 1: EVAPO+ green wall wall-mounted on the building

Key Data

- LOCATION: Outdoor
- TYPE OF GREENING: Vertical greening, wall-mounted or free-standing
- VEGETATION: Perennials, herbs
- CONSTRUCTION: Wooden construction with full-surface substrate body
- IRRIGATION: Automated irrigation

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Content

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Location Selection

- Determine the surface area and height of the installation site
  → **For defining the maximum dimensions of the greening system**

- Assess exposure and building shadowing
  → **Important for selecting suitable plants**

- Irrigation:
  - Water connection
  - Power connection (Alternatively: battery-powered control unit)
  - Optional: drainage system
  - Personnel for manual watering (In case automated irrigation is not possible in winter)

Figure 2: Visualisation front view EVAPO+ green wall - greened (left) and construction (right)

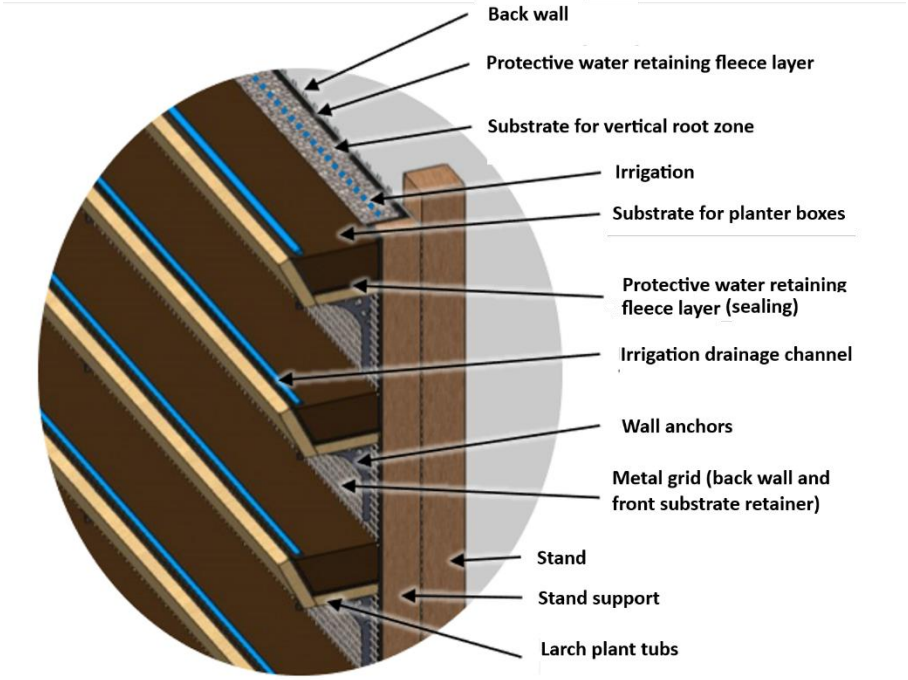

Figure 3: Sectional view with layer structure and designation EVAPO+ green wall

Material

The following list provides an overview of the materials needed, including approximate dimensions and quantities for constructing an **EVAPO+ green wall system of approximately 2.50 x 6 meters**.

The exact lengths, quantities, and specifications must be determined based on a detailed construction plan and the site-specific conditions. The listed dimensions are intended as a guideline for ordering materials and as construction support. It is strongly recommended to prepare a construction drawing or sketch based on the actual available component sizes or custom project requirements.

For wooden elements, it is generally recommended to use a locally sourced, durable, and easy-to-work type of wood. The surface should ideally be planed and untreated. For **outdoor installations**, the wood should be weather-resistant—larch, for example, is a suitable choice.

The use of reclaimed or leftover wood is also possible. Through appropriate surface preparation or placement (e.g., good side facing outward), materials can be saved and reused effectively.

Timber Components

Recommended for outdoor use – planed and chamfered larch wood, untreated surface.

- **Square Timber ~ 80/80 mm ~ 15 m**
  - 6 pcs. ~ 250 cm each (posts)

- **Square timber ~ 50/80 mm ~ 40 m**
  - 6 pcs. ~ 250 cm each (horizontal top beams / support for uprights)
  - 6 pcs. ~ 50 cm each (substructure for cladding)
  - 15 pcs. 20 - 200 cm (~ 18 m) (cross members)

- **Decking Boards ~ 26/140 mm ~ 110 m**
  - 24 pcs. ~ 300 cm each (planter boxes)
  - 6 pcs. ~ 250 cm each (side cladding)
  - 6 pcs. ~ 300 cm each (bottom cladding)

Metal Components

- **Spacers (~10 mm)** – to create distance from the façade (moisture protection)
  - 36 pcs. hex nuts + 2 washers each
  - or metal or plastic spacer sleeves

- **Post bases** (dimension according to upright size) – for vertical load transfer
  Recommended: height- and width-adjustable, height > 12 cm
  - 6 pcs. (one for each post)

- **Wall anchors / threaded rods + wall plugs** – for anchoring to the wall
  - 18 pcs. (3 per upright) including hex nuts and washers

- **Angle** – for squared timber (cross timbers)
  - 30 pcs. approx. 100 x 100 mm

- **Heavy-duty brackets / angle consoles** – as supports for planter boxes
  - 36 pcs., e.g. 150 x 125 mm heavy-duty bracket (load capacity ~60 kg each)

- **Cover plate** or wooden board – for top of upright end grain
  - **6 pcs**. approx. 100 x 150 mm

- **Metal grid (~2 x 12 m² total)** – for back wall and front substrate retainer
  - Rustproof galvanized, coated, or stainless steel
  - e.g. welded wire mesh panels, fence panels, etc.
  - Mesh size: front mesh must be smaller than substrate grain size
  - e.g. 3 pcs. 2000 x 2000 mm (for back wall)
  - e.g. 3 pcs. 2000 x 2000 mm (for front substrate holder – check mesh size)
  - Optional: additional fine mesh 2000 x 2000 mm (front substrate retention)

- **Perforated mounting strip**, ~**5 linear meters** – for upper support of planter boxes
- **Flat connectors**, **12 pcs**. – for connecting planter box walls internally
- **Screws** [d/l mm → diameter/length]
  - Anchor bolts – for securing post bases to ground
  - Sheet metal screws, 25 pcs. – for top cover plates
  - Wood screws – match types to material
    - 50 pcs. 8x50 mm (post base to upright)
    - 25 pcs. 6x100 mm (cross beam to upright)
    - 150 pcs. 5x70 mm (brackets to cross beam)
    - 150 pcs. 3.5x25 mm (brackets to planter box)
    - 200 pcs. 4.5x25 mm (for planter box supports, flat connectors, angle brackets)
    - 150 pcs. 4.5x30 mm (angle brackets to cross members)
    - 150 pcs. 5x60 mm (cladding side & bottom)
- **Nails / U-staples (clamps)**, ~**200 pcs.** – for attaching mesh
- and/or **clamp brackets** – for mesh installation
- Optional: **wire clips (~100 pcs.)** or wire – for mesh-to-mesh connections
- **Staple gun staples**

Drainage / Dewatering (if required)

Only required if necessary for the specific site conditions. Without a drainage channel, excess water will drip down along the full length of the system.

- **Drainage channel** – down to the ground (protects wood from moisture from below)
  - e.g. gutter system "box gutter 70 mm" or similar
  - approx. 6 linear meters of open gutter
  - End caps
  - Outlet connector
  - Elbow and downpipe, as needed
  - Connector – to drainage line if required
  - Sealant
  - Mounting brackets and screws

Vegetation Support Layer

- **Sealing – Back Wall and Planter Boxes (~20 m² total)**
  - Dimpled membrane (construction material) - This is an advantage as it allows for wood-side ventilation
  - and/or pond liner made of e.g. EPDM
  - 1 pc. ~250 x 700 cm (~18 m²) – for back wall
  - 6 pcs. ~30 x 650 cm (~2 m² total) – for planter boxes

- **Protective and Water-Retaining Layer – Fleece (~20 m²)**
  - e.g. recycled fleece (200 g/m²)
  - 1 pc. ~250 x 700 cm (~18 m²) – for back wall
  - 6 pcs. ~30 x 650 cm (~2 m² total) – for planter boxes

- **Substrate for Vertical Root Zone** Approx. **600 litres** (thickness ~5 cm, ~50 l/m²)
  - Coarse, water-retaining mineral mix (e.g. volcanic rock, perlite, expanded clay, clay granules, etc.)

- **Substrate for Planter Boxes -** Approx. **400 litres** (~10–12 litres per box)
  - e.g. intensive green roof substrate
  - or planting substrate with mineral and organic components (peat-free)

Automated Irrigation System

- Water connection
- Supply pipe, e.g. PE pipe 25 mm or 16 mm
- Drip pipe, approx. 36 linear meters (e.g. PE pipe 16 mm with emitter spacing ~20 cm or smaller)
- Micro-drip line, approx. 24 linear meters (emitter spacing ~20 cm or smaller)
- Ground stakes (for 16 mm pipe)
- Shut-off valve (16 mm)
- Irrigation controller
- Solenoid valve (as needed, depending on controller type)
- Connectors for 16 mm and micro-drip (T, L, straight)
- Automatic drain valve
- Optional: water meter
- Optional: frost sensor (for winter operation) + 2-core cable

Plants

- **Robust perennials and herbs, approx. 200 pcs**. (~5–6 plants per meter of planter box)
  → Consider site exposure and moisture requirements!

Tools

- Measuring tape, folding ruler
- Marking square
- Pencil
- Wood saw: circular saw, mitre saw, or hand saw
- Hammer drill
- Cordless drill/driver + bit set
- Wood drill bits
- Masonry/concrete drill bits (for wall and ground anchoring)
- Optional: wood planer
- Sander
- Sandpaper
- Utility knife
- Staple gun + staples
- Wrench (for ground/post anchors)
- Scissors (for cutting fleece)
- Pruning shears
- Buckets
- Shovel
- Hand trowels
- Watering can or garden hose
- Ladders ~2 m standing height (2 pcs.)
- Spirit level
- Hammer
- Pry bar / crowbar
- Caulking gun
- Vacuum cleaner (for dust during drilling)
- Angle grinder with metal cutting disc
- Hacksaw

Step-By-Step

Once all materials have been procured, preparations and assembly can begin.

To ensure a quick installation, many tasks can be carried out simultaneously: The timber can be cut and prepared, the substructure can be mounted, and in parallel, the planter boxes can be pre-assembled, and the sealing membranes and fleeces cut to size.

Step 1: Planning Sketch and Measurements

Based on the determined overall dimensions, a construction plan can be drawn, and the exact component lengths calculated. It is recommended to prepare a list of all cutting lengths and drill holes. However, individual component lengths must be adjusted later to fit the already installed elements, and actual dimensions must be measured on site.

Step 2: Substructure and Back Wall Assembly

First, all lengths are marked on the timber, then the wood is cut and processed, and finally mounted onto the building wall. When determining the length of the vertical posts, the height of the post bases should be taken into account.

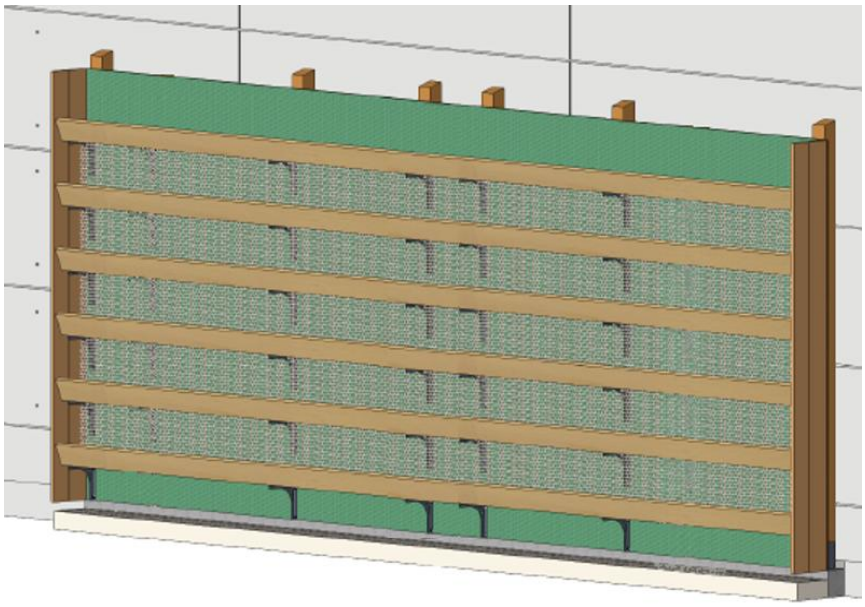

Figure 4: Visualization of EVAPO+ green wall – construction

2.1 Mounting the Vertical Posts

Each vertical post should be fixed to the wall using at least three wall anchors. Vertical load transfer can be handled via post bases anchored to the ground.

Wall anchors can be selected according to wall type, using either appropriate threaded screws with wall plugs or threaded rods bonded in place with mounting mortar. The length of the wall anchors or threaded rods should include: spacer + post + mesh panel + post support + mesh panel (+ wall plug or anchoring depth into the wall).

1. Mark the position of the **vertical posts** – two in the centre (to align with the joints of the planter boxes), and distributed to the sides and middle as needed, or adapted to the mesh panel dimensions (e.g., 2 x 2 m)
2. Drill the **holes** in the **posts (80/80)** and **post supports (50/80)**. Drill a larger recess at the front for the hex nuts, and transfer the positions precisely to the wall and ground
3. Drill and clean the **holes in the wall**
4. If needed, anchor the **post bases** to the ground
5. Fix the **wall anchors** with plugs or set **threaded rods** into the drilled holes in the wall
6. Install the **posts** with **spacers** (~1 cm) from the wall and fix using hex nuts and washers (These should sit flush and recessed into the post)
7. Mount the **crossbeams** between the posts (top and middle) using angle brackets, adjusted to mesh size and potential joints

2.2 Mounting the Back Wall

This section describes the installation of a lightweight and cost-efficient back wall using mesh panels and waterproofing membrane. Alternatively, a sealed, waterproof panel made of wood, metal, or plastic may also be used.

1. Slide the **mesh panel** onto the wall anchors and press it against the vertical posts
2. Fix to the uprights with **nails/loops**
3. Slide the suitable **post supports (50/80)** onto the wall anchors
4. Tighten using hex nuts and washers, and additionally fix with wood screws
5. Position the lower horizontal cross beams between the post supports so they serve as the bottom edge of the vertical root zone and substrate retainer, and fix them with angle brackets
6. Lay the **dimpled membrane** and/or **pond liner** (ideally in one continuous piece) over the entire surface, with an overlap of approx. 30 cm on the sides and bottom, and staple or nail it at the top
7. Optionally, fix it at select points on the posts using a stapler to simplify handling
8. At the bottom, fold the membrane over the lower cross beam and press it into the corners so that no wood remains visible

Figure 5: Assembly upright with spacer and rear wall made of mesh, dimpled foil and fleece

Step 3: Mounting the Planter Boxes and Substrate Retainers

First, all planter box dimensions are marked onto the wooden boards ("scribed"), then the boards are cut and processed. The planter boxes are assembled separately and then mounted onto brackets fixed to the green wall substructure.

Figure 6: Planting trays with 20° bevelled edge

3.1 Preparing the Planter Boxes

1. Mark the length dimensions on the **wooden boards**
2. Cut the **boards** to the exact lengths
3. For angled planter boxes: cut a ~20° wedge along one long edge
   → Alternatively, the boxes can also be assembled at right angles (without angled cuts)
4. Chamfer or sand the outer visible edges
5. **Pre-drill holes** for assembly → Pay attention to screw angles if assembling with bevel cuts
6. Form one planter box from two **boards** and screw them together
7. Place two finished **planter boxes** end-to-end (long side) and connect with flat connectors
8. Cut the **dimpled membrane** and **fleece** to fit the planter boxes
   → The dimpled membrane should reach from the top edge to approx. 1 cm below the bottom edge inside the box (to protect the boards from moisture); leave ~20 cm overlap on the sides
9. Insert the **dimpled membrane** and **fleece**, and staple just below the top edge on the inside

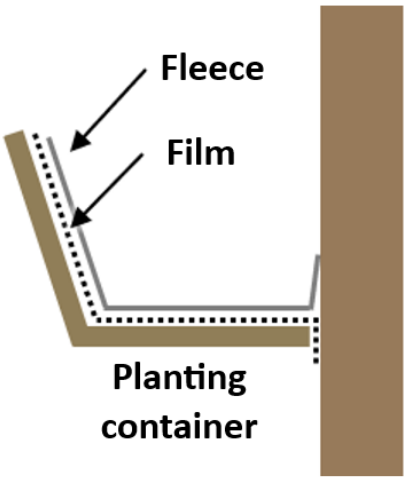

Figure 7: Planting trays with 20° bevelled edge

3.2 Installing Brackets, Substrate Holders and Plant Trays

1. Define the **area for the planter boxes** on the vertical posts and divide the height evenly
   → Measure approx. 30 cm down from the top for the bottom edge of the uppermost planter box
   → Maintain approx. 45 cm clearance from the bottom edge of the lowest planter box to the ground
2. Mark **the bottom edge** of the planter boxes on both sides at the same height using a spirit level
3. Screw the **brackets** into the marked positions → make sure the correct bracket arm lengths are used
   → Fleece and membrane should be firmly pressed against the vertical posts during mounting
4. Lay the **metal mesh** (optionally with fine-mesh reinforcement on the inside) over the brackets and up to the vertical posts. Fix in place using **nails/loops** or **clamp brackets**
   → If necessary, use a hacksaw or angle grinder to remove obstructive mesh bars
5. Starting from the top, place the finished **planter boxes** onto the brackets and screw them down
   → The sides of the planter boxes should be flush with the posts
6. Between the lowest planter box and the bottom horizontal crossbeam with membrane, leave only a narrow gap (~5 mm). This allows water to drain but prevents substrate loss
7. Use **perforated metal strips** to additionally fix the planter boxes at the back–top edge to the vertical posts, securing them in place

Step 4: Mounting the Cladding

First, all required lengths are marked onto the wooden boards ("scribed"), then the boards are cut, processed, and mounted. The frontmost board of the side cladding should connect the planter boxes to the vertical posts and cover the joint.

The bottom cladding should be easily removable for maintenance. To achieve this, a dedicated substructure (e.g. with squared timber) can be built, using spacers at the base to raise it slightly above the ground. It is recommended to design this bottom section in multiple segments to allow for easier removal.

Figure 8: Planting trays with foil and fleece

4.1 Mounting the Side Cladding

1. Mark the length dimensions on the **wooden boards** and cut them to size
2. Chamfer and sand the edges
3. Mark and pre-drill holes for screwing
4. Position the frontmost board on both sides so that it can be screwed to both the planter box and the vertical post
5. Screw additional boards to the post and fit the last board flush against the wall

4.2 Mounting the Bottom Cladding

1. Mark the length dimensions on both the **wooden boards** and the **substructure** (**squared timber**), then cut them to size
2. Chamfer and sand the edges
3. Mark and pre-**drill holes** for screwing
4. Attach **spacers** as "feet" to the **substructure** and place it flat on the ground
5. Position the **boards** on top and screw them onto the substructure
6. Set up the **cladding** under the green wall and fix it in place using small battens or screws on the posts or the bottom planter box
   → The bottom cladding should be easy to remove for maintenance access to the drainage channel

Step 5: Fitting an Automated Irrigation System

If possible, an automated irrigation system is always recommended to ensure consistent watering—even during holidays or staff/student turnover.

5.1 Required Connections

- Water connection (ideally also available in winter, frost-proof) with at least 3.5 bar pressure
- Power connection (for irrigation controller)
  alternatively, battery-operated controller
  → **reliable battery replacement must be ensured!**
- Connections should ideally be located in a frost-proof interior space (e.g., storage room, basement, etc.)
- And pipe routing with a slope leading outside → or installed outdoors (but then no operation in winter)

5.2 Installing the Controller

- Interior control:
  - The pipe to the outside should slope downward from the solenoid valve, ensuring frost-proof drainage
  - Optionally connect a water meter
  - Connect the solenoid valve
  - Install the controller and connect it to the solenoid valve
  - Route and connect the 2-wire cable for the frost sensor to the exterior
- Outdoor control:
  - Use a valve box for the solenoid valve and controller
  - Or use a controller with an integrated valve directly at the water connection (battery-powered)

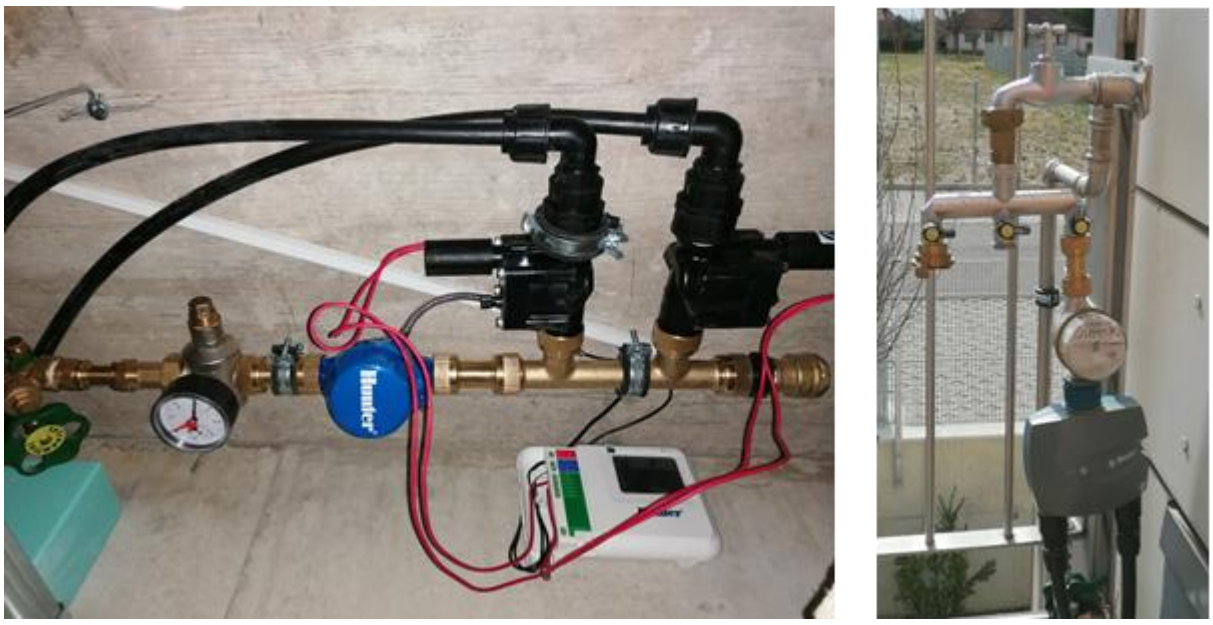

Figure 9: Control with solenoid valves in the interior (left) and with battery control unit (2 zones) outside (right)

5.3 Installing Pipes and Drippers

1. Route the **supply lines** (possibly multiple zones/lines) to the green wall, and guide them upward behind the substructure (back wall) on one side
2. At the top, begin with **a T-connector**, and lay a **drip line** in the planter box slightly below the top edge, across the entire length
3. Install an **end cap** at the end of the drip line
4. Guide a short **piece of supply pipe** down through the mesh to the next lower planter box, and again install a **T-connector** with **drip line** and **end cap**
5. Repeat this process down to the bottom planter box, using an **L-connector** at the bottom
   → It is recommended to install **multiple vertical irrigation zones** for tall green walls
6. At the very top, an **additional zone** can be installed for the vertical root space, allowing for separate irrigation of the substrate body

→ **Ground stakes** for securing the drip lines are inserted during planting

7. If needed, install the **frost sensor** outside and connect it to the controller
8. Check all connectors and fittings for **leaks**

9. Set **Irrigation Times and Duration**
   a. **Start time / interval** – depending on substrate volume, location, and season: 1–2 times per day up to 3 times per week
   b. **Duration** per cycle – depending on dripper flow rate, spacing, and substrate volume: approx. 2 to 30 minutes

Step 6: Installing a Drainage System (If needed)

Figure 10: Drainage channel and panelling at the bottom

Excess water can drain down through the narrow gap between the lowest planter box and the bottom cross beam. However, if the ground below the green wall cannot absorb water or should remain dry, a drainage system can be installed to direct water into a (sewer) connection or similar outlet.

The simplest solution is to install a compatible drainage or gutter system.

1. Assemble an **open gutter** with **end caps** and a **drain outlet.** Connect by gluing, inserting, and sealing so that the gutter fits within the full length of the side cladding
2. Position the **gutter** centrally beneath the drainage gap and ensure a slight slope toward the drain outlet
3. Mount the gutter using appropriate **brackets.**
4. Trim the **overhanging membranes** from the back wall so that they extend into the gutter, allowing water to be directed into it
5. **Test** the drainage function – either by turning on the irrigation system until water begins to exit below, or by watering the green wall using watering cans or a hose
6. Connect appropriate **bends** and **drainage pipes** to the drain outlet in order to guide the outflow to the intended destination

Step 7: Filling with Substrate

1. First, fill the vertical root space from above with the **coarse-grained mineral substrate**, and gently shake or tap if necessary until the entire area is filled
2. Now, the planter boxes can be filled about halfway with **green roof or planting substrate** – this leaves enough space for the root balls of the plants

Step 8: Planting

Planting should only begin after the irrigation and, if necessary, drainage system have been installed, tested, and are fully operational.

A planting plan can be created in advance to define which plants are to be placed where. Drought-tolerant plants should preferably be positioned at the top and along the sides, while moisture-loving plants should be arranged more toward the bottom. Simple patterns and shapes using the different plants can also be created.

Approximately 5–6 plants per meter of planter box can be used. It is best to arrange the plants ("lay them out") first and then (or simultaneously) fill in with substrate.

1. Remove the **root ball** from the nursery pot and, if the roots are already heavily matted, lightly score or loosen the roots at the bottom (this helps with root establishment)
2. Place centrally into the planter boxes and distribute across the area (e.g., according to the planting plan) → The drip line should lie on top and in front of the plants, i.e., visible
3. Simultaneously or afterward, fill in **substrate** (using small hand shovels), press down with hands, and continue filling until just below the top edge of the planter box
4. **Water** thoroughly immediately after planting, until everything is well moistened, and water starts draining at the bottom (the substrate initially absorbs a lot of water)

Step 9: Final Tasks

After completing the planting and substrate filling, the following tasks still need to be carried out:

1. Install the **cover** (metal sheet or wooden piece) on top of the end grain surfaces of the vertical posts, using sheet metal screws
2. Trim the **ground stakes** for fixing the drip lines or install them at an angle, to avoid damaging the waterproofing membrane inside the planter boxes

Figure 11: Freshly completed and planted EVAPO+ green wall in spring

Green Care and Maintenance

- Daily inspection check → Are the plants healthy and is the irrigation system intact?
- Establishment care:
  - Watering approx. once per day
    Once the plants are well-rooted, reduce frequency to 3–5 times per week
  - Guide and tie shoots to the trellis
    → **Unwind young shoots of aggressive twining/climbing plants and tie them parallel to the support!**
  - Remove brown leaves and dead shoots as needed
  - Fertilize (spring/summer), e.g. with slow-release or solid fertilizers

- Check water accumulation and drainage (~ weekly):
  - Water level in the inspection pipe max. ~6 cm
  - Check the drainage function and clean if necessary

- Pruning and replanting:
  - Cut back dead or excessively long shoots as needed
  - Remove above-ground dead leaves or shoots of perennials in spring
  - In case of plant loss – remove the entire root ball and replace with a new plant

- Automated irrigation system and winterizing:
  - Adjust watering times and duration to seasonal needs (e.g. spring – summer – autumn – possibly winter)
  - Winterize before the first frost, unless the system is frost-resistant:
    - Shut off the supply line
    - Open valves and drain the lines
    - If applicable, remove the controller and store it frost-protected
  - During winter, manual watering may be needed – if no frost-proof automatic system is installed
  - In spring (once no more frost days): reinstall and activate
  - Check and replace batteries, if applicable

Figure 12: Plant care

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