

Fortin Flower Technical Design Basis

System architecture, Energy Leaves, rainwater channels, solar generation, wind rotor, atmospheric water, targeted air treatment, controls, safety, testing and procurement.

CONCEPT BY SERGE FORTIN

Prepared for multidisciplinary engineering review and proof of concept development.



What this handbook is and is not

A technical basis for engineering discussion, supplier qualification and POC planning.

DOCUMENT PURPOSE

Define intended functions, interfaces, calculations, risks, tests and design decisions before detailed engineering.

DEMONSTRATED COMPONENTS

PV modules, slewing bearings, electric actuators, small wind turbines, rainwater harvesting, filters, tanks, pumps and supervisory controls are established technologies.

UNPROVEN INTEGRATION

The complete rotating leaf, its aerodynamic interaction, fatigue life, water hygiene, public safety, output and cost remain to be demonstrated.

NOT FOR CONSTRUCTION

Dimensions, loads, materials, yields and costs are design assumptions. They cannot be issued for procurement or construction without project engineering.

Top level engineering requirements

Every function receives a measurable requirement, a safe failure state and an accountable owner.

STRUCTURE

Design life, wind class, seismic case, corrosion class, fatigue cycles, deflection and vibration limits.

MOTION

Travel envelope, speed, torque, braking, locking, manual recovery, obstruction detection and emergency stop.

ENERGY

Hourly generation, load, storage, grid interface, islanding scope, earthing and protection coordination.

WATER

Catchment, design storm, intended use, treatment barriers, tank turnover, sampling and overflow route.

AIR

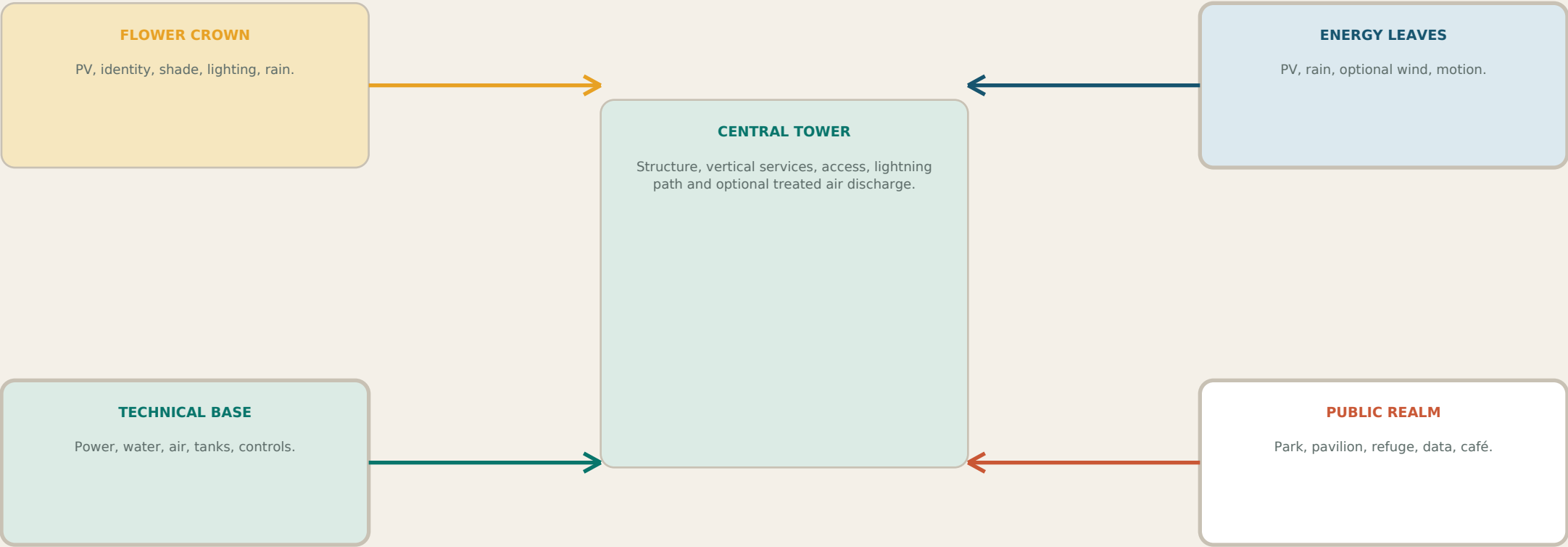
Source flow, pollutant load, capture fraction, pressure drop, media life, discharge and noise.

PUBLIC

Safe clearances, accessibility, falling object protection, fire strategy, evacuation and maintenance segregation.

Long life shell, replaceable technical modules

The civil structure and public realm should outlive filters, batteries, rotors, pumps and control hardware.



Interface rule: each module receives defined mechanical, electrical, hydraulic, data, fire and maintenance boundaries. Removing one module must not disable unrelated essential services.

Zero to three leaves

The leaf count is a site decision, not a status symbol.



ONE LEAF

Preferred POC and compact site.

One rotary collar, one tilt drive, one rotor.



TWO LEAVES

Civic scale with separated wakes.

Two independent modules and travel zones.



THREE LEAVES

Flagship with maximum complexity.

Three modules require coordinated stow and access.

Zero leaf remains the correct solution where wind, structure, heritage, aviation, acoustics or lifecycle cost fails the gate.

The interface control document

Every connection receives an identifier, owner, capacity, isolation method and verification record.

MECHANICAL

- Collar flange and bolt circle
- Tilt hinge and lock
- Travel envelope
- Lifting points
- Drainage movement

ELECTRICAL

- PV DC strings
- Rotor generator
- Actuator power
- Earthing and bonding
- Emergency isolation

HYDRAULIC

- Leaf gutter outlet
- Flexible rotary hose
- Downpipe and air gap
- Tank overflow
- Sampling points

DATA + SAFETY

- Position feedback
- Wind and vibration
- Water quality alarms
- Guard status
- Emergency stop chain

Visible functions and service boundaries

The leaf is a moving solar and water collector with an optional wind rotor. It is not one indivisible product.

**A****PV SKIN**

Replaceable module zones and protected wiring.

B**CIRCULAR ROTOR**

Ducted, guarded, braked and independently isolated.

C**RAIN CHANNEL**

Perimeter and vein channels drain toward the root.

D**TILT HINGE**

Actuator, pin, lock and position feedback.

E**AZIMUTH COLLAR**

Slewing bearing, drive, brake and rotary services.

F**SERVICE ROUTE**

Accessible inspection path inside root and tower.

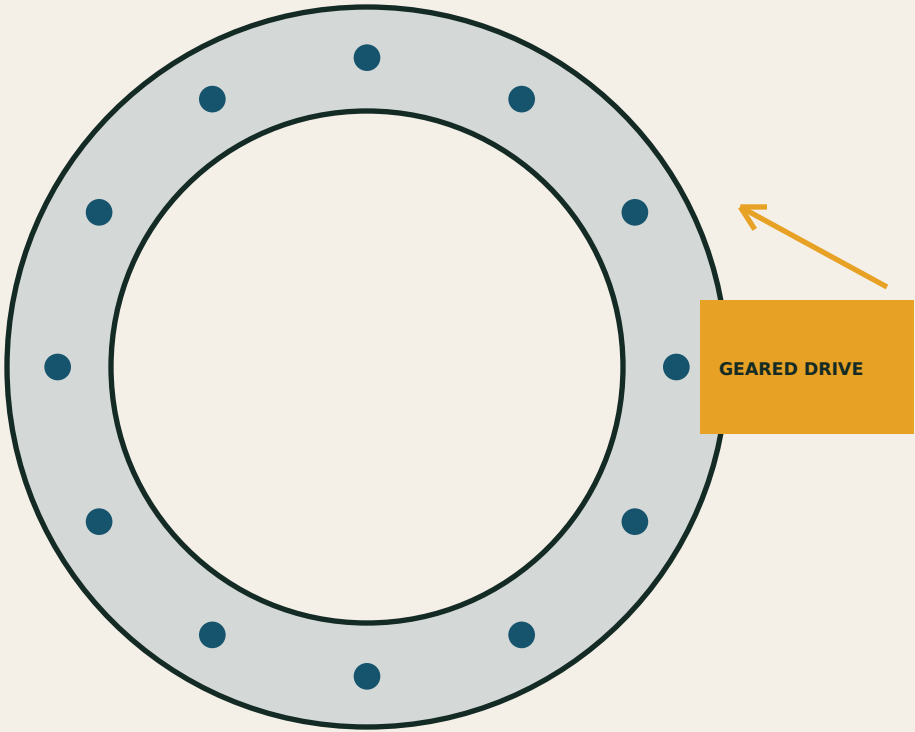
Proposed layered construction

Final materials follow structural, fire, corrosion, electrical and repair requirements.



Rotary collar concept

A commercial slewing bearing and geared drive are adapted as a maintained machine assembly, not hidden as architecture.



Fail safe state: controlled stop, brake application, mechanical lock and electrical isolation. Manual recovery must be possible after loss of power.

SLEWING BEARING

Axial, radial and overturning load rating.

DRIVE + BRAKE

Operating torque, holding torque and backlash.

LOCKING

Positive storm lock independent of motor torque.

ROTARY SERVICES

Rated slip ring or controlled cable loop plus flexible water hose.

POSITION

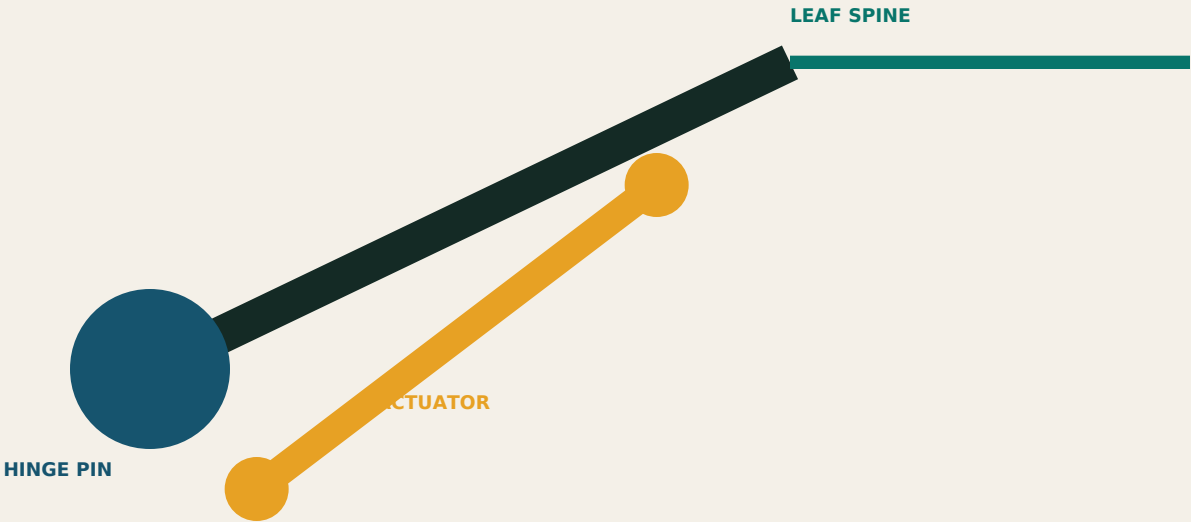
Absolute encoder plus independent limit switches.

LUBRICATION

Accessible points, seals, drainage and condition monitoring.

Hinge, actuator and mechanical lock

The actuator positions the leaf. A separate structural lock carries parked storm loads.



ACTUATOR

Electric or hydraulic unit sized for operating and fault cases. Include brake or load holding valve.

HINGE

Replaceable bearings, sealed pin, wear measurement, drainage and retained fasteners.

LOCK

Mechanical engagement verified by two independent sensors before storm state is accepted.

LIMITS

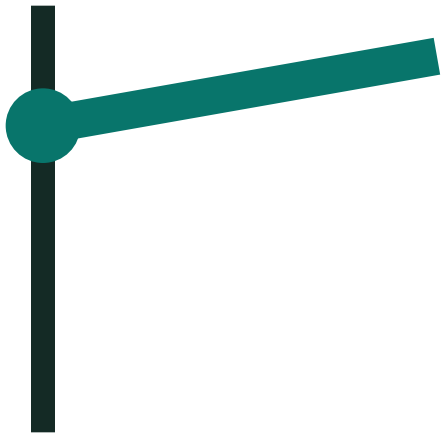
Hard stops remain outside normal control limits. Software cannot be the only travel protection.

RESCUE

Provision for controlled lowering, manual release and safe isolation during maintenance.

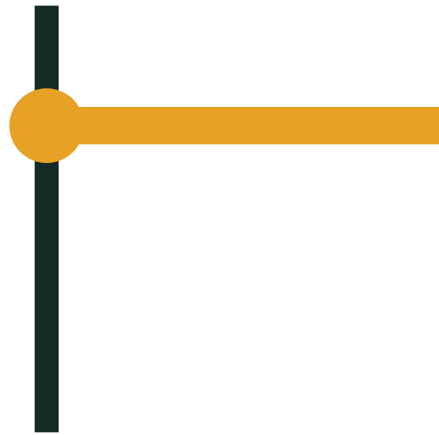
Operating, parked and survival states

Wind limits are derived from site climate, aeroelastic analysis and tested hardware. The values below are states, not universal speeds.



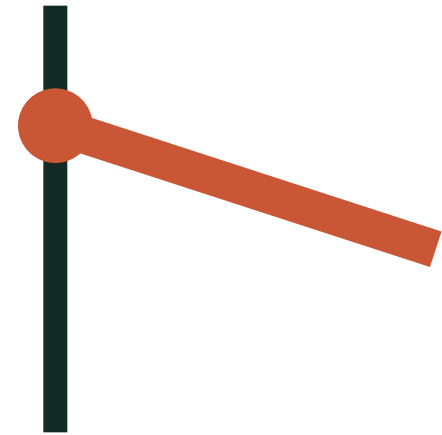
NORMAL

Track solar or wind within the approved operating envelope.



PARK

Move to minimum load angle, stop rotor, engage brake and lock.

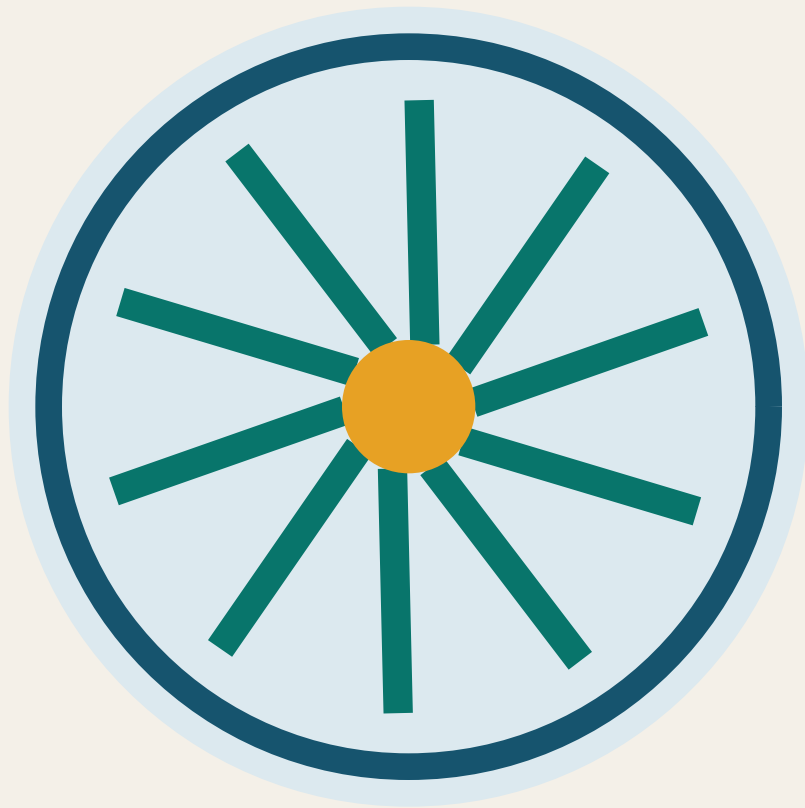


SURVIVAL

Mechanical lock carries load. Nonessential power isolated. Inspection required after threshold event.

Circular ducted rotor

The visual fan is treated as a small wind turbine with guarding, braking, certification evidence and measured acoustics.



ROTOR CHOICE

A ducted horizontal axis appearance requires the leaf to face wind. A vertical axis rotor would not require yaw but would look different.

GUARDING

Prevent public access, bird entry at rest where required, loose part release and contact during service.

PROTECTION

Overspeed detection, aerodynamic or mechanical braking, electrical dump load and mechanical lock.

ACOUSTICS

Declare sound power, tonal content, operating modes and receptor limits. Verify after installation.

EVIDENCE

Use an independently tested power curve. Visual rotation does not prove useful annual energy.

Power sensitivity

Wind power rises with the cube of speed. Small urban rotors can remain visually active while producing little energy.

$$P = 0.5 \times \rho \times A \times v^3 \times C_p \times \eta$$

AIR DENSITY

$\rho = 1.225 \text{ kg/m}^3$

SWEPT AREA

$A = 4 \text{ m}^2$

POWER COEFFICIENT

$C_p = 0.20$

EFFICIENCY

$\eta = 0.85$

ILLUSTRATIVE INSTANTANEOUS OUTPUT



3 m/s



5 m/s



8 m/s



10 m/s

Annual output cannot be calculated from average wind speed alone. Use the measured frequency distribution, turbulence, wake losses, availability and the certified or independently tested turbine curve.

PV integration on a moving leaf

Qualified modules, drainage, thermal movement and cable fatigue receive equal attention.

GLASS + CELLS

LAMINATE / BACKSHEET

VENTILATED SUPPORT

STRUCTURAL RIB

QUALIFICATION

IEC 61215 design qualification and IEC 61730 safety evidence for the selected module family

GEOMETRY

Module zones follow allowable curvature, drainage falls, access routes and replacement dimensions

CABLING

UV and motion rated cable, strain relief, drip loops, protected connectors and monitored insulation

THERMAL

Allow laminate, frame and structure expansion without glass edge load or seal damage.

FIRE

Module classification, DC isolation, cable routing and fire service access follow local requirements

Illustrative leaf energy

The example sizes the order of magnitude. Detailed yield uses site irradiance, orientation history, temperature, shading, mismatch and availability.

ACTIVE AREA 25 m2	MODULE DENSITY 200 Wp/m2	LEAF CAPACITY 5 kWp	SITE YIELD 900 to 1,700 kWh/kWp/y
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Annual AC energy before project losses

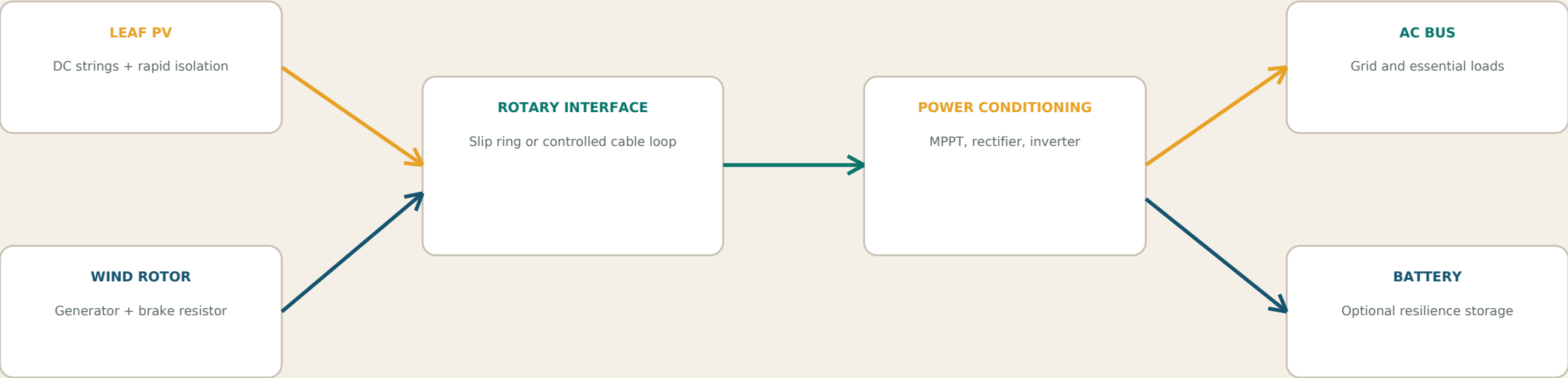
$5 \text{ kWp} \times 900 = 4.5 \text{ MWh/y}$

$5 \text{ kWp} \times 1,700 = 8.5 \text{ MWh/y}$

Tracking position is not automatically optimal because the wind rotor, storm state and public operating limits may override the solar angle. Compare the moving leaf against fixed PV of equal capacity and lifecycle cost.

Separated sources, common supervised bus

The moving leaf requires isolation at the module, tower and technical room.

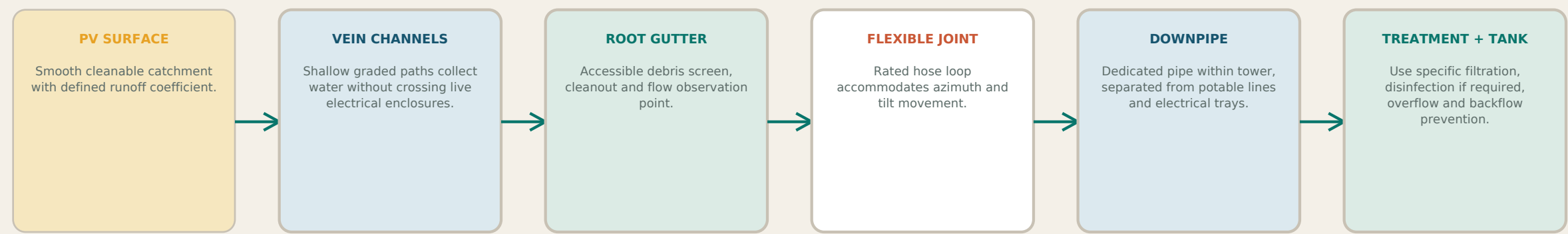


PROTECTION STUDY

Define DC arc protection, overcurrent, surge protection, earthing, bonding, anti-islanding, fault ride behavior, emergency shutdown, fire service isolation and safe restoration. The public display reads metered AC energy, not nameplate capacity.

From leaf surface to declared end use

Rainwater remains non-potable unless a competent authority approves a complete treatment and monitoring system.

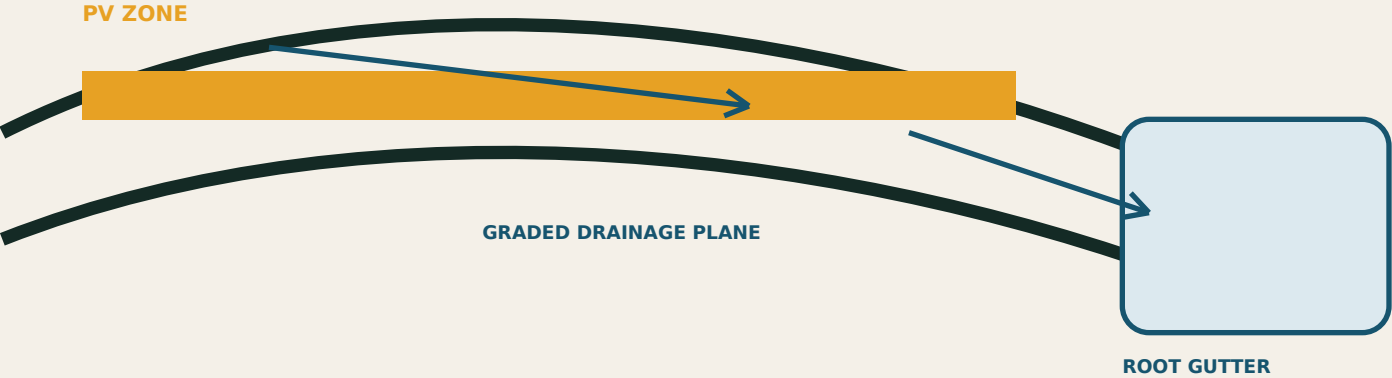


SEPARATION RULE

Atmospheric water, harvested rainwater, condensate, greywater and potable water are distinct sources. They require separate identification, risk assessment, treatment barriers, sampling points and physical backflow protection.

Leaf cross section and drainage details

The leaf must drain in every permitted operating and parked position. Geometry is verified through digital analysis and full scale hose testing.



DESIGN STORM

Use local intensity duration frequency data, leaf projected area, runoff coefficient and blockage allowance.

FREEBOARD

Channel depth includes dynamic motion, crossfall changes, debris and wind driven rain.

MATERIALS

UV, salt, temperature and cleaning chemical compatibility. Avoid galvanic couples and inaccessible sealants.

ACCESS

Removable screen, rodding point, inspection camera route and drain test connection.

OVERFLOW

A visible safe overflow prevents water entering the structure or falling onto occupied paths.

WINTER

Cold sites require freeze drainage, heat tracing assessment and ice fall controls.

Two calculations answer different questions

Annual harvest estimates resource. Peak flow sizes channels, outlets and overflow.

ANNUAL VOLUME

$$V = \text{rainfall} \times \text{area} \times \text{runoff} \times \text{efficiency}$$

Example: $0.60 \text{ m/y} \times 30 \text{ m}^2 \times 0.85 \times 0.90 = 13.77 \text{ m}^3/\text{y}$ per leaf.

PEAK FLOW

$$Q = \text{intensity} \times \text{area} \times \text{runoff} / 3600$$

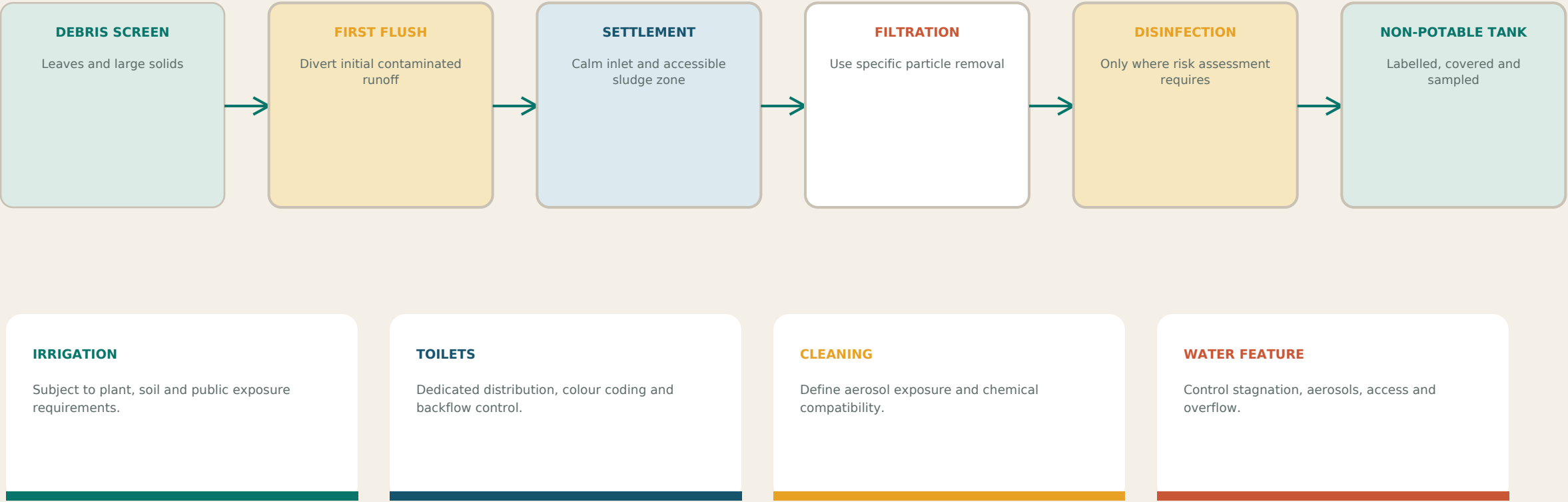
Example: $100 \text{ mm/h} \times 30 \text{ m}^2 \times 0.90 / 3600 = 0.75 \text{ L/s}$ per leaf.

ENGINEERING USE

Annual rainfall must be converted from millimetres to metres for volume. Peak flow uses millimetres per hour, square metres and the 3600 conversion to litres per second. Final sizing applies local storm duration, wind effects, leaf attitude, blockage, overflow routing and climate allowance. Tank size comes from a time series demand balance, not annual volume alone.

First flush and non-potable supply

The treatment train follows source quality and intended use. A decorative irrigation system is not a drinking water system.



Physical separation and water safety plan

No harvested or atmospheric source becomes potable through marketing language. Safety requires validated barriers and regulatory approval.



Climate dependent supplementary source

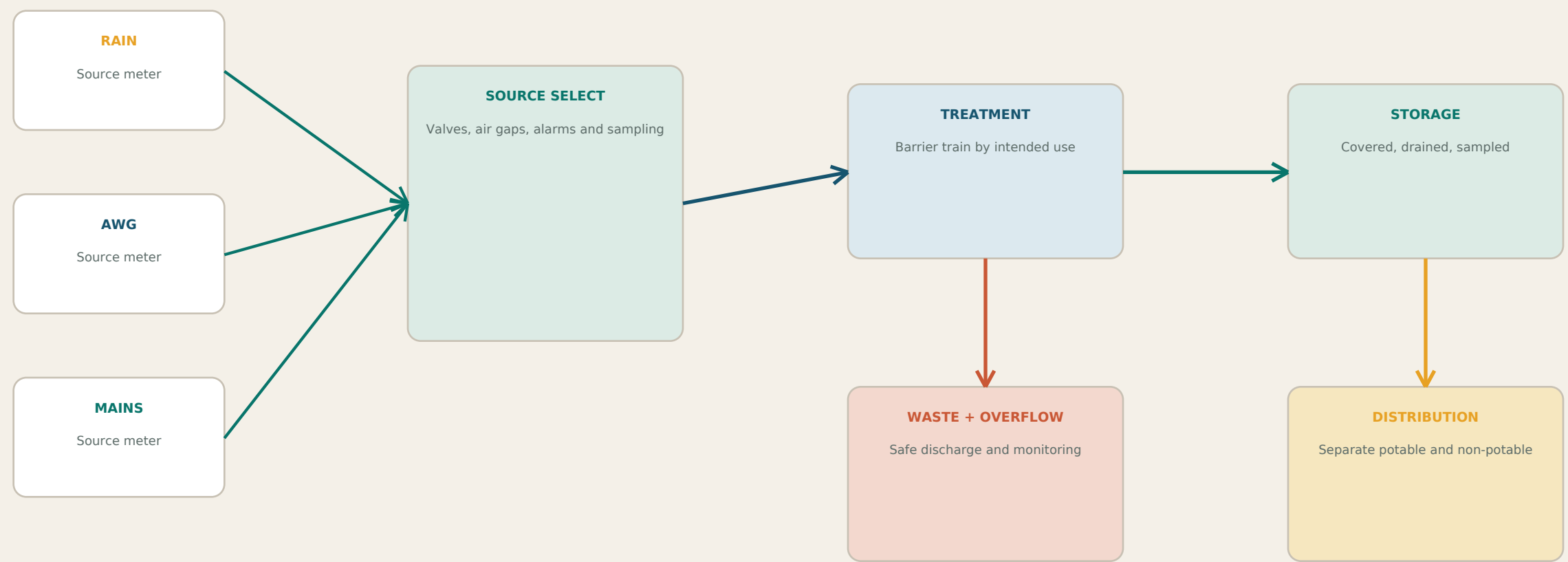
A condensing atmospheric water generator uses familiar refrigeration technology. Output and energy vary sharply with temperature and humidity.



The three energy intensities are sensitivity cases, not equipment claims. Procurement requires certified hourly output and kWh/L maps across the site's temperature and relative humidity distribution.

Modular treatment and storage

Each source enters a declared process line. Common tanks are allowed only after compatibility and water safety review.



Capture before cleaning

Air treatment becomes credible where a hood, duct, tunnel, car park or other controlled source delivers a measurable flow.

OPEN PLAZA

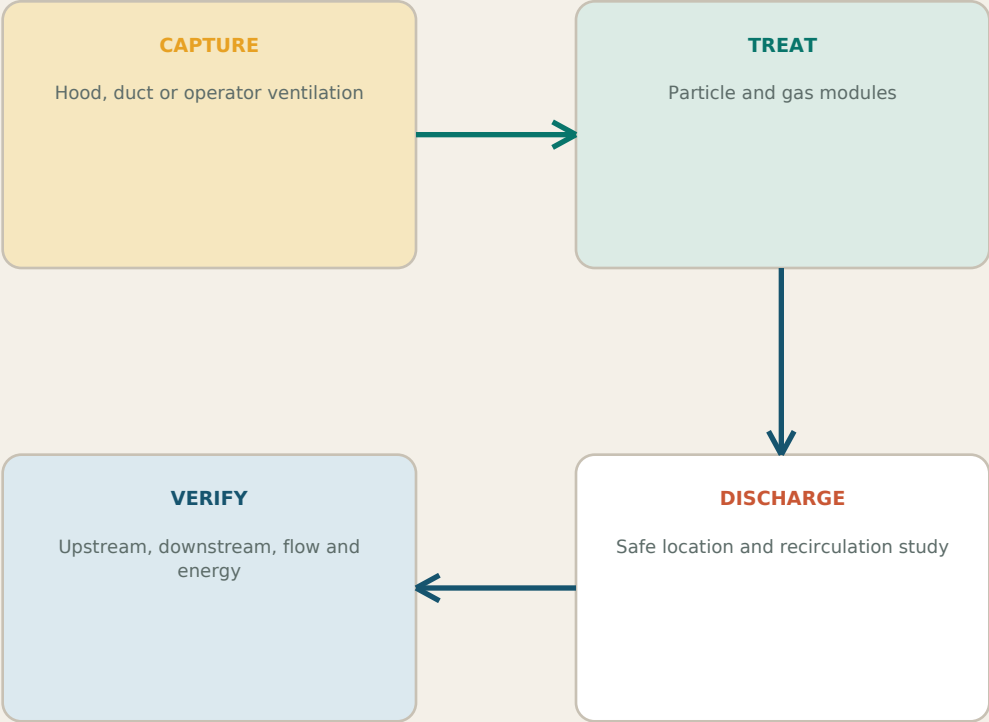
Wind replaces treated air faster than a tower can process it.

COVERED BAY

Partial enclosure raises capture fraction and defines an exposure zone.

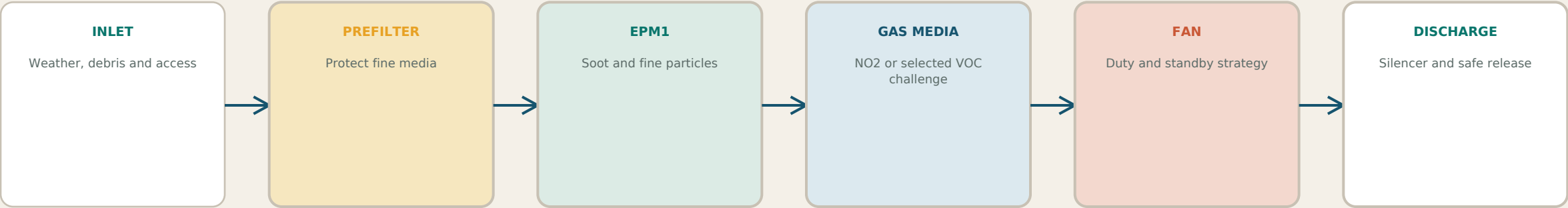
TUNNEL / CAR PARK

Existing or controlled ventilation provides measurable source flow.



Replaceable stages and bypass safe operation

The train is selected from measured pollutants, humidity, temperature, fire risk, pressure budget and waste route.



PARTICLES

ISO 16890 classification, clean and loaded pressure, dust capacity and fractional efficiency.

GASES

ISO 10121 challenge data, breakthrough definition, humidity sensitivity, byproducts and media mass.

FIRE

Combustible loading, detection, isolation, extinguishing, smoke mode and emergency bypass.

WASTE

Characterize spent media and dust. Use sealed changeout and licensed disposal or regeneration route.

Energy and removed mass

Both calculations require measured flow and concentration. Removal inside equipment is not the same as population exposure reduction.

FAN POWER

$P = Q \times \text{pressure} / \text{efficiency}$

20 m3/s x 350 Pa / 0.65 = 10.77 kW. Continuous operation equals about 94.3 MWh/y.

REMOVED MASS

$m = Q \times \text{concentration} \times \text{efficiency} \times \text{time}$

5.56 m3/s x 40 micrograms/m3 x 0.90 x 1 year = about 6.3 kg/y NO2.

INTERPRETATION

Low ambient concentration produces low recovered mass even with high percentage removal. A tunnel case with 100 m3/s and 200 micrograms/m3 at 90 percent removal yields about 568 kg/y, before downtime. Site capture fraction, leakage, media breakthrough and bypass must be included. Exposure benefit requires a separate dispersion and receptor analysis.

Nature performs different work

Planting cannot replace source control or mechanical filtration. It can provide shade, habitat, stormwater management and public comfort.

TREE CANOPY

Shade and thermal comfort

RAIN GARDEN

Slow and treat landscape runoff

BIOSWALE

Convey stormwater visibly

NATIVE HABITAT

Biodiversity with lower irrigation demand

FILTERED REFUGE

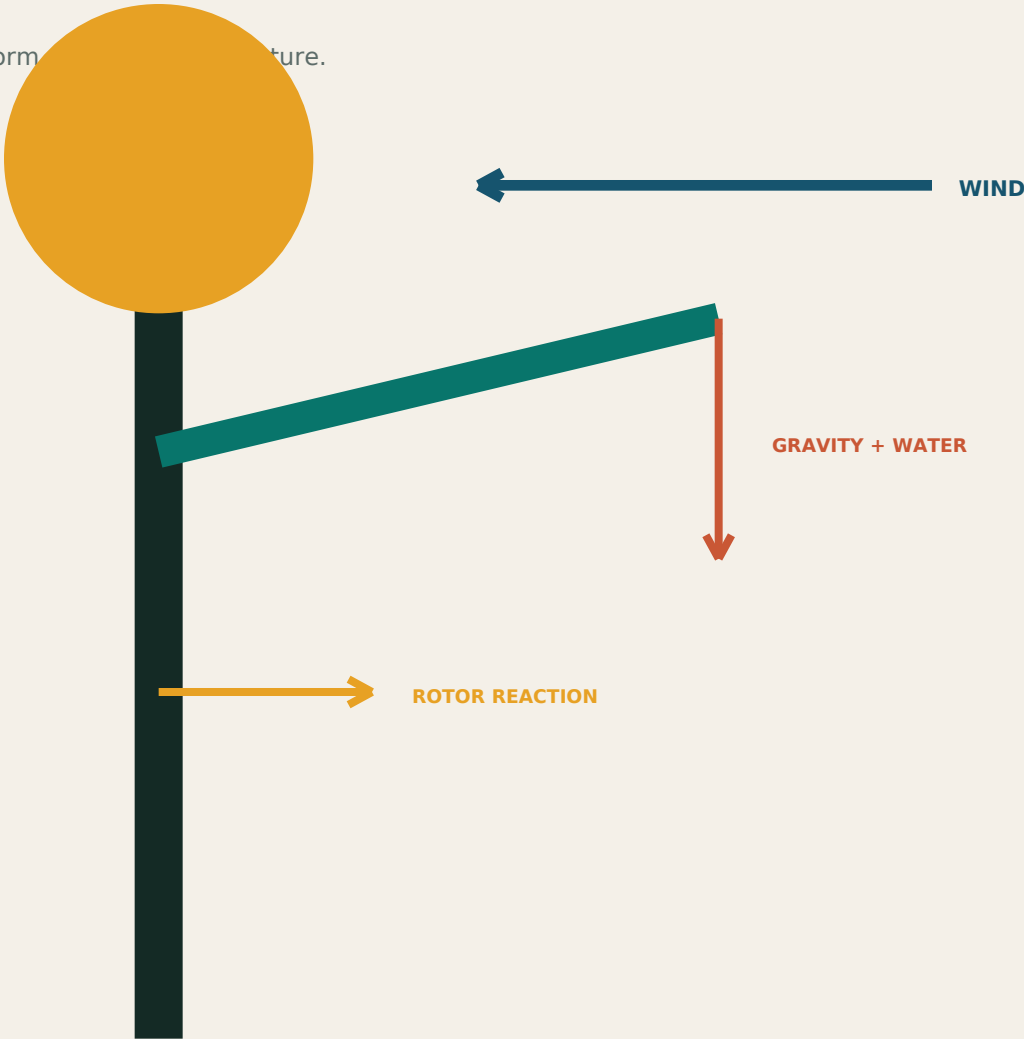
Defined occupied zone with controlled clean air

EDUCATION

Explain flows, limits and measured data

Actions and combinations

The flower, leaves, rotor and moving joints form the structure.



- DEAD**
Structure, PV, rotor, water retention, equipment.
- WIND**
Directional, gust, local pressure, parked and survival cases.
- MOTION**
Acceleration, braking, emergency stop and end stop.
- FATIGUE**
Rotor cycles, turbulence, actuator starts and vortex response.
- CLIMATE**
Temperature, snow, ice, corrosion, seismic and lightning.
- ACCIDENT**
Jam, imbalance, failed lock, dropped object and fire.

Fatigue, vibration and resonance

A static strength check is insufficient for rotating equipment mounted on a flexible landmark.

ROTOR EXCITATION

Blade passage, imbalance and generator torque ripple.

AEROELASTIC RESPONSE

Leaf and crown wakes, vortex shedding and changing aerodynamic damping.

DRIVE BACKLASH

Impact loads at reversals and gust driven motion.

TOWER MODES

Avoid operating harmonics and verify damping.

HUMAN COMFORT

Deck and visitor vibration limits may govern before strength.

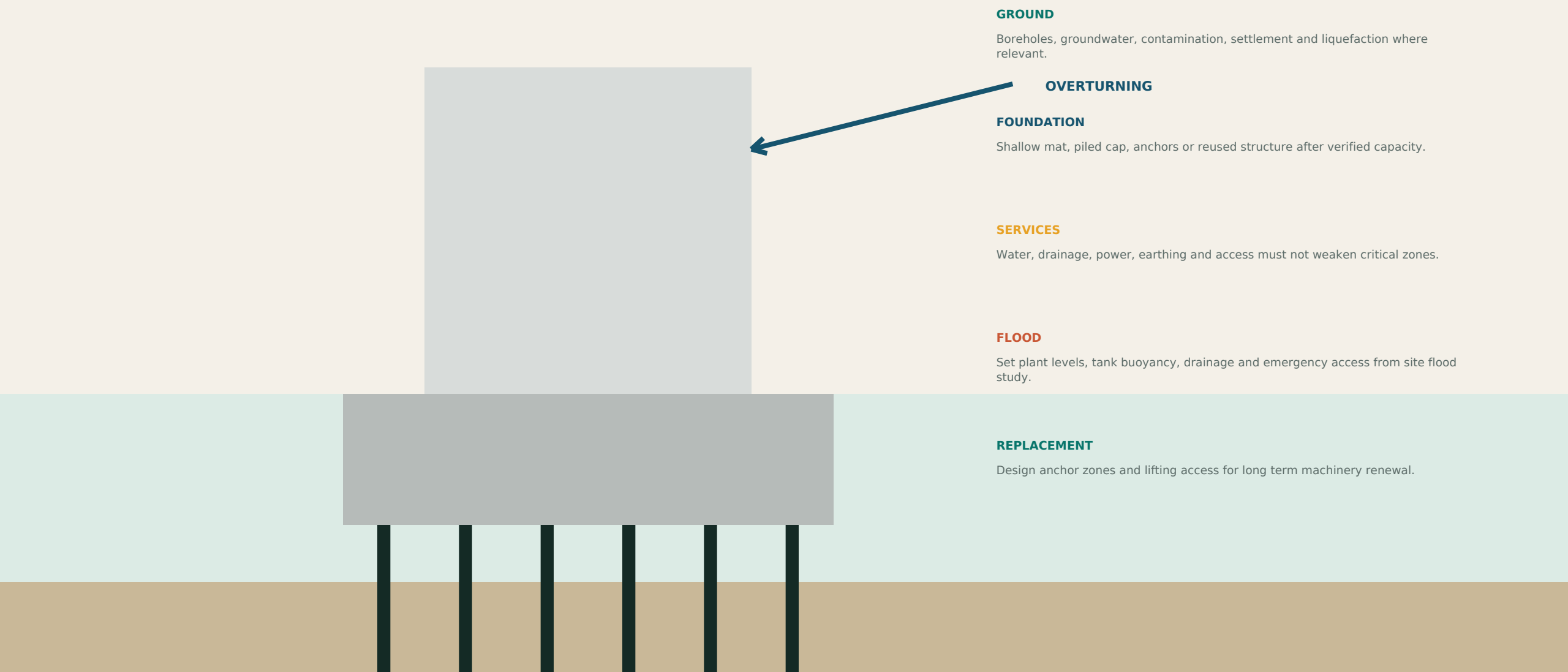
MONITORING

Accelerometers, bearing temperature, motor current and trend alarms.

Required sequence: modal model -> component test -> full assembly test -> monitored commissioning

Tower base and foundations

The highest uncertainty may be below ground, especially on reclaimed waterfront, contaminated land or reused infrastructure.



Machinery, lightning, fire and public access

A kinetic landmark is simultaneously a structure, machine, electrical plant, water system and occupied public place.

MACHINERY

Risk assessment, guards, safety functions, emergency stop, lockout, restart prevention and technical file.

LIGHTNING

IEC 62305 risk assessment, air termination, down conductors, bonding, surge protection and inspection.

FIRE

PV DC, batteries, filters, café, evacuation, smoke modes, firefighter isolation and water supply.

PUBLIC

Exclusion zones, climb prevention, falling object protection, noise, ice, accessibility and crowd loads.

MAINTENANCE

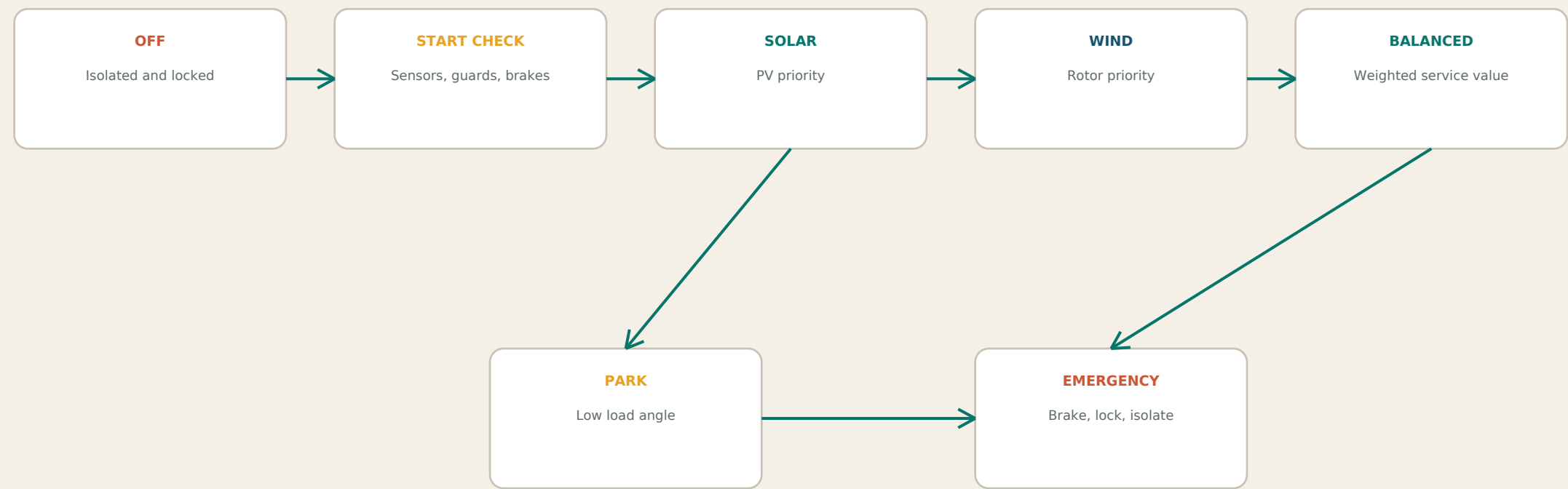
Safe access, rescue plan, lifting, confined spaces, hygiene, waste and permit to work.

CYBER

Authenticated control, least privilege, event logs, offline safe state and tested recovery.

State machine and safety separation

The optimization controller may request movement. The independent safety layer decides whether movement is permitted.



SAFETY FUNCTIONS

Overspeed, excessive wind, failed lock, position disagreement, high vibration, open guard, water leak, electrical fault and loss of communications initiate defined safe actions. Safety functions require an appropriate integrity assessment and proof testing.

Measure inputs, outputs and operating state

Public data is a selected view of a traceable engineering historian, not an independent display counter.

WEATHER

Wind speed and direction at relevant heights, gust, rain, temperature, humidity and irradiance.

MOTION

Azimuth, tilt, lock state, actuator torque or current, travel time and brake status.

ENERGY

PV DC, rotor AC or DC, inverter AC, battery flow, auxiliaries and imported energy.

WATER

Source flow, tank level, pressure, conductivity, turbidity, disinfectant where used and sample records.

AIR

Flow, differential pressure, upstream and downstream pollutants, fan power, temperature and humidity.

CONDITION

Vibration, bearing temperature, leakage, door and guard status, corrosion inspection and alarms.

Declare priorities and constraints

Every mode has entry conditions, permitted equipment, termination conditions and a safe fallback.

MODE	FUNCTION	PRIMARY PURPOSE	EXIT / OVERRIDE
SOLAR	Leaf tracks irradiance within wind and travel limits.	PV yield	Storm, motion fault, public restriction
WIND	Leaf faces accepted wind sector and rotor operates.	Wind research or energy	Overspeed, noise, vibration, low yield
RAIN	Leaf angle favours drainage and tank demand.	Water capture	Wind load, tank full, water quality alarm
BALANCED	Controller evaluates combined service value.	Site objective	Any safety constraint
PARK	Rotor stopped, leaf locked in low load attitude.	Equipment protection	Release only after checks
EMERGENCY	Energy isolated, brakes and locks commanded.	Risk reduction	Manual investigation and reset

Maintenance concept

Access and replacement strategy are design inputs. Equipment at height without a safe service method is not maintainable.

DAILY / AUTOMATIC	Alarm review, energy and flow plausibility, lock state, leaks and abnormal vibration.
MONTHLY	Visual inspection, drainage test, guards, emergency stops, water turnover and filter pressure.
QUARTERLY	Actuator, brakes, locks, rotor, electrical protection, sensors, cleaning and water sampling.
ANNUAL	Structural inspection, bolt checks, lightning system, corrosion, rescue drill and performance audit.
CONDITION BASED	Bearings, vibration, generator, filters, media breakthrough, battery and pump service.
MAJOR OVERHAUL	Lift or lower replaceable leaf equipment using planned crane zones and isolation boundaries.

Preferred one leaf test article

The first build should answer integration questions before a three leaf landmark is commissioned.



Class 5 concept allowances

Ranges indicate order of magnitude only and may be wider. They exclude land, taxes, finance and major external infrastructure.

ONE LEAF PACKAGE	EUR 180k to 450k	Collar, hinge, drive, lock, PV skin, rotor, drainage, controls and local structure.
TWO LEAF PACKAGES	EUR 320k to 800k	Shared engineering and controls, two independent mechanisms.
THREE LEAF PACKAGES	EUR 450k to 1.2m	Coordinated movement, access, higher tower and foundation consequences.
GROUND TEST PROGRAM	EUR 150k to 500k	Design, fabrication, instrumentation, load, drainage, motion and safety testing.
SITE POC PROGRAM	EUR 1.5m to 5m	Indicative integrated demonstrator with one leaf, tower, base systems and public works.

Procurement gates: measured site basis, employer requirements, interface control document, performance test schedule, maintainability review, independent cost plan, risk allocation and whole life operating model.

Required engineering disciplines

No single supplier should silently own unresolved interfaces.

LEAD DESIGNER Requirements, interfaces and design integration.	STRUCTURAL Tower, leaf, fatigue, dynamics and foundations.	MECHANICAL Motion, rotor, bearings, guards and maintenance.
ELECTRICAL PV, generator, storage, protection and earthing.	WATER Hydraulics, treatment, hygiene and water safety plan.	AIR + HVAC Capture, filters, fans, discharge and acoustics.
CONTROLS Safety functions, PLC, historian, cyber and data.	LANDSCAPE Stormwater, ecology, comfort and irrigation.	ARCHITECT Public program, access, heritage and experience.
FIRE + LIFE SAFETY Fire strategy, evacuation and emergency response.	COST + LCA Capital, operation, replacement and embodied impacts.	INDEPENDENT REVIEW Safety, claims, tests and stage gate evidence.

Stop, redesign or proceed

A gate is passed by evidence, not enthusiasm.

0

G0 NEED

Named owner, measured need, site and service boundary.

1

G1 FEASIBILITY

Planning, aviation, heritage, grid, water, source capture and initial business case.

2

G2 CONCEPT

Load paths, interfaces, hazards, access, calculations and cost plan.

3

G3 GROUND RIG

Motion, drainage, rotor, cabling, locks and safety functions demonstrated.

4

G4 SITE POC

Seasonal measured performance, maintenance, noise, public operation and independent review.

5

G5 SCALE

Only proven modules and corrected claims progress to two or three leaf deployment.

Standards and primary references

Confirm current edition and local adoption at project start. Standards guide design but do not certify the Fortin Flower.

E01	IEC 61215-1:2021	PV module design qualification and type approval.	webstore.iec.ch/en/publication/61345
E02	IEC 61730 series	PV module safety qualification.	webstore.iec.ch
E03	IEC 61400-2:2013	Safety and engineering integrity for small wind turbines.	webstore.iec.ch/en/publication/5433
E04	IEC 62305 series: 2024	Lightning risk, structural protection and surge measures.	webstore.iec.ch/en/publication/6797
E05	EN 1991-1-4	Wind actions on structures, with national annex.	eurocodes.jrc.ec.europa.eu
E06	Regulation EU 2023/1230	Machinery framework and essential requirements.	eur-lex.europa.eu/eli/reg/2023/1230/oj
E07	IEC 60364-7-712	Electrical installations for PV systems.	webstore.iec.ch
E08	IEC 62446-1	PV documentation, commissioning tests and inspection.	webstore.iec.ch

Additional references and verification tools

Confirm current edition and local adoption at project start. Standards guide design but do not certify the Fortin Flower.

W01	EN 16941-1:2024	On-site non-potable systems using rainwater.	knowledge.bsigroup.com
W02	WHO Water Safety Plan Manual, 2nd ed.	Risk based management for drinking water supplies.	who.int/publications/i/item/9789240067691
W03	Directive EU 2020/2184	Quality of water intended for human consumption.	eur-lex.europa.eu/eli/dir/2020/2184/oj
A01	ISO 16890 series	General ventilation particle filter classification and testing.	iso.org/standard/57864.html
A02	ISO 10121-1:2014	Gas phase air cleaning media challenge testing.	iso.org/standard/51372.html
A03	DOE Small Wind Guidebook	Site wind, power curves, turbulence and losses.	energy.gov/cmei/systems/windexchange/small-wind-guidebook
A04	NREL Built Environment Wind Turbine Roadmap	Built environment assessment and deployment issues.	nrel.gov/docs/fy13osti/50499.pdf
A05	JRC PVGIS	Site specific photovoltaic resource and yield modelling.	joint-research-centre.ec.europa.eu/pvgis-online-tool_en

FORTIN FLOWER ENGINEERING PATH

Build one leaf. Measure everything. Scale only what survives the evidence.

The next engineering decision is not the final appearance. It is the selection of one representative site, one accountable owner, one measured need and one multidisciplinary team prepared to test the integrated system honestly.

PARTNERS SOUGHT

Structural, mechanical, electrical, water, air, controls, safety, landscape, cost and research specialists.