CurvatureInvest

Industrial Energy Optimisation Without CAPEX

A BESS + PV case study on bill reduction, site monetisation, and risk transfer for energy-intensive manufacturers.

Methodology — How CurvatureInvest reconstructed an existing PV signal, optimised across BESS × PV configurations, and structured the optimal split between peak-shaving and grid services for an anonymised European industrial host.

EUR 10.2M	EUR 415k	~7.7%	12–20 yr
indicative project CAPEX, behind project structure	indicative year-1 host benefit (base-case)	host bill reduction (base-case)	strategic partnership horizon

All numerical values have been rescaled and adjusted for anonymisation purposes — the case demonstrates methodology, not client-specific economics.

The case at a glance

The deal in one page — methodology and detail follow.

8 MW / 16 MWh LFP BESS + 1.5 MWp incremental PV, behind-the-meter — EUR 415k base-case Year-1 host benefit, zero host CAPEX, 12–20-year EaaS structure.

SITUATION

European industrial host, MV-connected manufacturing site with substantial year-round consumption (~27 GWh/yr). ~26% of the bill is the demand charge — every shaved kW carries high marginal value.

Inputs typically required / modelled

- One calendar year of 15-min net-meter data
- Stated nameplate of a small existing on-site PV (~1.0 MWp)
- Site plan + DSO connection profile
- Recent utility invoices for tariff verification

METHODOLOGY

Four sequential analytical pillars. The recommendation is the optimiser's output — not an assumption made in advance and back-justified.

Built end-to-end

- Quarter-hour intervals classified across one full year (HT/NT, peak vector)
- Parametric clear-sky fit to recover PV from net meter
- Sequential-SOC dispatch sim across 12 BESS × PV configurations
- Capacity bounds from satellite imagery (roof + carport + ground)

RECOMMENDATION

8 MW / 16 MWh LFP behind-the-meter, 2-hour duration, with an explicit 15 / 85 capacity split between host services and the grid.

Why this configuration

- Host slice (1.2 MW / 2.4 MWh): ~1 MW sustained shaving + Dec cluster buffer
- Grid slice (6.8 MW / 13.6 MWh) bounded by MV connection envelope
- +1.5 MWp PV from on-site roof + carport — no land deal needed
- EaaS structure: 100% project-vehicle CAPEX (~EUR 10.2M); funded by an investor-backed project vehicle

ECONOMICS & RISK

Behind-the-meter, multi-year EaaS structure. The host pays zero CAPEX and carries no merchant or technology risk; the operator carries the project capital and all merchant risk.

What the deal delivers

- Host: EUR 415k base-case Year-1 benefit, up to 460k with kicker
- Host: ~7.7% bill reduction; 15-yr cum EUR 6.3M+ (base-case)
- Operator: full merchant + technology + augmentation risk
- Sensitivities, risk, deferred-diligence topics: slides 12, 13, 14

CurvatureInvest acts as advisor — structuring, developing and managing the opportunity. The asset is funded and owned by an investor-backed project vehicle. Nothing sits on CurvatureInvest's balance sheet.

All numerical values have been rescaled and adjusted for anonymisation — the case demonstrates methodology, not client-specific economics. Full disclosures: slide 17.

THE HOST · THE QUESTION

The host, and the representative decision question

Demand charges drive ~26% of the bill — every shaved kW carries high marginal value.

ANONYMISED HOST PROFILE

European industrial host

MV-connected manufacturing site with year-round demand, single point of supply.

Annual electricity demand	**~27 GWh**
Estimated annual energy bill	**EUR 5.4M**
Demand-charge share of bill	**~26% (EUR 1.40M)**
Tariff class	**MV high-utilisation**
Demand charge	**~EUR 235 / kW / yr**
Existing on-site PV	**~1 MWp · small relative to load**
BESS compound footprint	**~800 m² ground area, indicative**
PV expansion potential	**Roof + carport surfaces, on-site**
Connection envelope	**~10 MW BTM headroom**

BILL STRUCTURE

Where the EUR 5.4M actually goes

THE REPRESENTATIVE DECISION QUESTION

“Given our existing PV, our load curve, and our connection — what's the right BESS size, and how much should be doing peak-shaving for us versus selling services to the grid?”

The question is the right one because it accepts the trade-off honestly: more BESS capacity dedicated to the host increases bill savings linearly, but each marginal MW past the binding constraint earns less than it would in the FCR / aFRR market. The answer is not a single number — it is a configuration, a split, and a contractual structure. The next nine slides show how we got there.

How the analysis was built — a four-step pipeline

Sequential pillars: each one's output feeds the next. The recommendation falls out of pillar 03.

01 Meter ingestion

One year of fifteen-minute meter intervals, ingested end-to-end. Tariff classification (HT/NT), monthly billing peak identification, December binding-constraint analysis.

02 PV signal reconstruction

The meter sees only NET load. We separate the implied PV bell from the factory's load shape with a parametric fit against winter-baseline weeks. Anchored to nameplate.

03 Configuration sweep

Sequential-SOC dispatch simulation on the full year, sweeping BESS sizes × additional-PV scenarios. Each cell yields Year-1 EBITDA, IRR, NPV, and payback — comparable apples-to-apples.

04 Capacity bounding

Satellite imagery and site plans set the upper bound on PV expansion: roof, carport, ground-mount. Realistic vs stretch — both fed back into the optimiser.

From raw meter exports to a fully-classified load year

Why the December peak — not the annual average — drives the BESS-sizing answer.

INPUTS

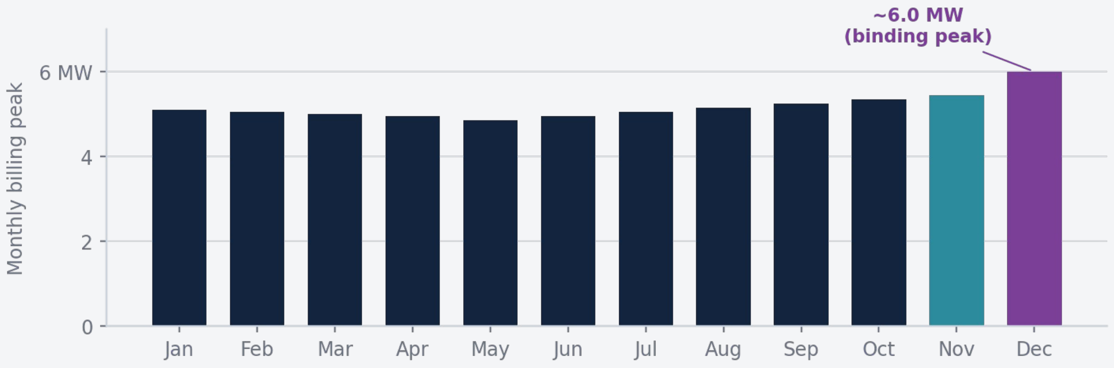
- **Quarter-hour meter readings**
  One full calendar year of net consumption from the host's MV meter.
- **Tariff plate (current year)**
  Public-domain regional DSO MV tariff structure — HT/NT split, capacity charge.
- **Site connection profile**
  Connection size, MV/LV interface, single-point or multi-feed.

OUTPUTS

- Hourly + monthly load shapes, HT/NT decomposition
- Monthly billing-peak vector + the calendar of binding peaks
- Identification of back-to-back peak clusters (cycling-feasibility test)
- Annualised baseline kWh (energy) and kW (capacity) profiles for every scenario

WHY DECEMBER BINDS

The constraint that sizes the host slice



The host's typical operating peak sits in a ~5.0–5.5 MW band. December clusters back-to-back peak hours that lift the monthly peak ~600 kW above this band — the binding constraint that drives BESS sizing. The full-year shaving envelope supports ~1.0 MW of sustained reduction; the 1.2 MW host slice includes operational buffer.

PILLAR 02 · PV SIGNAL RECONSTRUCTION

Recovering the existing PV signal from a net meter

The host has on-site PV. The meter shows only what crosses the boundary. We separate the two.

THE PROBLEM

The meter is netted of behind-the-meter PV. To dispatch a BESS against PV (self-consumption time-shift, midday soak, evening cover), we have to recover the PV signal quarter-hour by quarter-hour — without inverter logs.

THE METHOD

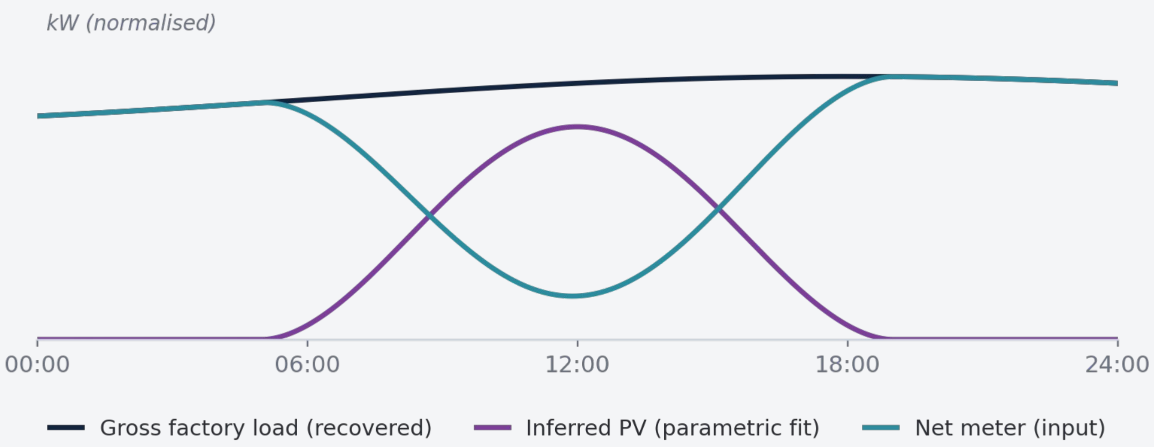
A. Isolate a winter-baseline window where PV is minimal; recover a clean factory load shape.

B. Fit a parametric clear-sky PV bell to the residual: amplitude, day-of-year, latitude/azimuth shape.

C. Subtract fitted PV from net load → gross factory load → implied PV time-series.

D. Reconcile to nameplate. The implied effective capacity should sit below stated nameplate by a plausible real-world derate (~10–20% for older arrays) — and the gap quantified.

ILLUSTRATIVE DAY · SIGNAL DECOMPOSITION



RECONCILIATION CHECK

Stated nameplate of existing PV	**~1.0 MWp**
Effective capacity (from meter fit)	**~0.84 MWp**
Implied annual production	**~1.0 GWh / yr**
Reconciliation status	**~16% below nameplate**

Sweeping the BESS × PV decision space

Each cell is a full-year sequential-SOC dispatch run — same engine, same dispatch logic, comparable outputs.

BESS SIZE	ADDITIONAL PV		
4 MW / 8 MWh	EUR 175k combined 55	EUR 250k combined 72	EUR 320k combined 78
8 MW / 16 MWh	EUR 280k combined 82	**EUR 415k** ★ combined 100	EUR 475k combined 95
12 MW / 24 MWh	EUR 350k combined 88	EUR 475k combined 95	EUR 525k combined 88
16 MW / 32 MWh	EUR 385k combined 80	EUR 510k combined 85	EUR 555k combined 80

Annual host benefit (EUR k, base-case)

WHAT THE GRID TELLS US

Concavity, not corner-solutions

Host benefit concave in BESS size

Demand-charge savings are bounded by the full-year shaving envelope (~1.0 MW sustained). Past that point, incremental MW flow into grid services — which the host does not capture.

Combined project value peaks before host benefit does

Combined value (host plus operator) turns over before host benefit flattens. Past a certain BESS size, the marginal MW earns less than its incremental cost — combined value falls.

PV adds a near-constant uplift

+1.5 MWp lifts host benefit by ~EUR 75–135k/yr regardless of BESS size — self-consumption compounds with PV up to roof capacity.

Why 8 MW × +1.5 MWp is the chosen point

Dominant on Pareto frontier of (host benefit, combined value, site footprint, DSO complexity). Larger configurations give the host more savings but at lower combined value.

What's actually buildable on this site

The optimiser is only as honest as its constraints — bounded directly from satellite imagery.

RECOMMENDED

+1.5 MWp · REALISTIC

From visible on-site capacity, no land acquisition.

Unused main-hall roof	+0.6–1.0 MWp
Carports over parking	+0.3–0.6 MWp
PV contribution vs BESS-only	+EUR 135k / yr
Host annual benefit (BESS+PV)	EUR 415k / yr
Host CAPEX	ZERO

Achievable with on-site permitting; no off-site land deal. Would be funded by an investor-backed project vehicle under the EaaS structure.

STRETCH

+2.5 MWp · UPSIDE

Maxes out on-site footprint — full carports + opportunistic ground-mount.

Full parking carports	+0.5–0.7 MWp
Roof + opportunistic ground	+1.8 MWp
PV contribution vs BESS-only	+EUR 195k / yr
Host annual benefit (BESS+PV)	EUR 475k / yr
Host CAPEX	ZERO

Tighter on permitting and structural cost. Off-site PV remains a fallback if on-site stretch slips.

THE STRUCTURAL DECISION

The optimal split — peak-shaving vs grid services

The single most consequential design choice. It is set by the data, not by negotiation.

8 MW / 16 MWh BESS — capacity allocation

HOST SLICE — 15%

1.2 MW / 2.4 MWh

GRID SLICE — 85%

6.8 MW / 13.6 MWh

The split is the structural answer to the representative decision question.

HOST SLICE · WHY 1.2 MW

Sized to the binding peak — not to the battery's nameplate

- Binding constraint: December peak uplift (~600 kW above normal operating peaks)
- Full-year shaving envelope: ~1.0 MW sustained reduction across all 12 billing months
- Host slice 1.2 MW / 2.4 MWh — includes operational buffer for back-to-back cluster events
- Annual host-stack value (illustrative): ~EUR 478k — aggregate before commercial split

GRID SLICE · WHY 6.8 MW

Sized to the connection envelope and to ancillary-services liquidity

- Capped by MV connection headroom (host-provided profile, subject to DSO confirmation) and 2-hour duration
- Stacks FCR primary control + aFRR + day-ahead / intraday wholesale arbitrage
- The project vehicle / operator retains grid-services revenue and bears merchant-market risk
- Underwritten with diversified-product haircuts; performance kicker shares upside with host

The recommended configuration

8 MW / 16 MWh BESS + 1.5 MWp PV — what the four-pillar methodology converges to.

8 / 16	+1.5 MWp	EUR 10.2M	EUR 415k	~7.7%
MW / MWh LFP, 2-hour	incremental on-site PV	indicative project CAPEX, project structure	indicative year-1 host benefit	host bill reduction (base-case)

WHAT THE HOST RECEIVES

EUR 415k base-case Y1 host benefit · up to EUR 460k

Bill-savings share (45% of host stack)	**EUR 215k**
Land lease (indexed)	**EUR 90k**
Performance-kicker base	**EUR 110k**
Performance-kicker upside	**up to +EUR 45k**
15-yr cumulative base-case, undiscounted	**EUR 6.3M+**

STRUCTURE & RISK ALLOCATION

Multi-year EaaS, behind-the-meter

Project CAPEX	**100% operator / project structure**
Technology + augmentation risk	**Operator (warranty + reserve)**
Merchant / market risk	**Operator (haircuts, diversified)**
Tariff drift	**Symmetric — both sides exposed**
Host balance-sheet impact	**Zero**

HOW THE BASE-CASE BENEFIT IS BUILT · OPERATIONAL DECOMPOSITION

Where the EUR 415k actually comes from

Three meter-side levers + one commercial split + two contractual additions — no magic, no rounding.

STEP 1 · THREE METER-SIDE LEVERS GENERATE THE HOST STACK (EUR 478k / yr)

Peak-shaving	PV self-consumption	Time-shift / export / residual arbitrage
EUR 235k	EUR 195k	EUR 48k

Two levers carry the value: peak-shaving ~49%, PV self-consumption ~41%. Time-shift, export, and HT/NT arbitrage together add ~10% — residual, but explicitly modelled.

STEP 2 · CONTRACTUAL SPLIT — HOST KEEPS 45%, OPERATOR TAKES 55% AS SERVICE FEE

HOST — bill-savings share	OPERATOR — service fee (funds CAPEX, ops, augmentation, market risk)
EUR 215k	EUR 263k

STEP 3 · HOST'S YEAR-1 BASE-CASE BENEFIT = STACK SHARE + LAND LEASE + PERFORMANCE-KICKER BASE

Bill-savings share

EUR 215k

45% of host stack — direct meter savings

Land lease (indexed)

EUR 90k

Fair-market industrial rate on hosted footprint

Performance kicker base

EUR 110k

Fixed; gated on uptime > 98%

YEAR-1 HOST BENEFIT (BASE-CASE)

EUR 415k

Up to EUR 460k with kicker · ~7.7% bill reduction

How the host's benefit holds — and where it moves

Effect on the host's Year-1 base-case benefit across five core variables.

Variable	Bear case	Base case	Bull case	Host Y1 benefit range
Tariff drift (real, p.a.)	−1% / yr	0% (flat real)	+2% / yr	**EUR 360k – 485k**
Ancillary clearing — FCR + aFRR	−30%	market consensus	+30%	**EUR 415k ***
Augmentation cadence (% CAPEX/yr)	2.0%	1.5%	1.0%	**EUR 415k ***
Battery degradation, Year-1	3.0%	2.0%	1.5%	**EUR 415k ***
PV yield (existing + incremental)	−10%	parametric fit	+5%	**EUR 395k – 425k**

** Host Year-1 base-case benefit unaffected: ancillary, augmentation, and degradation are merchant- and operator-side risks absorbed by the investor-backed project vehicle. The host's exposure is to tariff drift (symmetric) and PV yield (proportional).*

THE STRUCTURAL INSIGHT

The host's Year-1 base-case benefit is preserved across all merchant-side stresses. Downside risk on FCR / aFRR clearing, augmentation cadence, and battery degradation is borne entirely by the project vehicle / operator.

WHERE THE HOST CARRIES RISK

Tariff drift (symmetric — the host benefits from inflation, loses on real declines) and PV yield (operational performance of an asset owned by the project vehicle, but reflected in the host stack).

RISK ALLOCATION · WHO BEARS WHAT

How the structure divides risk between host and operator

By category, with the contractual mechanism that delivers the allocation.

Risk category	Host	Operator	Mechanism
CAPEX	None	Full	An investor-backed project vehicle would fund 100% upfront (~EUR 10.2M); host holds zero balance-sheet exposure.
Technology / battery degradation	None	Full	Performance warranty; augmentation reserve 1.5% / yr CAPEX; tier-1 OEM with availability SLA.
Market — FCR / aFRR / arbitrage	None	Full	Diversified-product haircuts in UW; merchant tail absorbed within the investor-backed project vehicle.
Operational — uptime, dispatch	None	Full	Performance kicker gated on > 98% uptime; service-level guarantee; operator-controlled dispatch under agreed contractual parameters.
Tariff drift	Symmetric	Symmetric	Both sides exposed to DSO tariff inflation. Host gains a structural hedge as tariff rises.
Counterparty	Site continuity 12–20 yr	Funding & operations	Host credit + multi-year off-take; investor-backed project vehicle + asset salvage value.
Termination	Exit penalty	Asset removal at cost	Bilateral schedule with calibrated triggers; pre-agreed buy-out formula at year-7 onwards.

THE ASYMMETRY THAT MAKES THE STRUCTURE WORK

The host is exposed to one variable it cares about (tariff drift — which it would carry anyway, with or without the BESS) and to PV yield. Everything else — funding, technology, merchant markets, operations — sits with the project vehicle / operator.

FREQUENTLY ASKED IN DILIGENCE · COVERED IN DIRECT DISCUSSION

What this case study deliberately leaves at the perimeter

Each topic below becomes a working agenda item once an engagement progresses to term-sheet.

Accounting treatment

IFRS 16 / local GAAP analysis. Off-balance-sheet structuring where lease accounting permits; rating-agency briefing if material to the host's credit profile.

Insurance & site liability

Hardware and operations covered by the operator's policies; interaction with the host's existing site policy to be confirmed and documented in the EaaS agreement.

Counterparty resilience

Step-in rights to a designated successor operator. Asset transferable; pre-agreed exit and asset-removal triggers if the operator defaults — host always has an exit path.

Volume / load volatility

Base-case benefit adapts to consumption shifts within ±20%; structural review beyond that. Provisions for production growth (capacity headroom in place) and contraction (right-sizing clauses).

OEM, EPC, TSO prequalification

Tier-1 OEM long-list; EPC selection driven by site-specific connection terms and warranty package; TSO prequalification confirmed before any binding offer.

Cybersecurity & fire safety

Compliance with applicable local electrical-code, fire-safety, insurer and permitting requirements; BESS safety standards documented through tier-1 OEM certifications; site fire-protection plan integrated with host's existing system.

Tax & jurisdictional treatment

Local tax treatment, capital allowances, depreciation modelled into the project vehicle's UW. Tax memo provided on request; cross-border structuring where the host's group sits abroad.

Track record & references

Relevant project materials, advisor bench, and references shared on a confidential basis as appropriate.

Four choices that shaped the answer

The optimiser's output is only as good as the modelling decisions feeding it. Each choice below was deliberate.

01 On the load characterisation

The right input is the binding peak — not the annualised average, and not the single worst quarter-hour. The cluster-feasibility test (back-to-back peak events within hours) is what eliminated the 4-hour BESS scenarios from contention before the optimisation even ran.

02 On the PV signal reconstruction

Parametric clear-sky fit, not a statistical regression on weather data. A regression-based recovery over-fits to a single calendar year of irradiance and factory-load coincidence; the parametric anchor surfaces the gap between stated nameplate and effective capacity — a 16% derate, in this case.

03 On the dispatch simulation

Sequential SOC tracking on the full year of intervals — not a closed-form approximation. Closed-form formulas misprice back-to-back peak events, augmentation cadence, and PV-time-shift interactions. The simulation captures all three by construction.

04 On the host vs grid-services split

Set by the data, not by negotiation. The host slice is bounded above by the binding peak; the grid slice is bounded above by the connection envelope and ancillary-services liquidity. The 15 / 85 ratio is what those two physical constraints produce on this site.

SCOPE OF THE METHODOLOGY

What was modelled, what was delivered, what sat outside

The work behind the answer — and the explicit perimeter of this methodology.

ANALYTICAL SCOPE

- Year-of-meter quarter-hour intervals processed end-to-end
- Parametric reconstruction of the existing PV signal
- Sequential-SOC dispatch simulation across 12 BESS × PV configurations
- Sensitivity sweeps: tariff drift, ancillary clearing, augmentation cadence, degradation
- Cash-flow build: floors, performance kickers, host-share splits, 15-yr IRR / NPV

ILLUSTRATIVE DELIVERABLES TO AN INDUSTRIAL HOST

- Recommended configuration with documented dominated alternatives
- Year-1 host benefit (base-case) and full sensitivity grid
- Indicative term-sheet outline — sizing, PV scope, commercial split, contract length
- Strategic-fit memo and discussion deck for management review
- Bounded site-capacity assessment from satellite imagery

OUTSIDE THE PERIMETER

- Detailed electrical engineering and EPC selection
- Local permitting and DSO / grid-operator connection-study filings
- Final tariff renegotiation with the regional DSO
- Procurement, construction, and commissioning
- Binding commercial commitment — subject to definitive agreement

The optimisation engine, the parametric PV recovery, and the cash-flow build were developed as part of CurvatureInvest's internal analytical infrastructure.

Methodology disclosures

Please read before relying on any content in this document.

CurvatureInvest's role & anonymisation

CurvatureInvest acts solely as advisor — structuring, developing and managing the opportunity. The asset would be funded and owned by an investor-backed project vehicle (referred to throughout as "the operator" or "the project vehicle"); CurvatureInvest does not fund, own, operate or hold any project asset on its balance sheet. The case is anonymised, materially adjusted, and should not be read as a reproduction of any specific client, site or engagement.

Indicative & forward-looking

Year-1 economics, IRRs, NPVs, and 15-year benefit projections are modelling outputs at a point in time. Realised outcomes depend on tariff evolution, ancillary-services market behaviour, BESS performance, and the final commercial structure. None are guaranteed. Tariff inputs reference public-domain DSO MV tariff schedules; ancillary-services prices reference CurvatureInvest's internal market views.

Not an offer or solicitation

This document is a methodology case study prepared by CurvatureInvest for general illustrative purposes. It does not constitute a binding offer, a financial proposal, or investment advice. Any commercial engagement on a specific site would proceed only after (i) recalibration against actual host invoices and current DSO tariffs, (ii) detailed engineering, (iii) due diligence on grid interconnection and permitting, and (iv) negotiation of a definitive written agreement.

No professional advice & no liability

Nothing in this document constitutes legal, tax, regulatory, accounting, or investment advice. Recipients should consult their own advisors. To the fullest extent permitted by law, CurvatureInvest and its affiliates, principals, and agents disclaim any liability for loss arising from the use of, or reliance on, this document. All numbers are denominated in EUR and exclude VAT.