From a pressure-reduction idea to a system roadmap

How a compressed air assessment at a waste sorting plant connected supply control, demand-side process behavior and operating states to a quantified savings path.

~35 m³/min	7.5–9.3 bar	€163k–€166k	€20k–€32k
average observed demand	observed pressure range	annual generation cost	projected combined annual saving

The central question was not simply "How low can pressure go?" It was "What prevents the site from going lower safely, and what sequence of actions removes those constraints?"

Site: The Netherlands.
Assessment team: The Analysts
Assessment period: May 2026

A savings estimate existed. A safe implementation path did not.

A 2024 compressed air study had already identified pressure reduction as a major opportunity. It suggested a path from roughly 8.5 bar toward 6 bar and eventually 5 bar, with an indicative annual pressure-reduction value of €42,600. It also estimated leak losses above €80,000 per year. The missing element was a practical roadmap: which users set the minimum pressure, why the system was unstable, how off-shift demand should be served, and how savings could be validated without putting production at risk.

- Translate a broad pressure-reduction ambition into a staged, reversible implementation strategy.
- Understand why a relatively new system still operated across a large pressure band and wide demand range.
- Separate supply-side control problems from demand-side process constraints.
- Identify low-load and off-shift operating states that were being served inefficiently.
- Quantify a realistic first savings range in euros, while keeping unvalidated opportunities separate.

The customer questions we had to answer

Question	Why it mattered
How low can the system pressure safely go?	Pressure could not be reduced by assumption; critical users and local pressure drops had to be identified first.
Why does pressure swing so widely?	A 1–1.5 bar control band and reactive compressor behavior can mask process-side problems and increase artificial demand.
What happens during cleaning, blockages and weekends?	These states change demand faster and further than a single "average day" can represent.
Which processes are driving peaks and local pressure losses?	Transient users can force the whole site to run at a higher header pressure than the process actually needs.
What should happen first?	The site needed a roadmap that preserves reliability and measures the effect of each action.

A system assessment built around evidence, operating states and process mapping

The assessment combined temporary compressor-side logging, permanently installed plant instrumentation, on-site observation, staff interviews and a complete process walk-through. Flow, pressure and dew point data were logged at one-second resolution through the site DS-500 system. Temporary loggers recorded supply pressure and single-phase compressor amperage; those amperage values were used to estimate kW. The datasets were synchronized into a common timeline and then compared with what operators and process equipment were doing.

1-second flow / pressure / dew point logging	**5 compressors** 2 × 110 kW VSD + 3 × 90 kW fixed	**~8 days** multi-day operating profile	**plant-wide** walk-through and process mapping

Our strategy: answer the customer's question by connecting four layers

1. Establish the operating envelope
Measure demand, pressure and estimated power across production, transient events and low-load periods.

2. Classify day types and operating states
Avoid averaging together production, cleaning, blockage events, off-shift and weekend conditions.

3. Map process constraints
Trace high/transient and low/continuous users; identify where local restrictions or storage gaps force higher central pressure.

4. Build an enabling roadmap
Fix measurement and control first, prove local process modifications, then lower pressure in controlled steps with a rollback path.

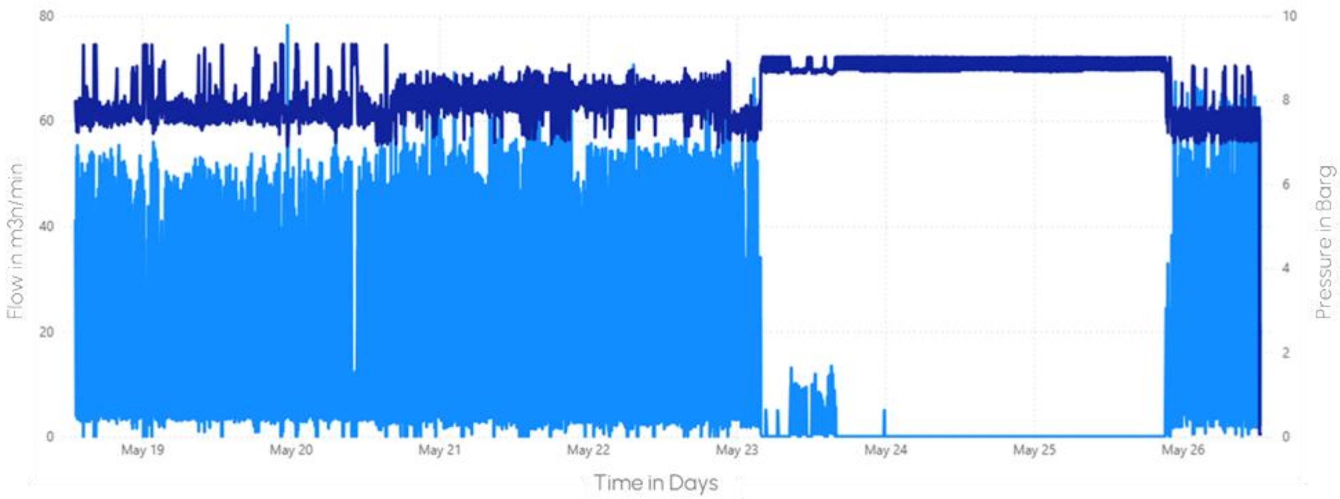
Important validation boundary

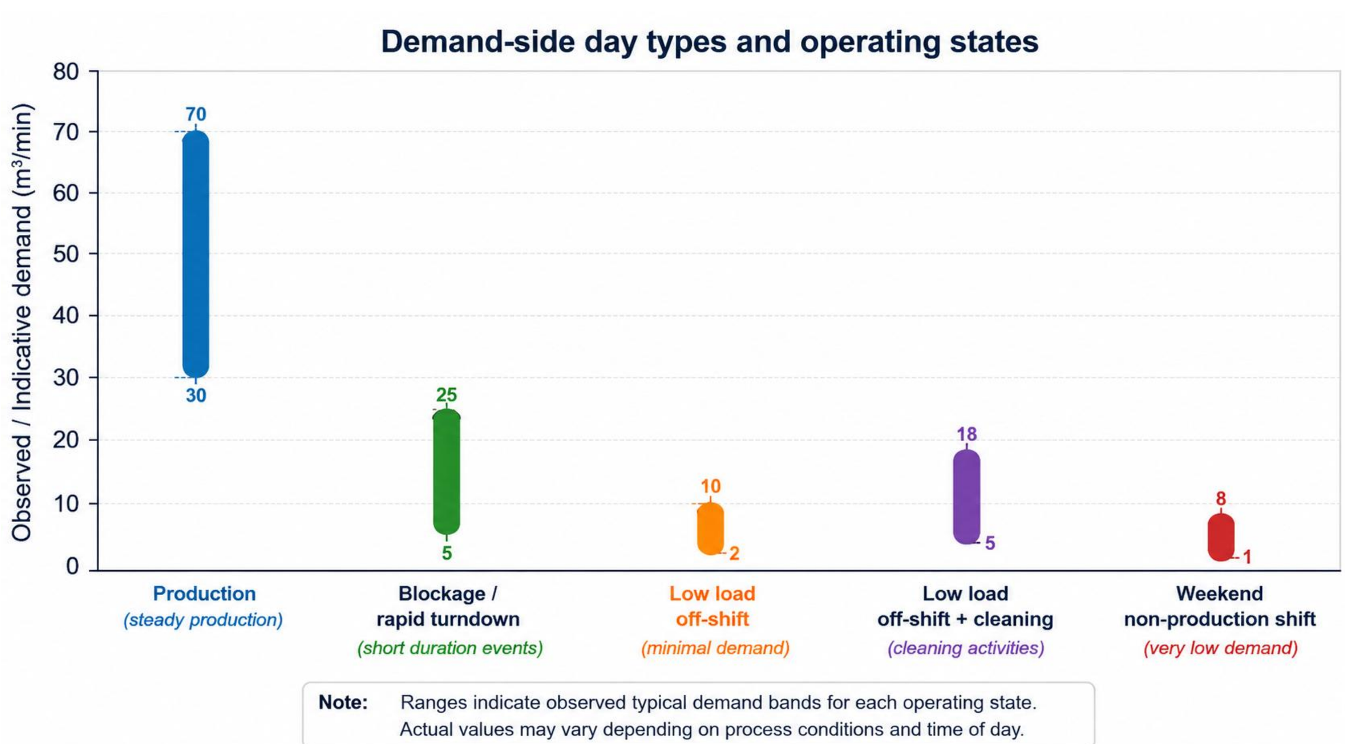
True three-phase power and compressor discharge flow were not measured simultaneously. The resulting savings values are therefore engineering estimates, not revenue-grade guarantees. This limitation shaped the roadmap: install proper power measurement, service flow sensors and validate each pressure step against production performance.

3 | DEMAND SIDE: DAY TYPES AND OPERATING STATES

One plant, several compressed air systems depending on the hour

The assessment showed that a single average demand value is not sufficient. The same plant behaves very differently during normal production, cleaning, process blockages, off-shift operation and weekends. These states need separate baselines because the compressor control requirement, useful storage and process risk are different in each one.



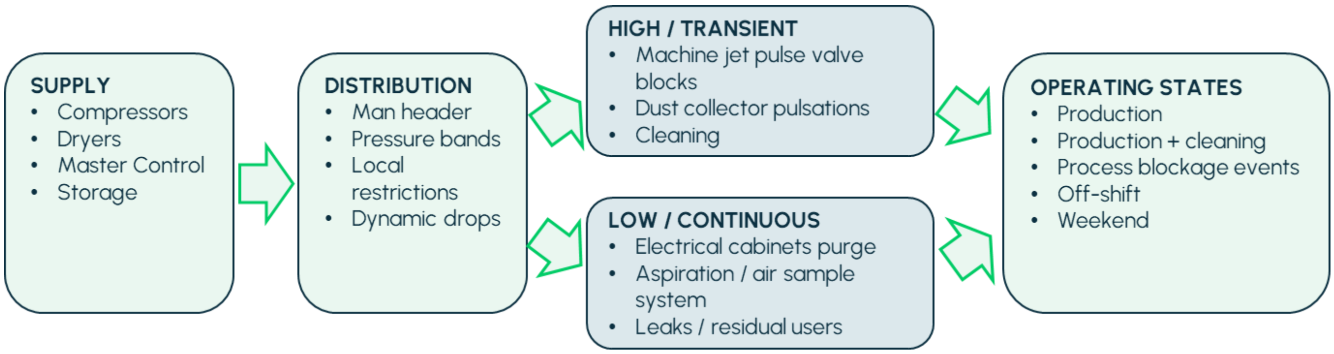


The ranges above are a compact interpretation of the measured profile and observed operating states. Production demand reached roughly 70–78 m³/min, while low-load and weekend periods dropped to a small fraction of that level. The most important finding was not only the size of the range, but the fact that pressure instability remained visible even when demand was low.

Day type / state	Compressed air behavior	Assessment implication
Production	Broad, variable demand; frequent transient users	Use stable base capacity plus one active trim compressor.
Blockage event	Rapid demand collapse followed by recovery	Control logic must recognize abrupt state changes and avoid over-pressure / delayed reload.
Off-shift + cleaning	Low demand plus high open-blow demand	Regulate cleaning pressure and avoid forcing the entire header upward.
Off-shift / low load	Small residual users with pressure still fluctuating	Investigate hidden users and control setup; size supply to the actual remaining load.
Weekend	Very low demand served by an oversized 110 kW VSD package	Measure accurately, isolate avoidable users and evaluate a dedicated smaller compressor.

Pressure reduction starts at the process, not at the compressor setpoint

The process map was used to distinguish between users that consume continuously, users that create short high-flow events, and users that may remain connected during non-production periods. The objective was to identify which local conditions were driving central pressure and peak response.



Strategy: Map Pressure, flow and operating state together, then remove local constraints before reducing supply pressure

Mapped demand-side priorities

Process / user	Observed issue	Why it matters	Next test
Optical sorting machines	Approx. 0.5–1.5 bar local pressure drops at valve blocks	Local restrictions can make the whole plant run at excessive pressure.	Instrument before/after regulator and near MAC valves; test larger connection and local storage.
Dust collector pulse system	Large local pressure collapse and mechanical stress in flex piping	Short pulse events can destabilize the header and trigger extra compressor response.	Review S1–S4/S6 with OEM: pulse pressure, valve capacity, piping and local receiver volume.
Manual cleaning	Unregulated air around 7.5 bar	Open blowing creates avoidable demand and artificial pressure load.	Regulate receiver/cleaning pressure; evaluate lower-pressure amplification methods.
Plant blockage events	Demand falls rapidly; compressors over-pressurize and unload	Current control does not match actual operating states.	Create state-based control logic and test slow-stop / recovery behavior.
Electrical cabinet purge	Dedicated dry-air route with uncertain final need and pressure	Potential double drying and unnecessary air-quality cost.	Verify OEM air-quality requirement, final pressure and dryer sequence.
Kingspan aspiration / residual users	Potential continuous or off-shift load	Can define the minimum weekend compressor size.	Measure separately; evaluate local compressor and check-valve backup.

The compressor room was functional, but the control philosophy was not aligned with the plant

~597 kW	~310 kW	8.86 kW/(m³/min)	531 J/l
approx. maximum package input	estimated average production power	calculated average specific power	calculated average SER

The installed system consists of two 110 kW VSD full-feature compressors and three 90 kW fixed-speed full-feature compressors. The observed demand range was much wider than the equipment could serve efficiently with one undifferentiated control strategy.

Key supply-side findings

- Pressure was observed roughly between 7.5 and 9.3 bar, with an excessively wide effective operating band.
- The two 110 kW VSD compressors did not show a clean "one trim, one standby/rotation" relationship; both were used actively and sometimes erratically.
- The 90 kW fixed-speed machines appeared to enter reactively rather than as a predictable base-load group.
- Low-demand periods still showed pressure fluctuation, pointing to control setup, pressure signal, storage arrangement or system response - not production demand alone.
- The BD850 desiccant dryer strategy appears over-dry for a freeze-protection requirement if -40 °C PDP is not process-mandated.
- Condensate quality differed between compressor groups; drains, oil-water separation and preventive inspection need attention.
- A correctly sized wet-side receiver may help damp pressure rate-of-change, but storage is an enabler, not a substitute for proper control.

Preferred control concept

Demand condition	Preferred operation	Intent
Low	One 110 kW VSD trimming	One active trim machine within a stable range.
Medium	1 × 90 kW fixed loaded + 1 × 110 kW VSD trim	Base + trim.
Higher	2 × 90 kW fixed loaded + 1 × 110 kW VSD trim	Add stable base capacity.
Very high	3 × 90 kW fixed loaded + 1 × 110 kW VSD trim	Full base + trim.
Peak / abnormal	Second VSD only when first trim is near capacity	Peak assist, redundancy or rotation - not dual low-load trimming.

The dominant constraint was not average demand. It was how short events and local losses influenced the whole system.

Several demand-side observations explained why the site could not simply lower the compressor setpoint. The plant was already operating some sorting equipment around 5.5–6 bar, yet the compressor system regularly ran much higher. This gap pointed to local distribution losses, transient peaks and control behavior rather than a universal process requirement for high pressure.

Low-load and off-shift hours: oversized supply for a small remaining load

During the weekend profile, a 110 kW VSD compressor cycled at very low package power, roughly 5–20 kW, with a repeating wave close to a two-minute period. This indicates a remaining demand below the machine's useful turndown range. The direct concern is poor specific power and wasted operating hours; the reliability concern is prolonged low-temperature operation, repeated control movement and the use of a large compressor to serve small non-production demand.

5–20 kW observed low package power band	**~2 min** repeating weekend cycle	**~36 h/weekend** low-value runtime used in case	**€5.6k/yr** conservative combined case value used in report

The full assessment also showed a more aggressive theoretical weekend case based on 110 kW versus 20 kW name plate operation. For the white-paper roadmap, the conservative €5,600/year value is retained because the weekend flow must first be measured accurately and the final compressor size must be validated.

Demand-side conclusion

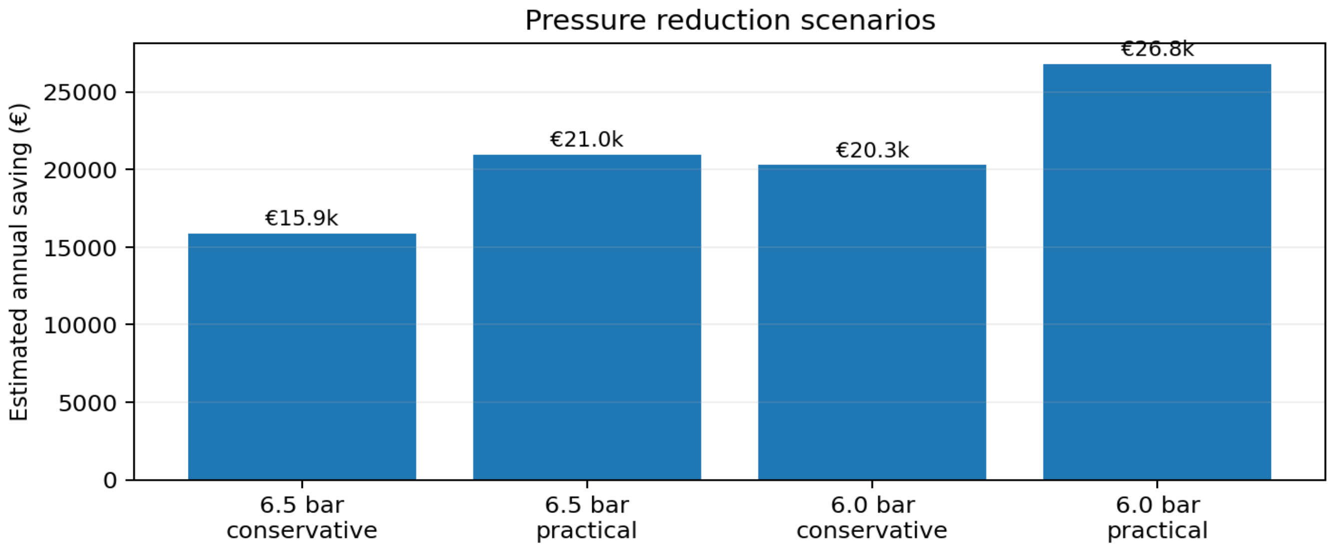
The safest pressure-reduction strategy is therefore to remove local restrictions and transient instability first, then reduce central pressure. A successful Optical Sorting Machines pilot, dust collector review, regulated cleaning strategy and isolation of unnecessary off-shift users can lower both average demand and the pressure cushion currently carried by the compressor room.

What the assessment revealed

1	**The plant does not have one demand profile.** Production, cleaning, blockage events, low-load and weekend operation must be treated as different control states.
2	**Pressure instability is a system issue.** Wide compressor control bands, sequencing, signal/storage behavior and rapid process events interact.
3	**The highest header pressure is not the same as the process requirement.** Some equipment already runs around 5.5–6 bar; local drops of 0.5–1.5 bar are a key constraint.
4	**Utilizing an oversized 110 kW FF VSD for the weekend load.** Low-load operation wastes energy, consumes service life and may introduce reliability risk.
5	**Pressure reduction is the main quantified opportunity - but it must be enabled.** Control stabilization and local process fixes are prerequisites, not separate add-on savings.
6	**The first savings range is meaningful without aggressive redesign.** A practical combined annual potential of roughly €20,000–€32,000 is projected before several additional demand-side opportunities are quantified.
7	**The second and third savings range will require engineering, more work, cultural change and system thresholds and alerts** A practical combined annual potential of roughly €65,000–€80,000 is projected after several additional supply and demand-side opportunities are gradually carried out. Improve the demand side → adjust the supply side → verify system response → identify the next demand-side opportunity → adjust the supply side again → repeat.

A quantified first step, with additional upside not yet counted

The baseline used in the assessment is approximately 310 kW average compressor power during production, 35 m³/min average demand, 6,240 operating hours per year and €0.086/kWh. This gives about 1,934,400 kWh/year and €166,358/year. The reported 2025 compressed air electricity total was similar at about €163,291/year.



Scenario	Annual cost	Annual saving
Current estimated condition	€166,358	—
6.5 bar - conservative	€150,474	€15,884
6.5 bar - practical	€145,400	€20,958
6.0 bar - conservative	€146,071	€20,287
6.0 bar - practical	€139,558	€26,800

Combined first-stage potential

When the pressure-reduction scenarios are combined with the conservative weekend-load correction used in the report, the projected annual saving is approximately €20,000 - €32,000. The corresponding annual compressed air generation cost falls to roughly €134,000 - €146,000 in the combined scenario table, with the broader report summarizing a realistic post-improvement range of about €138,000 - €149,000 depending on validated pressure target and operating assumptions.

Not included in the €20,000 - €32,000 range: additional dryer optimization, cleaning-air reduction, dust collector improvements, leak repair, cabinet purge optimization and future demand-side reductions. These should remain separate until measured and validated.

9 | BROADER SAVINGS POTENTIAL BEYOND THE FIRST STAGE

The quantified first-stage opportunity of approximately **€20,000 to €32,000 per year** focuses primarily on controlled system-pressure reduction and correction of inefficient weekend and low-load operation.

However, the assessment identified several additional opportunities that were not included in this first-stage savings range. These include:

- desiccant dryer optimization;
- reduction of high-pressure cleaning air;
- optimization of major dust collector pulse-air demand;
- continued leak management;
- deeper process-side pressure and flow optimization.

These opportunities should not simply be added together without adjustment. Some measures, particularly dust collector optimization and correction of local process restrictions, may help enable the pressure reductions already included in the first-stage case. To avoid overstating the business case, the broader estimate therefore allows for overlap between measures.

Projected additional opportunity

Opportunity	Indicative annual saving potential p/yr	Confidence / treatment
Dryer optimization	€500–€2,200	Partly quantified
Cleaning-air reduction	€2,000–€8,000	Projected; requires flow and usage validation
Dust collector optimization	€5,000–€20,000	Major opportunity: direct and enabling value may overlap
Leak reduction	€9,500–€14,000	Based on expected 8–10% system leakage and practical recovery
Deeper demand-side optimization	€4,000–€15,000	Projected; overlap with pressure reduction must be controlled

The gross technical sum of these opportunities is larger than the practical additive value. After allowing for overlap, the assessment indicates an additional practical opportunity of approximately:

€18,000–€35,000 per year

This places the broader realistic compressed-air improvement potential at approximately:

€40,000–€65,000 per year

A more ambitious technical scenario may reach approximately:

€65,000–€80,000 per year

but this higher range depends on successful engineering and validation of the major transient demand users, particularly the four dust collectors that use the same pulse-air configuration as the unit observed producing a pressure drop of approximately **5 bar, from around 8 bar to around 3 bar**.

Opportunity level	Annual projected savings
First-stage quantified opportunity	€20k–€32k
Broader realistic total potential	€40k–€65k
Higher technical scenario	€65k–€80k

The initial business case is already meaningful. The wider system opportunity is potentially twice as large.

Reduce risk first. Then reduce pressure.

The roadmap is intentionally staged. Each step either improves the quality of the evidence, removes a process constraint or enables the next pressure reduction. The objective is a controlled series of improvements with measured before/after comparison and a clear rollback path if a critical process is affected.

Phase	Action	Purpose	Euro relationship
1 (0–90 days)	Install three-phase power meters on all compressors and desiccant dryers; service both main flow meters; consolidate high-resolution data.	Create a trustworthy baseline and M&V layer.	Enabler - protects the savings case.
1 (0–90 days)	Tighten pressure band incrementally; create compressor roles/groups; review VSD minimum speed and GA90 reload behavior.	Stabilize pressure and stop machines from fighting each other.	Enables €15.9k–€26.8k pressure opportunity.
1 (0–90 days)	Instrument one Optical sorting machine pilot at three points; improve connection/storage; lower machine pressure carefully and measure impact at machine with Flow & Pressure sensor.	Prove that local losses, not header pressure, are the constraint.	Unlocks lower site pressure; avoid double counting.
1 (0–90 days)	Measure weekend residual load; isolate avoidable users; size dedicated smaller compressor.	Match supply to non-production demand.	~€5.6k/yr retained in conservative combined case.
			Phase 1 potential 20.000, - … 32.000, -
2 (3–6 months)	Review the 4 dust collector pulse air with OEM, measure pulse volume, pulse frequency and recovery; investigate local receiver storage; correct excessive local pressure drops;	Reduce transient pressure collapse and avoidable demand.	€12.500, - … €20.000 +
2 (3–6 months)	Regulate cleaning air from 8 to 2 bar. Investigate air amplifier	Avoid artificial demands for weekend cleaning hours	€5.000, - … €8.000, -
2 (3–6 months)	Optimize BD850 dew point set point and seasonal strategy; verify CD35 requirement and double-drying risk.	Meet freeze protection and process quality at lowest energy.	€1.500, - … €2.200,-
2 (3–6 months)	Replicate successful Optical sorting machine modifications and create operating-state logic for blockage/cleaning events.	Turn pilot learning into system-wide pressure reduction.	Supports practical €20k–€32k/yr first-stage range.

Phase	Action	Purpose	Euro relationship
			Phase 2 potential 40.000, - ...65.000, -
3 (6–12 months)	Perform off shift leak survey	Reduce overall demand	€7.500, - ... €9.500, -
3 (6–12 months)	Evaluate wet receiver, Kingspan local compressor and systematic off-shift isolation.	Deepen reliability and demand reduction.	€2.000, - ... €3.500, -
3 (6–12 months)	Optimize different compressor-control strategies by day type;	Deepen reliability, lower risk position and unnecessary equipment run hours.	€1.500, - ... €2.000, -
3 (6–12 months)	Verify energy performance against production output.	Set and manage this KPI for trending, reporting and benchmarking with other sites.	
			Phase 3 potential 65.000, - ...80.000, -

Decision gates

- Do not lower overall system pressure until critical users are instrumented and local dynamic losses are understood.
- Keep pressure-band stabilization as an enabling action; do not add it again as a separate guaranteed saving.
- Validate weekend load before buying a smaller compressor.
- Use before/after power, pressure and flow trends by day type - not a single blended average.
- Maintain a defined rollback ("kill switch") to the previous stable settings during each controlled trial.

The most valuable outcome is not just a lower setpoint. It is having a sequence for getting there.

The assessment started with an apparently simple question: how much money can we save from pressure reduction without affecting the quality of our end product? The answer required a broader view. The site's compressor room, distribution network, transient users, operating states and low-load hours were interacting. A high central pressure was compensating for local pressure drops and fast demand events, while the compressor fleet was not sequenced around the plant's real demand states.

By combining synchronized data, day-type analysis and process mapping, the assessment converted a generic pressure-reduction idea into a practical roadmap. The first quantified target is approximately €20,000–€32,000 per year from pressure reduction and low-load correction, with additional upside from dryers, cleaning, dust collection, leaks and deeper process optimization still to be measured.

The strategic lesson: demand should lead supply. Stabilize the process, remove local constraints, match generation to the actual operating state - and only then lower the system pressure with confidence.

About this reduction

This document is a reduced case-study version of the 2026 Waste Recycling Facility Compressed Air Assessment in The Netherlands performed by The Analysts. It is intended to explain the problem-solving method, key findings and implementation logic. Savings figures are engineering estimates based on the available site data and should be validated with calibrated three-phase power, verified flow and pressure measurement before being treated as guaranteed results. However, we strongly believe in the number presented in this report to be achievable.

THE ANALYSTS

MORE MINDS. BETTER RESULTS.