Plasselva kraftverk

Run-of-river · · price zone **NO4** — full-year optimised dispatch, 1 Jan – 31 Dec 2025.

INSTALLED	MAX FLOW	RESERVOIR
4,6 MW	1,5 m³/s	0 h · 0,0 Mm³

WATERCOURSE & COMPONENTS · LAVANGEN

THE HEADLINE · 2025

Co-optimising Plasselva kraftverk across **all balancing markets** lifted modelled revenue **+199 %** over day-ahead-only dispatch — almost entirely from reserve capacity, not extra energy.

+199 % REVENUE UPLIFT

€ 107 799 ADDITIONAL / YEAR

PERFORMANCE — ALL MARKETS (HYBRID)

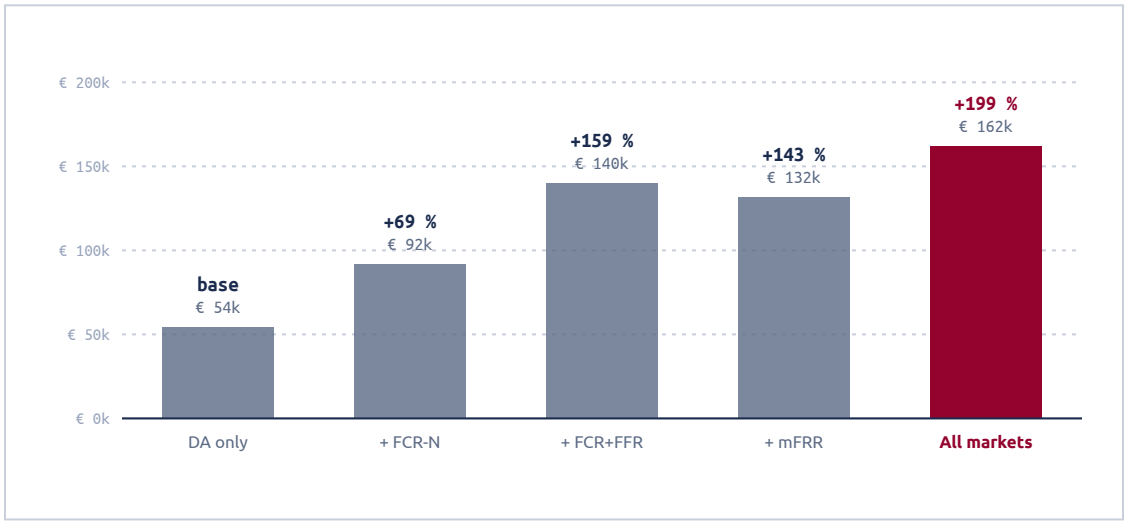
SELECT MARKET STRATEGY ↓

Day-ahead only	DA + FCR-N (standalone)	DA + FCR + FFR (hybrid)	DA + FCR-N + mFRR (standalone)	**All markets (hybrid)**

TOTAL REVENUE	ENERGY	CAPACITY FACTOR	CAPTURE RATE	RESERVOIR CYCLES	SPILL
€ 161 999	7 531	18,7 %	164 %	n/a	4,3
+198,9 % vs. DA only	MWh to grid	of 4,6 MW	21,5 €/MWh realised (all markets ÷ energy)	full equiv. / yr	Mm³ · 33,7 %

REVENUE BY STRATEGY

EUR · Δ vs day-ahead only



REVENUE BY MARKET

All markets (hybrid) · reserved MW · activated MWh/h

MARKET	AVG MW	ACT MWH	PEAK MW	REVENUE	SHARE
Day-ahead energy	–	0,86	4,6	€ 41 509	26%
FCR-N reserve	0,30	0,03	1,7	€ 62 668	39%
FCR-D up	0,04	0,00	1,8	€ 4 309	3%
mFRR up / down	0,51	0,00	4,6	€ 41 074	25%
FFR profile + flex	0,09	0,00	0,9	€ 12 439	8%
Total				**€ 161 999**	

THE MARKET STRATEGIES · what each scenario co-optimises

1 **Day-ahead only**
Spot-price optimised dispatch only — no reserves. The revenue baseline.

2 **DA + FCR-N (standalone)**
Adds FCR-N (symmetric frequency reserve). Autonomous droop setpoint, capped at 10 % of capacity.

3 **DA + FCR + FFR (hybrid)**
FCR-N + FCR-D up + fast frequency response (FFR). Assumes a small ESS hybrid for the sub-second products.

4 **DA + FCR-N + mFRR (standalone)**
FCR-N plus manual restoration reserve (mFRR up/down) — TSO-activated, needs an operations function.

5 **All markets (hybrid)**
Co-optimised across every balancing market (DA, FCR-N/D, mFRR, FFR) as a hybrid.

Day-ahead only	DA + FCR-N (standalone)	DA + FCR + FFR (hybrid)	DA + FCR-N + mFRR (standalone)	**All markets (hybrid)**

01 SCENARIO COMPARISON · uplift vs. day-ahead only

STRATEGY	REVENUE	REVENUE (BAR) · Δ VS DAY-AHEAD		ENERGY (MWH)	CAPTURE RATE	CAP. FACTOR	RESERVE UTIL.
Day-ahead only	€ 54 200		–	10 968	55 %	27,2 %	0 %
DA + FCR-N (standalone)	€ 91 737		+69,3 %	8 680	93 %	21,5 %	6 %
DA + FCR + FFR (hybrid)	€ 140 134		+158,5 %	6 258	142 %	15,5 %	14 %
DA + FCR-N + mFRR (standalone)	€ 131 974		+143,5 %	9 030	134 %	22,4 %	23 %
All markets (hybrid)	€ 161 999		+198,9 %	7 531	164 %	18,7 %	20 %

02 WATER BALANCE & CAPTURE · All markets (hybrid)

TOTAL INFLOW
12,8
Mm³ · Sildre (Øvrevatn) × 0.01 — scaled so capped-turbinable energy matches the NVE concession estimate (11.37 GWh; beta)

TURBINED
8,5
Mm³ through turbine

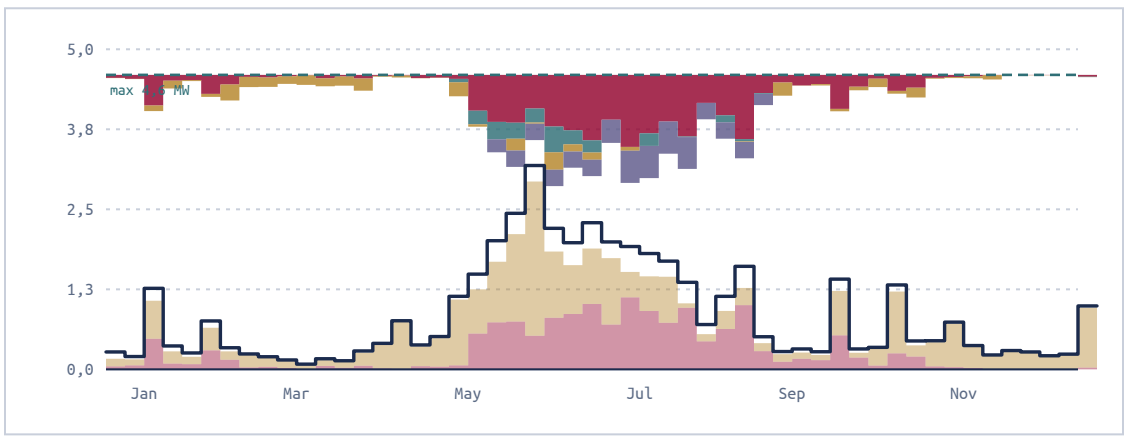
SPILL (LOST)
4,3
Mm³ · 33,7 % of inflow

AVG RESERVOIR
n/a
% of usable volume

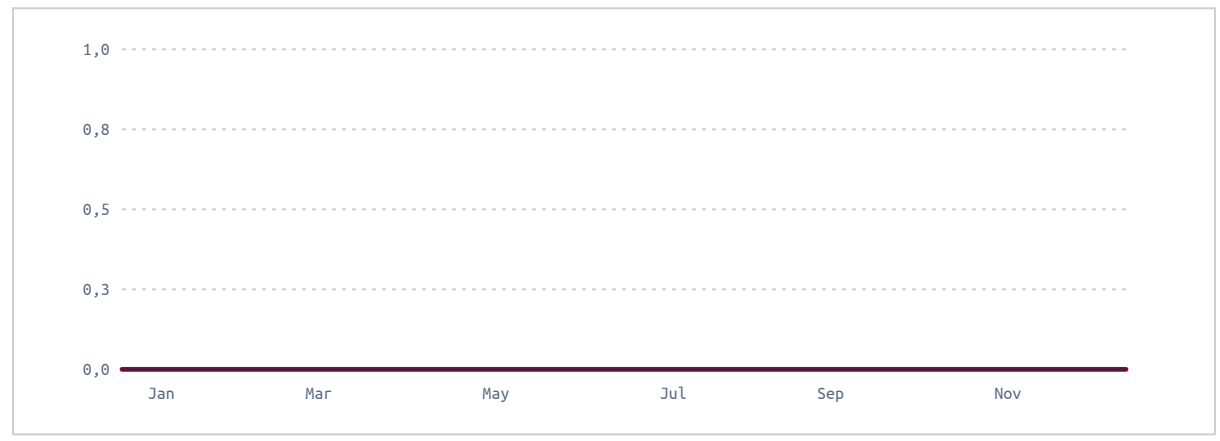
CAPTURE RATE
164 %
revenue ÷ (inflow energy × 8,7 €/MWh)

03 HOW THE PLANT WAS DISPATCHED · optimised dispatch for the selected strategy

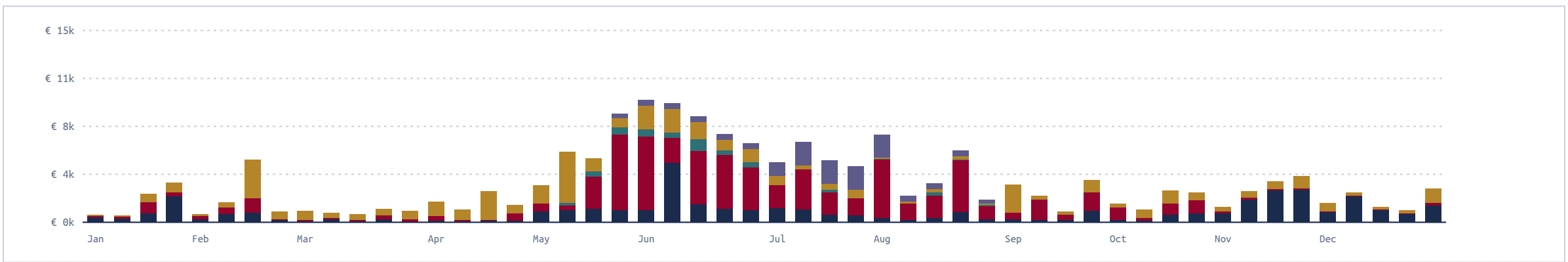
RESERVE CAPACITY HELD
All markets (hybrid) · up from top, down from bottom



RESERVOIR TRAJECTORY
weekly · Mm³ · all strategies, selected highlighted



WEEKLY REVENUE BY MARKET
All markets (hybrid) · 52 equal periods

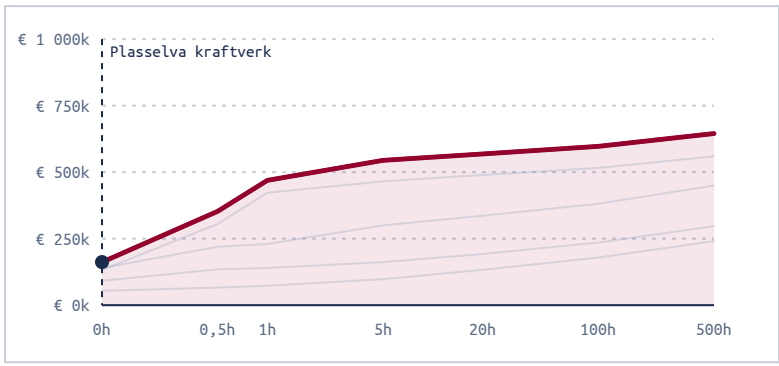


Day-ahead only	DA + FCR-N (standalone)	DA + FCR + FFR (hybrid)	DA + FCR-N + mFRR (standalone)	**All markets (hybrid)**

01 WHERE THE MARGINAL VALUE IS

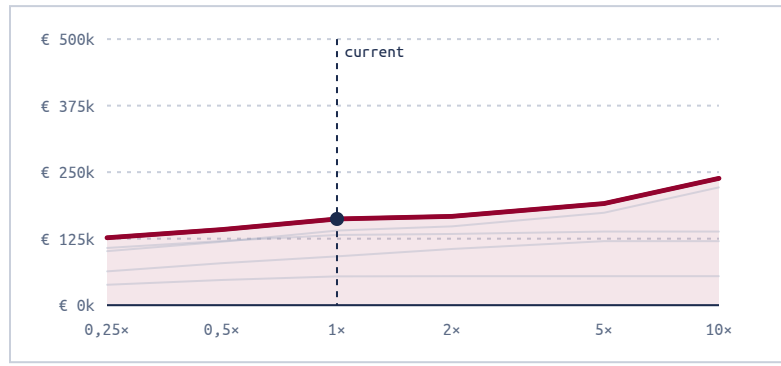
Sensitivity of optimised revenue to the plant's physical envelope, under each market strategy. The **highlighted line is the selected strategy**; the dashed marker is Plasselva kraftverk's current operating point.

STORAGE DISCHARGE DURATION



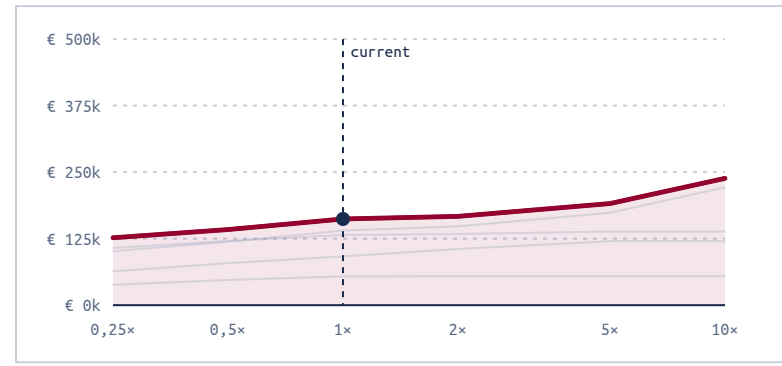
Annual revenue vs. usable storage hours (log). Marker = as-built.

TURBINE CAPACITY



Annual revenue vs. turbine flow capacity (× as-built, log). Marker = as-built.

PLANT SCALE



Revenue vs. scaling turbine + reservoir together (× as-built, fixed inflow). Saturates when the plant outgrows its water.

All markets (selected) · Other strategies · Plasselva kraftverk as-built

MARGINAL VALUES & BINDING CONSTRAINTS

as-built · All markets (hybrid)

Marginal water value	17,3 €/MWh	Extra revenue from one more MWh of stored water
Turbine capacity (+1 MW)	1 051 €/yr	Extra annual revenue from a turbine uprate at current scale
Storage (+1 MWh)	103 457 €/yr	Extra annual revenue from more usable storage (≈0 when over-provisioned)
Reserve-cap headroom (+1 MW)	2,8 €/MW·h	Extra €/MW·h from relaxing the binding reserve reservation cap
Day-ahead spot (reference)	8,7 €/MWh	Avg. zone NO4 day-ahead price
Reservoir upper bound	binds 100 %	Share of hours at the cap — spill risk in the melt

READING MARGINAL (SHADOW) PRICES

A marginal (shadow) price is the extra revenue the optimiser would earn from **one more unit** of a scarce resource — an MWh of stored water, +1 MW of turbine, +1 MWh of storage, or +1 MW of reserve-cap headroom — holding everything else fixed.

A value near **zero** means that limit isn't binding: loosening it wouldn't help, so don't invest there. A **large** value flags the binding bottleneck — where a relaxed limit or an upgrade would pay back, and roughly how much it is worth per year. They answer: *what is holding this plant back, and what is it worth to change it?* (Values are for the selected strategy at the as-built size.)

RECOMMENDATIONS

1 **2025: +199 % from reserves as NO4 spot collapsed to 8,6 €/MWh**

Day-ahead alone earned €54 000; full participation €162 000/yr. FCR-N standalone added €38 000 (+69 %) for a droop setpoint — the cheapest revenue in the portfolio. File one prequalification package with Sandneselva. Perfect-foresight modelled figures: an upper bound.

2 **Hybrid led mFRR in 2025 — but the fork stays a cost decision**

The ESS-hybrid reached €140 000/yr versus €132 000 for the mFRR route (mFRR alone €54 000). The two-year picture (mFRR marginally ahead in 2024, hybrid in 2025) says the routes are economically equivalent; pick the one whose cost structure Småkraft can operate cheapest. Spill at full reserves: 34 % of inflow.

3 **0,5 h of pondage ≈ 2,3× the 2025 revenue**

The sweep prices half an hour of buffering at €352 000/yr against the as-built €162 000, and 5 h at €543 000 — in a reserve-priced year the zero-storage bound is the plant's binding constraint, full stop. A modest intake pond dominates every market-entry decision in value; verify LER/prequalification treatment before relying on the exact figure (model-preliminary).

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SIMULATION SETUP & ASSUMPTIONS

MODEL

Method	MILP co-opt.
Solver	CBC
Segments	5
Boundary	cycling res.

HORIZON

Period	2025 full-year
Resolution	60 min MTU
Hours	8 760
Storage bounds	concession

HYDROLOGY

Inflow source	Sildre (Øvrevatn) × 0.01 — scaled so capped-turbinable energy matches the NVE concession estimate (11.37 GWh; beta)
Station	Øvrevatn
Total inflow	12,8 Mm³
Usable res.	0,0 Mm³ · 0 h

CAPS

FCR-N	10% / 40% hyb.
FCR-D	40%
FFR	10%
mFRR	100%

MARKETS & PRICES

Strategies	DA · FCR-N/D mFRR · FFR
Price zone	NO4
Avg spot	8,7 €/MWh