

# Neverdalselva kraftverk

Run-of-river · price zone **N04** — full-year optimised dispatch, 1 Jan – 31 Dec 2025.

INSTALLED 3,7 MW    MAX FLOW 2,4 m<sup>3</sup>/s    RESERVOIR 0 h · 0,0 Mm<sup>3</sup>

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THE HEADLINE · 2025

Co-optimising Neverdalselva kraftverk across all balancing markets lifted modelled revenue **+178 %** over day-ahead-only dispatch — almost entirely from reserve capacity, not extra energy.

**+178 %**

REVENUE UPLIFT

**€ 91 734**

ADDITIONAL / YEAR

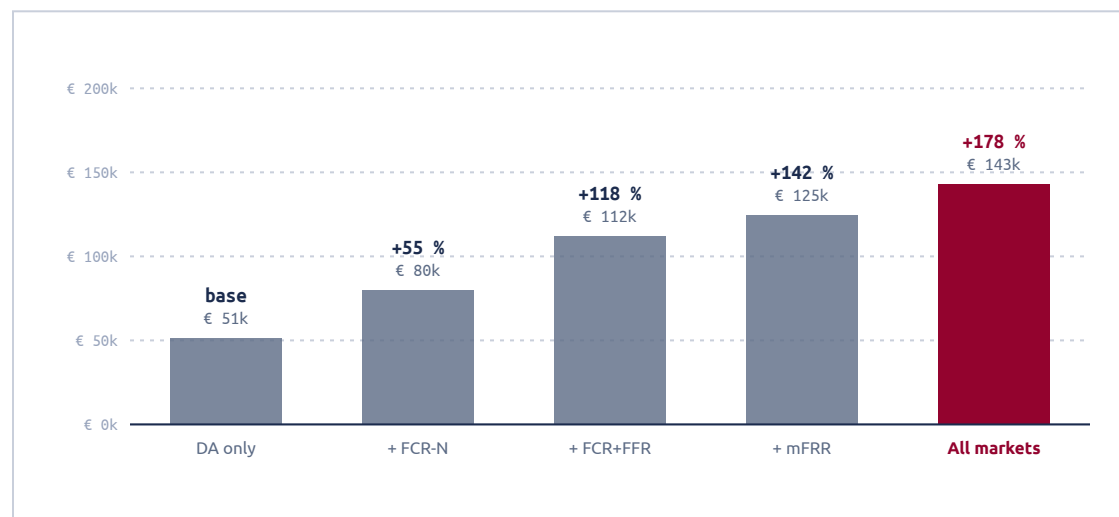
PERFORMANCE — ALL MARKETS (HYBRID)

SELECT MARKET STRATEGY ↓

Day-ahead only	DA + FCR-N (standalone)	DA + FCR + FFR (hybrid)	DA + FCR-N + mFRR (standalone)	All markets (hybrid)	
<b>TOTAL REVENUE</b> <b>€ 143 179</b> +178,3 % vs. DA only	<b>ENERGY</b> <b>6 116</b> MWh to grid	<b>CAPACITY FACTOR</b> <b>18,9 %</b> of 3,7 MW	<b>CAPTURE RATE</b> <b>163 %</b> 23,4 €/MWh realised (all markets ÷ energy)	<b>RESERVOIR CYCLES</b> <b>n/a</b> full equiv. / yr	<b>SPILL</b> <b>9,3</b> Mm <sup>3</sup> · 39,3 %

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	—	0,70	3,7	€ 43 205	30%
FCR-N reserve	0,16	0,02	1,4	€ 36 324	25%
FCR-D up	0,02	0,00	1,5	€ 2 405	2%
mFRR up / down	0,56	0,00	3,7	€ 51 240	36%
FFR profile + flex	0,07	0,00	0,7	€ 10 005	7%
<b>Total</b>				<b>€ 143 179</b>	

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)	<b>All markets (hybrid)</b>
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**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	€ 51 445	—	8 431	59 %	26,0 %	0 %
DA + FCR-N (standalone)	€ 79 824	+55,2 %	6 648	91 %	20,5 %	6 %
DA + FCR + FFR (hybrid)	€ 112 115	+117,9 %	5 073	128 %	15,7 %	12 %
DA + FCR-N + mFRR (standalone)	€ 124 567	+142,1 %	6 648	142 %	20,5 %	22 %
<b>All markets (hybrid)</b>	<b>€ 143 179</b>	<b>+178,3 %</b>	<b>6 116</b>	<b>163 %</b>	<b>18,9 %</b>	<b>22 %</b>

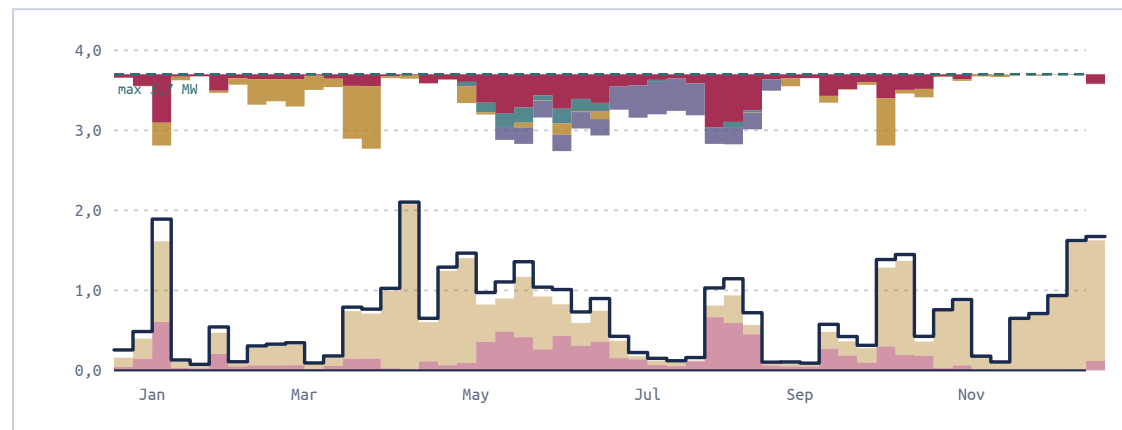
**02 WATER BALANCE & CAPTURE** · All markets (hybrid)

TOTAL INFLOW <b>23,8</b> Mm³ · Sildre (Lavvatn) × 0.11 — scaled so capped-turbine energy matches the NVE concession estimate (8.7 GWh; beta)	TURBINED <b>14,4</b> Mm³ through turbine	SPILL (LOST) <b>9,3</b> Mm³ · 39,3 % of inflow	AVG RESERVOIR <b>n/a</b> % of usable volume	CAPTURE RATE <b>163 %</b> revenue ÷ (inflow energy × 8,7 €/MWh)
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**03 HOW THE PLANT WAS DISPATCHED** · optimised dispatch for the selected strategy

**RESERVE CAPACITY HELD**

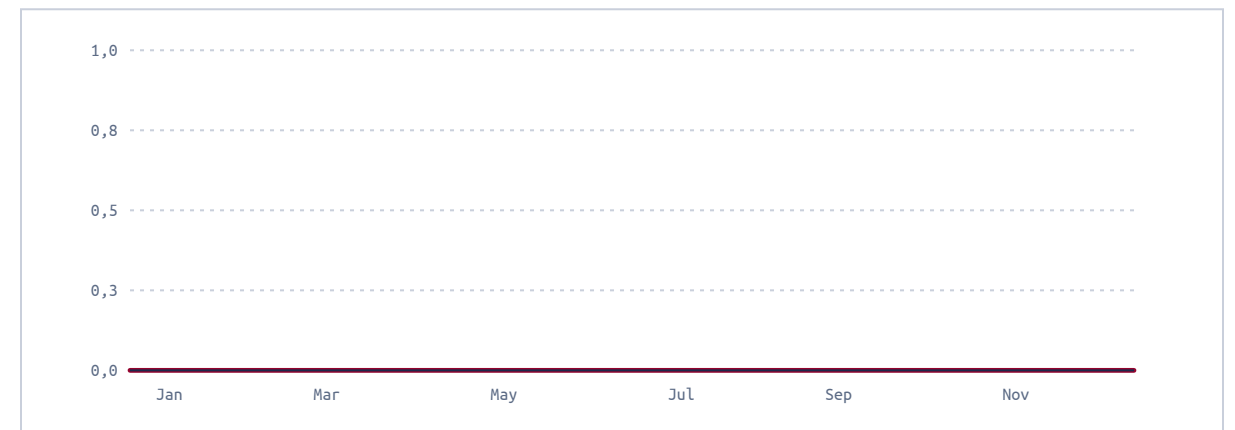
All markets (hybrid) · up from top, down from bottom



FCR-N FCR-D mFRR FFR Plant output Max capacity

**RESERVOIR TRAJECTORY**

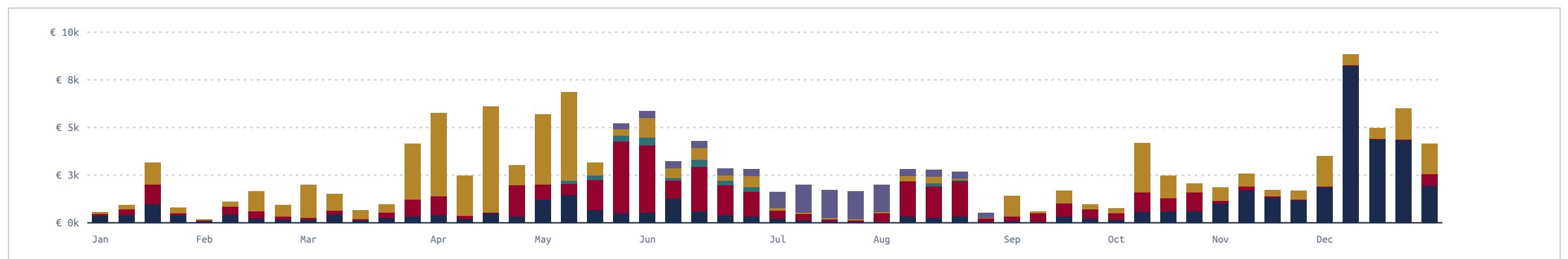
weekly · Mm³ · all strategies, selected highlighted



All markets (selected) Other strategies Min / max bounds

**WEEKLY REVENUE BY MARKET**

All markets (hybrid) · 52 equal periods



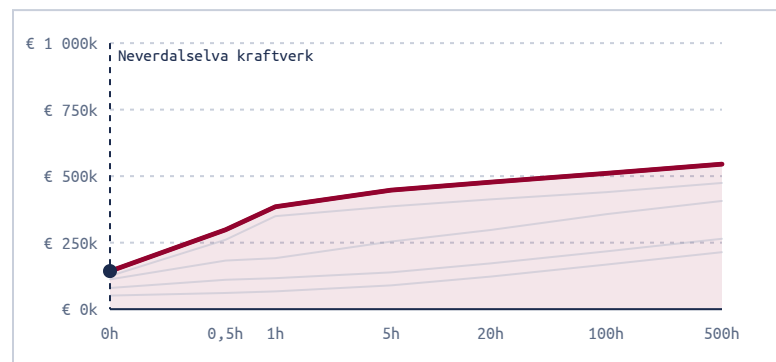
Day-ahead FCR-N FCR-D mFRR FFR

Day-ahead only	DA + FCR-N (standalone)	DA + FCR + FFR (hybrid)	DA + FCR-N + mFRR (standalone)	<b>All markets (hybrid)</b>
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### 01 WHERE THE MARGINAL VALUE IS

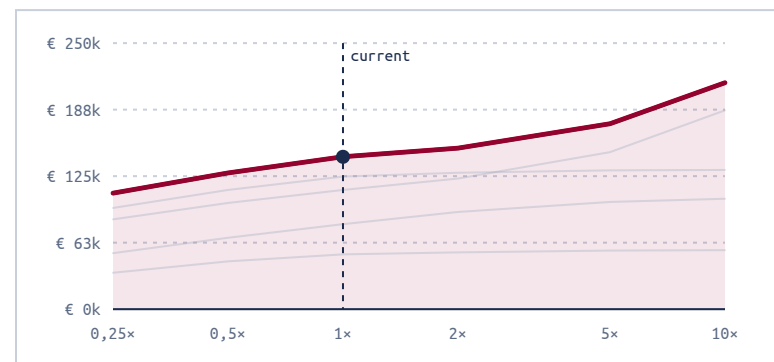
Sensitivity of optimised revenue to the plant's physical envelope, under each market strategy. The **highlighted line is the selected strategy**; the dashed marker is Neverdalselva kraftverk's current operating point.

#### STORAGE DISCHARGE DURATION



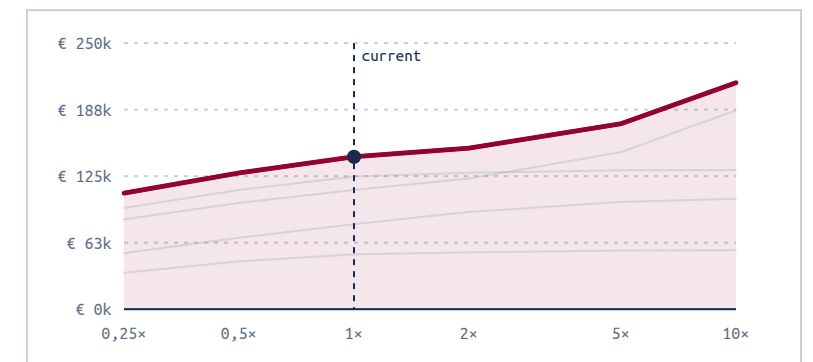
Annual revenue vs. usable storage hours (log). Marker = as-built.

#### TURBINE CAPACITY



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

#### PLANT SCALE



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

— All markets (selected) — Other strategies — Neverdalselva kraftverk as-built

#### MARGINAL VALUES & BINDING CONSTRAINTS

as-built · All markets (hybrid)

Marginal water value	17,4 €/MWh	Extra revenue from one more MWh of stored water
Turbine capacity (+1 MW)	2 184 €/yr	Extra annual revenue from a turbine uprate at current scale
Storage (+1 MWh)	104 942 €/yr	Extra annual revenue from more usable storage (≈0 when over-provisioned)
Reserve-cap headroom (+1 MW)	3,2 €/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

- 2025: +178 % — reserves carried Neverdalselva through the price collapse**  
At NO4's 8,6 €/MWh average spot, day-ahead alone earned €52 000/yr; full participation €143 000. FCR-N standalone added €28 000 (+55 %) with autonomous activation — prequalification remains the single highest-return step. Perfect-foresight modelled figures on a proxied inflow (see rec 3): an upper bound.
- mFRR led 2025 (€125 000 vs €112 000 hybrid)**  
mFRR alone was worth €58 000/yr — nearly double its 2024 value — as balancing prices held while spot fell. At 3,7 MW this belongs inside a portfolio balancing agreement with the neighbouring Nordland prospects rather than a standalone operation. The two-year evidence keeps the capex/opex fork open; FCR-N first either way.
- Proxied inflow, and the buffer signal repeats**  
Inflow uses Lavvatn (14 km, same Vefsna watershed — the plant's own gauge is dead), scaled so capped-turbinable energy matches the 8,7 GWh concession estimate; DA-only solves within -3 % of it. The sweep prices 0,5 h of pondage at €298 000/yr all-markets versus €143 000 as-built — the portfolio-wide design finding, at its strongest in reserve-priced years. Model-preliminary (LER assumptions); spill at full reserves is 39 % of inflow.

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#### SIMULATION SETUP & ASSUMPTIONS

<b>MODEL</b>		<b>HORIZON</b>		<b>HYDROLOGY</b>		<b>CAPS</b>	
Method	MILP co-opt.	Period	2025 full-year	Inflow source	Sildre (Lavvatn) × 0.11 — scaled so capped-turbinable energy matches the NVE concession estimate (8.7 GWh; beta)	FCR-N	10% / 40% hyb.
Solver	CBC	Resolution	60 min MTU	Station	Lavvatn	FCR-D	40%
Segments	5	Hours	8 760	Total inflow	23,8 Mm <sup>3</sup>	FFR	10%
Boundary	cycling res.	Storage bounds	concession	Usable res.	0,0 Mm <sup>3</sup> · 0 h	mFRR	100%
<b>MARKETS &amp; PRICES</b>							
Strategies	DA · FCR-N/D mFRR · FFR						
Price zone	NO4						
Avg spot	8,7 €/MWh						

