



Supplement of

Technical note: A Water Analysis Trailer for Environmental Research (WATER)

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A Water Analysis Trailer for Environmental Research (WATER): Supplement

S1 Construction costs for the WATER

Table S1 provides a breakdown of the hardware costs associated with constructing the WATER. Unit and total prices are for 2015 unless otherwise indicated. To correct all prices to an equivalent 2025 value, the consumer price indexes (CPI) in Germany for 2015 (94.5) and 2025 (121.9) were used in the following equation:

$$Cost_{2025} = Cost_{2015} \times \frac{CPI_{2025}}{CPI_{2015}}$$

10 The CPI were reported by Finanz-tools.de (2026).

Table S1: The hardware costs associated with constructing the WATER. Unit and Total Prices are for 2015 unless preceded by a *, which indicates a price for 2025.

Part	Manufacturer	Models or part numbers	Qty	Unit price (€ inc. VAT)	Total price (€ inc. VAT)	Price as of 2025 (€)
<u>Basic infrastructure</u>						
Custom-made insulated trailer	Berger Fahrzeugbau GmbH	Trailer (max weight rating of 2.7 tonnes).	1	67014.85	67014.85	86445.61
Rooftop-mounted solar panels	Victron Energy B.V.	SPM190-24/3a (190 W peak output)	3	253.61	760.83	981.43
Lithium-ion batteries (12V 300 Ah)	Transwatt	TH12-300	2	3552.39	7104.78	9164.79
Diesel generator	Fischer Panda GmbH	5000i with PMGi	1	6928.50	6928.50	8937.40
Generator radiator	Fischer Panda GmbH	Typ RV1.2	1	983.45	983.45	1268.60

Fuel tank (91 L)	Akterbatuue Technology Group GmbH	SE2030	1	540.62	540.62	697.37
Inverter and battery charging system	Victron Energy B.V.	Quattro 24 5000	1	2072.16	2072.16	2672.98
Solar charge controller	Victron Energy B.V.	MPPT 150 100 MC4	1	758.00	758.00	977.78
Battery monitor	Victron Energy B.V.	BMV-700S	1	100.08	100.08	129.10
Battery shutoff switch	Acusysteme	10014130	1	697.10	697.10	899.22
Diesel heater	Webasto	Air Top Evo 40	1	1998.59	1998.59	2578.08
Server cabinet and thermoelectric coolers	Rittal GmbH & Co. KG	Server cabinet: TS IT 5528 SO2102 Thermoelectric coolers: SK 3201300	1	2889.26	2889.26	3726.99
Passive ventilation system	Maico	Axial wall ventilator: Typ EZQ 20/4 E Temperature regulation system: EAT 6 G/1 2 × Closure flaps: Typ MK 20 Inner grill: Typ IG 20	1	1115.48	1115.48	1438.91
Trailer fire suppression system	Mk Marine	Firekill system with HFC 227	1	1141.27	1141.27	1472.18
Fire and gas detection	ESSER	IP8Quad fire and gas sensor with relay hub	1	238.84	238.84	308.09
Server cabinet fire suppression system	Sea-Fire	FT50A	1	584.29	584.29	753.70
Fire alarm	Sonos	Multi-tone LED klaxon	2	60.75	121.50	156.73
GSM, GPS and security	YAWiD Electronics	Mobile Autonomous Java Application (MAJA) unit, JAVA MIDlet and peripherals	1	2482.33	2482.33	3202.07
<u>Sample acquisition system</u>						
Industry PC	NEXCOM International Company	NISE 101	1	1491.07	1491.07	1923.40
Programmable logic controller	WAGO Kontakttechnik GmbH	WAGO I/O system 750 starter kit (8003-001) 1 × 8-channel analogue input module (750-497) 1 × 4-channel analogue input module (750-460) 4 × 8-channel digital output modules (750-530) 1 × 8-channel digital input (750-430) 1 × end module (750-600)	1	1020.21	1020.21	1316.02
Peristaltic pump (P1)	Verder GmbH	M1500	1	293.93	293.93	379.15

Solenoid valves	Christian Bürkert GmbH & Co. KG	0331-42991	12	6.90	82.80	106.81
3/2-way solenoid valve (VRIn)	ODE Srl	31JP1XP1V23-ST0	1	36.17	36.17	46.66
Filter holder	Advantec	43303020	1	110.00	*110.00	110.00
Sample reservoir	Isolab Laborgeräte GmbH	1000 mL separating funnel	1	100.00	*100.00	100.00
Load cell 5kg	Hottinger Brüel & Kjaer GmbH	1-SP4MC3MR/5KG-1	1	225.00	*225.00	225.00
Backup reservoir	-	500 mL Duran bottle	1	10.00	10.00	12.90
Peristaltic pump (P2)	Gemke Technik GmbH	CP83	1	88.30	88.30	113.90
3/2-way solenoid valve (VROut)	ODE Srl	21JP1R1V23-TO	1	33.17	33.17	42.79
10 L DI bottle	Kautex Textron	2000084133	1	41.00	*41.00	41.00
Leak sensors	H-Tronic	1114465	2	15.00	*30.00	30.00
PE-tubing (5 m)	-	6 mm outer diameter; 4 mm inner diameter	5	1.00	*5.00	5.00
<u>Measurement instruments</u>						
CRDS and CWS	Picarro Inc.	L2130-I and A0217	1	104982.49	104982.49	135421.86
Multi-parameter probe	YSI Inc.	600R	1	17500.00	17500.00	22574.07
UV spectrometer	TriOS GmbH	ProPS with TriBox2	1	15000.00	15000.00	19349.21
Total (€ inc. VAT)						307608.79

S2 Monthly operating costs for the WATER

To provide an indication of monthly operating costs for the WATER whilst deployed to the Schwingbach Environmental Observatory (SEO), it was necessary to undertake a series of calculations to estimate the power demand from the system under different conditions, the likely available solar power and deficit relative to the power demand (Table S2), and the consequent amount of diesel required to run the backup 5000i diesel generator and, if necessary, the Air Top Evo 40 heater (Table S3). These variable costs were then added to the regular costs for each month and contributions to costs associated with longer-term deployment costs (Table S4). Based on experience in the SEO, it was assumed the filter needed replacing once a week and a low-data monthly mobile phone contract would be needed for the GSM modem. Long-term costs include a vehicle safety test every two years and a new cassette membrane for the Continuous Water Sampler every year.

Three operating conditions were considered: 1) normal, 2) with interior heating, and 3) with interior cooling. Under normal conditions, the main power demand comes from the measurement devices and is approximately 450 W. When cooling is required, an additional load of 250 W for 12 hours a day is assumed to be required by the passive ventilation system and thermoelectric coolers of the server cabinet. This gives an average daily power demand of 575 W. For heating, no additional power demand is required above normal operating conditions, but additional diesel is required to run the diesel heater at a rate of 0.5 L h⁻¹ for 3 hours a day. All consumption values are based on manufacturer specifications.

To calculate solar power generation by the WATER, the average monthly incoming solar radiation values (W m⁻²) at the SEO assuming an optimal panel orientation of 37° were averaged over the period 2010-2020 for each month (European Commission, 2025). Generated solar power was then estimated by multiplying the incoming radiation by the area of the nine solar panels (11.34 m²), efficiency of the solar panels (20%) and assumed system losses (5%). The average daily energy deficit (kWh) was then calculated for each month. The amount of diesel necessary for the generator to cover the deficit was then calculated using the manufacturer-specified rate of 0.35 L kWh⁻¹. Any necessary diesel for heating was then added to give the final diesel requirement for each month. The average monthly diesel requirements across a full year and for just months with heating or cooling were then calculated and added to the regular monthly costs.

Table S2: Calculations for solar power generation by the WATER and the average daily energy deficit for each month.

Month	Average (2010-2020) monthly sum of solar energy (kWh / m ²)	Average (2010-2020) hourly solar power (W / m ²)	Average solar power generation (W)	Power demand (W)	Solar power deficit (W)	Daily solar energy deficit (kWh)
Jan	41.91	56.34	121.38	450	328.62	7.89
Feb	65.22	97.05	209.10	450	240.90	5.78
Mar	118.64	159.47	343.59	450	106.41	2.55
Apr	155.30	215.70	464.75	450	0.00	0.00
May	161.02	216.43	466.32	575	108.68	2.61
Jun	164.26	228.14	491.55	575	83.45	2.00
Jul	173.60	233.33	502.73	575	72.27	1.73
Aug	160.90	216.26	465.96	575	109.04	2.62
Sep	127.76	177.45	382.34	450	67.66	1.62
Oct	86.61	116.41	250.82	450	199.18	4.78
Nov	47.17	65.51	141.15	450	308.85	7.41
Dec	33.54	45.07	97.12	450	352.88	8.47

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Table S3: Diesel consumption calculations for each month.

Month	Diesel usage for energy deficit (L / month)	Diesel usage for heating (L / month)	Total diesel usage (L / month)
Jan	85.57	46.5	132.07
Feb	56.66	42	98.66
Mar	27.71	46.5	74.21
Apr	0.00	0	0.00
May	28.30	0	28.30
Jun	21.03	0	21.03
Jul	18.82	0	18.82
Aug	28.39	0	28.39
Sep	17.05	0	17.05
Oct	51.87	46.5	98.37
Nov	77.83	45	122.83
Dec	91.89	46.5	138.39

Table S4: Monthly operational cost calculations for the WATER.

Item	Quantity per month	Unit price (€ incl. VAT)	Monthly cost (€ incl. VAT)
<u>Consumables</u>			
5 µm filters (47 mm diameter)	5.00	1.68	8.42
Mobile phone contract	1.00	5.00	5.00
<u>Longer-term deployment contributions</u>			
Membrane cassette for Continuous Water Sampler	0.08	1074.56	89.55
TÜV (vehicle safety test)	0.04	32.90	1.37
<u>Averaging period for diesel usage</u>			
Monthly diesel consumption averaged over a full year	64.84	*1.61	104.40
Monthly diesel consumption averaged over months requiring cooling	24.14	*1.61	38.86
Monthly diesel consumption averaged over months requiring heating	110.75	*1.61	178.31
Monthly running cost averaged over a full year			208.74
Monthly running cost averaged over months requiring cooling			143.20
Monthly running cost averaged over months requiring heating			282.65

* The average cost of diesel in 2025 as published by ADAC (2026)

50 **References**

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