

Energiewende auf Balkonien

DIY Solaranlagen und Energiespeicher



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A young girl with braided hair, wearing a yellow robe, stands against a dark, starry background. She is holding a glowing yellow lightsaber. The scene is illuminated by the light of the lightsaber and a bright yellow star in the background.

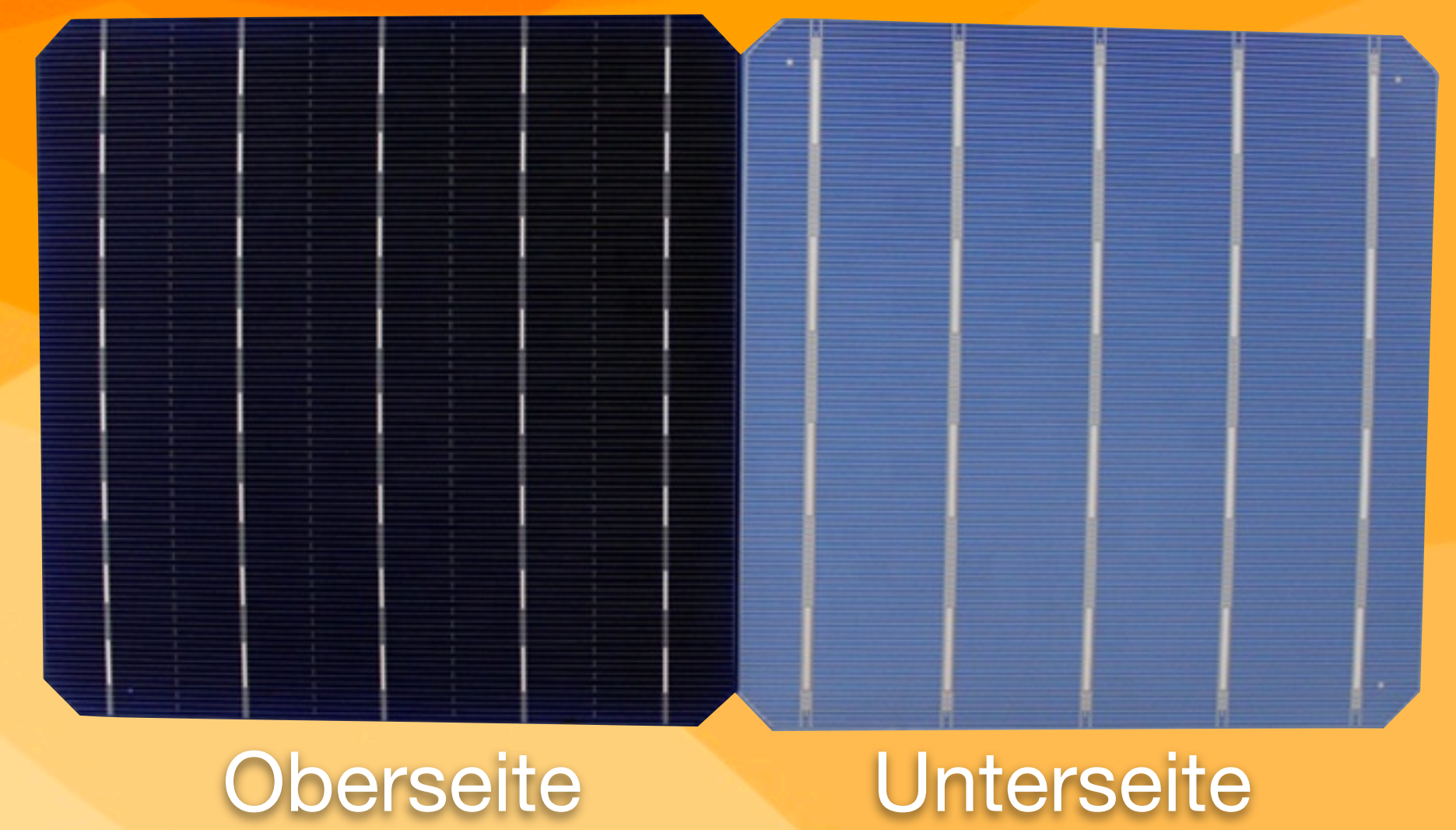
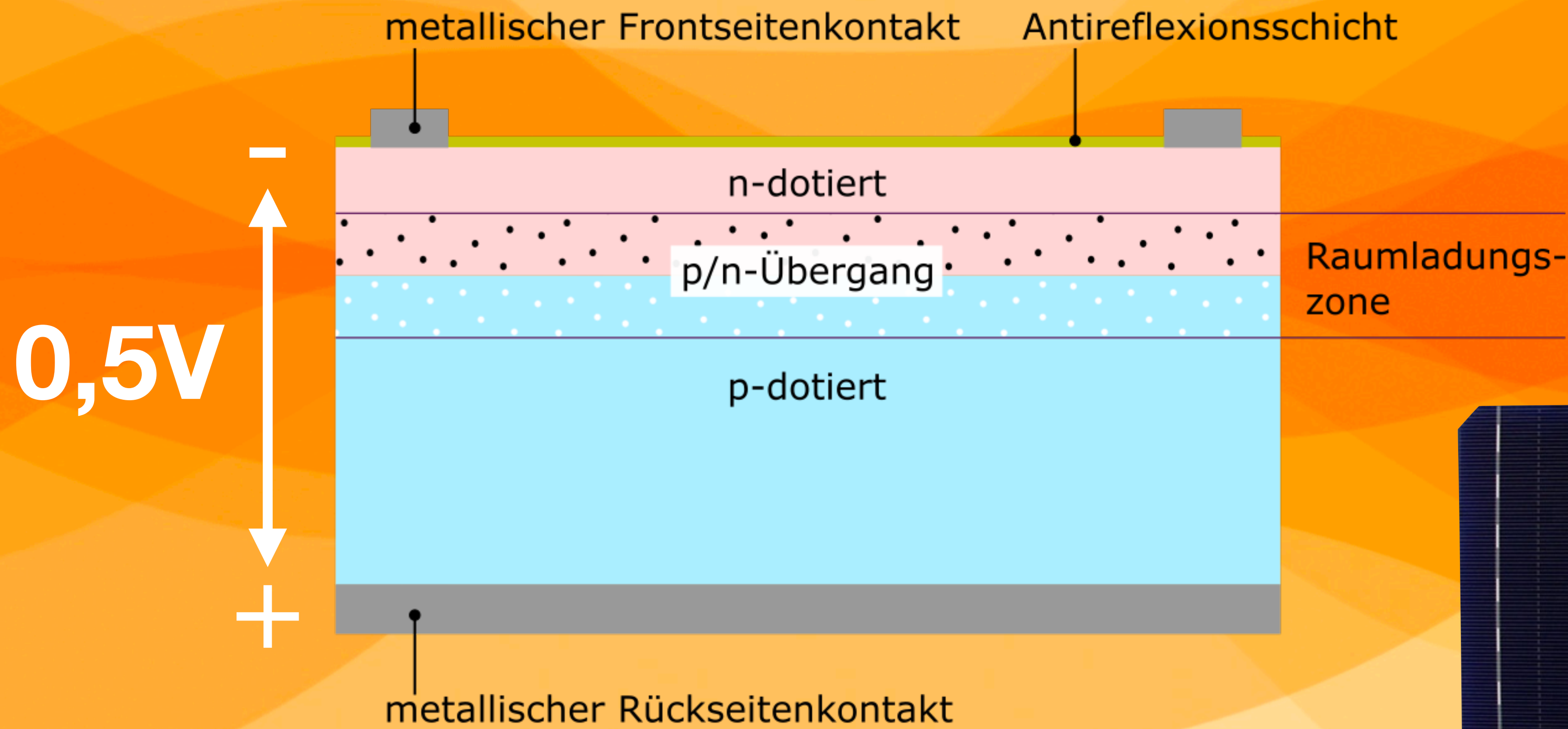
May the solar force be with you



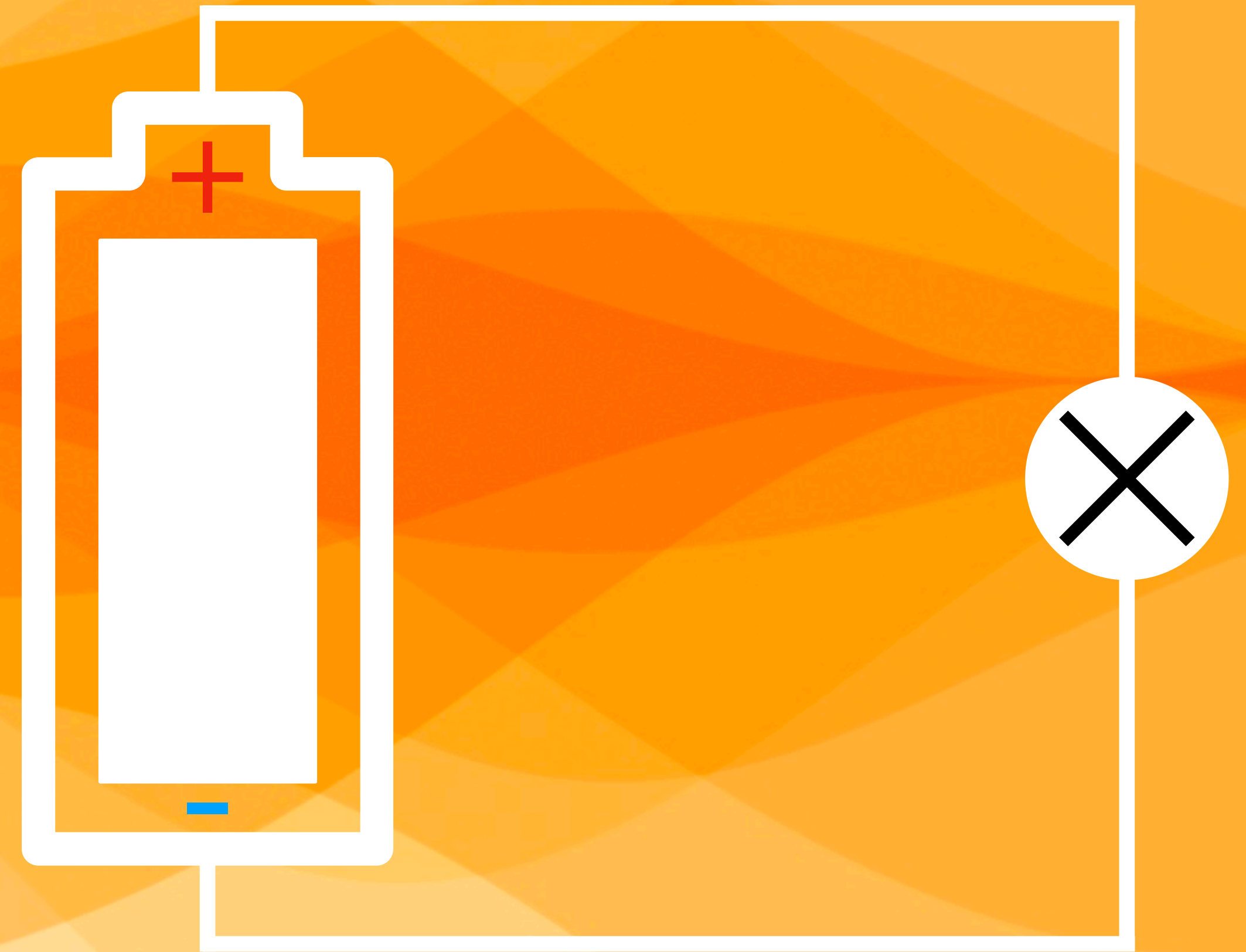
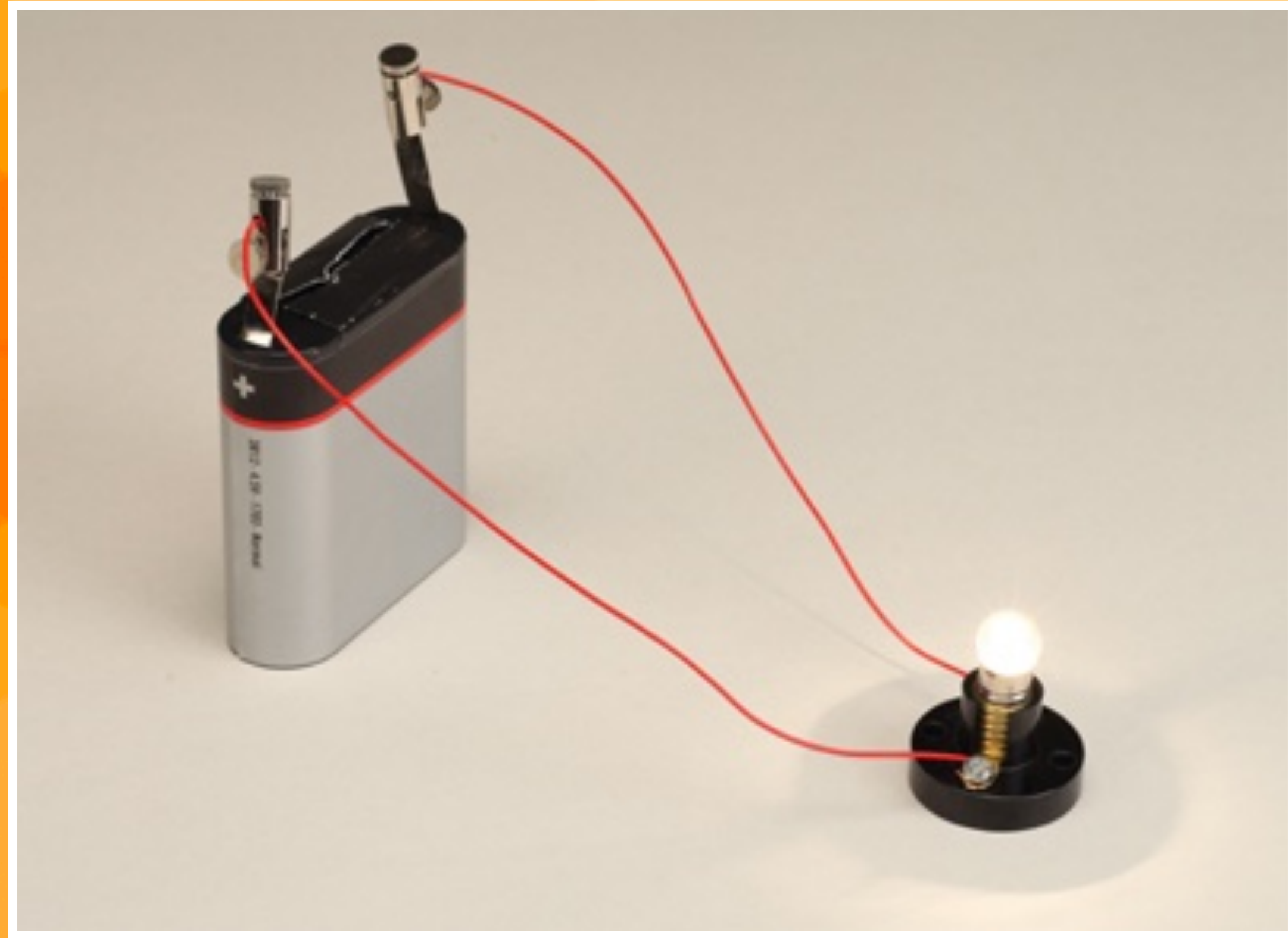
Solartechnik wissen du musst!

WTF, Strom aus Licht?

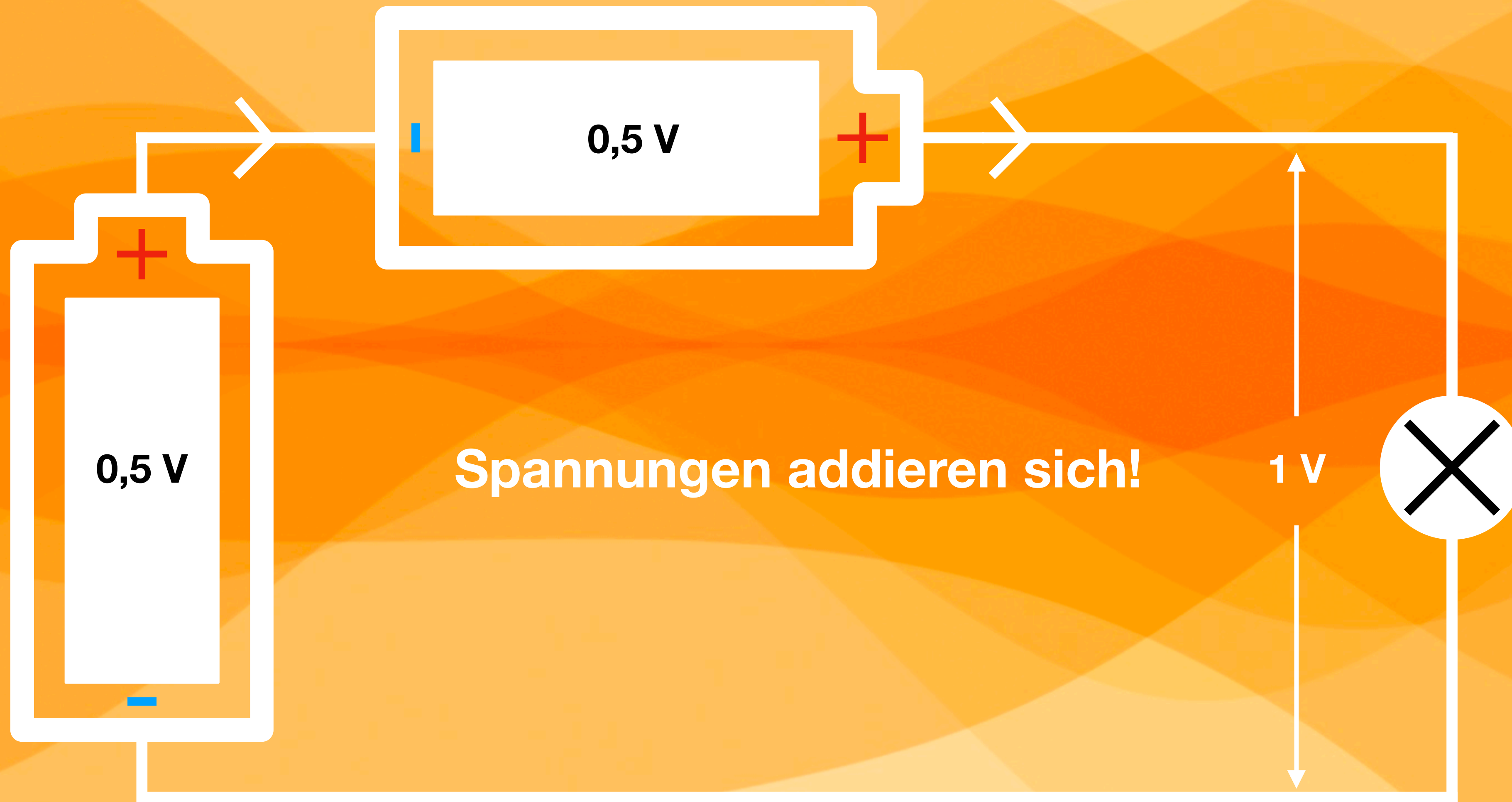
Schichten einer Solarzelle



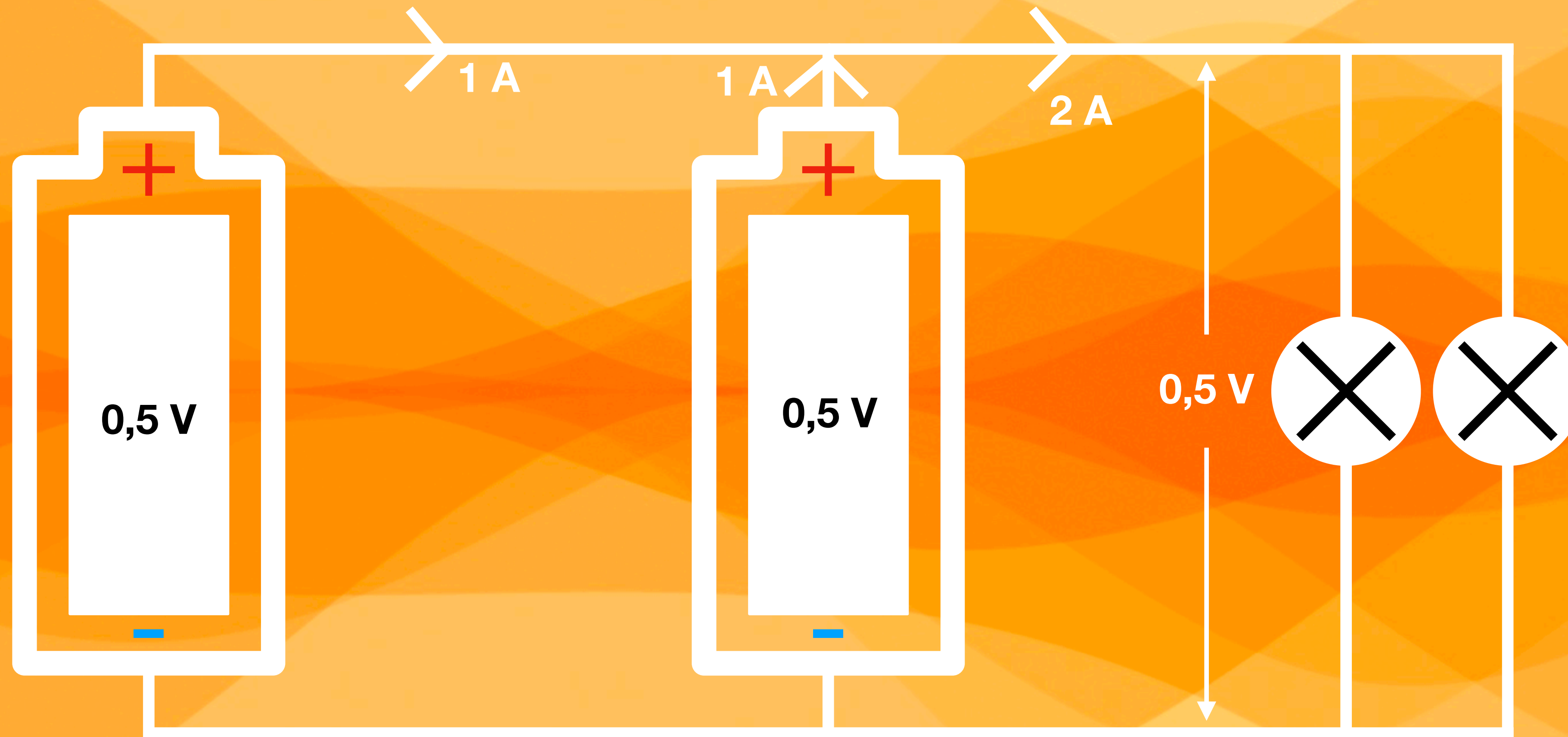
Stromkreis



Reihenschaltung



Parallelschaltung



Die Ströme addieren sich und die Spannung bleibt gleich

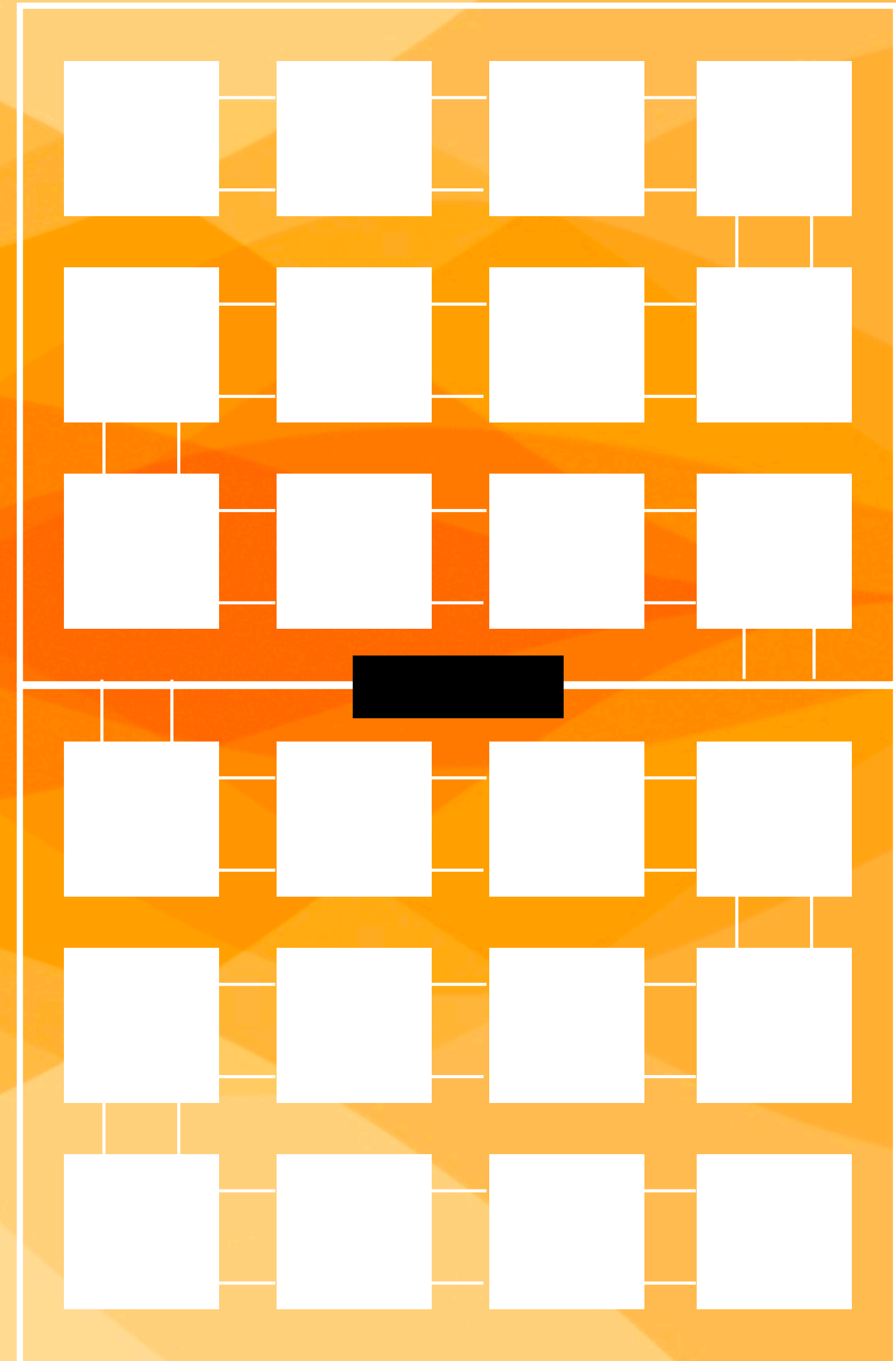
Elektrische Leistung

Leistung = Spannung x Stromstärke

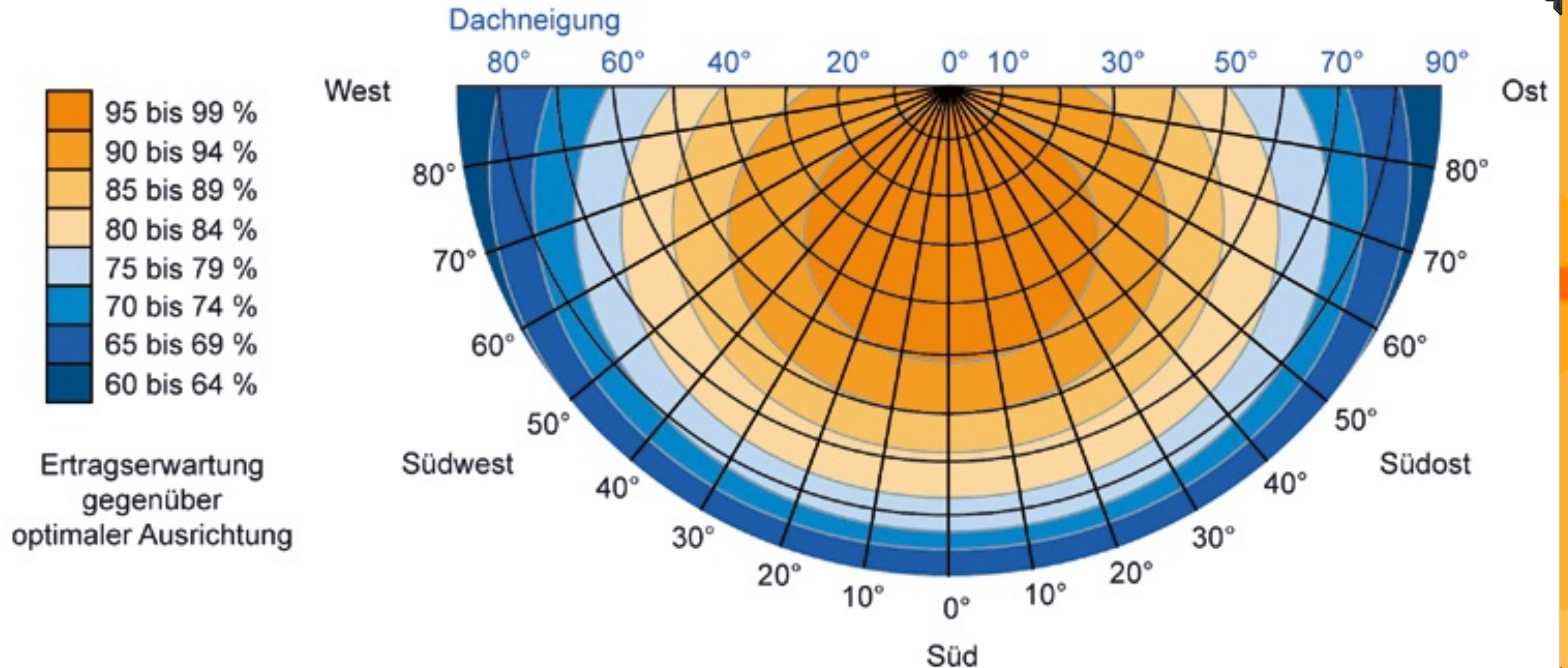
Leistung = 3,2 V x 2 A = 6,4 W

Solarmodul

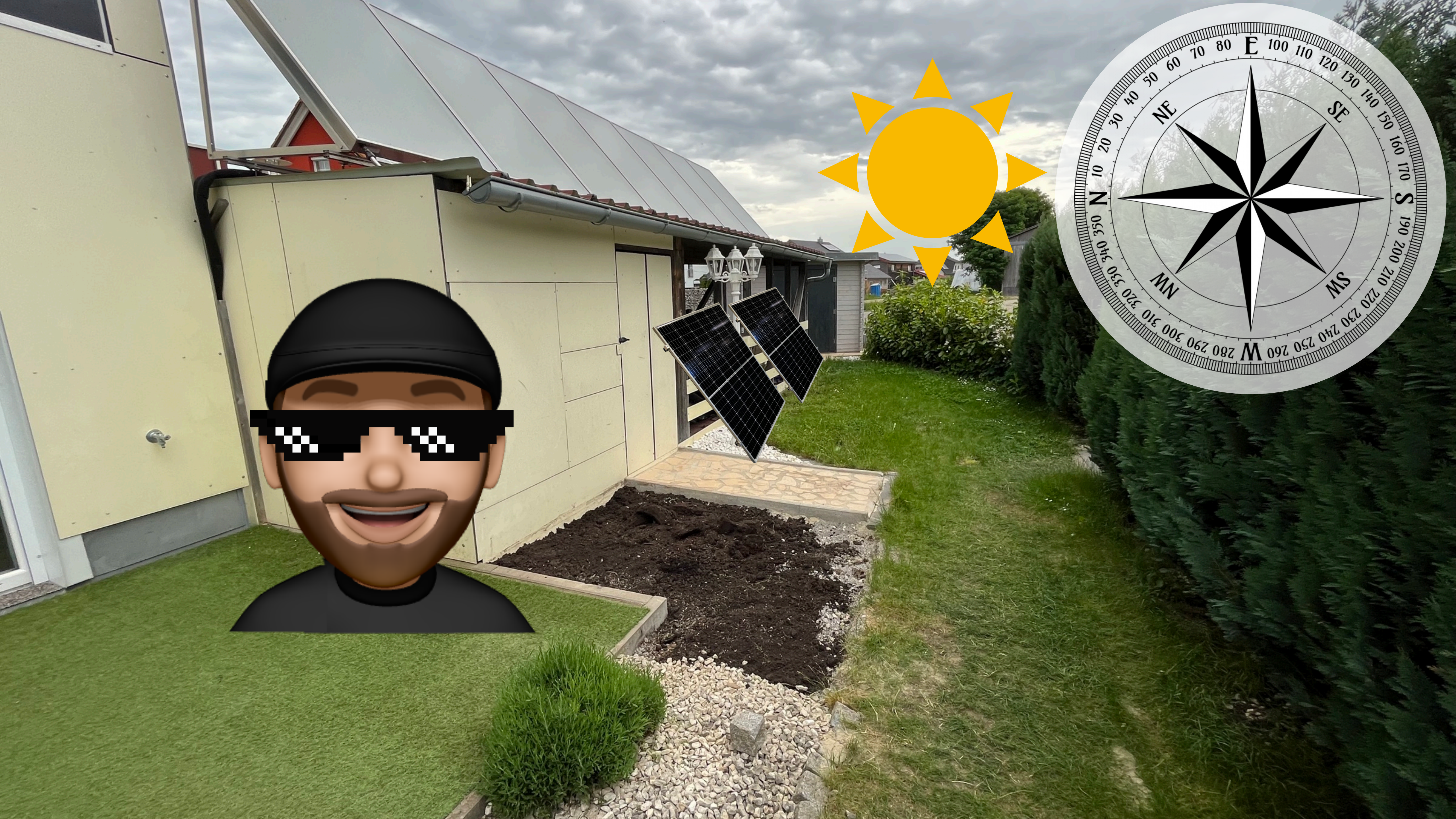
- 120 (Halbzellen)
- Modulgröße Ca. 1,75m x 1,1m
- Wirkungsgrad 20-22%
- 380 Wp - 430 Wp pro Modul



Ausrichtung



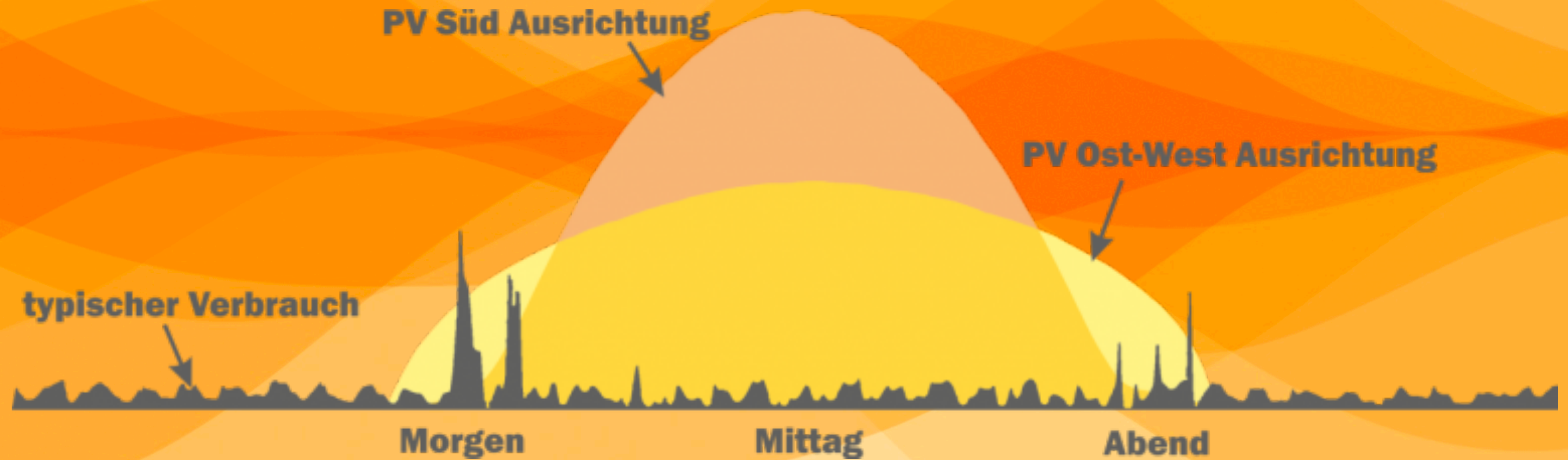
עושה עבודה!



Erwartbarer Ertrag

- Pro 100 Wp installiert ca. 100Kwh pro Jahr (bei optimaler Südausrichtung)
- Beispiele:
 - 800Wp Balkongeländer 90° Süd (65%) -> 520 KWh
 - 2500 Wp Garten aufgeständert 60° Neigung (90%) -> 2250 KWh

Ertrag vs Verbrauch



Balkonkraftwerk



+



+



PV Modul(e)

(Mikro)-Wechselrichter

Halterung

Mangel an verfügbaren Komponenten (2022)



3 x OmnisPower 410M54-P3



Soyosource 1200W Grid Tie Inverter

36V

36V



72 V





M4...1,5 Nm M6...4,5 Nm
M5...2,5 Nm M8...10 Nm

MC3
RESOURCE
EXHAUSTION

IR-Datenschnittstelle

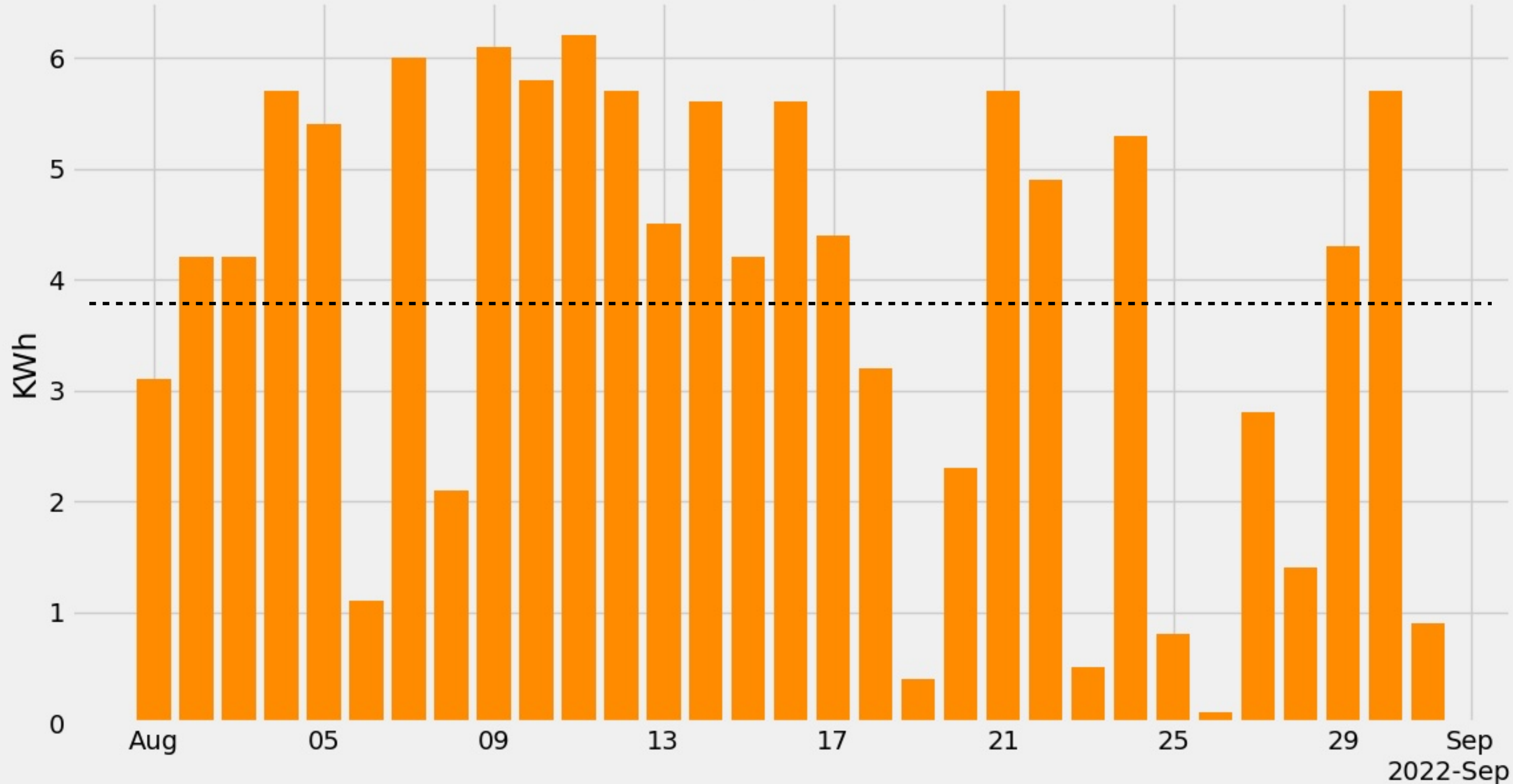
Drehstromzähler
EHZ361W5
3 x 230/400 V
0,1-5 (60) A
50 Hz
Cl. A -25...55 °C
Nr. 0000100825
2010 V.S.M.OFF1
4000 L1 L2 L3
CE M10 0102 DE-08-M1003-PTB010

Rücklaufsperr



August 2022

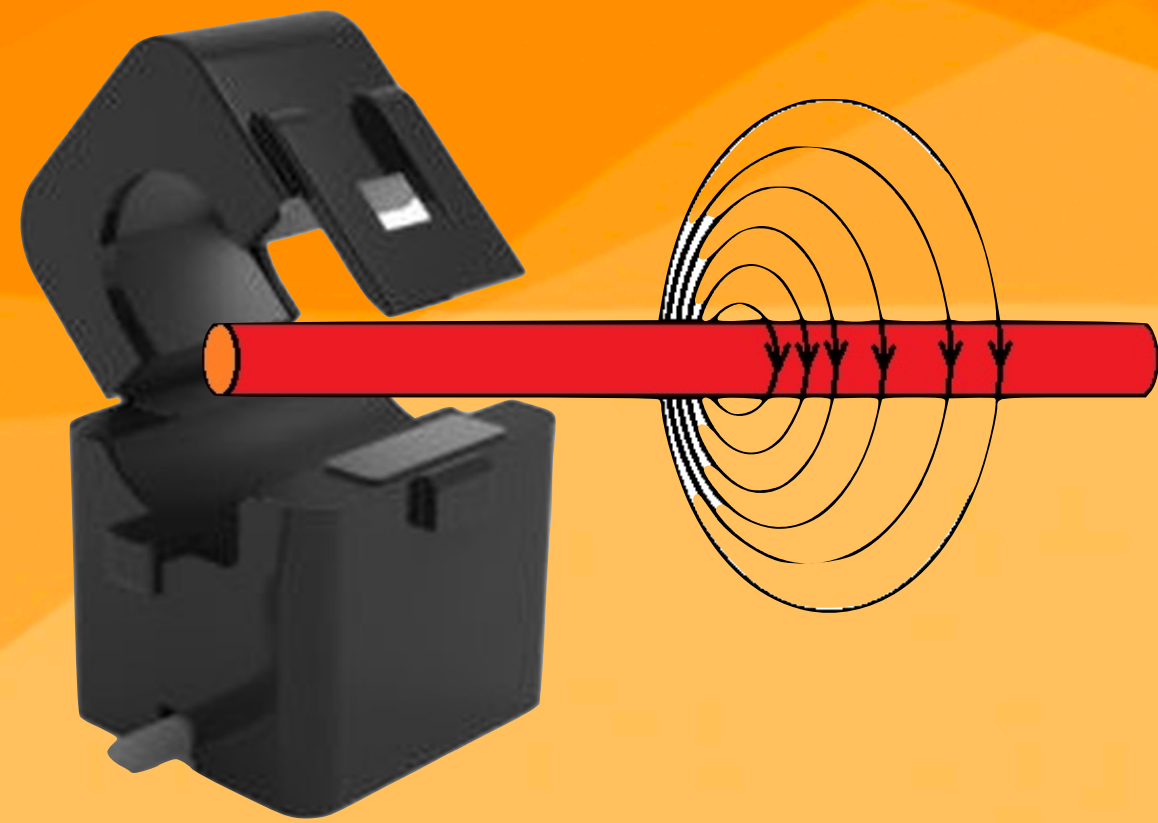
Solar production



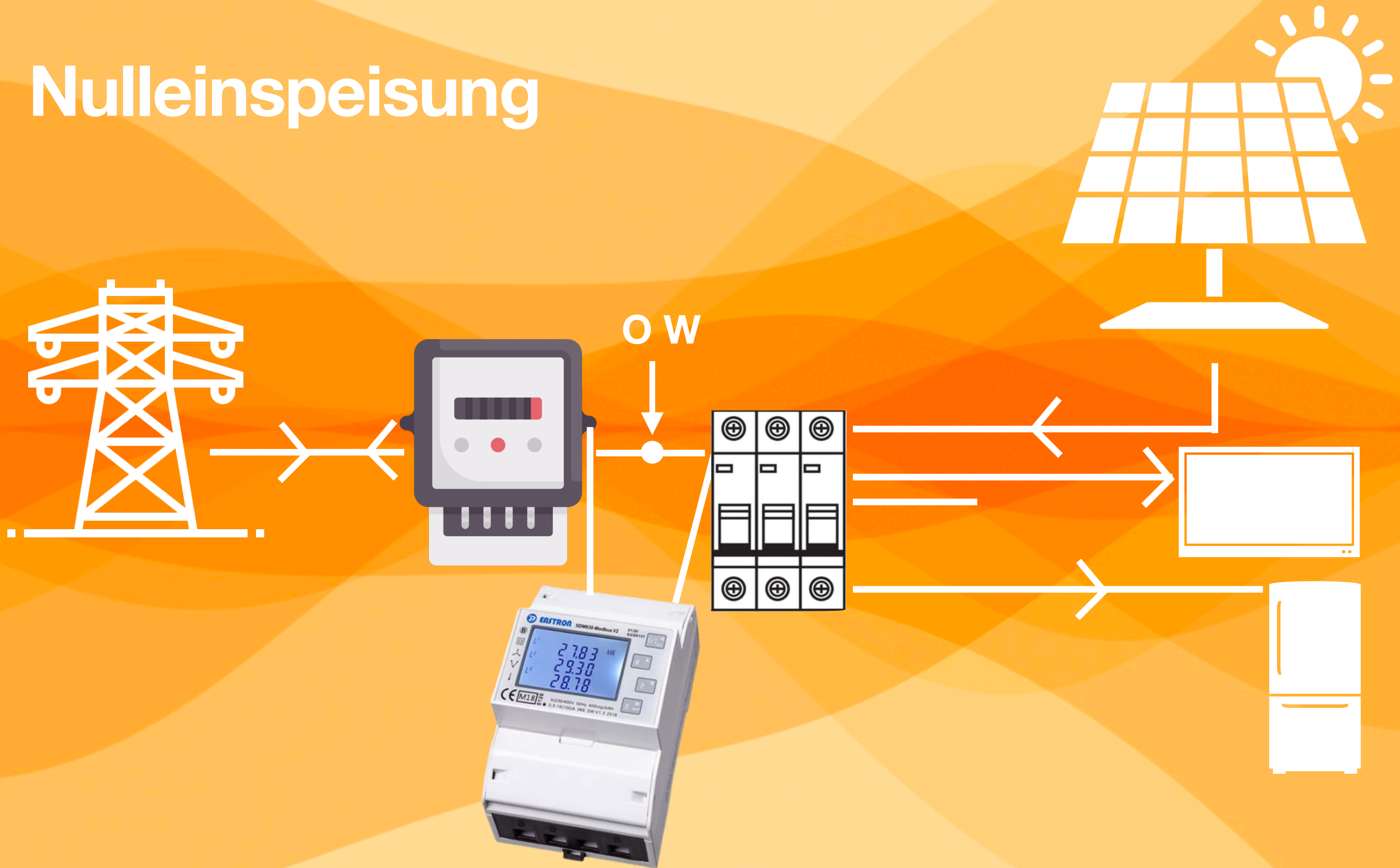
Gesamt:
120 KWh

Ø 3,8 KWh
/ Tag

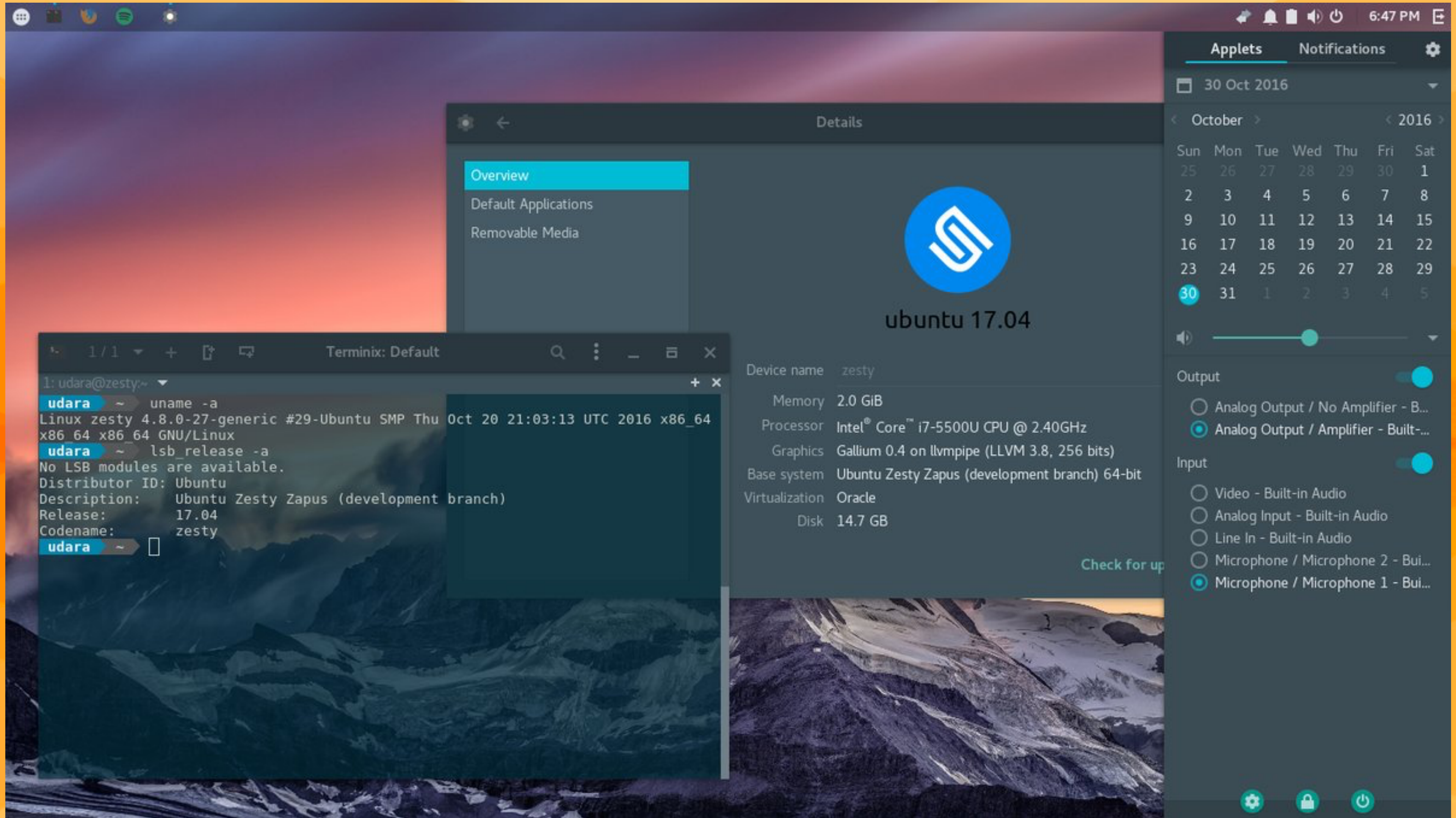
Vorbereitung Nulleinspeisung



Nulleinspeisung




Kilo Whhhhatt für ne Stunde?



8 Stunden Desktop PC



Himmel

- es wird einen Call for Angles geben
- Infos für Helfende folgen im Eventblog
- ab wann eine Hilfe für Helfende möglich ist, folgt im Eventblog 



5 Stunden

MEDIA.CCC.DE

AND

CHILL



2 x eine Pizza aufbacken



1 Spülgang im ECO Programm



2x E-Bike Aufladen

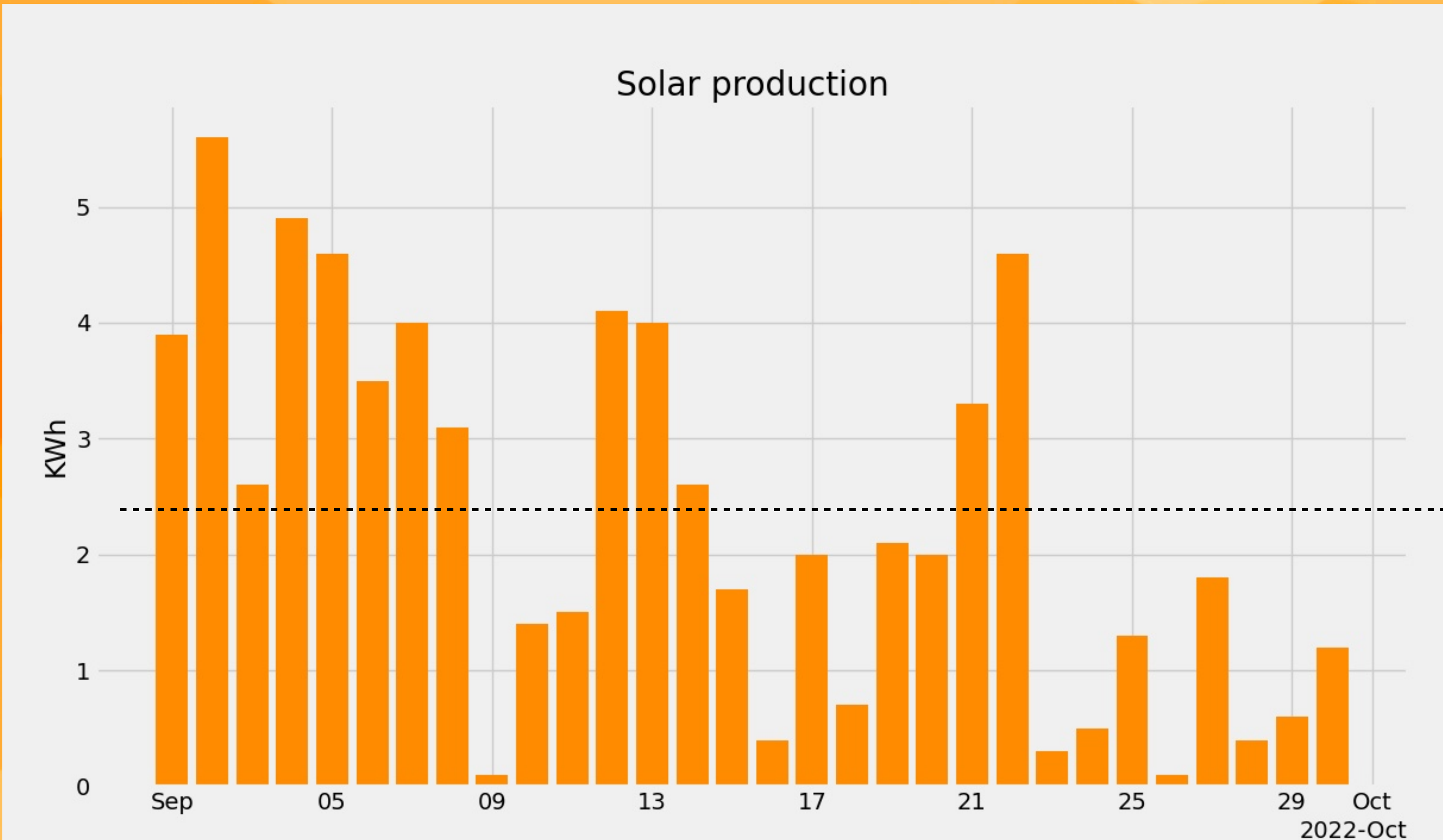


1/2 Wäsche



7,7 Km mit dem E-Auto

September 2022

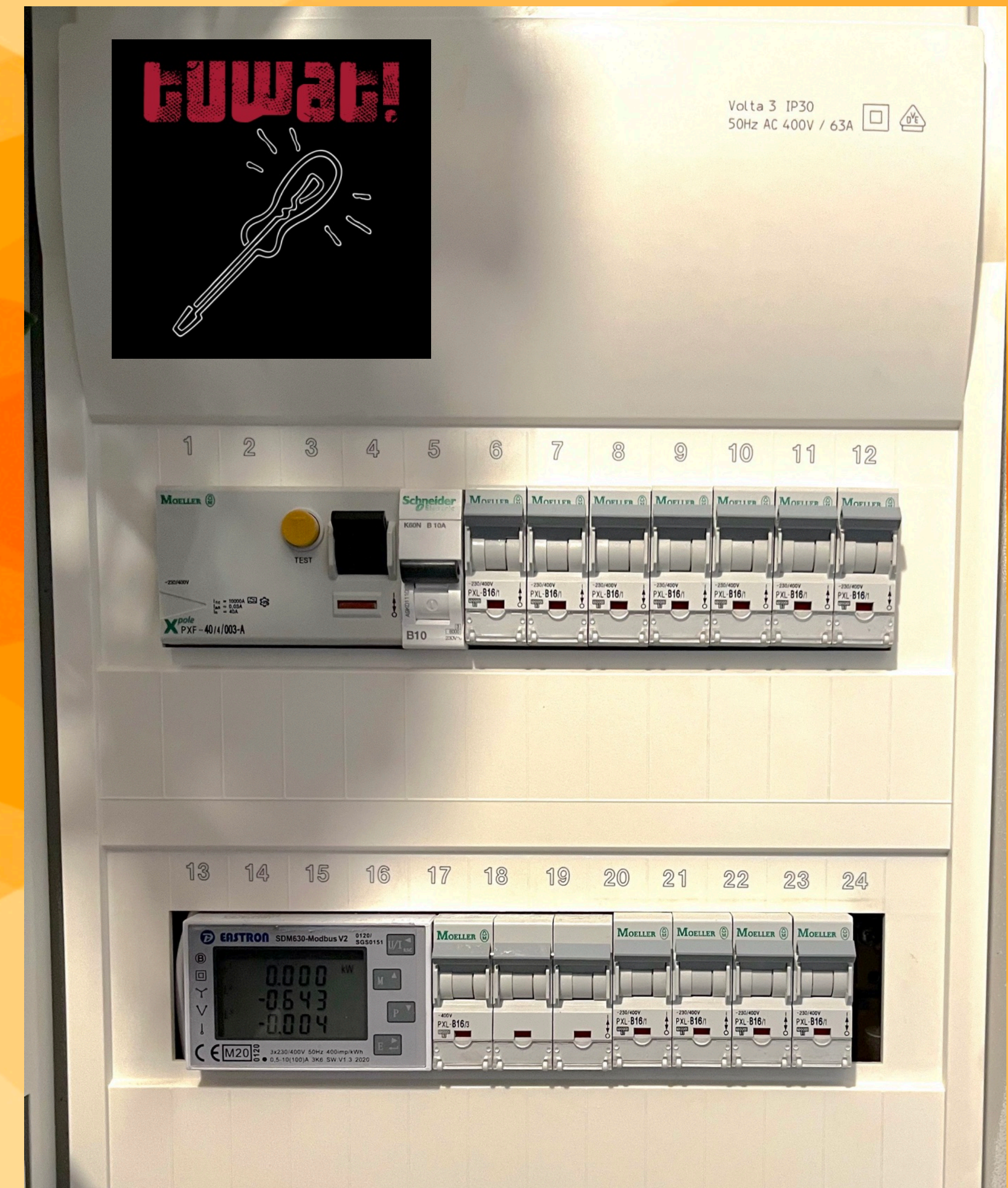
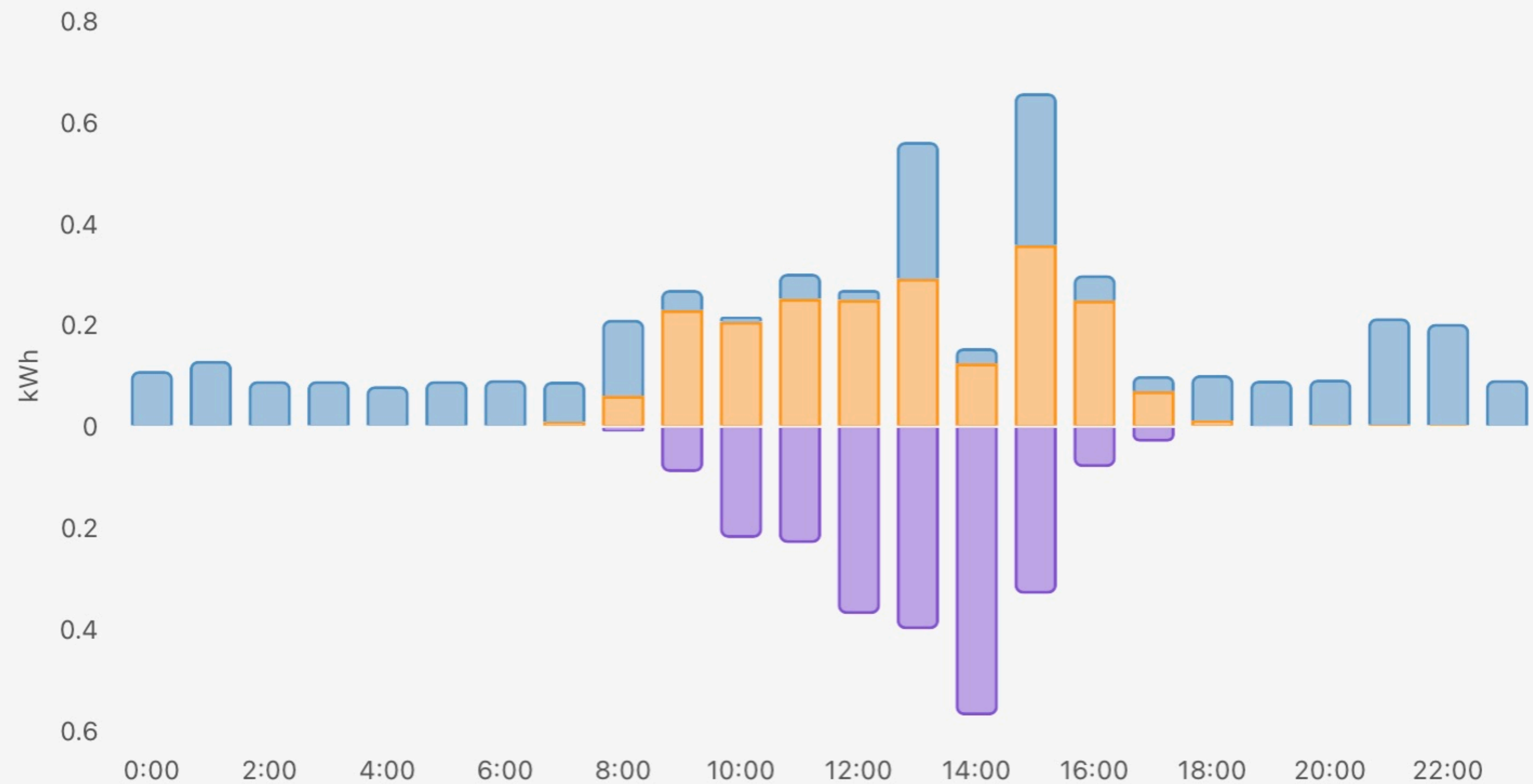


Gesamt:
70 KWh

Ø 2,3 KWh
/ Tag

Energiemessung an der Unterverteilung

Energy usage



mbmd

- Kleines Go Tool
- Ließt Modbus RTU Meters aus und publisht neue Werte per MQTT
- Werte in InfluxDB archivieren
- REST & Websocket API

Measurements

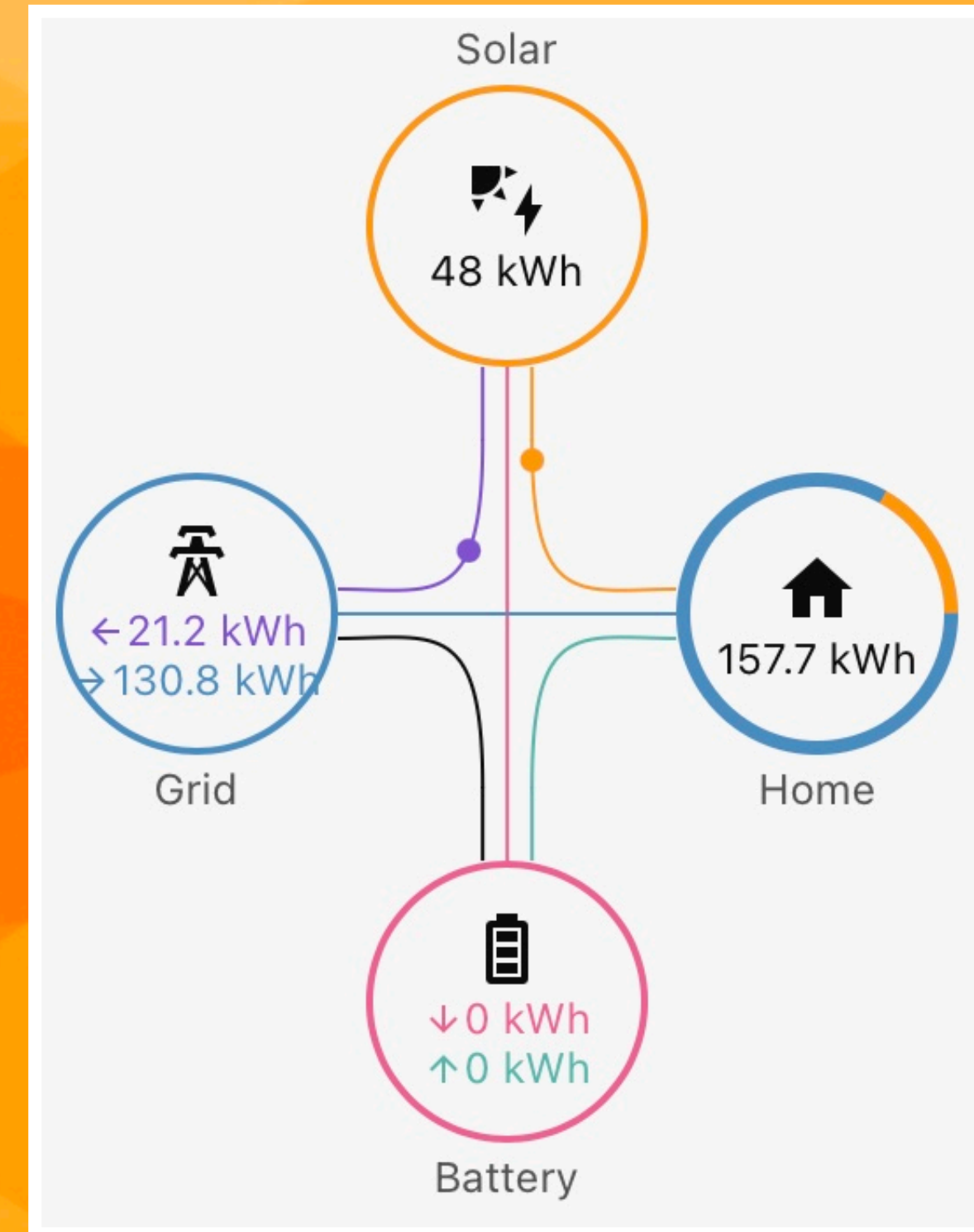
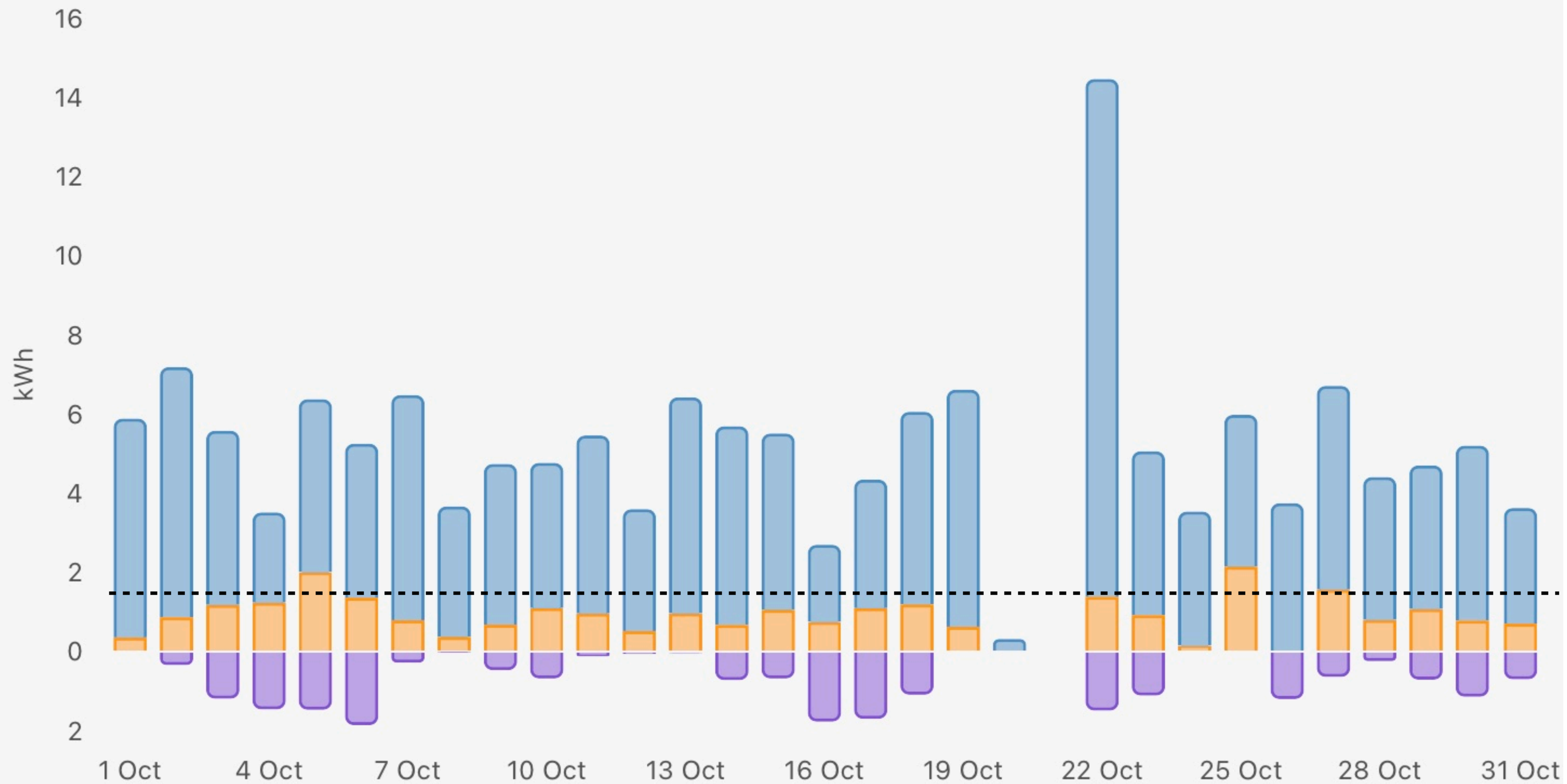
Received SDM1.1 / ReactivePower: -190

SDM1.1	L1	L2	L3	Total
Voltage (V)	230.10	229.64	229.81	—
Current (A)	0.02	1.01	0.00	1.03
Power (W)	0.00	-49.68	0.00	-51.40
Reactive Power (var)	—	—	—	-190.01
Apparent Power (VA)	—	—	—	197.16
Import Power (W)	—	—	—	-46.84
Sum (kWh)	1964.50	4288.92	1001.75	7255.18
Import (kWh)	1964.50	4119.82	1000.68	7085.00
Export (kWh)	0.00	169.10	1.07	170.17
Power Factor (cos φ)	1.00	-0.24	1.00	-0.25
THD Voltage (%)	3.93	4.05	3.55	3.62
Frequency (Hz)	—	—	—	49.91

<https://github.com/volkszaehler/mbmd>

Oktober 2022

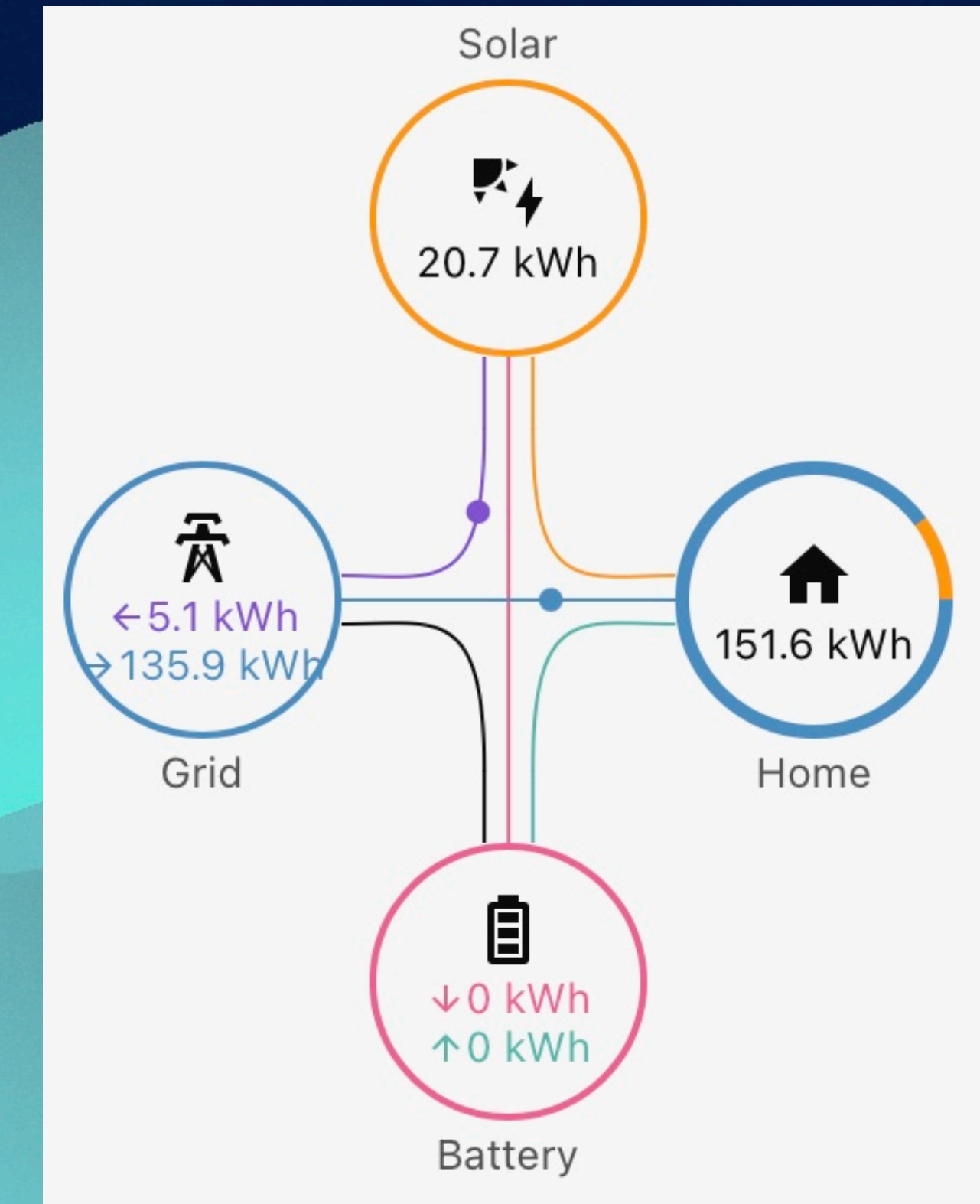
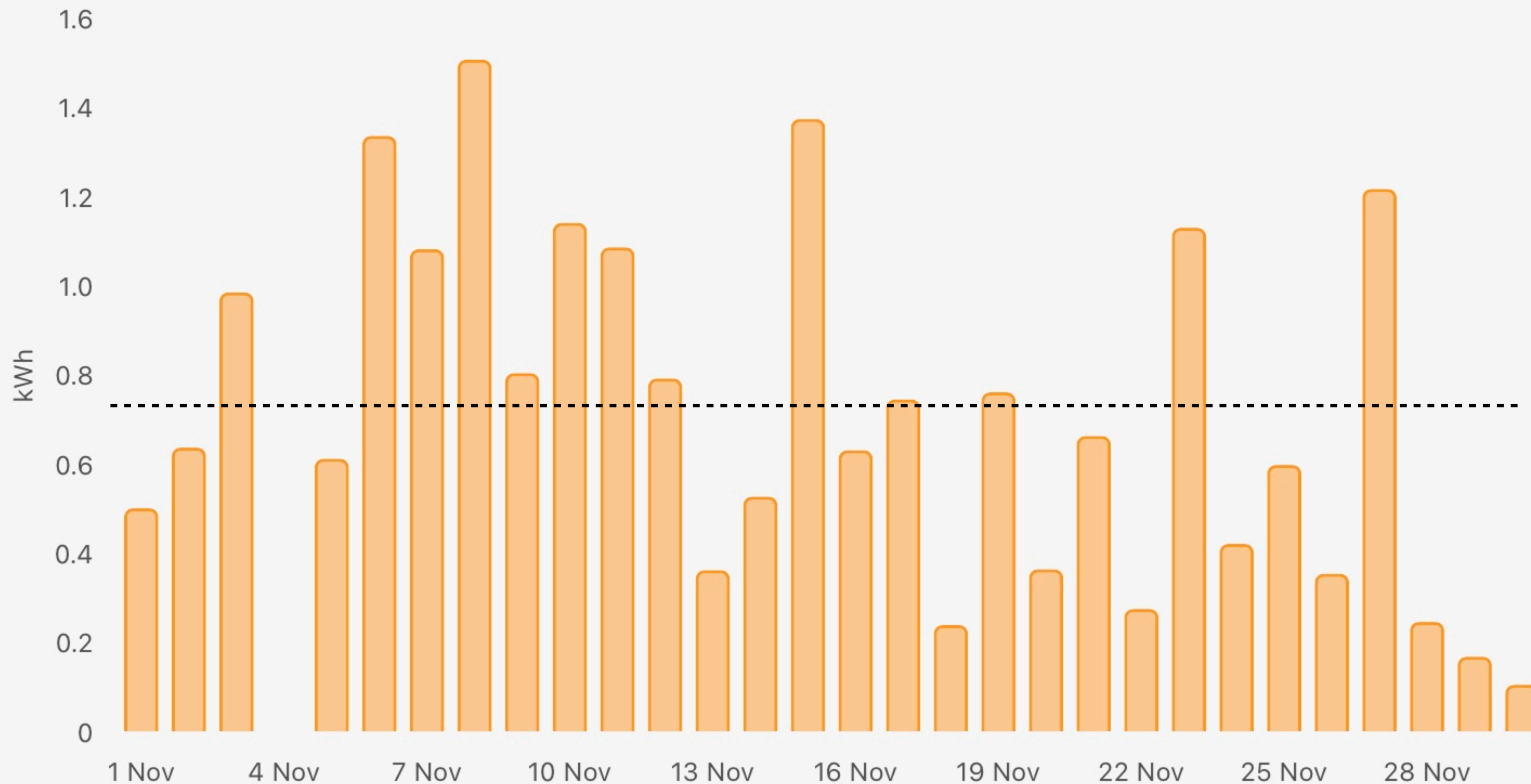
Energy usage



Ø 1,7 kWh / Tag

November 2022

Solar production



Ø 0,7 KWh / Tag

Akku Recycling

- Gehäuse aufbrechen und 18650 Zellen entnehmen
- Sichtprüfung
- Spannung prüfen ($> 2,5 \text{ V}$?)
- mOhm Meter Innenwiderstand überprüfen
- Restkapazität bestimmen durch:
Aufladen -> Entladen -> Aufladen
- Temperaturanstieg überwachen





Akkupack

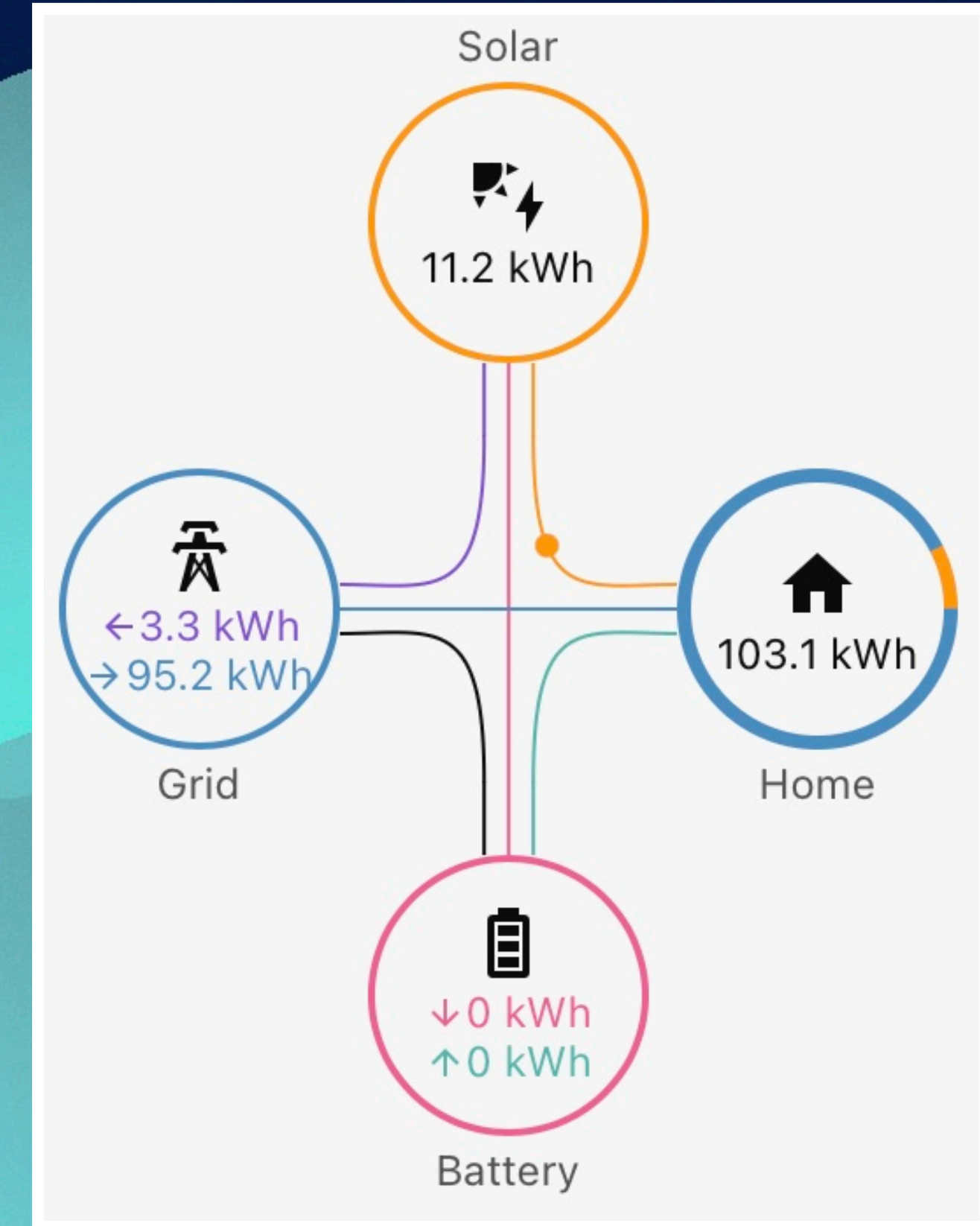
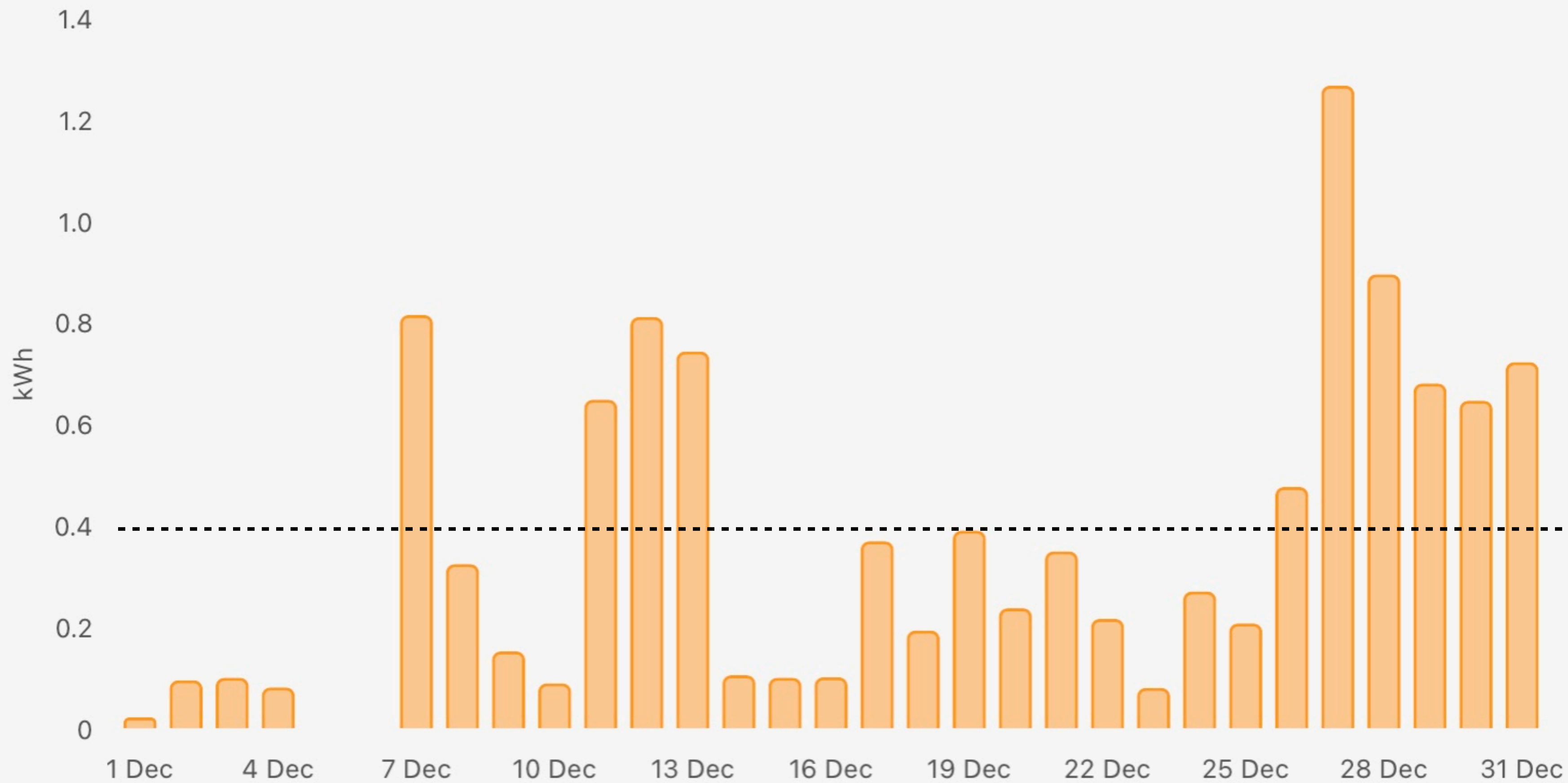
- 20 18650 Zellen Parallel
- 15 Packs in Reihe
- Punktschweiß "Gerät" ca. 20€



Tal der Tränen

Dezember 2022

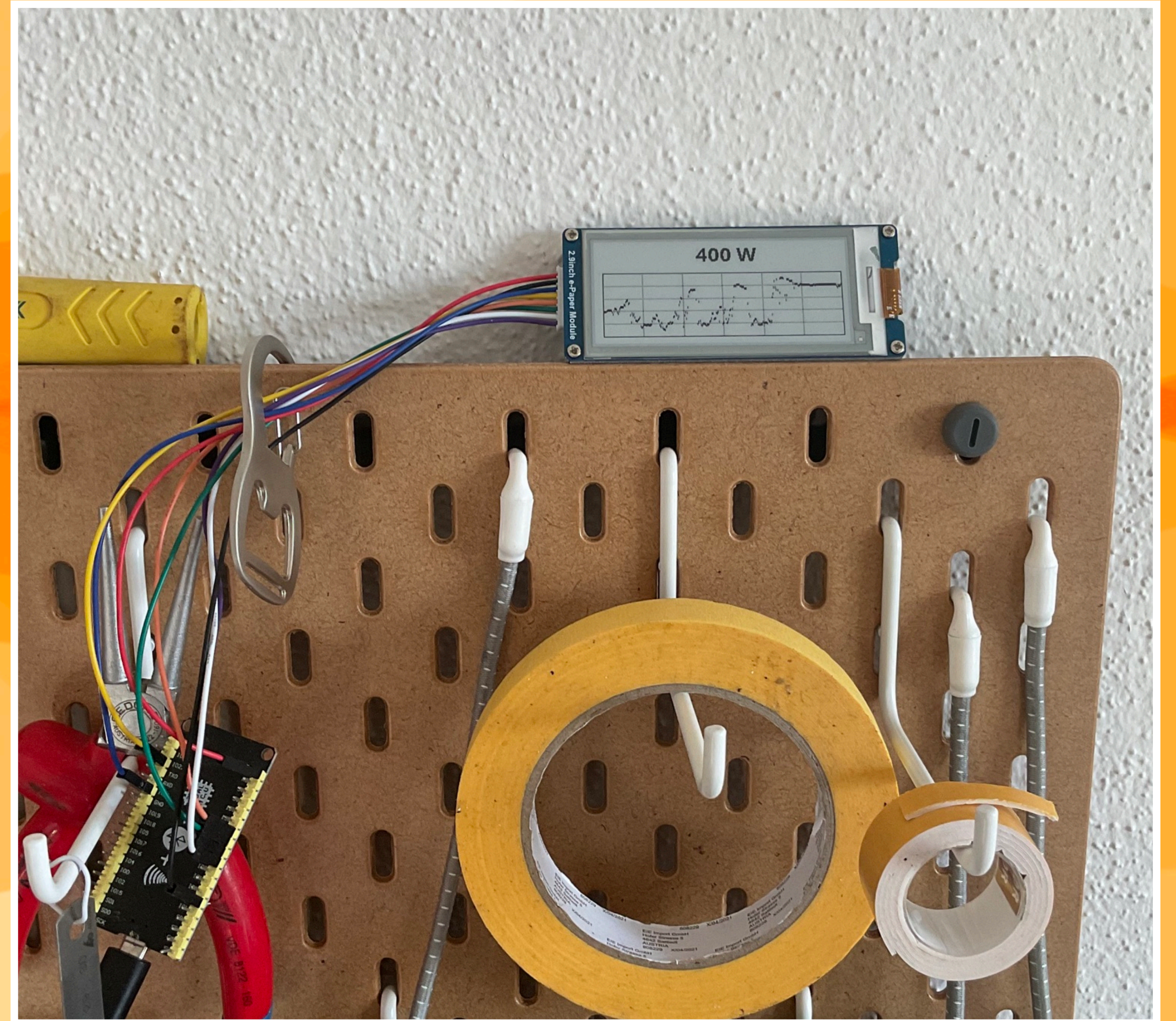
Solar production



Ø 0,4 kWh / Tag

ESP HOME Anzeige

- Projekt für Anbindung von Sensoren, Aktoren, Anzeigen an Home Automation
- ESP32 + 2.9" ePaper Display
- Konfiguration über eine YML-File

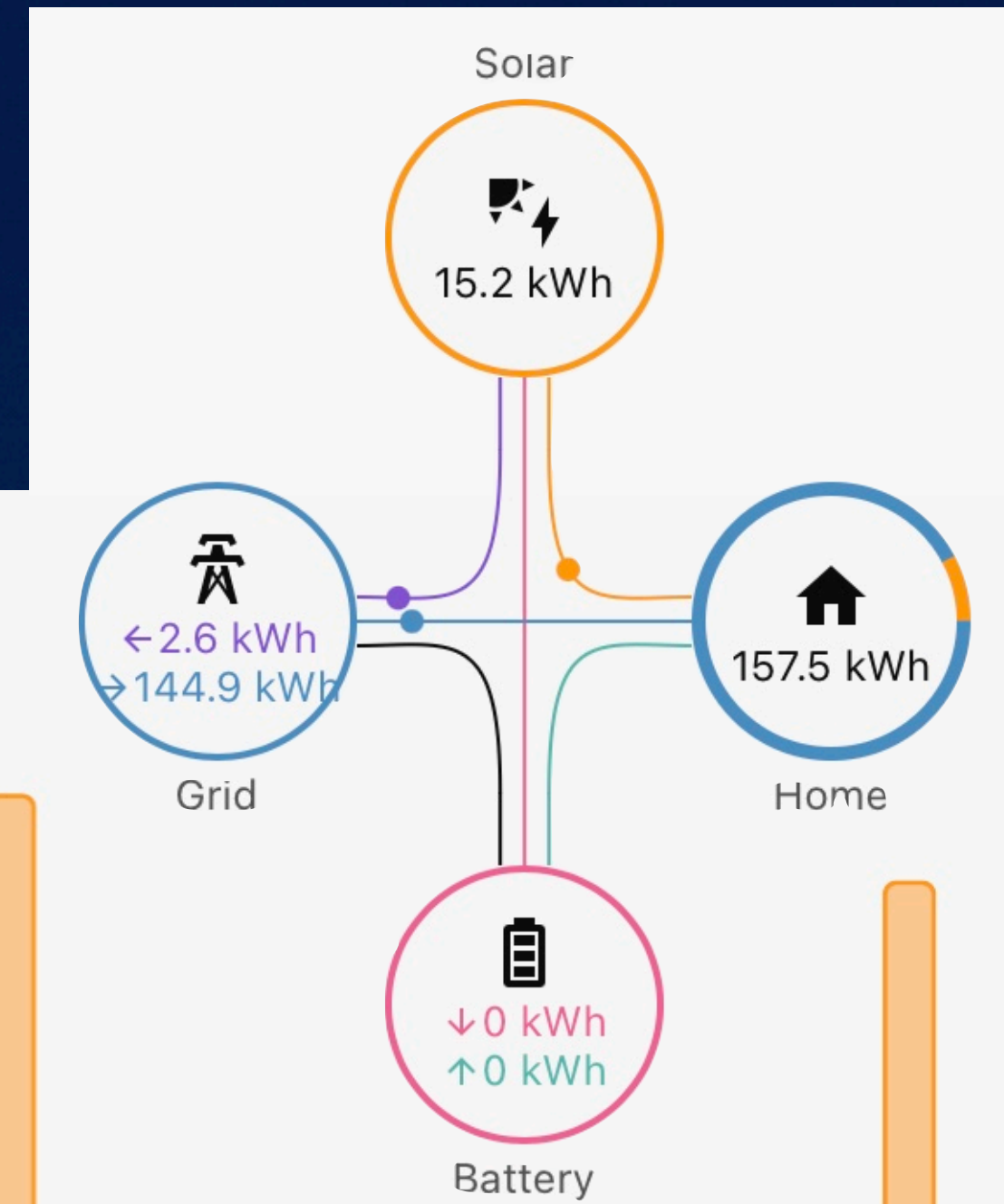
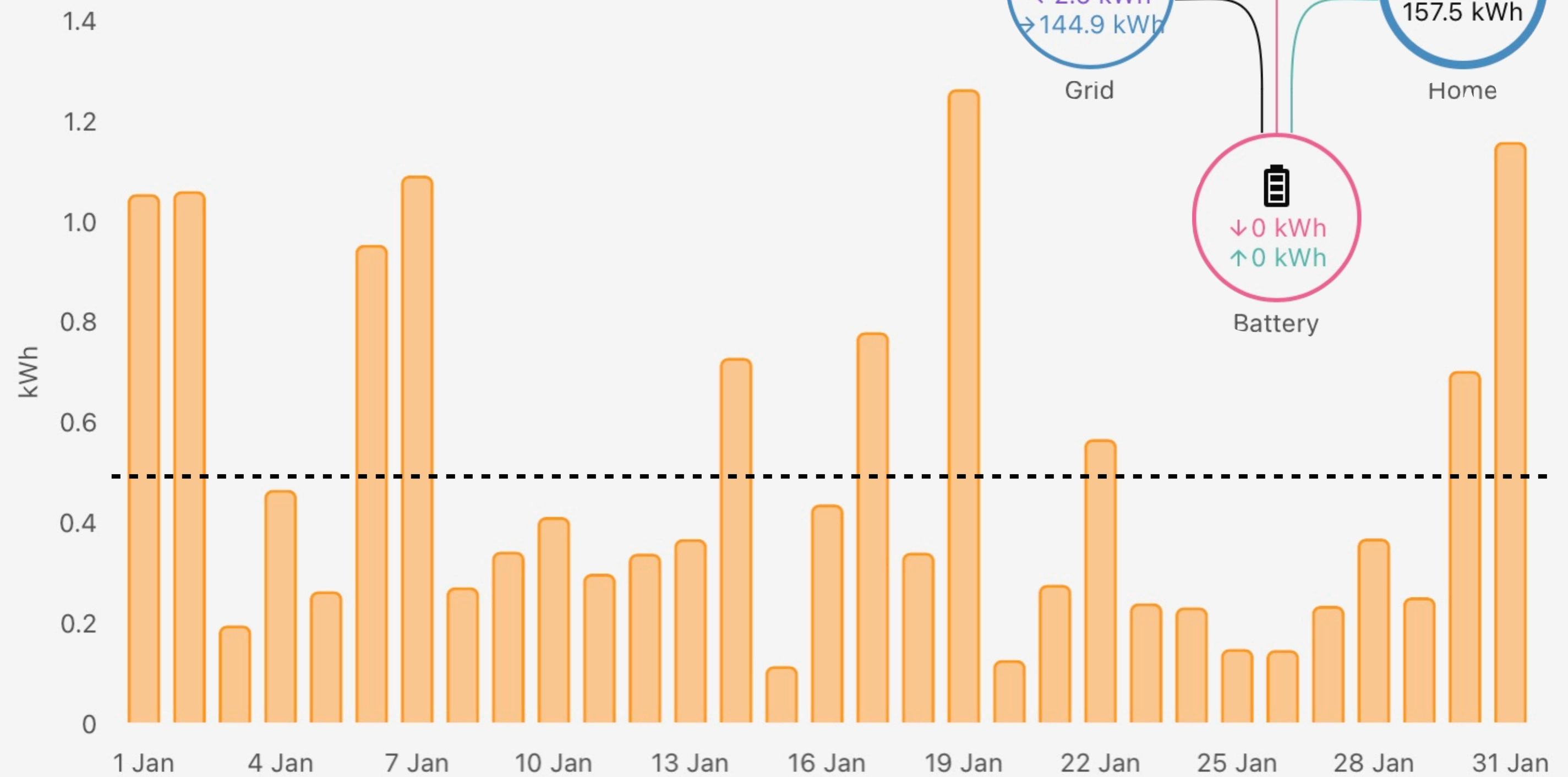


Tal der Tränen

Januar 2023



Solar production



Temp. bis -8°C

0,5 kWh / Tag

Kompatibilität PV Modul Wechselrichter

ELECTRICAL DATA(STC)

Part Number	OP390M54-P3	OP400M54-P3	OP410M54-P3	OP415M54-P3
Peak Power Watts-P _{MAX} (Wp)*	390	400	410	415
Power Output Tolerance	0~5W			
Open Circuit Voltage-V _{oc} (V)	36.54	36.94	37.34	37.9
Short Circuit Current-I _{sc} (A)	13.5	13.6	13.7	13.72
Maximum Power Voltage-V _{MPP} (V)	30.42	30.82	31.22	32
Maximum Power Current-I _{MPP} (A)	12.82	12.94	13.06	12.97
Panel Efficiency (%)	19.95	20.46	20.97	21.22

STC :Irradiance 1000w/m², Cell Temperature 25 °C Power Binning: +/-5W Air Mass AM1.5

Kälteste Betriebstemperatur:

z.B. T_{min} = -10°C

T_{diff} = 25°C - (-10) °C = Δ 35°C

TEMPERATURE RATINGS

NOCT(Nominal Operating Cell Temperature)	41°C (±3°C)
Temperature Coefficient of P _{MAX}	-0.34%/°C
Temperature Coefficient of V _{oc}	-0.25%/°C
Temperature Coefficient of I _{sc}	-0.04%/°C

(Do not connect Fuse in Combiner Box with two or more strings in parallel connection)

Maximale Spannung PV:

$$V_{\max} = V_{oc} + V_{oc} \times \text{Temp Coef } V_{oc} \times T_{\text{diff}}$$

$$V_{\max} = 37,34 \text{ V} + (37,34 \text{ V} \times -0,25\%/^{\circ}\text{C} \times 35 \text{ }^{\circ}\text{C})$$

$$= 40,6 \text{ V}$$

Kompatibilität PV Modul & Wechselrichter

Technische Daten

Modell	HM-600	HM-700	HM-800
Angaben zum Eingangsstrom (DC)			
Maximale Eingangsspannung (V)		60	> 40,6 ✓
Maximaler Eingangsstrom (A)	2 x 11,5	2 x 11,5	2 x 12,5
Maximaler Eingangskurzschlussstrom (A)		2 x 15	> 13,9 ✓

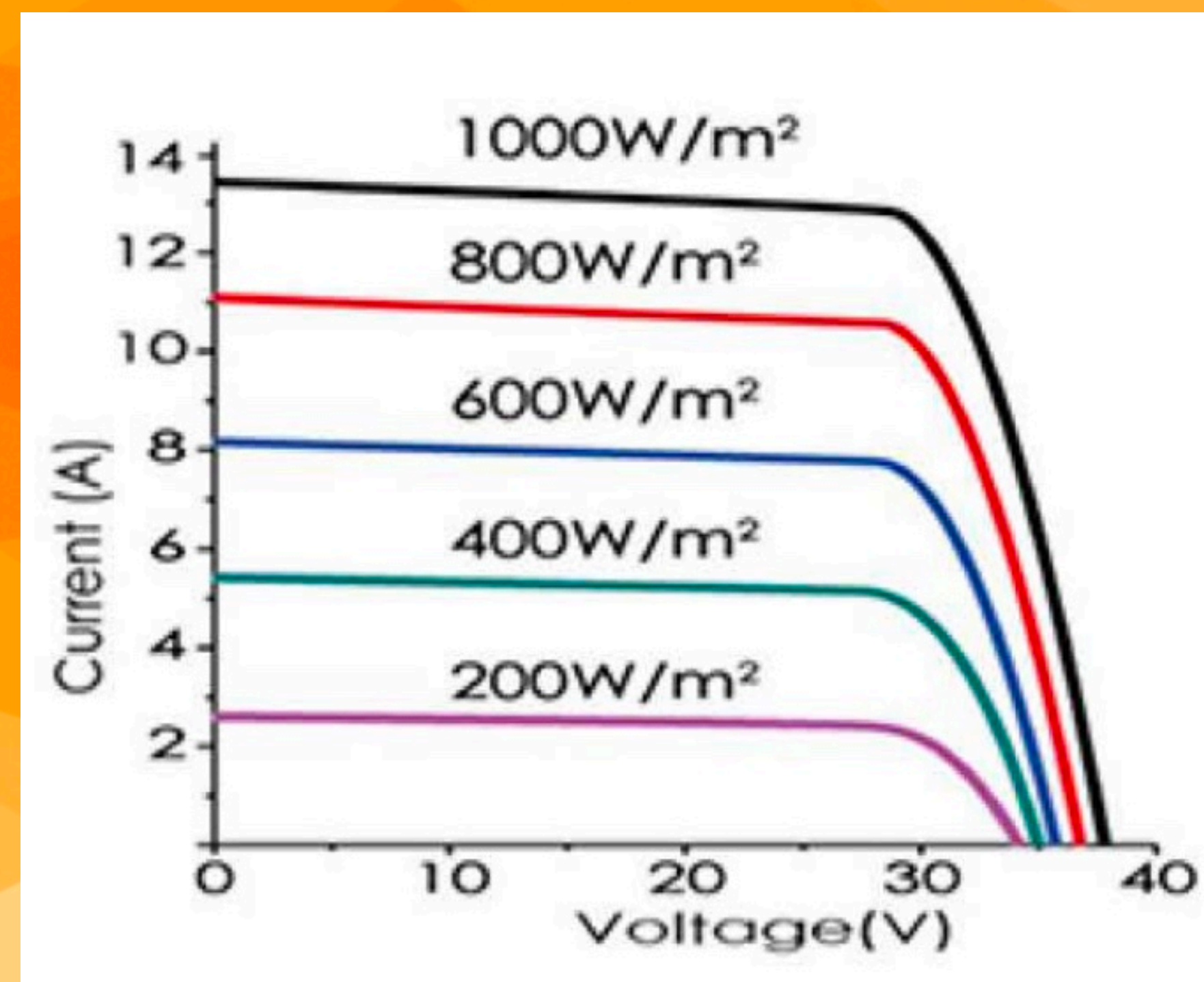
$$V_{mpp} = 31,20 \text{ V}$$

$$I_{mpp} = 13,09 \text{ A}$$

$$31,2 \text{ V} \times 11,5 \text{ A} = 358,8 \text{ W}$$

Strahlungsleistung der Sonnenenergie in Deutschland

Wetterlage	Sommer [W/m ²]	Winter [W/m ²]
klarer bis leicht diffuser Himmel	600 - 1.000	300 - 500
leicht bis mittel bewölckter Himmel	300 - 600	150 - 300
stark bewölckter bis nebelig-trüber Himmel	100 - 300	50 - 150
∅ Alle Wetterlagen	483	225



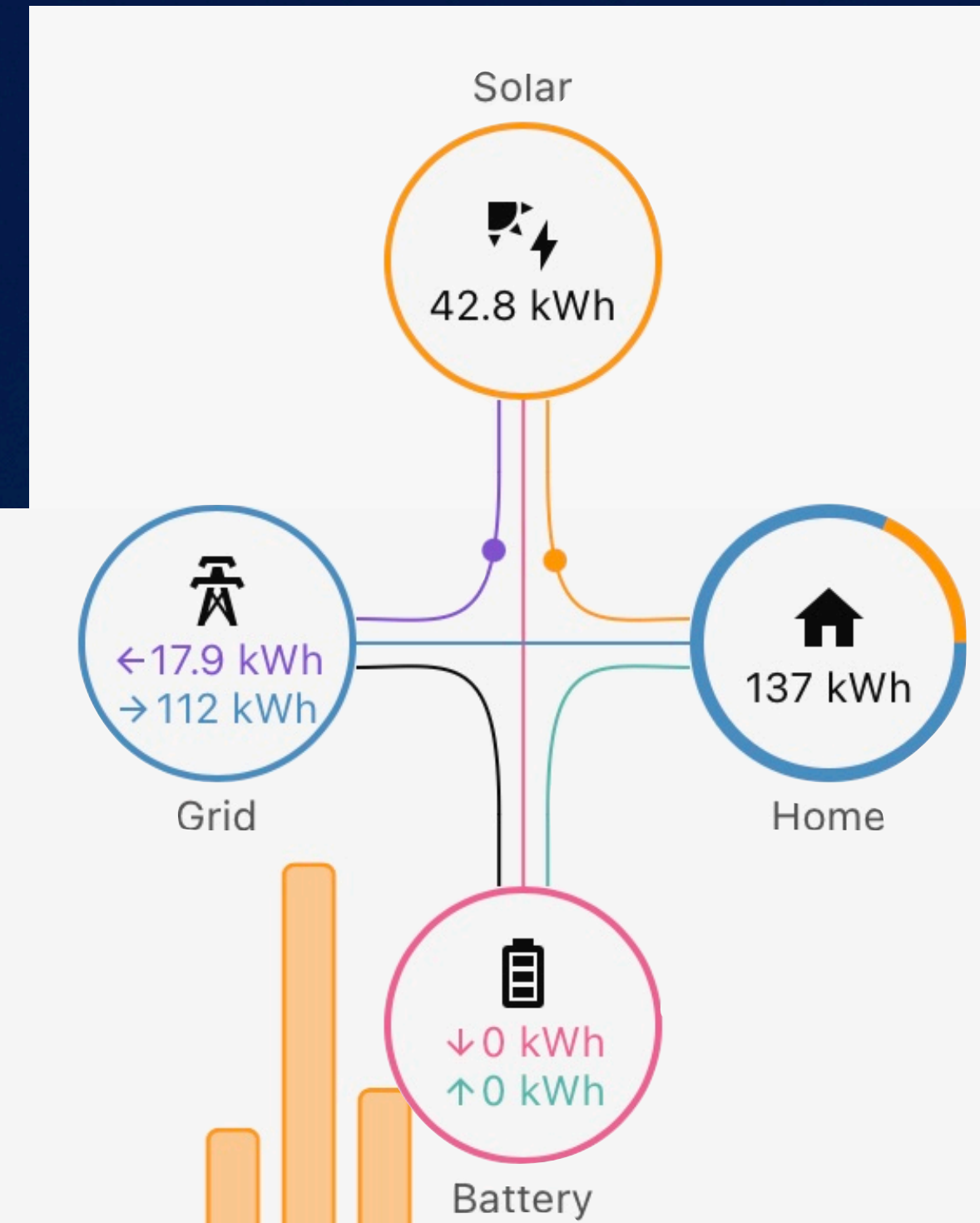
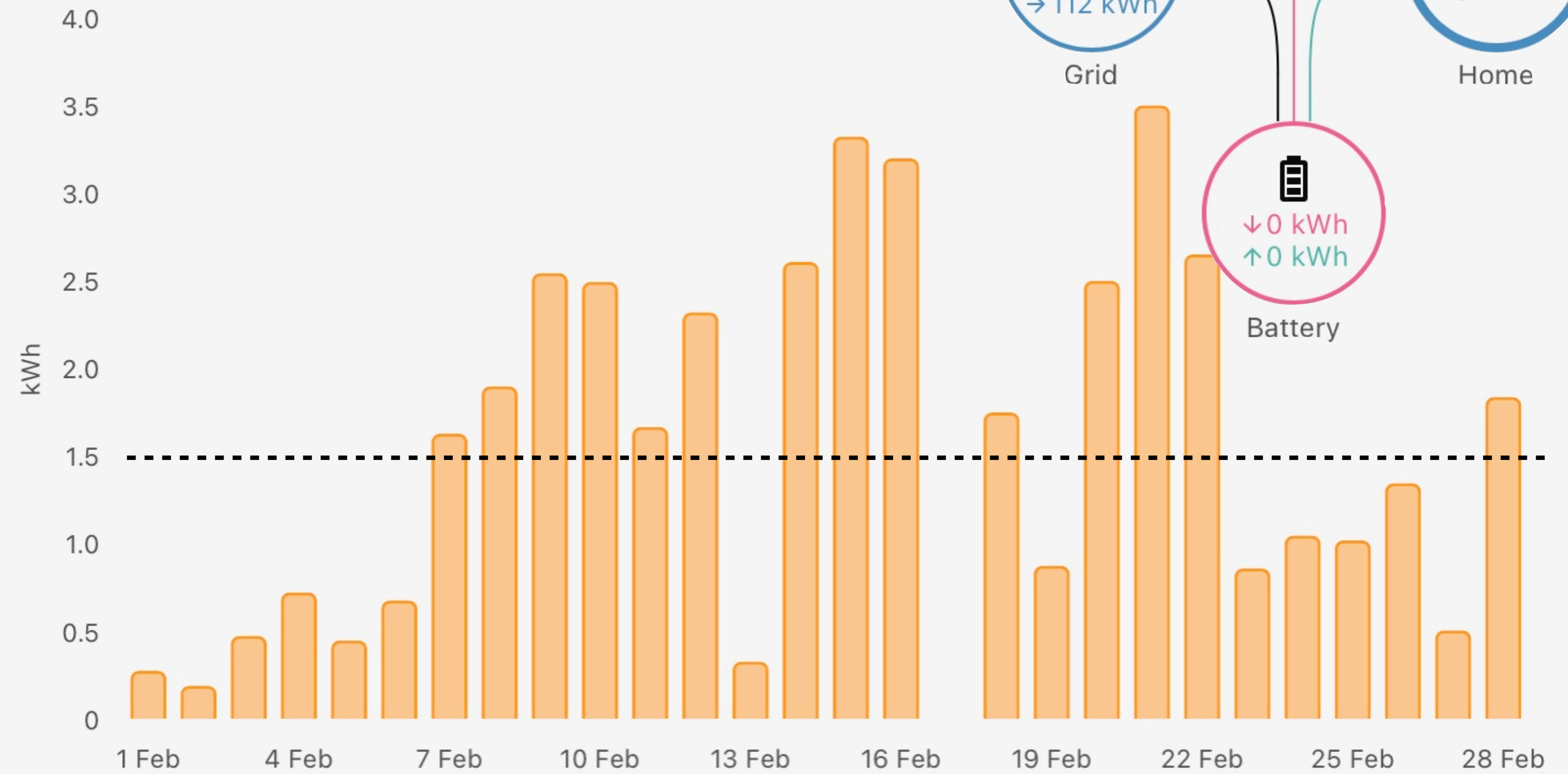
Kennlinien PV Panel

Tal der Tränen

Februar 2023



Solar production

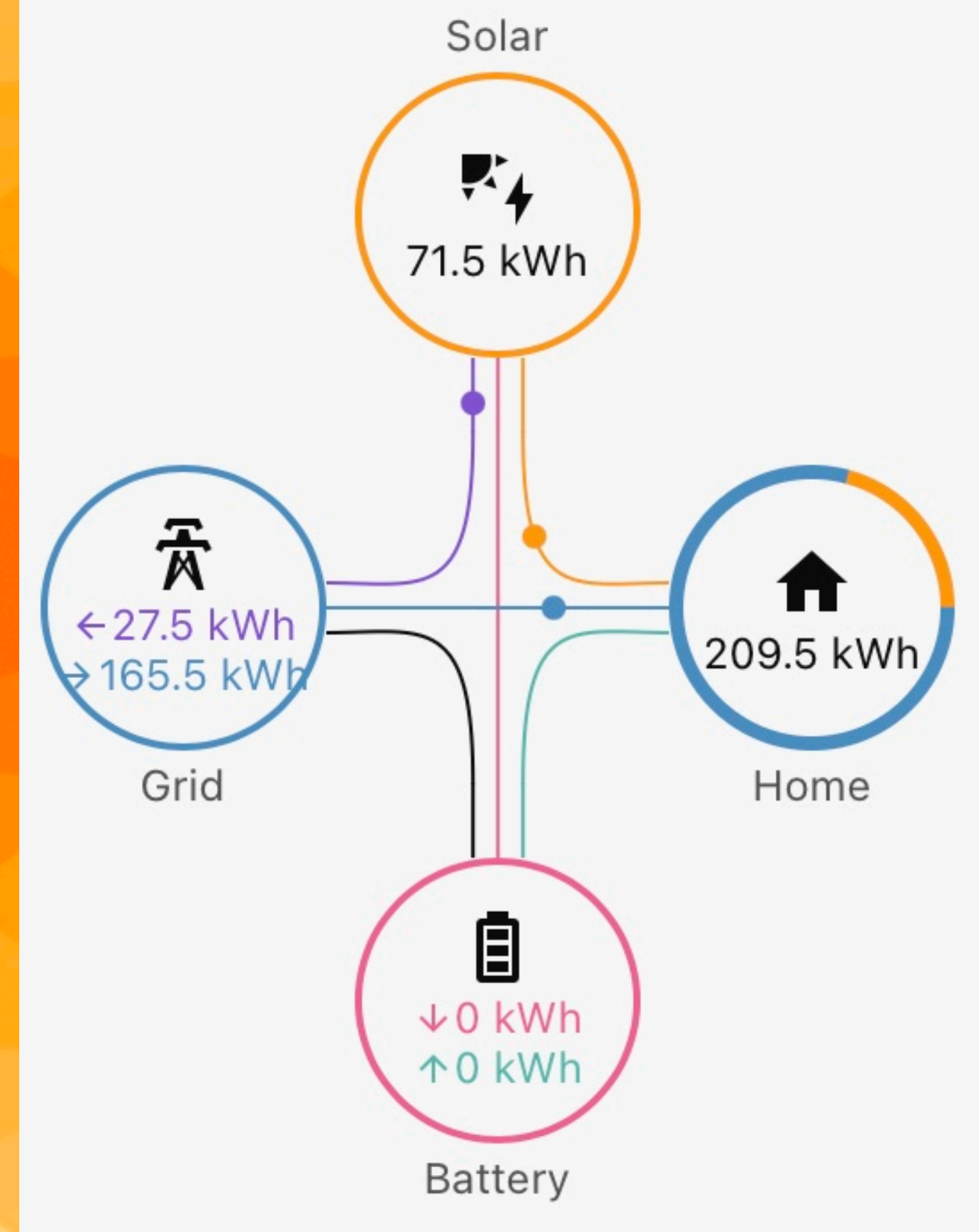
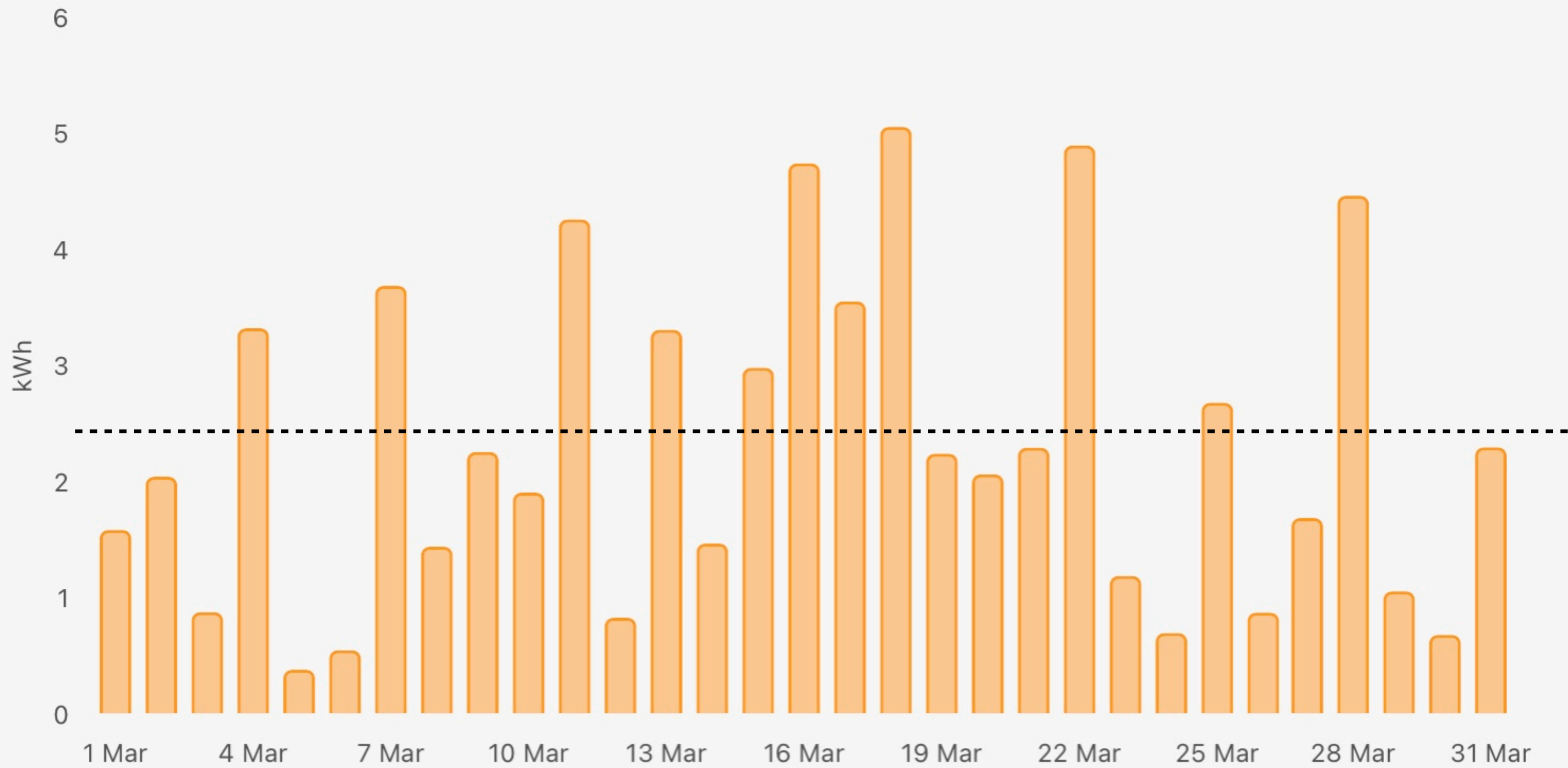


Gesamt: 42,8 KWh | ø 1,5 KWh / Tag



März 2023

Solar production



Ø 2,3 kWh / Tag

Energie Speichern



Akkuzelle Lithium Eisenphosphat (LiFePo4)

EVE LF280K

Spannung: 3,2 V

Kapazität: 280 Ah

Entspricht ~0,9 KWh

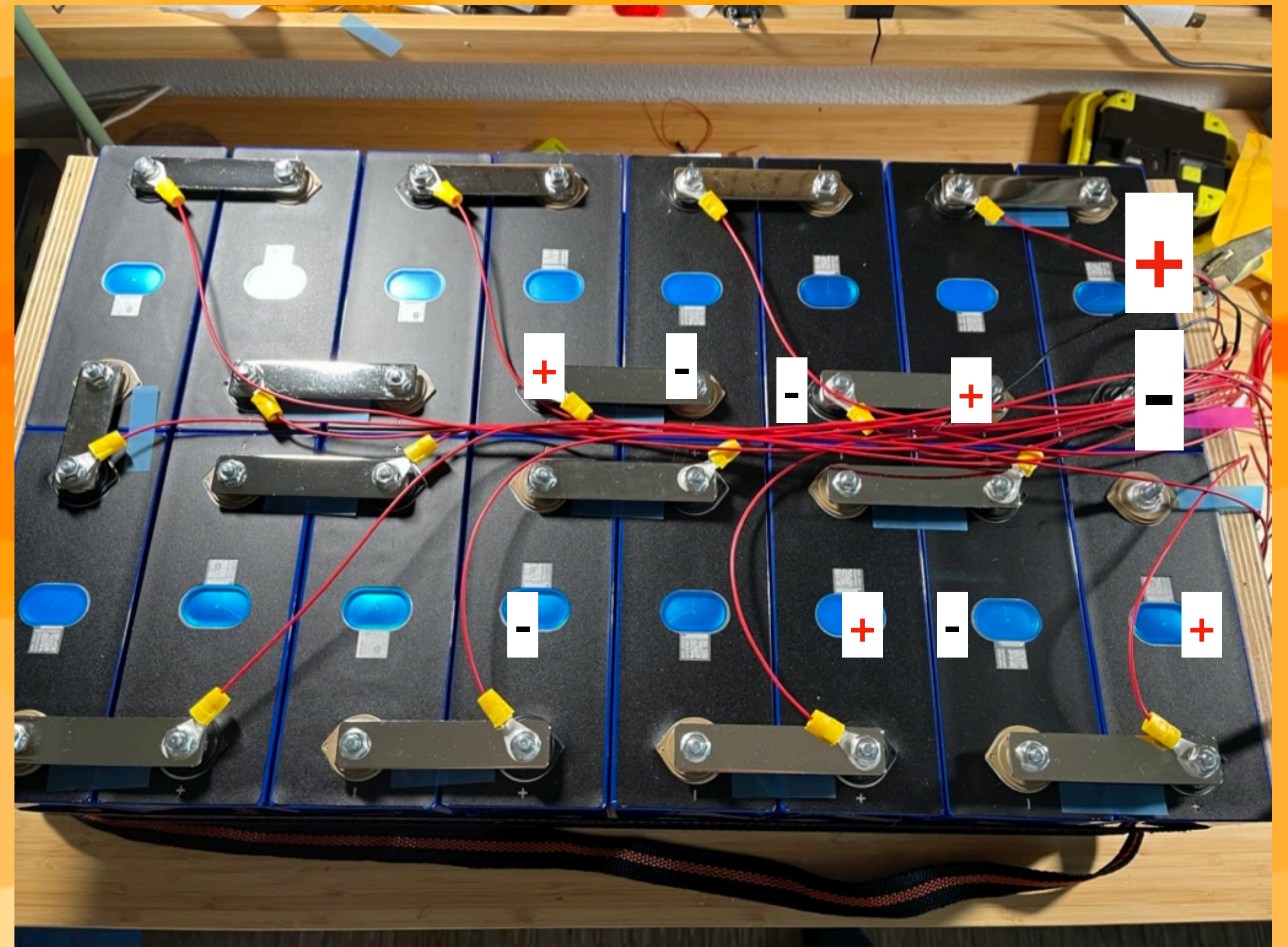
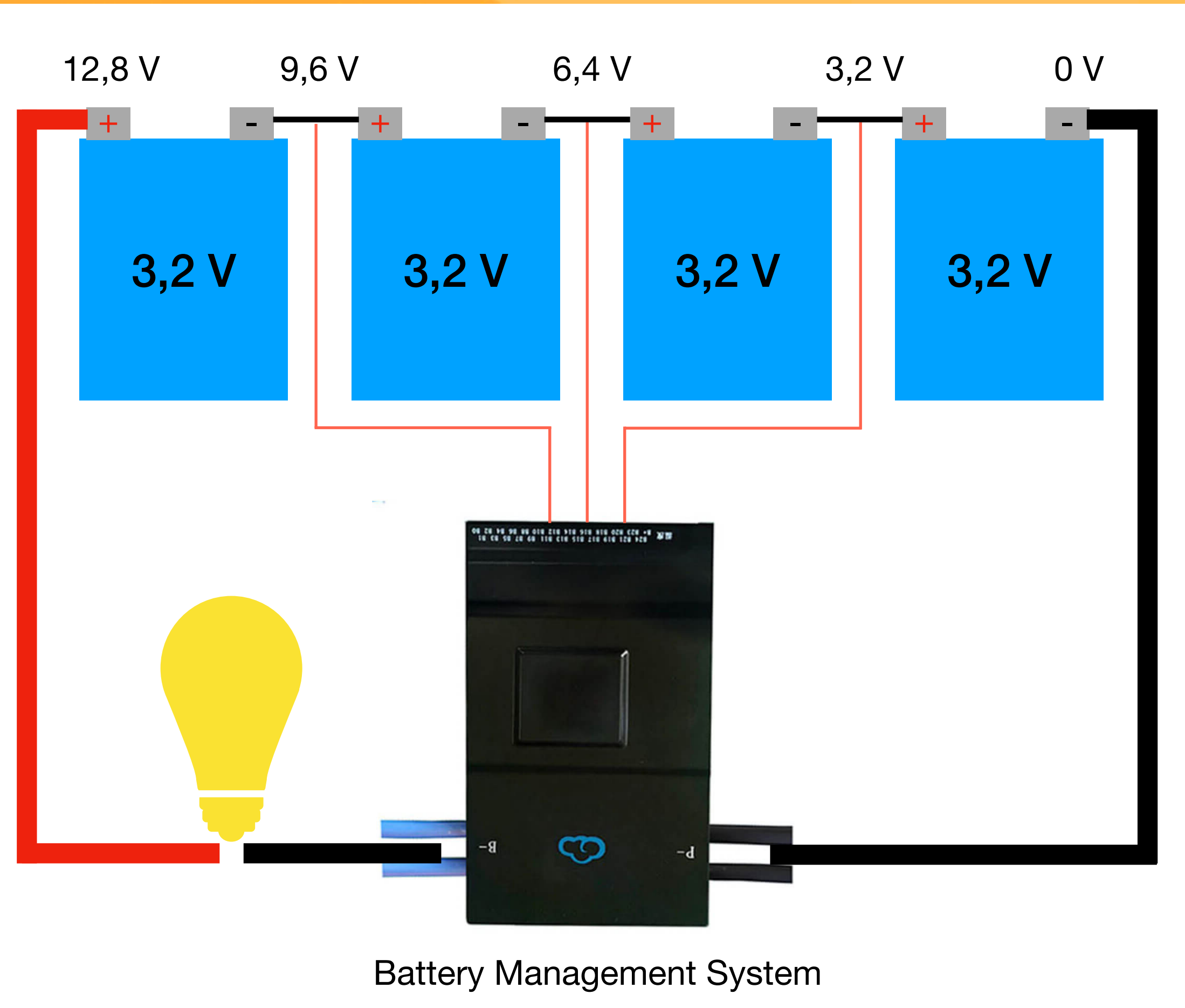
Bis zu 6000 Zyklen (80%)



Aufbau PV Energiespeicher



Akkuzellen verschalten (16S)

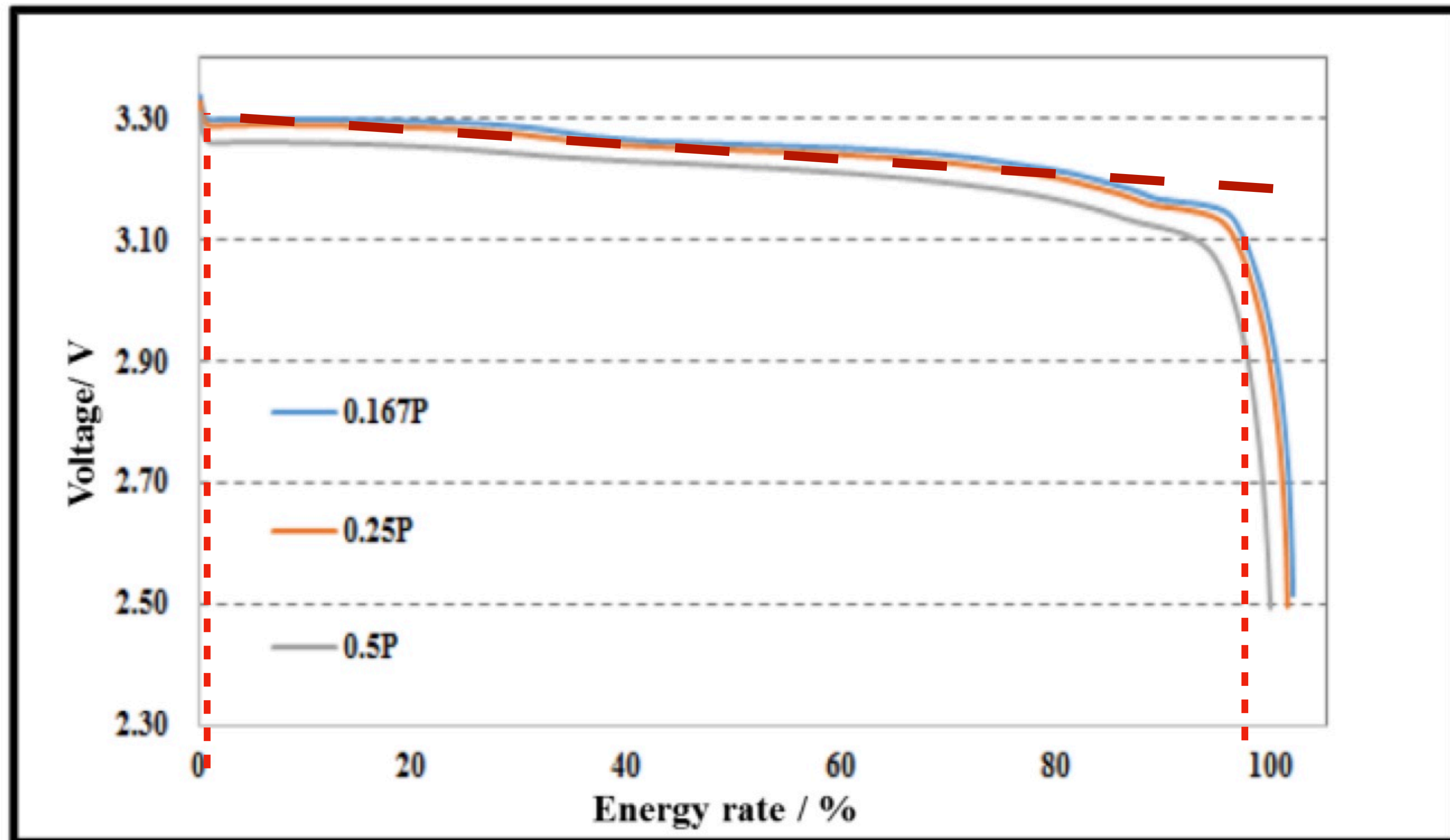


Entladekurve EVE LF280K

Spannungsbereich

Min.: 2,5 V

Max.: 3,65 V



13:32

TIME: 1M37S

Charge: OFF | Discharge: OFF | Balance: On

52.69^V 0.0^A

Battery T2: 22^{°C}

Cells Voltage

01	3.294 ^V	09	3.293 ^V	17	--
02	3.291 ^V	10	3.293 ^V	18	--
03	3.293 ^V	11	3.293 ^V	19	--
04	3.293 ^V	12	3.293 ^V	20	--
05	3.293 ^V	13	3.293 ^V	21	--
06	3.293 ^V	14	3.293 ^V	22	--
07	3.293 ^V	15	3.293 ^V	23	--
08	3.294 ^V	16	3.293 ^V	24	--

Cells Wire Resistance

01	0.051 ^Ω	09	0.050 ^Ω	17	0.000 ^Ω
02	0.051 ^Ω	10	0.050 ^Ω	18	0.000 ^Ω
03	0.051 ^Ω	11	0.050 ^Ω	19	0.000 ^Ω
04	0.051 ^Ω	12	0.051 ^Ω	20	0.000 ^Ω
05	0.050 ^Ω	13	0.050 ^Ω	21	0.000 ^Ω
06	0.051 ^Ω	14	0.051 ^Ω	22	0.000 ^Ω
07	0.050 ^Ω	15	0.050 ^Ω	23	0.000 ^Ω
08	0.051 ^Ω	16	0.050 ^Ω	24	0.000 ^Ω

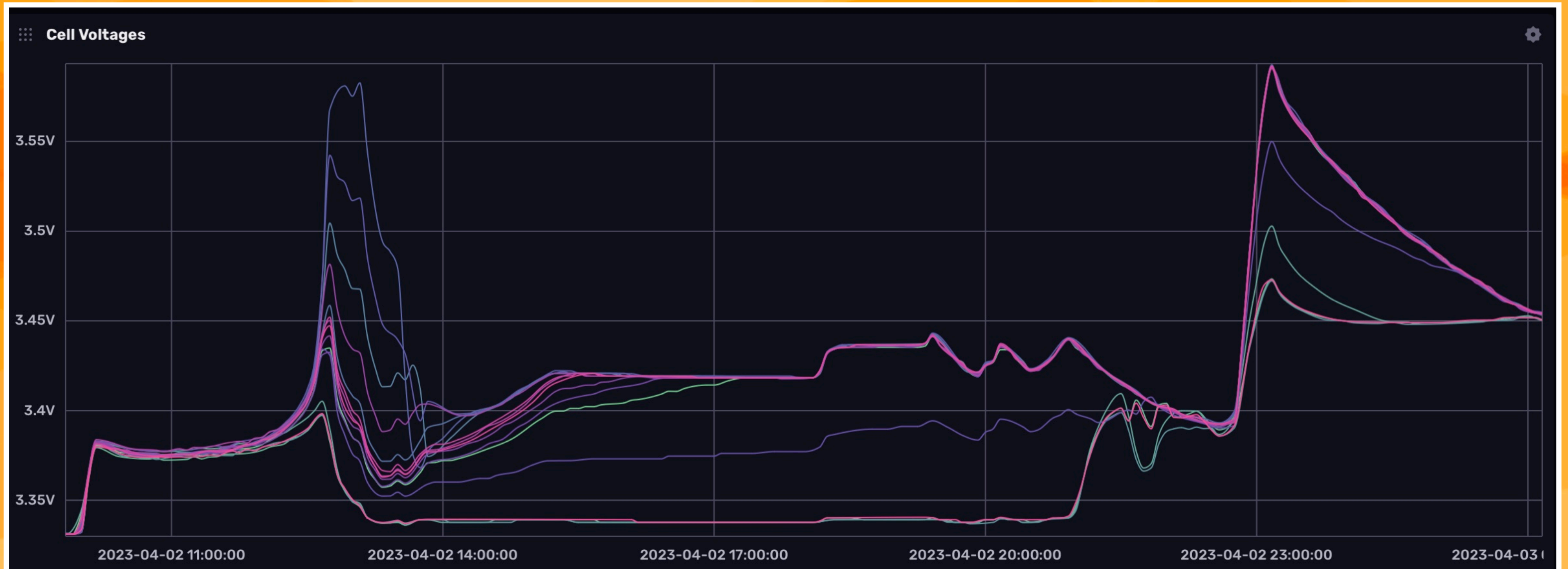
STATUS SETTINGS CONTROL

Top Balancing



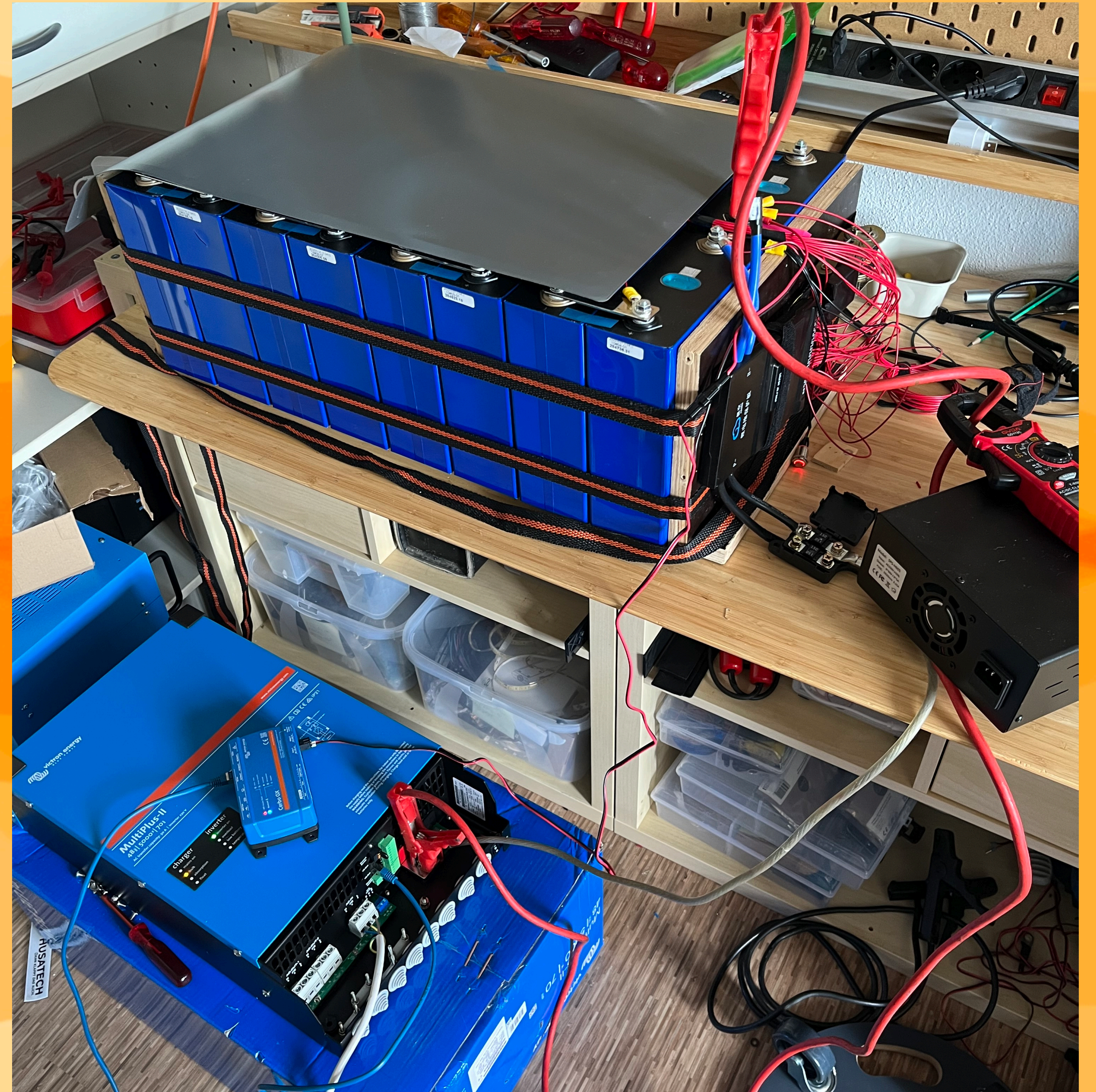
Zellspannungen beim Angleichen

95+% Ladezustand



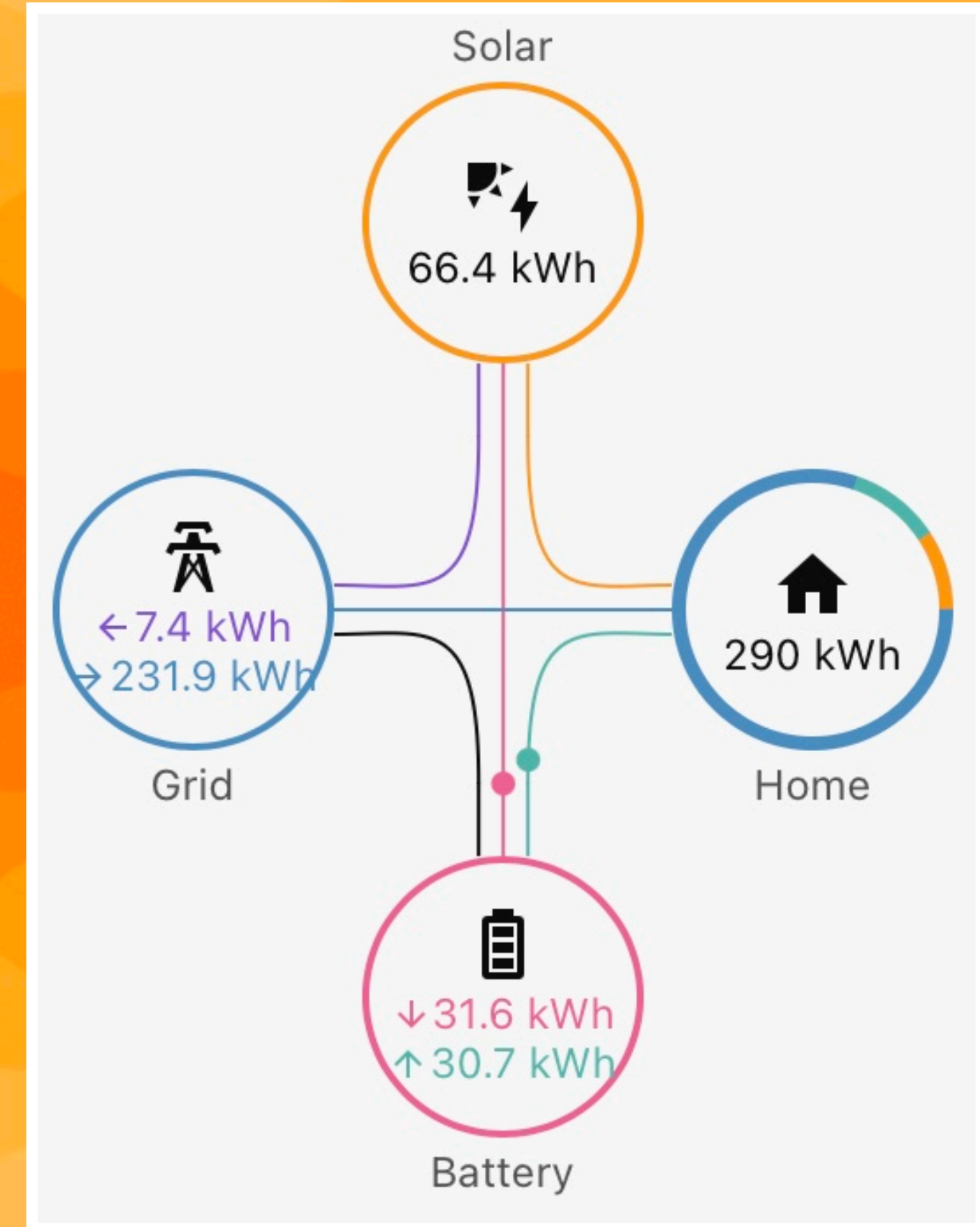
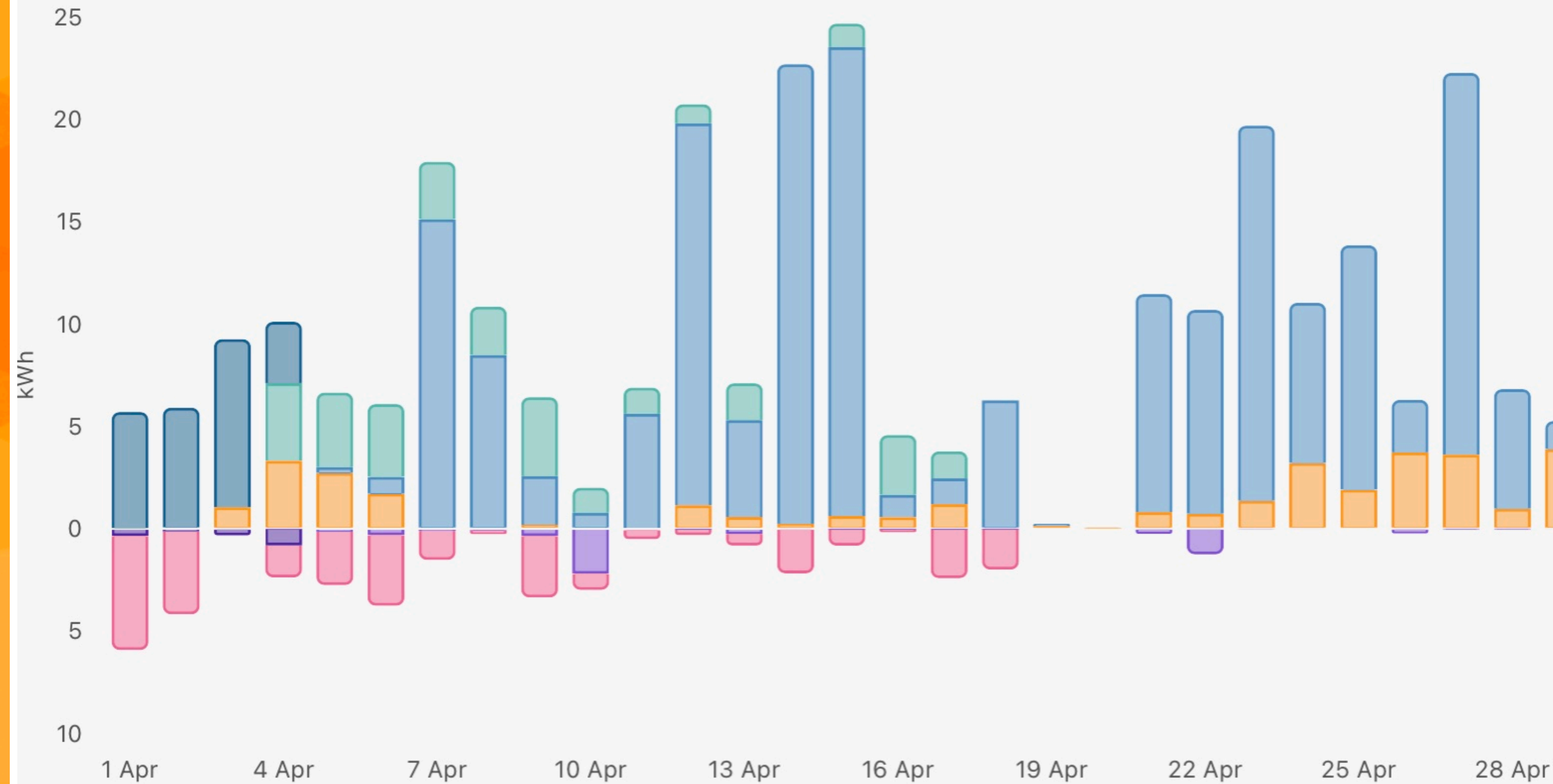
Testaufbau mit Multiplus II 48-5000

DO NOT TRY THIS AT HOME



April 2023

Energy usage



Ø 2,4 kWh / Tag



**Vergrößerung auf
4 kWp**

JW-HD108N

N-type

Bifacial Double Glass Mono All Black Module

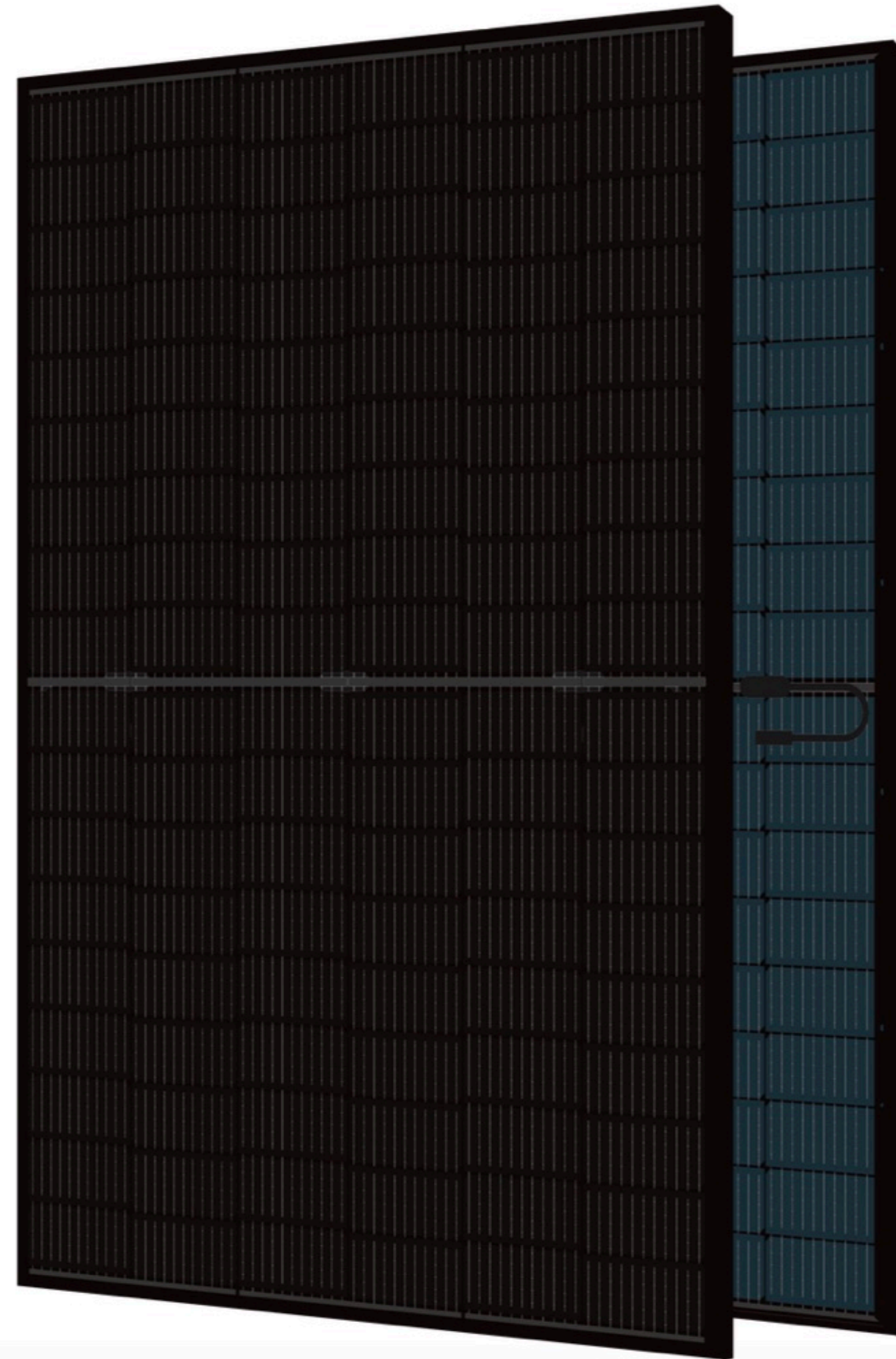
400-420W

IEC61215(2016), IEC61730(2016)

ISO9001:2015: Quality Management System

ISO14001:2015: Environment Management System

ISO45001:2018: Occupational health and safety management systems



420W

Maximum Power Output

21.43%

Maximum Module Efficiency

0~+5W

Power Output Tolerance

Electrical Properties | STC*

Testing Condition	Front Side	Front Side	Front Side	Front Side
Peak Power (Pmax) (W)	400	405	410	415
MPP Voltage (Vmp) (V)	31.1	31.3	31.5	31.7
MPP Current (Imp) (A)	12.87	12.95	13.02	13.10
Open Circuit Voltage (Voc) (V)	37.1	37.3	37.5	37.7
Short Circuit Current (Isc) (A)	13.67	13.75	13.82	13.90
Module Efficiency (%)	20.41	20.67	20.92	21.18

*STC: Irradiance 1000 W/m², Cell Temperature 25°C, AM1.5
The data above is for reference only and the actual data is in accordance with the practical testing
Power Measurement Tolerance ±3%

Electrical Properties | NOCT*

Testing Condition	Front Side	Front Side	Front Side	Front Side
Peak Power (Pmax) (W)	303	307	311	315
MPP Voltage (Vmp) (V)	29.2	29.4	29.6	29.8
MPP Current (Imp) (A)	10.38	10.44	10.50	10.56
Open Circuit Voltage (Voc) (V)	35.5	35.7	35.8	36.0
Short Circuit Current (Isc) (A)	11.02	11.09	11.14	11.20

*NOCT: Irradiance 800 W/m², Ambient Temperature 20°C, Wind Speed 1 m/s

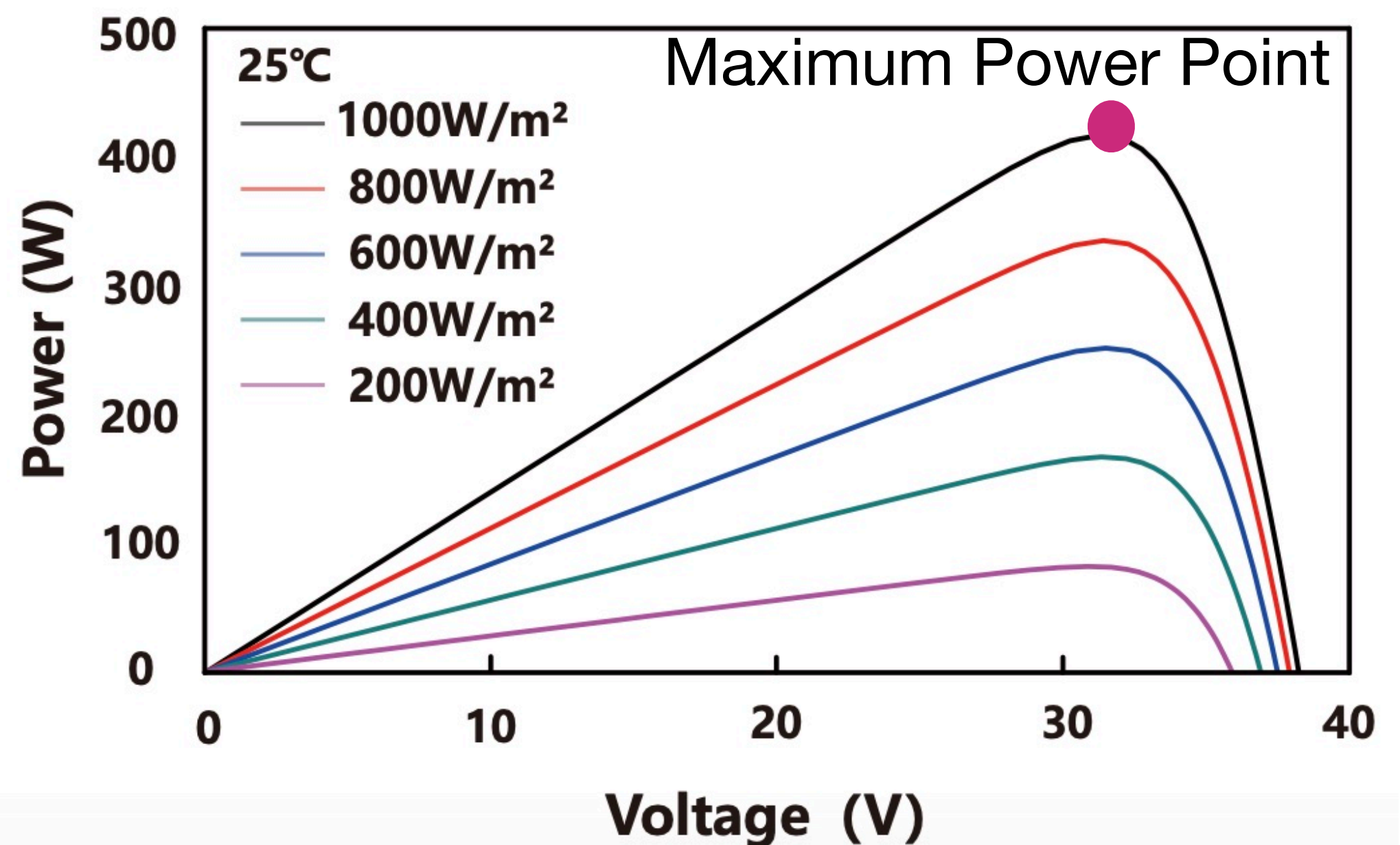
Operating Properties

Operating Temperature (°C)	-40°C~+85°C
Maximum System Voltage (V)	1500V DC (IEC)
Maximum Series Fuse Rating (A)	30
Power Tolerance	0~+5W
Bifaciality*	80%

*Bifaciality = $P_{maxrear} (STC) / P_{maxfront} (STC)$, Bifaciality tolerance: ±5%

With Different Power Generation Gain

Power Gain (%)	Peak Power (Pmax) (W)	MPP Voltage (Vmp) (V)
10	448	31.7
15	465	31.7
20	481	31.7
25	498	31.7
30	515	31.8



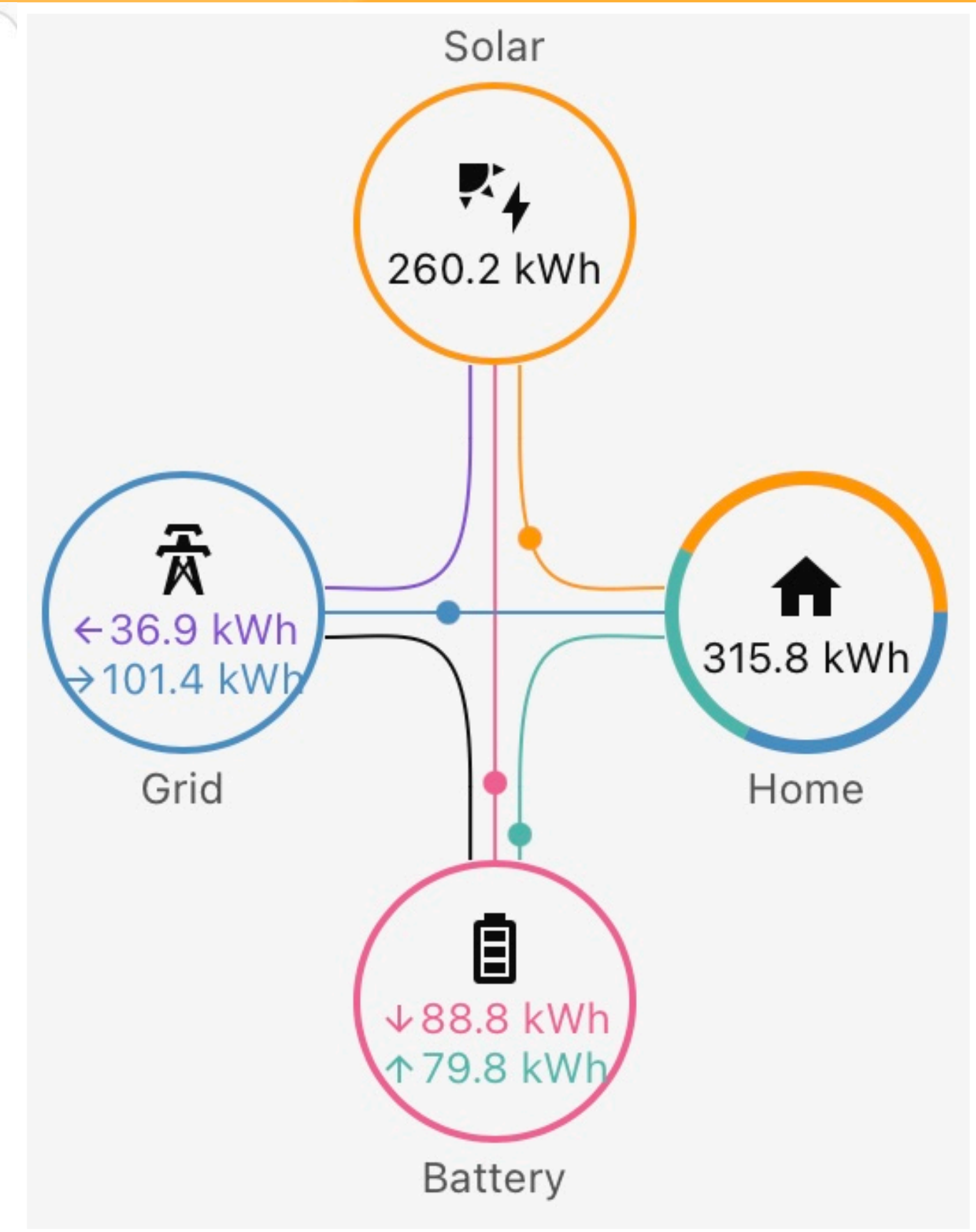
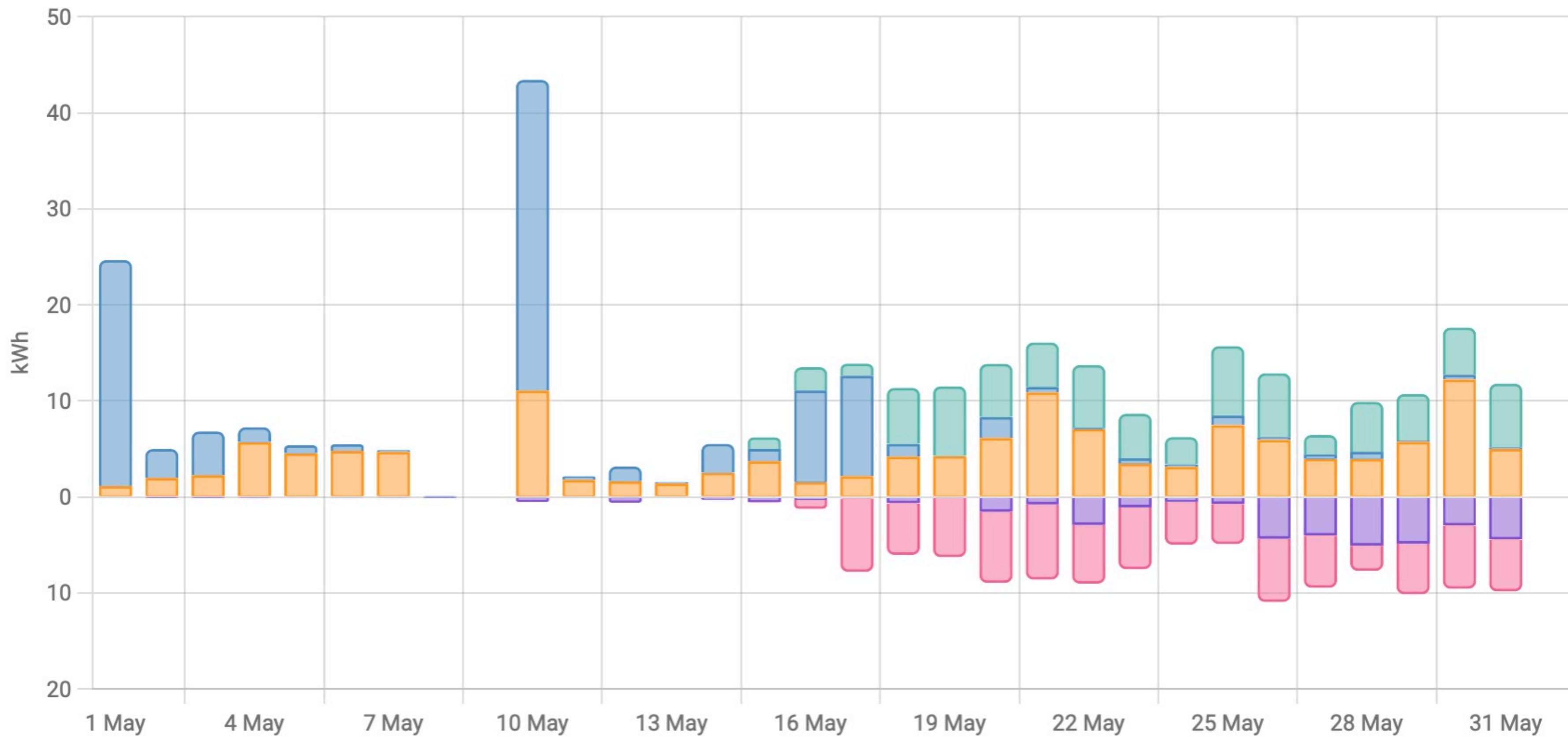
Technik

- Überspannungsschutz
- MPPT Charger 150V / 45A
- MPPT Charger 100V / 20A
- Victron Cerbo GX (ARM Rechner)
- Multiplus II 48/5000/70
- DIY 14,3 KWh LiFePo4 Akku



Mai 2023

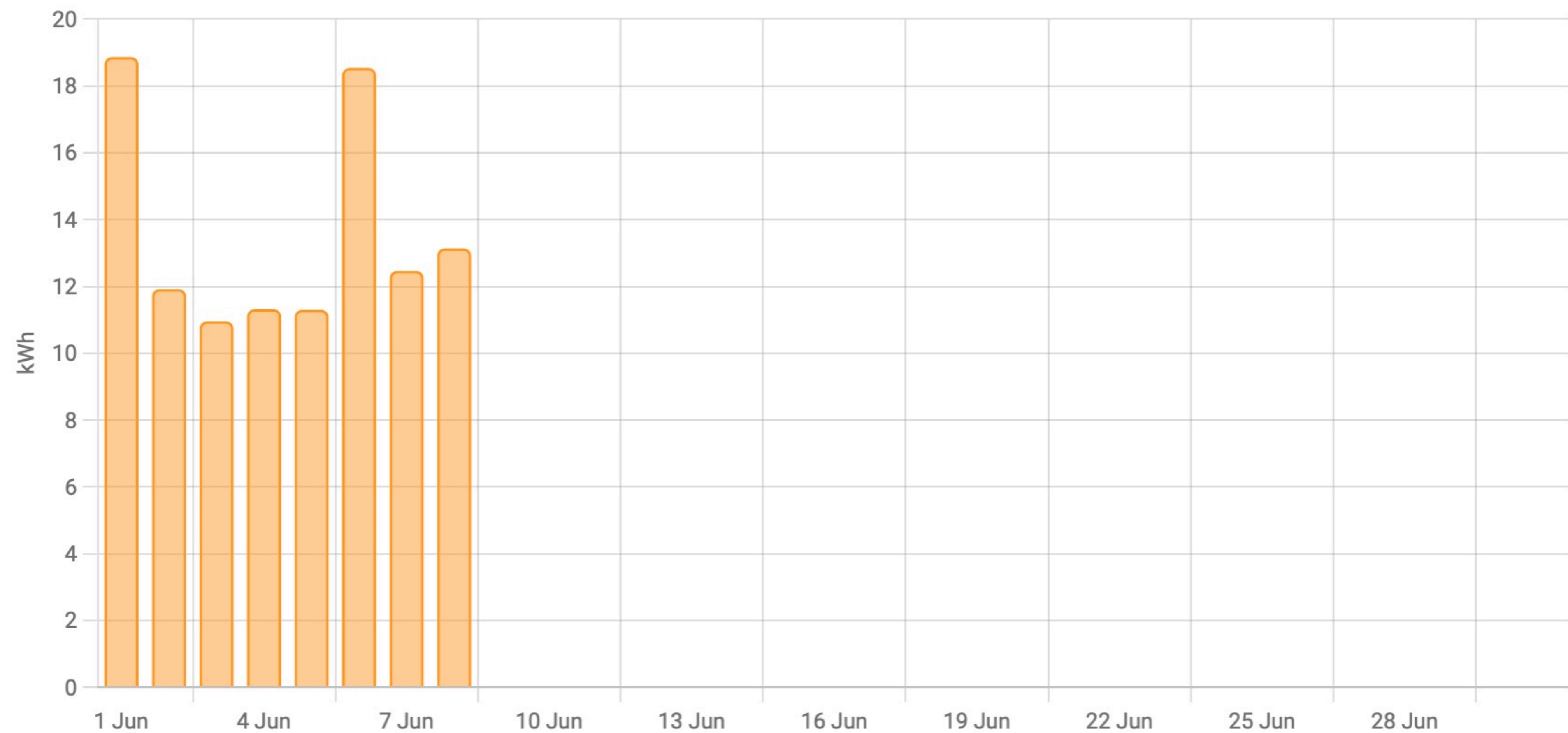
Energy usage



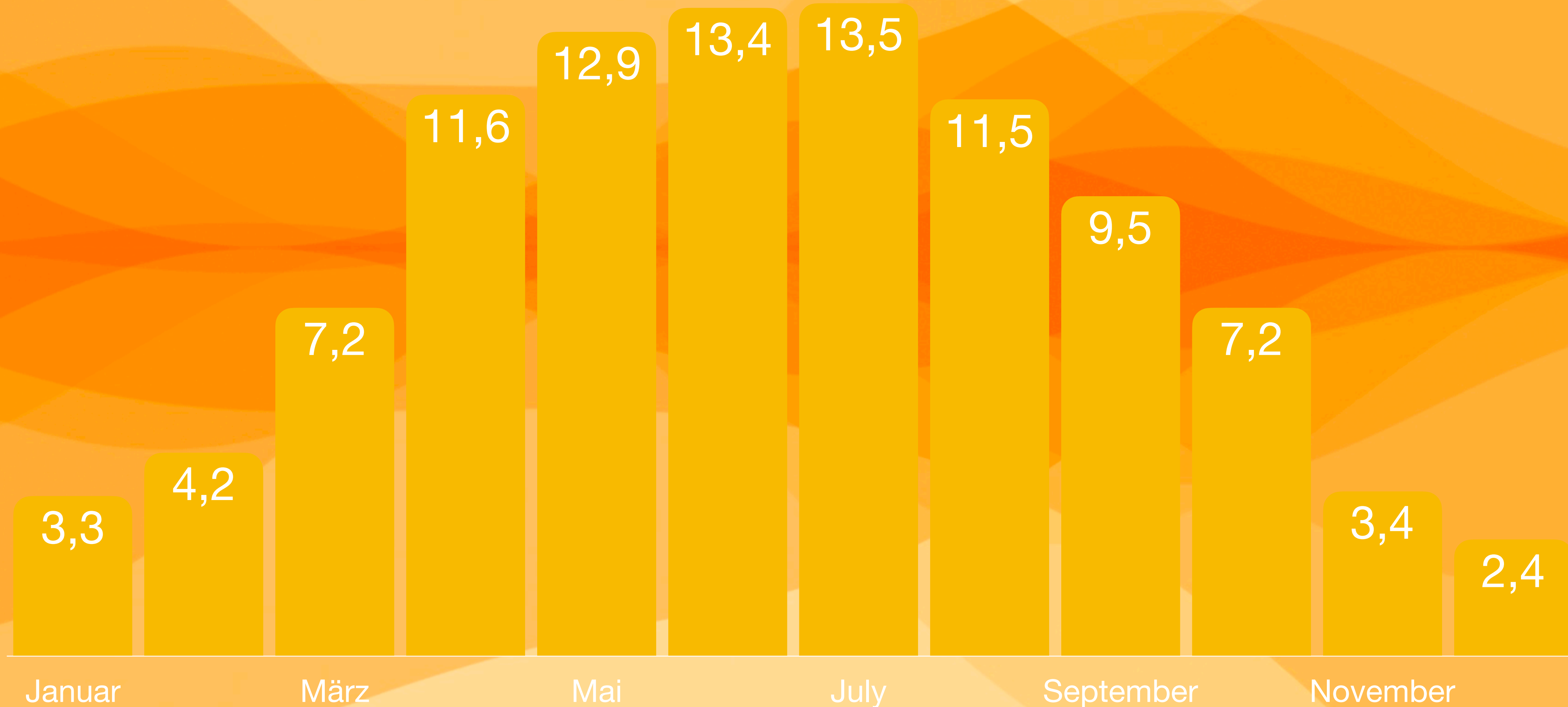
∅ 9 kWh / Tag

Juni 2023

Solar production



Ertrag übers Jahr in %







**Komm auf die helle
Seite der Energie**

Quellen

- [MSTE] <https://www.mste-solar.de/photovoltaik/>
- [AC] <https://www.ac-solartechnik.de/uploads/pics/einstrahlungskarte.jpg>