Flexinet - Hybrid Energy Storage

Hybrid Energy Storage by Sea salt Batteries with a Lithium battery and with a new CO2-free heating system

Gerrit Miedema, Dr Ten:

Hybrids at Dr Ten…

- Hybrid Lithium-Sea-Salt battery - cleaner / effective electricity storage by 2 batteries…
- Hybrid e-agam-seasalt battery - e-agam + green electricity and sea salt batteries…
- Hybrid e-Agam - water as CO2-free heating fuel + saltwater as low-cost e-to-heat battery….

R&D Demoproducts at Dr Ten…

vandaag

Seasalt battery-supercap
Storing solar / grid energy

Agam Air Heater
Water as CO2 free fuel..
Salt water as e-to-heat battery
Clean water from air…

Ammonia fuel cell
Electricity from Ammonia-Water

Enolate Fuel Cell
H2/Electricity from CO2/H2 or Gas…

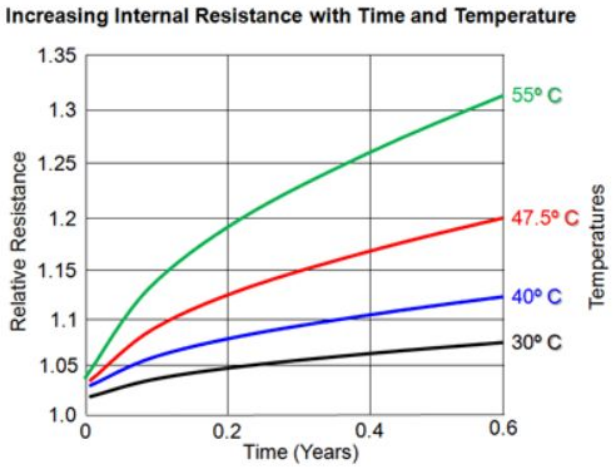
Dr Ten

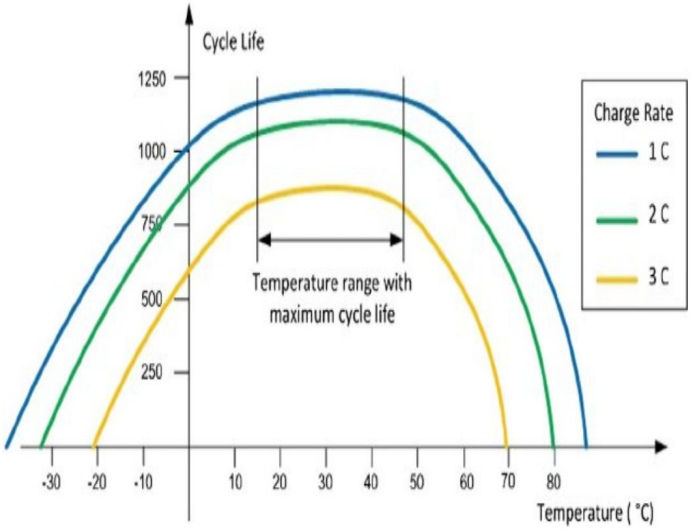
Hybrid battery– why?

Is Lithium an optimum solution? Yes and No….

- Use between 0 C till +40 C…..
- Limited number of life cycles.
- Damaged if too empty or too full.
- Difficult to recycle / limited lithium resources.
- Requires complex external electronics.
- Poor coupling of solar/peaks voltage to highly regulated lithium…
- Still it has relatively high power and it is a leader in the field…
- Prices are rising….

Lithium - limited outside use and prices





no battery yet in ground

1000% price rise…

Dr Ten

Hybrid battery- why?

Is the Current Sea-Salt battery the optimum solution?

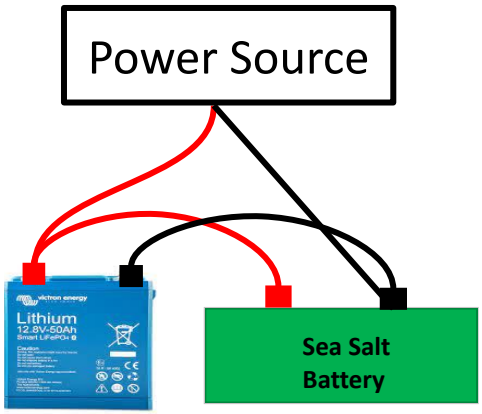
- Yes when
  - using outside in peak shaving / solar conditions
  - using in 2-20 hour or minute/second mode
  - when life span is needed
  - still smaller systems needed
  - when recyclable, abundant green resources needed.
  - when simple direct solar charging is needed.
- Not yet
  - when low cost is needed
  - when long high discharge power is needed
  - when small volume or low weight

So for now still market leader lithium and new seasalt may better conquer some markets together…But how….

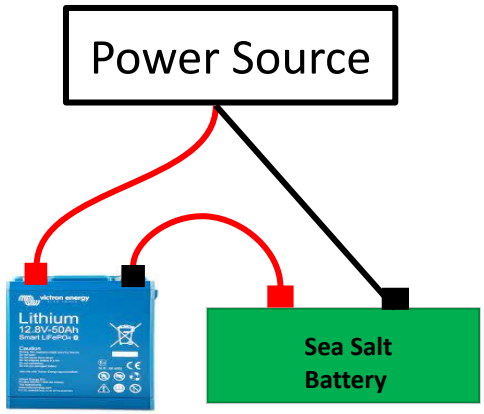
Hybrid battery – How?

How do we integrate the batteries into one optimal solution?

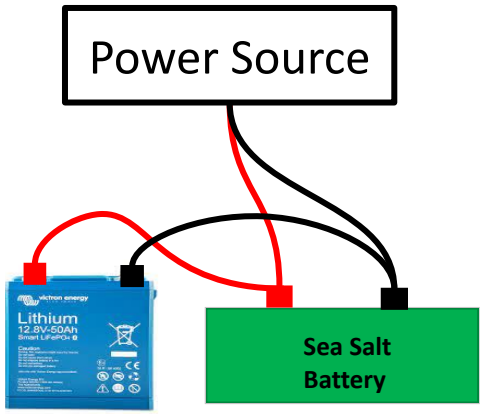
- Parallel connection
- Series connection
- Split Connection



Parallel



Series



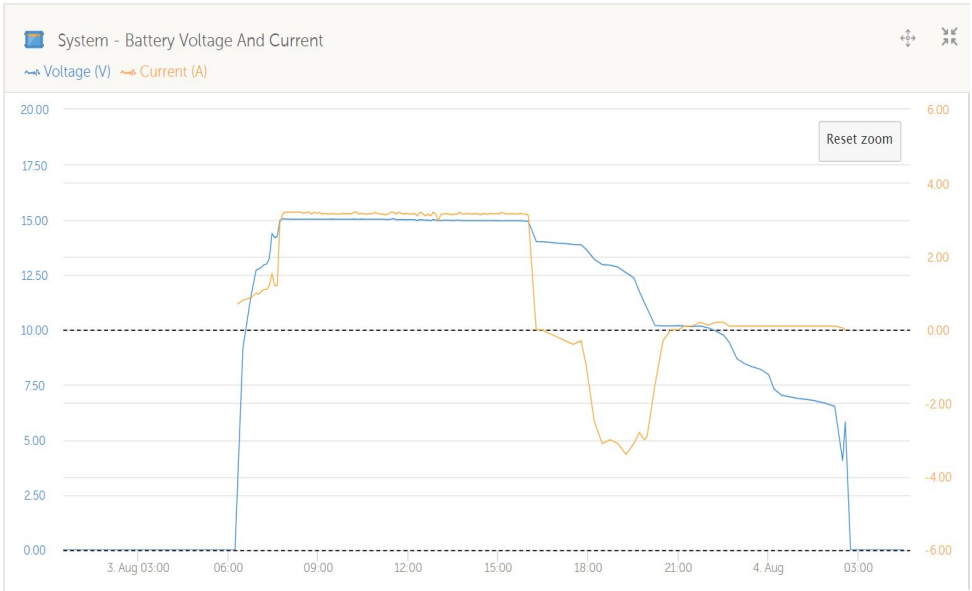
Split

Scale up

Solar PV / Lit / Sea-Salt batteries have different operating voltages…
Challenge is to make the Lithium battery co-act as BMS system for the seasalt battery

Cleversolarpower.com

Percentage (SOC)	1 Cell	12V	24V	48V
100% Charging	3.65	14.6	29.2	58.4
100% Rest	3.40	13.6	27.2	54.4
90%	3.35	13.4	26.8	53.6
80%	3.32	13.3	26.6	53.1
70%	3.30	13.2	26.4	52.8
60%	3.27	13.1	26.1	52.3
50%	3.26	13.0	26.1	52.2
40%	3.25	13.0	26.0	52.0
30%	3.22	12.9	25.8	51.5
20%	3.20	12.8	25.6	51.2
10%	3.00	12.0	24.0	48.0
0%	2.50	10.0	20.0	40.0



R&D showed that parallel connection is not possible….

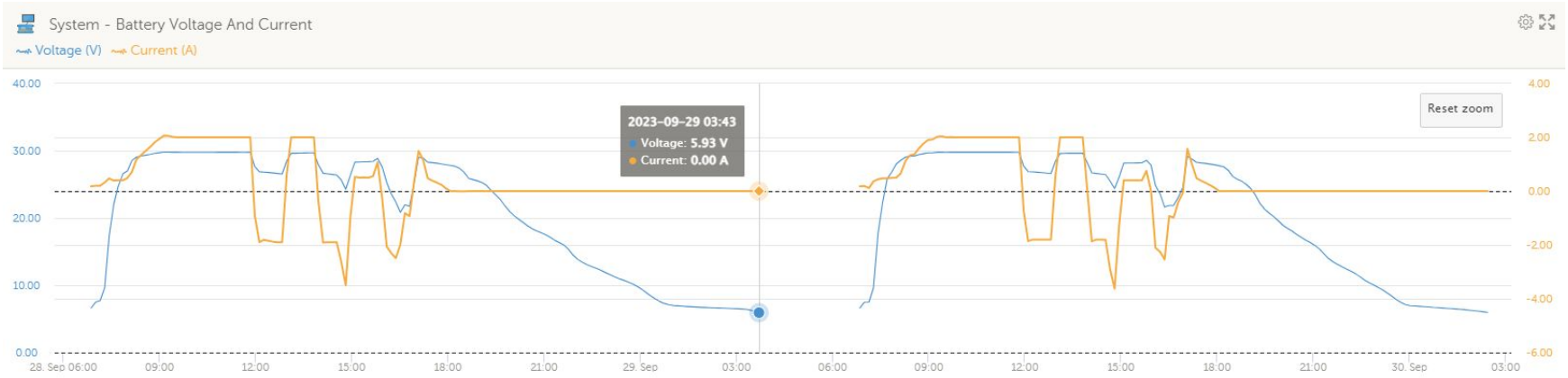
R&D showed seasalt is about 5-6V below PV (0-35 V) in active use

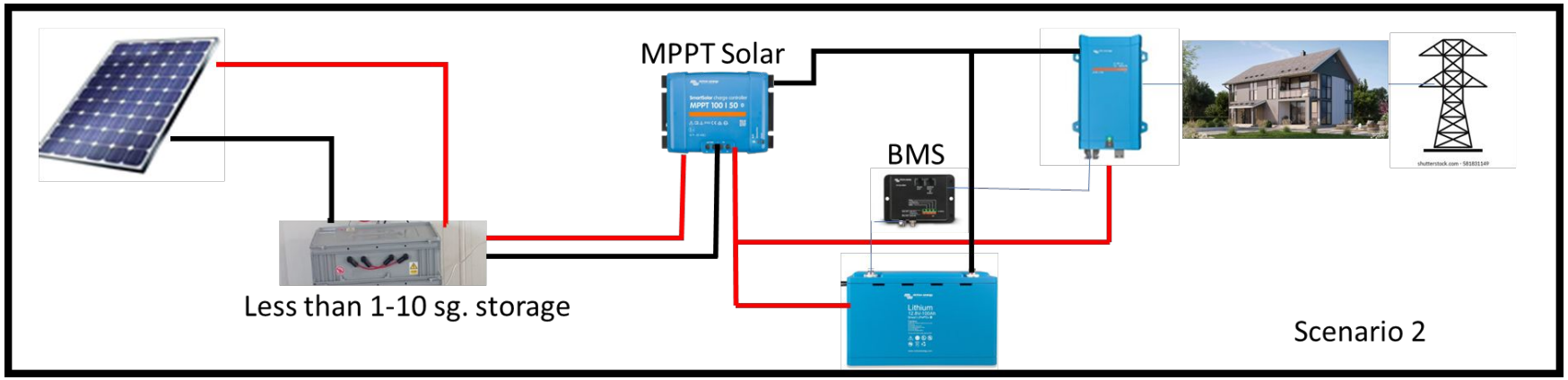
R&D showed that lithium may be charged after the hot solar moment when seasalt is full but system should be validated in tests..

Dr Ten

Scale up

Sesalt battery can be charged directly stable from PV feeding a load…





Dr Ten

Series Connection

We connected a Sea-Salt and Lithium battery in Series.

12.8V LiFePO4
560Wh 50Ah

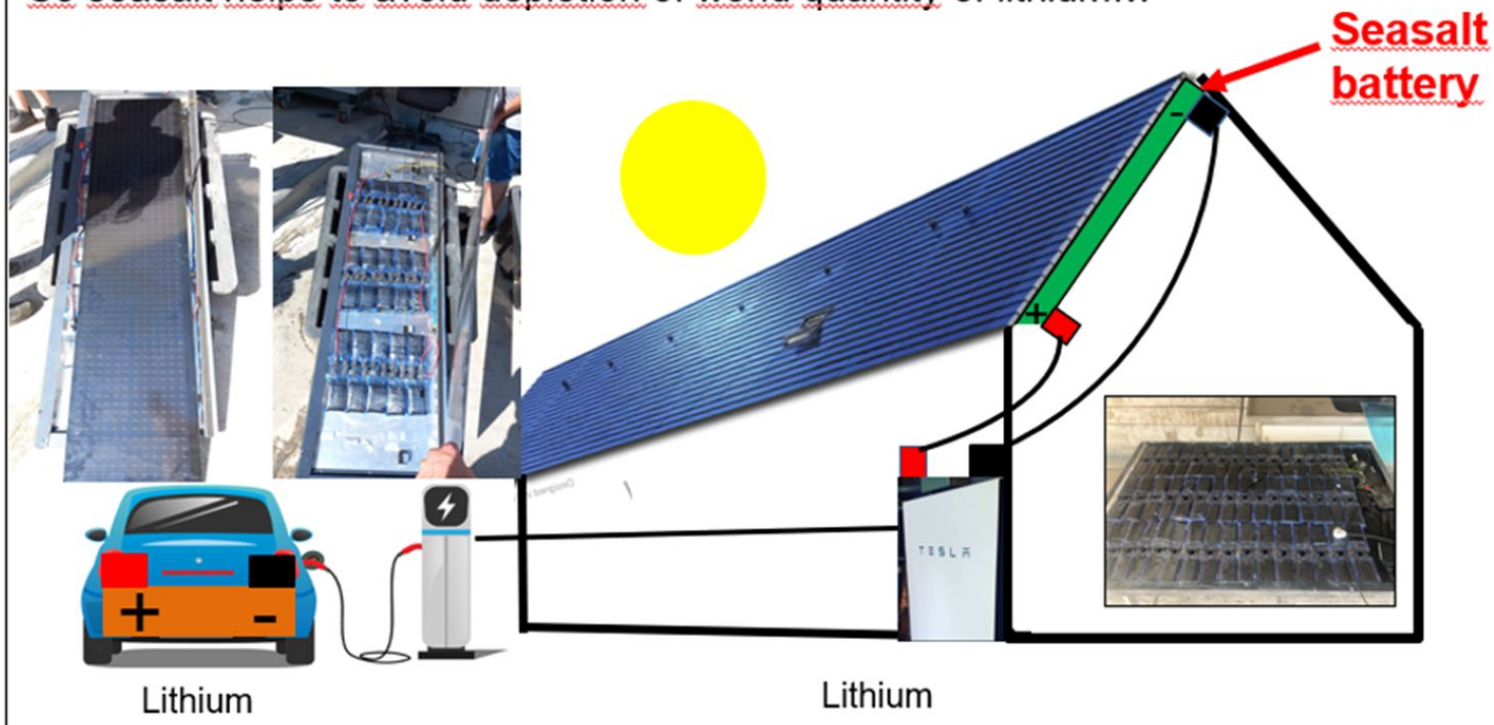
Hybrid battery in series

2 X 12V Sea Salt Batteries in Parallel
ca. 400Wh 40Ah

Scale up seen….

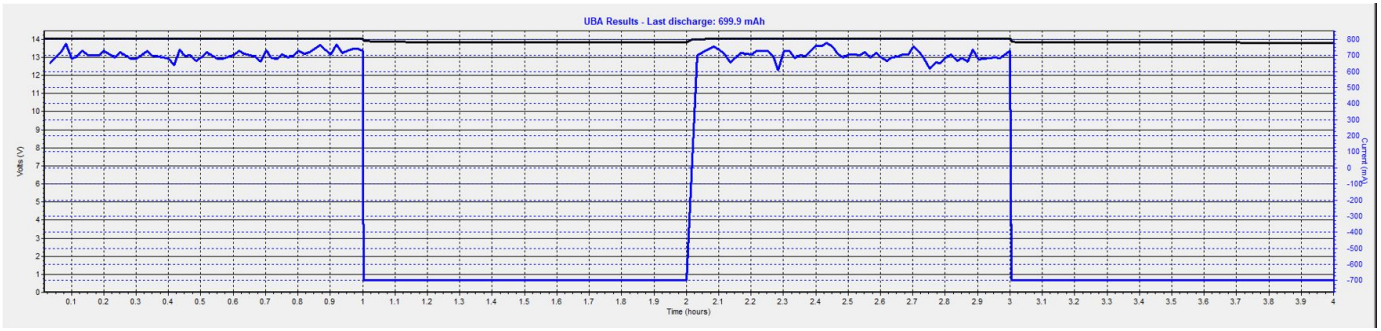
Rooftop hybrid solar-seasalt-lithium pilot

Seasalt battery only green battery able to handle ambient temperatures.
So pilot may makes lithium batteries live longer, greener, cheaper, act outdoor
So seasalt helps to avoid depletion of world quantity of lithium…

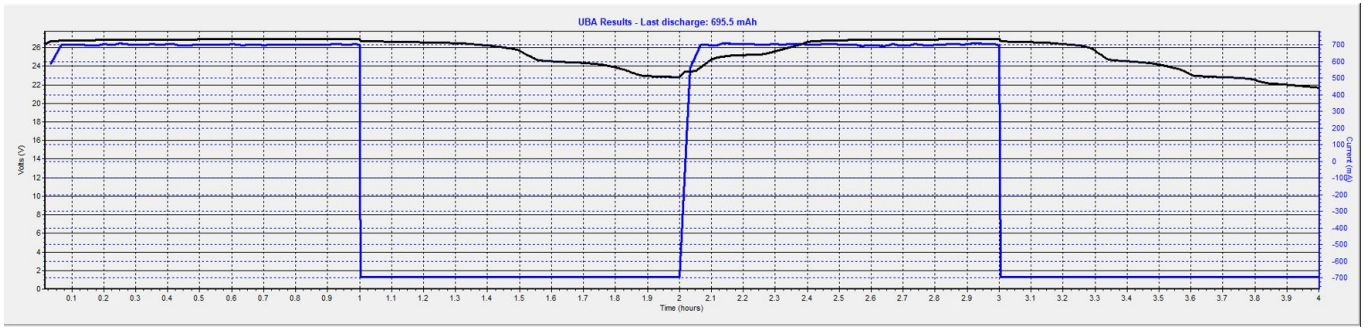


Sea-Salt vs. Hybrid

Sea-Salt:



Hybrid:

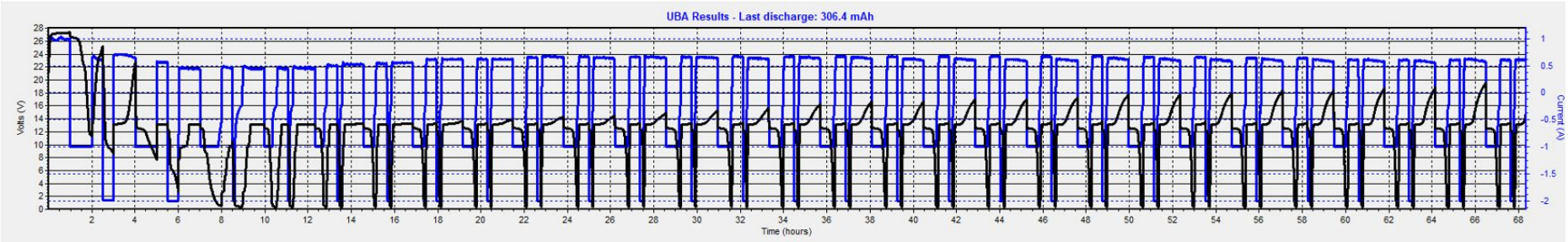


pre-charged box at ~97% power efficiency. Hybrid up to 95%.
Proof of principle done but….

Hybrid – Multiple Cycles

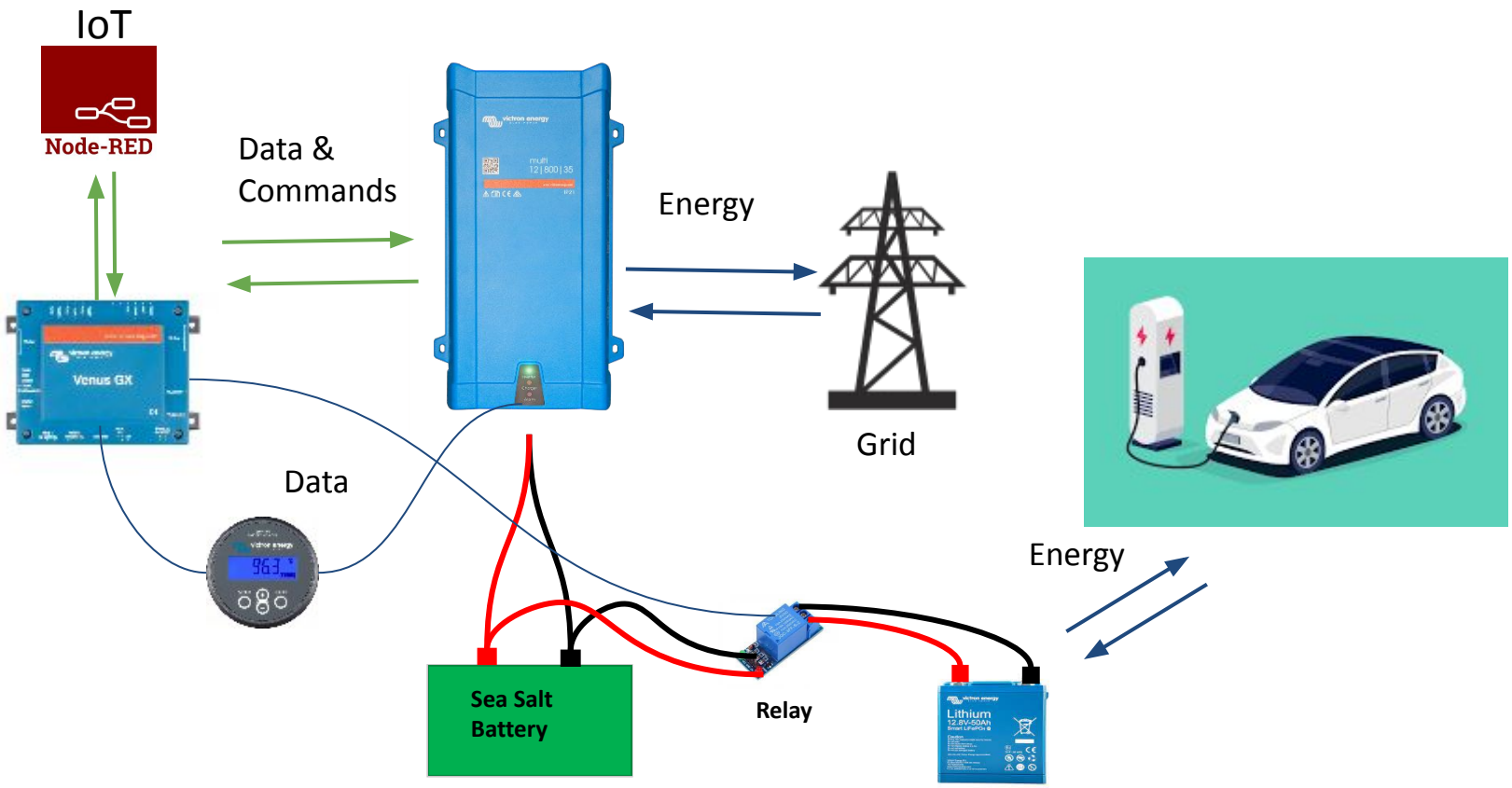
First Results:

- The Sea-Salt and LiFePO4 discharge at different rates.
- The Sea-Salt has higher resistance when empty then the LiFePO4.
- Only LiFePO4 gets charged when the Sea-Salt is empty.
- LiFePO4 is high power. If the Power source is low power it has difficulty charging the LiFePO4.



Conclusion: first systems should focus on time sequential, serial, solar connected systems with typically powerwall/charge e-carsystem alike lithium applications

A Possible Solution – Split Connection



Hybrid Pilot evaluation at Green Village…

Battery in ground - wireless charging of lithium battery using solar panel with seasalt battery in the ground

New Water fuel heating system…

Dr Ten….

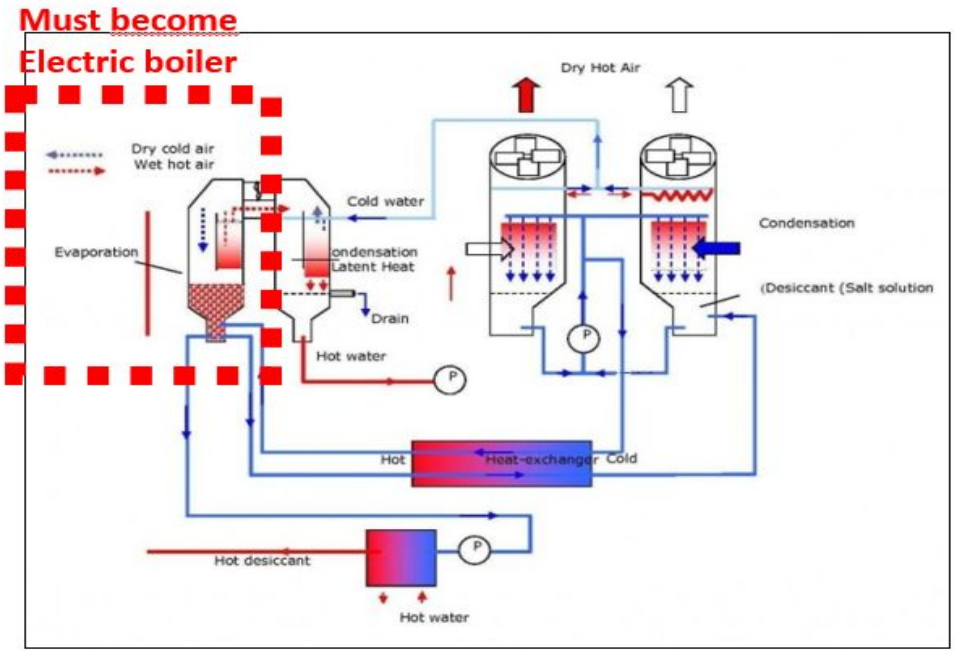
- Aims to set full next e-system….
- Aims to add seasalt battery
- Aims to proof that a new e-to-heat battery using water as fuel and salt water as storage vessel is possible..

A new product….

- Using air/water as the new fuel….
- Saving 50% gas in greenhouses
- Saving lots of CO2…
- Cleaning your air…

The e-Agam.....

We need also Agam condenser
but we like to add an electric boiler



The e-agam – a fully electric vapour heater

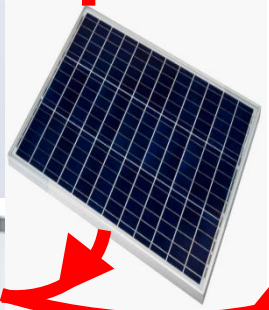
Seasalt battery

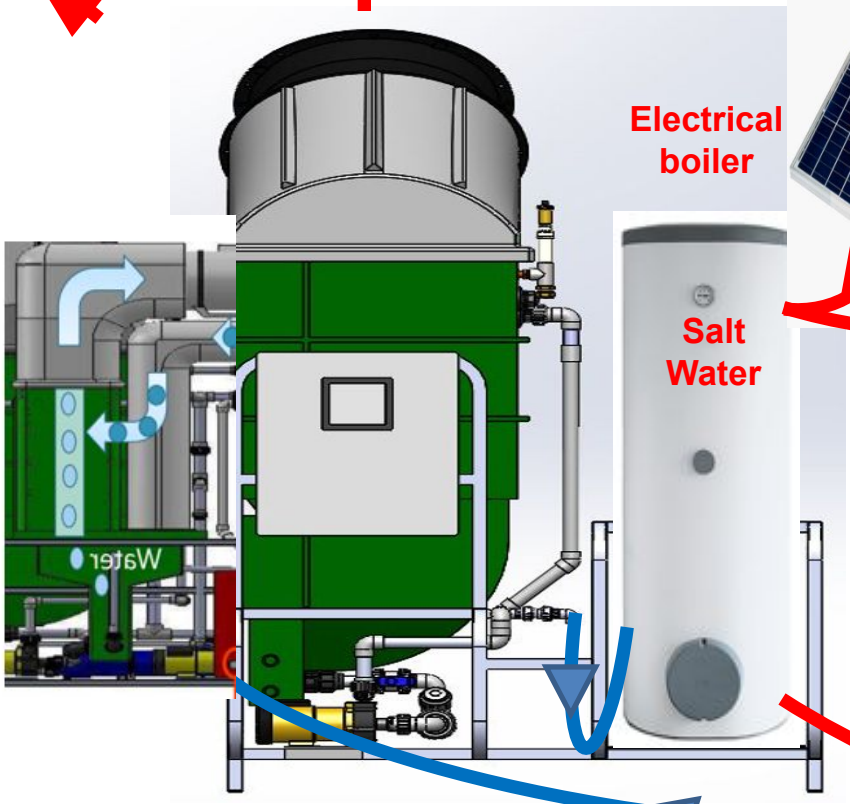
Grid energy

a/w a/a heat pump

Warm air

Sun-PV





Electrical boiler

Salt Water

Salt water buffer

Next integrated e-to-heat-battery with PCM/heatpump/battery…

Progress Hybrid Agam

- Simulation Agam energy balance finished
- Simplified mass-energy balance finished
- Next corrosion free titanium heating coil identified
- Evaluation with Borg as storage vessel done
- Integration Agam - next smart e-boiler started - system tests expected begin 2024
- Integration Agam - seasalt battery hybrid started, system tests expected in April 2024

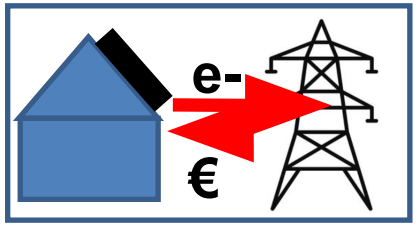
The new homes…

Lots of homes now

- Gasoline car
- No PV
- Without heat pump
- With gas heating

Sustainable home now

- receive money from PV
- With e-car
- With PV
- With w/w heat pump



Sustainable Home Soon

- No netting
- e-car / bidirectional charging
- Heat storage/source
- With a/w heat pump
- Home battery

Thank You!