EPISODE 8

Solid oxide: The Specialist of electrolysis

The most efficient electrolyser.
Also the most demanding.

THE EDGE | THE HEAT | THE FIT

Where its edge comes from, what 700–900 °C costs you, and where solid oxide actually makes sense.

THE WHOLE EPISODE IN THREE NUMBERS

The specialist, not the all-rounder

37–42
kWh per kg H_2

The lowest of all four technologies — alkaline and PEM need ~53–63. But only with heat or steam supplied.

700–900 °C
operating temperature

Alkaline and PEM run below 100 °C. The source of the edge — and of almost every challenge.

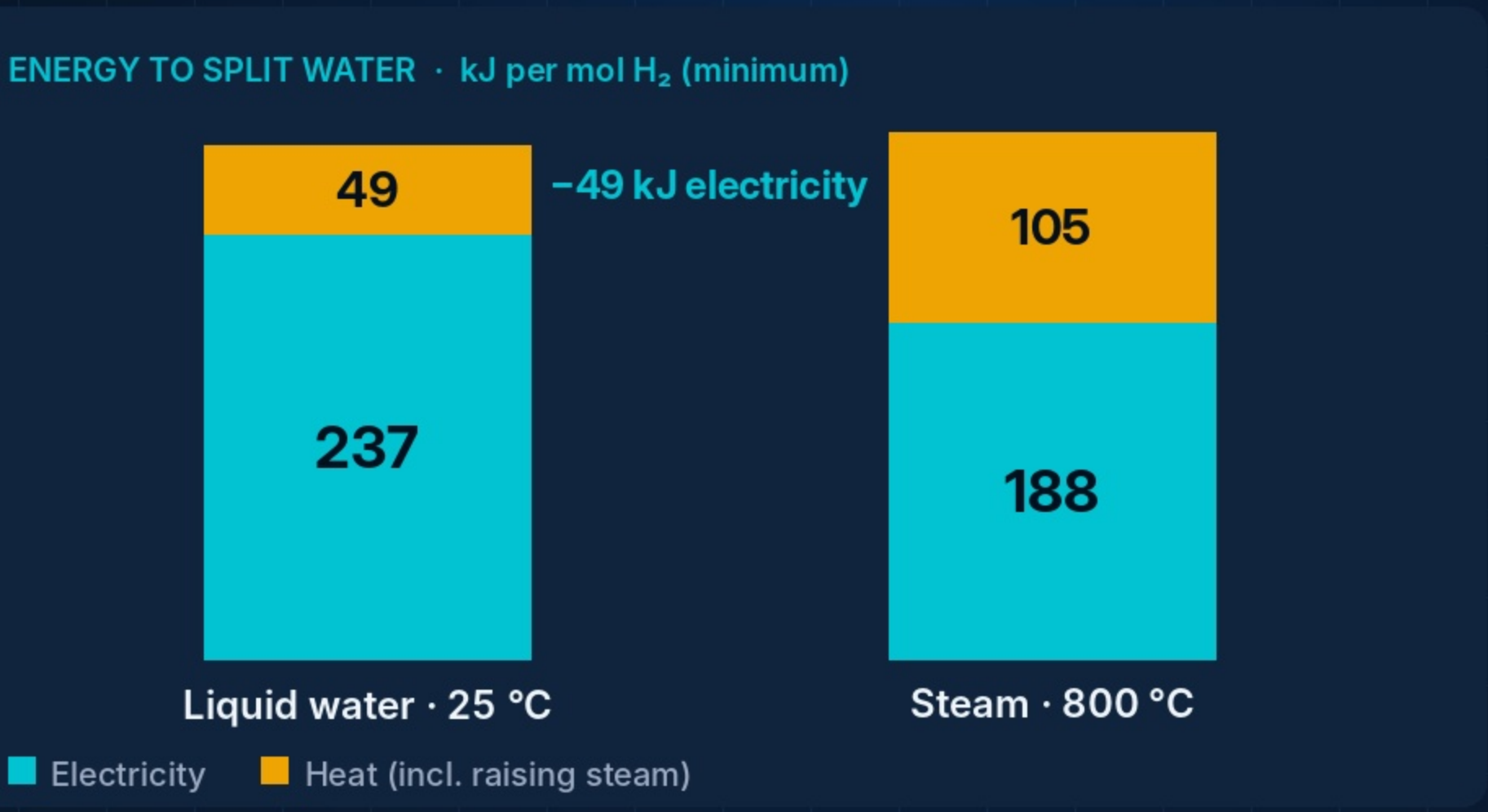
~3%
of installed capacity, 2024

Proven technology, but still a niche.

Solid oxide lets heat do part of the work of electricity.

THE EDGE · WHERE THE EFFICIENCY COMES FROM

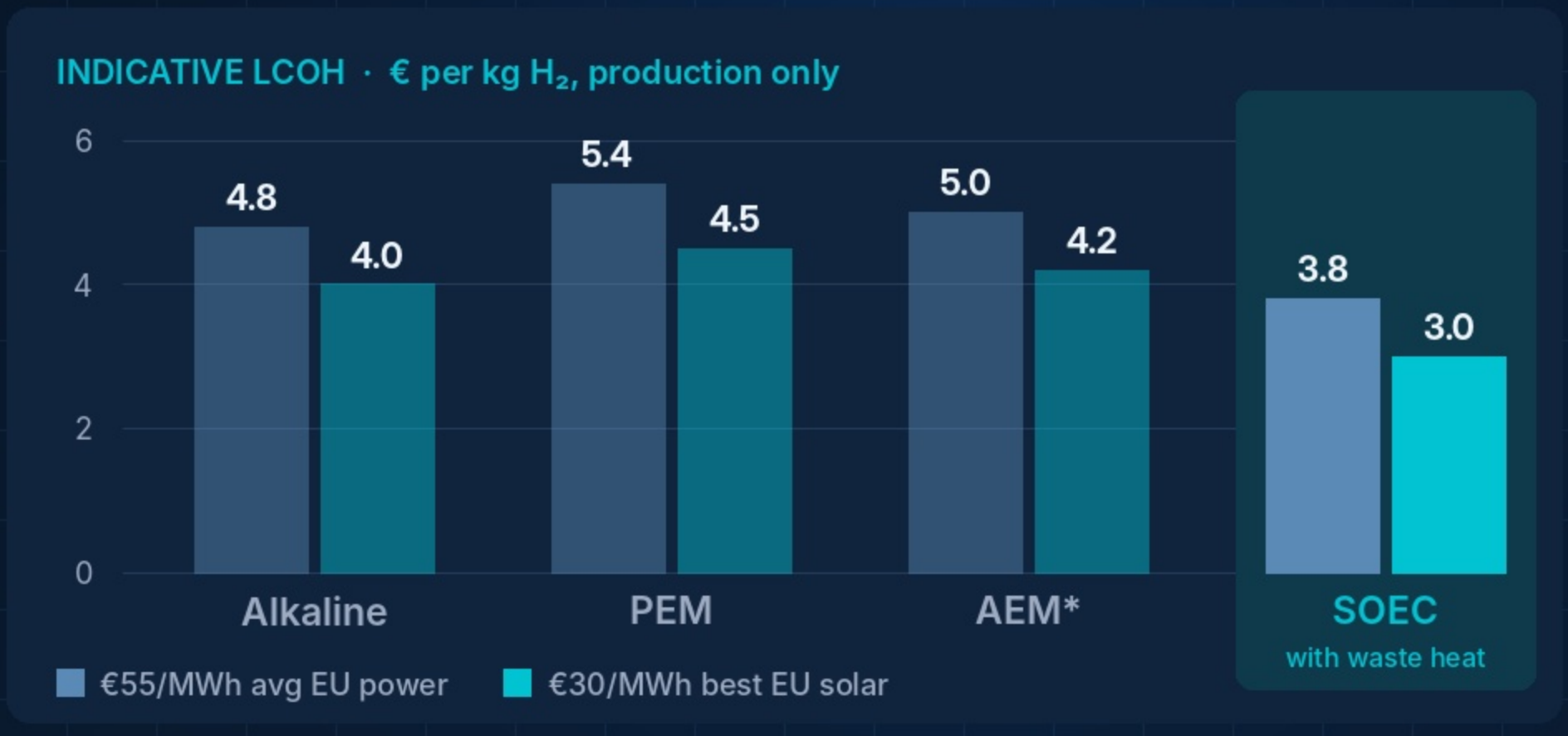
At 800 °C, heat pays part of the bill



Lower cell voltage (~1.3 V vs 1.8–2.0 V), and heat is cheaper than power — waste heat can be almost free. Net effect: ~37–42 kWh/kg instead of ~53–63.

THE EDGE · IN EUROS

The priciest stack can make the cheapest hydrogen



Yet the system costs €1,700–4,300/kW

vs €700–1,050/kW for alkaline.

Power is most of the cost of every kilo — so saving power beats the extra CAPEX, if the plant runs many hours.

*AEM indicative (TRL 5–7)

THE OTHER SIDE OF THE FLIP

No heat, no edge.

With waste heat	Lowest cost of the four
Without waste heat	Most expensive of the four

Same stack.
Same efficiency on paper.
Different site.

That is what “specialist” really means.

THE HEAT · WHAT 700–900 °C DOES TO A STACK

Four real engineering challenges

1 Thermal cycling & start-up

A cold start takes hours; every heat-up stresses ceramics and seals. Plants keep stacks in hot standby.

2 Degradation

Stack life 20–40k hours. Nickel migration, oxygen-electrode delamination, chromium from interconnects.

3 Materials & sealing

Ceramics and metals expand differently. A gas-tight seal for years at 800 °C is hard materials science.

4 Hot balance of plant

Steam generators, high-temperature heat exchangers, hot boxes, drying H_2 out of steam.

None is a showstopper. All come from the same temperature as the edge.

THE FIT · THE MAP

Where solid oxide actually makes sense

Spare heat + steady power + hydrogen demand next door

01 NATURAL HOME

Refineries & biorefineries

02 NATURAL HOME

Ammonia & methanol

03 NATURAL HOME

e-fuels & e-SAF

04 CONDITIONAL

Nuclear plants

05 CONDITIONAL

Steelworks (DRI)

06 POOR FIT

Standalone wind & solar

THE FIT · BEYOND HYDROGEN

Three things only a hot electrolyser can do

THE HEAT LOOP

Synthesis steam in

Ammonia, methanol and Fischer–Tropsch release heat. Feed their steam back and the plant partly powers itself.

CO-ELECTROLYSIS

$H_2O + CO_2 \rightarrow H_2 + CO$

Syngas in one step — a direct route to e-fuels and e-SAF that low-temperature electrolysers cannot take.

REVERSIBLE

Electrolyser ↔ fuel cell

The same cell can turn hydrogen back into power. Promising for storage, still early, not yet bankable.

Design the stack and the synthesis loop as one heat system.

TWO CASES, BOTH SIDES

Physics works.
Demand sets the pace.

MULTIPLHY · NESTE ROTTERDAM

2.6 MW
12 Sunfire modules, >60 kg H_2/h, 850 °C

< 40 kWh/kg
electricity (AC) in testing

Solid oxide works inside a real refinery. Next value: long-run degradation data.

TOPSOE · HERNING

500 MW/yr
factory opened Oct 2025, €94m EU support

2026
factory hibernated, US plant dropped

The technology didn’t fail — demand didn’t arrive fast enough.

Sources: CEA-Liten/MultiPLHY 2025; Sunfire 2021; Topsoe 2025; Hydrogen Central 2026.

THE TEST

Five questions before you choose solid oxide

1. Is there reliable heat on site?
2. Will it run near-baseload?
3. Who uses the hydrogen next door?
4. Does the CAPEX still pay back?
5. Would a lender trust the stack?

Any answer “no”? Alkaline or PEM is probably the better bet.

All five with evidence? It may be your cheapest hydrogen.

THE SPECIALIST NEEDS THE RIGHT SITE

Find the heat.
Then choose the stack.

The full episode goes deeper: thermodynamics, degradation, real projects and the five-question test.

Full episode: link in comments

chadehydrogen.com

May the hydrogen be with you.



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