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powered by  
**staxera:**

Can reversible solid oxide electrolyzers improve the business case for power-to-x?

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## Company facts

### Funding

~ 25.000 kEUR equity invest and subsidies since 2010

### Partnership

Strategic partnership with Bilfinger Industrial Technologies, Total & EDF

### Team

70 employees (90% engineers & technicians, 10% business graduates)

### Patents

> 30 patent families (i.e. „process patent sunfire“ WO/2008/014854)



**BiLFINGER**

**KFW**

**ELECTRANOVA**  
CAPITAL

**idinvest**  
PARTNERS





 Origin countries of customers
  Origin countries of customers (in neg.)

- 14 countries worldwide (i.e. Germany, Russia, China, Korea, Japan)
- Ca. 1.000 SOFC units sold
- > 11.000.000 EUR revenues since 2011

VAILLANT GROUP

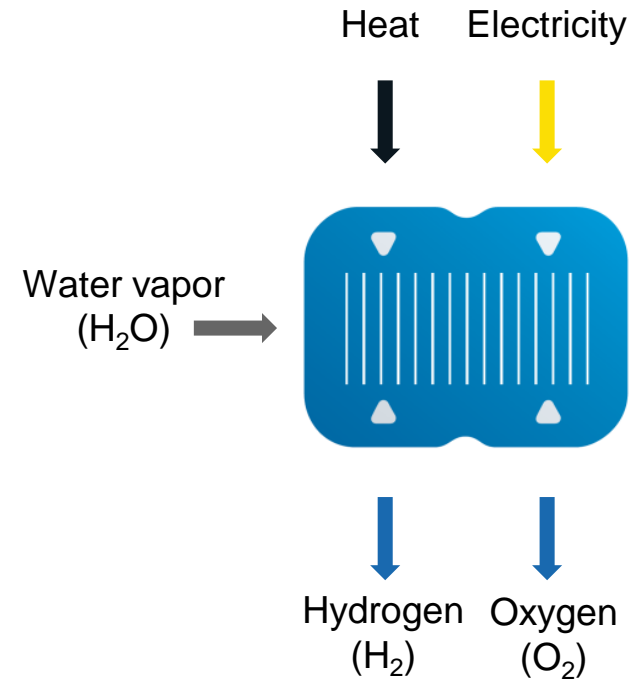
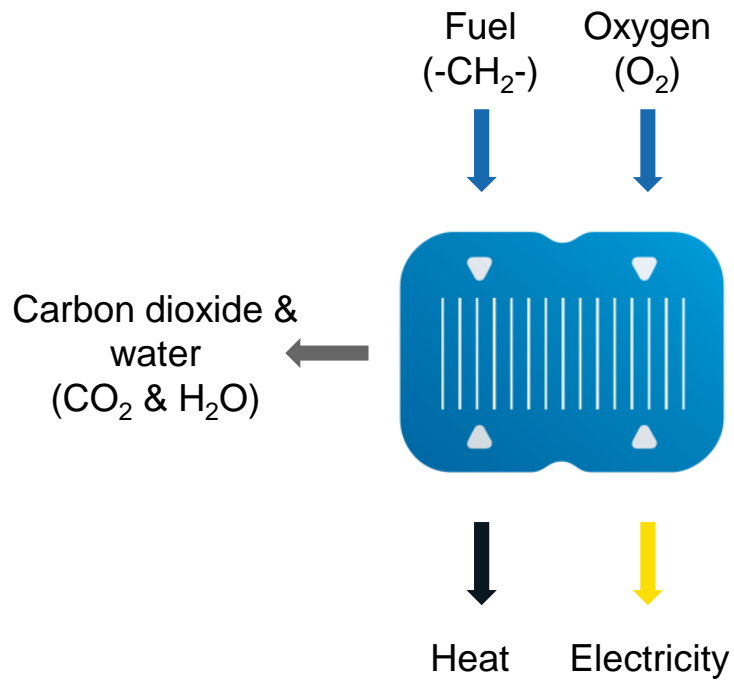
ThyssenKrupp 

Solid oxide fuel cells...

Solid oxide electrolyser cells...

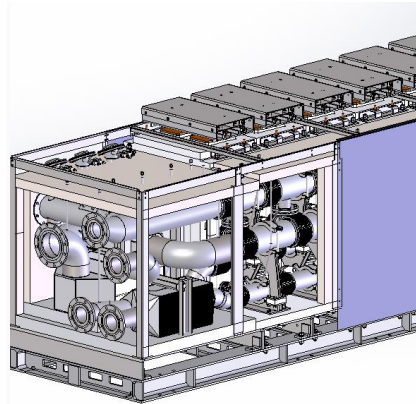
...convert chemical energy into electricity and heat

...convert electricity into hydrogen and oxygen



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# Products and projects



Power-to-Fuel  
(Diesel, Jet-A, Gasoline,  
Methane, Chemicals)



High-temperature  
fuel cell  
(SOFC)

High-temperature  
electrolyser  
(SOEC)

What's  
next...?

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## Politics: PtX in the *Energiewende*

### The *Energiewende* requires:

- storage capacity and grid stability
- renewable fuels to fulfill European fuel targets



### Today:

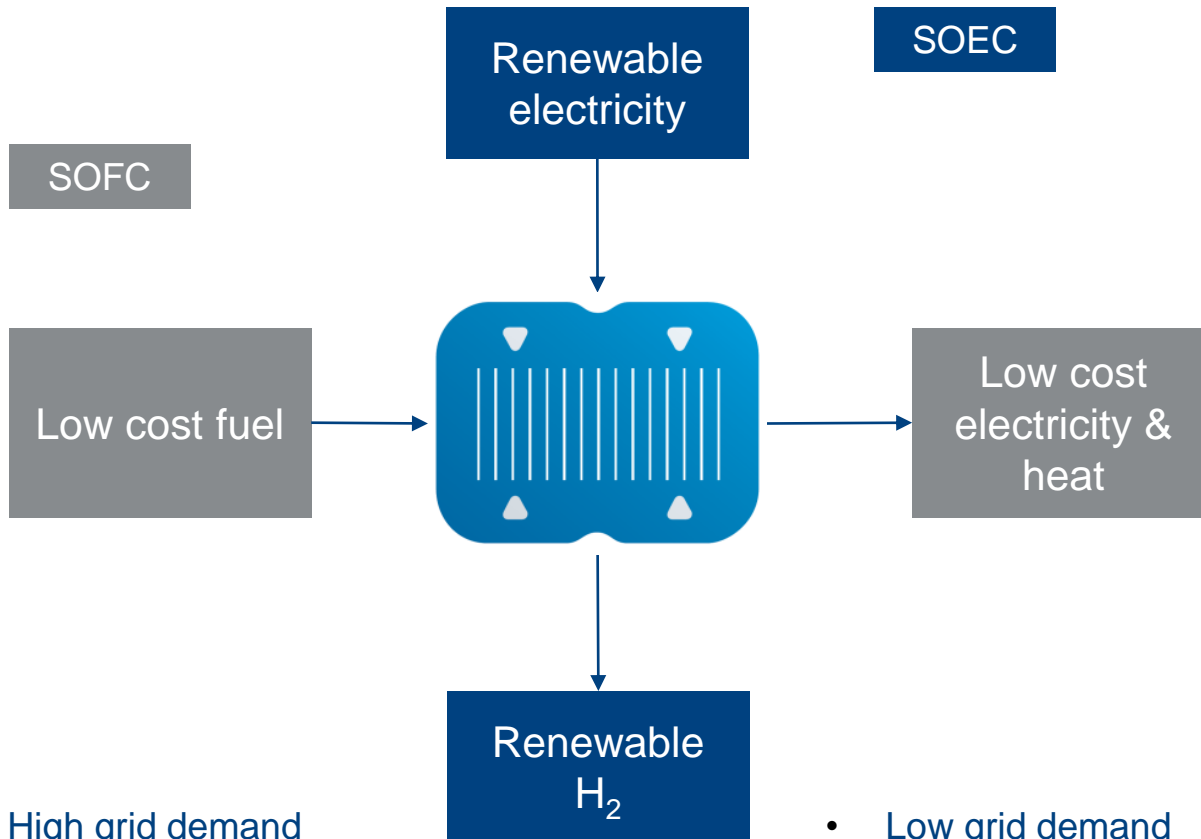
- Power-to-X could hardly operate >3,000 h/a due to high electricity prices
  - => high capex/kWh
  - => no business cases, no commercial investments

### Future:

- Could the SOC increase utilization rate by production of power during downtimes?

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# Innovation: Reversible solid oxide cells



- High grid demand
- High electricity prices (Output)
- Low gas prices (Input)

- Low grid demand
- Low electricity prices (Input)
- High fuel prices (Output)



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# Test results



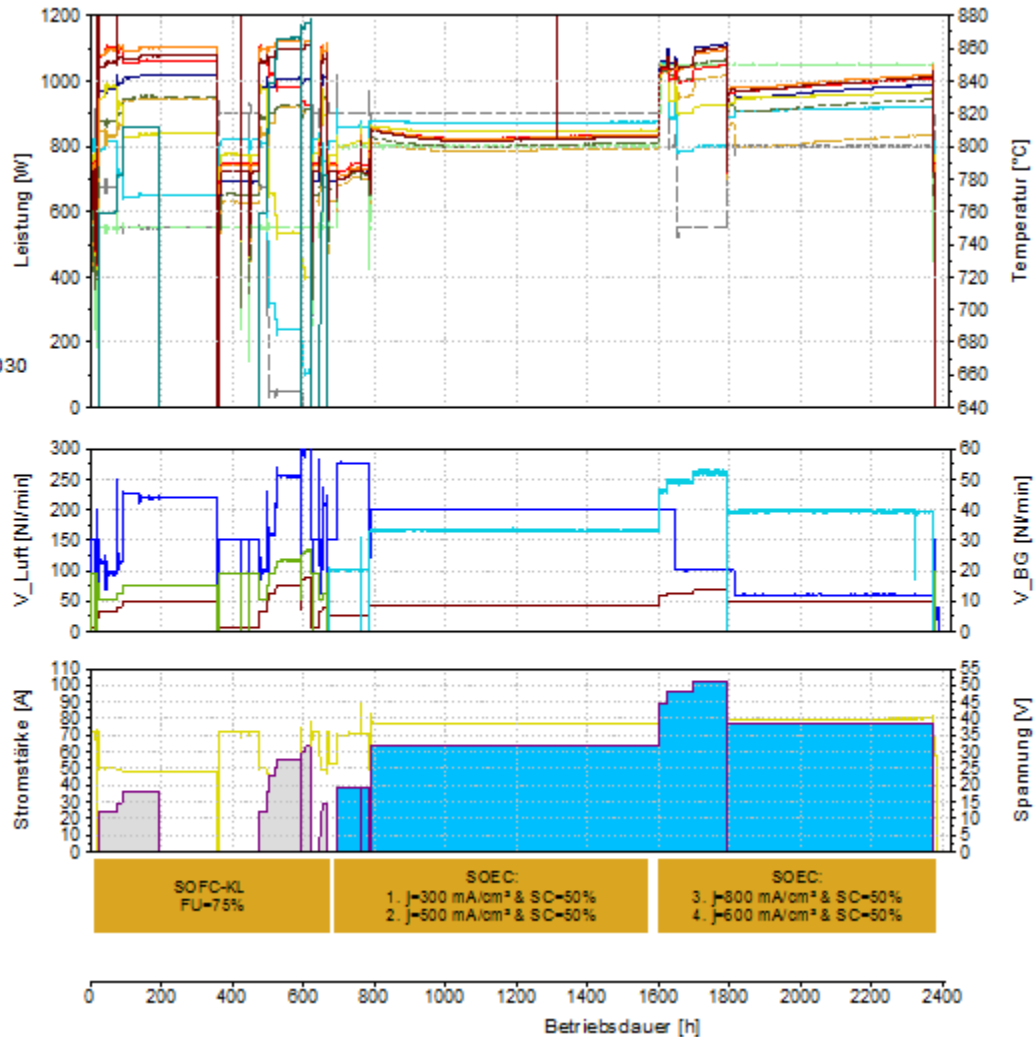
## Übersicht

t > 600°C: 2370 h  
 t(SOFC) > 5A: 340 h  
 t(SOEC) > 5A: 1874 h

Versuchsinfo:  
 2000h  
 SOEC inkl. KL SOFC und  
 SOEC

Sr.-Nr.: 3026  
 Art.-Nr.: -  
 Typ: SEC-B215-1Z-030  
 Zellfläche: 127 cm<sup>2</sup>  
 Teststand: 3.1 (FC3)  
 Bearbeiter: R. Stäber  
 erstellt: 31.03.2014

— V\_Luft\_ist  
 — V\_H2\_ist  
 — V\_N2\_ist  
 — V\_H2O(g)\_ist  
 — U\_Stack\_calc  
 — I\_Last\_ist  
 — I\_Netzteil\_ist  
 — P\_Stack\_calc  
 - - - T\_Kat\_E\_Rohr  
 — T\_Kat\_E\_E15  
 — T\_MEA\_4/4\_E16  
 — T\_Kat\_A\_E15  
 - - - T\_Kat\_A\_Rohr  
 - - - T\_An\_E\_Rohr  
 - - - T\_An\_A\_Rohr  
 — T\_MEA\_0\_4\_E14  
 — T\_MEA\_1\_2\_E16  
 — T\_MEA\_3\_4\_E13  
 — T\_MEA\_4\_4\_E15



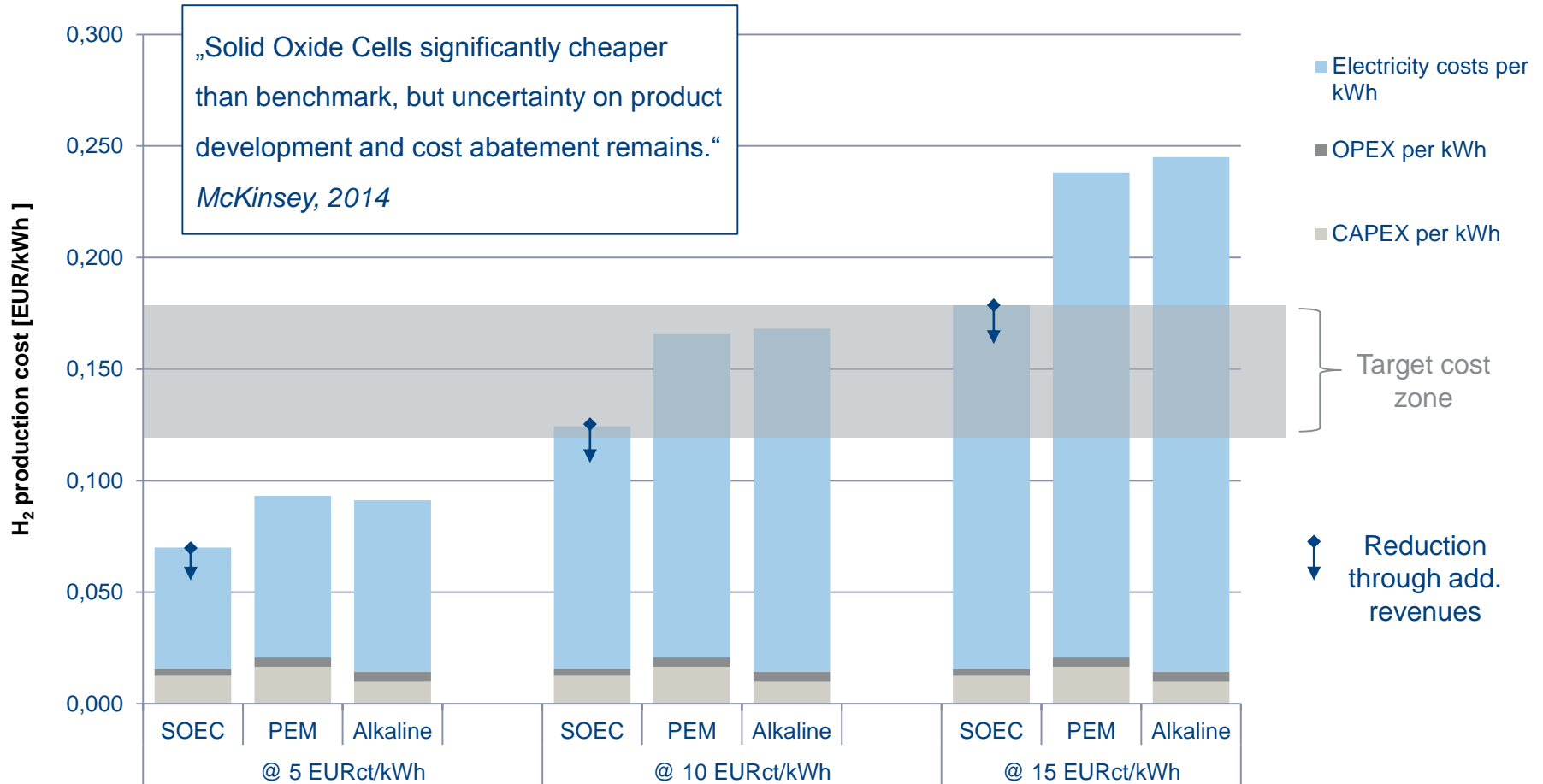
- 2,400 h of operations
- **Low cost materials:** metal, ceramics and glass
- Operation in reversible mode is **possible** (SOFC/SOEC)
- **Low degradation** of ca. 0.7%/1,000 h

✓ **Reverse SOC**





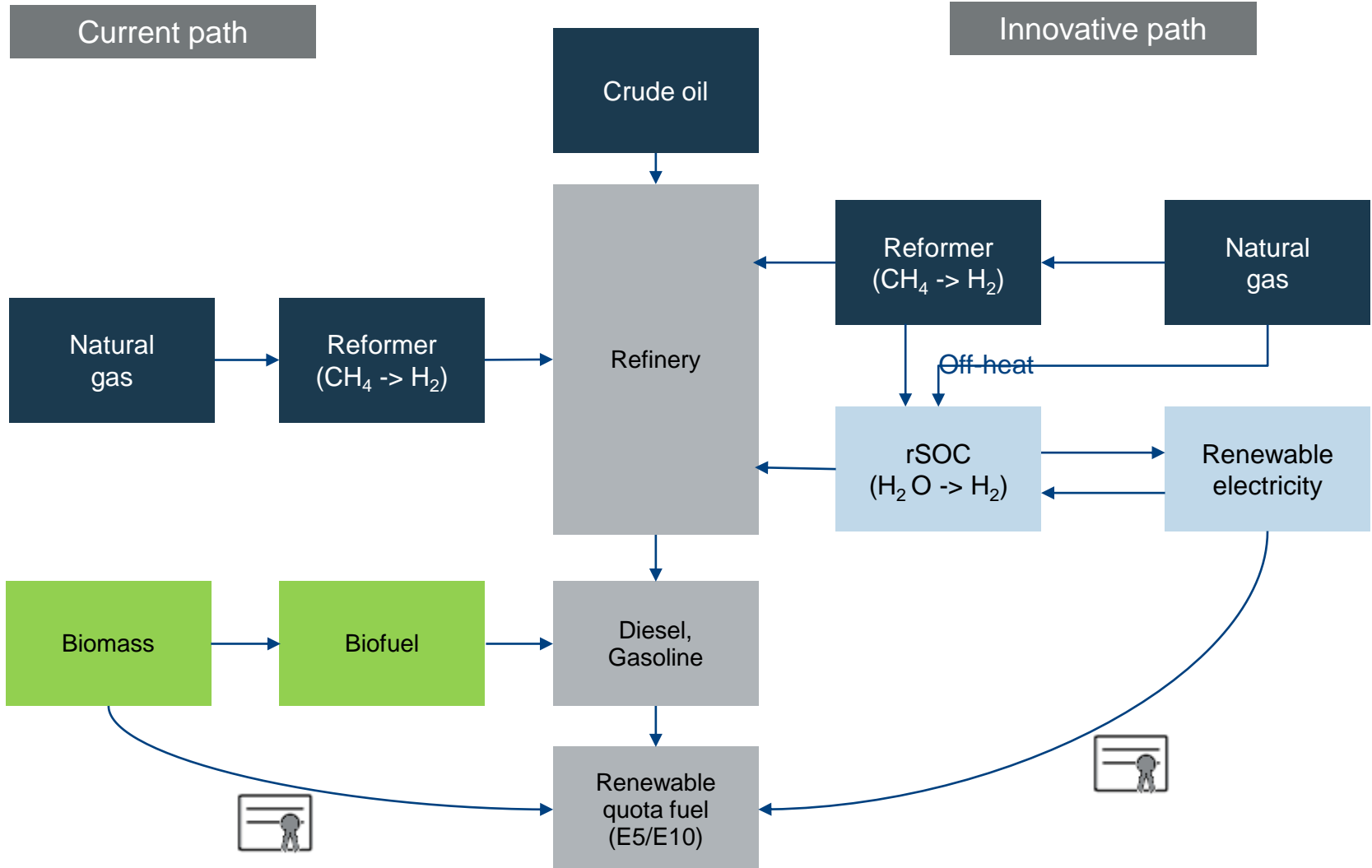
# Competition: rSOC/PEM/Alkaline



Source adapted from: Fuel Cells and Hydrogen Joint Undertaking, Study on development of water electrolysis in the EU (2014)

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# Finding profitable markets – renewable fuel quota



- sunfire's SOFC experience enables **quick development of SOEC**
- Usage of **reversible stack possible**, adding a revenue stream for Power-to-X plants
- SOEC potentially **cheapest electrolyser** technology (vs. PEM/ Alkaline)
- **Hydrogen for refineries** as low-hanging fruit to PtX market introduction
- **Demonstration projects required !**