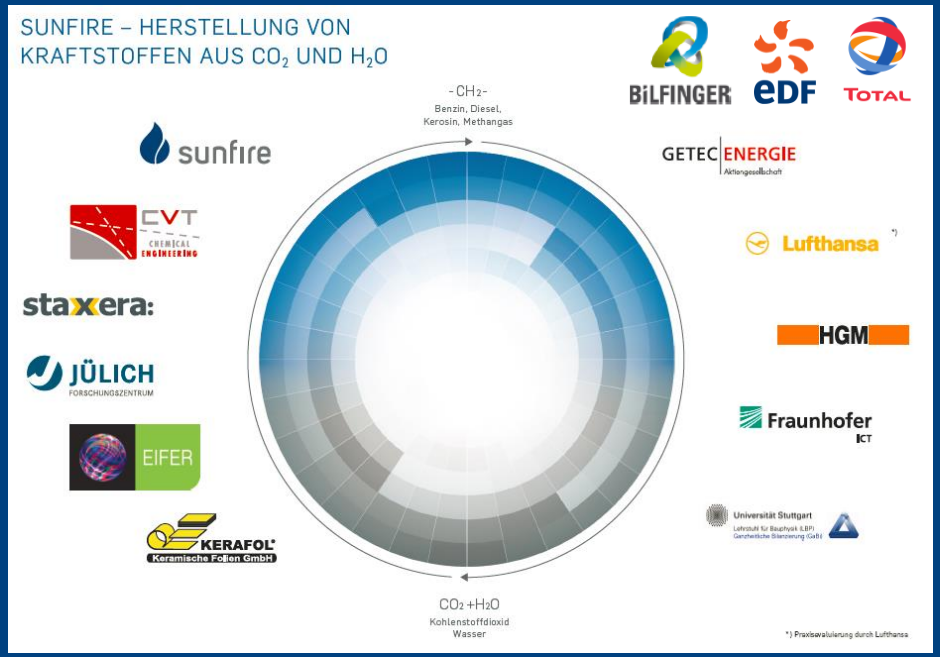
PtX scaling vs. Market Requirements

CLOSING THE CARBON CYCLE



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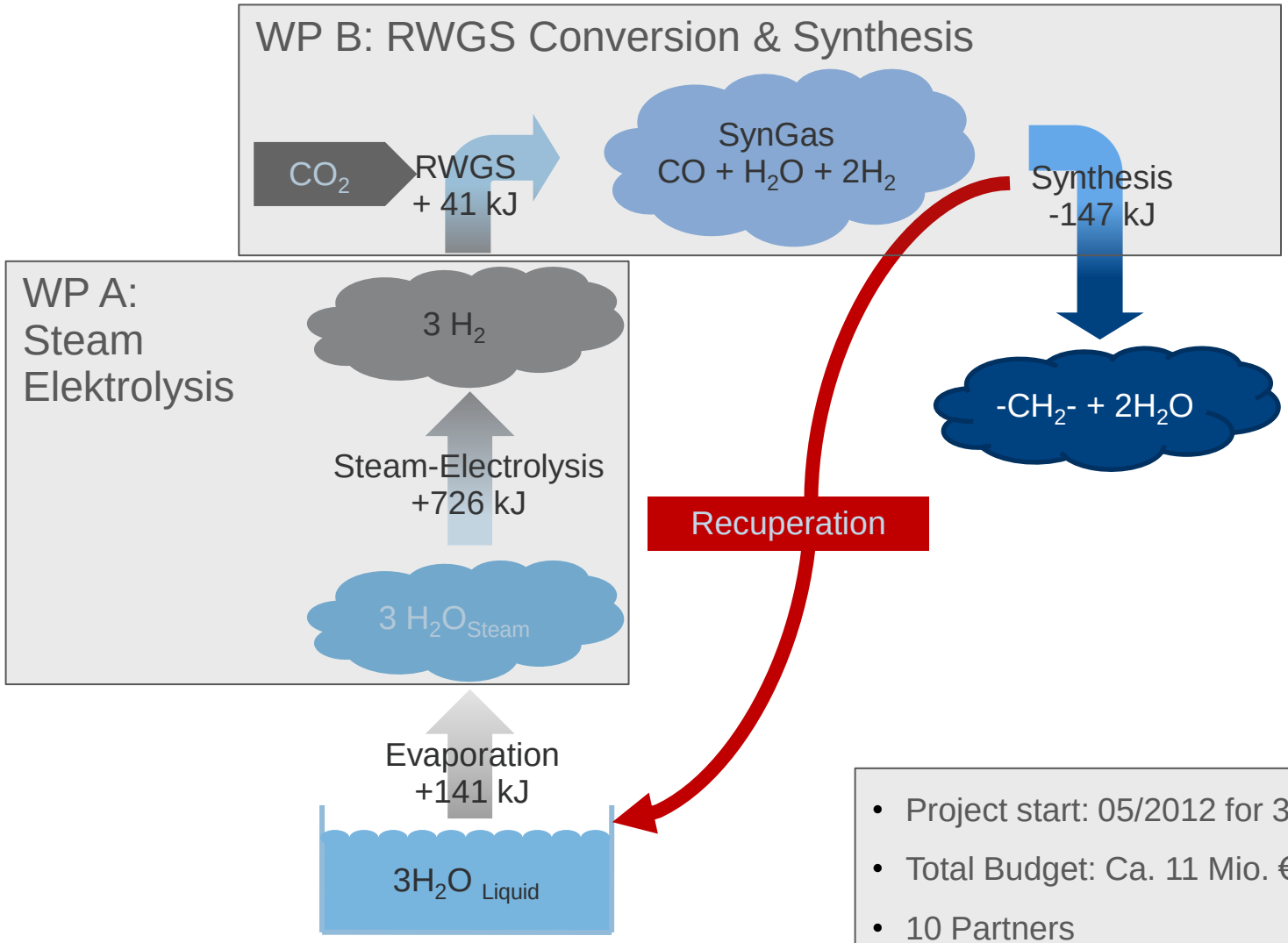
Contents

- Status SOEC-development
- Status Fuel 1 PtL-testplant
- Cost estimation
- **Why aim for small scale PtX-units?**

BMBF-Project: Process & Work-Packages



- Project start: 05/2012 for 36 months
- Total Budget: Ca. 11 Mio. €
- 10 Partners

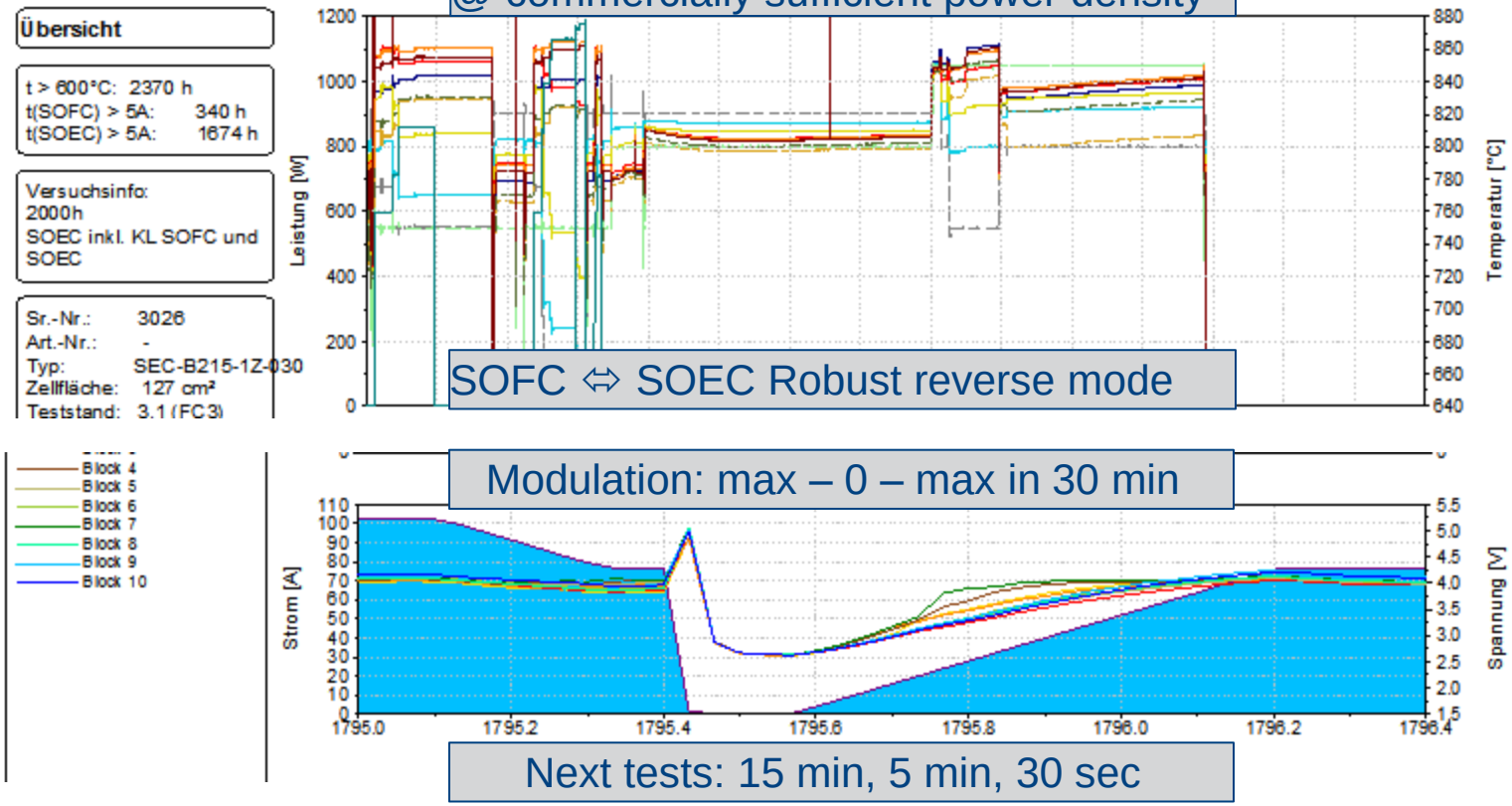
Work Package A: Steam Electrolysis

Major development goals for first SOEC – prototype – system

- ✓ Degradation < 1%/1000 hrs
- ✓ Reversible operation between Electrolysis and Fuel Cell mode
- ✓ Power modulation
- ➢ Scaling to 5-10 kW
- ➢ Pressurized Operation (15/30 bars)

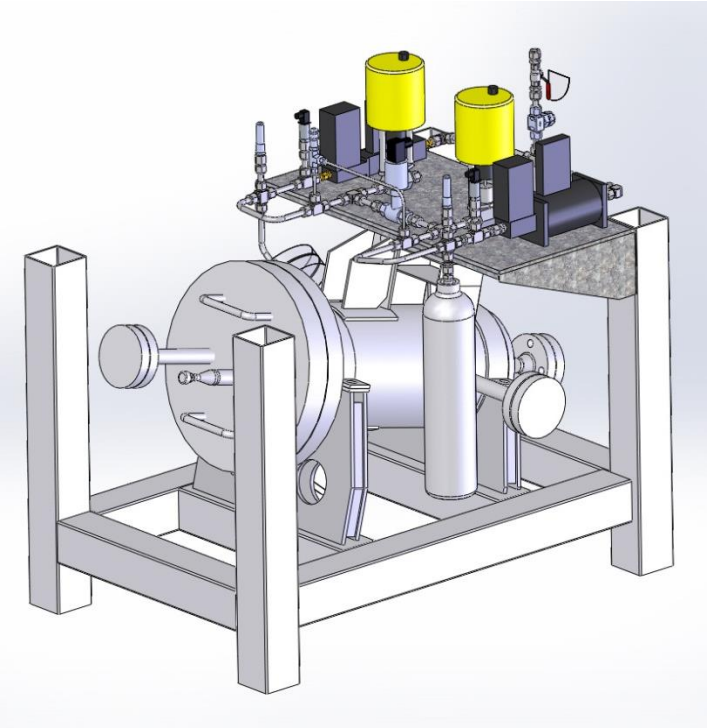
Work Package A: Results from Stack Generation # 6

Degradation: ca. 0,7%/1000h
@ commercially sufficient power density



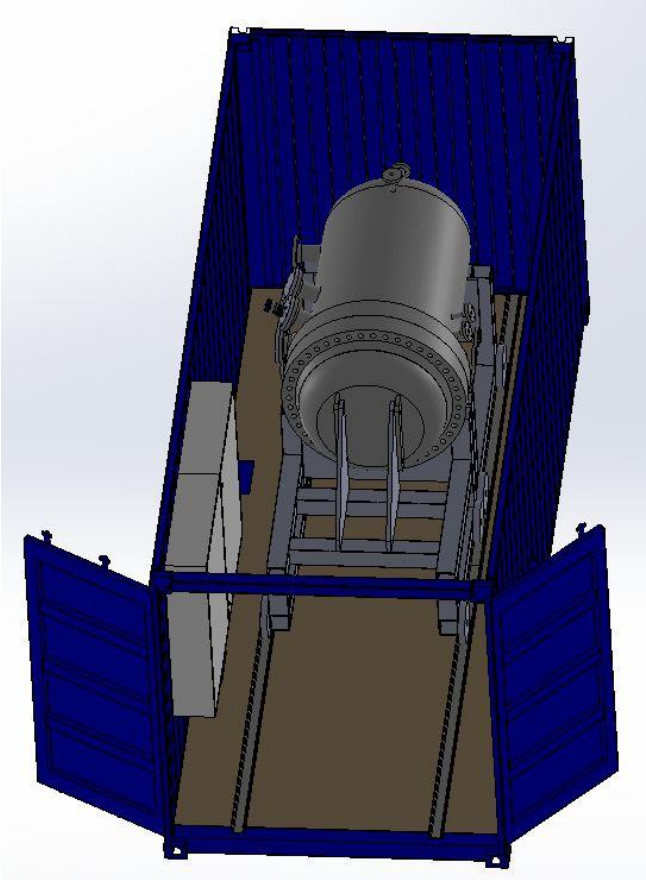
Major step towards industrialization of steam electrolysis!

Work Package A: Pressurized 5-10 kW System



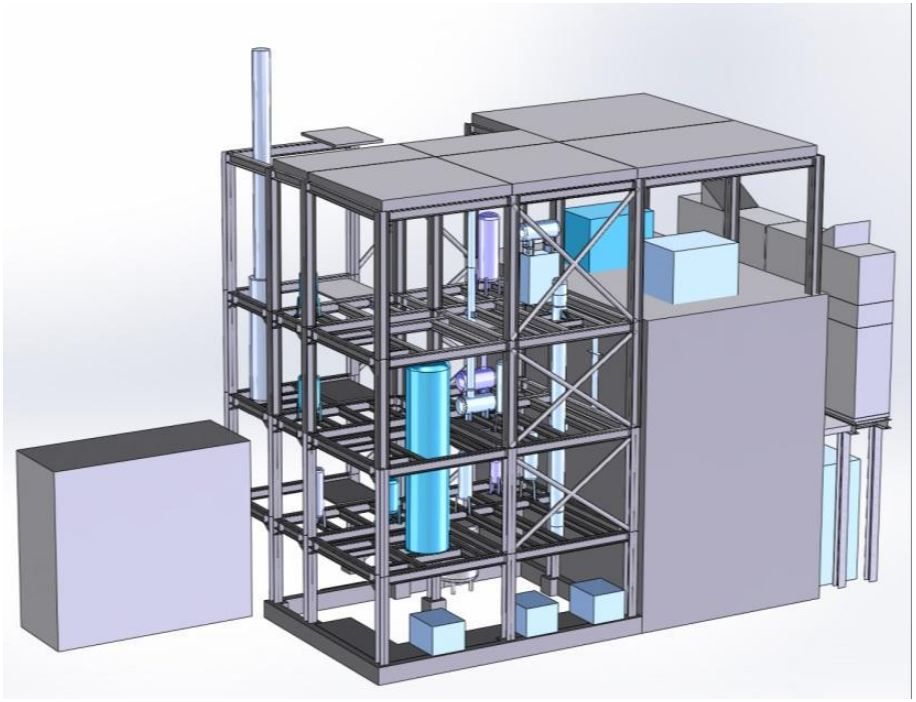
Testing facility to achieve minimum differential pressures between anode & cathode (completed).

Mobile protoype system; installation in standard container



(under construction)

Work Package B: Fuel 1 Test Plant



Fuel 1 test plant for RWGS & Fischer-Tropsch

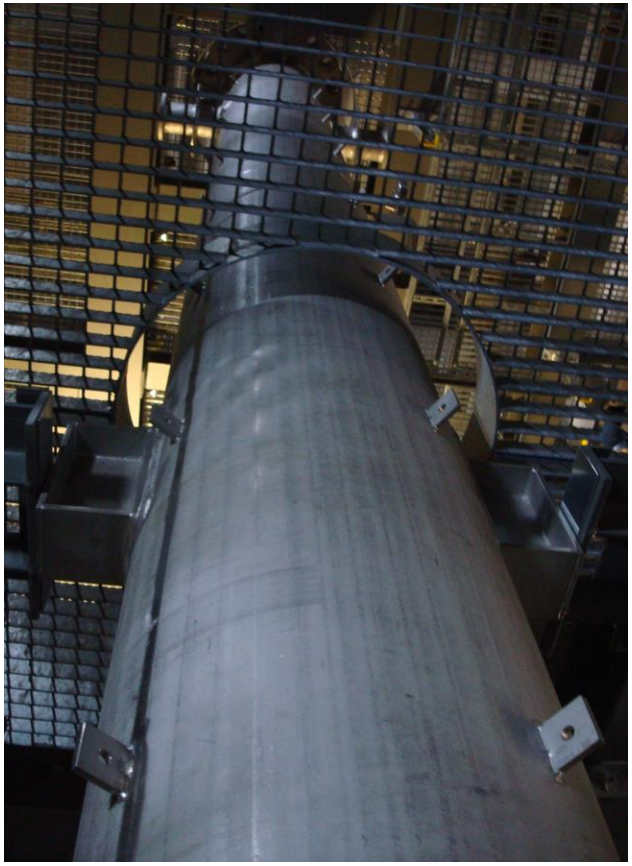
- Planned capacity 1 bbl/day (159 Liters)
- Start up As of Q3/2014

Current status

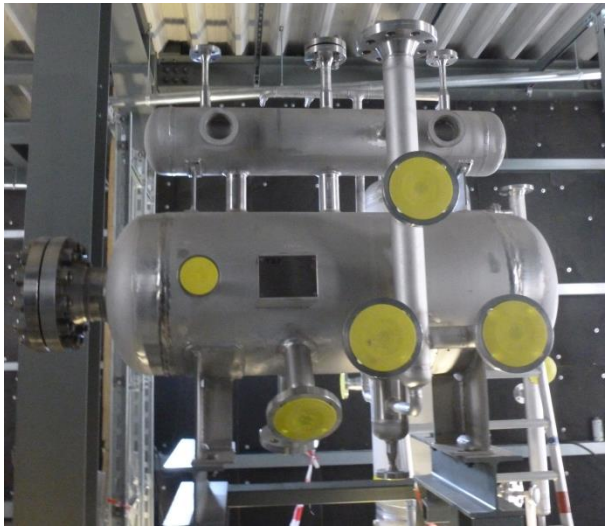
- Process components installed
- Tubes, valves & controls under installation
- Software under development

Work Package B: Fuel 1 Test Plant

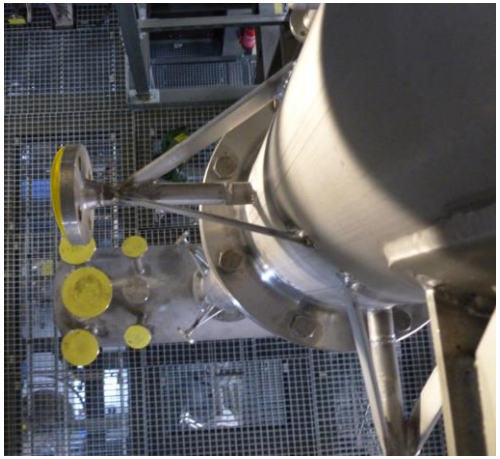
RWGS-Reactor



Fischer-Tropsch-Reactor

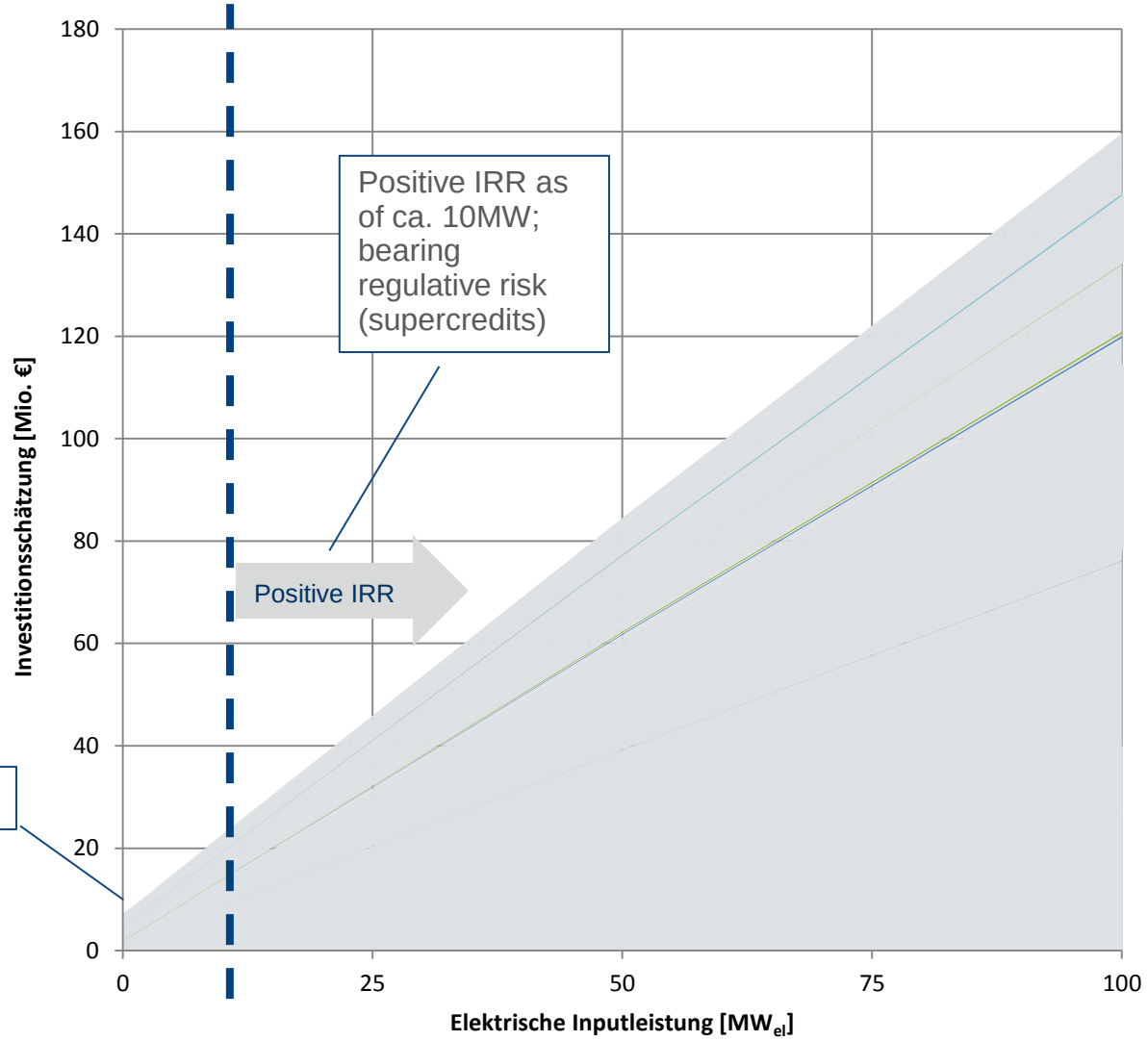


Steam drum



Destillation column

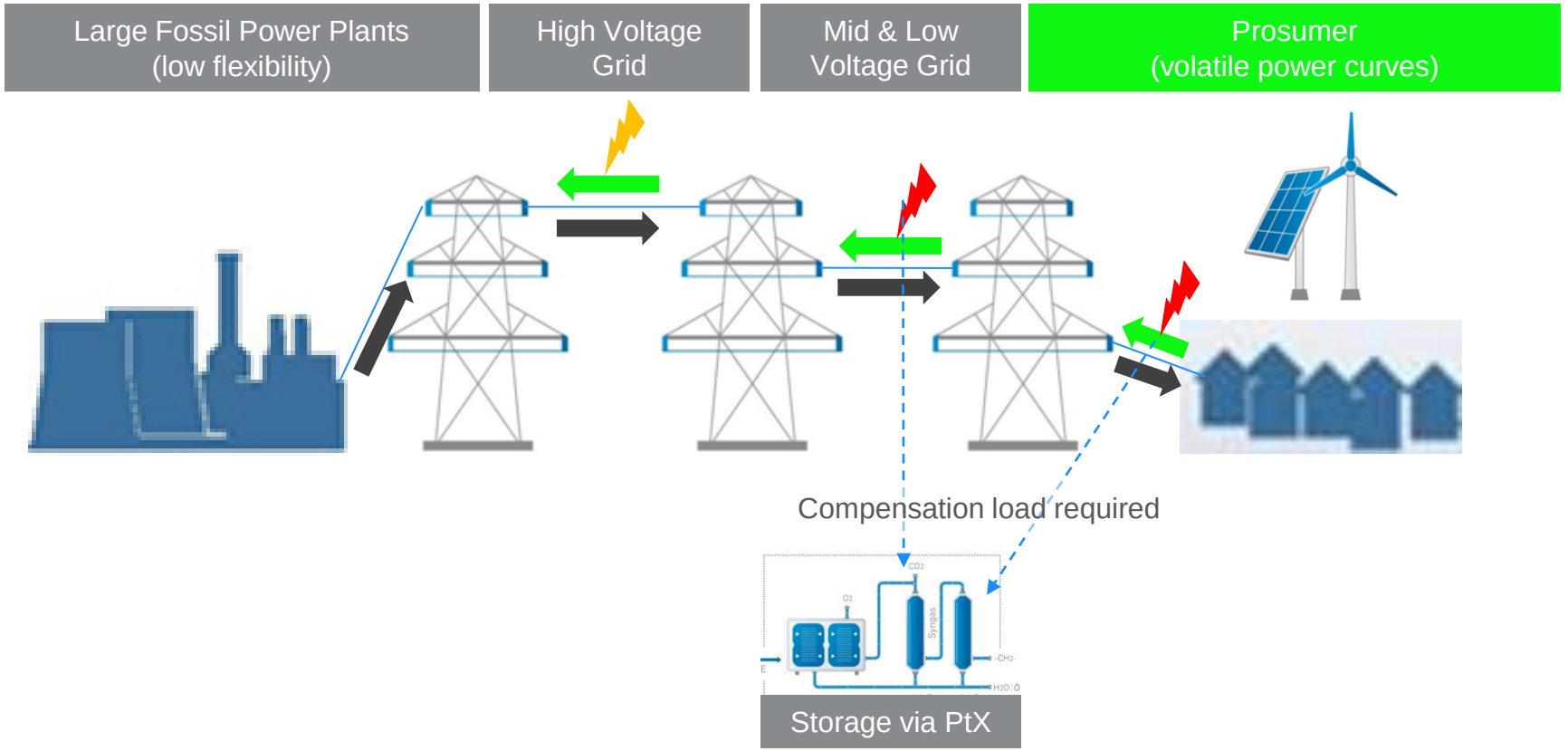
Cost estimation for PtL MW-plants



Energiewende: technical & commercial requirements

The *Energiewende* requires storage capacity to ensure

1. Security of supply (seasonal storage)
2. Grid stability, mainly for mid & low-voltage grid



Energiewende: technical & commercial requirements

PtX storage for the *Energiewende*

1. is mainly required in the mid & low voltage grids
   => **30 – 500 kW units** (current best guess to be confirmend)

2. hardly operates beyond 2000 hrs/a in storage mode (low cap. ut.)
   => high capex/kWh$_{storage}$
   => regulative incentives (supercredits) are not sustainable (risk)
   => no commercial investment

What does a commercially attractive storage business model look like?

Increase Capacity Utilization by Inclusion of Power-Supply for storage downtimes

rSOC/PtXtP in one unit

The concept of reversible Solid Oxide Cell (rSOC)

Driven by the need for *grid stability* and *high capacity utilization*, PtX-units **must be reversible to supply during energy shortage (XtP)**

- ✓ Grid connection allows flexible capacity share between storage & supply; (other than batteries, compressed air etc.) => operation according to currently best revenues
- ✓ PtX can supply other marktes (e.g. biofuel certificates) than XtP => extra revenues
- ✓ PtX can produce high quality fuel, XtP can use low quality fuel=> cost/rev. optimisation
- ✓ Various degrees of freedom reduce regulative risk for investors
- ✓ decentral/lateral power storage & supply is strategic for the Energiewende

Let´s make it real…

…and thanks for your attention!