Power-to-Liquids as a new Energy Option
Potentials and Difficulties/ Uncertainties

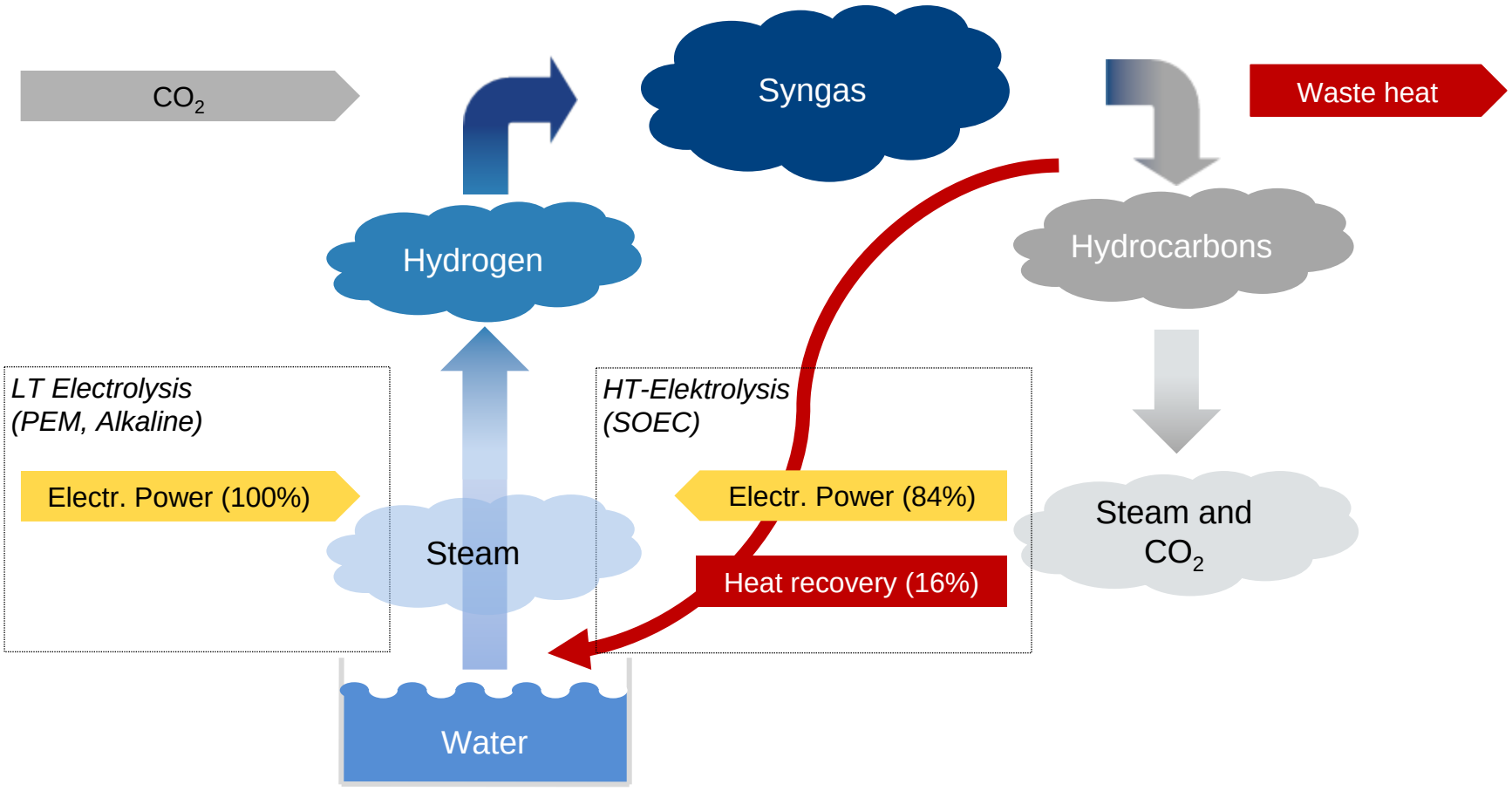
powered by staxera:

Content

An enormous Potential:

PtL & PtG based on High Temperature Steam Electrolysis

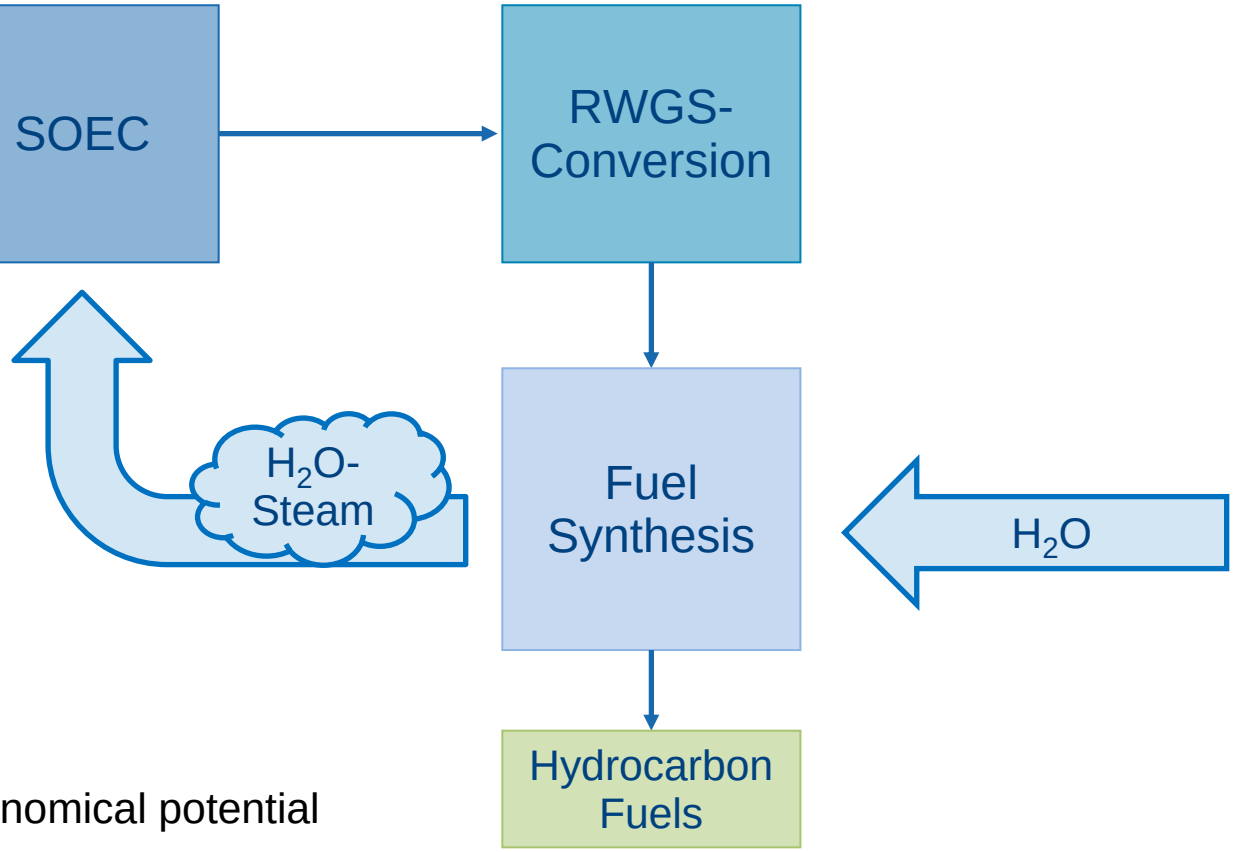
Patented efficiency advantage



High Temperature Steam Electrolysis increases the process efficiency significantly.
PtL: 50% → 70%, PtG: 55% → 80% (approximate values, based on LHV)

Production method #1
Power-to-Liquids

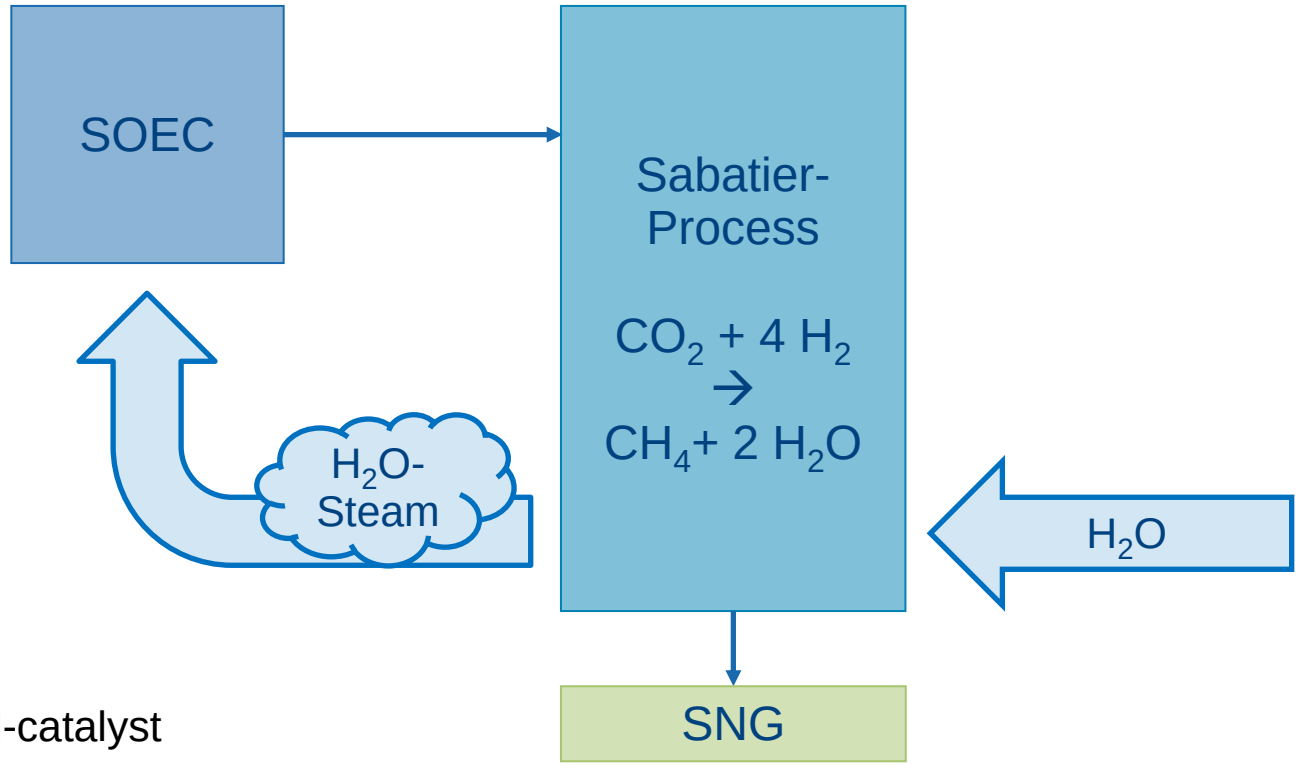
sunfire‘s Power-to-Liquids process consists of three components:
SOEC (Solid Oxide Electrolysis Cell), RWGS-conversion and fuel synthesis



High present economical potential

Production method #1
Power-to-Gas

Methanation is a relatively simple process. The increased efficiency due to the SOEC is still applicable. However, the economical potential of SNG is lower than for synthetic liquid fuels due to the cheap and still long time available natural gas.

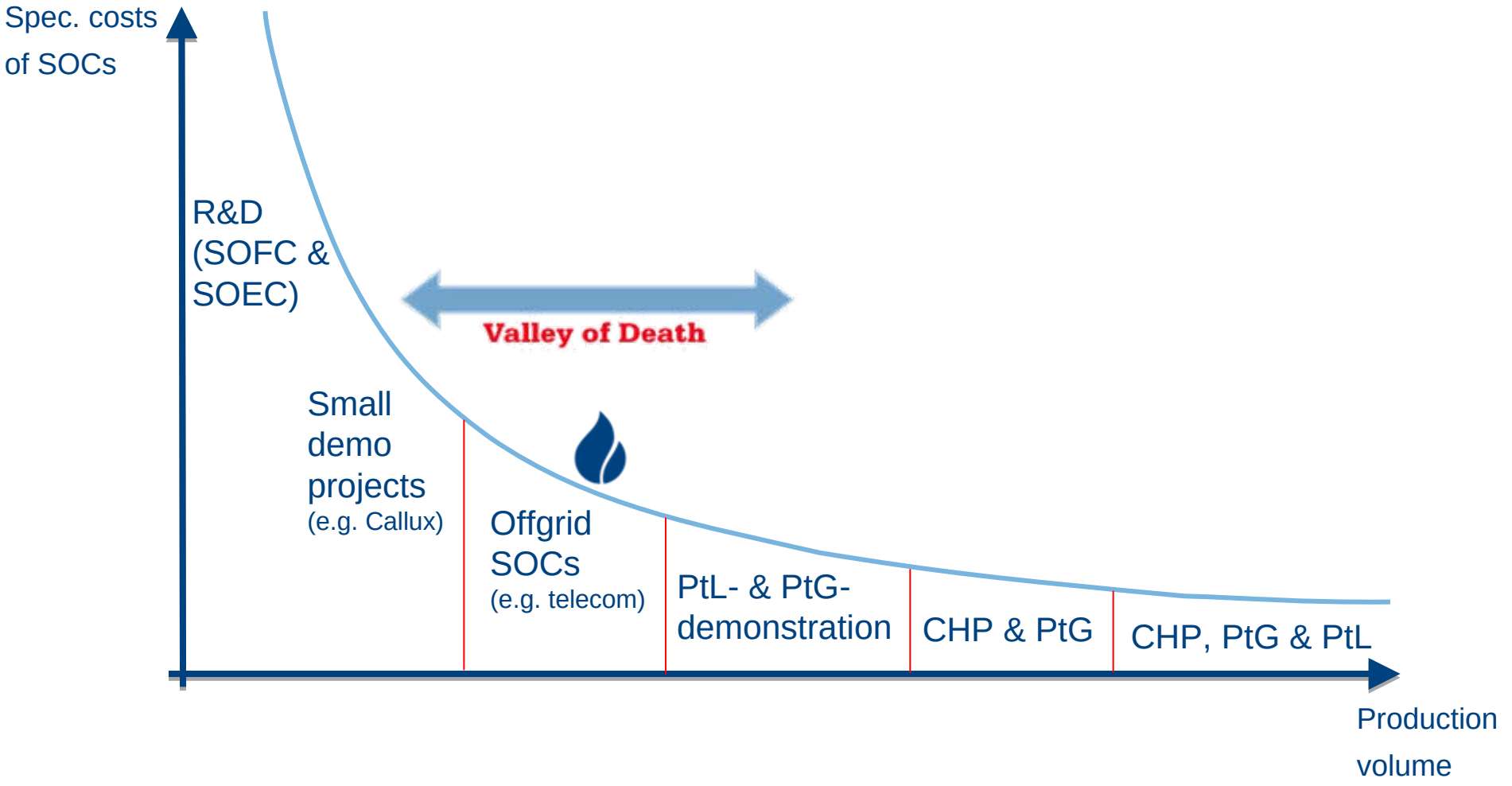


- Simple Nickel-catalyst
- No complex product separation

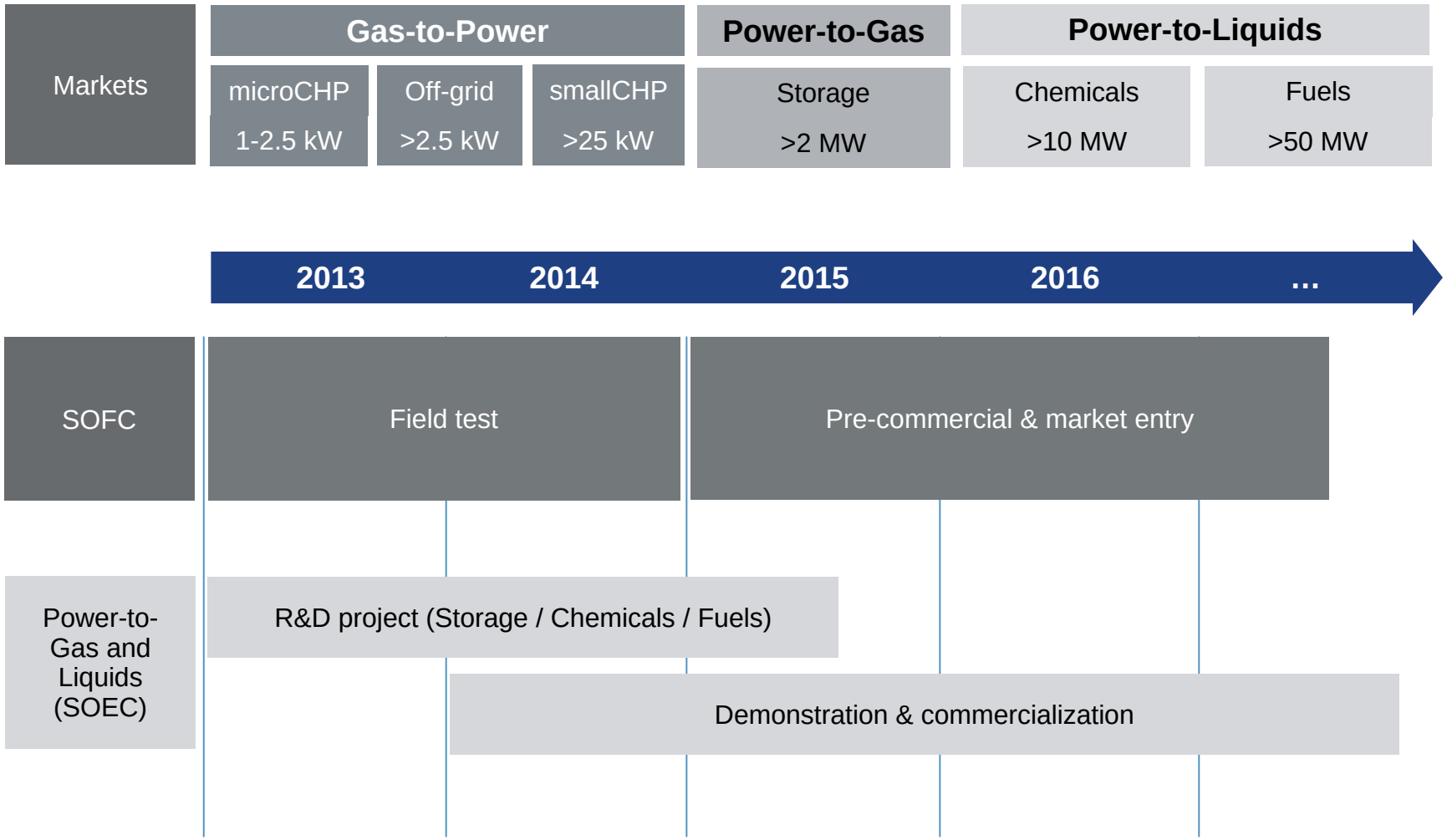
A challenging process:

sunfire's Road-to-Market

Road-to-Market
or “How to overcome the Valley of Death”



Road-to-Market
Strategy and timeline



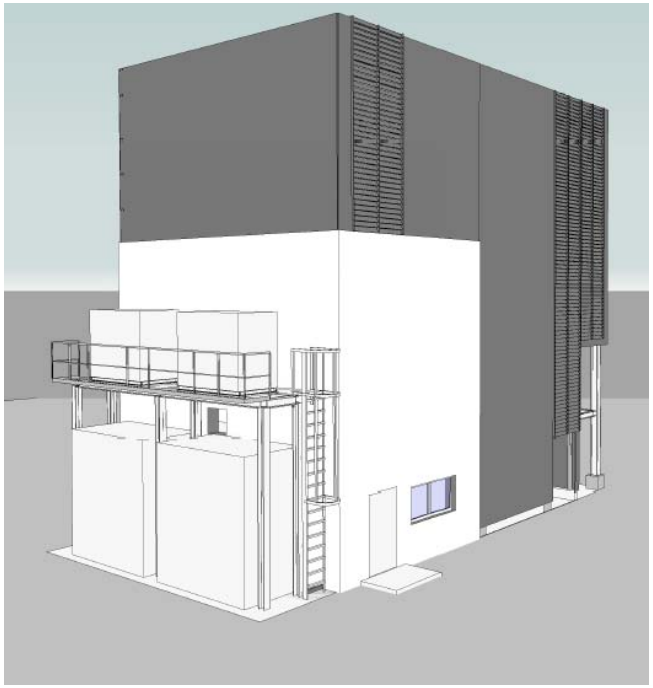
PtL Demo Plant Fuel1
Storage / Chemicals / Fuels

R&D project

- Construction of a Power-to-Liquids pilot plant targeting the verification of the chemical process & the development of a SOEC prototype
- Government-funded by Federal Ministry of Education and Research
- Project costs: € 12m (sf: € 8m)
- Project duration: May 2012 - June 2015 (start of operation in 2014)

Project consortium

Federal Ministry of Education and Research
sunfire
GE WI Aktiengesellschaft
CVT
Lufthansa
staxera:
HGM
JÜLICH
Fraunhofer ICT
EIFER
Universität Stuttgart
KERAFOL Keramische Folien GmbH



Power-to-Liquids demo plant Fuel1 in Dresden

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DLR Project Management Agency

PtL Demo Plant Fuel1
Storage / Chemicals / Fuels

Groundbreaking for demo plant at 22nd of July 2013 & construction progress after three months.

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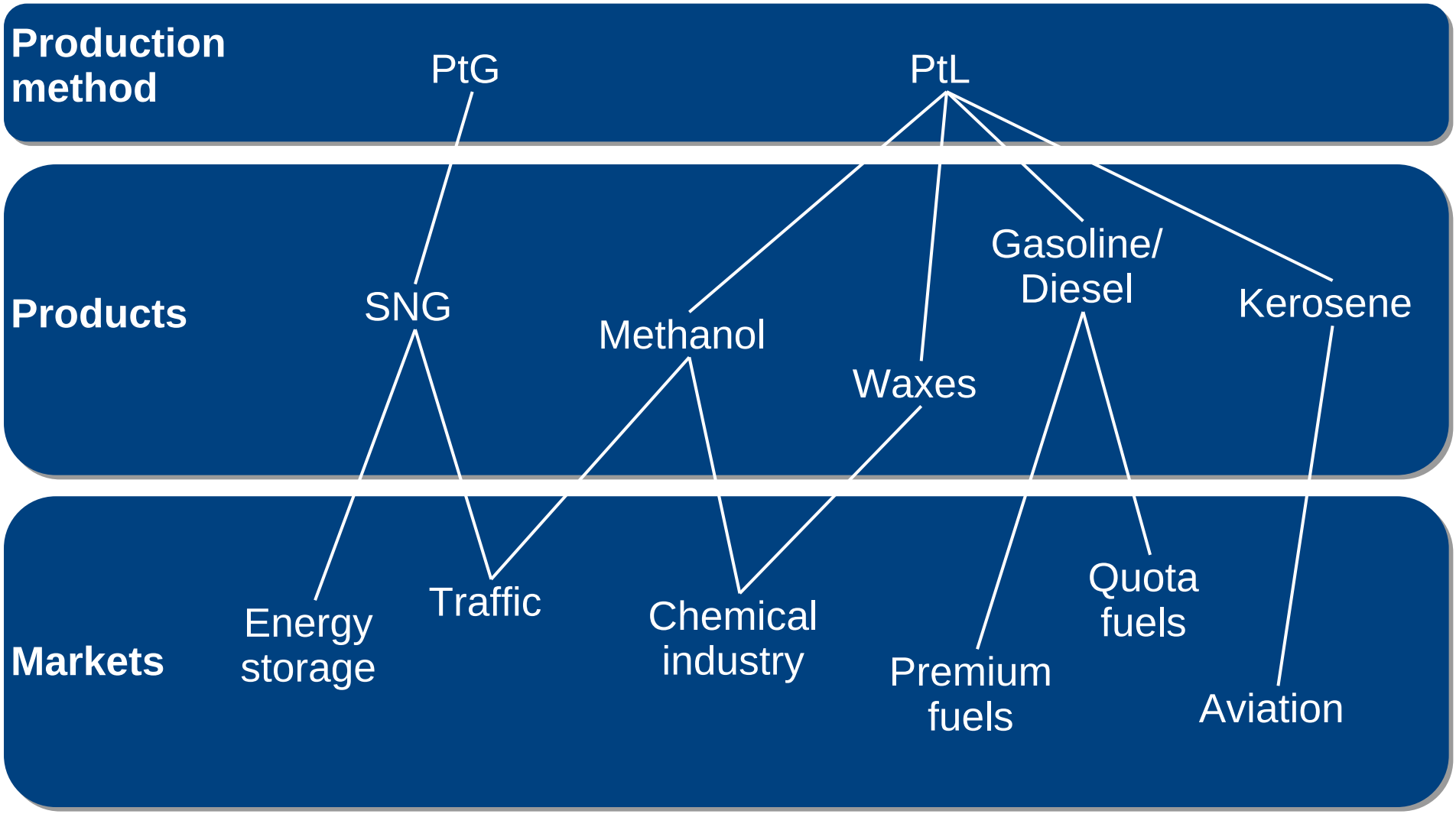
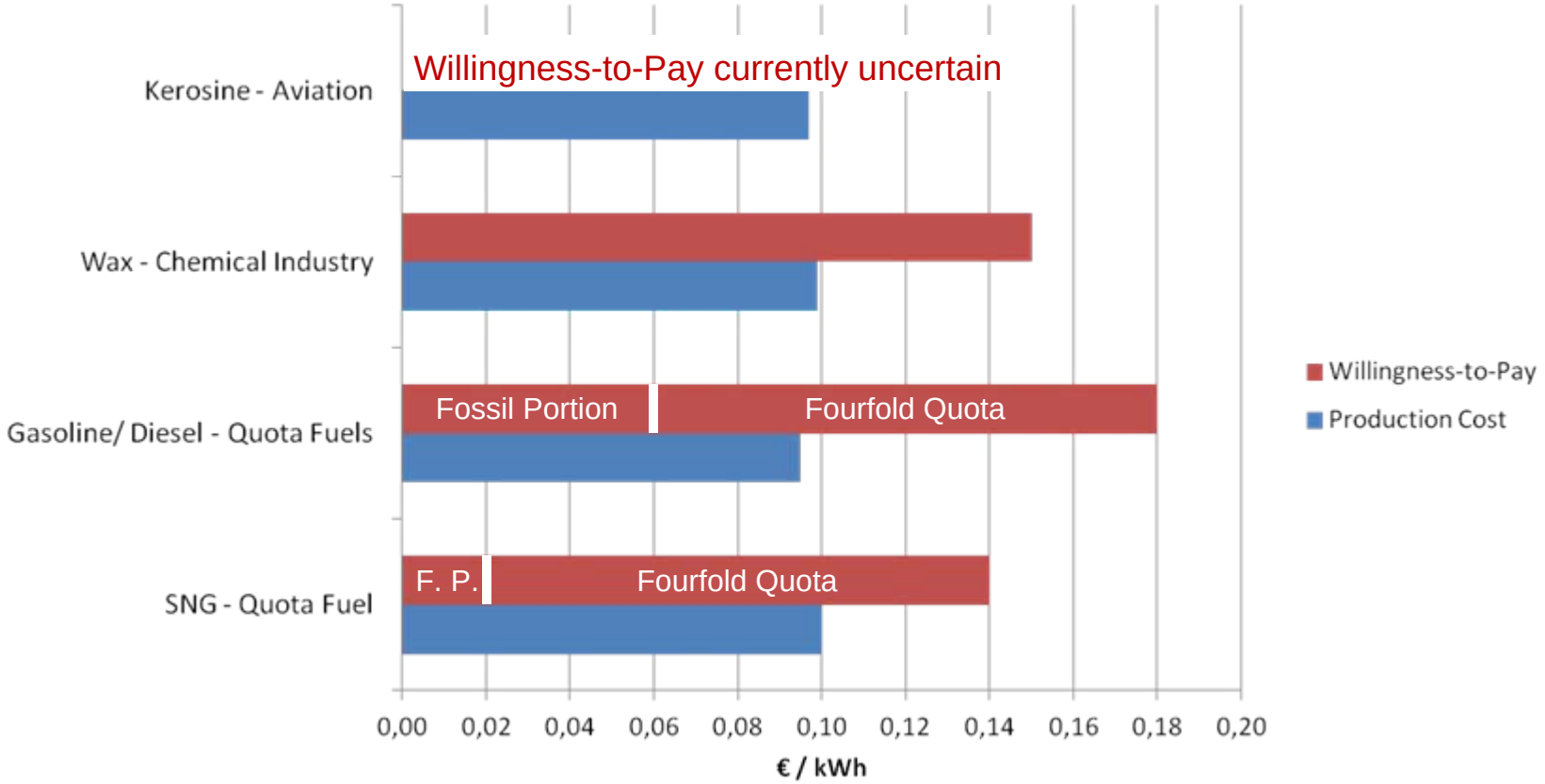
Still (as well) a political uncertainty: Markets & Willingness-to-Pay

Markets for PtG and PtL



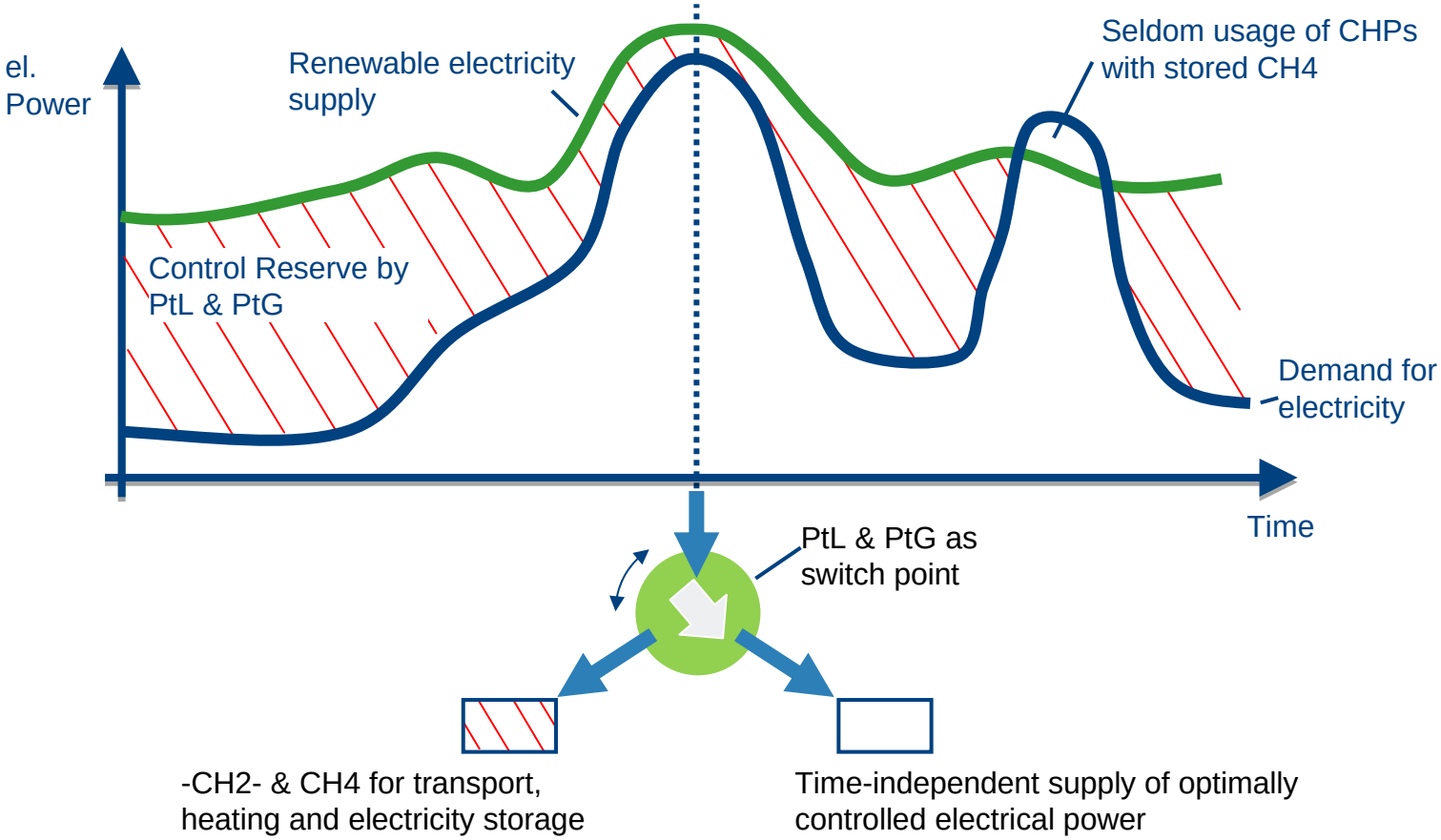
Power-to-Liquids
Willingness-to-Pay vs. cost

The willingness to pay for sunfire-fuels is clearly higher than 0.10 €/kWh(LHV). The reason is the obligatory addition of renewable fuels to fossil ones with respect to 2009/28/EG – **as well as the intended fourfold crediting of PtX-fuels to this quota (see source at the bottom)**.



Source of proposed amending: http://ec.europa.eu/clima/policies/transport/fuel/docs/com_2012_595_en.pdf

An enhanced Business Model for the “Energiewende”: PtL and PtG as economical Positive Control Reserve

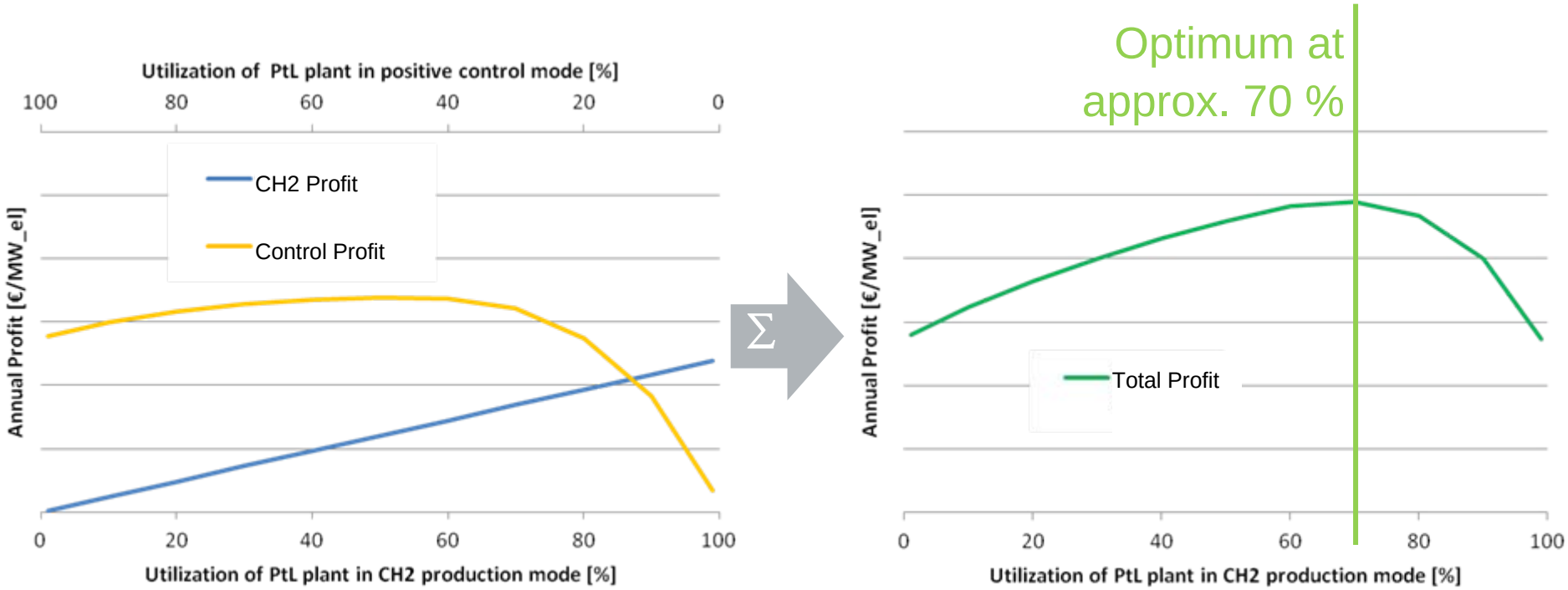


The renewable electricity “production” should always exceed the demand for electricity. The deviation can then be balanced by e.g. PtL and PtG plants.

The volitional excess-electricity will be utilized for 4 – 5 €ct/kWh and converted to products with a sufficient willingness-to-pay (e.g. liquid renewable fuels, clean synthetic waxes, SNG for CHPs, etc.).

The money for current gas and oil imports is invested into an integrated, cross-sectional electricity storage market and hence the “Energiewende”.

An enhanced Business Model for the “Energiewende”: PtL and PtG as economical Positive Control Reserve

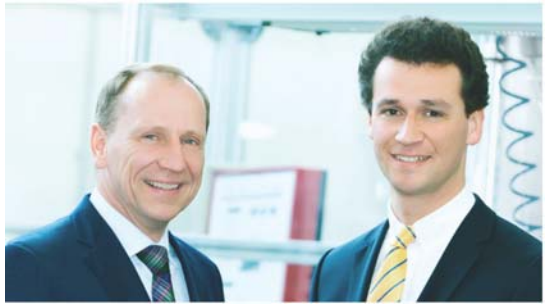


The generally positive effect of PtL and PtG for
1. A robust electricity grid and hence supply
2. 100% renewable primary energy supply in all other CH-based energy sectors

also enables the plant to increase its total economical profit.

Who is sunfire?
Company facts & partners

Management and company facts



Senior Management

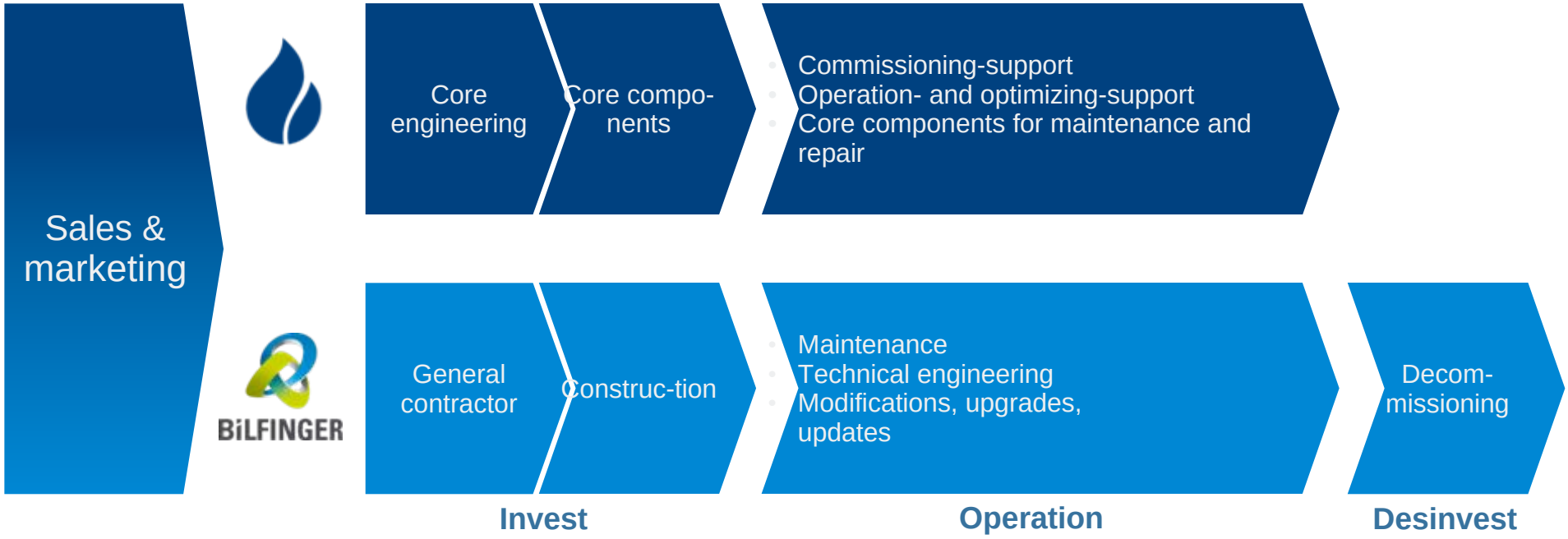
Carl Berninghausen (CEO), EBS, Karibu, Thermea, e.a.
Christian v. Olshausen (CTO), TU Dresden, P&G, Daimler Fuel Cells

Business Administration	Business Development	Stacks	Systems	Fuel
Nils Aldag EBS, Desertec Foundation	**Björn Erik Mai** TU Berlin, Webasto, staxera	**Mario Heinrich** HTW Dresden, Audi, staxera	**Dr. Oliver Posdziech** TU Dresden, EBZ	**Dietmar Rüger** TU Dresden, Choren Industries

History	**sunfire** founded in 2010 (**staxera** 2005), staxera merged into sunfire in 2012, Bilfinger entry in 2012
Employees	53 (47 engineers and technicians, 6 business graduates)
Infrastructure	Test environment for stacks, systems and PtL & PtG

The sunfire team has developed one of the most robust and cost competitive SOFC-stacks.

Cooperation Bilfinger/sunfire – a perfect fit for PtL & PtG



- Corporate sales & marketing but individual focus on core competencies

  sunfire: Engineering & core components

  Bilfinger: General contractor & construction

Thank you for your attention

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