

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



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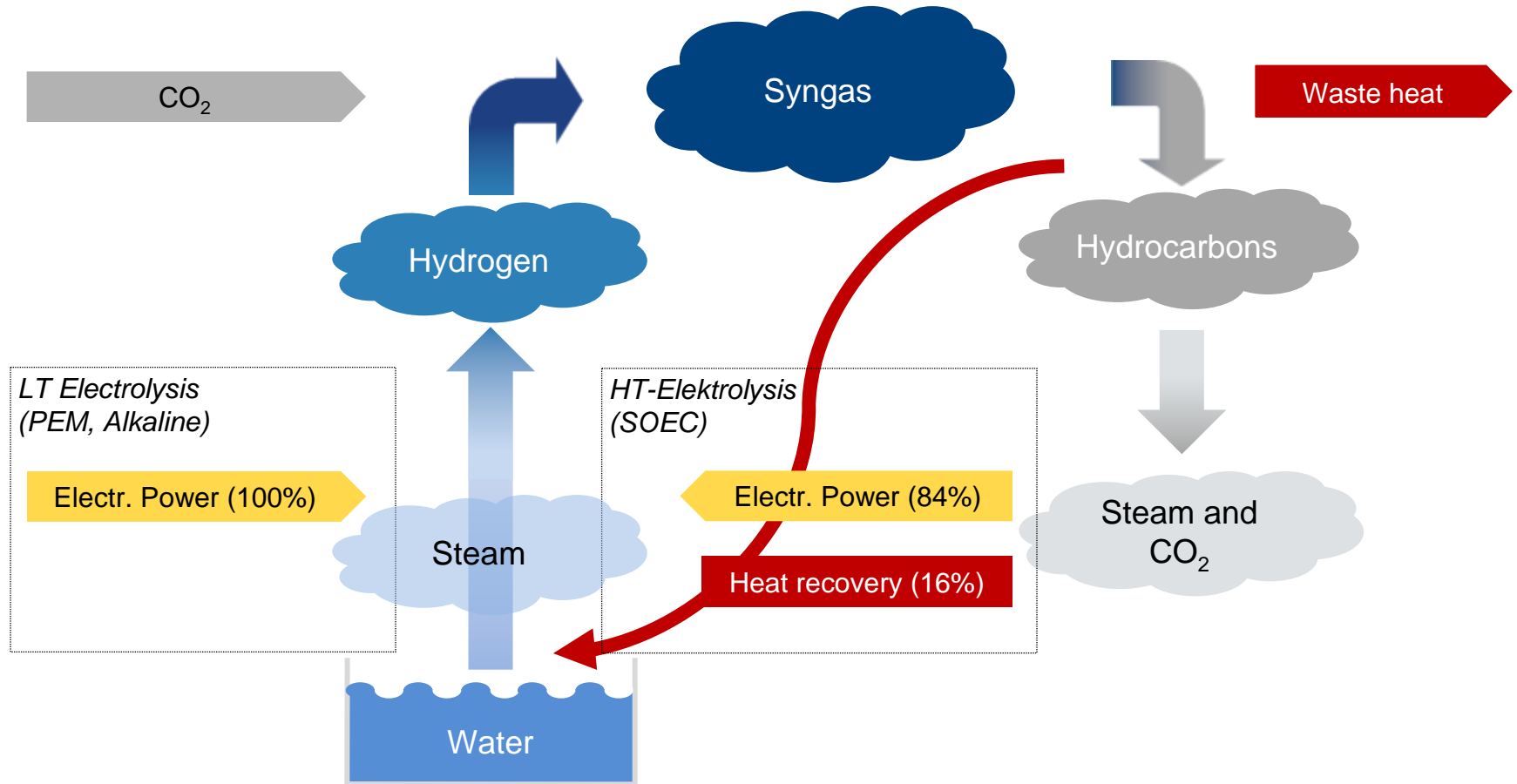
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- 01. Potential: Production methods for renewable CO₂-based fuels
- 02. Challenge: Road-to-Market
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An enormous Potential: PtL & PtG based on High Temperature Steam Electrolysis

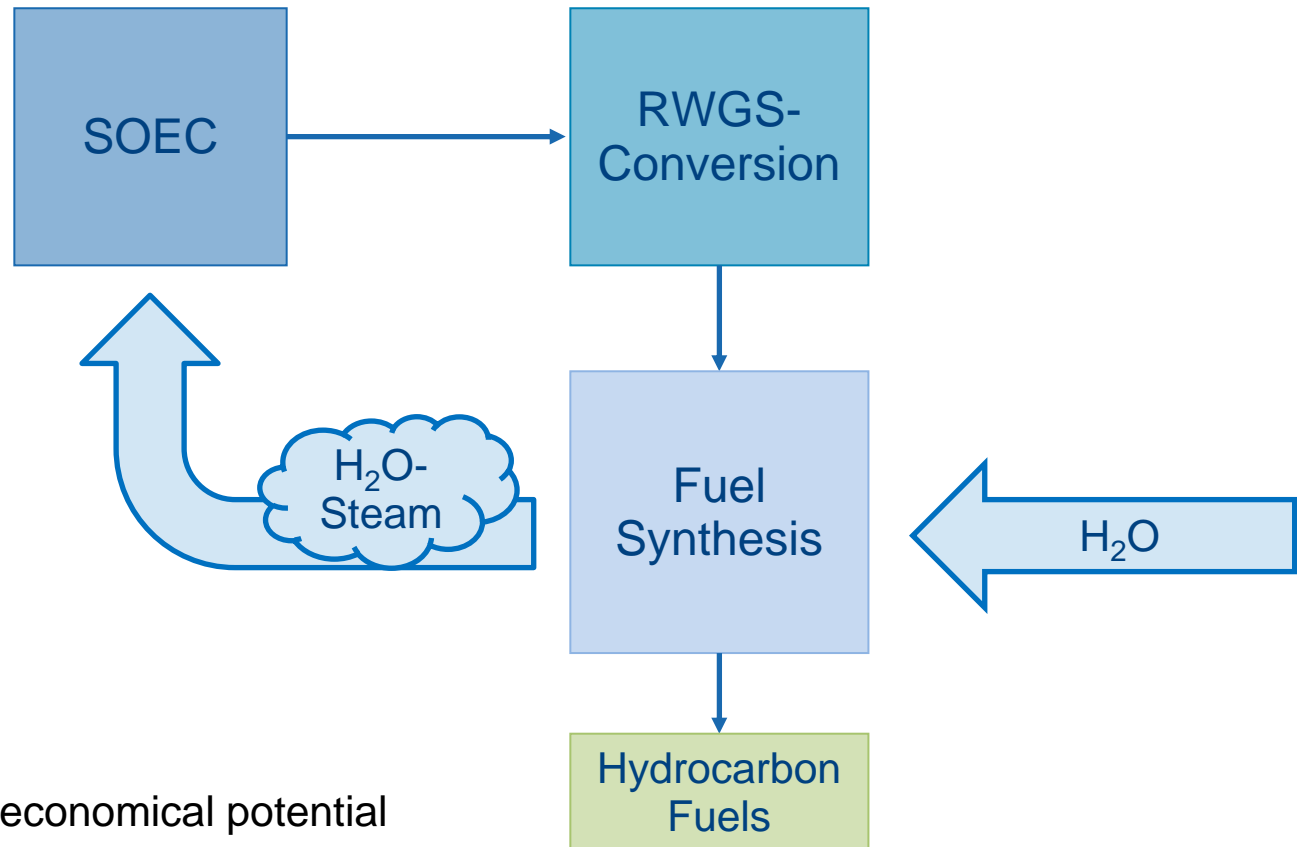


High Temperature Steam Electrolysis increases the process efficiency significantly.
 PtL: 50% → 70%, PtG: 55% → 80% (approximate values, based on LHV)

+ 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

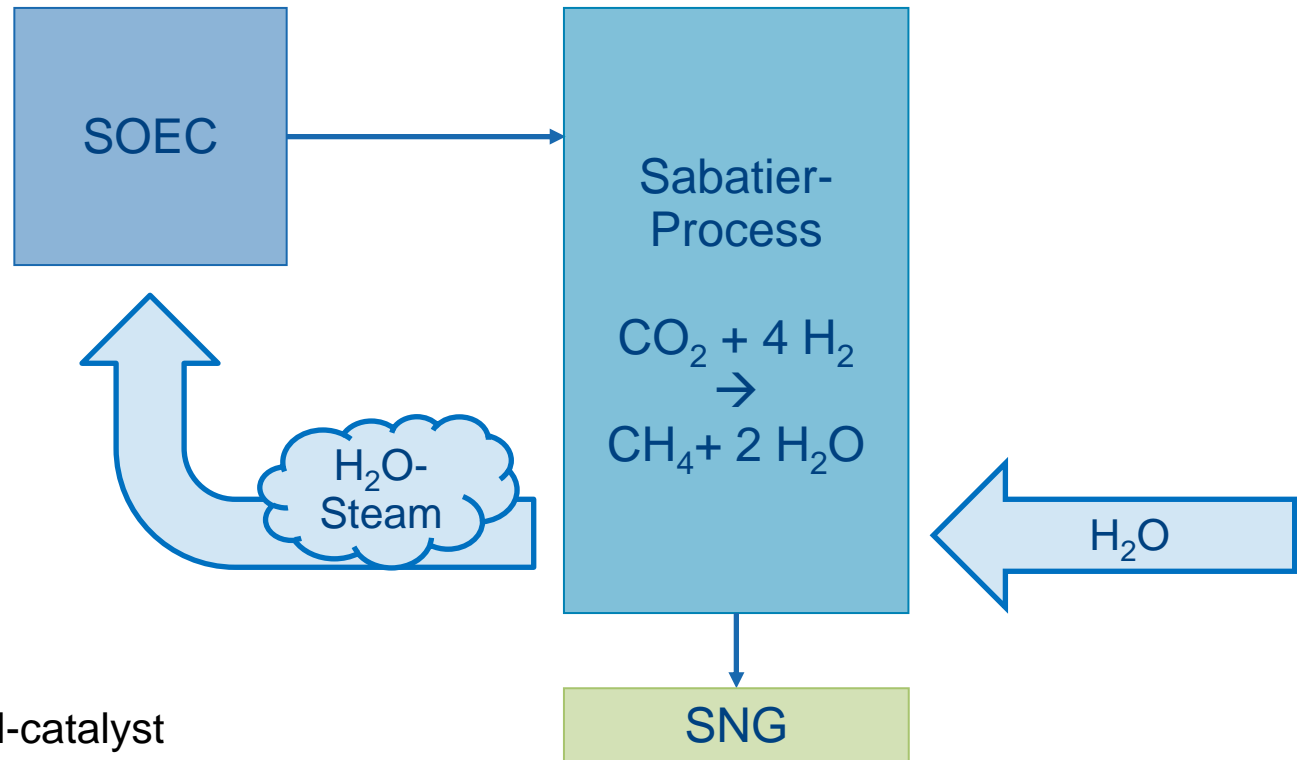


+ High present economical potential

+ 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.

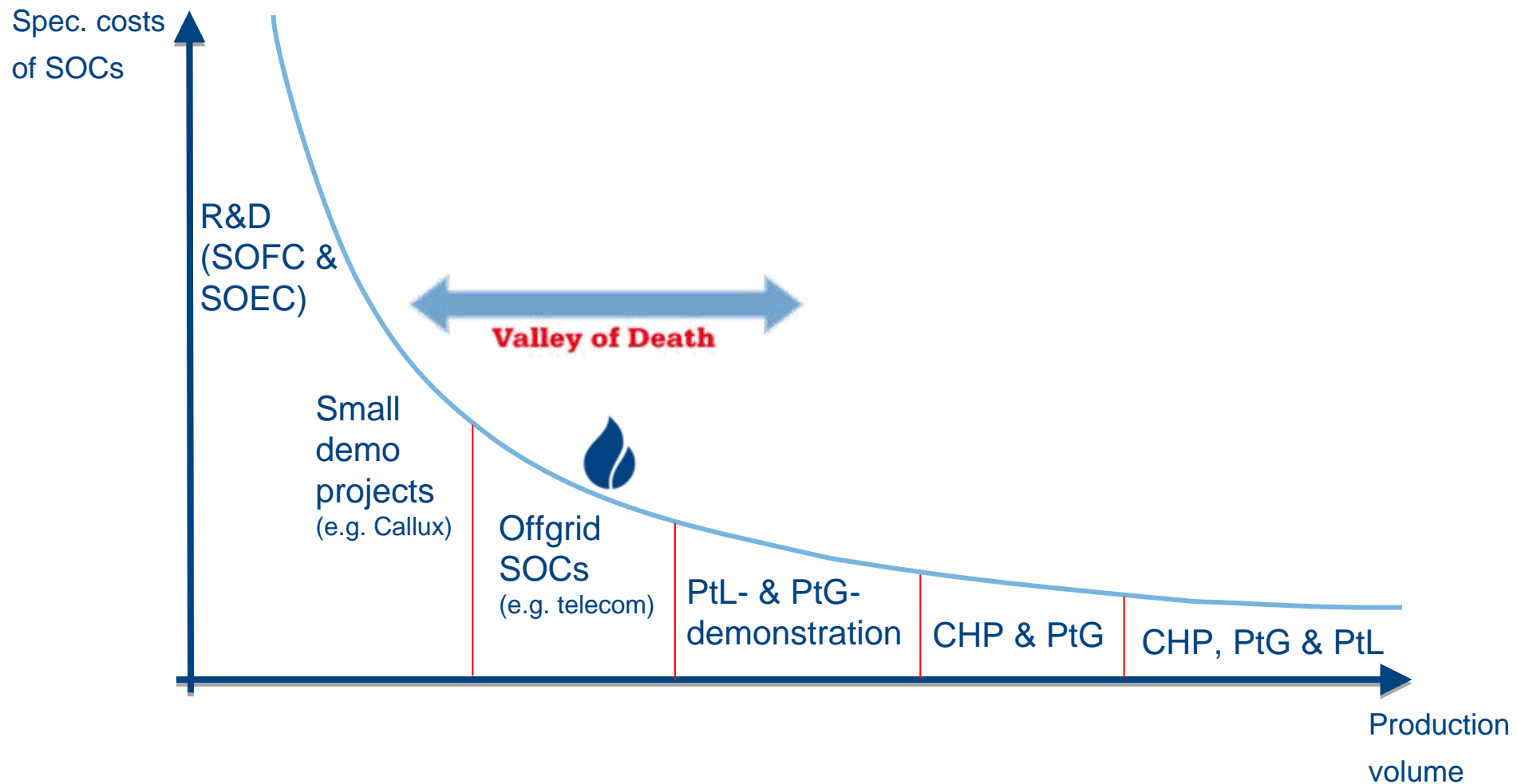


- + Simple Nickel-catalyst
- + No complex product separation



A challenging process: sunfire's Road-to-Market

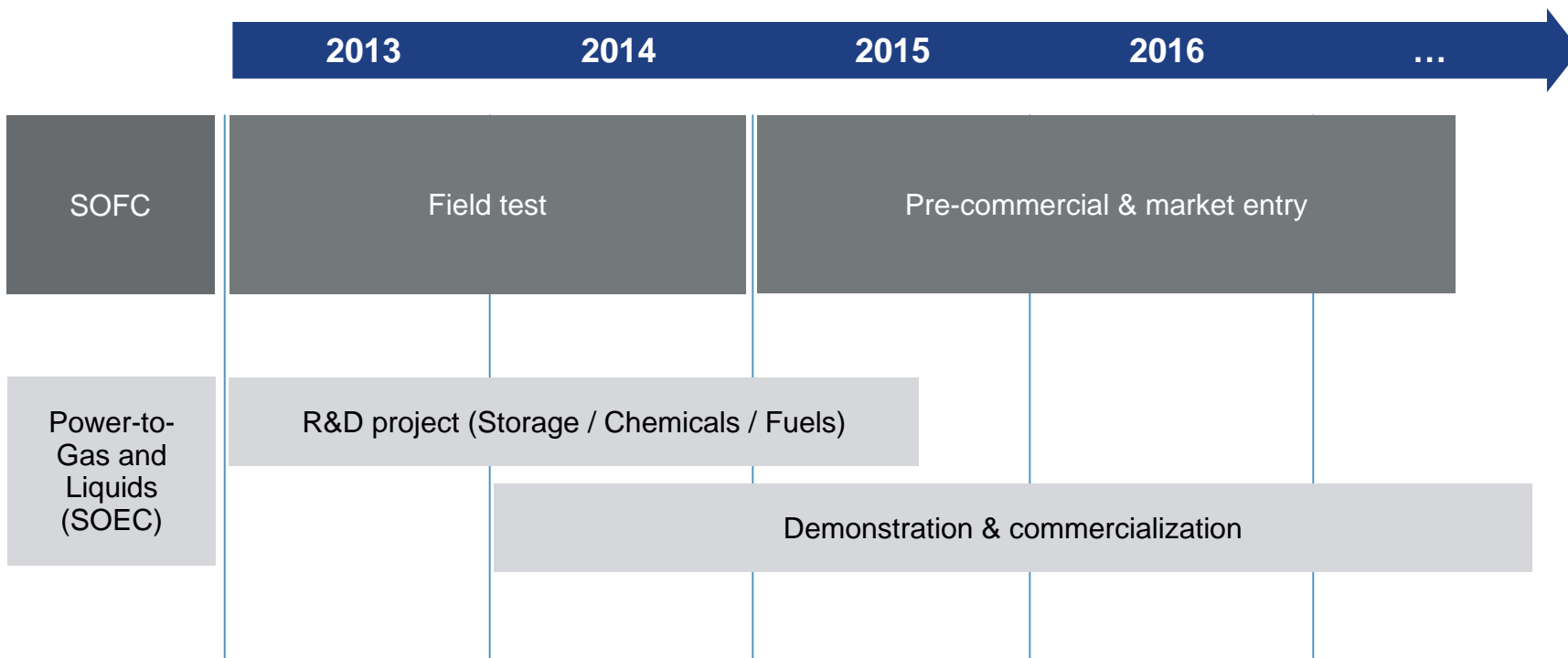
+ Road-to-Market or “How to overcome the Valley of Death”



+ Road-to-Market Strategy and timeline



Markets	Gas-to-Power			Power-to-Gas	Power-to-Liquids	
	microCHP 1-2.5 kW	Off-grid >2.5 kW	smallCHP >25 kW	Storage >2 MW	Chemicals >10 MW	Fuels >50 MW



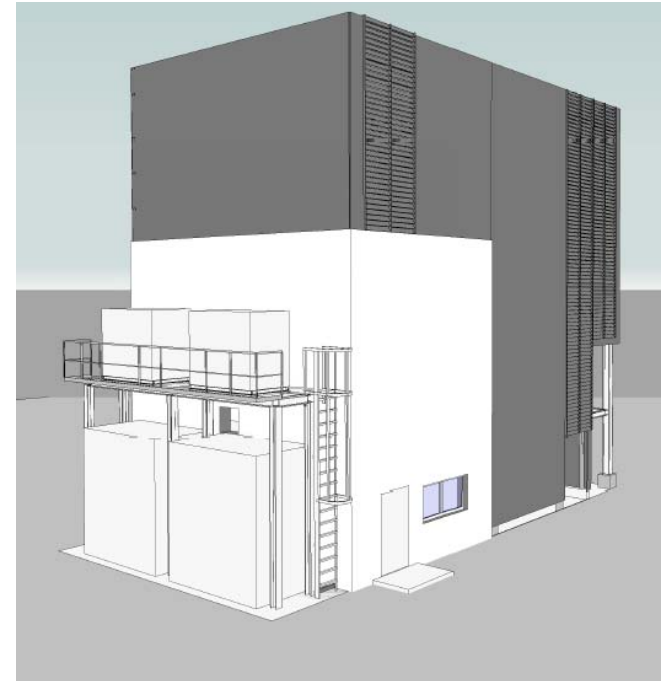
+ PtL Demo Plant Fuel1 Storage / Chemicals / Fuels



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



Power-to-Liquids demo plant Fuel1 in Dresden



+ 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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Federal Ministry
of Education
and Research



DLR Project Management Agency



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

Production method

PtG

PtL

Products

SNG

Methanol

Waxes

Gasoline/
Diesel

Kerosene

MarketsEnergy
storage

Traffic

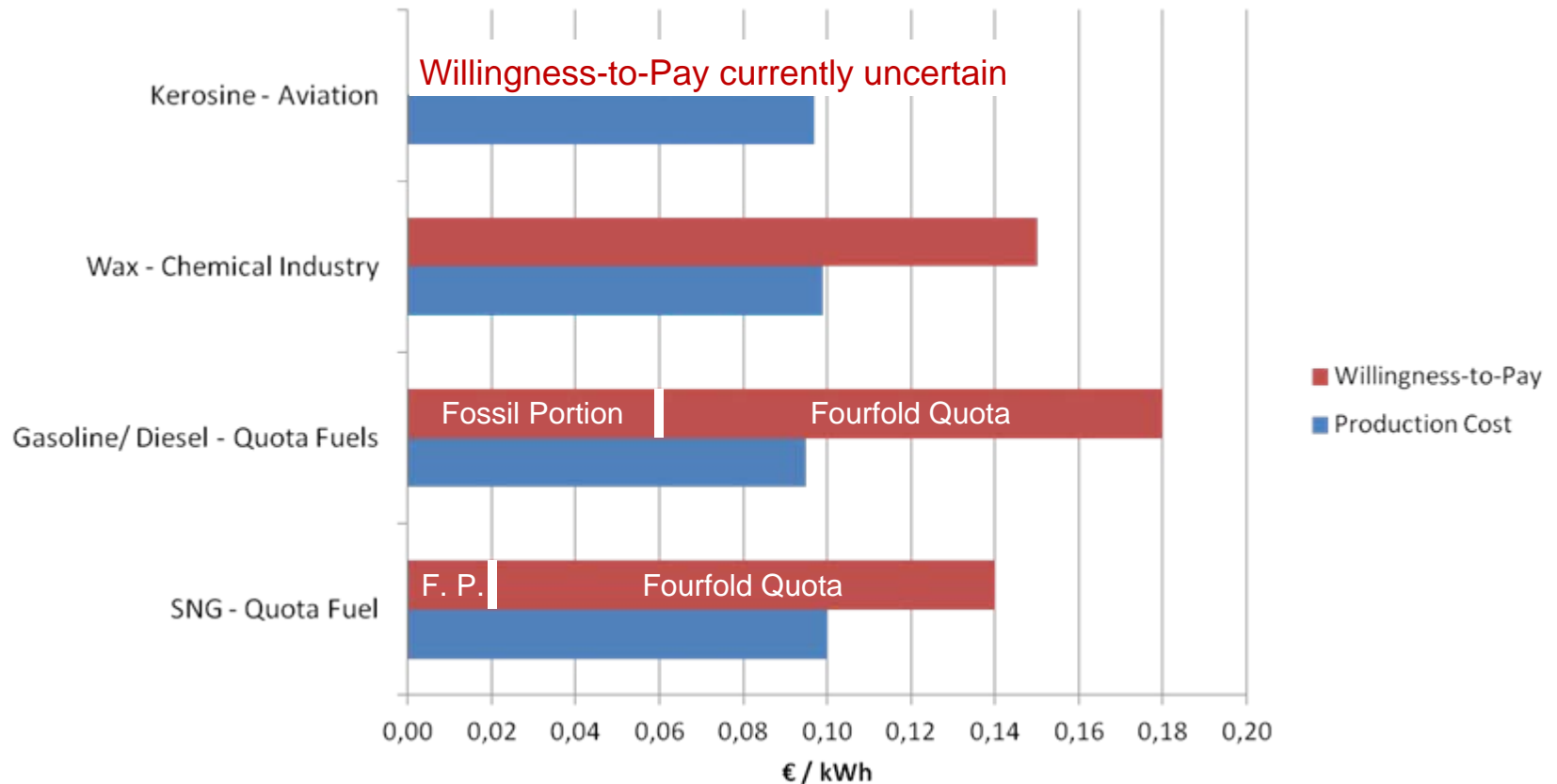
Chemical
industryPremium
fuelsQuota
fuels

Aviation

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

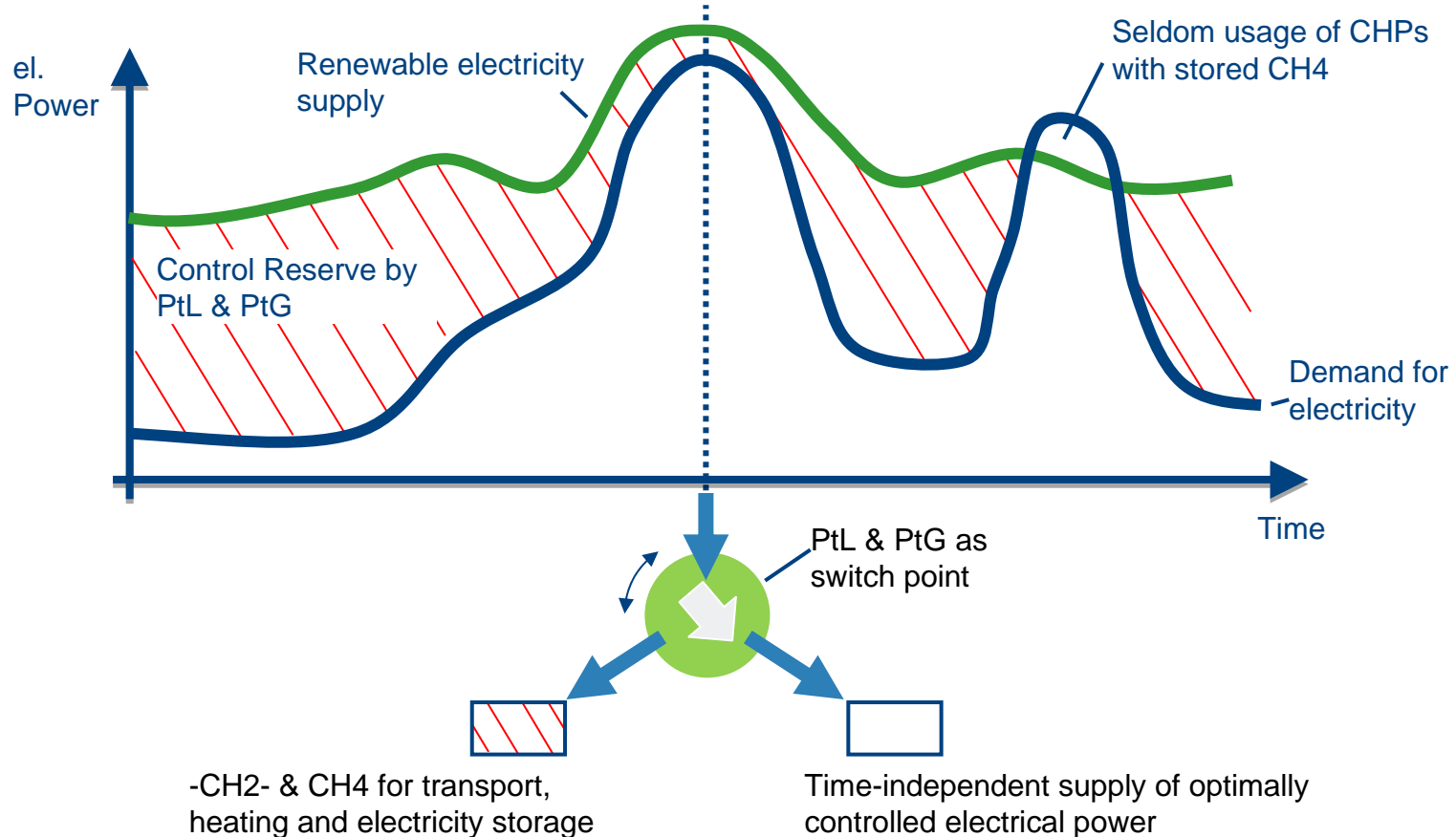


The willingness to pay for sunfire-fuels is clearly higher than 0.10 €/kWh(LHV). The reason is the obligatory addition of renewable fuels to fossil ones with respect to 2009/28/EG – **as well as the intended fourfold crediting of PtX-fuels to this quota (see source at the bottom).**



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

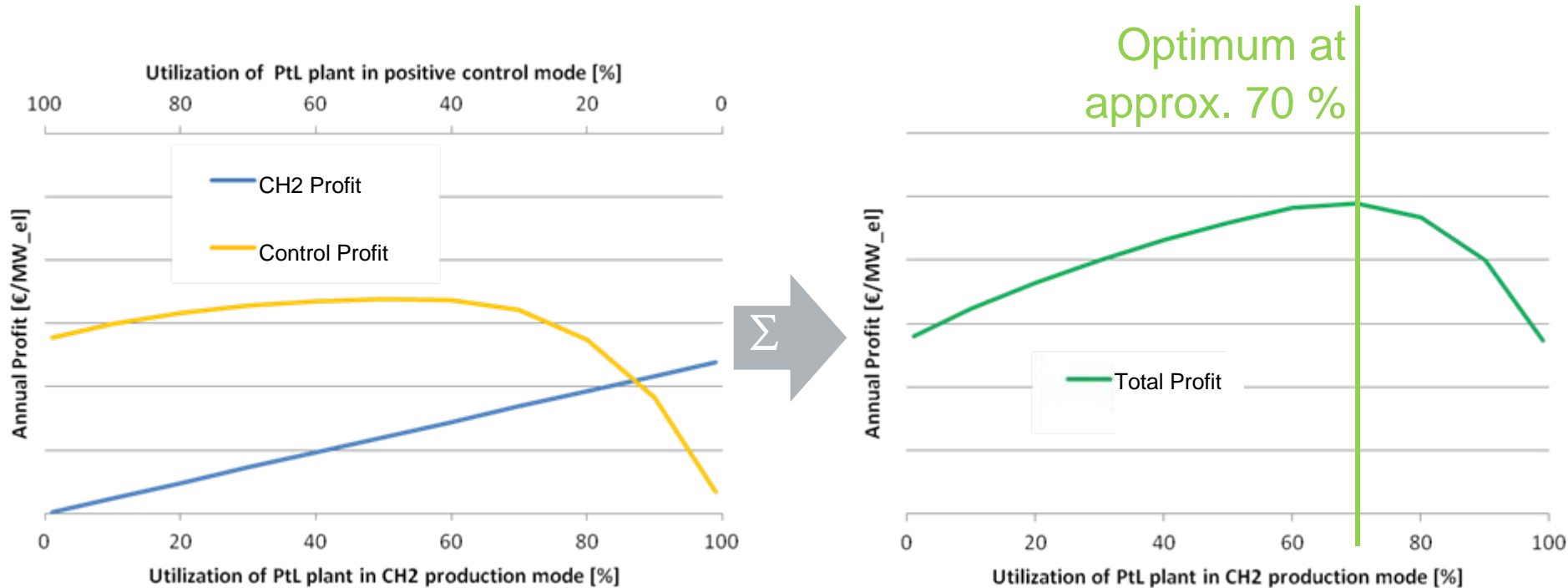


The renewable electricity “production” should always exceed the demand for electricity. The deviation can then be balanced by e.g. PtL and PtG plants.

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

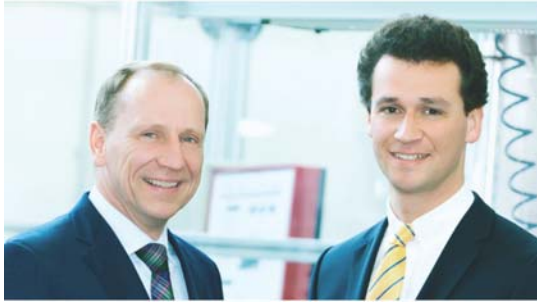
also enables the plant to increase its total economical profit.



Who is sunfire?

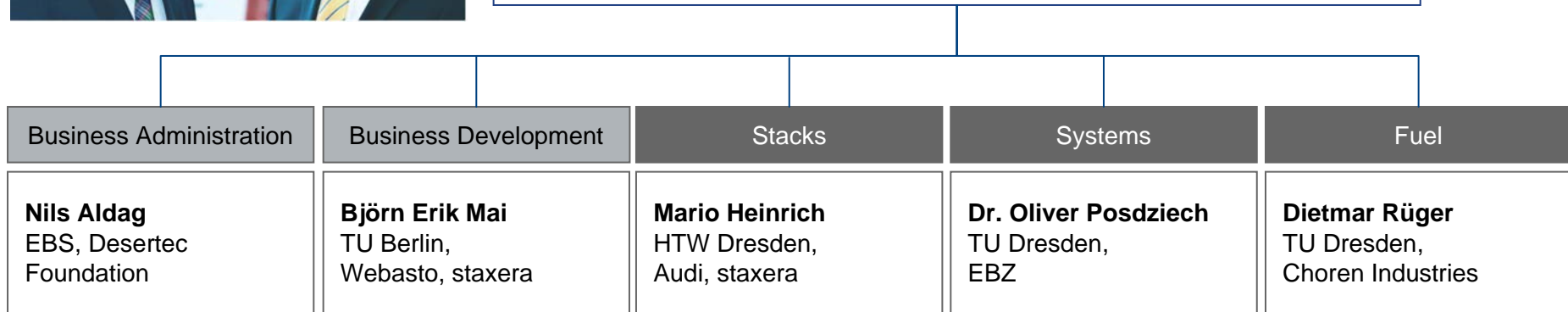
Company facts & partners

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



History

sunfire founded in 2010 (**staxera** 2005), staxera merged into sunfire in 2012, Bilfinger entry in 2012

Employees

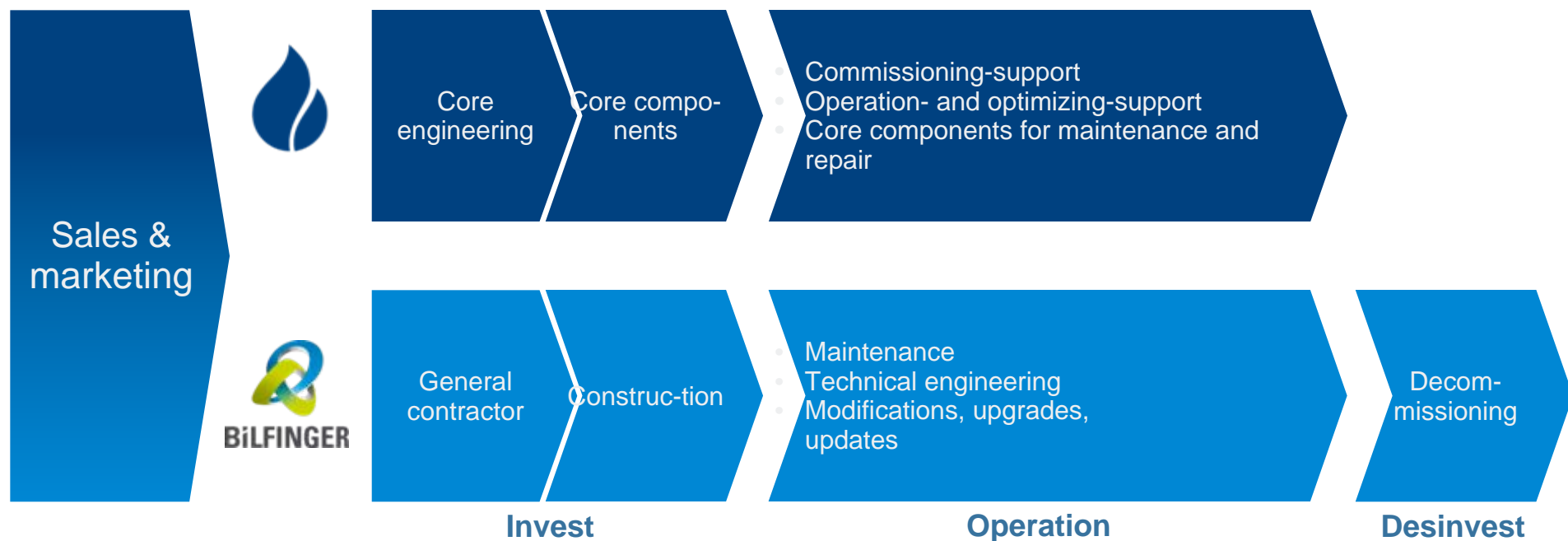
53 (47 engineers and technicians, 6 business graduates)

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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