Power-to-Liquids as a new Energy Option
Potentials and Difficulties/ Uncertainties
01. Potential: Production methods for renewable CO₂-based fuels
02. Challenge: Road-to-Market
03. Uncertainty: Politics, Markets and Willingness-to-Pay
04. Company facts and partners
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.
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.

\[
\text{CO}_2 + 4 \text{H}_2 \rightarrow \text{CH}_4 + 2 \text{H}_2\text{O}
\]

- 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”

Spec. costs of SOCs

R&D (SOFC & SOEC)

Small demo projects (e.g. Callux)

Offgrid SOCs (e.g. telecom)

PtL- & PtG-demonstration

CHP & PtG

CHP, PtG & PtL

Production volume
Road-to-Market Strategy and timeline

Markets
- microCHP, 1-2.5 kW
- Off-grid, >2.5 kW
- smallCHP, >25 kW

Gas-to-Power

Power-to-Gas
- Storage, >2 MW
- Chemicals, >10 MW

Power-to-Liquids
- Fuels, >50 MW

2013
- SOFC
- Field test

2014
- R&D project (Storage / Chemicals / Fuels)

2015
- Pre-commercial & market entry

2016
- Demonstration & commercialization

...
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
Groundbreaking for demo plant at 22nd of July 2013 & construction progress after three months.
Still (as well) a political uncertainty: Markets & Willingness-to-Pay
Markets for PtG and PtL

**Production method**

- PtG
- PtL

**Products**

- SNG
- Methanol
- Waxes
- Gasoline/Diesel
- Kerosene

**Markets**

- Energy storage
- Traffic
- Chemical industry
- Premium fuels
- Quota fuels
- Aviation

PtG (Power-to-Gas) and PtL (Power-to-Liquids) as new energy options are explored, focusing on various products like SNG, Methanol, Waxes, Gasoline/Diesel, and Kerosene, and markets such as Energy storage, Traffic, Chemical industry, Premium fuels, Quota fuels, and Aviation.
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).

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

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<thead>
<tr>
<th>Name</th>
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<tr>
<td>Nils Aldag</td>
<td>EBS, Desertec</td>
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<td>Foundation</td>
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#### Business Development

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<tr>
<td>Björn Erik Mai</td>
<td>TU Berlin, Webasto, staxera</td>
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#### Stacks

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<tr>
<td>Mario Heinrich</td>
<td>HTW Dresden, Audi, staxera</td>
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#### Systems

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<td>Dr. Oliver Posdziech</td>
<td>TU Dresden, EBZ</td>
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#### Fuel

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<td>Dietmar Rüger</td>
<td>TU Dresden, Choren Industries</td>
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### 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

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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
- Corporate sales & marketing
  - sunfire: Engineering & core components
  - Bilfinger: General contractor & construction
Thank you for your attention