Examples for PtX Applications using Fischer-Tropsch

Challenges and Opportunities

18.10.2018

Nils Aldag
Managing Director & Founder

Investors

Company Facts

Strategy

- Leading provider of electrolysers and fuel cells based on one Solid Oxide Cell technology
- Provide and operate hardware in emerging gigawatt markets of renewable gases and fuels
- Project development for commercial projects (fuels and gases as a service)

Knowhow

- ~120 Employees
- Skills in Ceramics, Stack + System Production, Engineering, Synthesis Processes, etc.

Investors

ELECTRANOVA CAPITAL
idinvest PARTNERS
INVIEIN CAPITAL CEZ GROUP
KFW
TOTAL

Patents

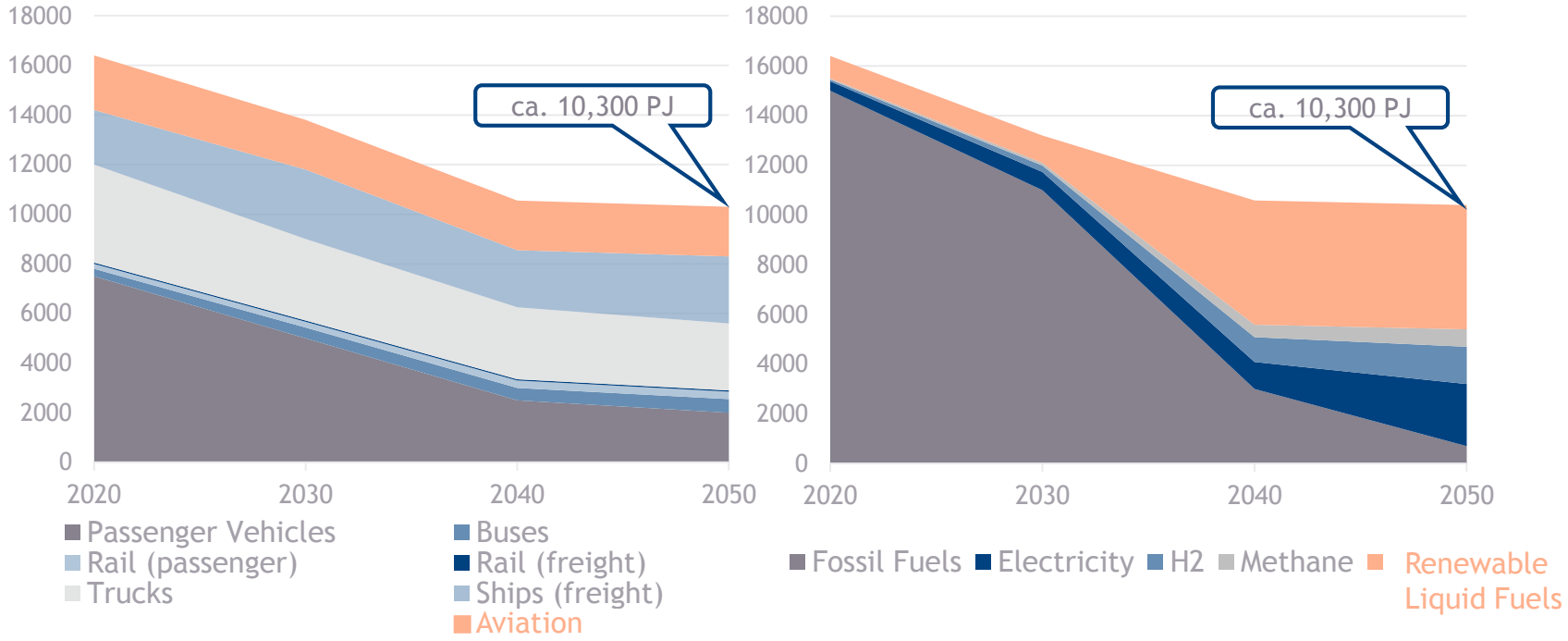
- Over 50 patent families (i.e. »process patent sunfire« WO/2008/014854)

Revenues

- Multi-million Euro Revenues in Global Markets since 2011

e-Fuel: A Necessity for Transport to Tackle Climate Change

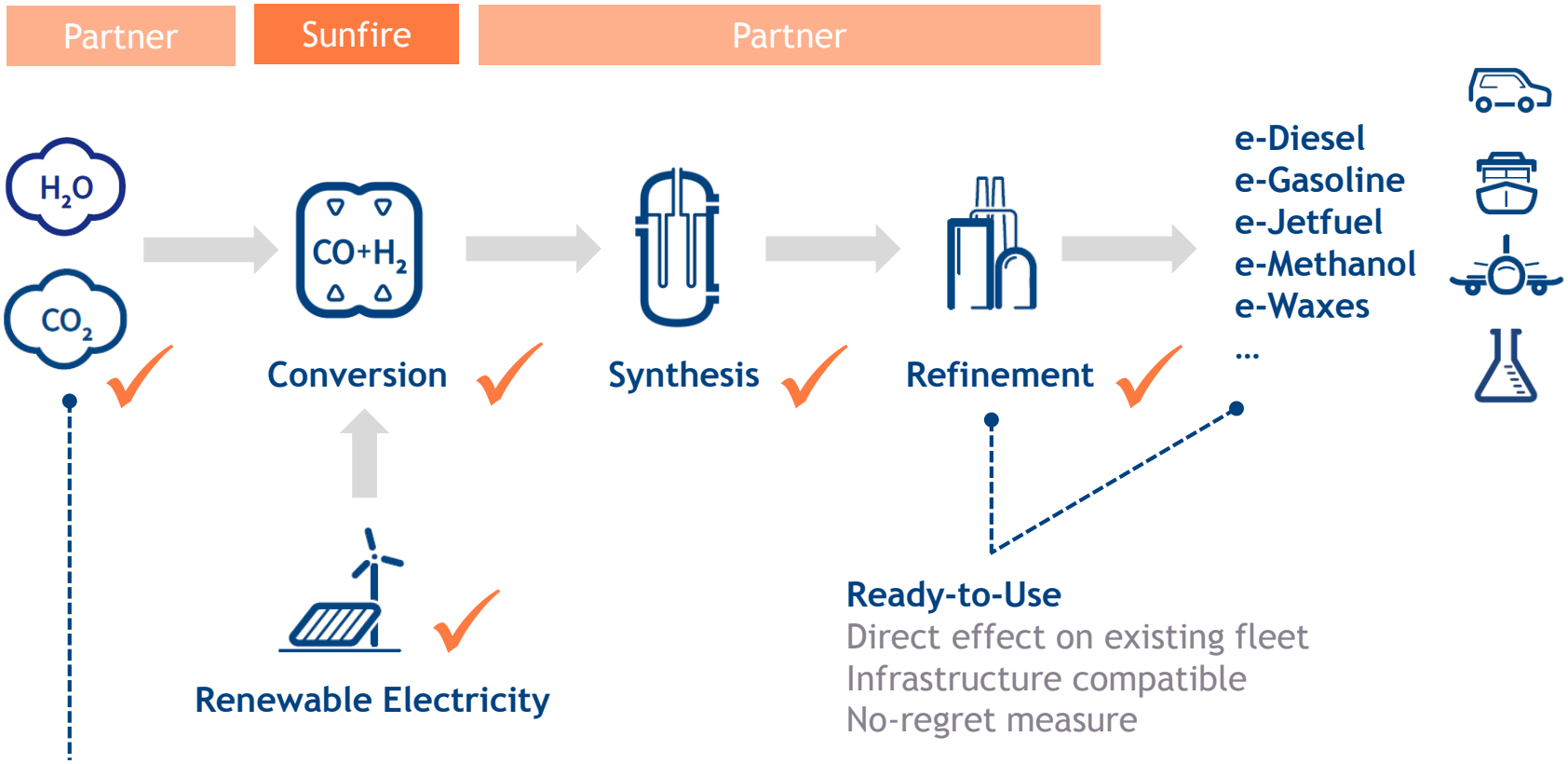
Anticipated primary-energy consumption of the EU transport sector



+ To achieve CO_2 reduction targets, fossil fuels need to be phased out
+ Hard-to-electrify sector will make up 50 % or 5,000 PJ in 2050
+ >300 GW of e-Fuels needed in 2050 (>10 GW/a from now)

Calculation based on dena/LBST „E-Fuels -The potential of electricity based fuels for low emission transport in the EU", 2017

Sunfire Process for e-Fuel Production



Differentiating Key Themes

+ **Highest efficiencies** leading to lowest total cost of ownership (TCO)

+ **Direct conversion of carbon molecules** to provide clean solutions for the energy transition in all sectors

+ **Non-toxic, no critical and no expensive materials** for easy manufacturing

"When steam can be generated from waste heat sources, such as in steelmaking, high temperature electrolysis is the most efficient technology."

Prof. Dr.-Ing. Heinz Jörg Fuhrmann, Chief Executive Officer and Chairman of the Executive Board of Salzgitter AG

Pilot-/ Demonstration Phase: Germany (2013 - 2014)

Project details:

+ Products: e-Diesel, e-Gasoline, e-Wax
+ Capacity: max. 60 t/a
+ Electricity: ~ 0.18 €/kWh (grid connected)
+ CO_2 source: Bioethanol (trucked)
+ Production costs: > 5 €/l
+ 50 % CAPEX funding from government

Challenges:

+ Full energy taxes and levies
+ No regulation regarding CO_2 sources
+ No regulation regarding e-Fuels

→ No business case!

Installation site

Prof. Dr. Wanka fueling with produced e-Diesel

Commercial Phase: Norway (expected after 2021)

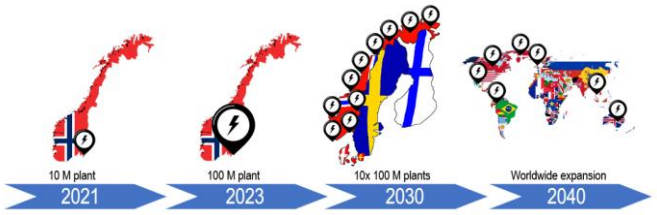
Project details:

- Products: e-Crude (requires upgrading to e.g. e-Diesel, e-Gasoline, e-Wax)
- Capacity: ~8.000 t/a
- Electricity: ~0.02 €/kWh (water power)
- CO_2 source: Industrial (pipeline)
- Costs: <2.5 €/l (offtake agreements in place)
- No funding

Installation site

Challenges:

- New EU regulation on CO_2 sources unclear
- New EU regulation on electricity supply unclear
- RED II enables accounting of fuel, but no support through CO_2 emission standards



Roadmap with NBC

→ No business case yet, but business case repetitive if favorable (EU) regulation

How to Initiate a Short-Term Roll-Out?

+ German government has introduced the idea of creating "Reallabore" to enable *regulatory learning*, *experimental regulatory clauses* and provide funding to enable commercial Power-to-X projects

+ German government will provide 100 M€ per year

+ Idea of OPEX instead of CAPEX funding (e.g. 400 €/tCO_2 abated) and support through experimental regulatory clauses suggested by Sunfire

→ This could help to overcome the phase of regulatory uncertainty for e-Fuel use in the EU

7. Energieforschungsprogramm

Summary

- e-Fuels are an undisputed necessity to fulfil the global climate targets
- All necessary processes steps have been demonstrated in multiple locations and are available at TRL 7 - 9 → Technology is not the problem!
- Regulatory uncertainty is delaying the roll-out of e-Fuels
  - Permit the use of all unavoidable CO_2 sources
  - Enable the use of renewable electricity purchased through the grid
- Temporal support schemes like "*Reallabore*" can only be a "workaround" to the current unsatisfactory regulatory environment
- As world leader in electrolysis and Power-to-X processes, Sunfire is best positioned to cater growing demand

THANK YOU!

ENERGY
EVERYWHERE

Nils Aldag
CCO and Managing Director
Nils.Aldag@sunfire.de

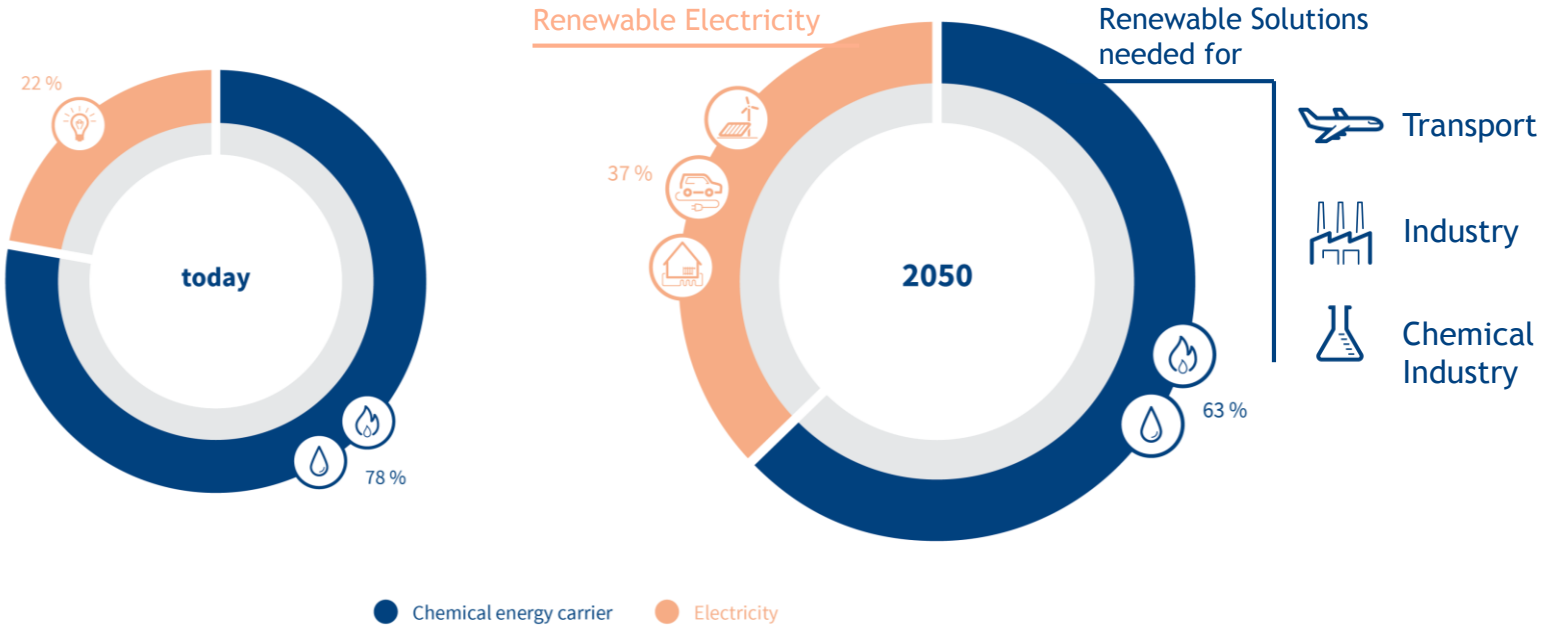
sunfire GmbH
Gasanstaltstraße 2
01237 Dresden
Germany

W: www.sunfire.de

Bringing the Energy Transition to the Next Level

+ Even in scenarios with large increase of direct electrification liquid energy carrier remain necessary to cover the global energy needs in 2050

Energy Consumption by Carrier



Source: IEA, June 2017
World Energy 2014-2050, Political economist, 2014