BioZEG; standalone production of hydrogen and electricity from biomass

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ZEG Power

OUTLINE

- The **ZEG**-technology
- **ZEG Power** as - the company
- **BioZEG** - the project
  - Status technology development

The ZEG - technology

High efficient co-production of electricity and hydrogen from hydrocarbon gases with integrated CO_2- capture

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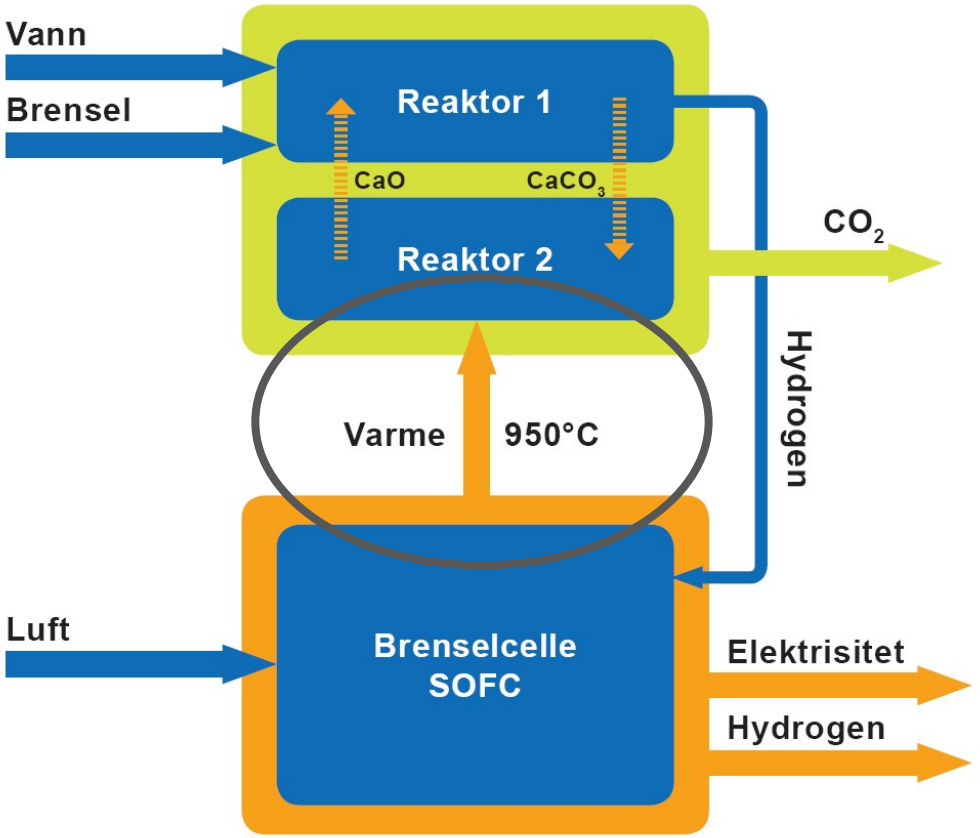
ZEG-teknologien (ZEG®)

- Samtidig produksjon av elektrisitet og hydrogen fra hydrokarboner med integrert CO_2-fangst
- Elektrisitet fra høytemperatur brenselcelle (SOFC)
- Hydrogenproduksjon ved reformeringsteknologi (SE-SMR) ved bruk av spillvarme fra SOFC
- Høy virkningsgrad (80 - 90%)
- Patentert teknologi



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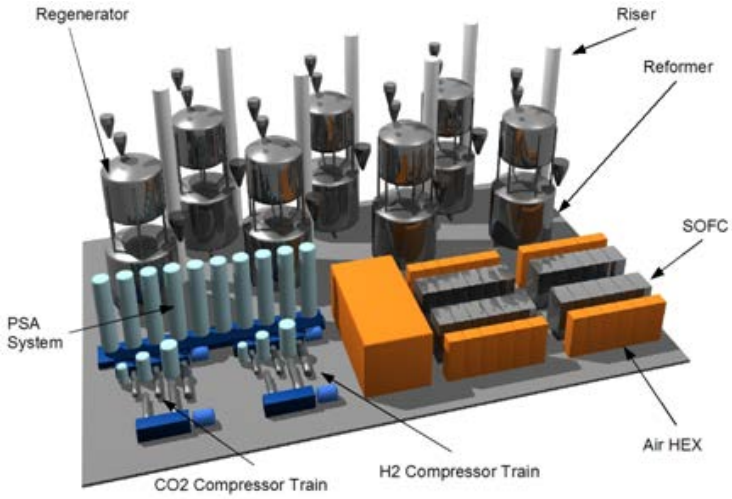
ZEG Power – more efficient, lower costs

- >80% energy efficiency
- Electricity and hydrogen with CO_2-capture at lower costs
  - NOK 0.33 / kWh from ZEG Power plant (400MW)
- All hydrocarbons can be used
  - Natural gas, biogas, gasified coal/tar/oil/biomass
- No emissions
- Flexible amounts of electricity, hydrogen (and heat)



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Superior technology for high-efficiency energy production from hydrocarbons, with integrated CO_2 - capture

Business idea

- Industrialization of the ZEG technology
- Offer unrivalled efficiency and environmental friendly energy production
- Bridging the gap to sustainable energy supply

Main objective

- Design, build and verify the patented ZEG-technology for commercial power plants at increasing size

Joint venture between two Norwegian research institutes

- Institute for Energy Technology & Christian Michelsen Research

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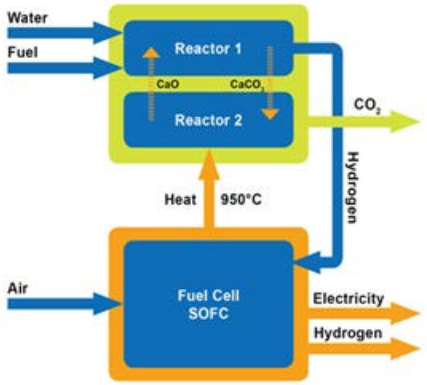
Why BioZEG?

- Cost-effective stand alone green production of hydrogen and electricity
  - Local, cheap resources (waste)
    - Biogas, cleaned landfill gas
    - Gasified biomass or organic waste
  - CO_2 capture included; negative climate contribution if sequestered, used locally or stored - otherwise climate neutral
  - No emissions
- Direct use
  - Transportation; electrical powered, hydrogen powered, plug-in hydrogen/batteries hybrid solutions
- Processing, bio refinery
  - Methanol
  - Bio-oil upgrading
- Combined, hybrid solutions



ZEG; only technology with positive economy

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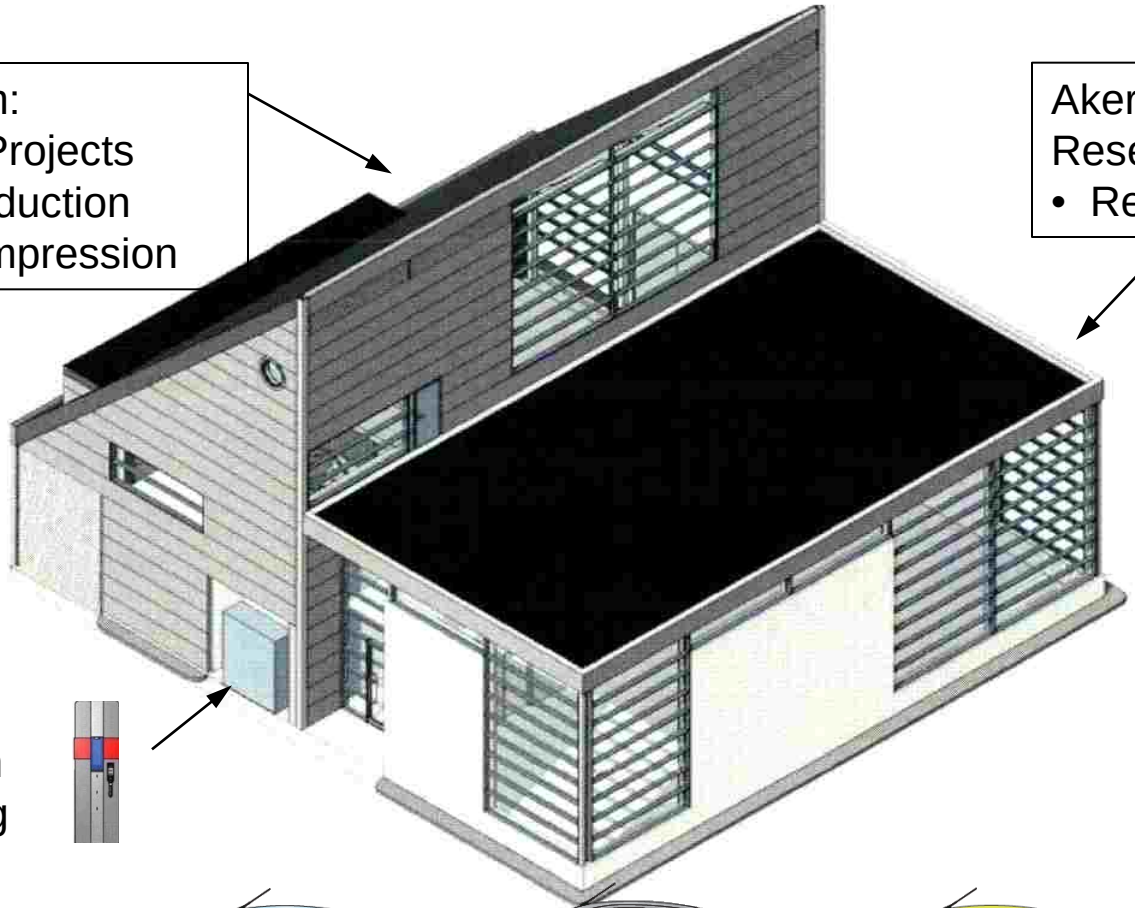
HyNor Lillestrøm
From Renewable Energy to Hydrogen for Fuel Cell Vehicles

HyNor Lillestrøm:
Demonstration Projects
- Hydrogen Production
- Hydrogen Compression

Akershus Energy:
Research Projects
- Renewable Energy



Hydrogen
Refuelling

Hydrogen
Fuel Cell Vehicles

Hynor Lillestrøm

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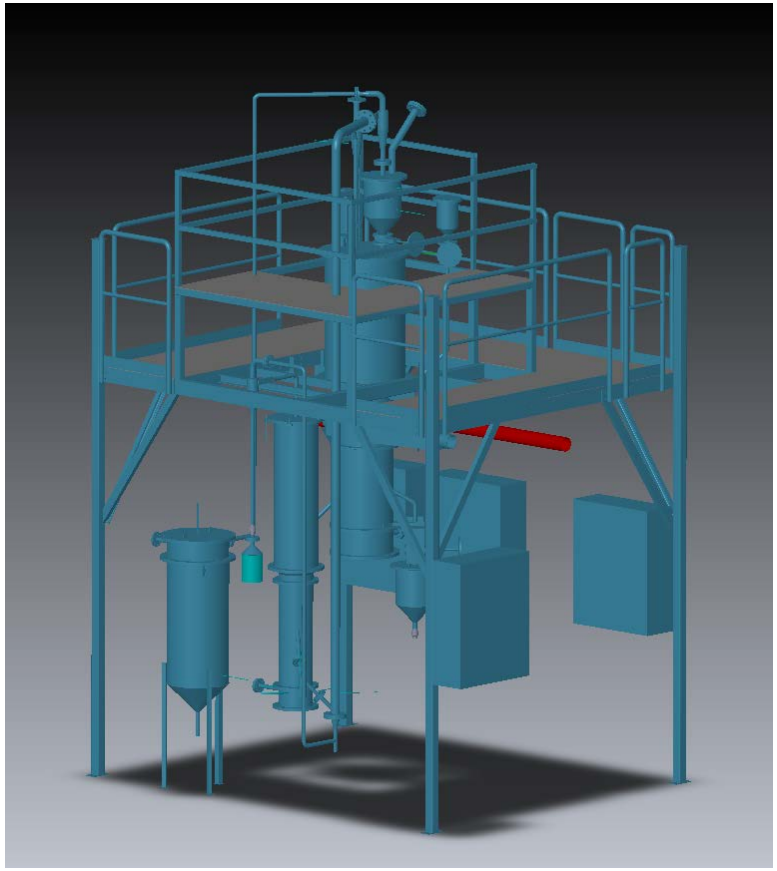
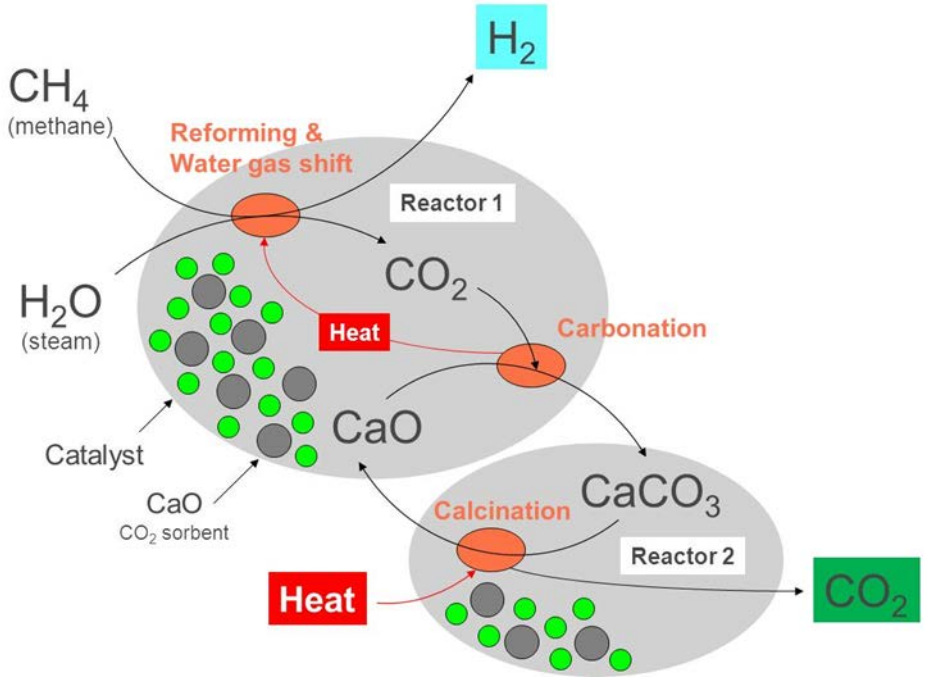
SESMR Demonstration (IFE)

with Fluidized Bed Reactor Technology





IFE

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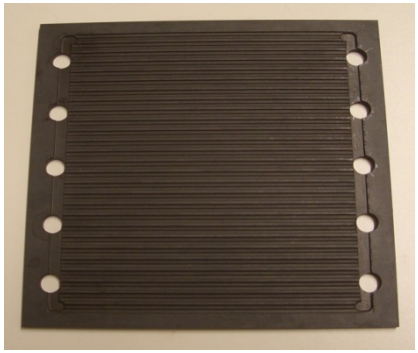
SOFC - development; new stack design



SOFC cell and interconnect

- Increased size
- Thinner membranes
- Interconnects with internal fuel manifolds
- 40 cell stack from end of 2011

Ceramic interconnects for SOFC

- Cause no degradation effects on the cells
- Allow operation above 900 ºC
- Increased power density and sulphur tolerance
- Can deliver process heat for high efficiency systems

Typical applications

- Applications for continuous operation
- Electricity and/or hydrogen production (ZEG Power)
- SOFC / Gasification systems
- Biogas

Requirements

- High quality production of ceramic components
- Correct managing of the operation conditions

cmr Prototech

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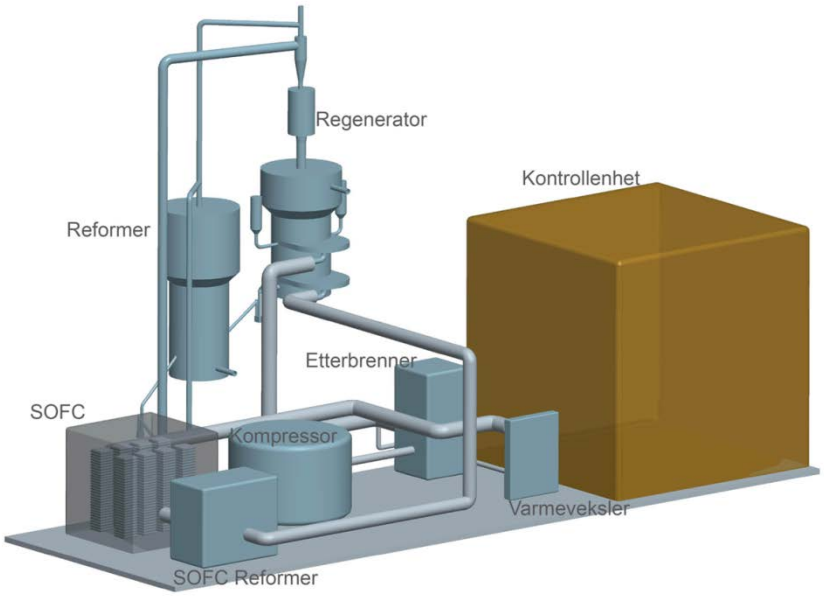
BioZEG – demonstration, HyNor Lillestrøm Phase 2

- Objective:
  - Thermal Integration of SOFC & Regenerator (in SESMR)
- Input:
  - Biomethane (upgraded gas)
- Output:
  - Hydrogen (30 kWH_2)
  - Electricity (20 kWel)
  - CO_2



Status:

2011: Different technogical solutions for thermal integration are evaluated

2012: Detailed engineering, production

2013: Installation, testing

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ZEG Power key team

ZEG Power AS

- Bjørg Andresen, PhD – Management

IFE Venture AS

- Lars Bjørn Larsen, PhD - Business development

IFE

- Julien Meyer - SE-SMR reactor technology and design
- Johan Mastin, PhD - SE-SMR CO2 sorbents
- Øystein Ulleberg, PhD – Technical Advisor

Prototech AS

- Arild Vik – SOFC and new hybrid systems
- Ivar Wærnhus, PhD - SOFC development
- Tor Kristian Bjørnebøle - Systems design and modelling
- Tomas Rydberg – Product engineering

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Thank you for your attention!

BioZEG

superior technology for efficient production of green hydrogen

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