LUXINNOVATION

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BALANCE

Hydrogen – Hype or real business opportunity?
Mondorf-les-Bains 21 Feb 2019

Fuelling Transport with Zero Net Emission Fuels

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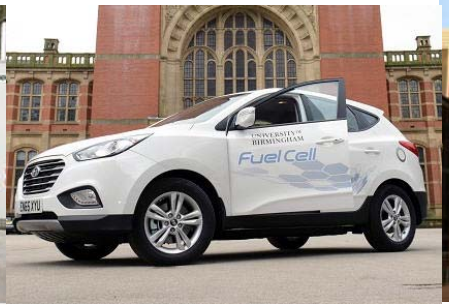
Centre for Fuel Cell & Hydrogen Research
School of Chemical Engineering



Centre for Fuel Cell & Hydrogen Research Overview

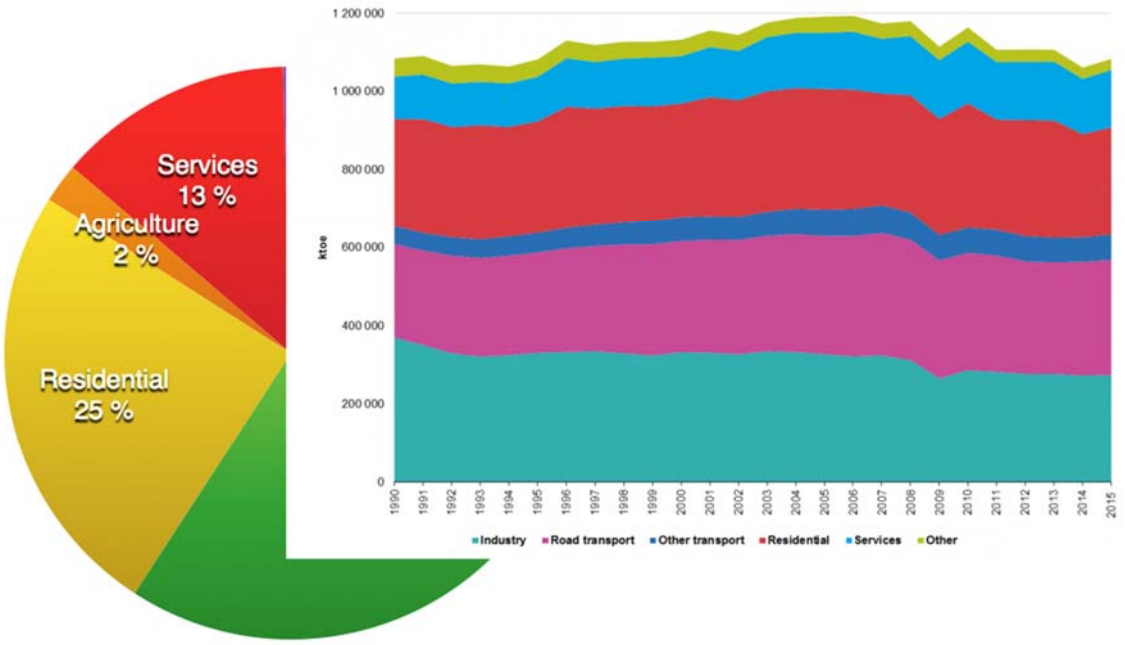
A group of 10 staff and ~35 PhD and MRes students working in:

- **Hydrogen and Synthetic Fuel Production**
- **Low Temperature Fuel Cells & Electrolysis**
- **High Temperature Fuel Cells & Electrolysis**
- **Socio-economic topics**
- **Educational initiatives**

The primary application is:

- Integration of fuel cell systems on vehicles

Motivation: Energy Use EU 2015



Source: EUROSTAT

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Hype??

Toxic air a 'national health emergency' responsible for 40,000 early deaths and £20bn in costs each year, MPs warn

'It is unacceptable that successive governments have failed to protect the public from poisonous air'

Each car in London costs NHS and society £8,000 due to air pollution, report finds

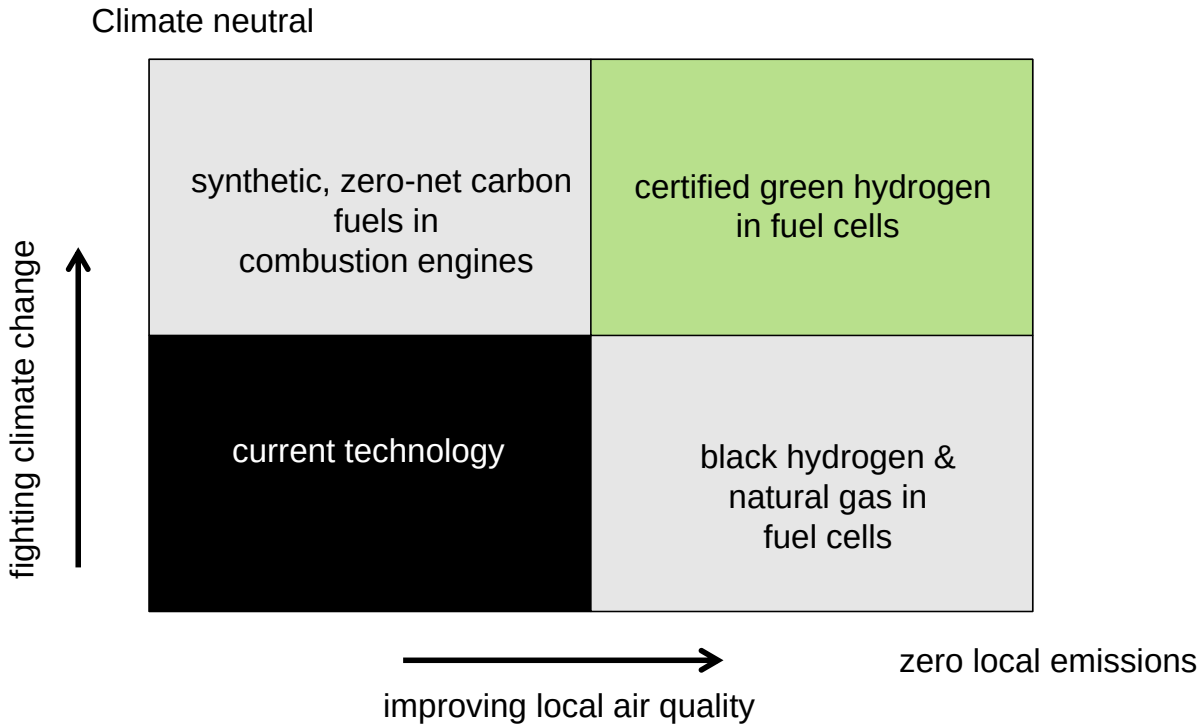
'We know the health impacts of air pollution, and now the economic case for cleaning up the air we breathe has been laid bare'

Extreme weather to cost UK billions and leave 2.5m homes at risk of flooding unless ministers take action, warns WWF

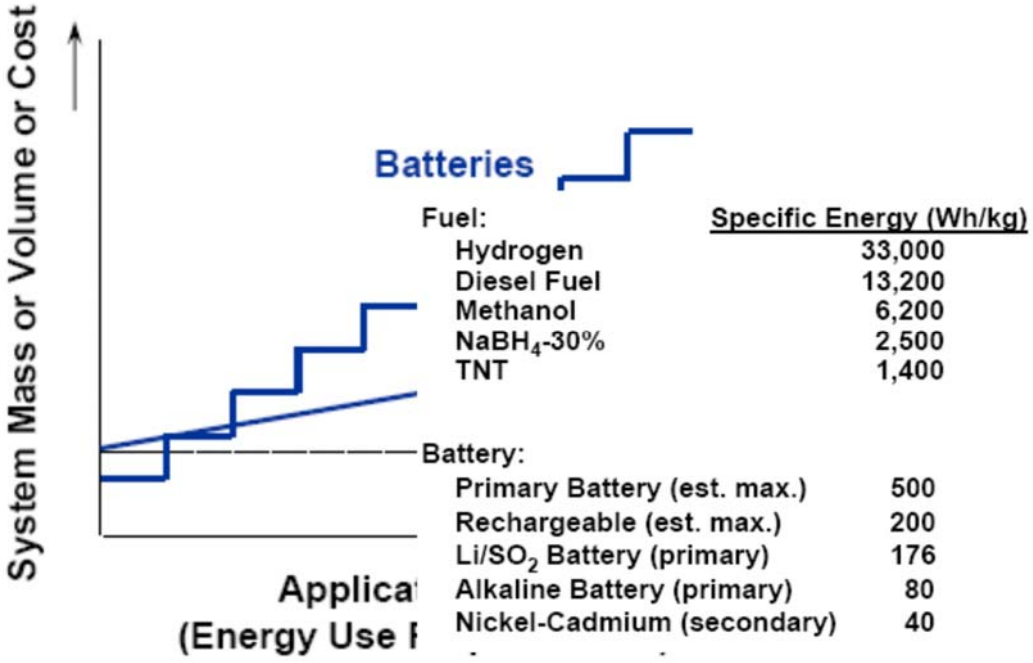
Report on the risks posed by climate change in 2050 warns there could be significant damage to the economy if it is not 'future-proofed'

Source: Independent/Dan Kitwood/Getty

Global vs. Local Zero Emissions

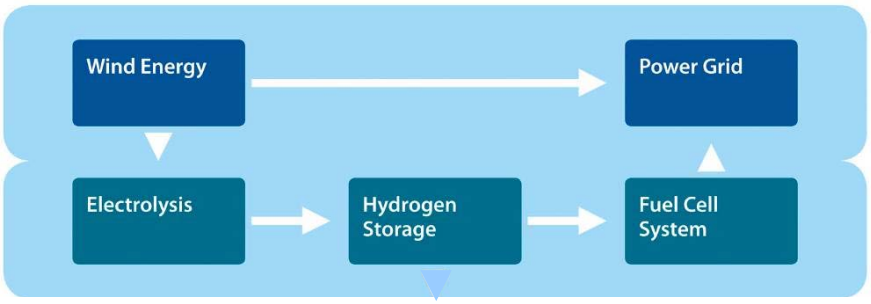


Competing with Batteries



Source: AZ State Univ

Hydrogen Grid Support Concept / Energy Storage
(HyWindBalance, 2004 - 2007)



CARL VON OSSIETZKY universität OLDENBURG

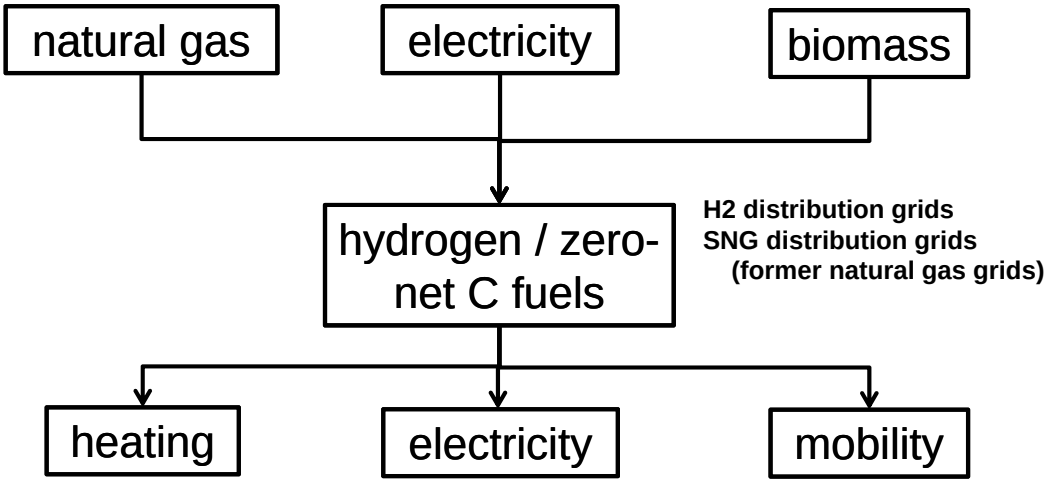
PLANET
Planungsgruppe Energie und Technik

- grid support / services
- energy storage
- security of supply
- firm power

nevertheless
- low round-trip efficiency

source: PLANET GbR

Transforming the Energy Infrastructure



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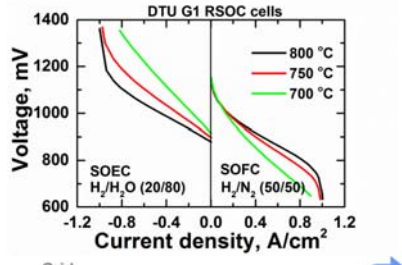
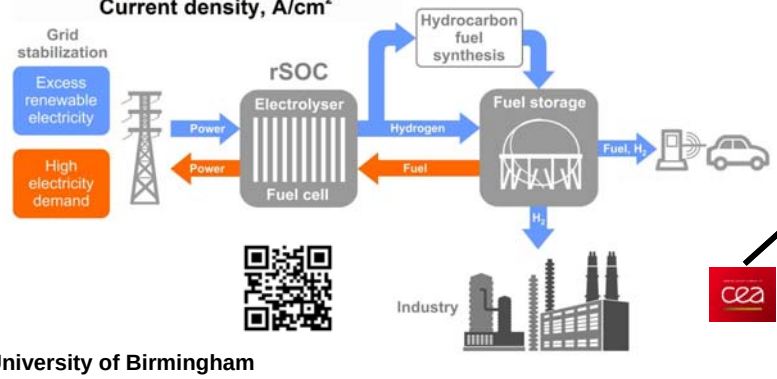
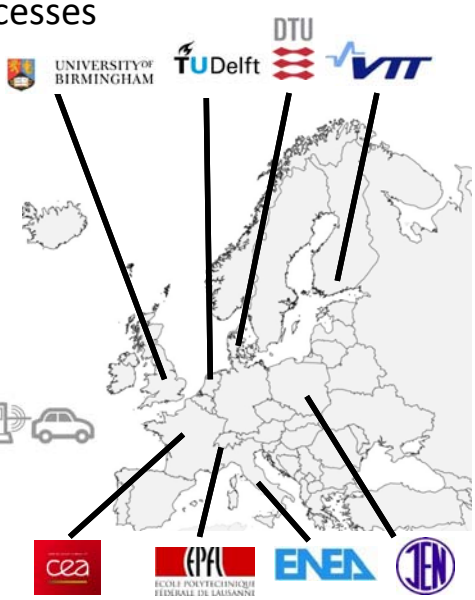
The BALANCE Project

Increasing penetration of renewable power, alternative fuels and grid flexibility by cross-vector electrochemical processes







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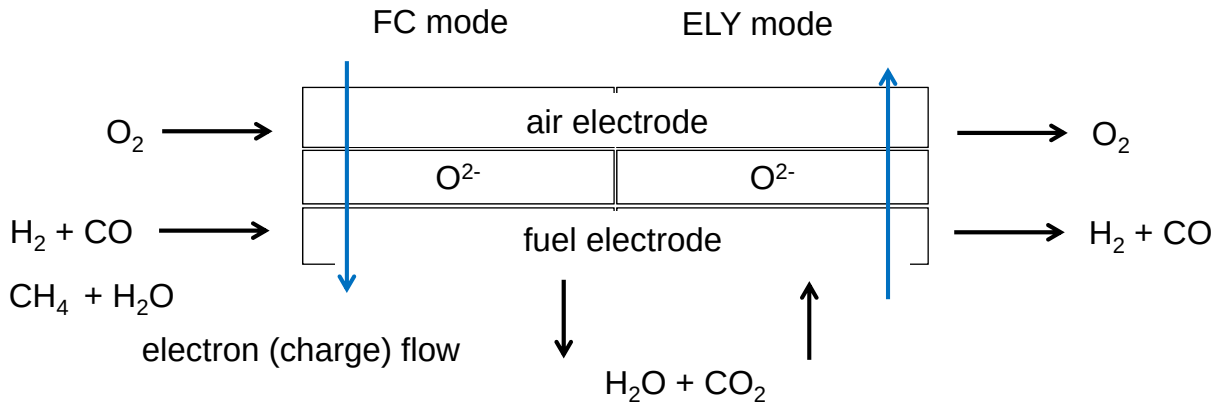
Reversible Fuel Cell (rSOC)



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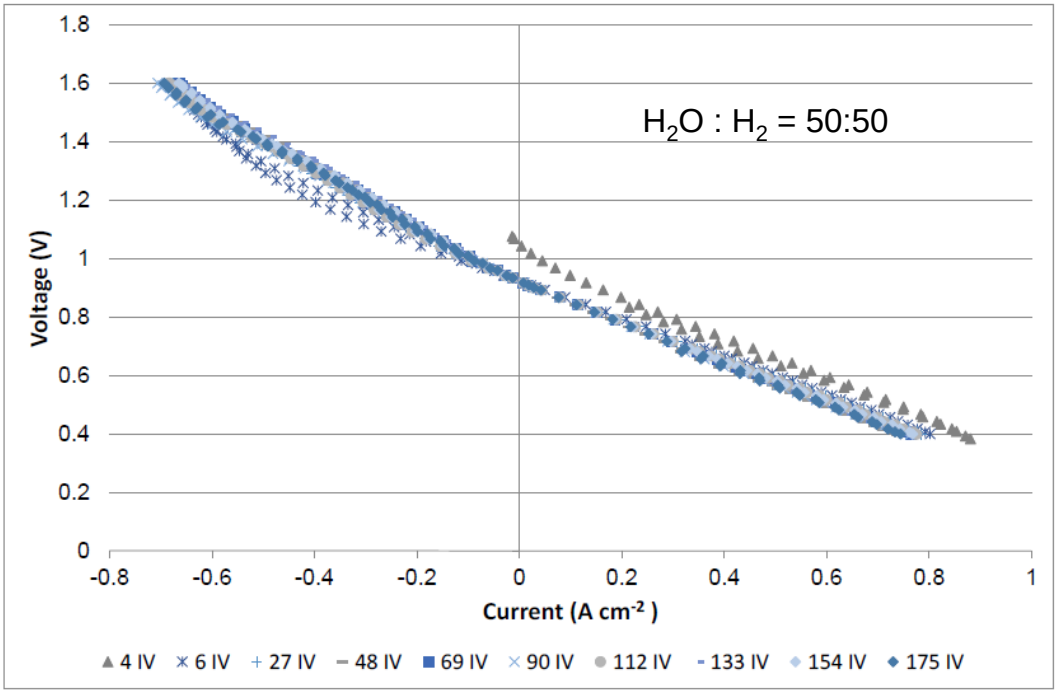
Reversible Operation on Hydrogen



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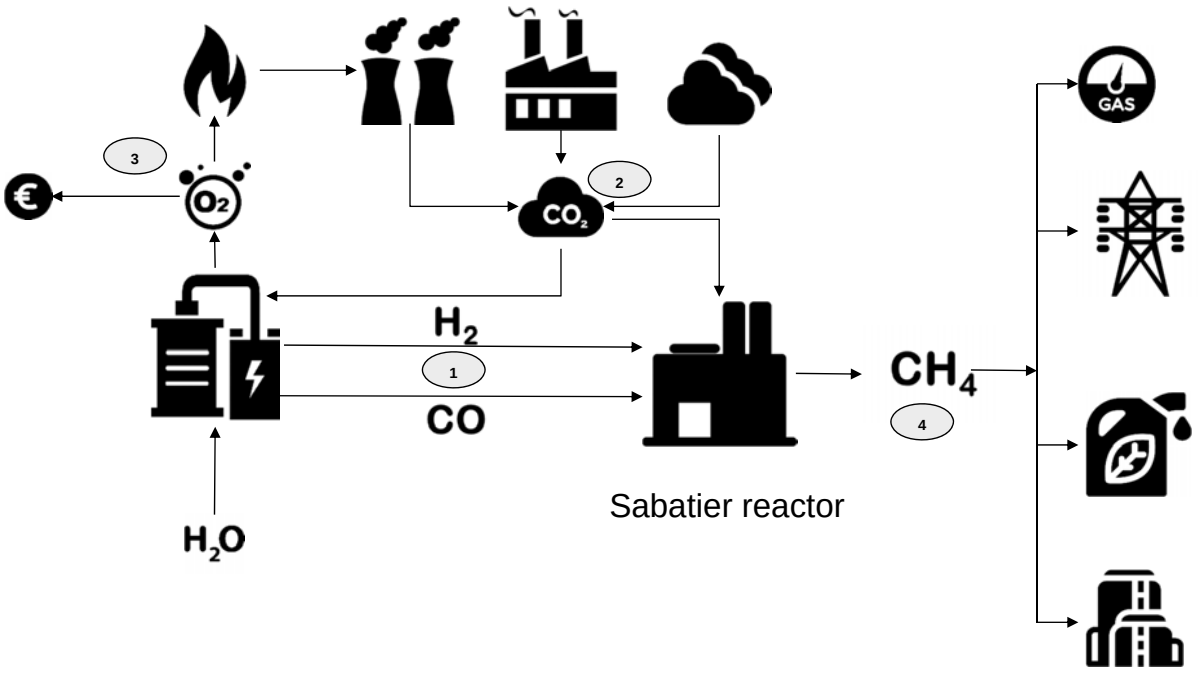
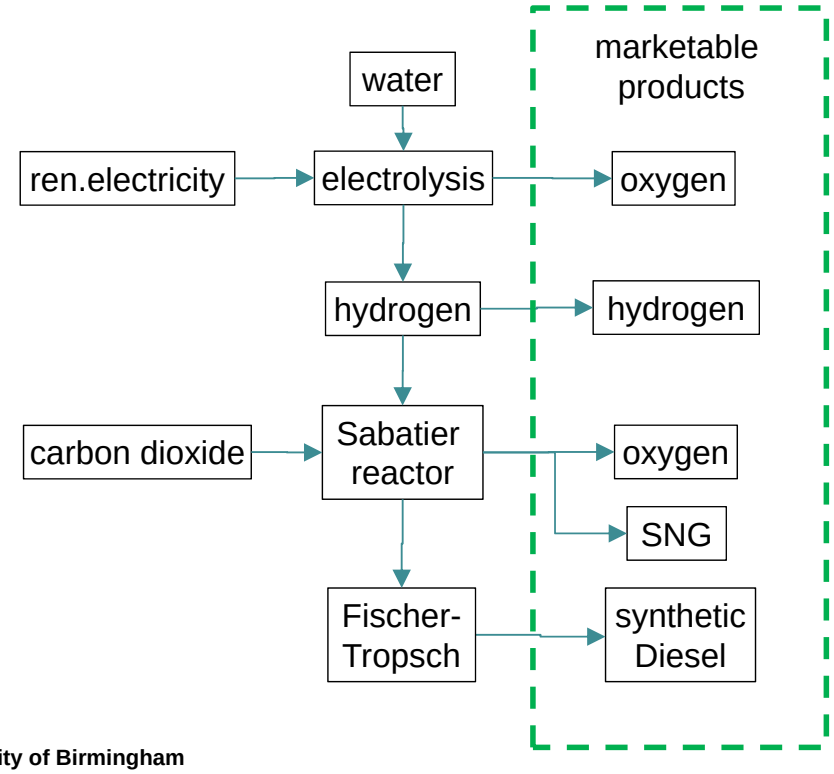
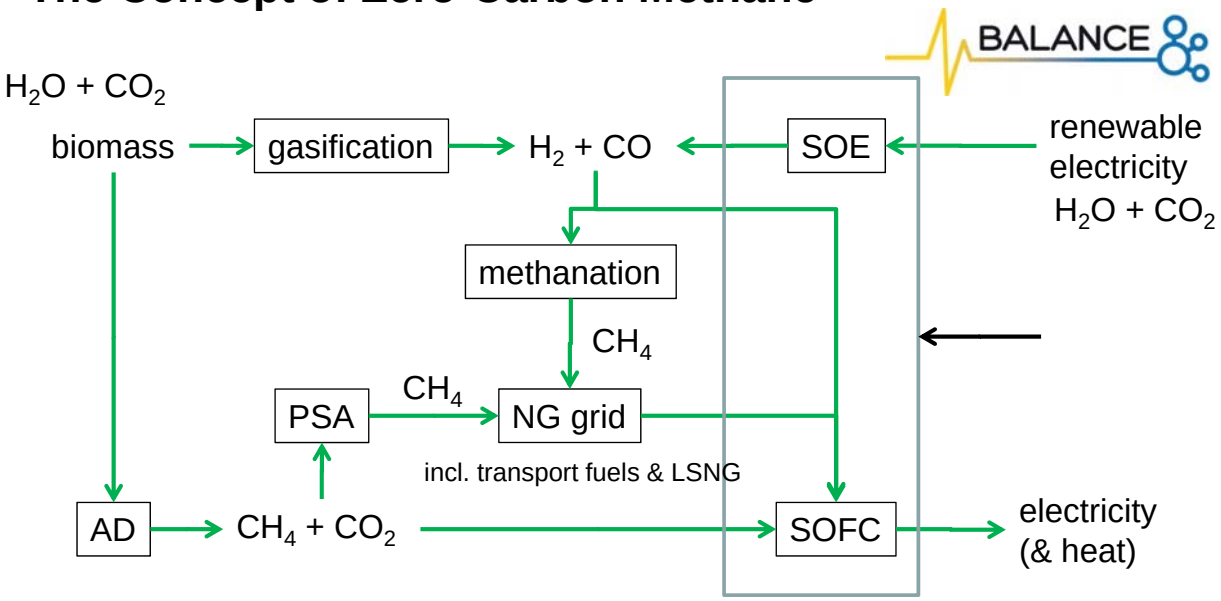
Power to Gas



P2G/P2L Product Supply Chain

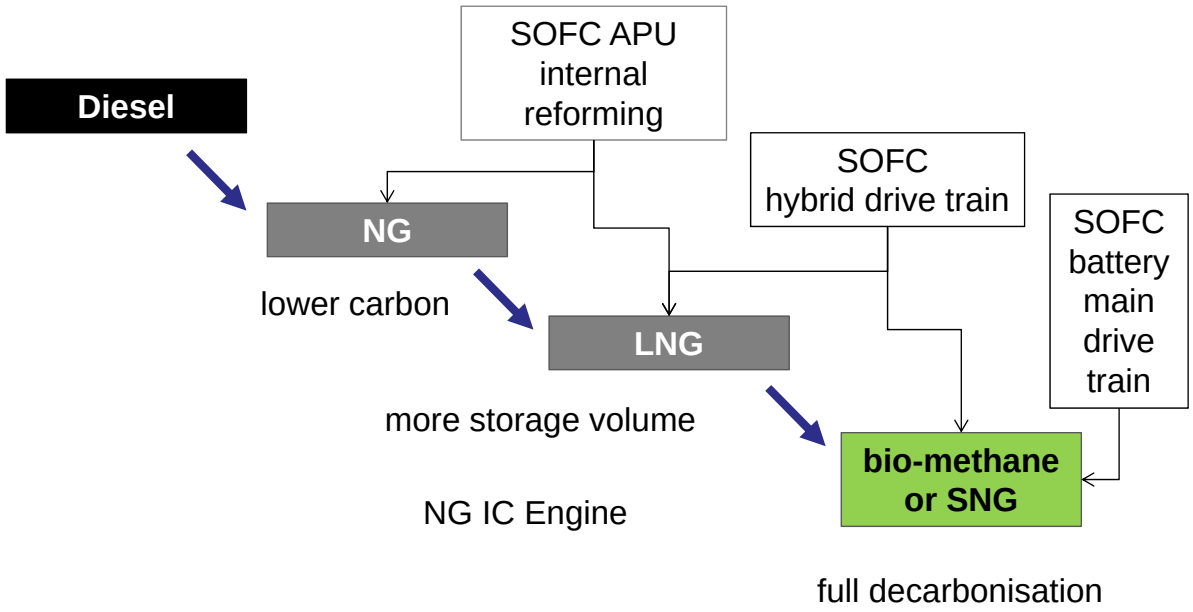


The Concept of Zero-Carbon Methane

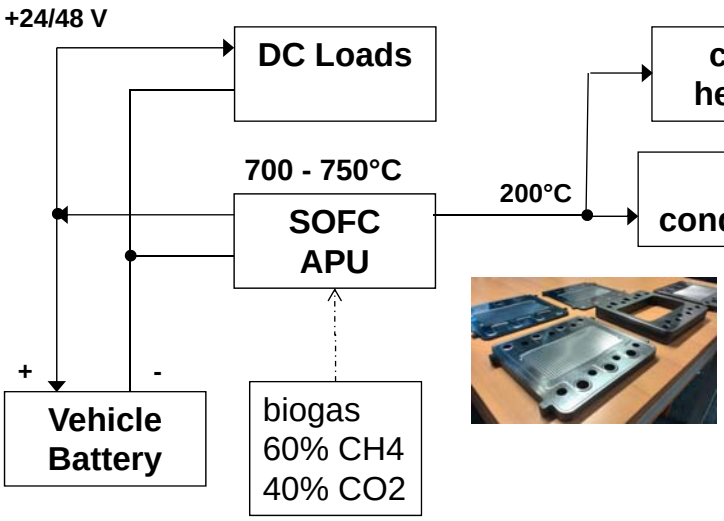


supplies synthetic natural gas for stationary applications and transport fuels without any fossil carbon conversion involved

Fuel Cell Propulsion for Freight Road Transport (HDV/HGV), Rail, Aircraft, and Maritime Applications



Electrical On-Board System Architecture with APU



MMLCR=SOFC

New Energy World JU
fuel cells & hydrogen for sustainability

Baltic Biogas Bus

ATI erc
ATI erc gGmbH

PLANET GbR

- no gas processing
- high electrical efficiency >50%

www.balticbiogasbus.eu

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Zero-Carbon Methane for Electrifying Large Vehicles

- ✓ from biomass and P2G (SNG)
- ✓ fully compatible with natural gas (NG) grid infrastructure
- ✓ compatible with NG/LNG trend
- ✓ zero-carbon fuel with considerable reductions in CO, NO_x, SO_2, particle and noise emissions

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SOFC and SNG as a solution to electrifying large vehicles

- compatibility with NG infrastructure
- compatibility with biomass-based fuels & with NG/LNG trend
- option to hybridise vehicles with existing NG engine technology
- option to take over full vehicle energy provision from SOFC
- electricity demand for electric vehicles is ~35% of ICE vehicles (in shipping probably more like 50%)
- with SOFC efficiency of 65% this would mean ~50% reduction in transport energy use
- zero emissions apart from recycled CO_2
- source of CO_2 in the future?

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Enter the ‚Hydrogen Economy'

- decarbonisation of transport, electricity, and transport fuel markets
- also includes decarbonisation of industry

but

- conversion of distribution infrastructure, including organisational, asset destruction, and investment issues
- source of electricity
- use of depletable resources and high cost of waste disposal for NG/CCS schemes

therefore

- a ‚hybrid' system in which H_2 only plays a partial role will be more intelligent

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Thank you for listening and happy to answer any questions

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Chair in Fuel Cell & Hydrogen Research

Upcoming events:

BALANCE

BALANCE Workshop – **22/23 May 2019**, Bruges, Belgium.

Fuel Cell Systems Workshop – **21/22 May 2019**, Bruges, Belgium.

EFCF 2019 – Low Temperature Fuel Cells, Electrolysers, and Hydrogen Handling – **2 to 5 July 2019**, Lucerne, Switzerland
www.efcf.com

JESS 2019 – Joint European Summer School,
16 to 21 & 23 to 27 Sept 2019, Athens
www.jess-summerschool.eu