



UNIVERSITY OF
BIRMINGHAM

The Learning Centre

Decarbonising Freight Transport with Hydrogen-Based Alternative Fuels

Robert Steinberger-Wilckens
School of Chemical Engineering
University of Birmingham

Quantifying Health Cost

**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'

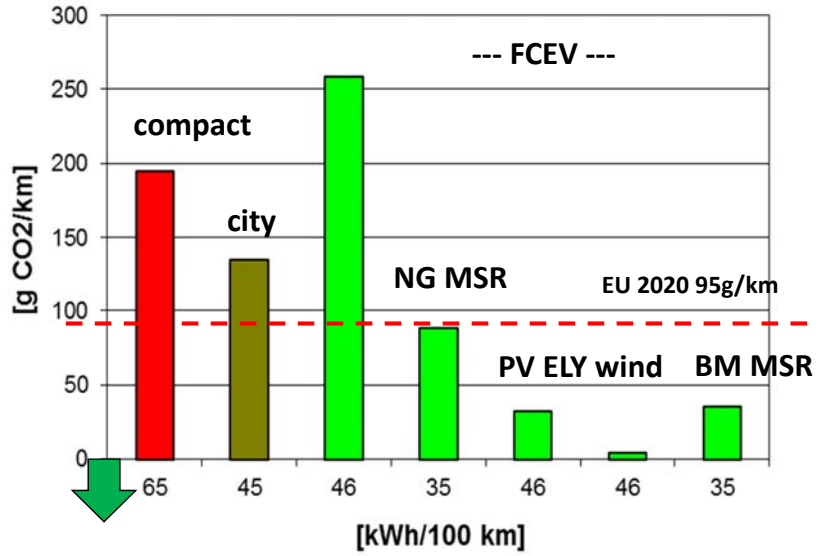
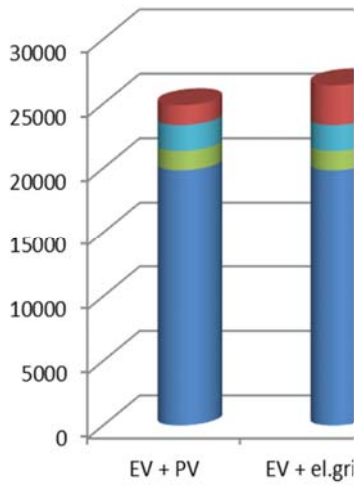
**Each car in London costs NHS and
society £8,000 due to air pollution,
report finds**

'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'

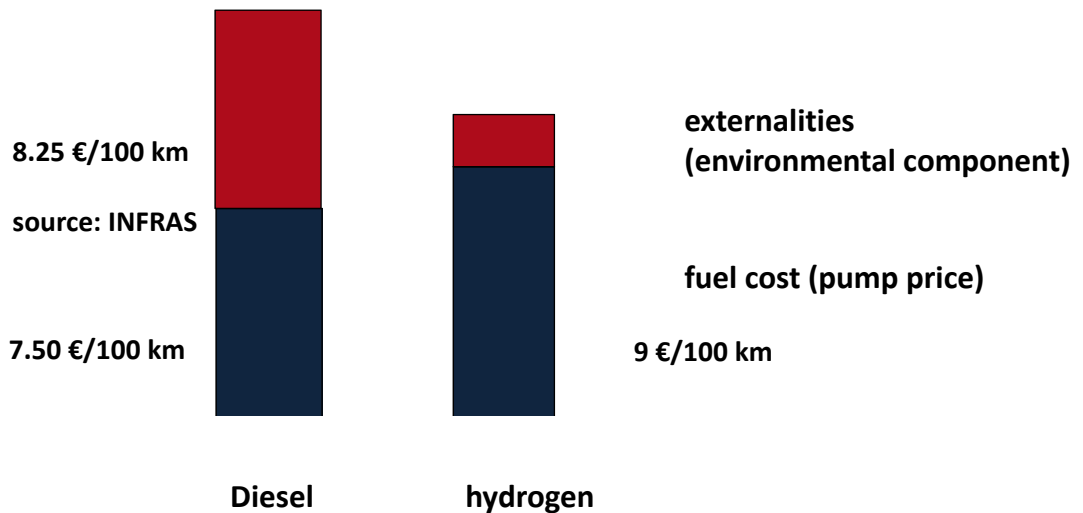
Investment Decisi



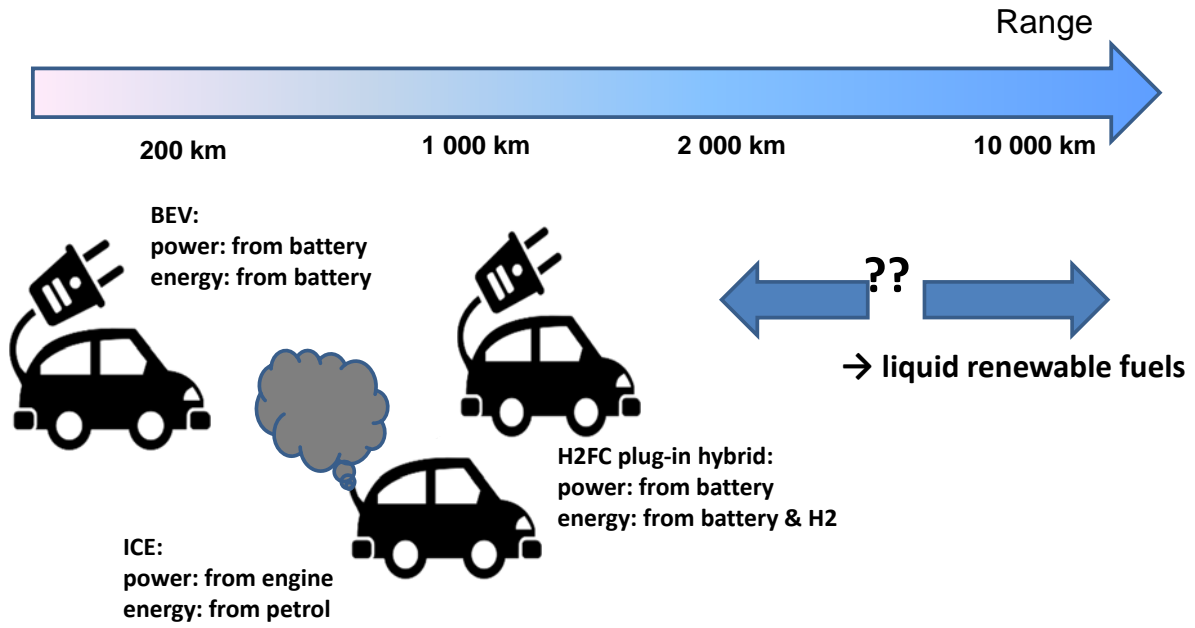
$$\begin{aligned}
 &+ t * \eta * P * (C_{O\&M} + C_{ext}) \\
 &+ n * L \\
 &+ DECEX
 \end{aligned}
 \quad \left. \vphantom{\begin{aligned} &+ t * \eta * P * (C_{O\&M} + C_{ext}) \\ &+ n * L \\ &+ DECEX \end{aligned}} \right\} \text{OPEX}$$

Externalities of Passenger Vehicle

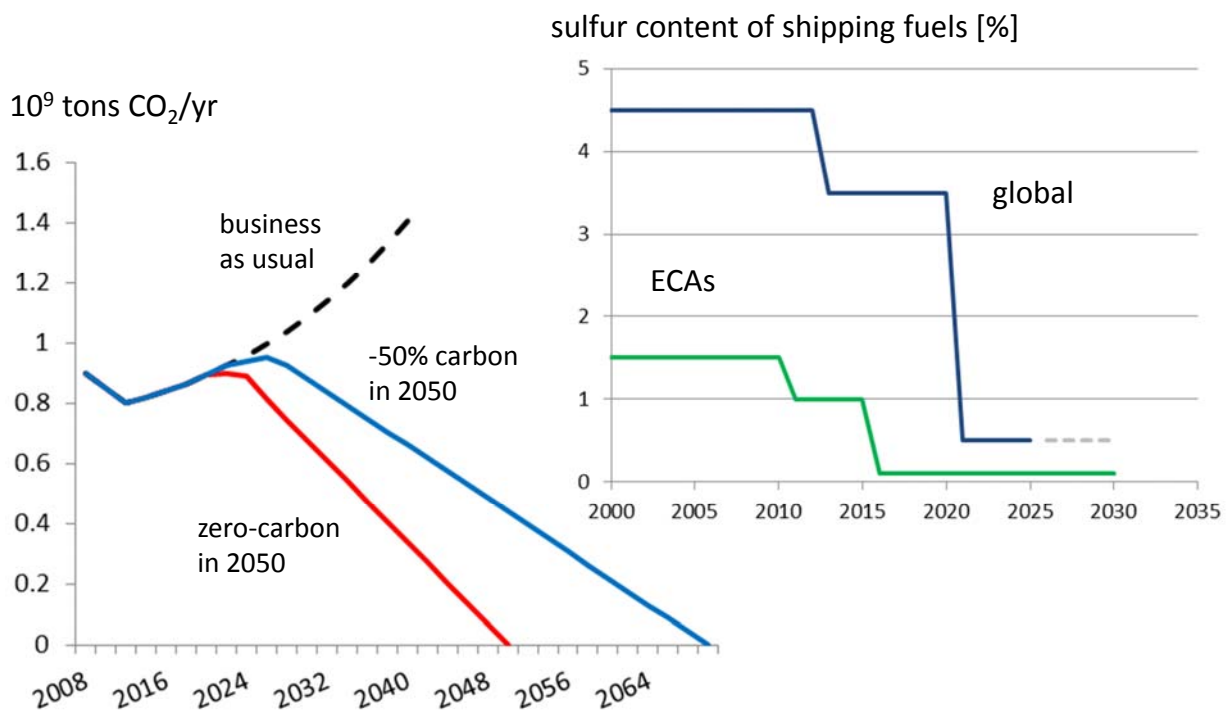
values for Daimler A-class



Zero Fossil Carbon Transport Solutions

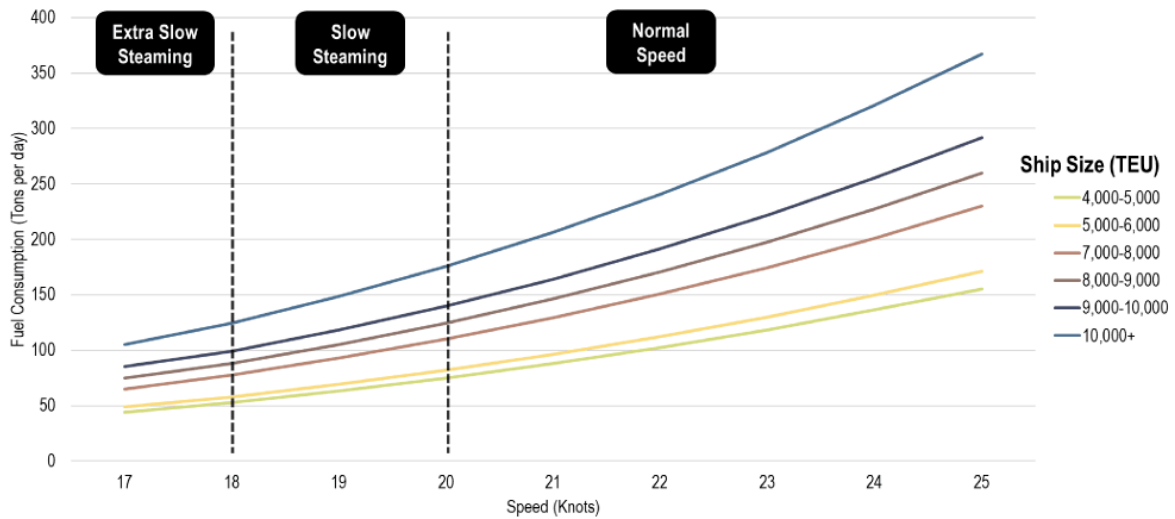


Shipping Emission Developments



Comparison: Fuel Amounts

- steaming distance 10 days, 150 to/dy, 16 500 MWh



Czech Hydrogen Days 2021

source: transportgeography.org
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Comparison: Fuel Amounts

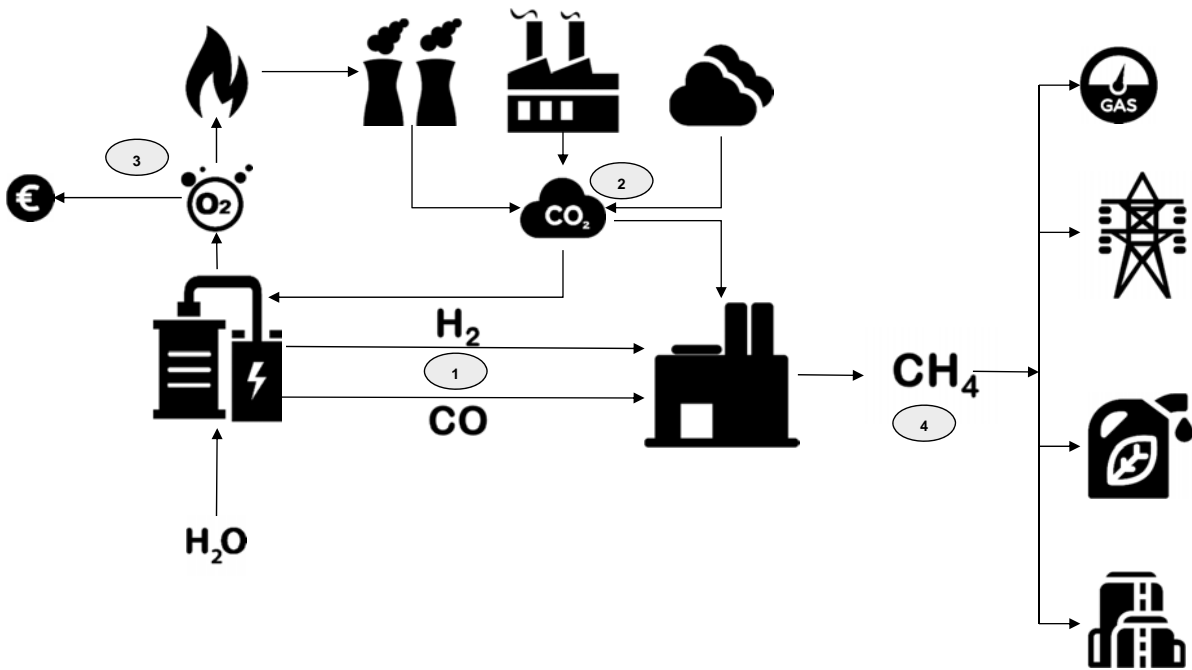
- steaming distance 10 days, 150 to/dy, 16 500 MWh

	Boil. Temp. [K]	Heat.Val. [kWh/kg]	Heat.Val. [kWh/L]	Heat.Val. [kWh/Ncbm]	bunker-volume [cbm]	Fuel weight [to]	
LH2	20	33	2.3	---	7000	500	
LSNG	111	14	6.3	---	3200	1200	
LNG	120	12.5	5.6	---	3500	1300	
H2	---	33	---	3	9900	500	70 MPa
CH4	---	14	---	9	8900	1300	25 MPa
NH3	240	5.2	3.2	3.9	5200	3350	
CH3OH	---	5.5	4.4	---	3750	3250	
M.Diesel	---	12	10	---	1500	1500	

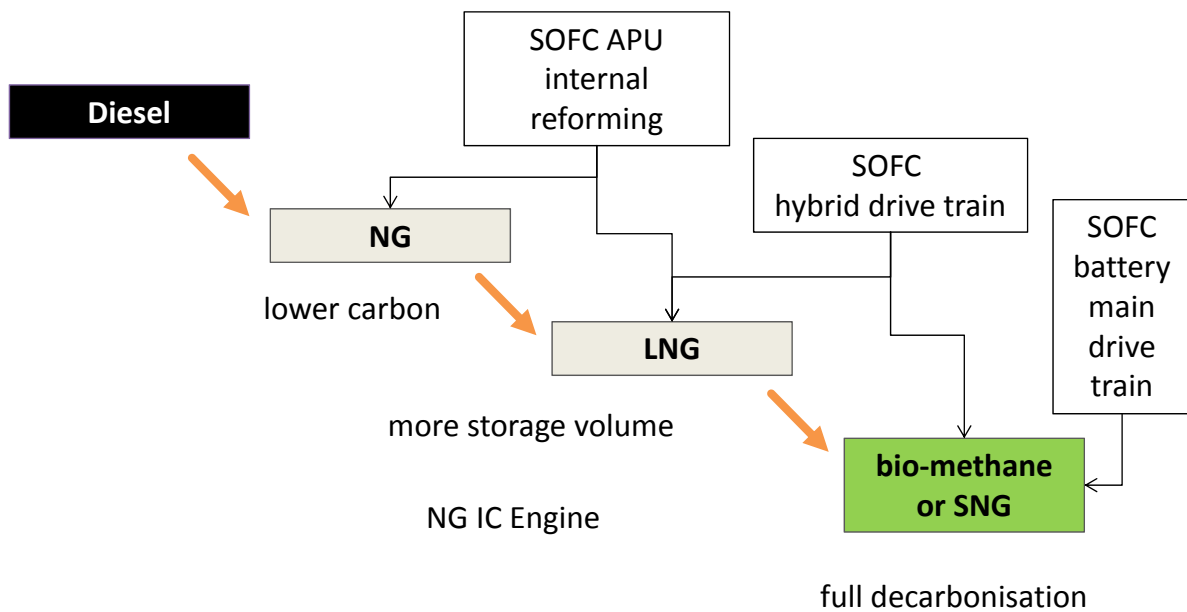
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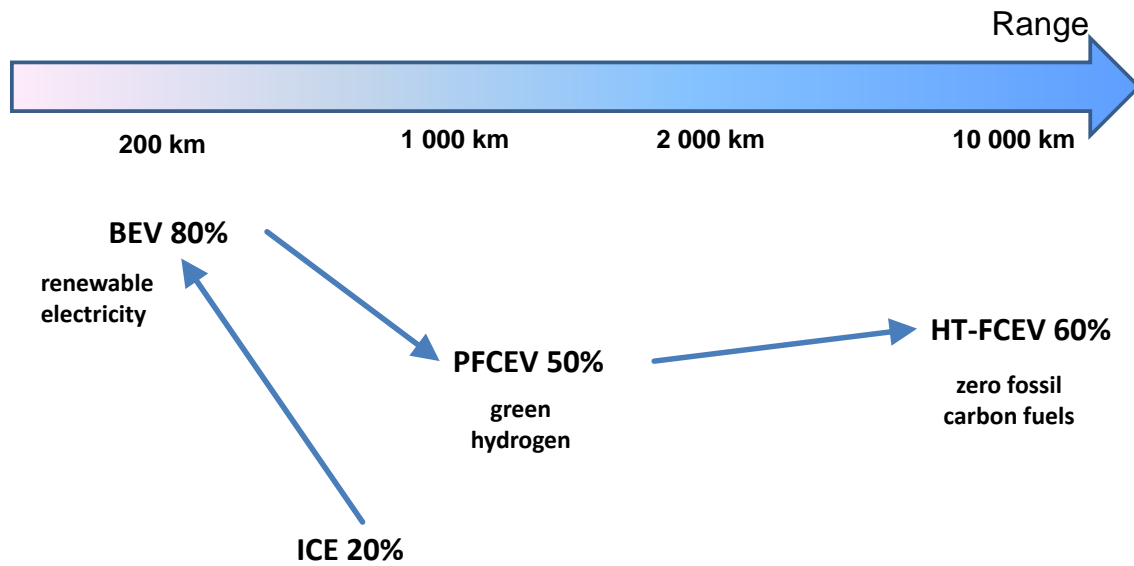
Power to Gas



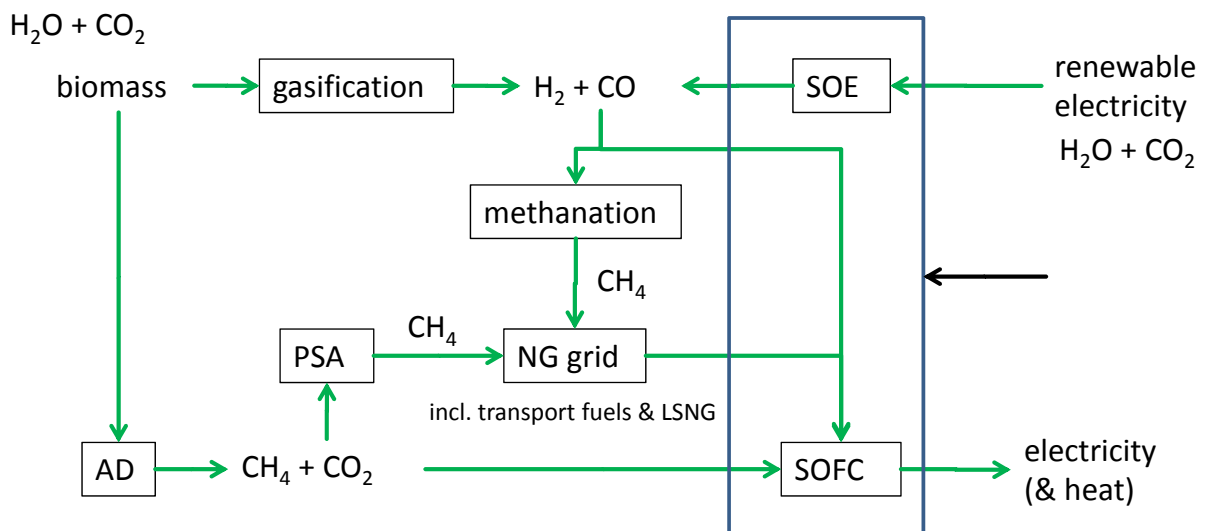
HT Fuel Cell Propulsion for Freight Road Transport (HDV/HGV), Rail, Aircraft, and Maritime Applications



Zero Fossil Carbon Efficiency

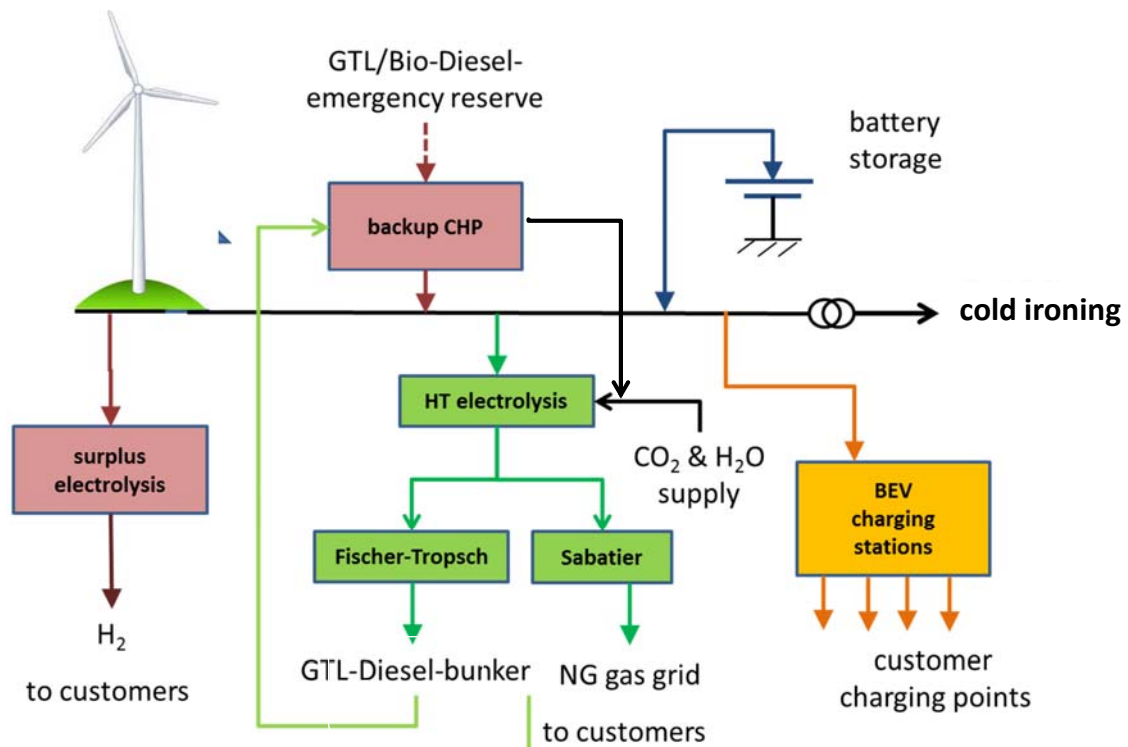


The Cycle of Zero-Carbon Methane



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

Power to Anything



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Zero-Net Carbon Methane for Electrifying Large Vehicles

- ✓ P2G and CO₂ from biomass (SNG)
- ✓ fully compatible with natural gas (NG) grid infrastructure
- ✓ compatible with NG/LNG trend for HDV, shipping etc.
- ✓ zero-fossil-carbon fuel with considerable reductions in CO, NO_x, SO₂, particle, and noise emissions even in ICE
- ✓ global zero emission scenario when used in fuel cells



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Upcoming events:

4th Degradation Workshop –
online **5 May 2021**

Fuel Cell Systems Workshop –
18/19/20 May 2021, Bruges,
Belgium / online

JESS 2020 – Joint European Summer School,
06 to 11 & 13 to 18 Sept 2021,
Athens

www.jess-summer-school.eu



Thank you for your Attention!

Any Questions?

contact:
r.steinbergerwilckens@bham.ac.uk