European Hydrogen Week

24 - 28 October 2022

Brussels, Belgium

euhydrogenweek.eu

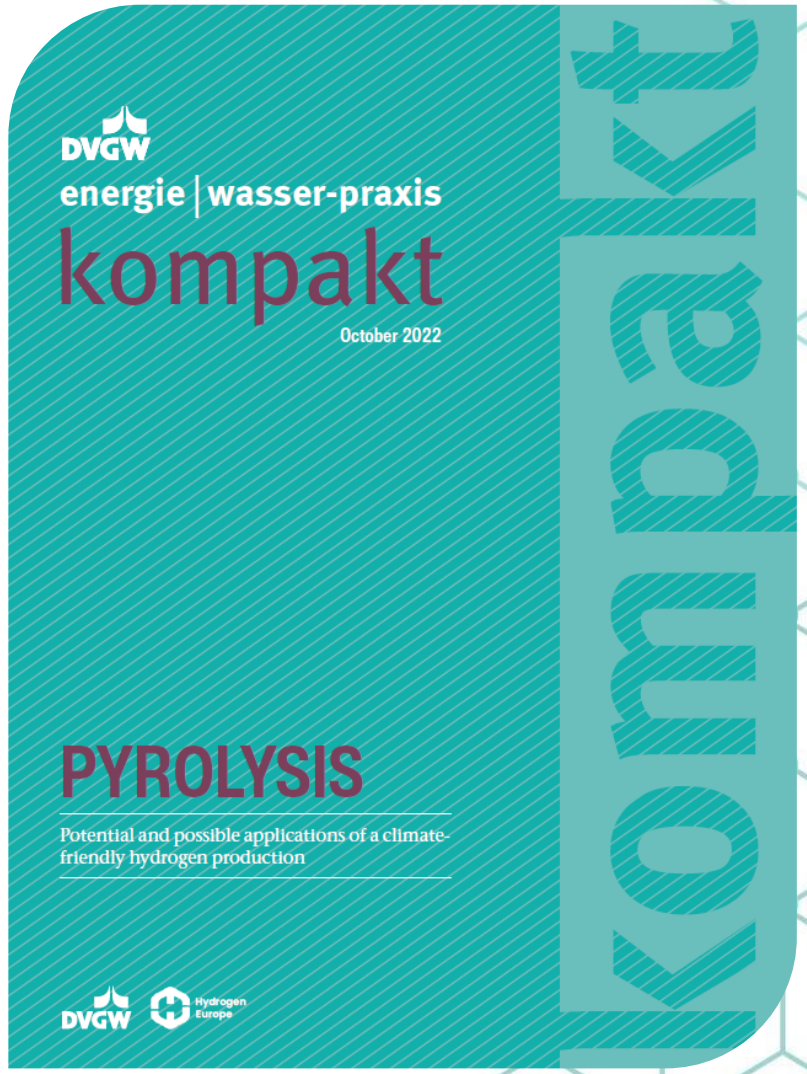
Hydrogen Europe

Flagship Expo

Clean Hydrogen Partnership

Pyrolysis

Joint DVGW – HE publication:
Potential and possible applications of a climate-friendly hydrogen production



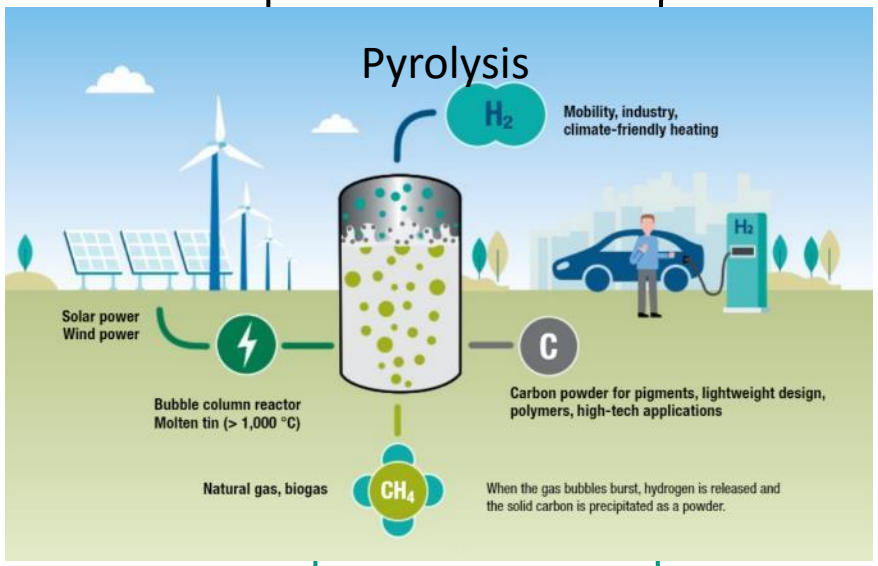
Welcome remarks

Gerald Linke

CEO

German Technical and Scientific Association for Gas and Water (DVGW)

Various option of hydrogen production



Waste / Biomass

Biogas / natural gas

Sun

Wind

Photovoltaics

Mechanical energy

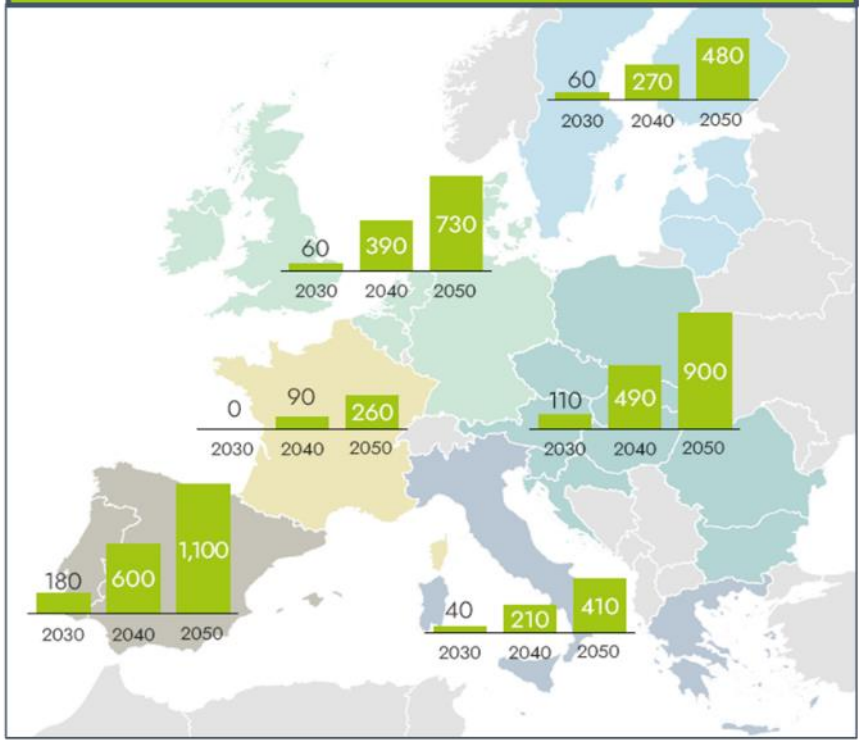
Electrical energy

Water electrolysis

Hydrogen

Studies show a rapid hydrogen ramp-up potential if all options are used

EU's hydrogen production capacity could be ramped up to 4 000 TWh by 2050



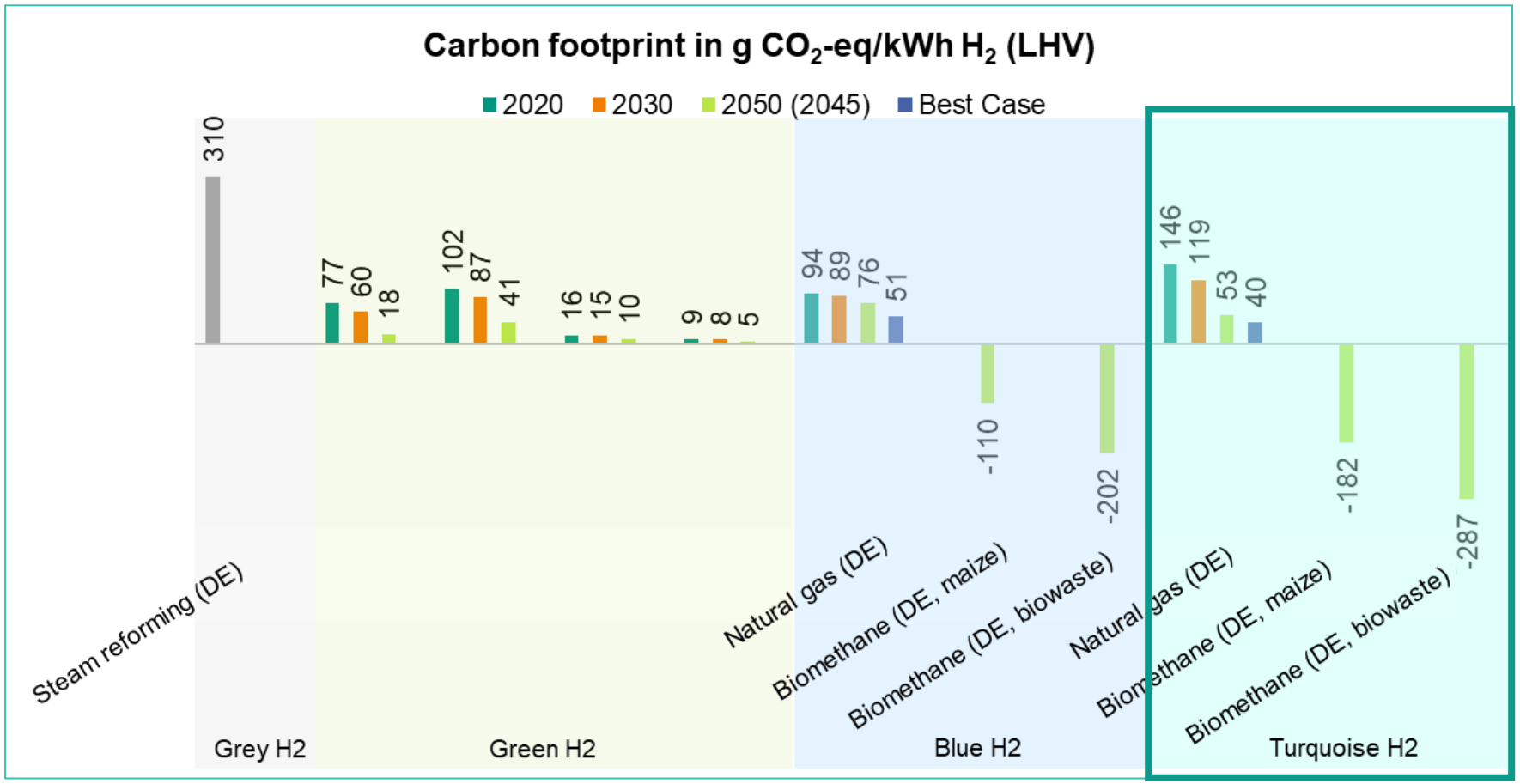
Source: Guidehouse, June 2021

Green or blue?

Whereas some opportunistic studies state that there will be enough generation capacity for a pure green hydrogen economy others predict a more balanced colour distribution (Hydrogen4EU)

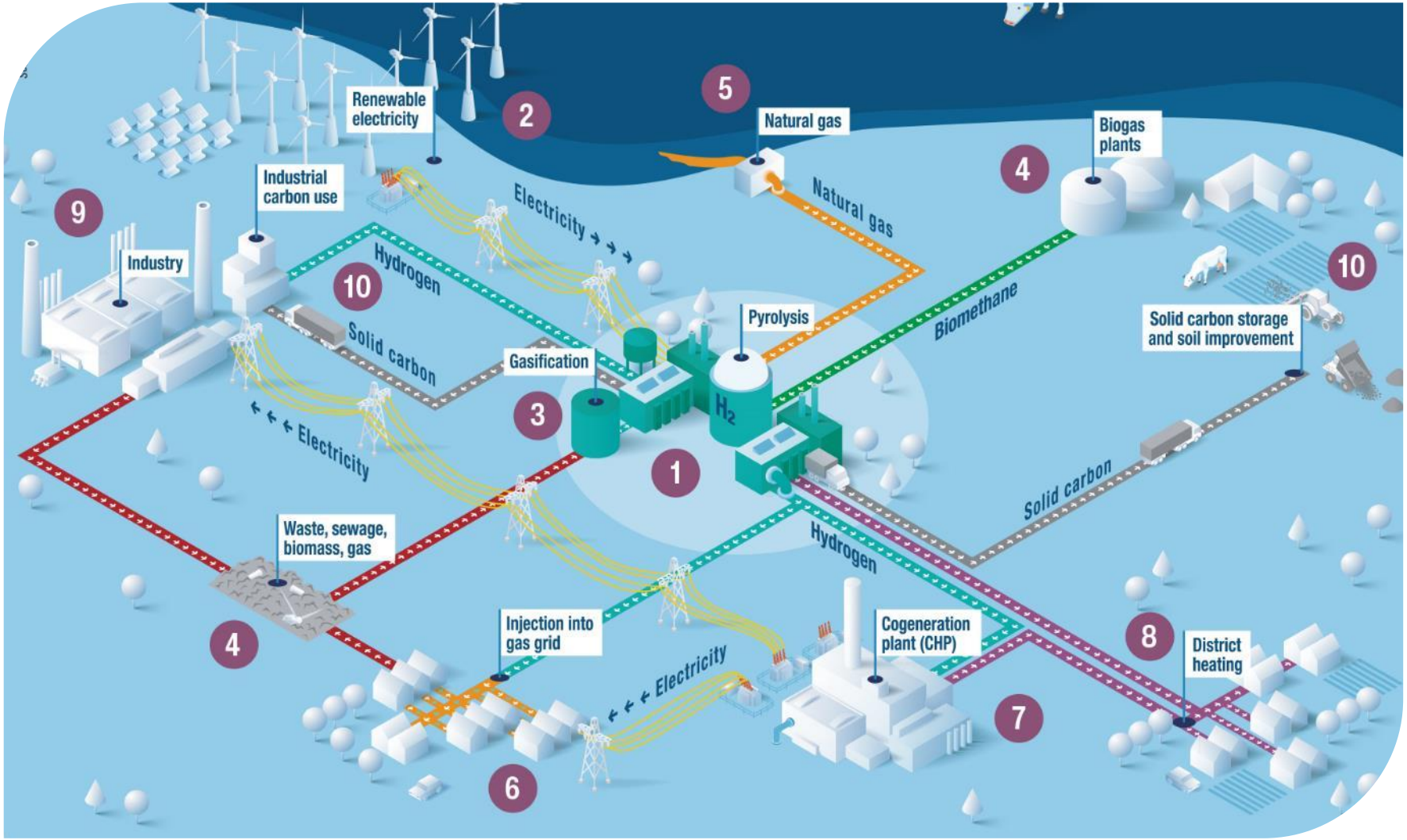
Source: Hydrogen4EU, June 2021

Footprint & quantity-wise turquoise is a pillar of a hydrogen economy



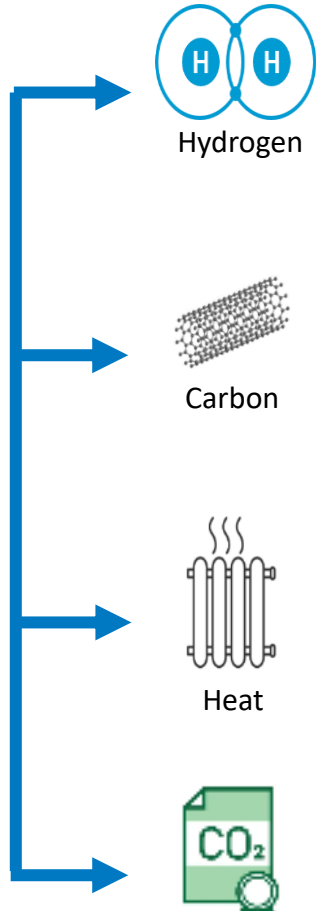
Source: Friedmann et al. (EBI): Ecological evaluation of hydrogen supply, Sensitivity analysis on GHG emissions of hydrogen, May 2022

The world of methane pyrolysis at a glance

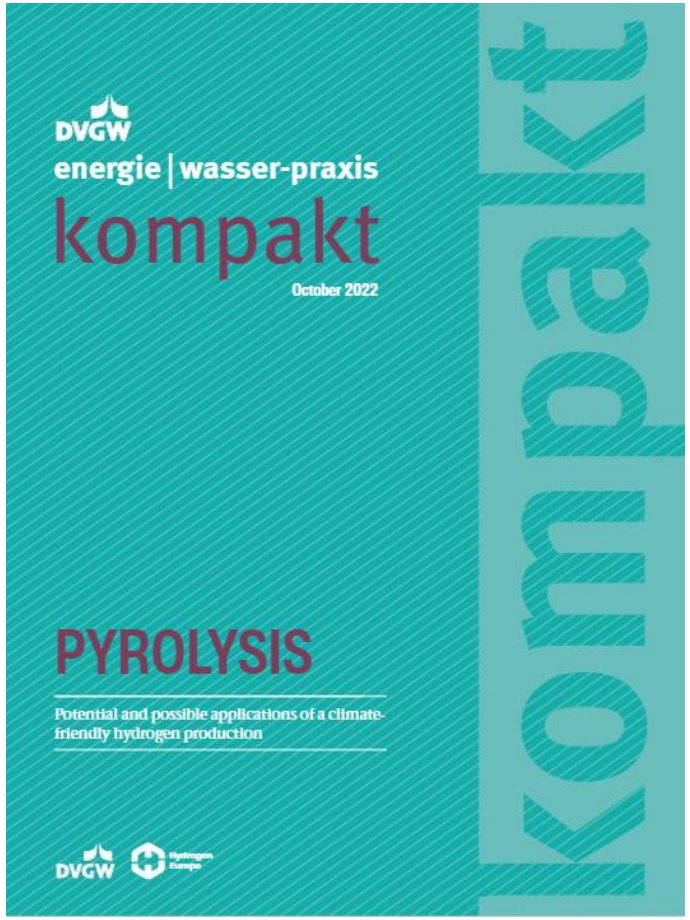


Pyrolysis

Outcomes



State of the art of pyrolyse and project descriptions in a brand-new joint DVGW – HE broschure



We must use all options!

An introduction to the perspectives for transforming the energy supply by **Prof. Dr Gerald Linke**, Chairman of the Board of DVGW e. V. and **Jorgo Chatzimarkakis**, CEO of Hydrogen Europe.

Source: DVGW

Source: Hydrogen Europe

Europe's energy supply is to become independent, diverse and climate-neutral - and that in just a few years. While the climate goals are to be achieved quickly in order to minimise the consequences of climate change, geopolitical risks due to dependence on energy imports from a few supply countries must be taken into account in parallel and the energy supply must be placed on a broad basis.

DOWNLOAD:
https://wvgw.de/dyn_pdf/ewp/2022/kompakt_Pyrolysis/

Table of content:
The world of pyrolysis

Intro presentation

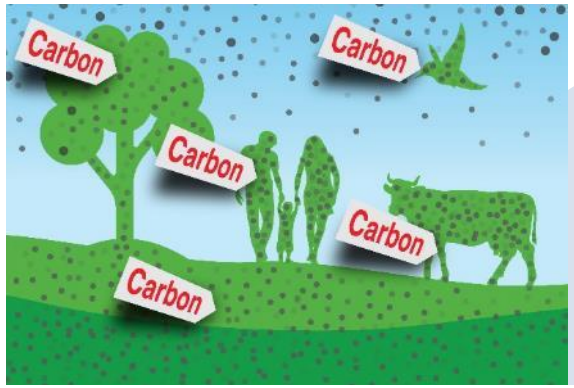
Stefan Petters

Business Development Consult

Carbotopia® Syndicate

Why squander our Wastes' CH_4-like total Hydrogen : Carbon Ratio?

Hydrogen can be dissociated from its Carbon-bonds and out of Water



H_2:C=1.2+50% H_2O

∑ 2.0H_2/C → 0.2CO_2/H_2

H_2:C=1.6+40% H_2O

∑ 2.2H_2/C → 0.14CO_2/H_2

- Why co-fire Fuel with extinguishing agent → Water?

H_2:C=0.9 → 0.5CO_2/H_2

- We can build wealth from what we pay to be burned!

- **Waste Transformation into new energy carrier Molecules can come at just 37% the CO_2-intensity of Oil!**

Resource-Efficiency [SDG12] of Waste versus W2E equiv. onshore Wind

measured in № E-Vehicles 100km/day refueling

1 plant per 160 000cpt

43MWh$_{chem}$

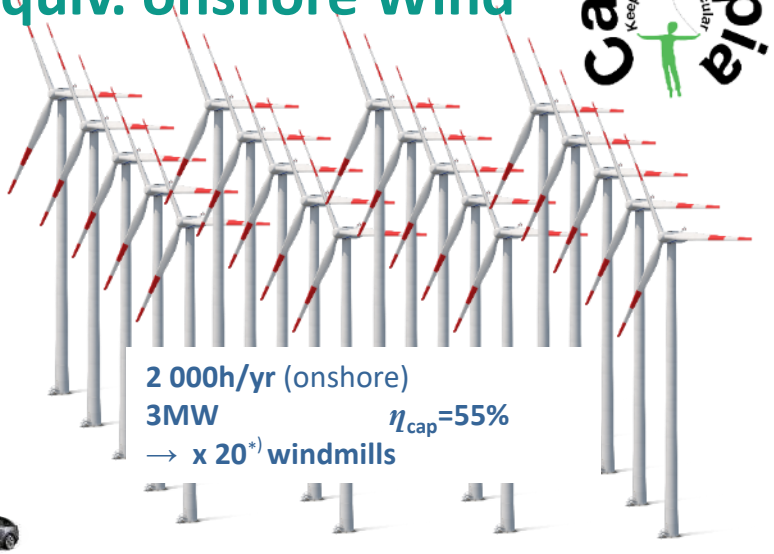
24/365 @ η_{avail} = 90% **Waste incineration**

50km Radius
EU27 ø1mln capita

9MWh$_{electric}$

equivalent

10 000 BEV



2 000h/yr (onshore)
3MW η_{cap}=55%
→ **x 20**[*)] **windmills**

9MWh$_{electric}$

refine

from intrinsic
H_2:C ratio incl. H_2O
✚ **10mln Liter** auxiliar **H_2O**

1 300tpy ← 60MW ✚

→ H_2 →

12 500 HFCV

3 600 ←

H_2

12mln Liter auxiliar **H_2O** **??**

W2H$_2$ η_{chem} = 50% → **4 500tpy**

*) EIT Europe Statistics

Resource-Efficiency of waste derived Syngas versus W2E equiv. E-Fuel

measured in № ICE-Vehicles 100km/day Synthetic Fuel fill-ups

1 plant per
160 000cpt

100 000tpy

24/365 @ η_{avail} = 90%

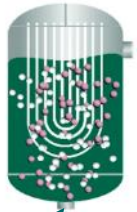
43MWh$_{chem}$ -1

50km Radius
EU27 ø1mln capita

Syngas Platform
Vienna at MA48
1110 Pfaffenau

from intrinsic
H_2:C ratio incl. H_2O
5mln Liter auxiliar **H_2O**

Fischer Tropsch Synthesis

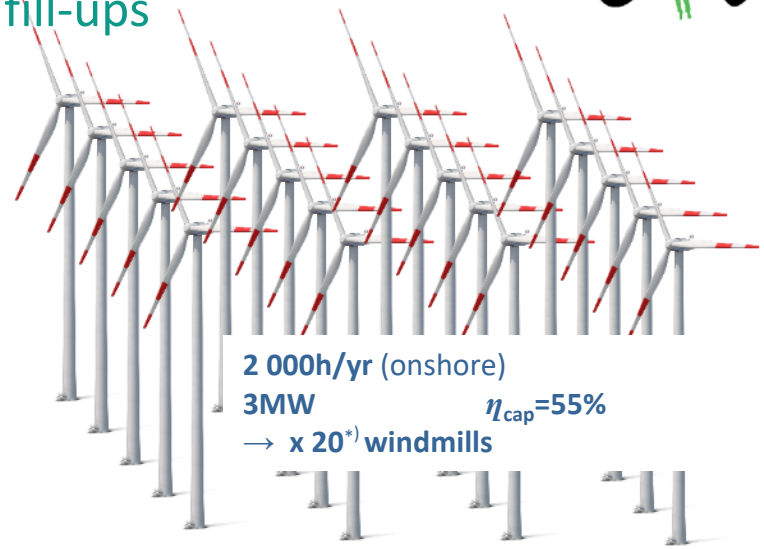


→ **13.7mln Liter/yr**

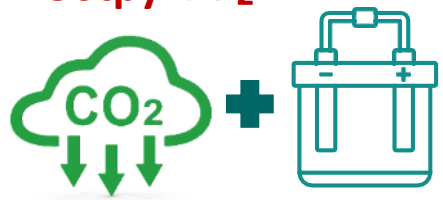
→ **5 400**

ICEV

W2E$_{lectricity}$
equivalent



1 300tpy H_2 ← **60MW**
7 150tpy CO_2



12mln Liter
auxiliar **H_2O**
??

870 ← **2.2mln Liter E-Fuel/year**

*) EIT Europe Statistics

Resource-Efficiency by waste Methanization combined with CH_4 Pyrolysis

derived Synthetic Fuel № ICEVs plus HFCV for 100km/day each

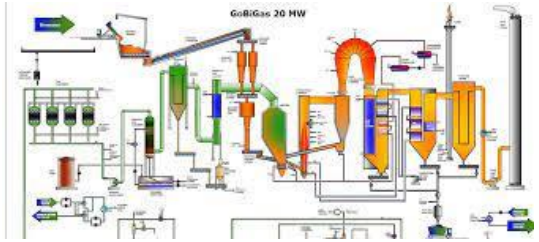
1 plant per 160 000cpt

100 000tpy

43MWh$_{chem}$

Wood 2 Methane

Gothenburg



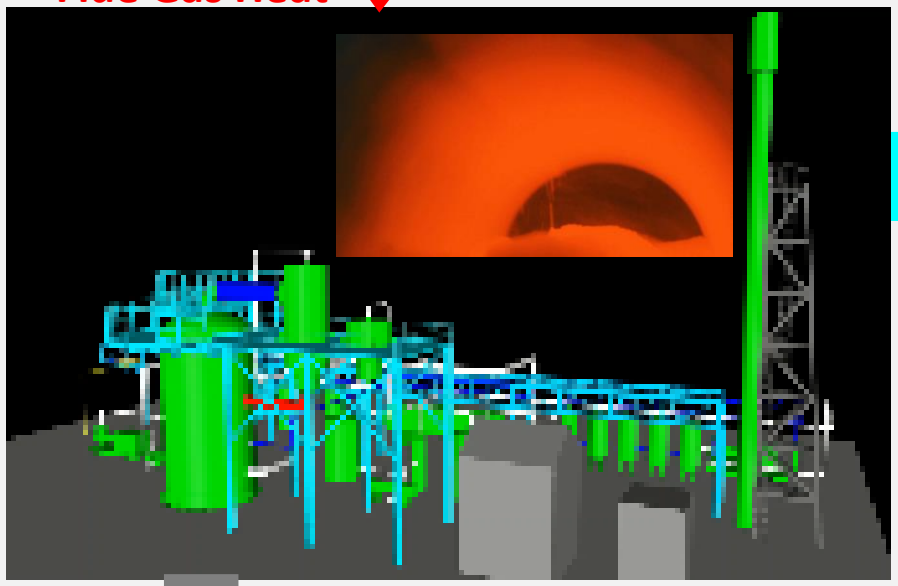
50km Radius

EU27 ø1mln capita

28MWh$_{Bio-SNG}$

3MWh^{-1} Flue Gas Heat

CH_4 TCD



15MWh^{-1} H_2

3 000tpy

12MWh^{-1} Carbon

-4MWh$^{-1}_{RE}$ → + 2mln Liter auxiliar H_2O

CO+H_2

9mln Liter/yr SF → **3 500 ICEV**

∑ 12 500 Cars

9 000 HFCV

The advantages of Moelcules2Molecule over Electrons2Molecules

measured in № Vehicles 100km/day refueling

Waste 2 . . . . . Electricity

→ 10 000 BEV

≡ 20 x 3MW onshore Wind + 60MW Electro-lysis

Hydrogen →

Total 12 500 HFCV versus 3 600 from Electrolysis

- 3.5 times Electrolysis H_2
- @ 22% auxiliary Water
- Adding Value to Waste
- eliminating incinerators' uncovered Cost overruns

Waste 2 Synthetic Fuel

2.3kg CO_2-mitigation per Liter Syn-Fuel

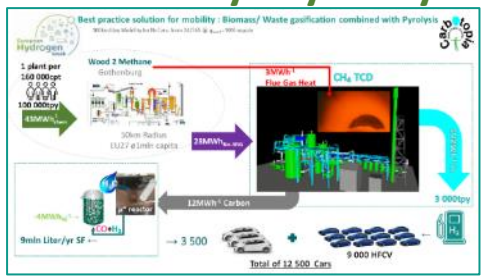
3.25kg CO_2-Use per Liter E-Fuel

→

Total of 5400 ICE Cars versus 870 from E-Fuel

- 6.2 times E- Syn Fuel
- @ 6.7% auxiliary Water
- Adding Value to Waste
- Eliminating incinerators' uncovered Cost overruns

Waste 2 Pyrolysis Hydrogen & Syn Fuel off Carbon



→

USP n.a. for electric

optional 3 500 ICEV plus 9 000 HFCV, in Total 12 500 Cars or HFCV only

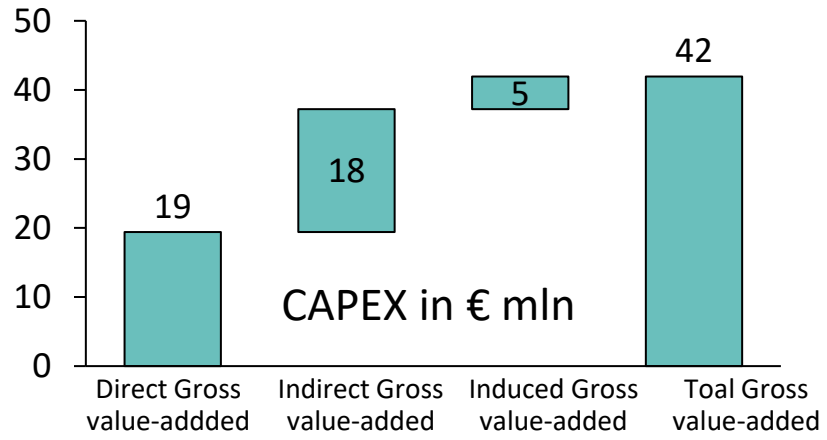
- Flexible for existing ICEVs
- @ 60% aux. Water of SF
- All European Technology
- supply chain autonomy
- Compatible for Bio- & Hybrid- Gas feedstocks

Socio-economic value Impact of combined gasification & pyrolysis

Macro-Economics study of a 43MW Carbotopia® Bio-Refinery (Economica Institute)

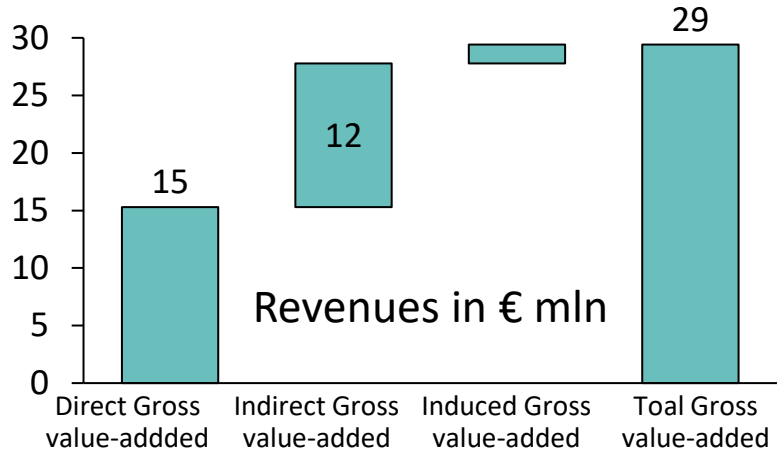
Investment Phase

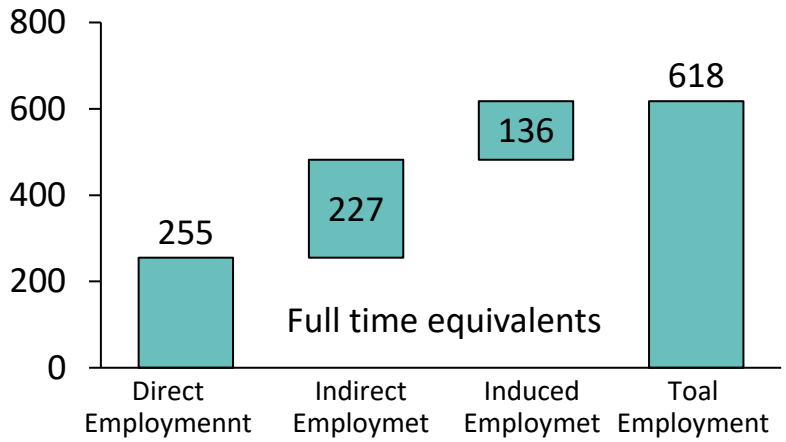
at e.g.:
5 yrs
Amoritzation



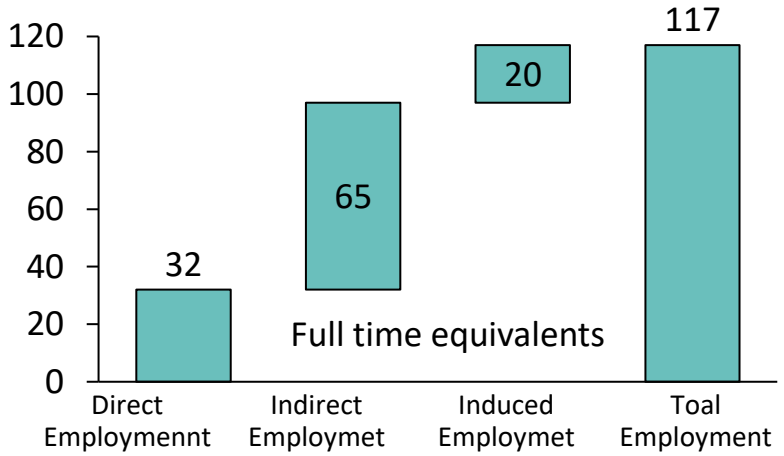
Operations Phase

at e.g.:
1kg H_2 = €5.0
1ltr SF = €1.6
20% Profit





plus
14% Fiscal Return from Employment Charges (in AT)



Source: Economica Institute 2012 for Carbotopia®

Europe incinerates 26% and still landfills 25% of its Household Wastes

Why not become World Market Leader in Self- refinancing Waste-Valorization?

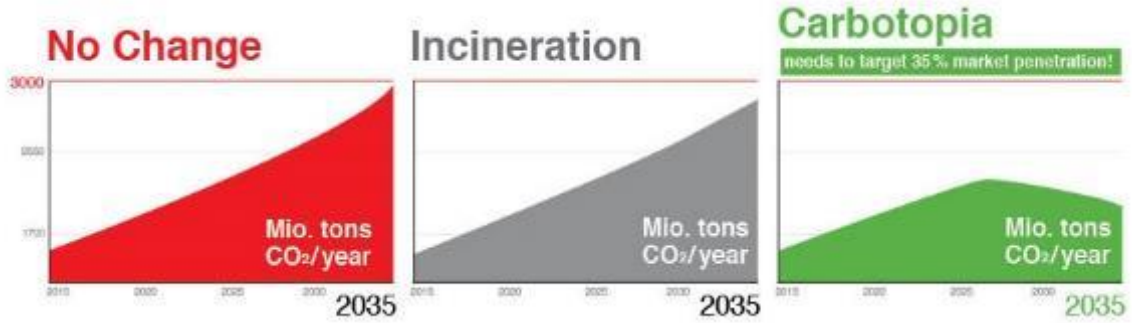
10 Plants versus Landfills:

2.2 Million Tonnes of CO_2 Equivalents/yr

65 Hectares of Landfill Area =

Turning around Climate Impact until 2035

Mio.ton CO_2/year



4,500 plants until 2035 can save:

cumulated 5 Giga-ton CO_2 equivalents

4.3 km³ less landfill space =

Ramping towards 35% Market Penetration in 2035

Profit from waste-valorization driving roll-out;
€56 bln waste transformation revenues and
€20 bln plant equipment industry from:

4,500 plant licensees

540,000 new job creations

elimination of 1 Giga-ton CO_2 per year

Summary

Isn’t Waste-Valorization a must in times of Energy-Supply security concerns?

- Waste is an available resource with a total H_2 : Carbon ratio of ≥ 2 (alike CH_4) that shouldn’t be wasted
- Utilizing waste-2-hydrogen via FCEV and ICE are 25% more effective than BEV (from W2E)
- Hydrogen can be split from and over Carbon at 20-35% of its Energy by pyrolysis or reforming
- Carbonaceous residues can be refined at 3-fold Carbon- & 5 times the Water- Efficiency than oil
- Today’s PPP-socialization of incineration’s uncovered Cost-overruns is like getting someone paid the value of a sellable house to just burn it down – but people don’t know what they’re forced to pay for!
- Why transform Molecules into not-storable Electrons that we lose when not synchronously used
- Water is an increasingly scarce resource and shouldn’t just be co-fired with biomass or trash

Panel Debate

Moderated by Luigi Crema, Director, Centre Sustainable Energy, Foundation Bruno Kessler (FBK)

Vjekoslav Majetić, CEO, Indeloop

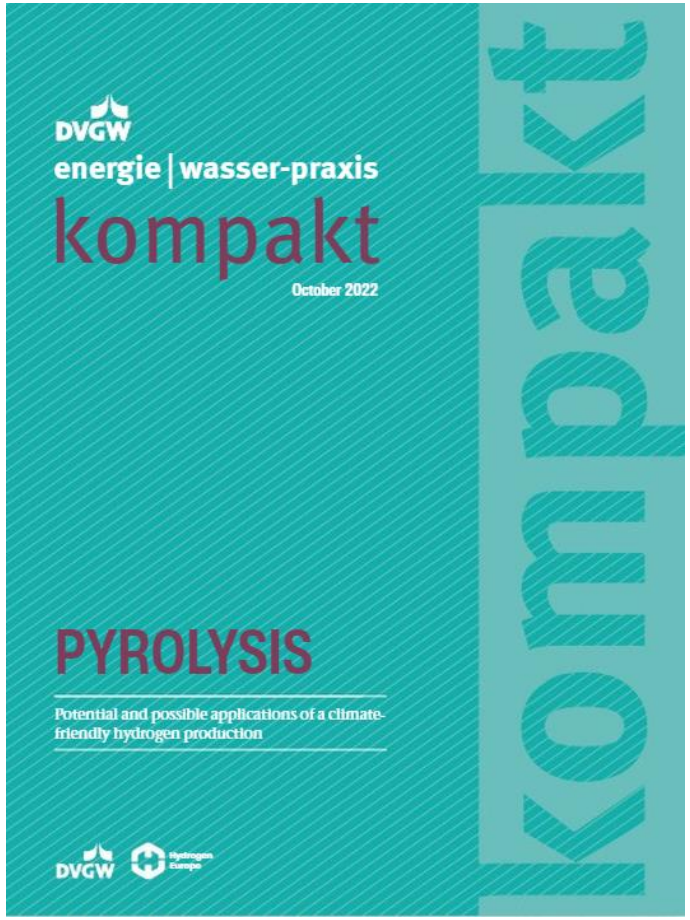
Nadia Romdhane, Head of Process Engineering, Green Hydrogen Technologies

Matti Malkamäki, Chairman of the Board, Hycamite TCD Technologies Ltd

Christian Bestien, Director, Business development, Sales and Marketing at Haffner energy

Stefan Petters, guo – Business Development Consult

Brand-new joint DVGW – HE broschure



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Deutscher Verein des
Gas- und Wasserfaches e.V.

DVGW

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