Life cycle assessment of Power to Gas technologies for long-term storage and sector coupling

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Store&Go Training school

Karlsruhe, 21 February, 2020

Co-Funded by the European Union under Grant Agreement no. 691797

Supported by the State Secretariat for Education, Research and Innovation under contract no. 15.0333

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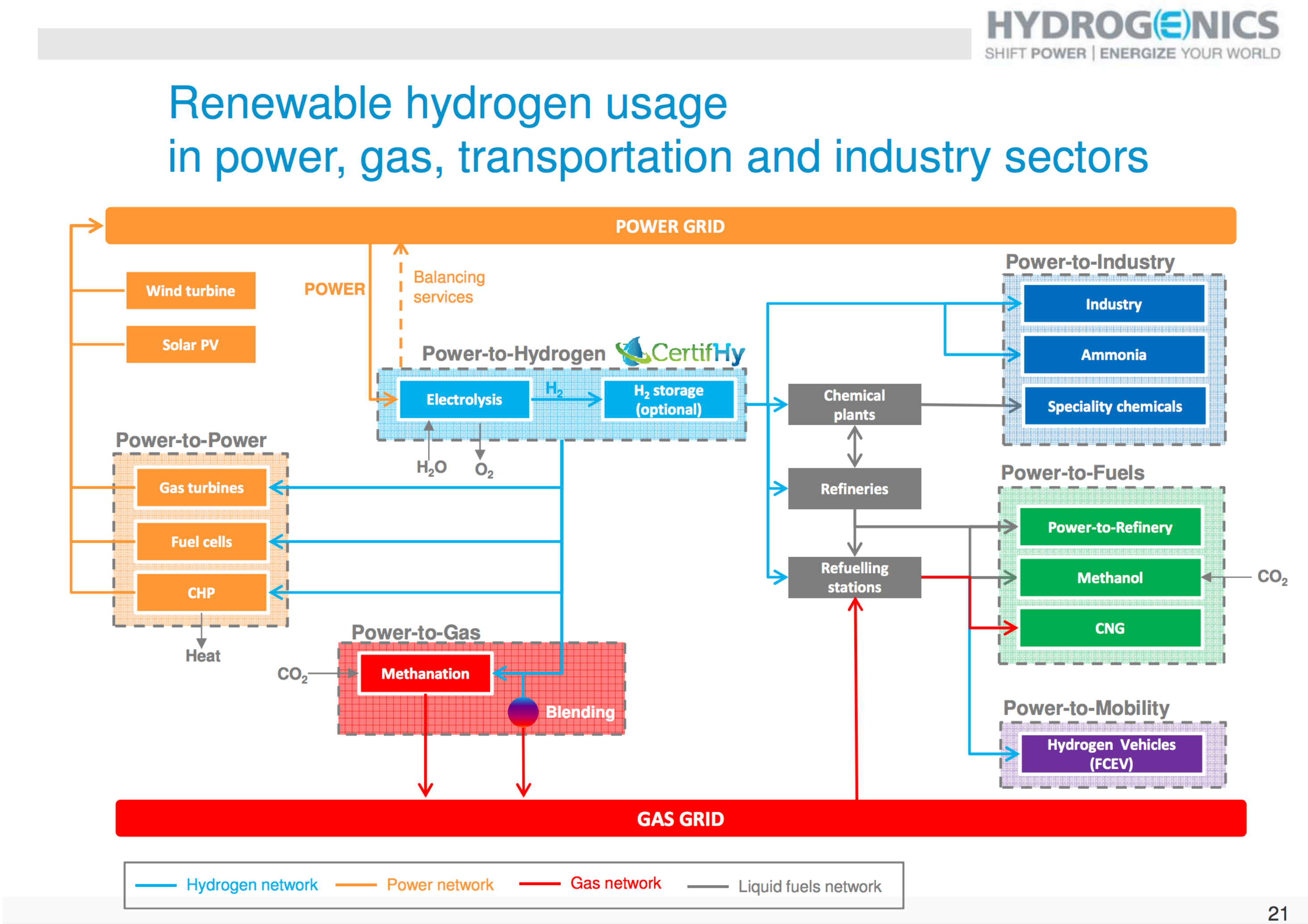
Agenda

- Introduction
- Demo site evaluation
- Understand the key factors
- Strategies for reducing PtG carbon footprint

PtG enables energy storage and sector coupling



Source: *Hydrogenics.*

Tax Exemption for “Green fuel” requires LCA evaluation

The Mineral Oil Tax Ordinance (Swiss)

Biofuels must generate at least **40%** less **greenhouse gas emissions** (from cultivation of raw materials till end use) compared to the **life cycle emissions** of fossil natural gas


Product Environmental Footprint Category Rules (PEFCRs):

Coffee

Working DRAFT

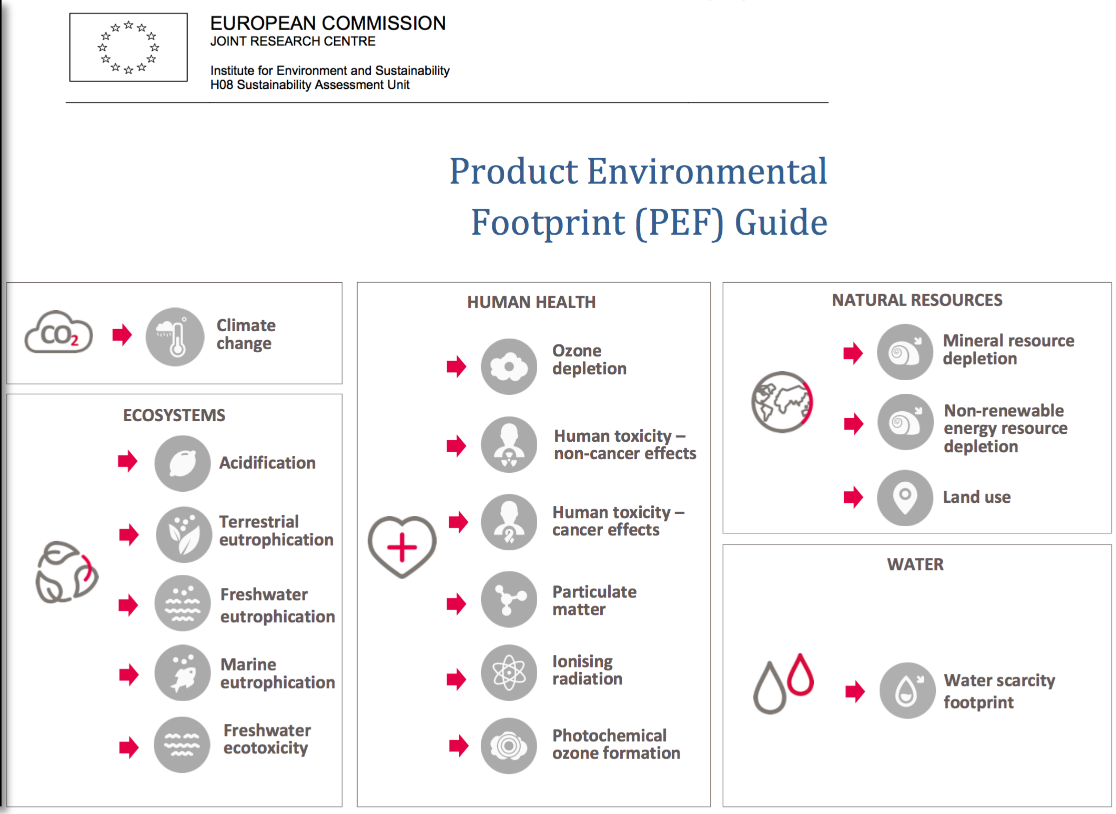
January 20, 2016

(version a)

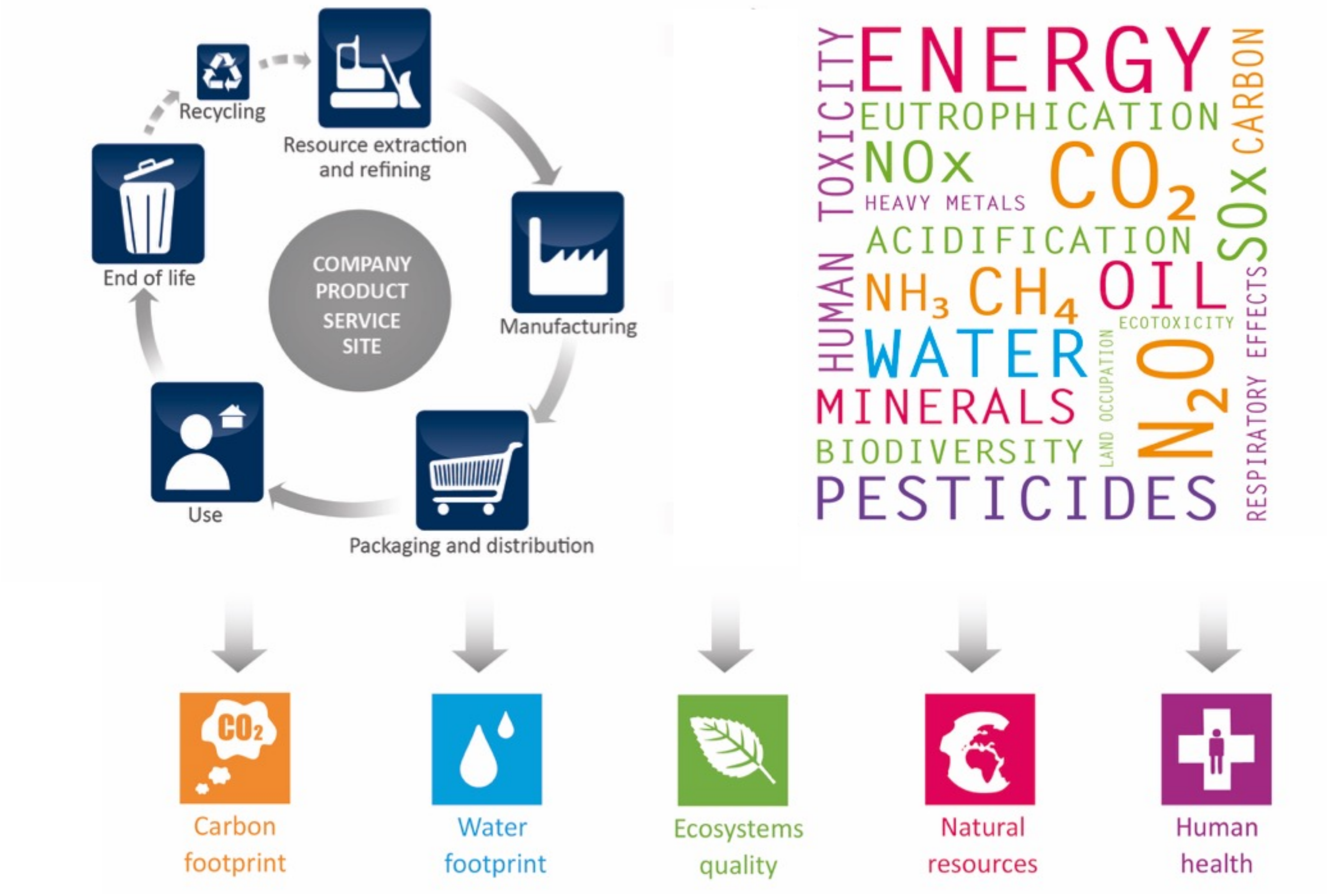
Version “b” of December 10, 2015 submitted to the TAB and SC for vote that contains the comments received during the SC presentation of January 19, 2016

Prepared by the Technical Secretariat:

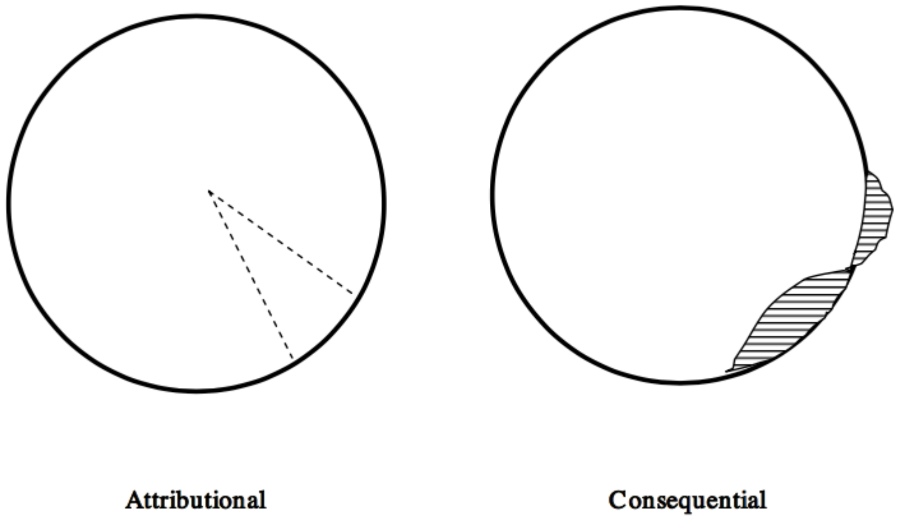
European Coffee Federation, Flexible Packaging Europe (FPE)/European Aluminium Foil Association (EAFA), Colombian Coffee Growers Federation (FNC), Swiss Federal Office for the Environment (FOEN), Illy Caffé, Jacobs Douwe Egberts (JDE), Lavazza, Nespresso, Nestlé, SAI Platform, Solidaridad, Tchibo, and Quantis

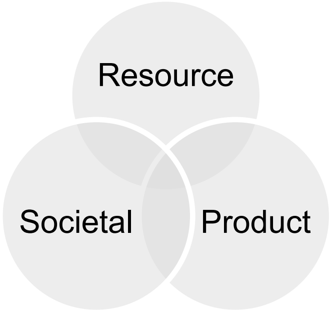


Life Cycle Assessment (LCA)?



Types of LCA analysis





Conceptual difference between attributional and consequential LCA (Weidema, 2003)

Key issues related to LCA of PtG

Power to what?

- Grid balancing: hydrogen, battery , SNG
- Mobility: LNG, Hydrogen, BEV, methanol
- Heating: power to heat
- Industry: hydrogen, ammonia

Technology and sourcing

- Electricity sourcing
- Electrolysis method
- CO2 sourcing
- Further conversion (methanation)
- Distribution method

Evaluation

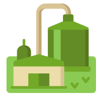
- Social , regulatory tax exemption, political framework
- Economic
- Maturity
- Life cycle assessment

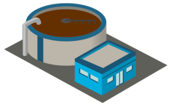
Time and space

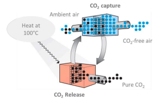
- Temporal scale
- Spatial scale and trade

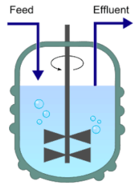
Power to gas: characteristics of three demo sites

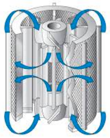
	Falkenhagen (Germany) 1000kW	Solothurn (Switzerland) 700kW	Troia (Italy) 200kW
CO_2	Bioethanol plant (300km, -35°C tanker truck)	Wastewater plant (2.5 km pipe)	Capture CO_2 from air (in-situ)
Electrolyser	HYDROGENICS	PROTON ON SITE	HYDROGENICS
Reactor	High temperature	Medium temperature	Medium temperature



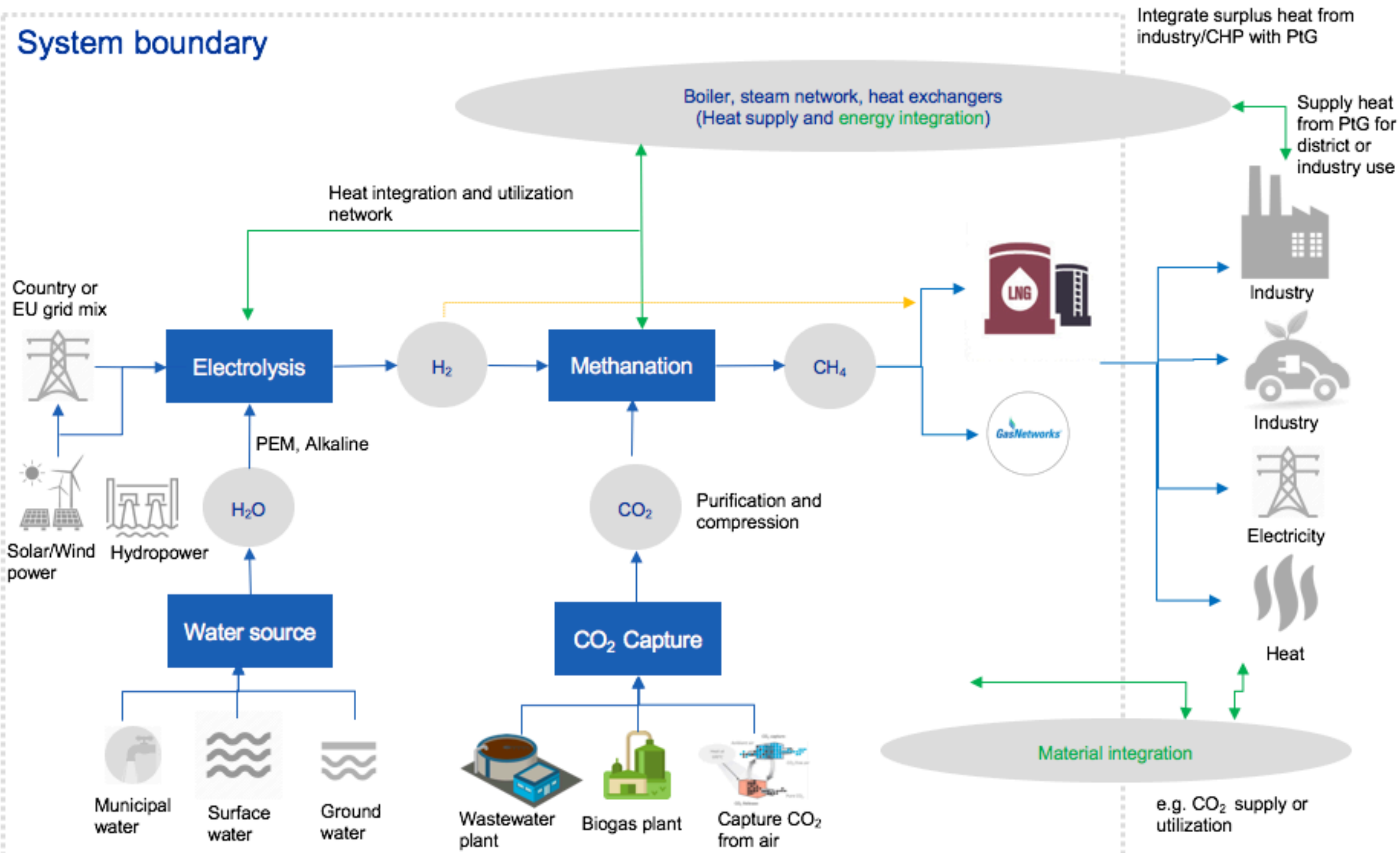








Scope of PtG in the store & go project

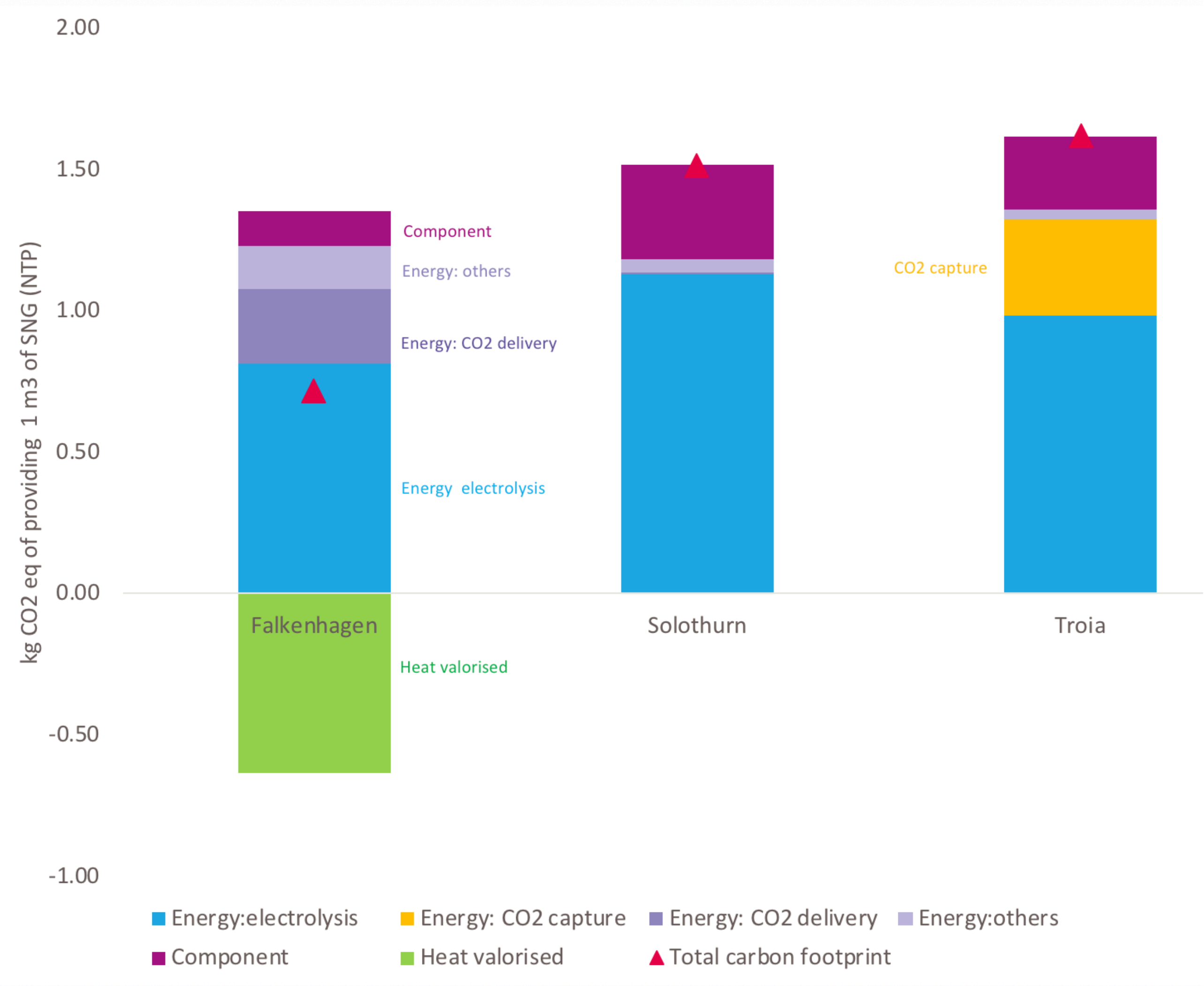


Source D5.4 (STORE&GO)

Key assumptions

lifetime	15	yr
hours_yr_de	2000	hours per year
hours_yr_ch	2000	hours per year
hours_yr_it	2000	hours per year
AEL_lifetime	80000	hours per life time
PEM_stack_lifetime	80000	hours per life time
PEM_BoP_lifetime	80000	hours per life time
cat_lifetime	4000	hours per life time

Climate change impact of the three PtG demo sites



Key observations

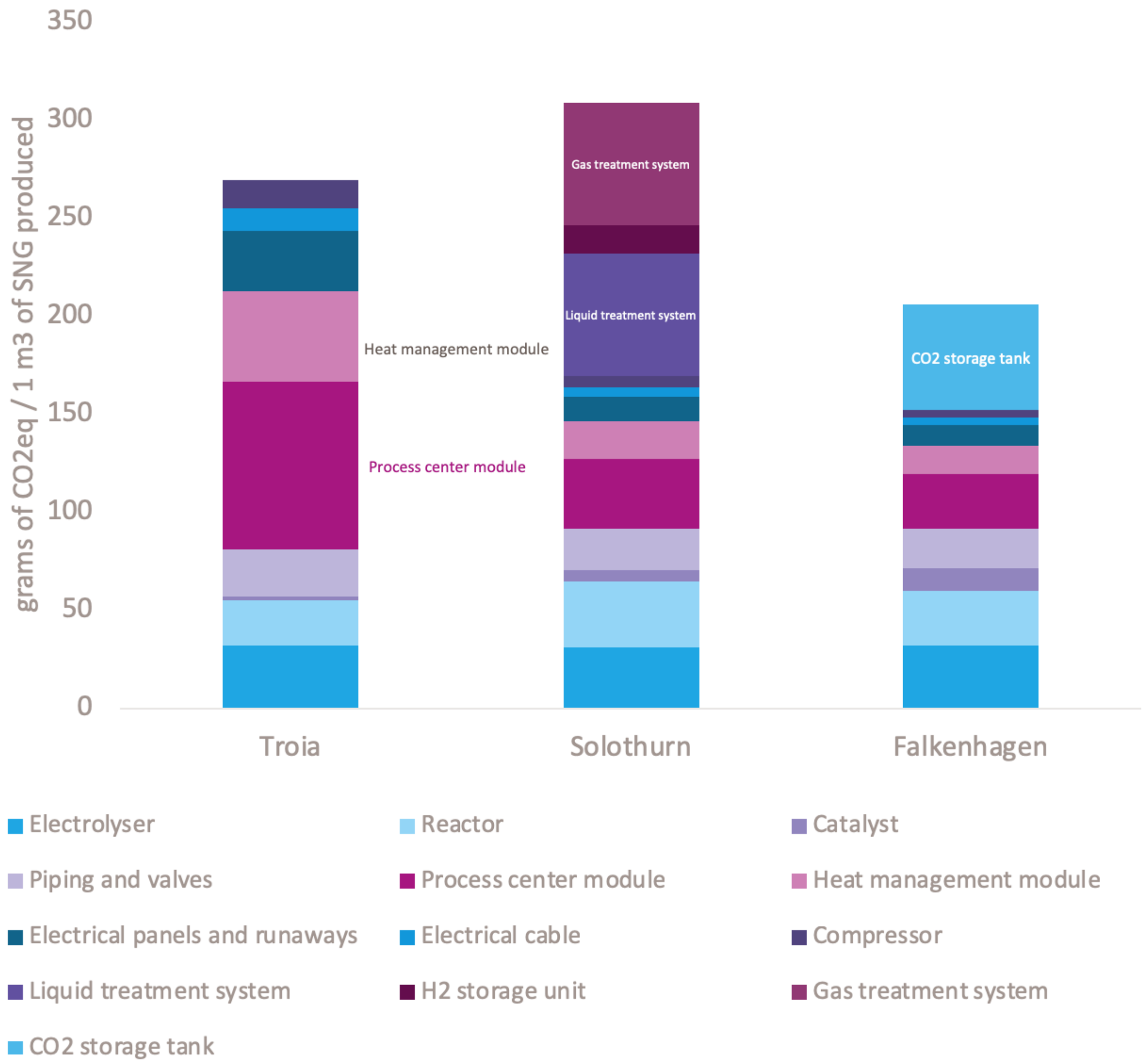
The impact is **dominated by energy consumption** used during the water electrolysis.

The **heat valorisation** from Falkenhagen if realised could be potentially a large carbon reduction factor.

Local sourcing CO_2 is another key factor

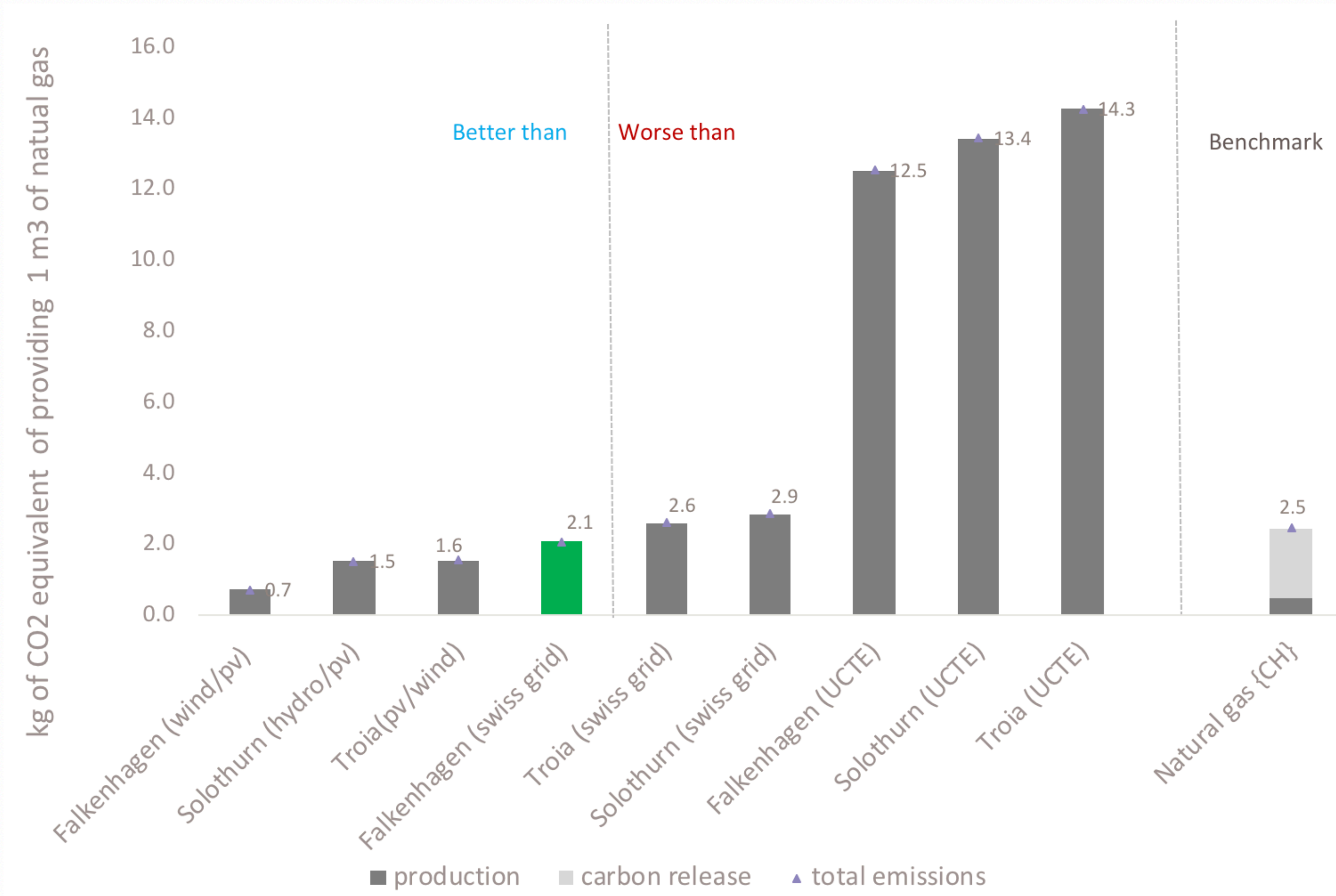
Warning: The three PtG systems should not be directly compared for climate change performance due to variabilities in electrolysis efficiencies, renewable energy sourcing profiles, CO2 sourcing, surplus heat valorisation scenarios, as well as methanation technologies.

Climate change impact of equipment impact



Source: Own calculation

Low-carbon electricity input is the key for “green” gas



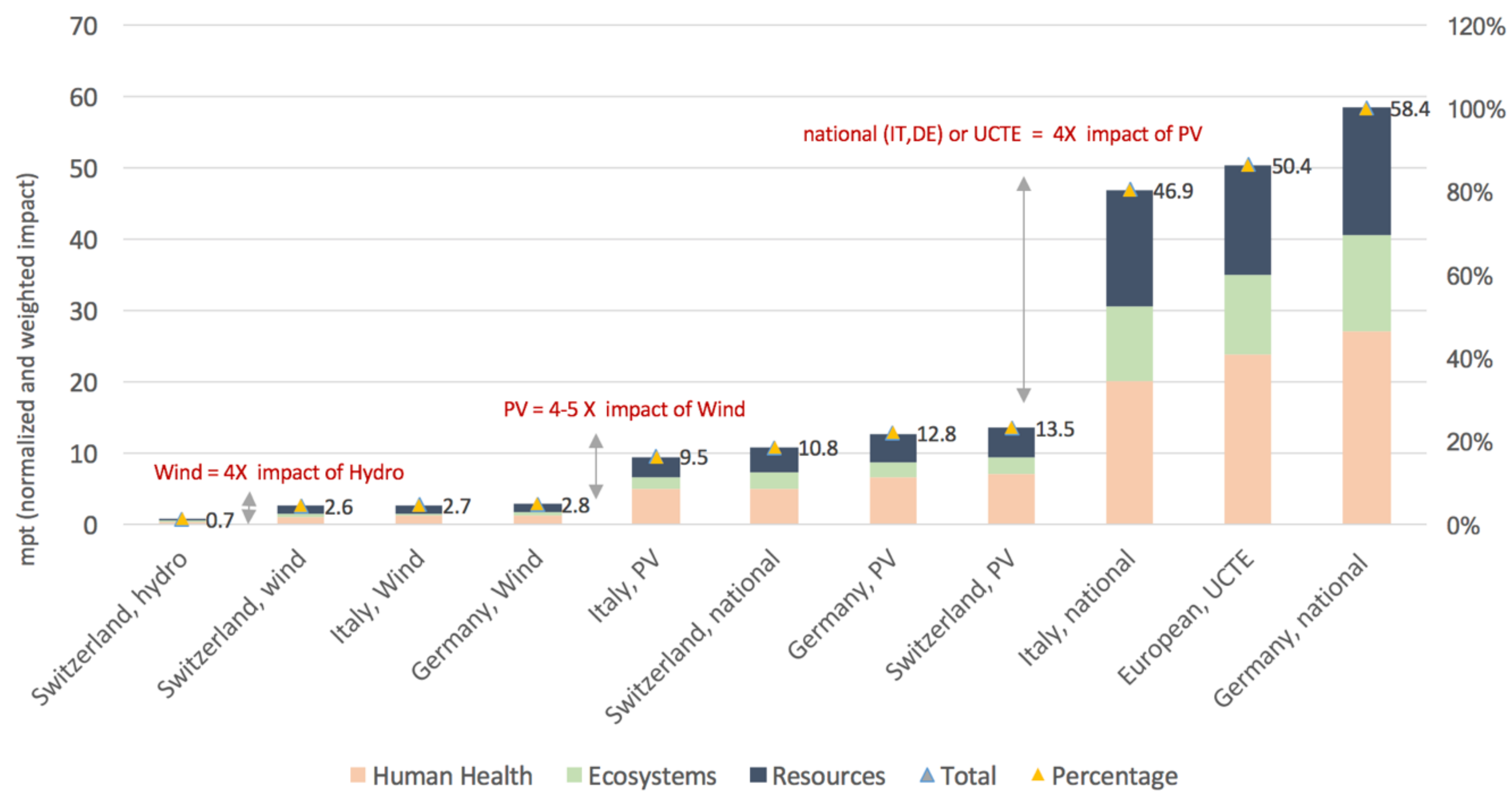
Max carbon intensity of electricity input to be better than fossil counterpart:

86-155 g CO_2-eq for Power-to-Methane

280 g CO_2-eq for Power-to-Hydrogen

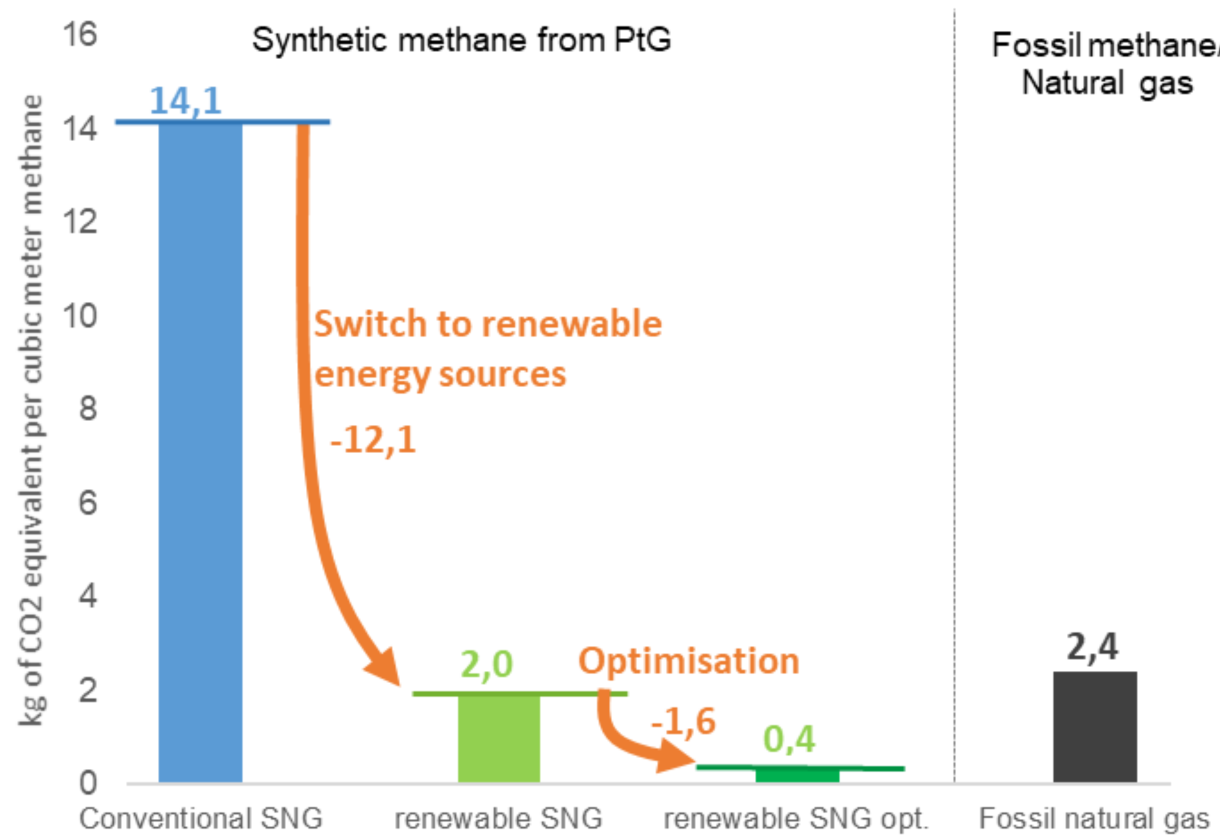
Source: Own calculation

Influence of electricity input



Source D5.4 (STORE&GO)

PtG could be a key enabler for a CO_2 neutral energy system



The conventional SNG reference is calculated based on the current Italian power grid, i.e. the annual national average high-carbon energy sources.

PtG could be a strategic approach to **store** electricity (from renewable sources) and provide **energy security** and **sector decarbonization.**

- High renewable penetration and are key for large scale deployment of PtG technologies, as well as environmentally friendly sourcing of CO_2
- Heat integration/valorization and economy of scale are effective strategies to reduce carbon footprint of PtG systems
- Important to examine nonlinear effects associated with learning curves (technology maturity, scale, cost) and environmental effect for given temporal horizons and geographical scopes.

Color coding: Medium/long term vs near-term

Thanks!

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