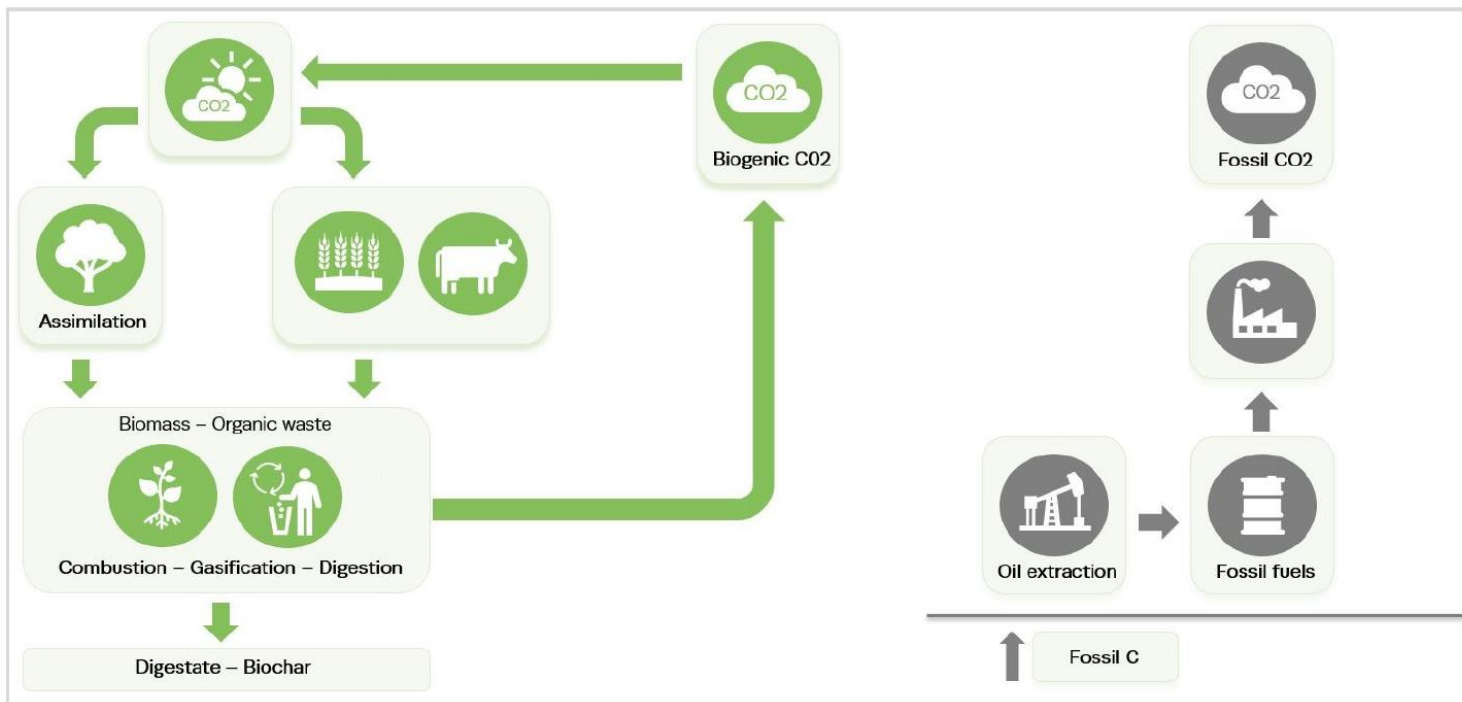


**10.**

# **BIOGAS E ALTRI GAS RINNOVABILI**

**INTEGRARE LE FONTI ENERGETICHE  
RINNOVABILI GRAZIE A IDROGENO VERDE,  
CO<sub>2</sub> E BIOMETANO.**

# CO<sub>2</sub> biogenica



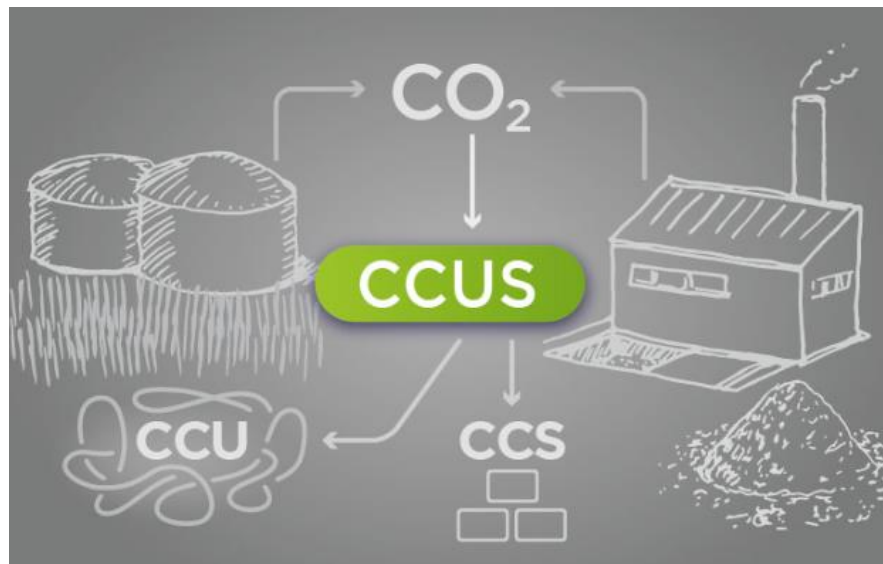
Biogenic CO<sub>2</sub> from the biogas industry. EBA (2022)

# CO<sub>2</sub> biogenica

*Per contrastare rapidamente il cambiamento climatico  
e raggiungere gli obiettivi di riduzione delle emissioni di gas ad effetto serra,  
è necessario ridurre il fabbisogno di CO<sub>2</sub> di origine fossile*

vom Berg, C. and Carus, M. et al. 2022: Renewable Carbon as a Guiding Principle for Sustainable Carbon Cycles. Editor: Renewable Carbon Initiative (RCI), Febr. 2022.

# Carbon Capture and Utilization / Storage



CCU: Carbon Capture and Utilization  
CCS: Carbon Capture and Storage

Sistema	Emissioni $\text{CO}_2$ evitate	Emissioni $\text{CO}_2$ neutre	Emissioni $\text{CO}_2$ negative
CCU	SI	SI	NO
CCS	SI	SI	SI

# RETE ELETTRICA NAZIONALE (National Electrical grid)



ENERGIA ELETTRICA (Electrical Energy)      ENERGIA TERMICA (Heat)

**COGENERAZIONE**  
(Cogeneration)

**UPGRADE**

**CO<sub>2</sub>**

Altri usi  
(Other)

Biogas

**BIOMASSE**  
(Feedstock)

**Bio-CH<sub>4</sub>**

DIGESTIONE  
ANAEROBICA  
(Anaerobic Digestion)

**Digestato**  
(Digestate)

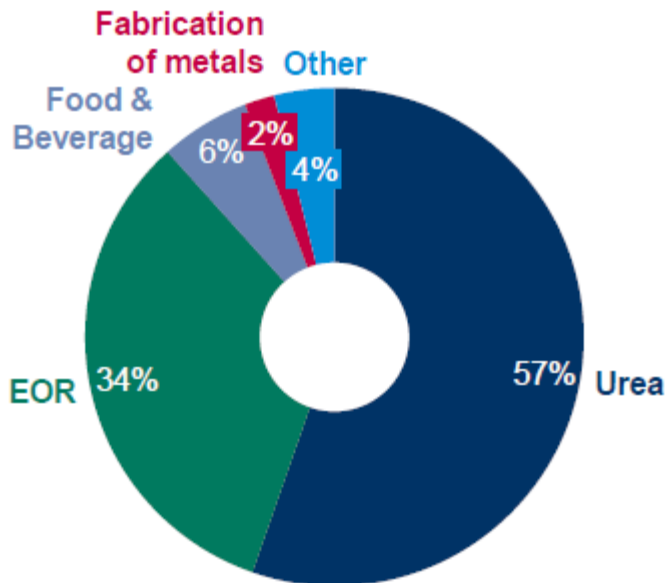
**FERTILIZZANTE DEL SUOLO**  
(Land fertilizer)

**RETE DI DISTRIBUZIONE DEL GAS NATURALE** (Natural gas grid)

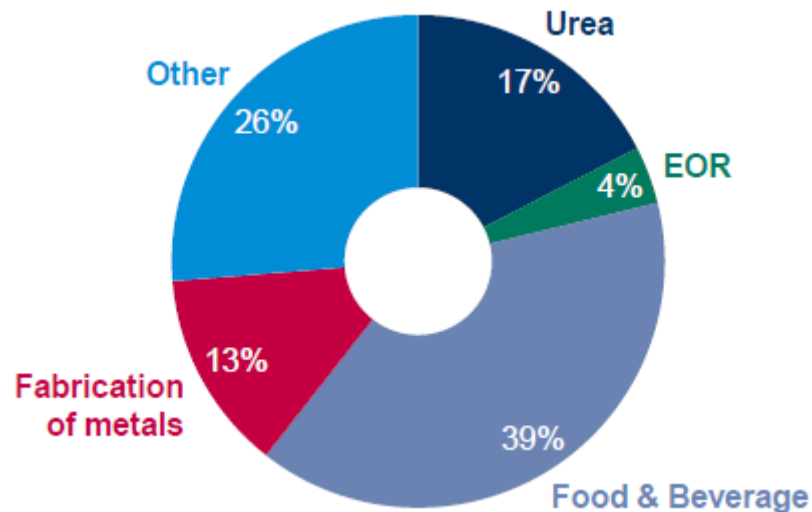
Fonte: CRPA (Centro Ricerche Produzioni Animali)

# Mercati della CO<sub>2</sub>

## Mondiale

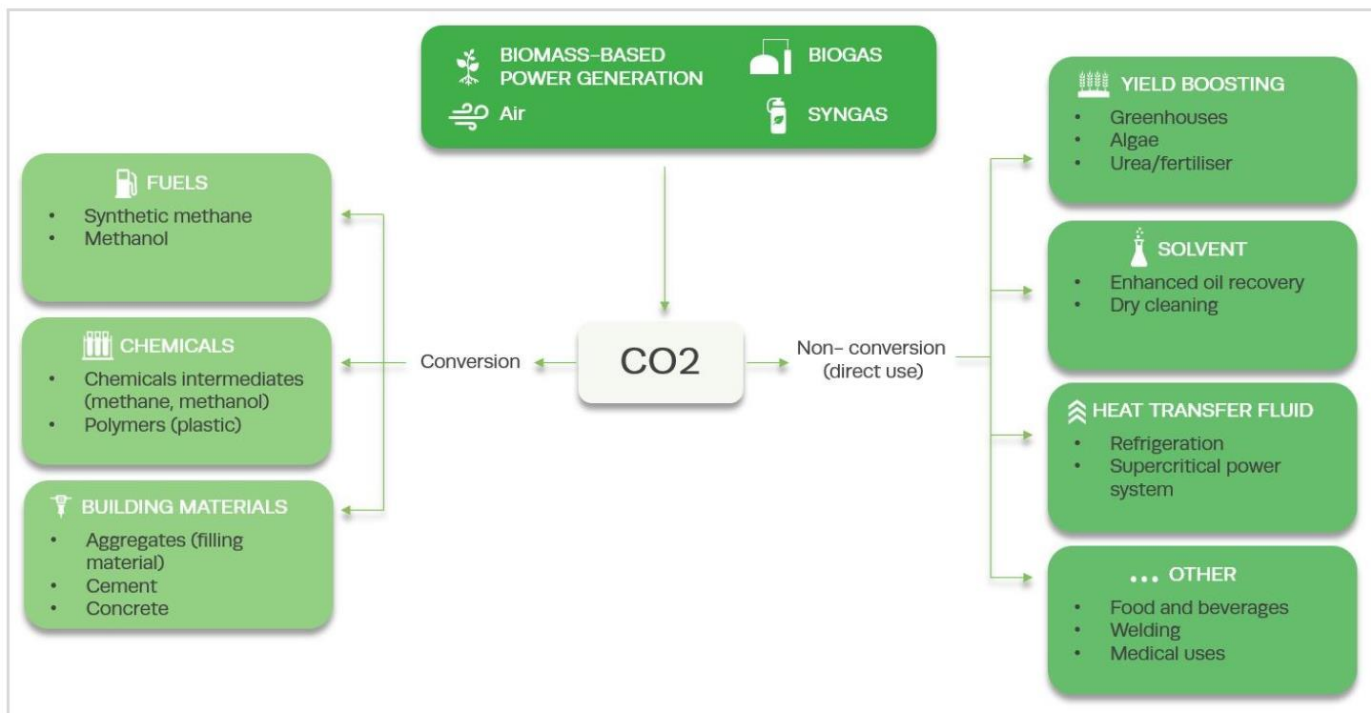


## Europeo



Assessment of European biogenic CO<sub>2</sub> balance for SAF production. ERM Worldwide Group Limited (2022)

# Applicazioni della CO<sub>2</sub>



Biogenic CO<sub>2</sub> from the biogas industry. EBA (2022)

# Biomateriali

### CO<sub>2</sub>-based Products

**Nivea Moisturiser**  
Lanzoltech (DE)

**CCU Ethanol**  
Lanzoltech alone will soon have an annual production of 200,000 tonnes in China and Belgium.

**Air Eau de Parfum & Air Veilina from CO<sub>2</sub>**  
Air Company (US)

**Power to Protein**  
Bioscience (DE)

**Zara Dress**  
Lanzoltech (DE)

**Detergent**  
Purif (DE)

**Peta Cleaning Products**  
Mitsuba (CA)

**PET Bottles**  
Mitsuba (CA)

**CCU Methanol**  
Covestro for annual production of 1 million tonnes are already under construction in Australia, China, China, Germany, the Netherlands, Sweden and Tunisia.

**Milk, Diesel and Naptha**  
Vahle (DE)

**Concrete Block**  
Carbonize (CA)

**CleanO<sub>2</sub> Soap**  
CleanO<sub>2</sub> Carbon Capture Technologies (CA)

**Fabric**  
Lanzoltech (DE) and Lanzoltech (CA)

**CO<sub>2</sub>-based Synthetic Fibre**  
Lanzoltech (DE)

**Field Hockey Surface Poligras Tokyo CT**  
Advanced Polymer Technology (AU) and Poligras (DE)

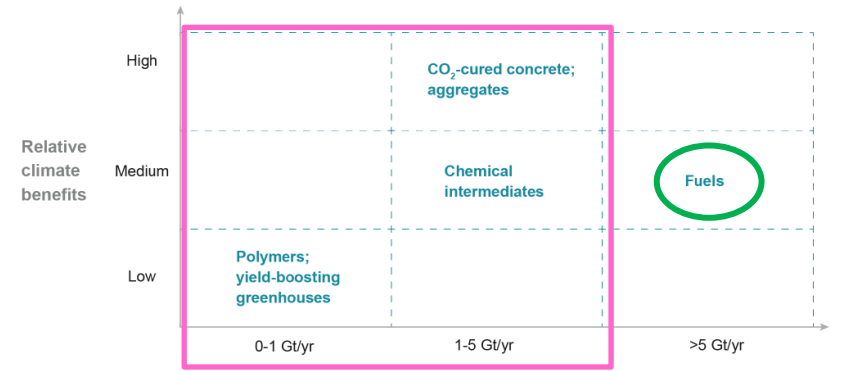
**CleanCloud Shoe**  
Lanzoltech (DE) and DE (DE)

**CCU-based Clothing**  
Hewlett Technologies (US)

**CCU Kerosene**  
Kerosene (US) - Separators of around 95 million litres annual production are under construction in Norway alone, with several other plants planned to start by 2030, e.g. in France, Canada, Portugal and the Netherlands. If all these projects are to be considered, CCU-based kerosene production should be higher than 100 million tonnes per year by 2030.

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Figure 20. Theoretical potential and climate benefits of CO<sub>2</sub>-derived products and services



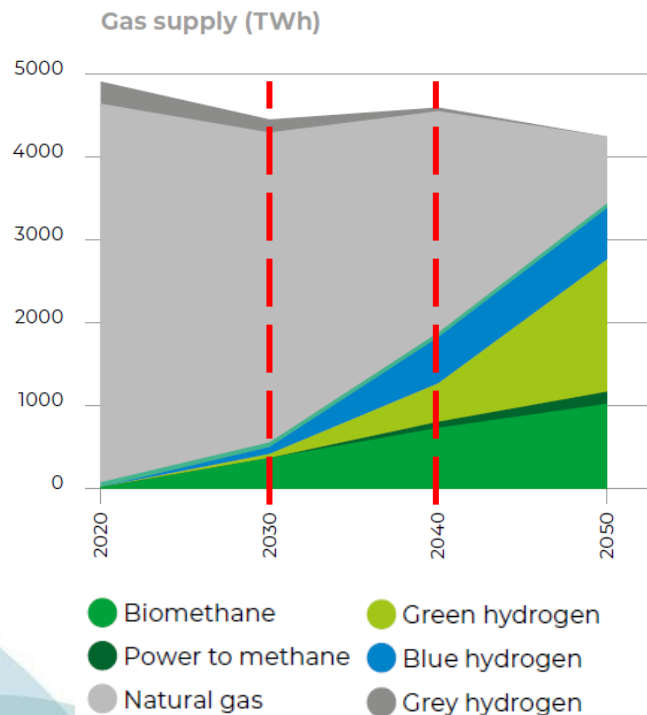
IEA 2019. All rights reserved.

Fuels show the greatest potential for CO<sub>2</sub> use by volume, while building materials have the greatest potential to deliver climate benefits per tonne of CO<sub>2</sub> used.

Putting CO<sub>2</sub> to Use: Creating Value from Emissions. IEA (2019)



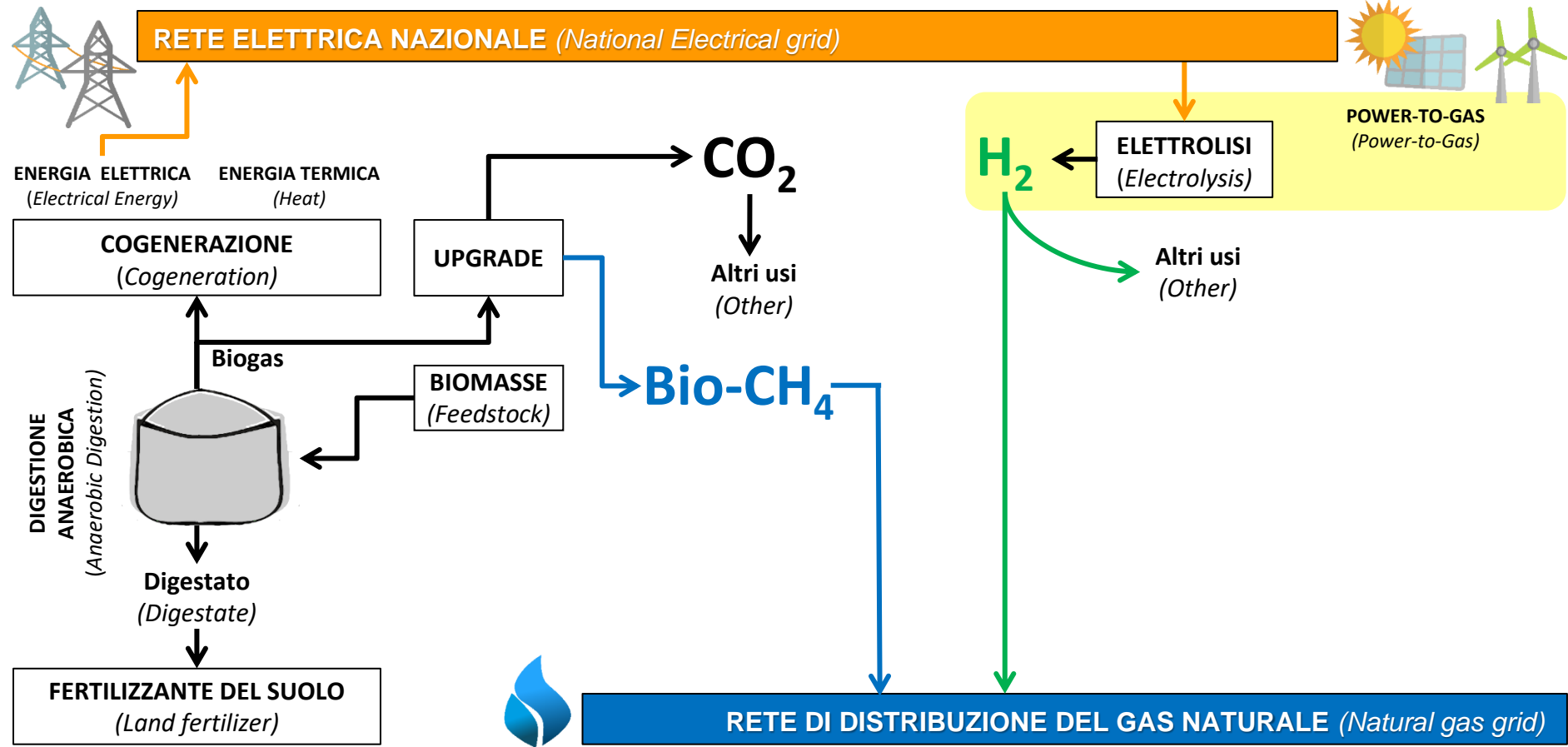
# Come decarbonizzare?



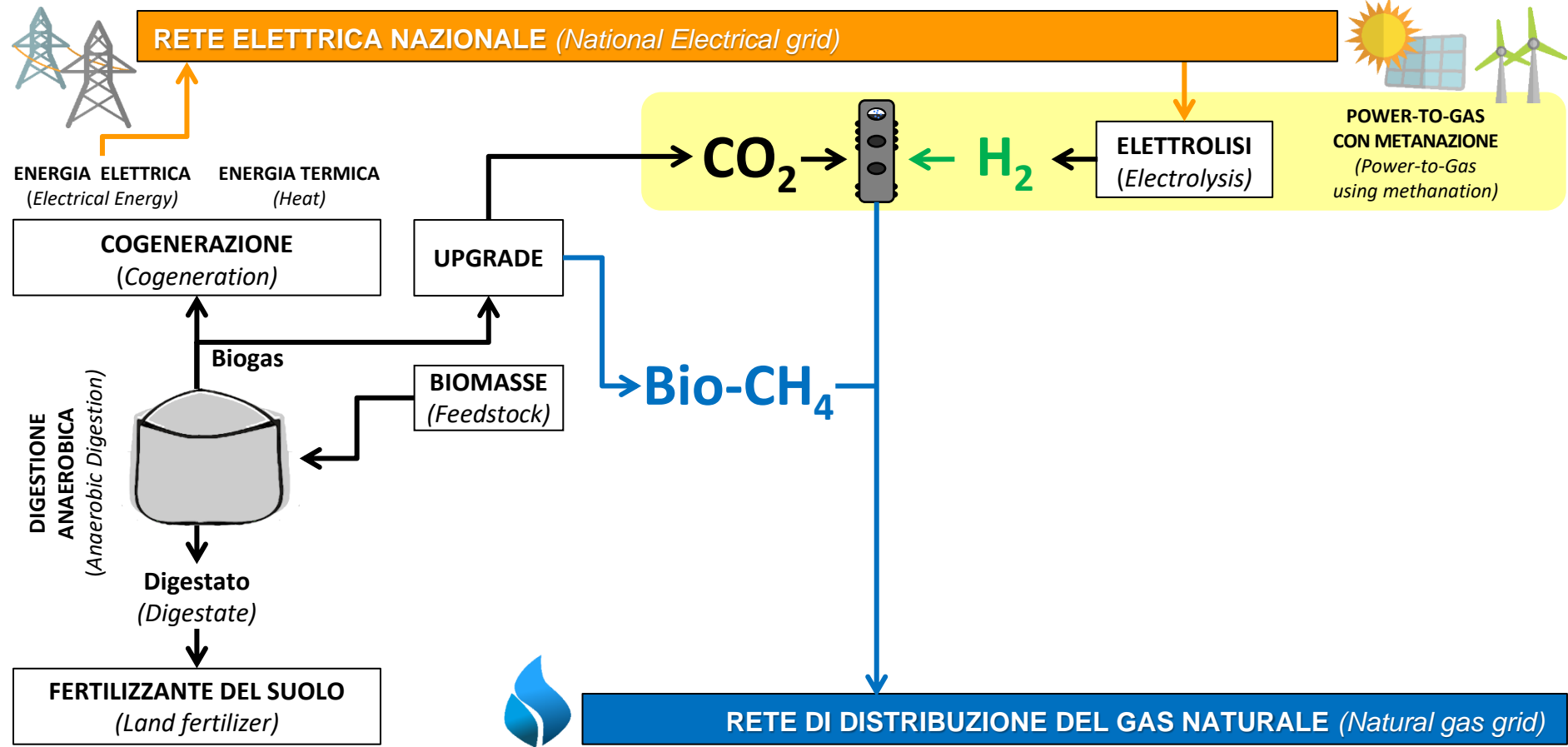
## La strada da percorrere

- 2020-2030: riduzione consumo gas grazie a efficienze energetica ed elettrificazione + aumento gas rinnovabili fino al 10% del totale
- 2030-2040: aumento nell'uso di idrogeno rinnovabile e biometano + aumento gas rinnovabili fino al 35-45% del totale
- 2040-2050: ulteriore riduzione nel consumo di gas naturale, ulteriore incremento nell'uso di gas rinnovabili fino a circa 80% del totale

\* Gas Decarbonisation Pathways 2020–2050



Fonte: CRPA (Centro Ricerche Produzioni Animali)

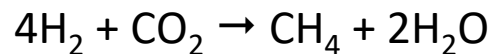


Fonte: CRPA (Centro Ricerche Produzioni Animali)



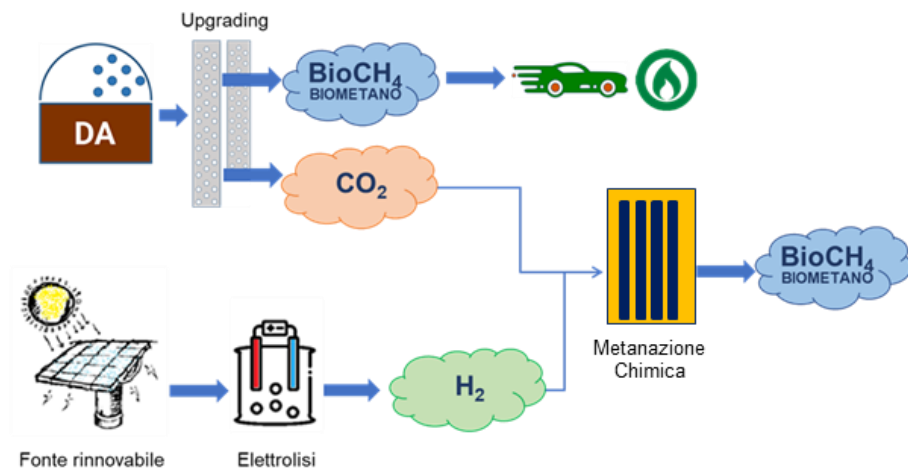
# Metanazione di CO<sub>2</sub> e H<sub>2</sub>

La reazione di Sabatier descrive la conversione di idrogeno e anidride carbonica in metano

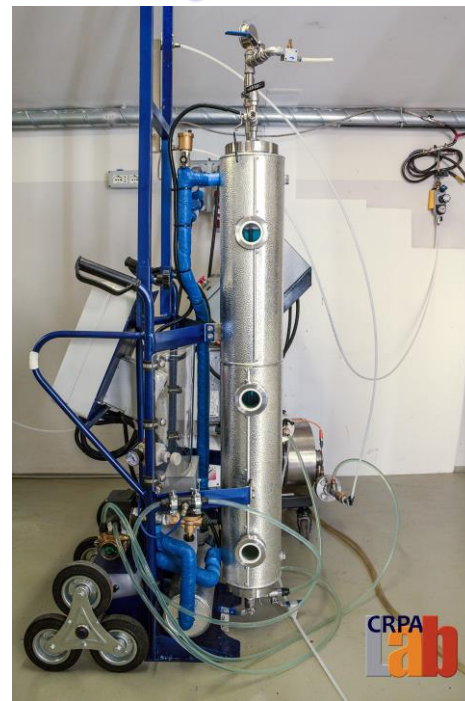


- Metanazione CHIMICA
- Metanazione BIOLOGICA

# CRPA - Progetti di ricerca applicata



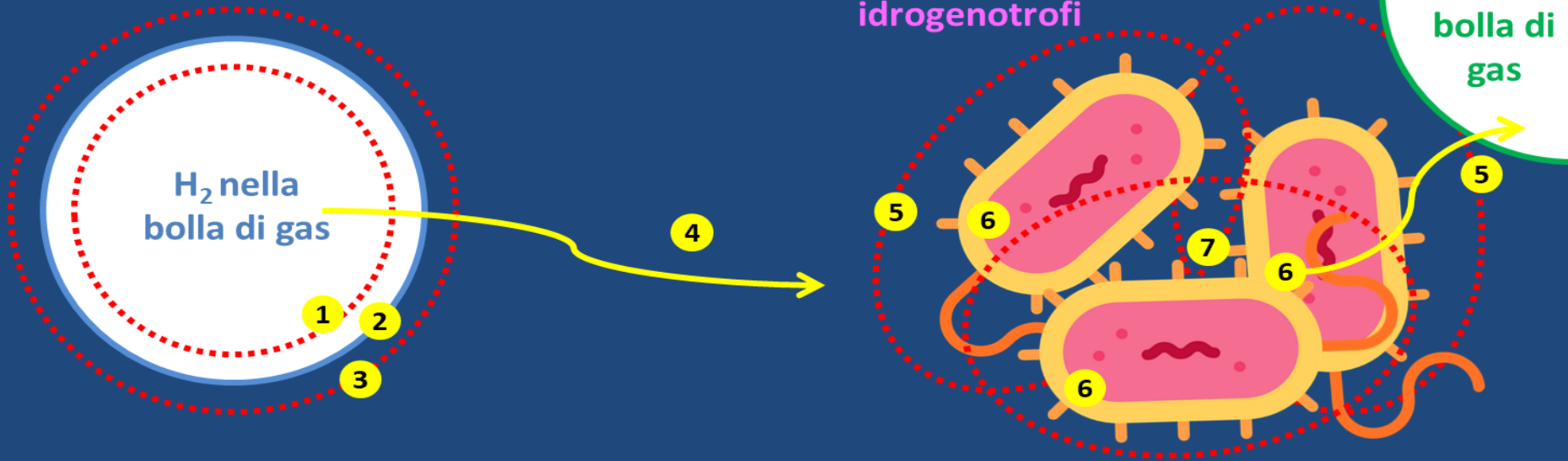
Fonte: CRPA (Centro Ricerche Produzioni Animali)



Uno dei fattori limitanti per il processo di metanazione biologica è la **velocità di trasferimento di massa gas-liquido dell'idrogeno**, a causa della sua scarsa solubilità in fase liquida.

*Archea*  
idrogenotrofi

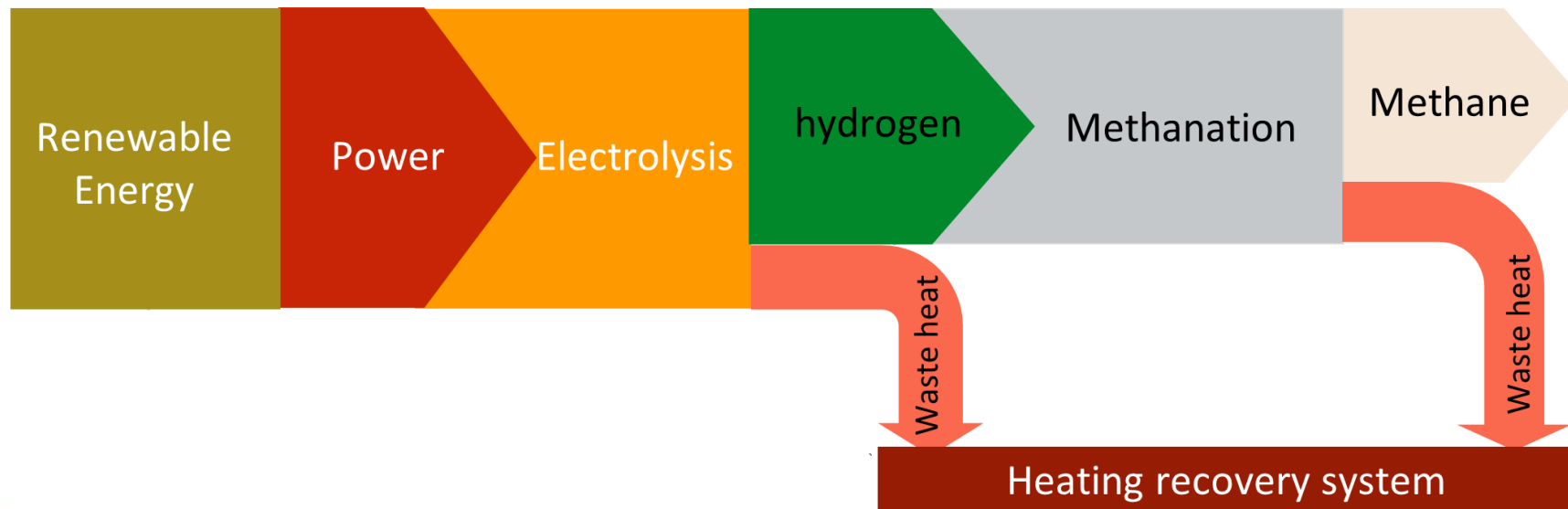
CH<sub>4</sub>  
nella  
bolla di  
gas



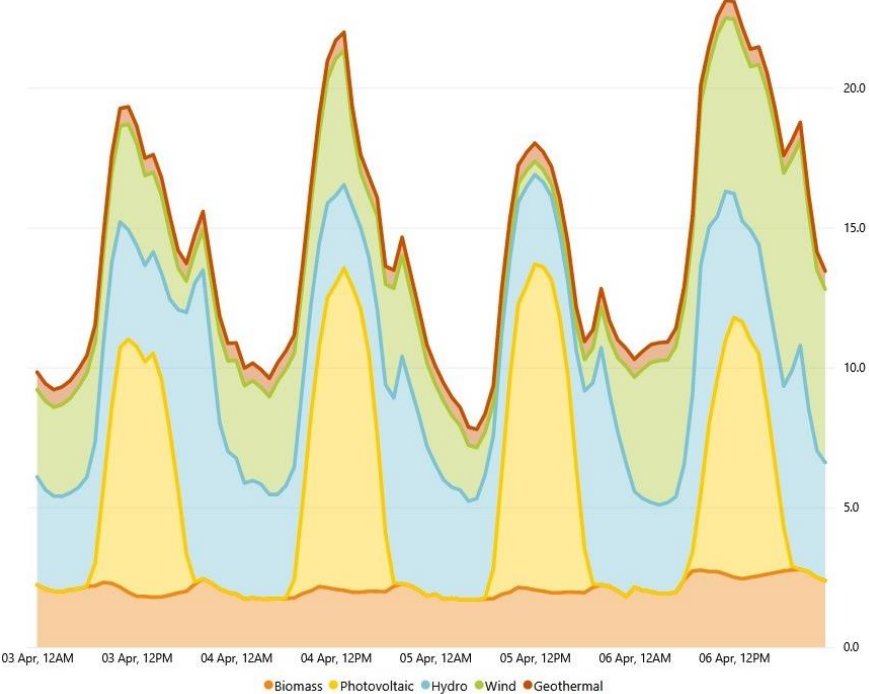
- (1) Resistenza film sottile lato gas    (2) resistenza interfaccia gas/liquido    (3) resistenza film sottile lato liquido  
(4) resistenza del liquido    (5) resistenza film sottile liquido/cellula    (6) resist. INTRAcellulare    (7) resist. INTERcellulare

Fonte: CRPA (Centro Ricerche Produzioni Animali)

# Sfide tecnologiche nel Power-to-Methane

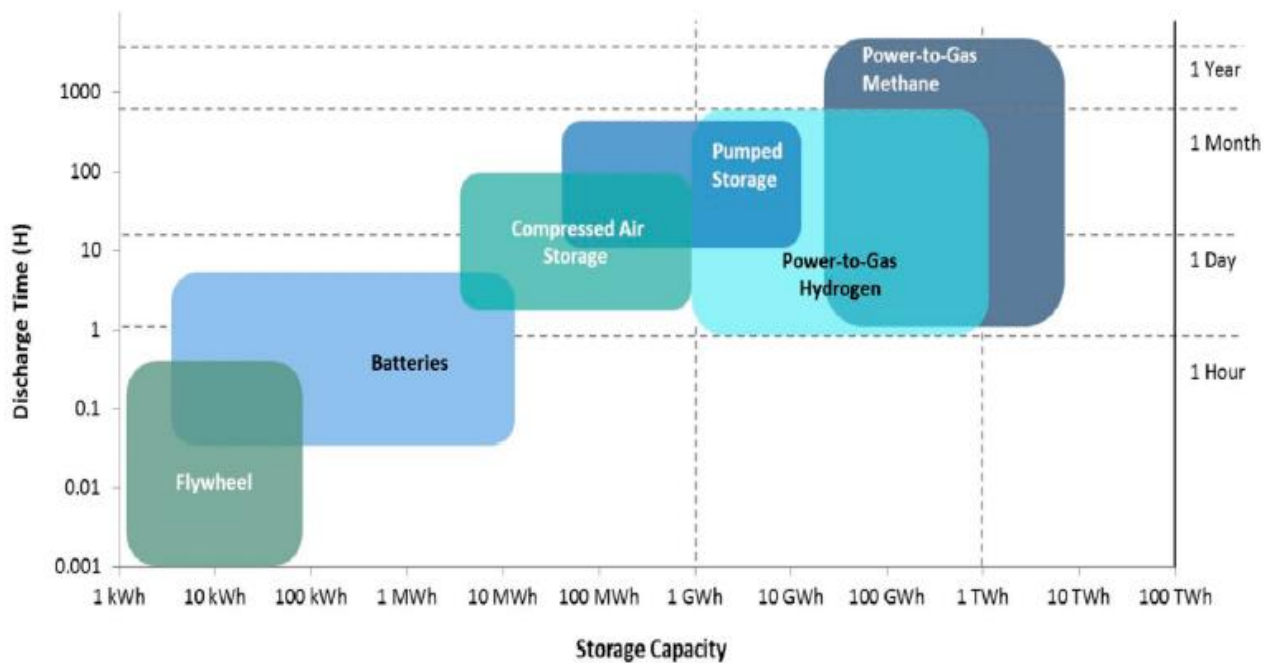


# Fonti Rinnovabili non programmabili





# Stoccaggio dell'energia



Moore et al. *Energies* (2016)