CENTRO STUDI
DI ECONOMIA E TECNICA DELL'ENERGIA
"GIORGIO LEVI CASES"

UNiPHy

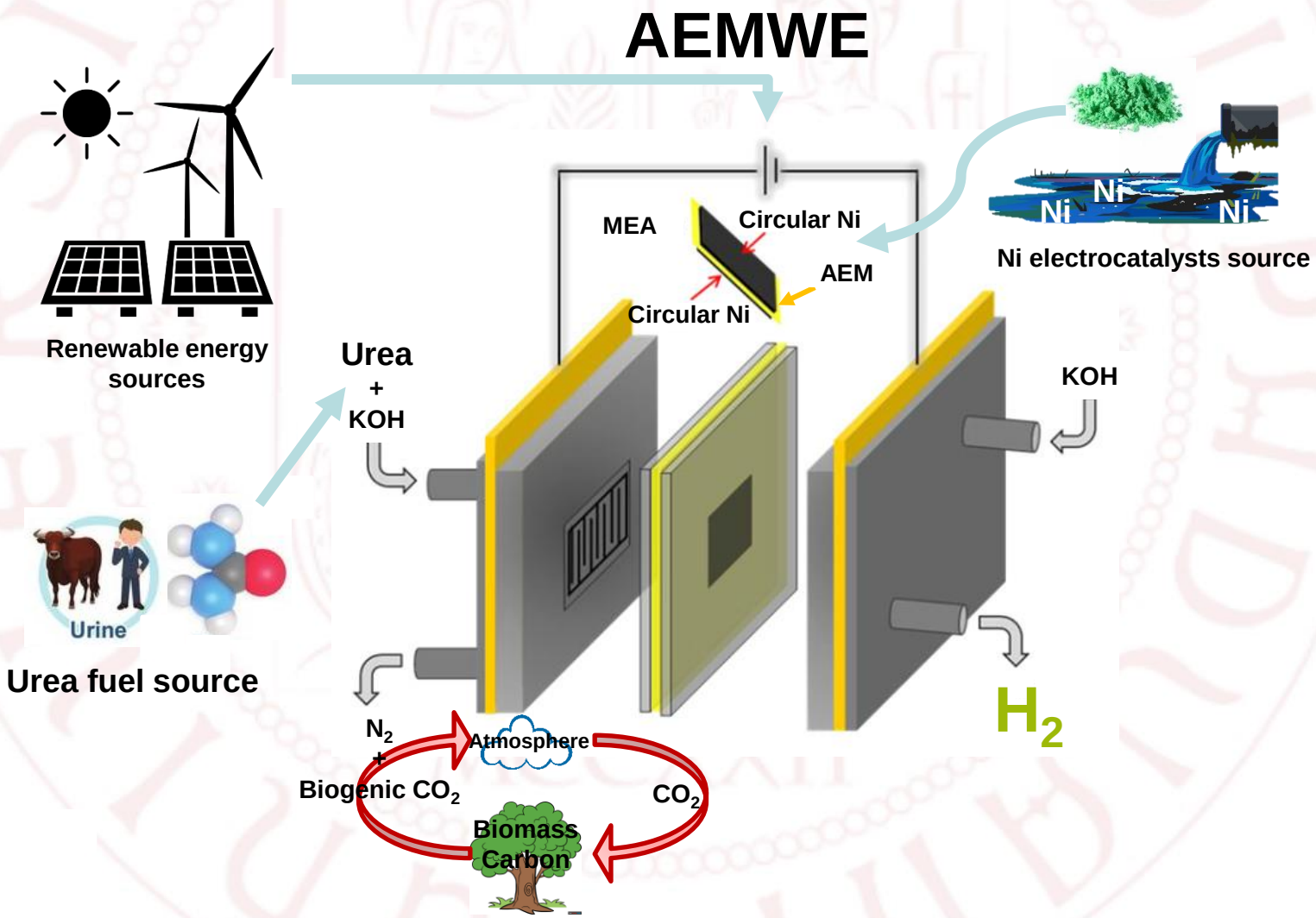
hydrogen from waste: using **U**rea and circular **Ni**ckel to **P**roduce cheap **Hy**drogen.

PI: Dr. Mattia Cattelan DiSC

Outline:

- Aim of the project
- Green Hydrogen
- Environment remediation
  - Urea
  - Circular Ni
- Research team
- Work packages

Aim of the project



Green Hydrogen

- Grey hydrogen: 1.5 €/kg
- Blue hydrogen: 2.5 €/kg
- Green hydrogen: 4.5 €/kg

Grey/Blue hydrogen:

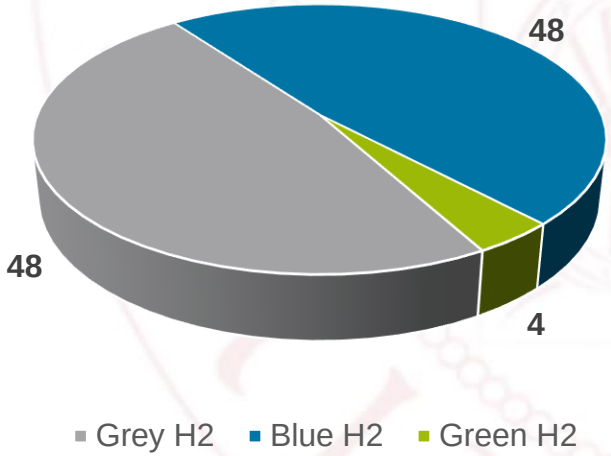
$$CH_4 + H_2O \rightarrow CO + 3H_2$$ **SR= Steam reforming**

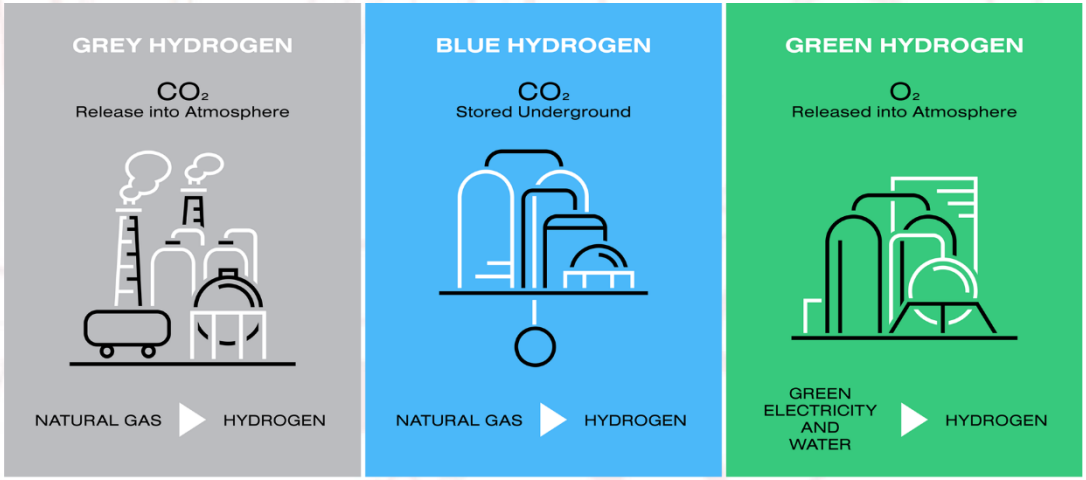
$$CO + H_2O \rightarrow CO_2 + H_2$$ **WGSR= Water-gas shift reaction**

Green hydrogen:

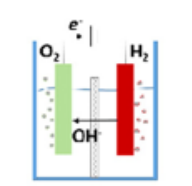
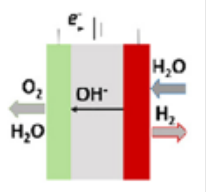
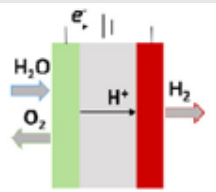
$$H_2O \rightarrow H_2 + \frac{1}{2}O_2$$ **Hydrolysis**

Actual H_2 production





Electrolyzers

	Alkaline		Acid
System	Conventional	Membrane (**A**EM)	Membrane (**P**EM)
Cathode	Ni, Ni-Fe, Ni-Fe-Co		Pt
Anode	Ni, Co, Fe oxides, hydroxides and alloys		IrO_2, RuO_2
Advantages	Limited cost, well-established technology, **non-noble cheap electrocatalysts**	**Combining the advantages of cheap electrocatalyst and MEA zero-gap** (1-2 A/cm^2 ?)	**MEA with zero-gap, high hydrogen purity,** well-know membranes, great current/cm^2 (1-3 A/cm^2), great efficiency
Disadvantages	High Ohmic resistance for the large anode/cathode distance, low current/cm^2 (0.25 A/cm^2)	Poor membrane conductibility for OH^- ions, **young technology**	Expensive noble metal required for the acid conditions
Efficiency	55-65%	50-70%	60-70%
Scheme			

Electrolyzers

Hyter s.r.l uses Anion Exchange Membrane Water Electrolyzers (AEMWE).

It is part of the PON and SIRIUS project with INCAT group (DiSC).

Environment remediation : Urea

1. the urea electrooxidation reaction (UOR) produces harmless molecular nitrogen and carbon dioxide

OER (water) → $4OH^- \rightarrow O_2 + H_2O + 4e^-$

UOR (urea) → $CO(NH_2)_2 + 6\ OH^- \rightarrow CO_2 + 5H_2O + N_2 + 6e^-$

HER → $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

2. the theoretical overall voltage

Urea **0.37 V** << H_2O 1.23 V

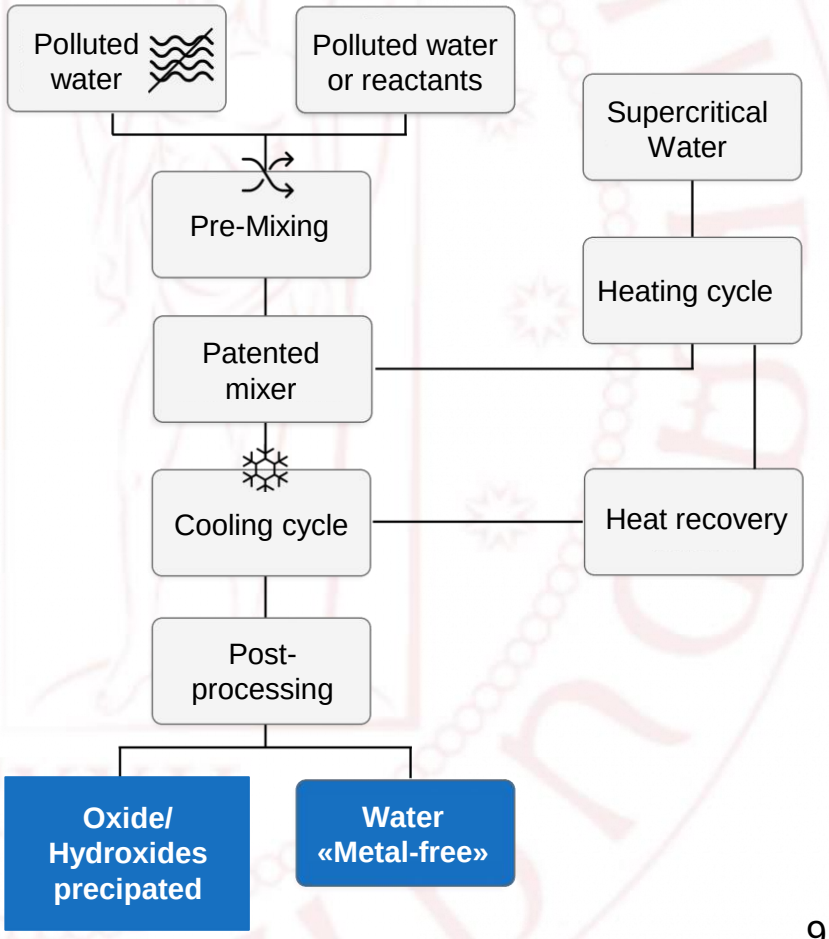
3. urea is abundant, chemically stable, and easy to store and it is found in concentrate solution, of about 0.3 M, in animals urine.

*The produced CO_2 is considered **biogenic**, because released as results of the decomposition of organic material and part of the **natural carbon cycle offset** by the CO_2 uptake by plants through photosynthesis.

Environment remediation : Circular Ni

Circular Materials s.r.l. has developed a green technology based on a precipitation in supercritical conditions allowing **Ni recovery from wastewater**, as $NiO/Ni(OH)_2$ powder

CIRCULAR MATERIALS



The Team

- **Dr. Cattelan**

DiSC Dipartimento di Scienze Chimiche

- **Dr. Colusso**

DII DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

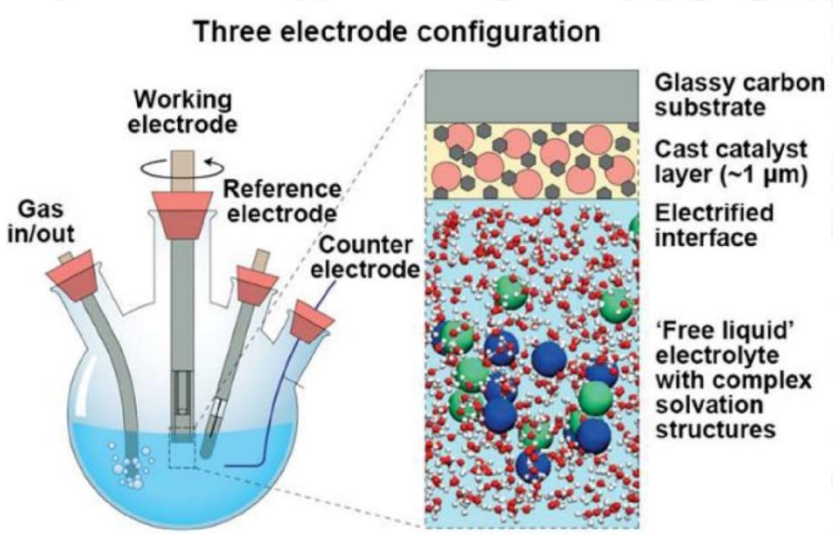
- **Dr. Berton**

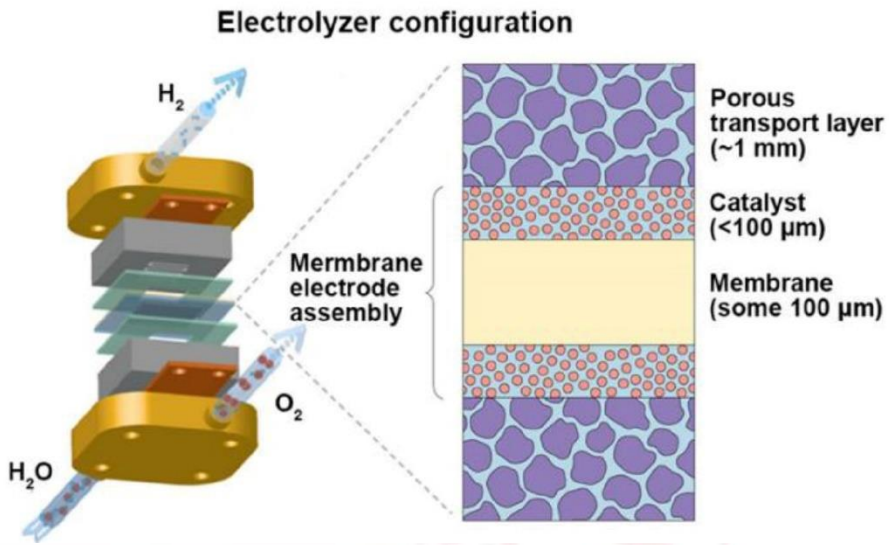
- **Dr. Schiavon**

DAFNAE Dipartimento di Agronomia Animali Alimenti Risorse naturali e Ambiente

Work packages

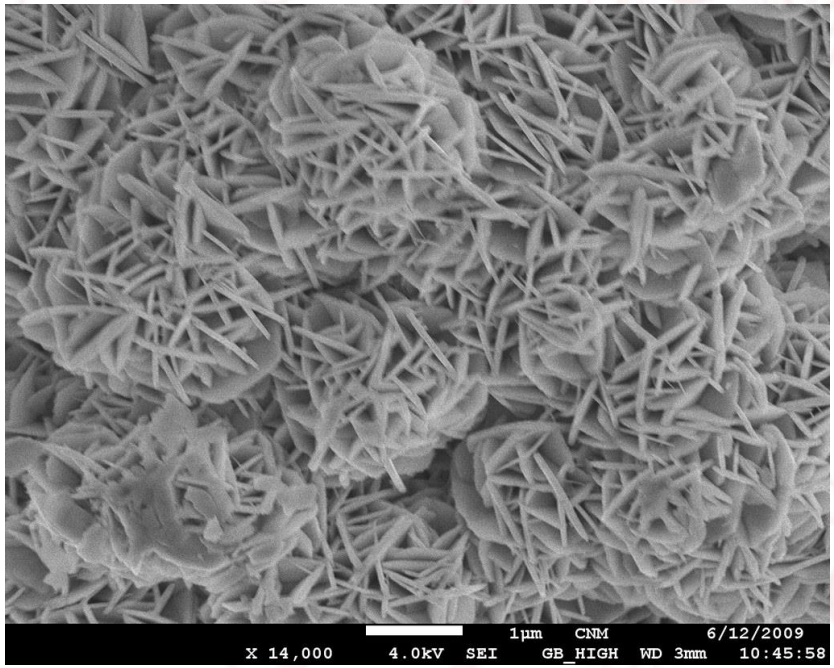
1. **Implementing urea with current electrolyzer technology (DiSC)**





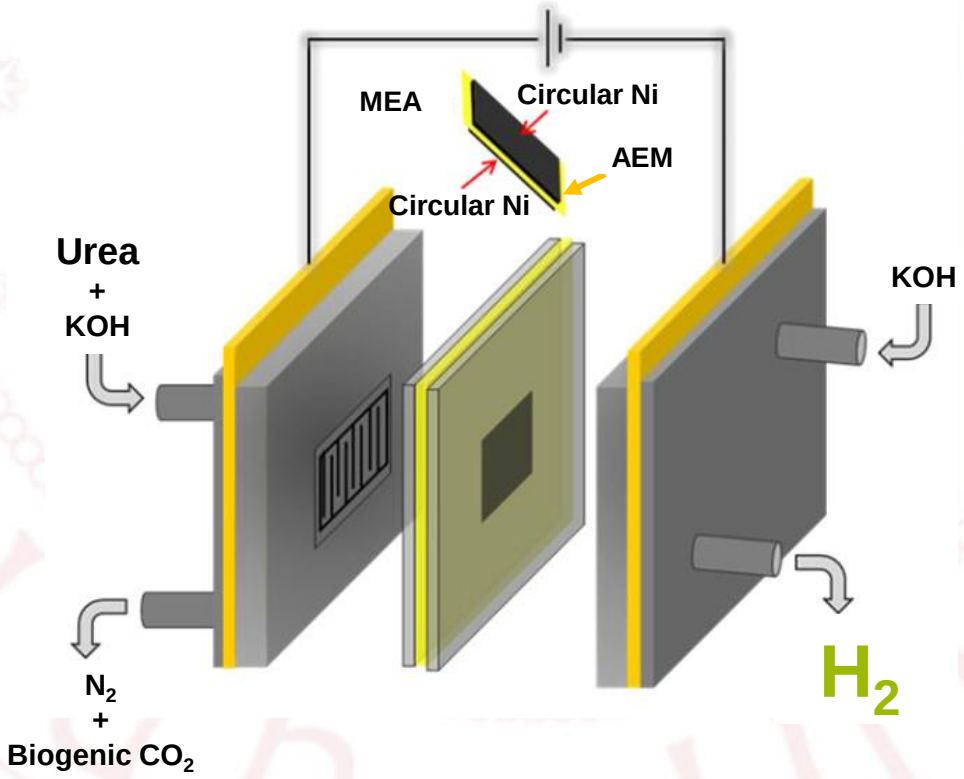
Work packages

1. Implementing urea with current electrolyzer technology (DiSC)
2. Optimization and deposition of "circular Ni" nanoparticles (DII)



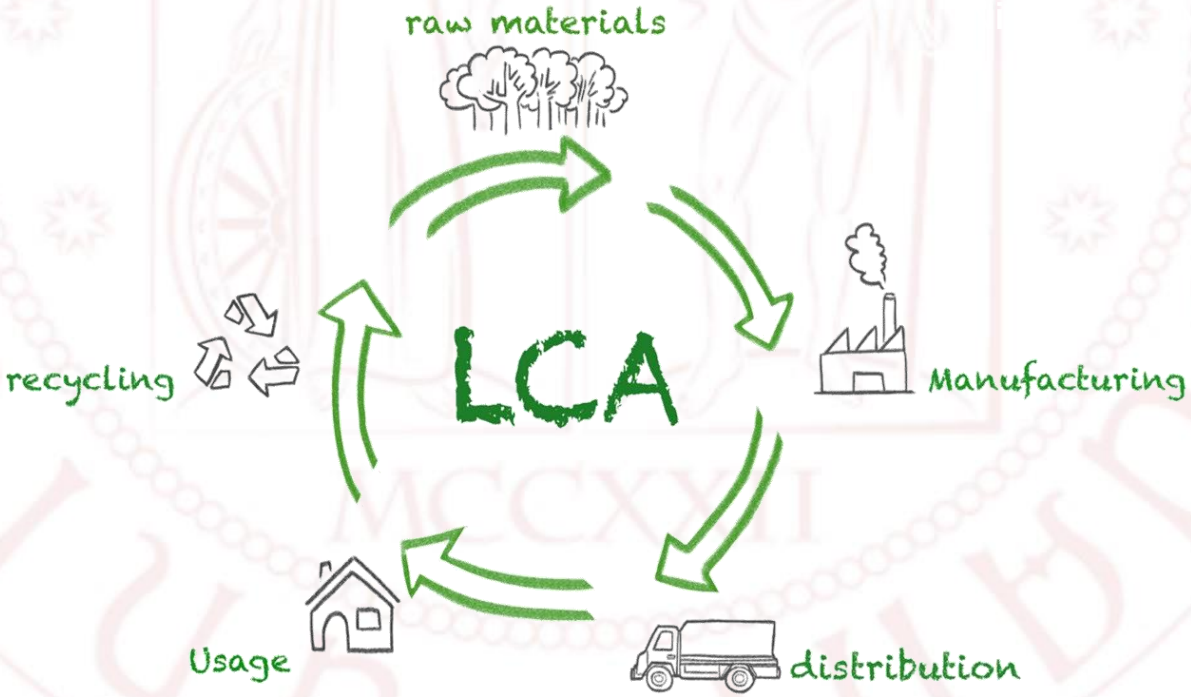
Work packages

1. Implementing urea with current electrolyzer technology (DiSC)
2. Optimization and deposition of "circular Ni" nanoparticles (DII)
3. Implementing urea and "circular Ni" in electrolyzer (DiSC)

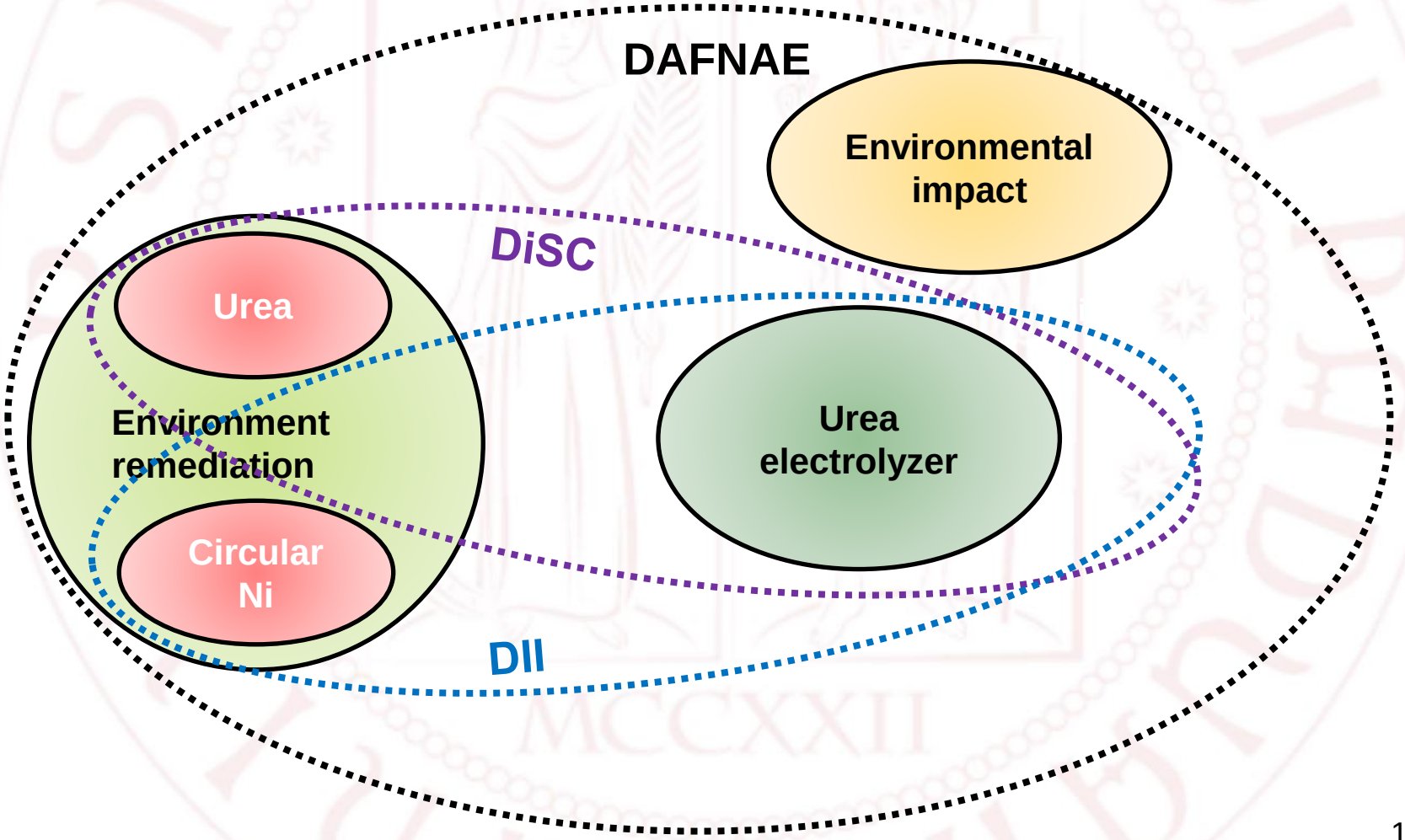


Work packages

1. Implementing urea with current electrolyzer technology (DiSC)
2. Optimization and deposition of "circular Ni" nanoparticles (DII)
3. Implementing urea and "circular Ni" in electrolyzer (DiSC)
4. Studying the environmental impact of the project (DAFNAE)



Conclusion


DAFNAE
Environmental impact
DiSC
Urea
Environment remediation
Circular Ni
Urea electrolyzer
DII

Acknowledgements

INCAT group DiSC

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Thank you for your kind attention!