COMPANY PROFILE

HYSYTECH

FILLING THE GAP

- Engineering, EPC & EPCM
- Special Equipment and "Turn-Key" Package Units
- Applied R&D
- Maintenance

Organization Name: Hysytech Srl
Type of Organization: SME
Country: Italy (Torino)
The Netherlands (Eindhoven)

61 personnel
from different nationalities

17 years
of professional expertise

STIRLING CRYOGENICS

Business areas

INDUSTRIAL PLANTS – 51%

R&D EQUIPMENT – 26%

ENGINEERING CONSULTING – 19%

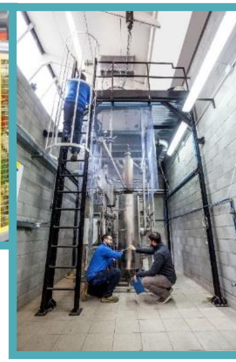
MAINTENANCE – 4%

- Biogas purification
- Industrial waste and by-products gasification
- Hydrogen generation from biogas/biomethane & NG
- Gaseous and liquid fuel treatments
- Supercritical processes
- Power to gas/LNG & methanation
  Cryogenic systems
- Electrochemical equipment design and manufacturing
- CO_2 recovery from flue gas

Our unique Knowledge & Infrastructure

Pilot and industrial plants

Power-to-gas & methanation



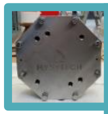
Waste and by-products gasification

Distillation columns and package unit

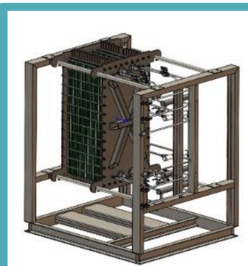
Gas feeding station for Steel mill furnaces

Process plants: Glycol recovery unit (Singapore)

Lab equipment, Test Rig, Prototypes



Electrochemical plants and reactors



Certified Lab units for the characterization of innovative processes (accurate data collection)

<u>Organization Name</u>: Hysytech Srl
<u>Type of Organization</u>: SME
<u>Country</u>: Italy (Turin)

Vision

Today, tomorrow and in the future ahead of us, more and more technology and knowledge (know-how) are the main competitive advantages to make new and better products, with high performance, sustainability and through more competitive processes.

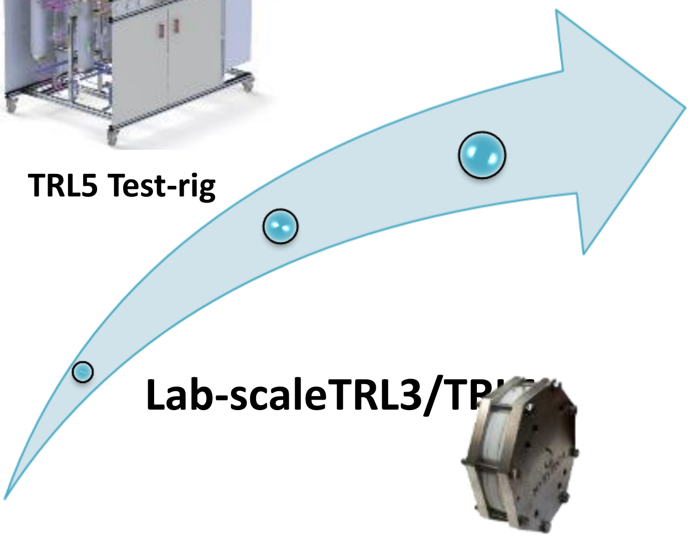
Mission

Building a wealth of experience, technological innovation and process, applying engineering to create a bridge between science and society, between technology and people, through the industrial implementation of products in everyday life.

Our role in R&D projects

Engineering, design, scale-up, manufacturing, commissioning, start-up and testing

TRL5 Test-rig



Lab-scaleTRL3/TR

>>>TRL6: Demonstrative plants

“We intercept innovation opportunities, developing them and transforming them into specific products and technologies with a high added value on the global market”.

FEATURED PRODUCTS

Biomethane

Biomethane from raw biogas.
Plants in Italy from MSW and Biomass
(2 Patents)

Bio-LNG

- Gas Conditioning (Treatment)
- Cooling and Liquefaction

STIRLING CRYOGENICS

Plants in Italy
(1 Patent)

H2Genio

Hydrogen generation directly on site, simply starting from Natural Gas, from small flow rates and up to industrial sizes.
Plants in Italy
(3 Patents)

EU-Funded projects

LICROX 2020-2023
Light assisted solar fuel production by artificial CO_2 Reduction and water Oxidation

LIESGO 2020-2023
Light to Store chemical Energy in reduced Graphene Oxide for electricity generation

REGEN-BY-2 2020-2024
Next REnewable multi-GENeration technology enabled by TWO-phase fluids machines

DECADE 2020-2024
DistributEd Chemicals And fuels production from CO_2 in photoelectrocatalytic Devices

SunCoChem 2020-2024
Photoelectrocatalytic device for SUN-driven CO_2 conversion into green CHEMicals

ENDURUNS 2018-2022
Development and demonstration of a long-endurance sea surveying autonomous unmanned vehicle with gliding capability powered by hydrogen fuel cell

PERFORM 2018-2022
PowerPlatform: Establishment of platform infrastructure for highly selective electrochemical conversions

STOREandGO 2016-2020
Innovative large-scale energy STORagE technologies AND Power-to-Gas concepts after Optimisation

BioRoburPlus 2017-2020
Advanced direct biogas fuel processor for robust and cost-effective decentralised hydrogen production

LIFECAB 2017-2020
Biogas and digestate with controlled ammonia content by a virtuous biowaste cycle with integrated bio&chemical processes

RECODE 2017-2021
Recycling carbon dioxide in the cement industry to produce added-value additives: a step towards a CO_2 circular economy

OCEAN 2017-2021
Oxaclic acid from CO_2 using Elcetrochemistry At demonstratioN scale

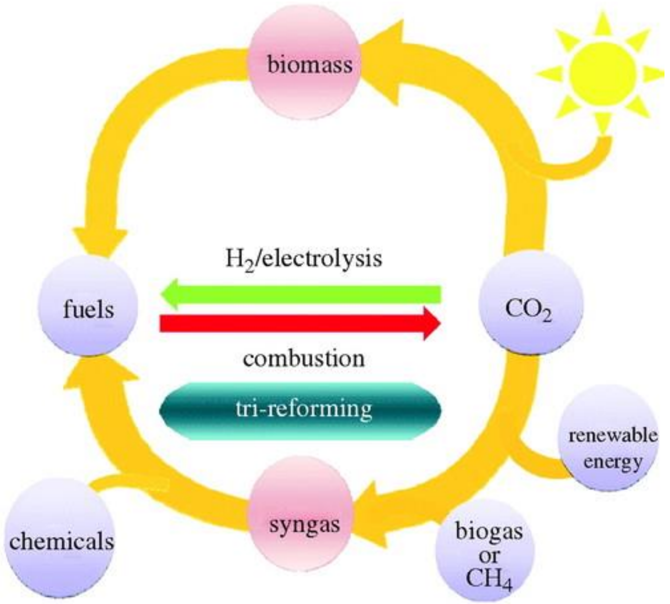
ENGICOIN 2018-2021
Engineered microbial factories for CO_2 exploitation in an integrated waste treatment platform

- Biological process: Biogas production, biomethane production
- Electrochemical process: Syngas production, chemicals production
- Photoelectrochemical process
- Thermochemical process: Syngas, SNG, H2 production
- Hybrid process: Bio-electrochemical

- The **challenges** associated with the conversion of CO_2 are primarily related to both its kinetic and **thermodynamic stability**.

- CO_2 **cannot be converted** into commodity chemicals or fuels **without significant inputs of energy** and contains strong bonds that are not particularly reactive. Consequently, many of the available transformations of CO_2 require stoichiometric amounts of **energy-intensive reagents**. This can often generate significant amounts of waste and can result in large greenhouse gas footprints.

- The main challenge for converting CO_2 waste streams into useful products is to develop processes that require **minimal amounts** of nonrenewable **energy**, are **economically competitive**, and provide substantial reductions in greenhouse gas emissions compared to existing technology.



ENGICOIN 2018-2021
Engineered microbial factories for CO_2 exploitation in an integrated waste treatment platform

CELBICON 2016-2020
Cost-effective CO_2 conversion into chemicals via combination of Capture, ELectrochemical and Biochemical CONversion technologies

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Recycling carbon dioxide in the cement industry to produce added-value additives: a step towards a CO_2 circular economy

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Cost-effective CO_2 conversion into chemicals via combination of Capture, ELectrochemical and BIochemical CONversion technologies

TRL

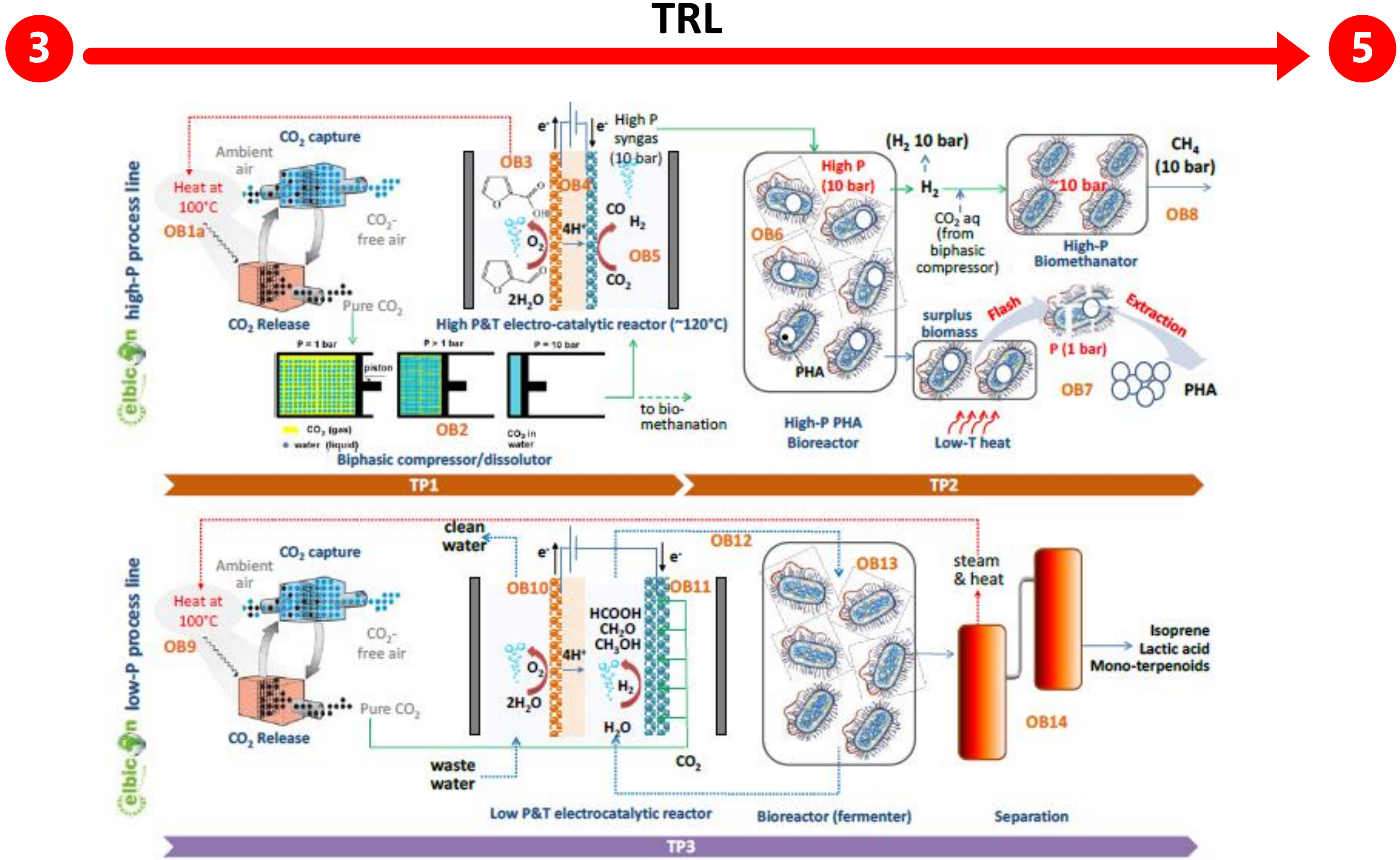
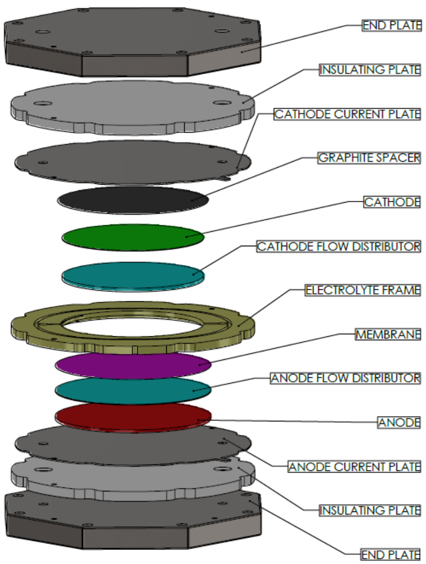
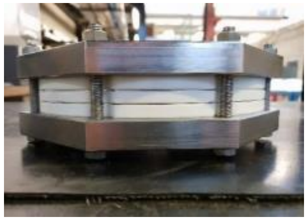


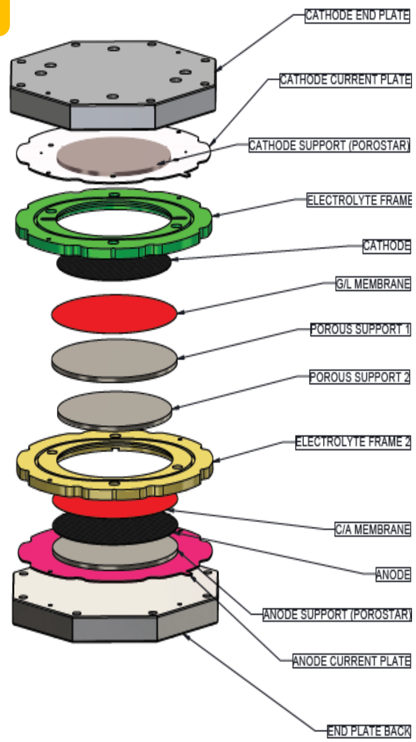
Fig. 2. The two CELBICON process lines with the related technology platforms (TPs) and objectives (OBs).

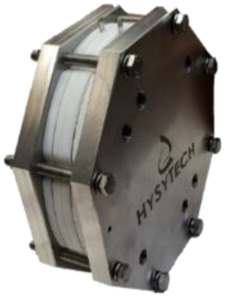
TP1


END PLATE
INSULATING PLATE
CATHODE CURRENT PLATE
GRAPHITE SPACER
CATHODE
CATHODE FLOW DISTRIBUTOR
ELECTROLYTE FRAME
MEMBRANE
ANODE FLOW DISTRIBUTOR
ANODE
ANODE CURRENT PLATE
INSULATING PLATE
END PLATE



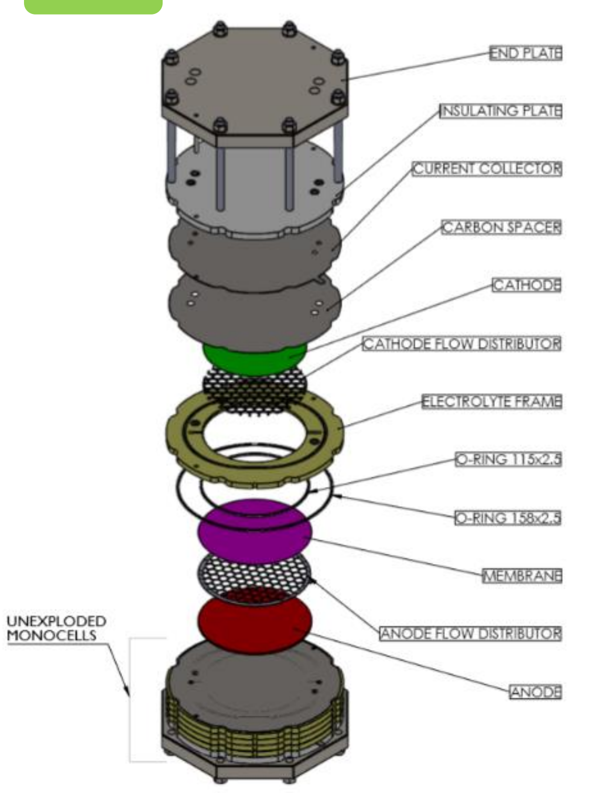
TP3


CATHODE END PLATE
CATHODE CURRENT PLATE
CATHODE SUPPORT (POROSTAR)
ELECTROLYTE FRAME
CATHODE
G/L MEMBRANE
POROUS SUPPORT 1
POROUS SUPPORT 2
ELECTROLYTE FRAME 2
C/A MEMBRANE
ANODE
ANODE SUPPORT (POROSTAR)
ANODE CURRENT PLATE
END PLATE BACK

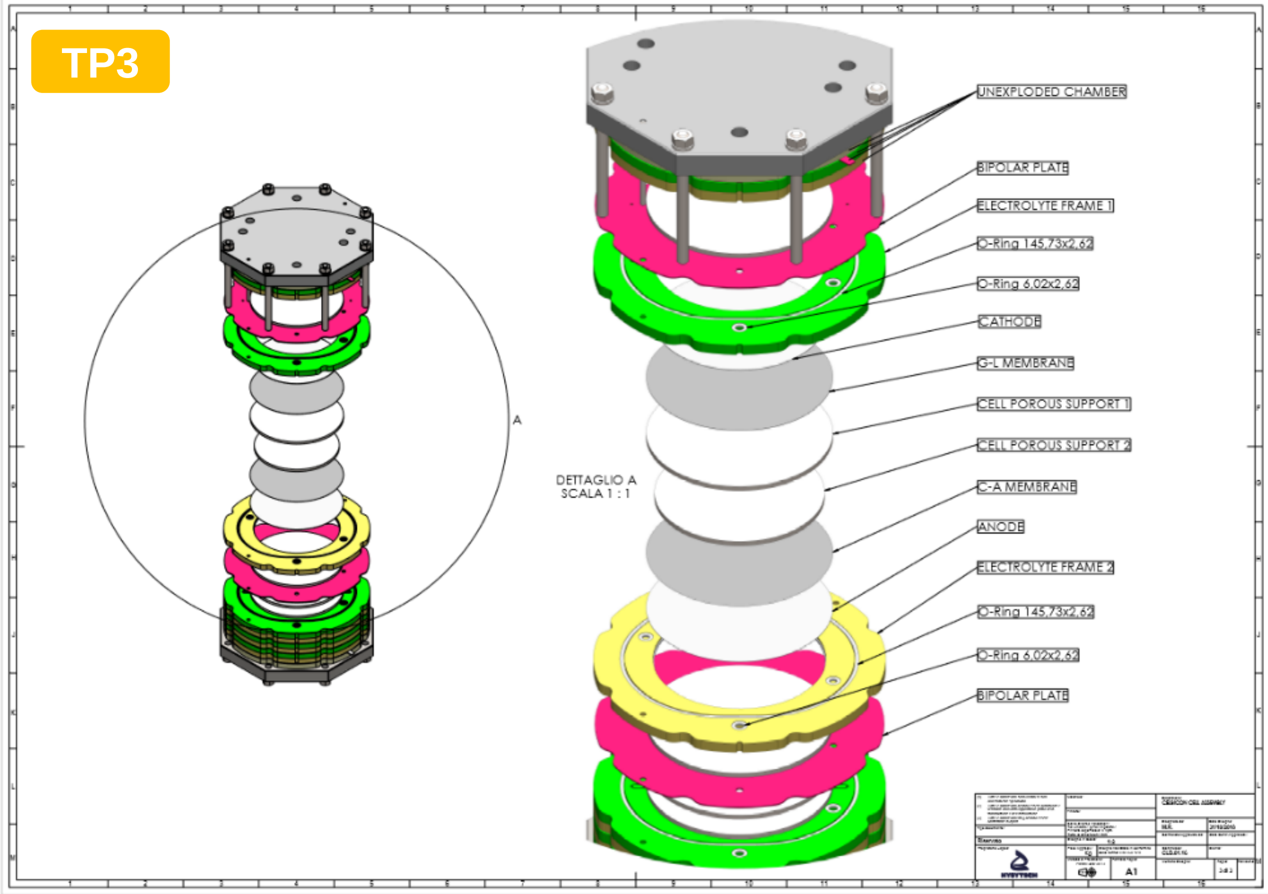

HYSYTECH

Stack

TP1

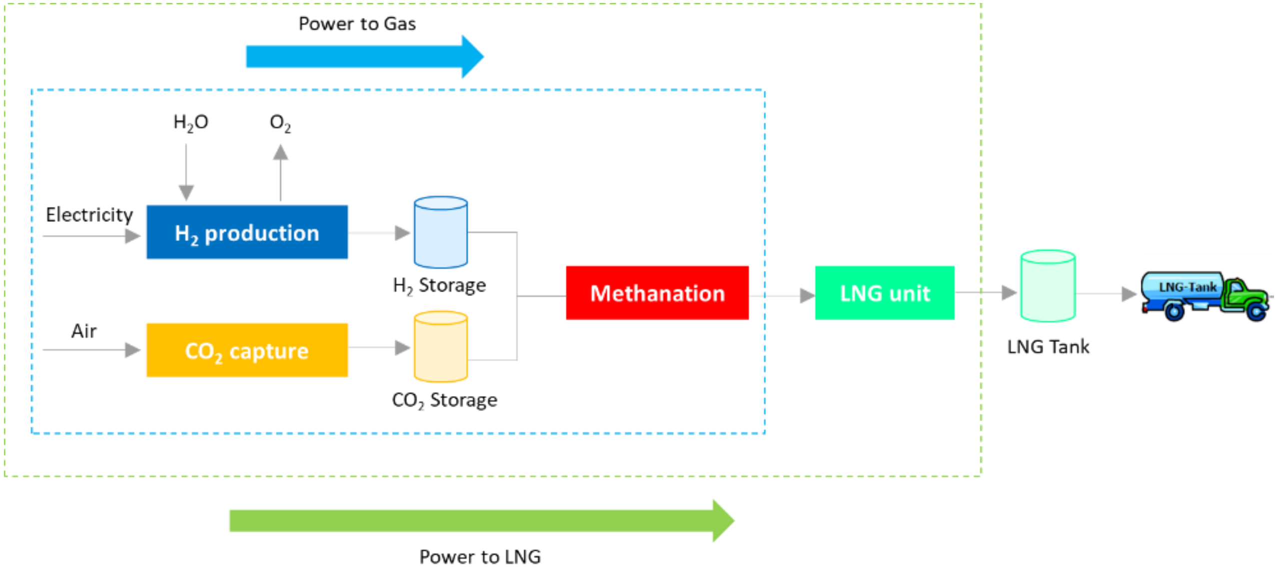


TP3



STOREandGO

Innovative large-scale energy STOragE technologies AND Power-to-Gas concepts after Optimisation


Power to Gas
H_2O
O_2
Electricity
H_2 production
H_2 Storage
Air
CO_2 capture
CO_2 Storage
Methanation
LNG unit
LNG Tank
LNG-Tank
Power to LNG

BioRobur^{plus}

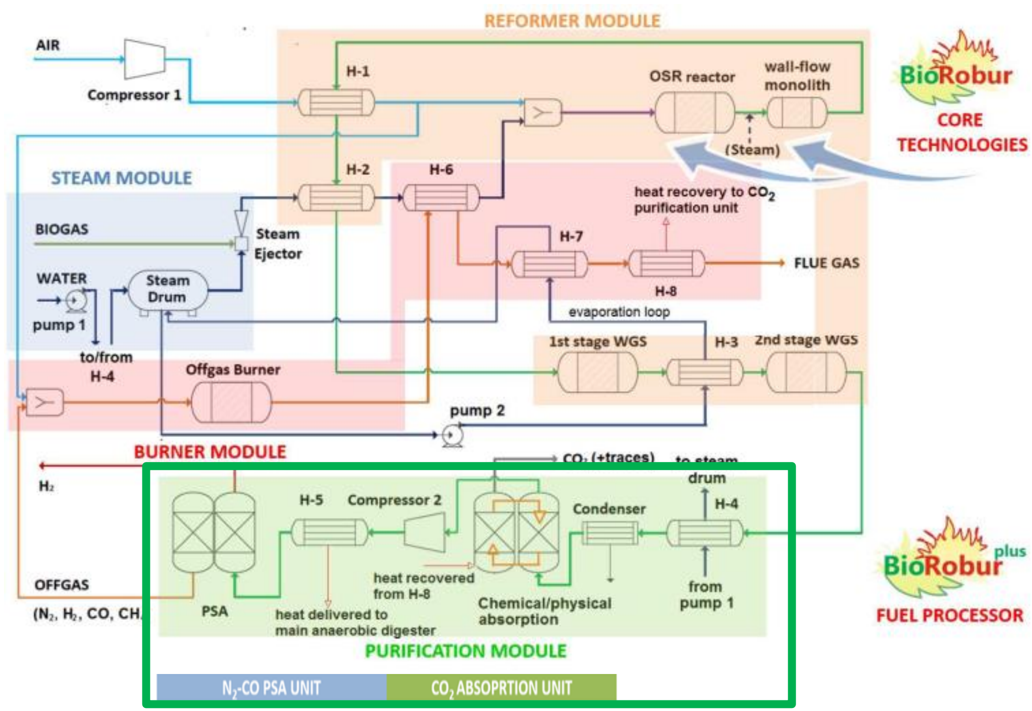
Advanced direct biogas fuel processor for robust and cost-effective decentralised hydrogen production

Main project objectives:

- Production of 50 Nm^3/h of 99,9% H_2;
- Overall plant efficiency ≥ 80% based on HHV;

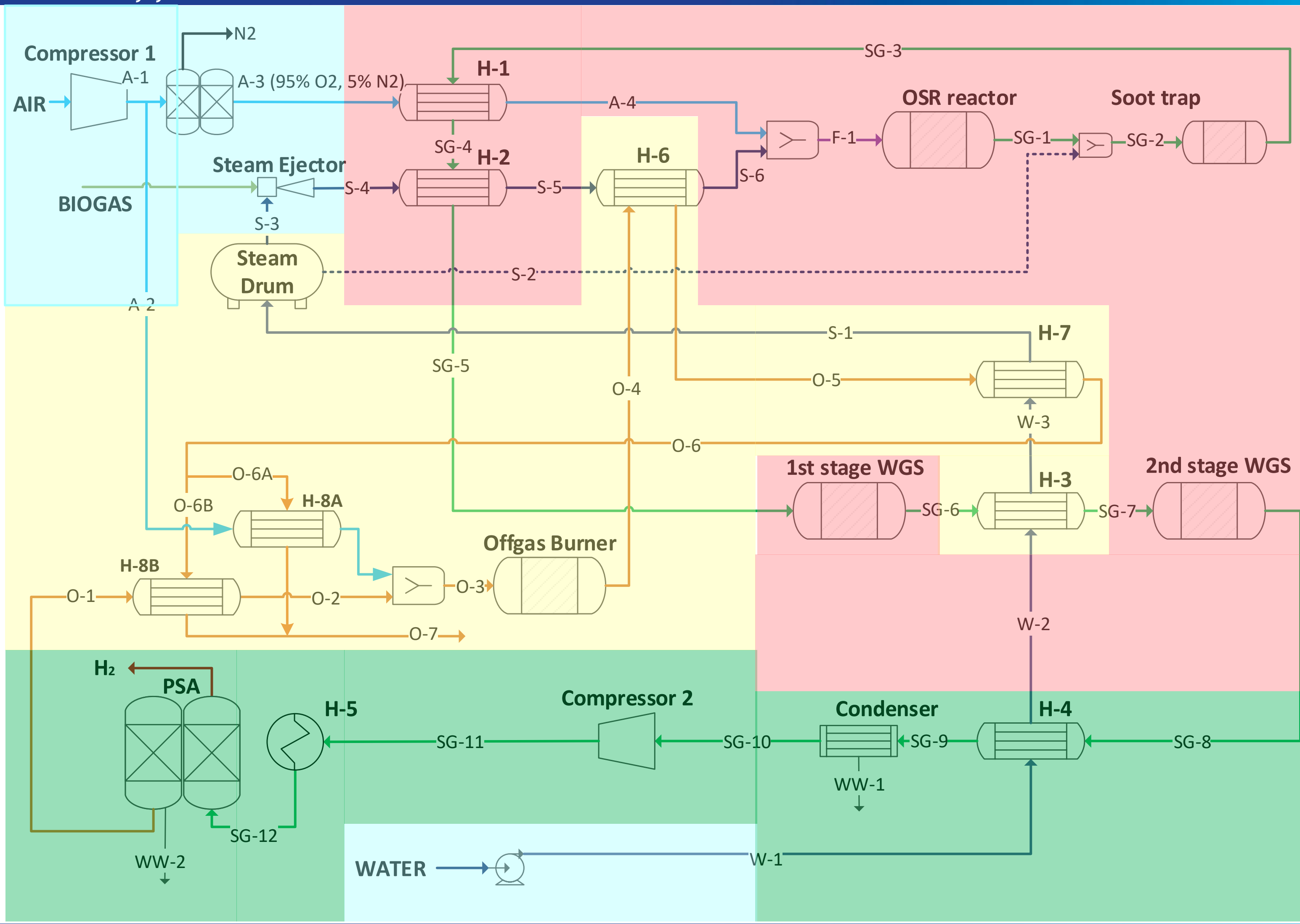
Challenges:

- Achievement of high purity H_2 from a mixture of CO_2, CO, H_2O and N_2.
- Development of a techno-economic process, with the minor cost possible (CAPEX, OPEX).
- Low environment friendly technology.



Project core technologies.

Project Scheme



U-01
Feeding Section (Lead: HST)

U-02
Reaction (Lead: DBI)

- OSR support: Engicer
- OSR & WGS catalyst: JM
- Soot trap: CPERI

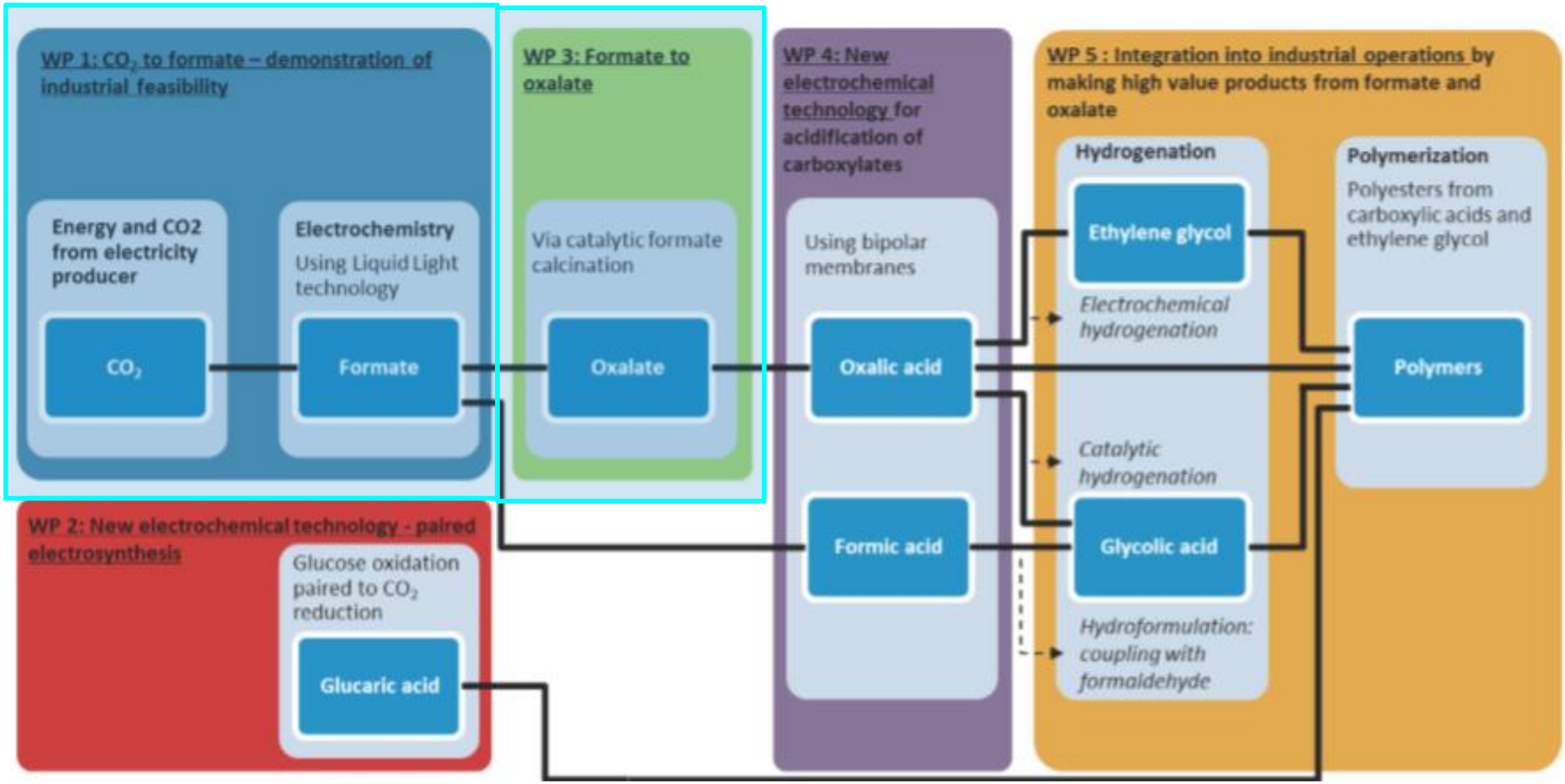
U-03
Heat Recovery (Lead: KIT)

- Offgas burner - Engicer/supsi

U-04
H2 Purification (Lead: HST)

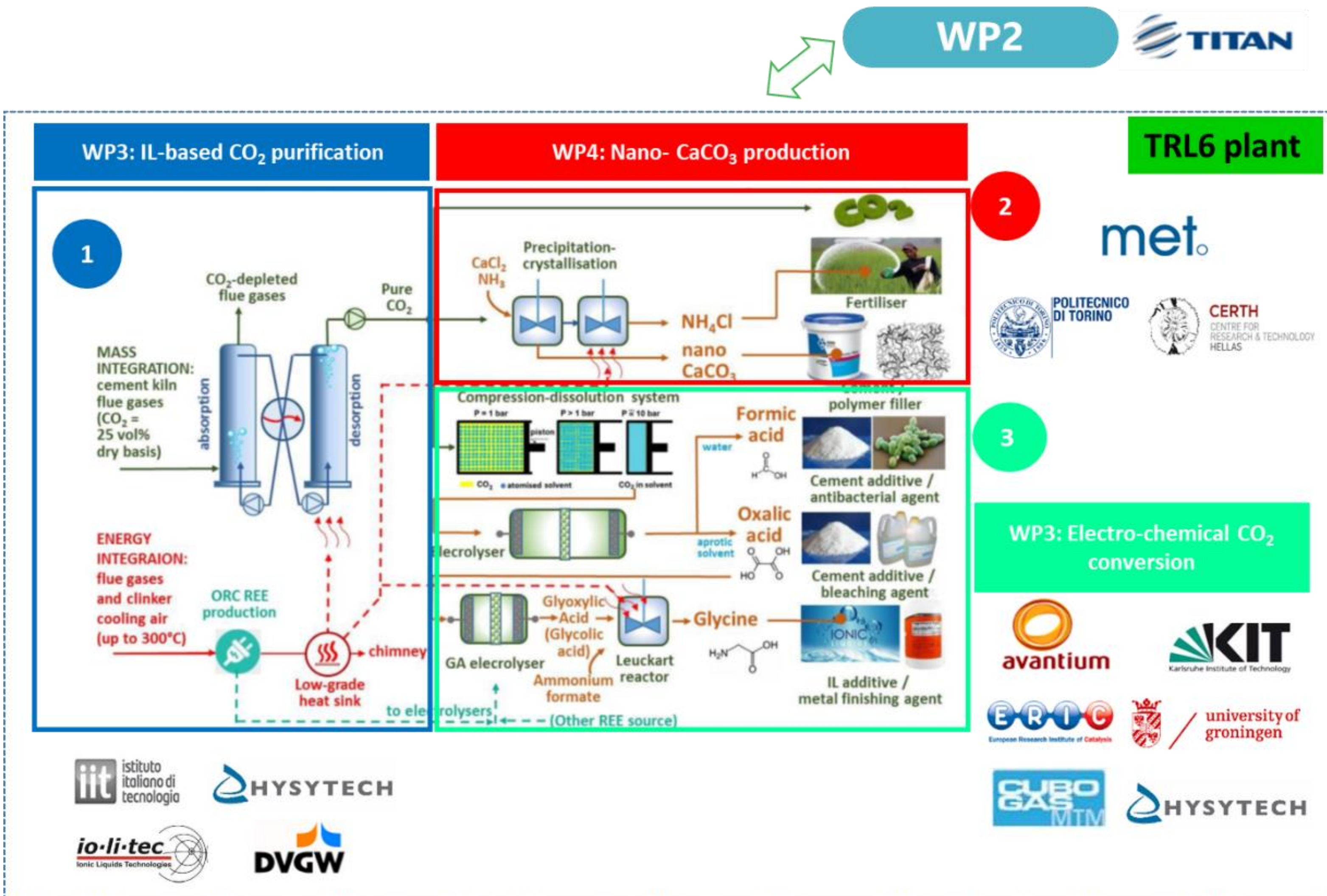
OCEAN

Oxalic acid from CO_2 using Eletrochemistry At demonstratioN scale

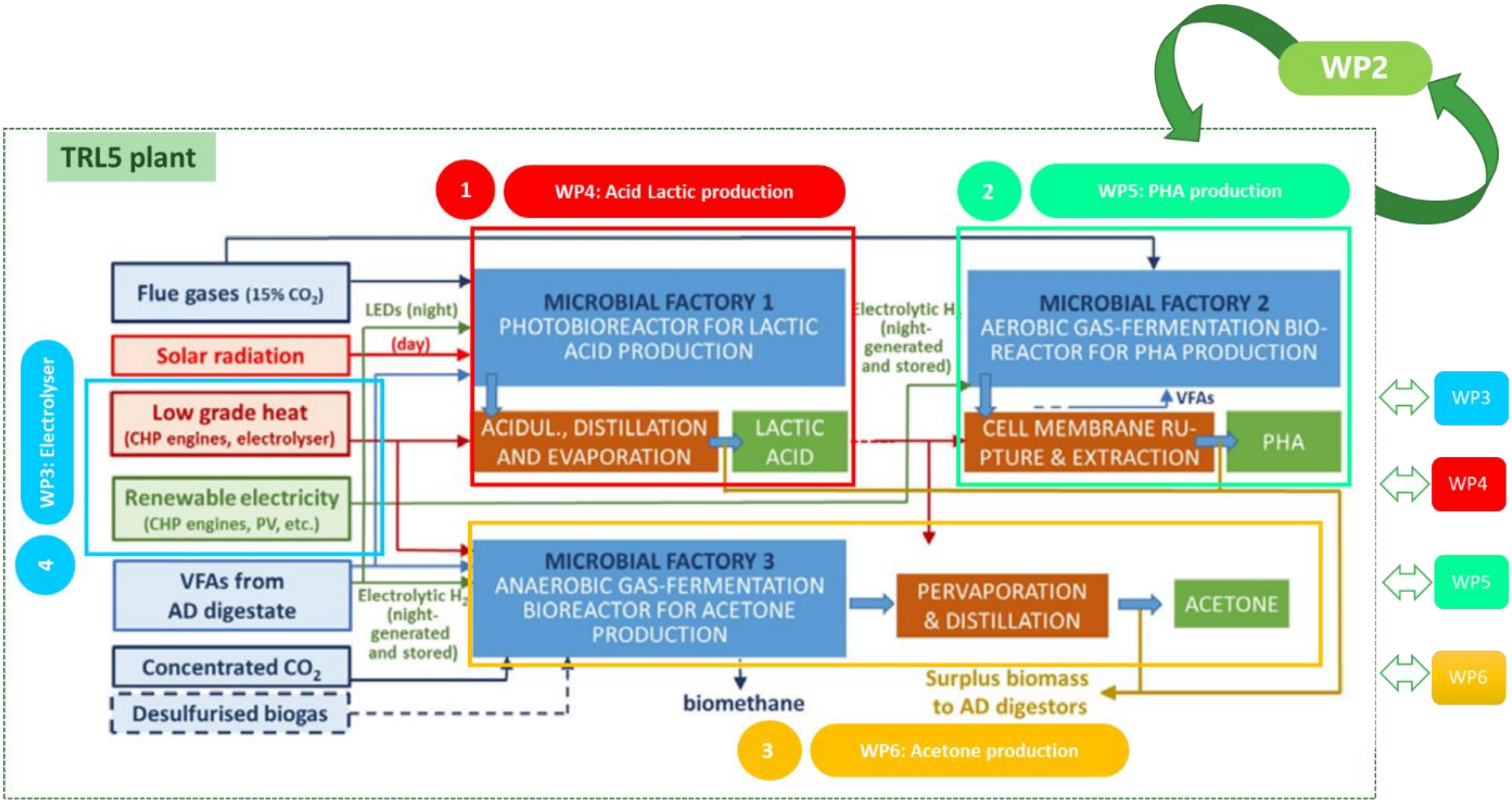

WP 1: CO_2 to formate – demonstration of industrial feasibility
Energy and CO2 from electricity producer
CO_2
Electrochemistry
Using Liquid Light technology
Formate
WP 3: Formate to oxalate
Via catalytic formate calcination
Oxalate
WP 4: New electrochemical technology for acidification of carboxylates
Using bipolar membranes
Oxalic acid
Formic acid
WP 5 : Integration into industrial operations by making high value products from formate and oxalate
Hydrogenation
Ethylene glycol
Electrochemical hydrogenation
Catalytic hydrogenation
Glycolic acid
Hydroformulation: coupling with formaldehyde
Polymerization
Polyesters from carboxylic acids and ethylene glycol
Polymers
WP 2: New electrochemical technology - paired electrosynthesis
Glucose oxidation paired to CO_2 reduction
Glucaric acid

RECODE

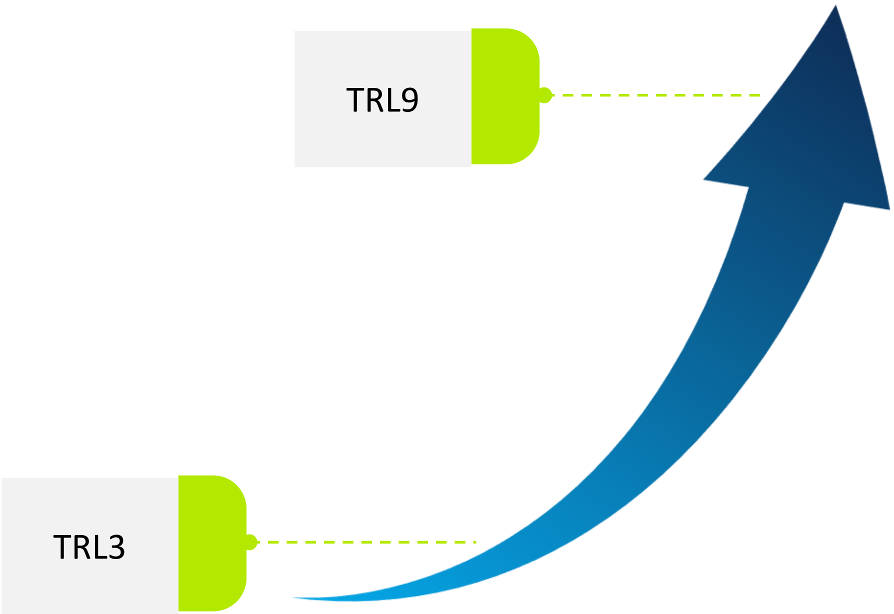
Recycling carbon dioxide in the cement industry to produce added-value additives: a step towards a CO_2 circular economy


WP2
TITAN
WP3: IL-based CO_2 purification
WP4: Nano- $CaCO_3$ production
TRL6 plant
1
CO_2-depleted flue gases
Pure CO_2
MASS INTEGRATION: cement kiln flue gases (CO_2 = 25 vol% dry basis)
absorption
desorption
ENERGY INTEGRAION: flue gases and clinker cooling air (up to 300°C)
ORC REE production
Low-grade heat sink
chimney
to electrolysers
2
$CaCl_2$ NH_3
Precipitation-crystallisation
NH_4Cl
nano $CaCO_3$
Fertiliser
polymer filler
3
Compression-dissolution system
Formic acid
Cement additive / antibacterial agent
Oxalic acid
Cement additive / bleaching agent
Electrolyser
GA elecrolyser
Glyoxylic Acid (Glycolic acid)
Ammonium formate
Leuckart reactor
Glycine
IL additive / metal finishing agent
(Other REE source)
WP3: Electro-chemical CO_2 conversion
met
POLITECNICO DI TORINO
CERTH
avantium
KIT
ERIC
university of groningen
CUBO GAS
HYSYTECH
istituto italiano di tecnologia
io·li·tec
DVGW

ENGINEERED MICROBIAL FACTORIES FOR CO_2 EXPLOITATION IN AN INTEGRATED WASTE TREATMENT PLATFORM


WP2
TRL5 plant
1
WP4: Acid Lactic production
2
WP5: PHA production
Flue gases (15% CO_2)
Solar radiation
Low grade heat
(CHP engines, electrolyser)
Renewable electricity
(CHP engines, PV, etc.)
VFAs from
AD digestate
Concentrated CO_2
Desulfurised biogas
WP3: Electrolyser
4
LEDs (night)
(day)
MICROBIAL FACTORY 1
PHOTOBIOREACTOR FOR LACTIC ACID PRODUCTION
ACIDUL., DISTILLATION AND EVAPORATION
LACTIC ACID
Electrolytic H_2 (night-generated and stored)
MICROBIAL FACTORY 2
AEROBIC GAS-FERMENTATION BIO-REACTOR FOR PHA PRODUCTION
VFAs
CELL MEMBRANE RU-PTURE & EXTRACTION
PHA
Electrolytic H_2 (night-generated and stored)
MICROBIAL FACTORY 3
ANAEROBIC GAS-FERMENTATION BIOREACTOR FOR ACETONE PRODUCTION
PERVAPORATION & DISTILLATION
ACETONE
biomethane
Surplus biomass to AD digestors
3
WP6: Acetone production
WP3
WP4
WP5
WP6

Design, scale-up, manufacturing, commissioning and testing,



Important points for industrial application

- Drop-in products are necessary to minimize costs related to transition.
- Decentralization
- Low cost
- Low environmental impact: lower carbon footprint
- Use of local resources

Important points for a technology for the transition

New technologies are necessary to meet requirements of a **distributed model** which cannot be thus based on the actual refinery scheme, it should

i) be highly integrated with minimisation of the nr of steps,

ii) use electrical energy rather than heat (from fossil fuels) which requires large plants to be effective in terms of heat integration and recovery,

iii) use selective processes to produce the target fuels rather that a variety of products, and

iv) be efficient on small-medium size, with the capacity of flexible use of local resources, but be adaptable to different local situations.

Important points for a technology for the transition

I. **integration with territory**, with thus many benefits in terms of positive impact on employment and symbiosis with local production,
II. use of the **local resources** avoiding transport on long distance of CO_2 and RE,
III. avoid cost and safety aspects related to long-distance transport of the final fuels,
IV. **better social acceptance** with respect to large plants,
V. **lower investment costs and specific cost** which allow new investors entering the game and break-down the current monopoly character of energy market, dominated by player which have large interest in oil and thus low reasons to create a market for alternative fuels.

Thank you for your attention

HYSYTECH

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