

Biogenic Carbon Dioxide

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SOL HQ Marketing Manager Food&CO₂

SOL GROUP

SOLGROUP | The story of a friendship

a breath of life

96 years, 3 generations and professional management



1927

Giovanni Annoni
Aldo Fumagalli Romario



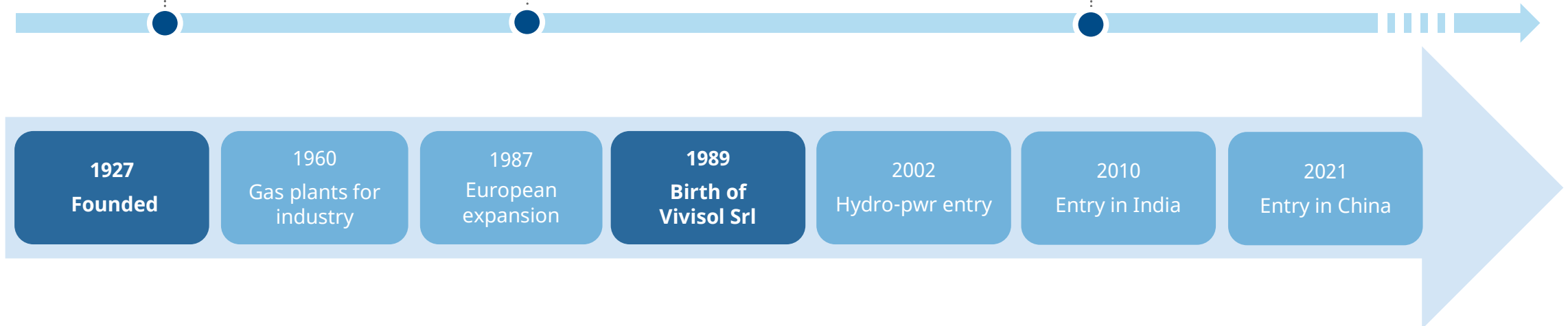
1960

Alessandro e Renzo Annoni
Giulio e Ugo Fumagalli Romario



1998

Giovanni, Marco Annoni
Aldo, Giulio, Matteo Fumagalli Romario

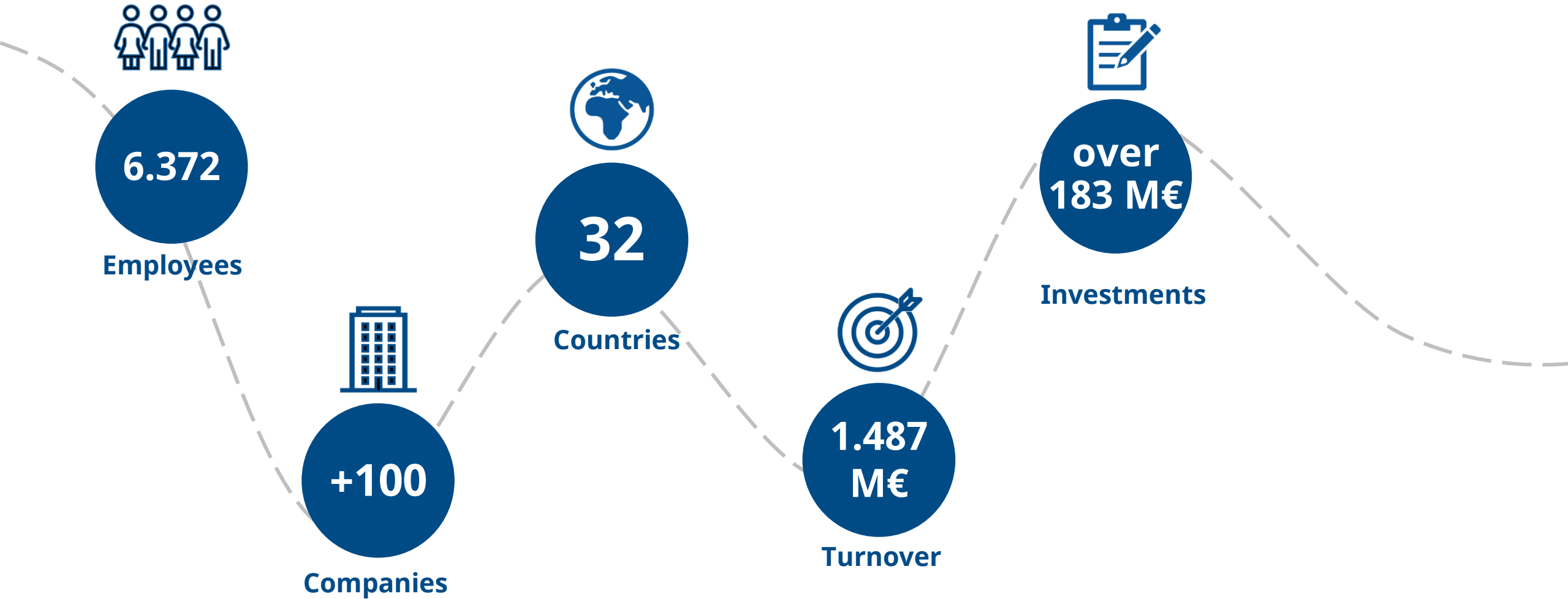


What we do

SOL Group operates in the production, applied research and marketing of **technical and medical gases**, in the **home care services sector**, in the **biotechnologies sector**, and in the production of **energy from renewable sources**.



Our identity in numbers



(2023 data)

| Countries 2022



SOL | Technical Gases

Our clients – Industry



FOOD & BEVERAGE

- Agriculture
- Fish & meat
- Fruit & vegetables
- Milk & derivatives
- Bread and pastries
- Beverages
- Wine & oil
- Catering



METAL PRODUCTION

- Aluminium
- Precious metal processing
- Glass, ceramic, cement, lime



METAL FABRICATION

- Thermal treatments
- Automotive
- Aeronautical & railway construction
- Shipyards
- Construction sites
- Boilers



CHEMISTRY & PHARMA

- Pharmaceutical specialties
- Cosmetics
- Herbalism
- Plastics & rubber



OIL & GAS

- Extraction
- Transport & pipelines
- Refining



ENERGY & ENVIRONMENT

- Purification
- Waste Management
- Incineration



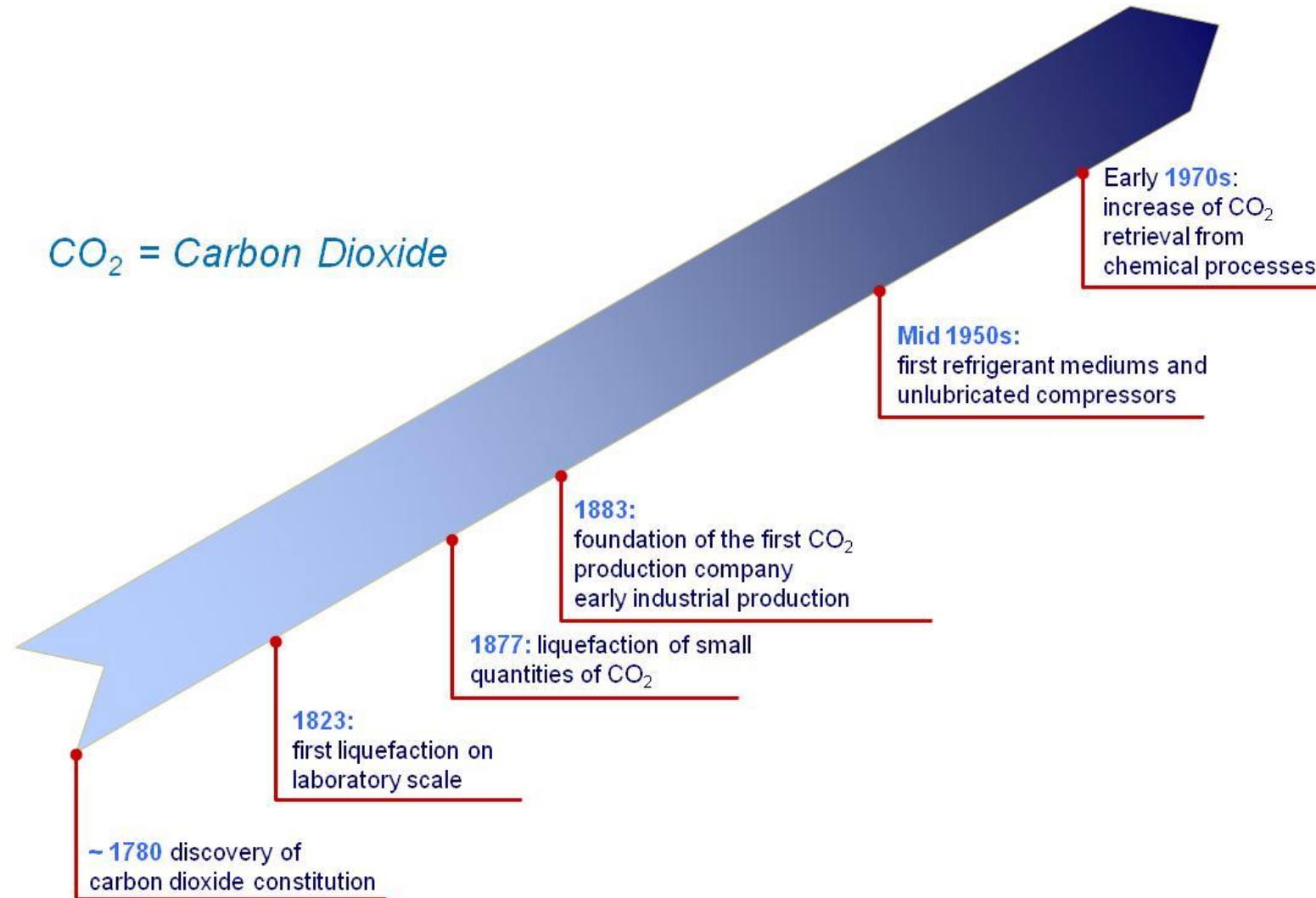
SPECIALITY GASES

- Research
- Electronics
- Chemical

The world of Carbon Dioxide



Generalities – History of CO₂



Generalities - CO₂ - A Greenhouse Gas

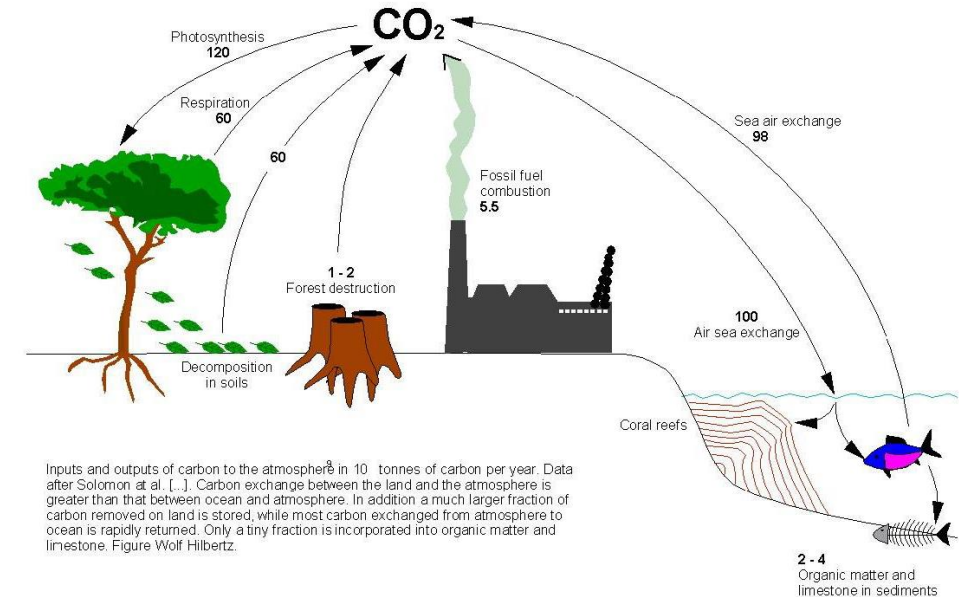
- In recent years carbon dioxide (CO₂) has increasingly become the focus of public concern as a greenhouse gas
- Carbon dioxide is key to our planet's ecosystem
 - used by plants to form organic matter by photosynthesis
 - respiration, the conversion of oxygen into carbon dioxide, is a further elementary process of nature to maintain life
 - a major end product of the decomposition of all organic materials



Doc 101
The carbon dioxide industry and the environment



Doc 111
Environmental impacts of carbon dioxide and dry ice production



Generalities - CO₂ Sourcing

- Natural sources
 - Underground wells or mineral springs
- Waste product of:
 - Chemical processes
 - Chemical and petrochemical plants
 - Ammonia (NH₃) production
 - Ethylene oxide production
 - + *Recovery for CCUS (new sources, very high quantities)*
 - Biological processes
 - Fermentation

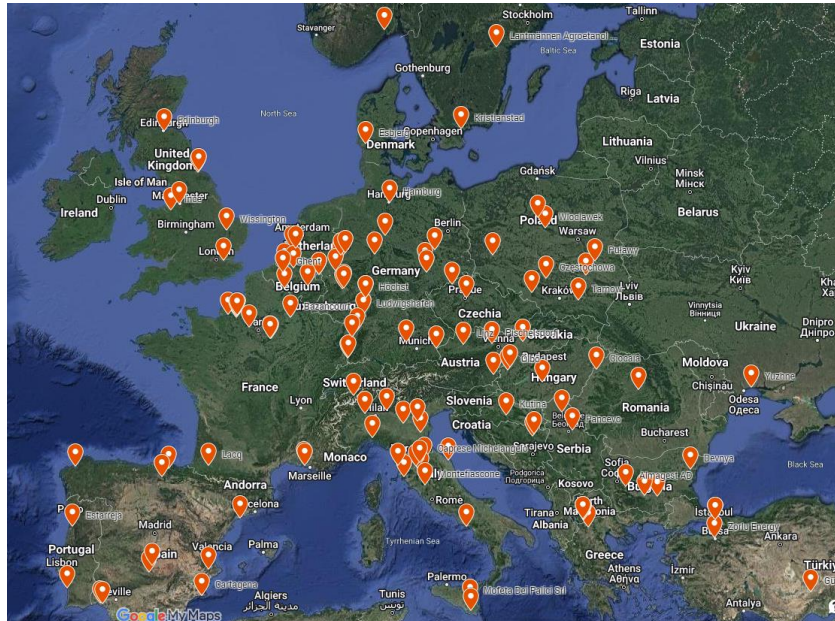


Doc 70
Carbon dioxide source qualification quality
standards and verification

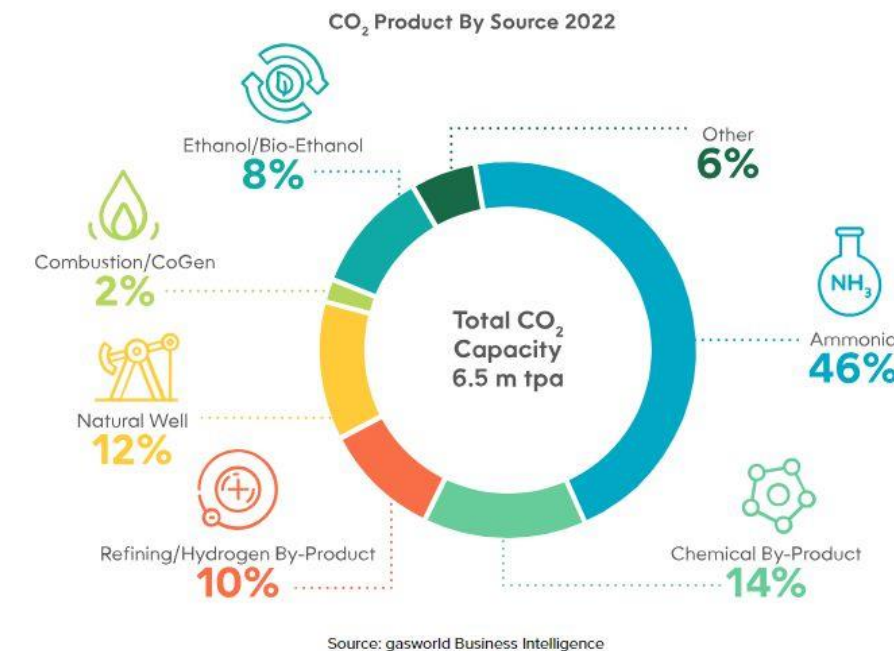
Carbon Dioxide Merchant Production and Demand in Europe

There is a merchant CO₂ demand for over 3.6 million tons of CO₂ (source Gasworld) in many different applications across the EU.

Share of bio-ethanol and bio-gas as a source has grown in 2023, while ammonia share dropped

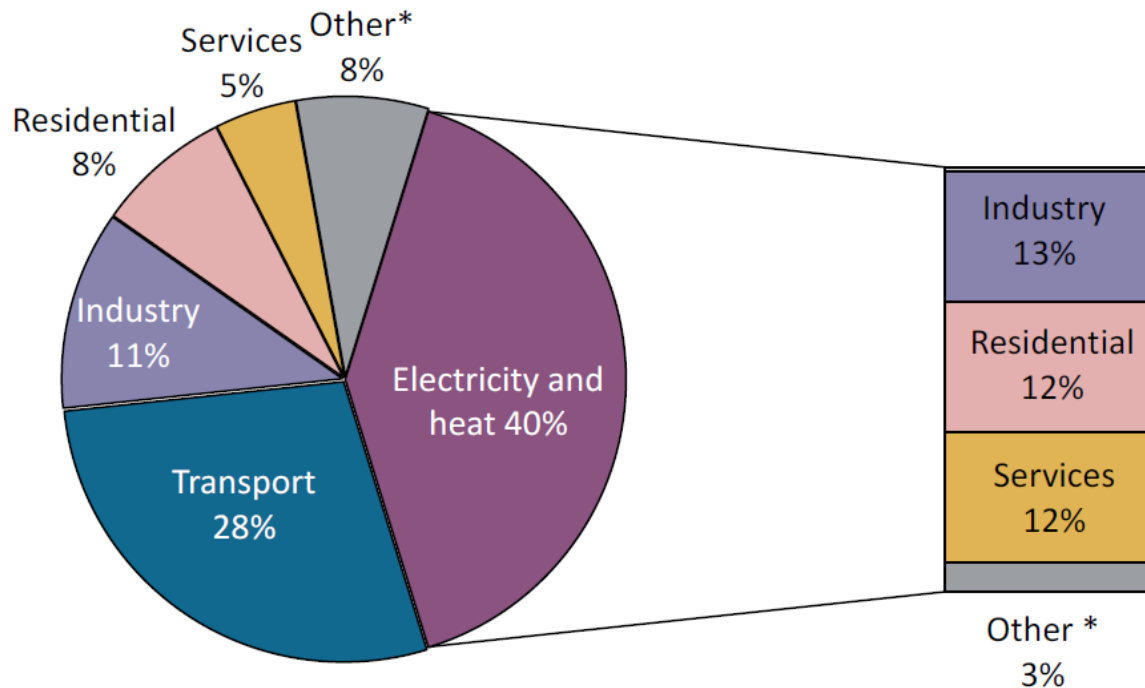


CO₂ plant in EU



Carbon Dioxide Industry and Environment

- CO₂ emissions by sectors from fuel combustion



Source: IEA publication 2015 - Gasworld

a) Carbon dioxide market in EU (4 MT) is less than **0.14%** of CO₂ emitted in EU

b) ETS directive will force industries to reduce Carbon dioxide emission

c) Carbon dioxide emitted from – e.g. – only one big cement plant is EQUAL to market in EU (4 MT)

SO : cement industry could make available enormous quantities of Carbon dioxide

CO₂ in the Food & Beverages industry shows the biggest demand



Carbon dioxide (CO₂) applied in the food and beverage industries is among the major consuming sectors of the merchant industry. In the developed markets, such as the US, Europe, and Japan, the application in food processing and preservation often holds a prominent place among merchant usage in many regions and markets.

In the US for example, food and beverage applications, on average, account for around 70% of the total demand in the merchant markets. Such processors purchase product as a liquid, for applications in cryogenic freezers, atmospheric modification in packaging operations, snow generation, and dry ice extrusion onsite.

In many developing world markets, beverage carbonation is the predominant demand for the product. In some cases, in developing markets CO₂ is generated from a combustion plant, which uses fuels such as diesel or natural gas for generation of

CO2 in beverage

more than additive

E290 the CO2 EU rules requirement

Component	Concentration
Assay	>99%
Carbon monoxide	<10 nL/l
Oil	5mg/kg



ISBT requirements

Quality Parameter	Guideline Impurity Limit
Purity (Assay)	99.90 % min.
Moisture (H ₂ O)	20.0 ppm max.
Oxygen (O ₂)	30.0 ppm max.
Carbon Monoxide (CO)	10.0 ppm max.
Oxides of Nitrogen (NO _x)	5.0 ppm max.
Nitrogen Monoxide (NO)	2.50 ppm max.
Nitrogen Dioxide (NO ₂)	2.50 ppm max.
Non-volatile Residue (NVR)	10.0 ppm w/w max.
Non-volatile Organic Residue (NVOR)	5.0 ppm w/w max.
Methanol (CH ₃ OH)	10.0 ppm max.
Total Hydrocarbons (THC) (as Methane)	50.0 ppm max. (includes 20.0 ppm total non-methane hydrocarbons)
Ammonia (NH ₃)	2.50 ppm max.
Acetaldehyde (C ₂ H ₄ O, or AA)	0.20 ppm max.
Aromatic Hydrocarbon (C ₆ H ₆)	20.0 ppb (0.020 ppm) max.
Total Sulfur – (TS) (Total sulfur impurities excluding sulfur dioxide)	0.10 ppm max.
Sulfur Dioxide (SO ₂)	1.0 ppm max.
Odor of Solid CO ₂ (Snow)	No foreign odor
Appearance of Solid CO ₂ (Snow)	No foreign appearance
Odor & Taste in Water	No foreign odor or taste
Appearance in Water	No color or turbidity

Quality Issues

Soft drink spec are strongly applied to most producers largely driven by major soft drink producer

CO2 quality standards are defined by ISBT, CGA, EIGA

The minimal CO2 content stated by ISBT call for 99,9%. Further the presence of water, volatile-non volatile residues, oxygen, nitrogen, carbonyl, sulfide, NOX, SOX and other are strictly limited. For the food industry there are standards which are written by large companies.

HACCP system

- Source evaluation
- Product qualification tests
- Quality Control / Quality Assurance (ISO9001, FS22000) Frequency of analysis to be determined by supplier
- Risk assessment to identify key process controls (HACCP or FMEA). To be reviewed on regular base



Keys topic for Bio CO2 as merchant CO2

Quality food and bev compliance

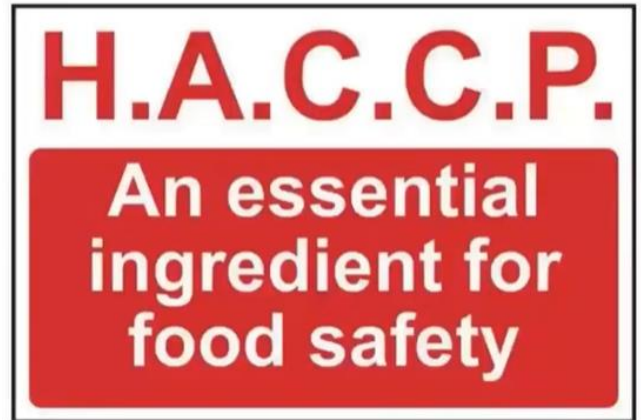
In many food applications Carbon Dioxide is a Food Ingredient

Availability

The CO2 source shall be stable with not production stop and less fluctuation

Reliability

The CO2 source shall be stable in the feedstock and CO2 production



Conclusion

- CO₂ is a gas used in wide range of applications and technologies in different industrial sectors
- The main applications and use of CO₂ is the food and beverage sector
- The quality specification is a driver for F&B requirements
- The Food safety for CO₂ is a crucial issue that involve the CO₂ feedstock
- Due to the CCUS project supported by the EU and local governments there will be a lot Carbon Capture activities from many different sources

Thank you



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