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Bio-CO2 Use & Removal 2025

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CCUS and the role of measurements

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Instruments and intelligence for climate action

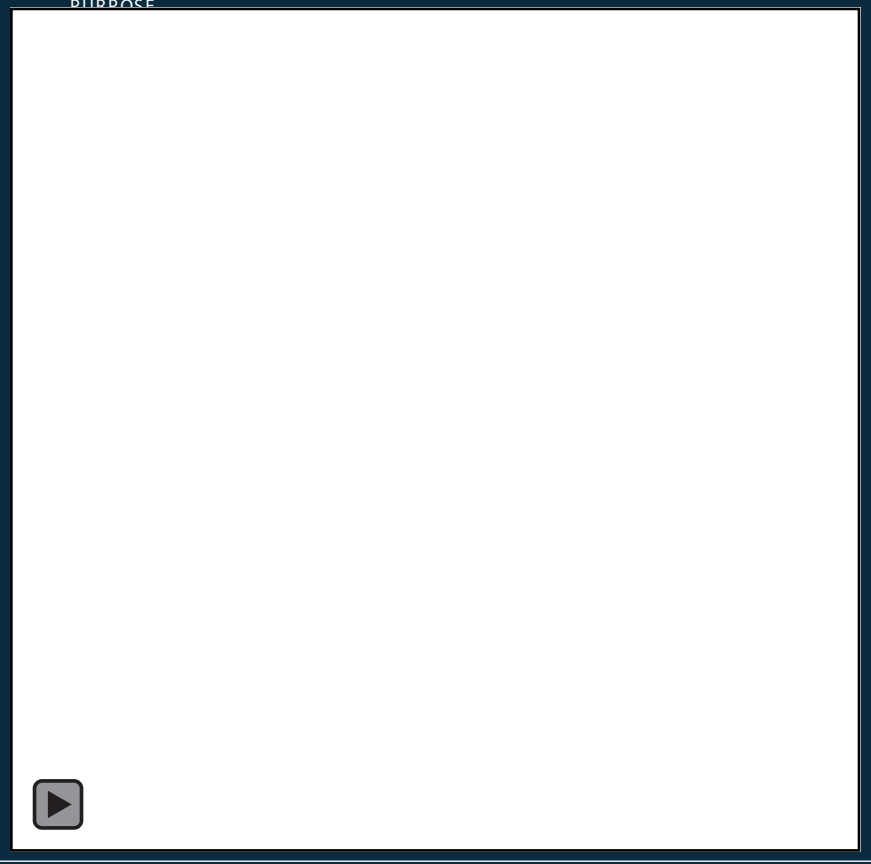
MEGATRENDS

Energy transition & decarbonization

AI & process optimization

Health & well-being

PURPOSE



SUCCESS DRIVERS

Customer understanding and application know-how

Product and technology leadership

Excellence in supply chain

Purpose-driven culture and talent

VALUES

Customer focus · Innovation & renewal · Strong together · Integrity

Vaisala's expertise in carbon capture, utilization and storage

Vaisala's real-time monitoring helps to improve decarbonization efficiency, emissions mitigation, and to verify and report the actual amount of CO_2 that is captured in your CCUS systems.

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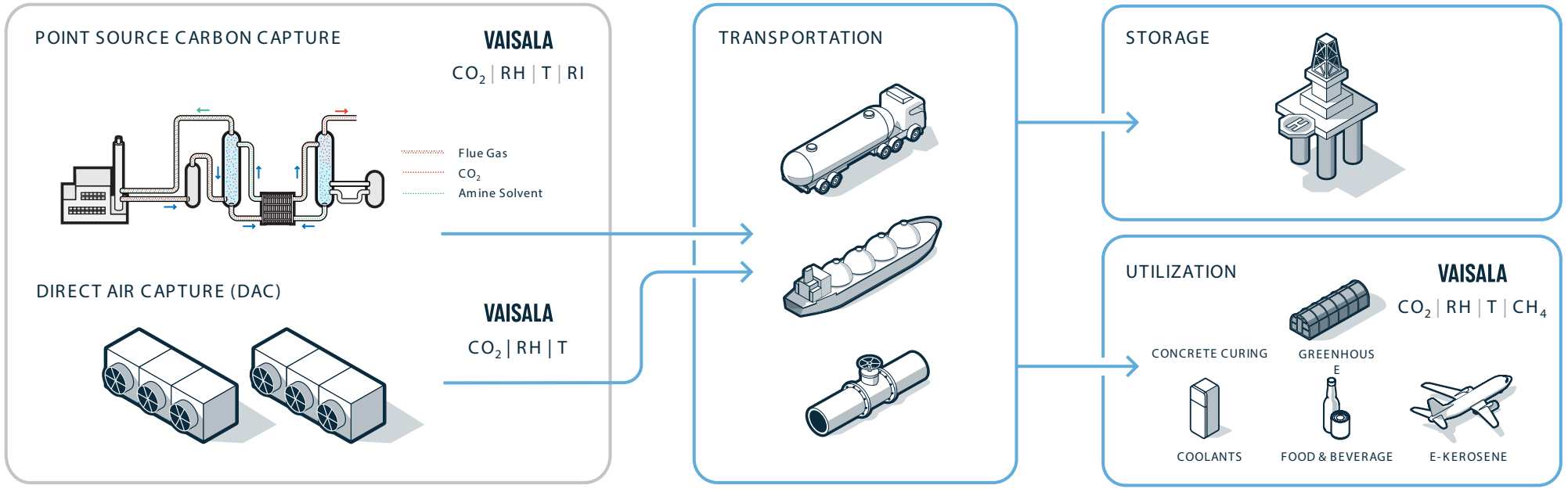
Vaisala expertise in carbon capture, utilization and storage (CCUS)



Common benefits of Vaisala's monitoring technology:

- Integrating data for process improvement
- Balancing cost, efficiency, and environmental impact
- Driving innovation in carbon capture research and development

Applications in point source carbon capture

Real time, in-situ monitoring ensures operational efficiency, high performance, and superior reliability of measurement

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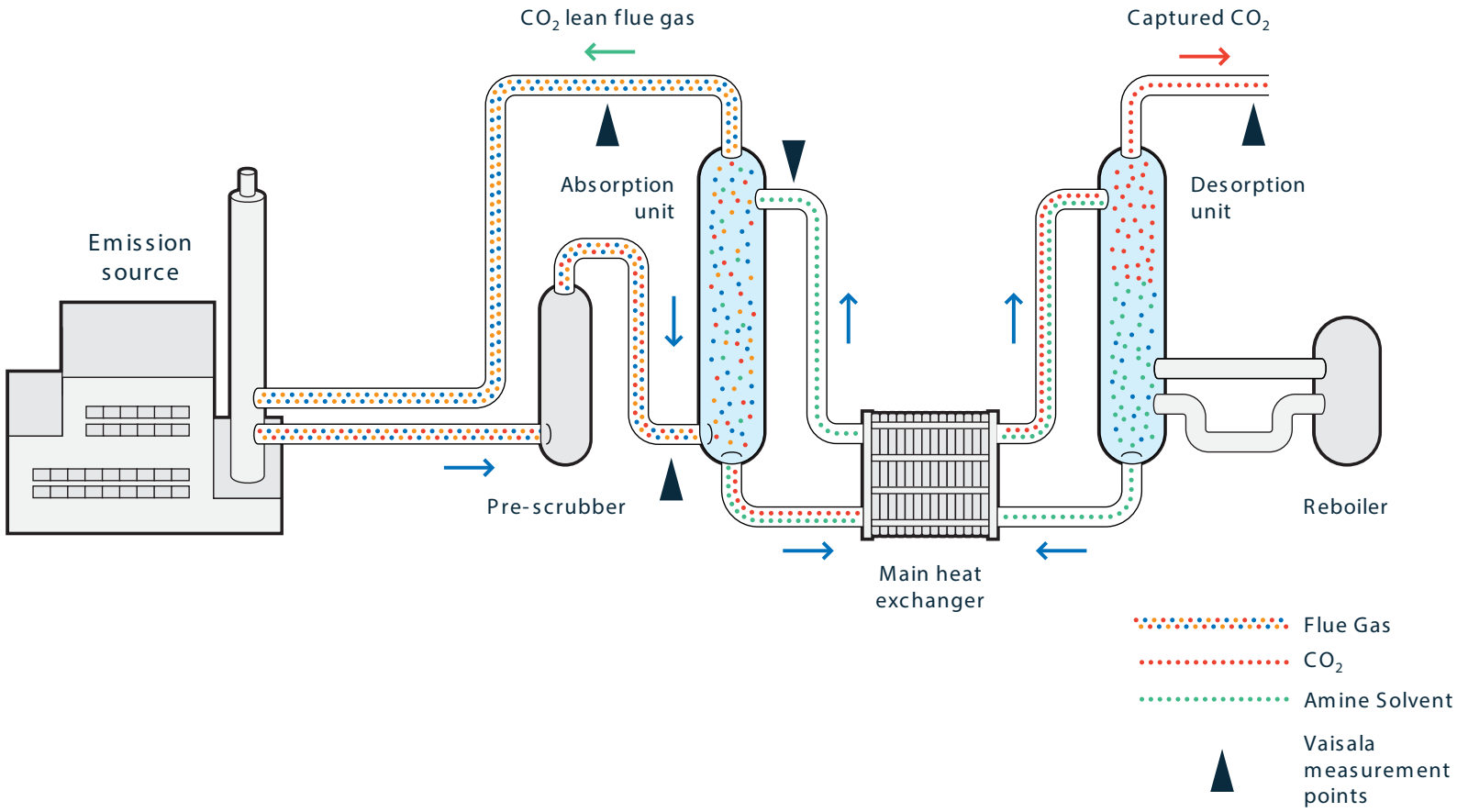
Typical applications in point source carbon capture

- Liquid solvents
- Solid sorbents
- Membrane separation

Monitoring CO_2 concentration in liquid solvent-based capture process:

- Evaluating absorption rates
- Monitoring solvent efficiency
- Guiding solvent regeneration cycles

VAISALA CO_2 | RH | T | RI



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Typical applications in point source carbon capture

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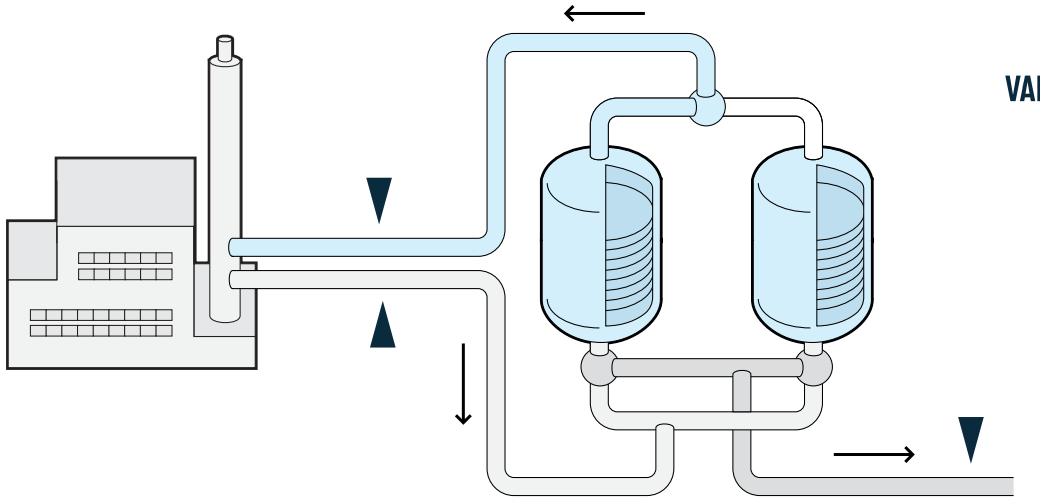


Monitoring CO_2 in solid sorbents adsorption process:

- Ensures that the sorbent material effectively captures the desired amount of CO_2
- Provides feedback for precise control of the adsorption
- Helps determine the saturation point of the sorbent, preventing overloading
- Early detection of any issues with the sorbent or the adsorption process

Monitoring temperature (T), pressure (p), and moisture (RH) in the regeneration process:

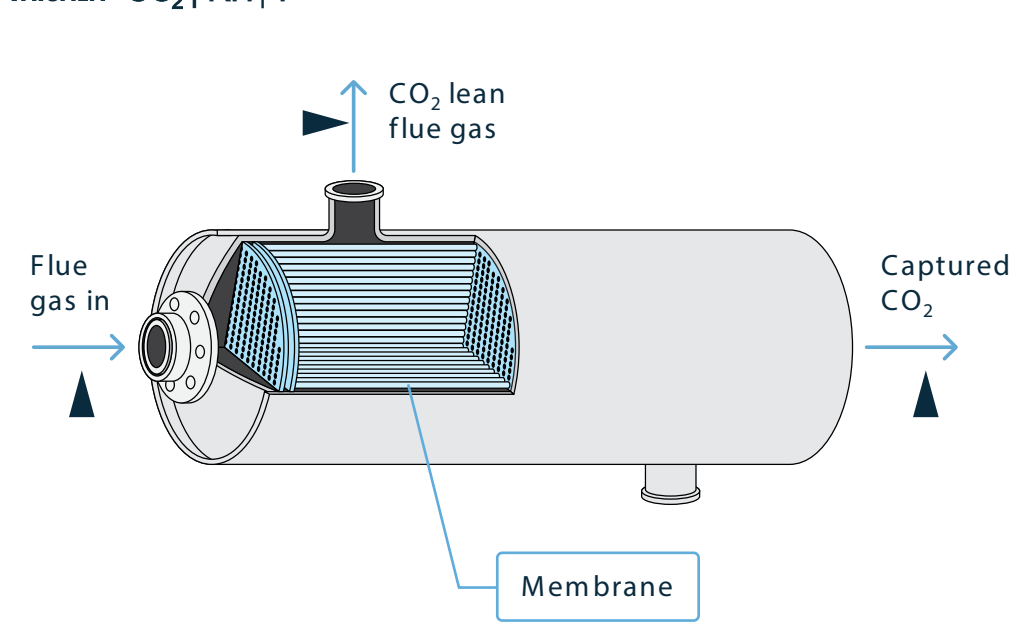
- Crucial for releasing captured CO_2 from the sorbent
- Temperature and pressure monitoring helps optimize energy consumption
- Helps prevent excessive temperatures or pressures that could lead to sorbent degradation
- Monitoring moisture content prevents sorbent hydrolysis or unwanted side reactions
- Helps sorbent lifecycle management and regeneration cycles

Typical applications in point source carbon capture

- Liquid solvents
- Solid sorbents
- Membrane separation

Monitoring CO_2 concentration in membrane-based capture process:

- Optimal CO_2 concentration is key to higher membrane permeability, capture selectivity, and overall efficiency
- Process can be optimized by adjusting pressure, temperature, and membrane characteristics based on inlet CO_2 concentrations
- Helps prevent the saturation of the membrane with CO_2
- Early detection of membrane damage or leaks



Applications in direct air carbon capture (DAC)

Real time monitoring enables DAC developers and operators to reduce carbon footprints, track and optimize CO_2 transformation processes, and credibly report emissions

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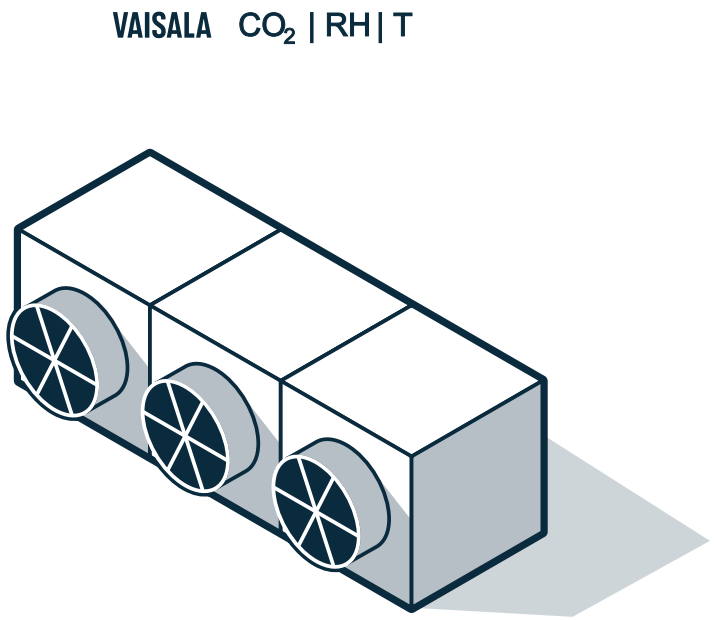
Typical applications in direct air carbon capture (DAC)

- Solid sorbents
- Liquid separation
- Membrane separation
- Other (e.g., electro swing)

- Accurately measuring low CO_2 concentrations, humidity and temperature enable sorbent performance optimization and life cycle management
- Adsorption and desorption cycle time optimization
- Measuring concentrated CO_2 in real time ensures that it meets purity standards for utilization and storage and helps detect process abnormalities
- Know the weather impact on your DAC plant performance by measuring wind speed & direction, humidity, temperature, atmospheric pressure and rainfall



Applications in carbon storage and utilization

Real time monitoring enables CCUS developers and operators to reduce carbon footprints, track and optimize CO_2 transformation processes, and credibly report emissions

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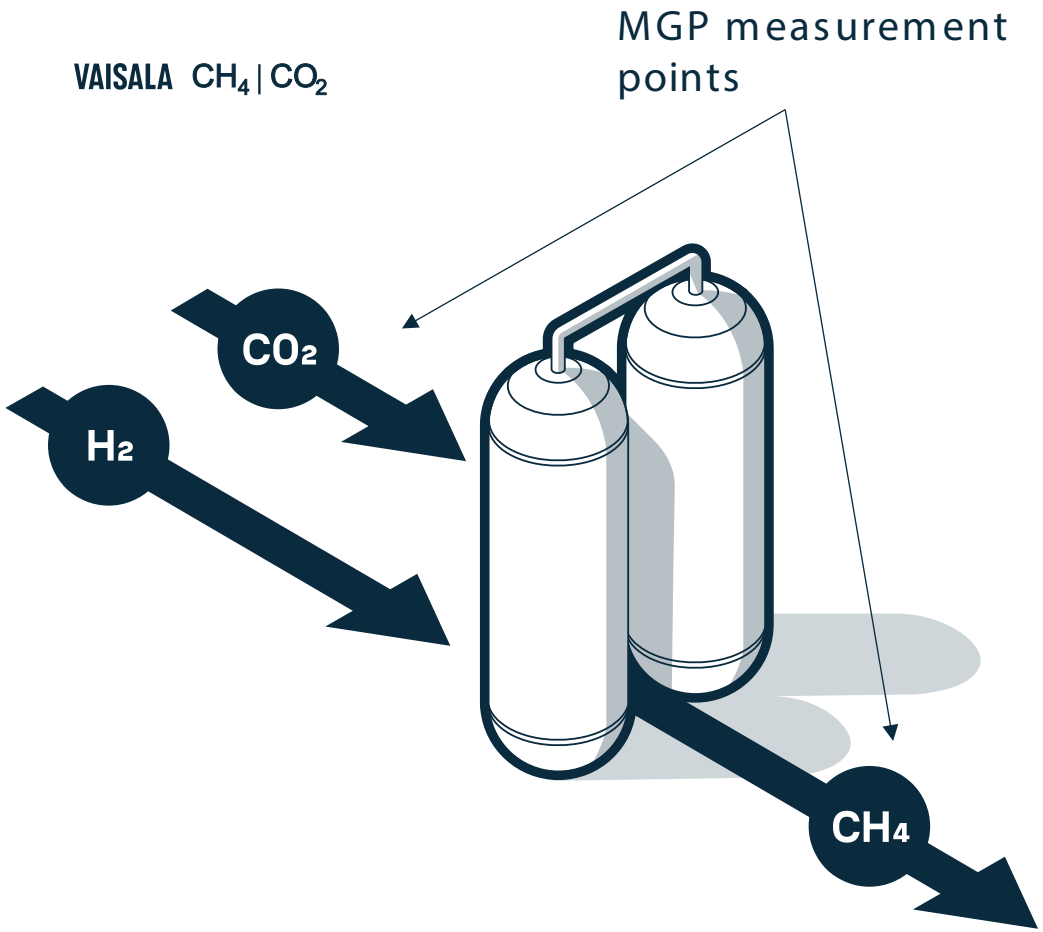
Applications in methanation

- Vaisala's technology enables accurate and reliable measurement in the conversion process of CO_2 into synthetic methane:
- With real-time methane and CO_2 monitoring the process efficiency can be maintained
- Monitoring humidity helps maintain optimal conditions during the chemical reactions, ensuring consistent and reliable output
- Monitoring pressure (third party) and temperature in real-time on process conditions is essential for maintaining the stability and safety of the methanation process
- Suitable for Sabatier, bio-methanation and SOEC co-electrolysis plants



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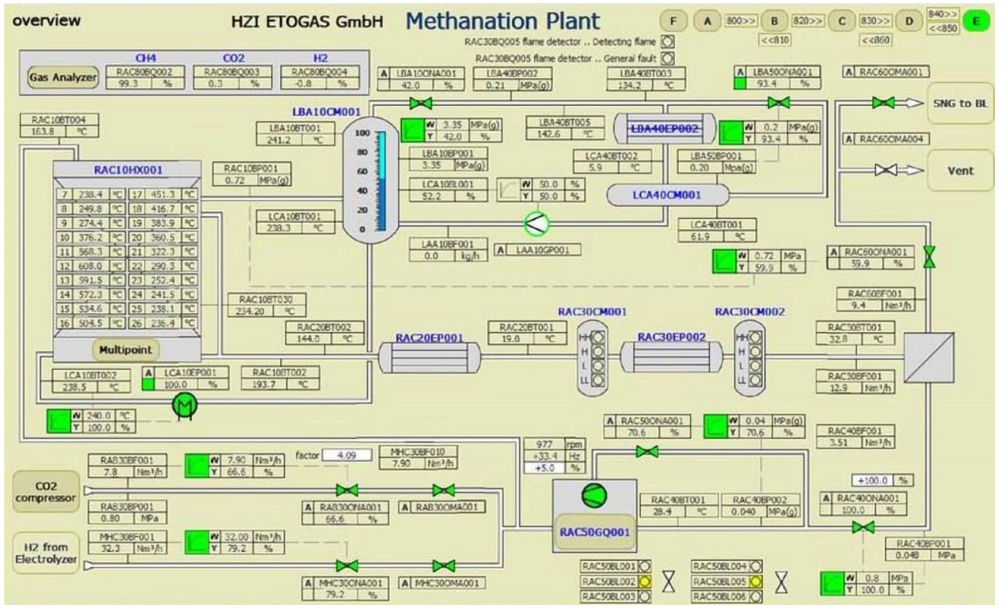
Case example: Japan

Source: INPEX



- INPEX Nagaoka test site
- CO_2 separated from natural gas is converted to synthetic methane with H_2 produced on-site
- Sabatier technology, high pressure and temp
- Online CH_4, CO_2 and H_2 measurement
- Desulfurization before methanation to protect catalyst material

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Transforming concrete into a carbon storage

- Monitoring CO_2 in concrete carbonation process in precast concrete plants:

- Concrete manufacturers can vastly reduce cement consumption and decrease the carbon footprint of their products by mineralizing CO_2 into concrete
- Monitoring CO_2 at the curing chamber inlet and outlet helps in controlling the process and understanding how much CO_2 is being utilized and stored by the concrete
- Accurately measuring humidity, temperature and pressure makes it possible to maintain ideal conditions for curing
- Reliable ppm level CO_2 measurements in the factory hall helps ensure staff safety

VAISALA CO_2 | RH | T |p (amb)

Photo source : Carbonaide

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