



**JICA Clean City Initiative (JCCI) Seminar**

# **Introduction to HORIBA Applications**

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**HORIBA, Ltd.**  
**International Sales Department**

2022/1/20

# Agenda

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**1. Corporate Profile**

**2. Monitoring Technology for FCV Hydrogen**

**3. Analyzer Technology for Carbon Neutral**

**4. Appendix**

# Agenda

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## 1. Corporate Profile

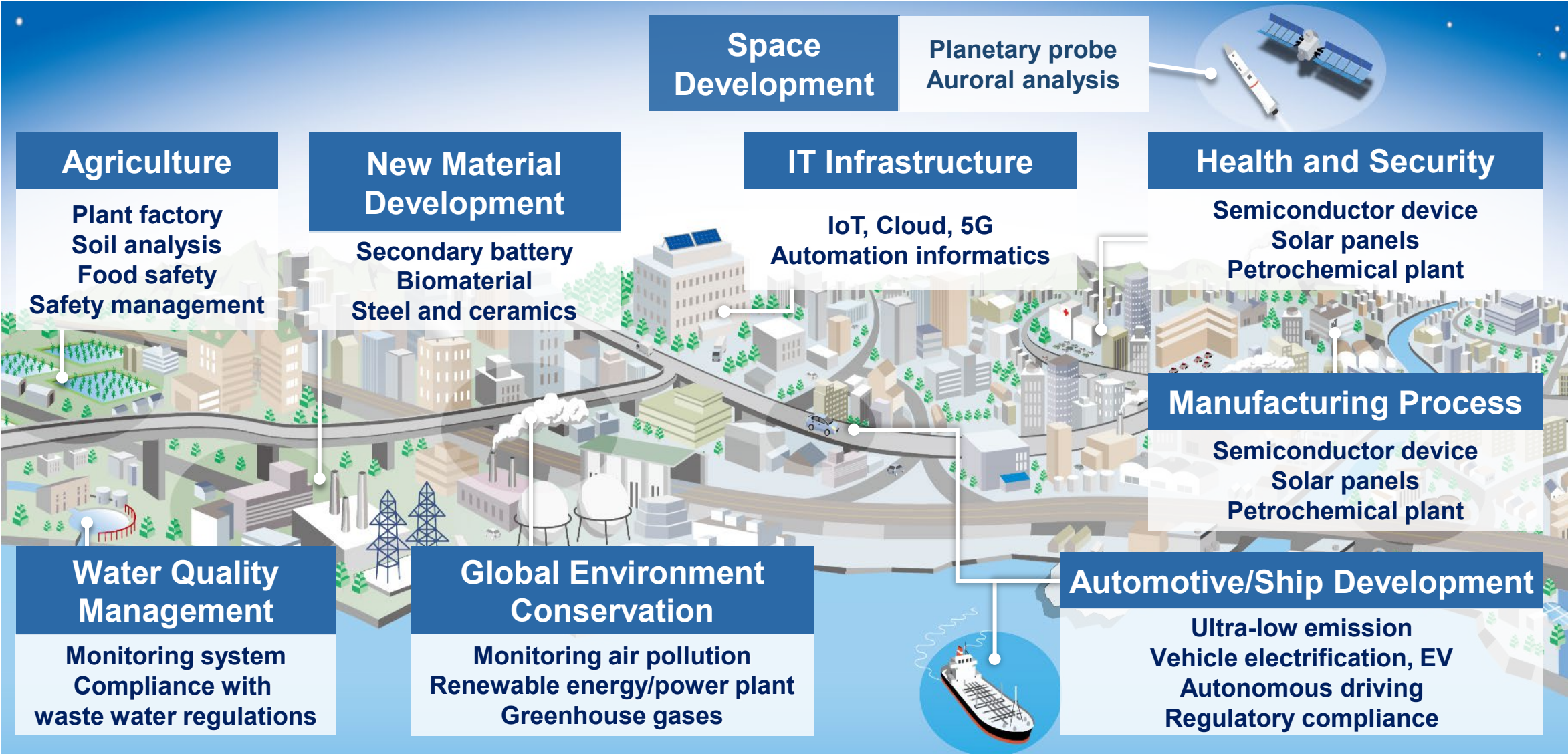
## 2. Monitoring Technology for FCV Hydrogen

## 3. Analyzer Technology for Carbon Neutral

## 4. Appendix



# HORIBA's Business Domain




# Application of Basic Technologies

**Gas Flow Control**



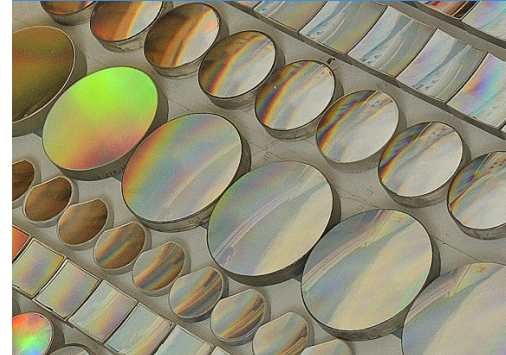
Automotive  
Process & Environmental  
Semiconductor

**Infrared Measurement**



Automotive  
Process & Environmental

**Spectroscopic Analysis**



Scientific  
Semiconductor

**Particle-size Distribution Analysis**



Automotive  
Medical  
Scientific

**Electrochemistry**



Process & Environmental  
Semiconductor  
Medical  
Scientific

HORIBA allocates its development resources by focusing on specific analytical and measurement technologies, through the applied development of these technologies, efficiently conducts product development in 5 business segments with different markets.

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Realize a Smart Hydrogen Society by

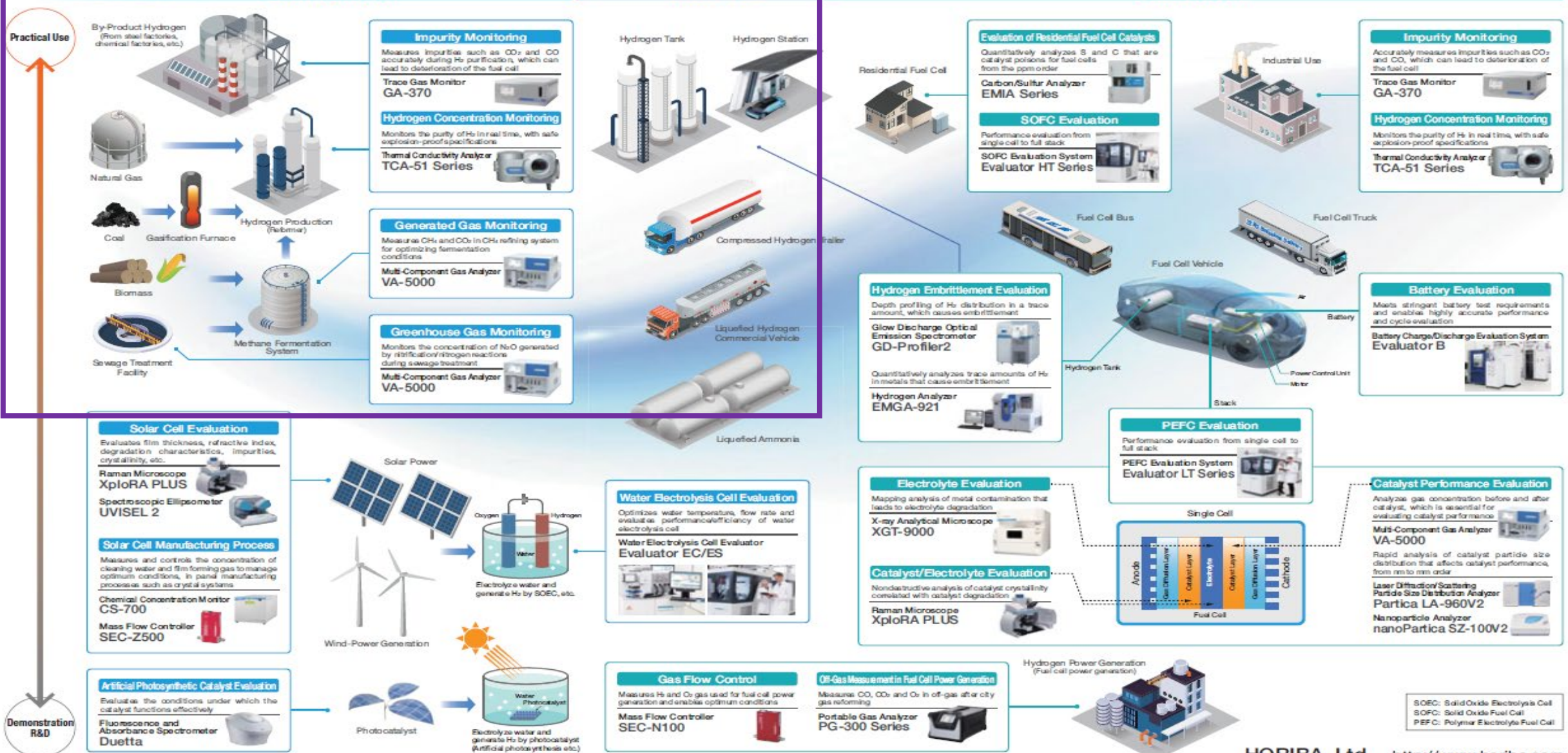
# HORIBA Contributes to a Sustainable Hydrogen Energy Society with Analysis and Measurement Technology



## Generation

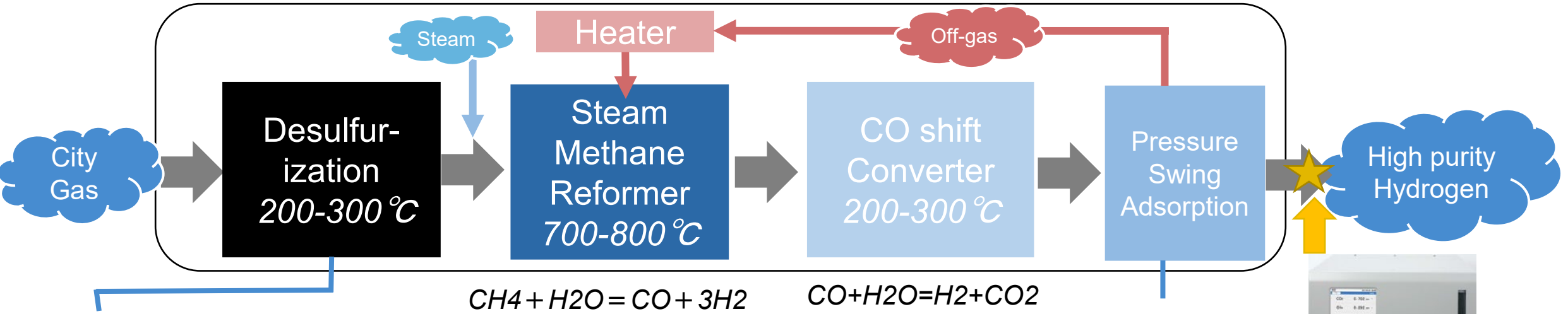
## Storage

## Utilization





# Hydrogen Production System Flow (on-site)

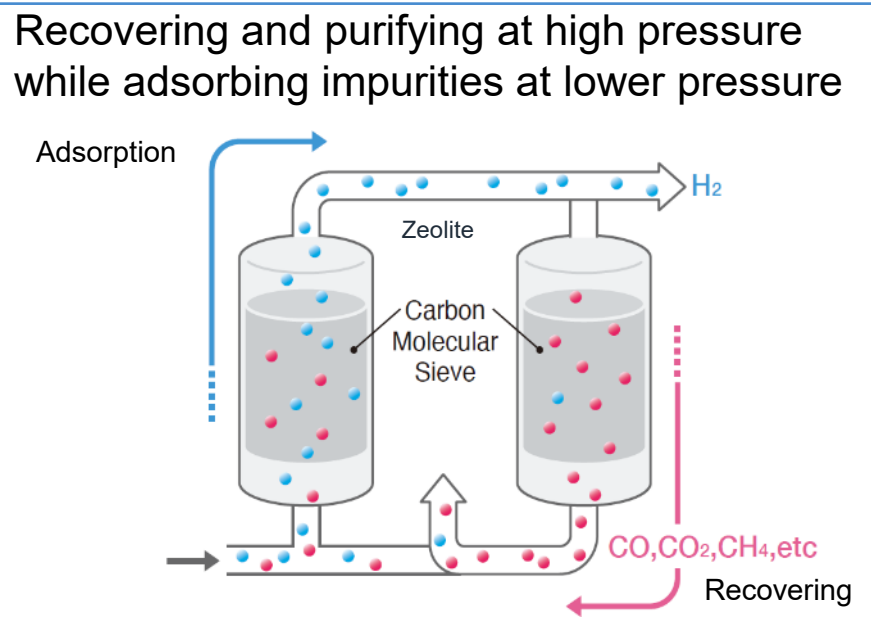


e.g. (B) Ultra high dimension de-sulfuring agent



图 2. 超高次脱硫剂 写真

Many different material available



GA-370  
Continuous monitor of ppb level CO/CO2/CH4 gas in Hydrogen

Reference: SIP 大阪ガス株式会社 "https://www.jst.go.jp/sip/dl/k04/end/team3-7.pdf"

https://www.jst.go.jp/sip/dl/k04/end/team3-7.pdf



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# Hydrogen Quality for FC

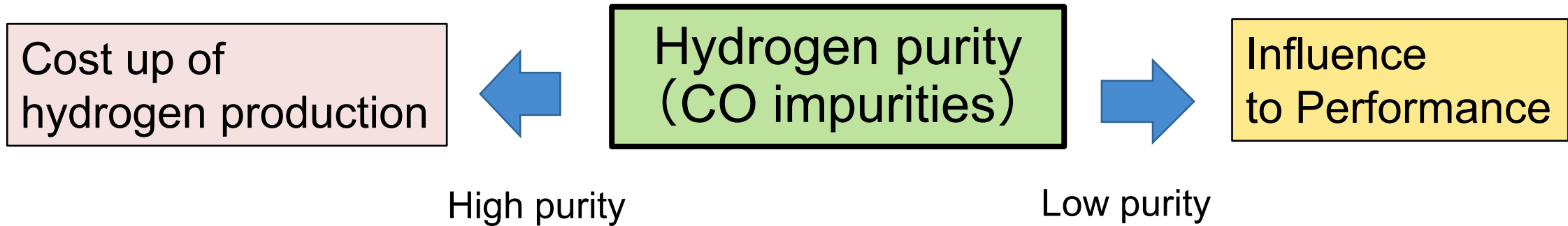
## ISO14687-2: 2019

## Hydrogen fuel — Product specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles

Items	Standard ( $\mu\text{mol/mol} = \text{ppm}$ )	
<b>Hydrogen</b>	<b>99.97%</b>	
H <sub>2</sub> O	5 ppm	
Hydro Carbon (CH <sub>4</sub> conversion )	2 ppm	
O <sub>2</sub>	5 ppm	
He	300 ppm	
N <sub>2</sub> , Ar	100 ppm	
CO <sub>2</sub>	2 ppm	
<b>CO</b>	<b>0.2 ppm</b>	Annex C2: Recommendation of CO online monitoring after SMR-PSA line
H <sub>2</sub> S	0.004 ppm	
HCHO	0.2ppm	
HCOOH	0.2 ppm	
NH <sub>3</sub>	0.1 ppm	
Total Halogen	0.05 ppm	
Dust	1mg/kg	

# Real-time Measurement of Impurity Concentration in Hydrogen for FC Vehicles

- Purity monitoring in hydrogen production process helps to achieve both power generation performance / durability and economy



Real time monitoring



Trace Gas Analyzer  
GA-370  
Low concentration CO

## Sales Reference

- ✓ Hydrogen purification process monitoring, impurity measurement in PSA \*
- ✓ Measurement of impurities in hydrogen gas used in electronic, semiconductor and chemical factories
- ✓ Impurity measurement during filling and acceptance in hydrogen transport

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1. Corporate Profile

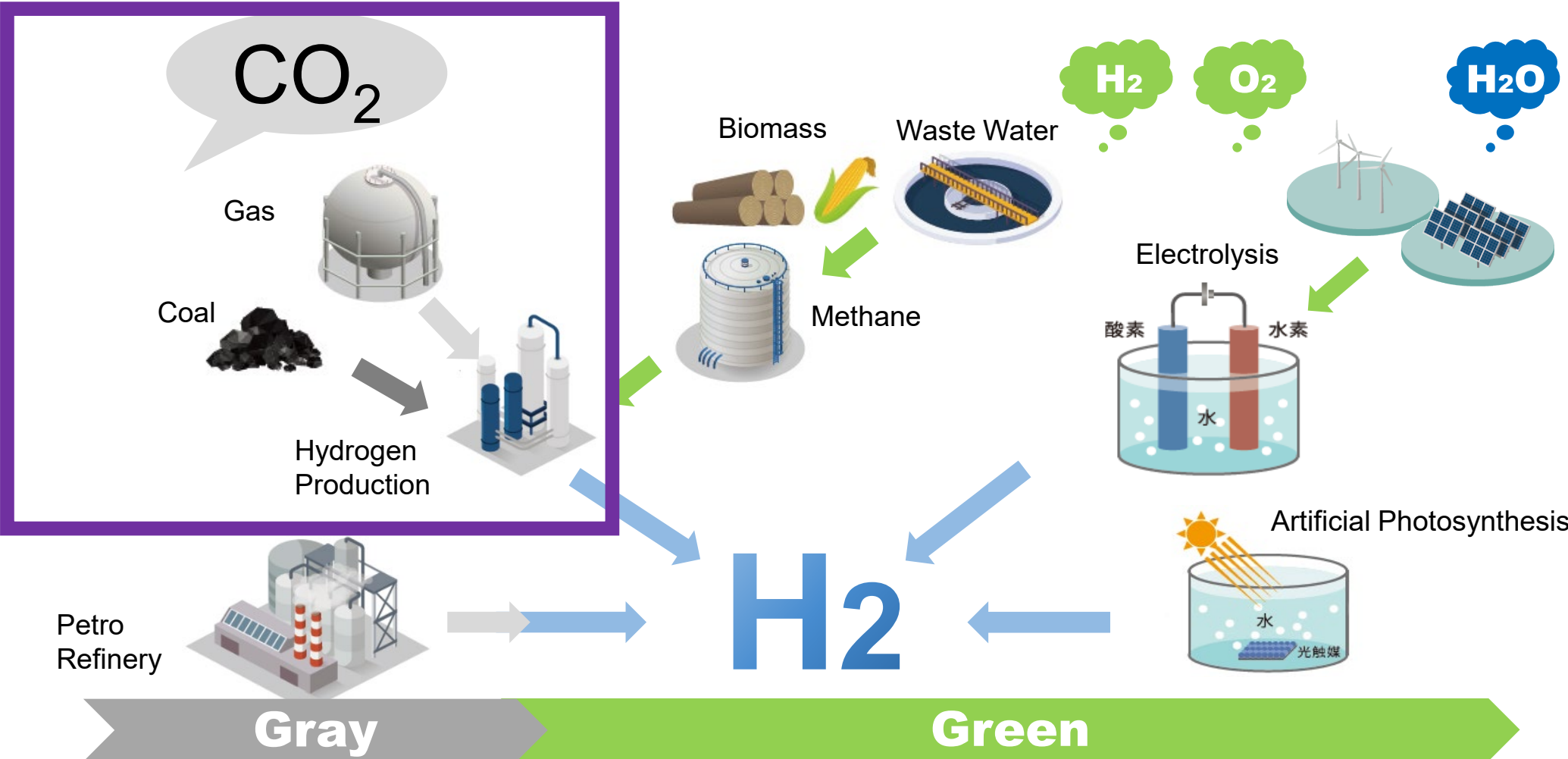
2. Monitoring Technology for FCV Hydrogen

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# Utilize Gray Hydrogen as Blue Hydrogen

- Carbon recycling CO<sub>2</sub> generated during hydrogen production to Blue Hydrogen

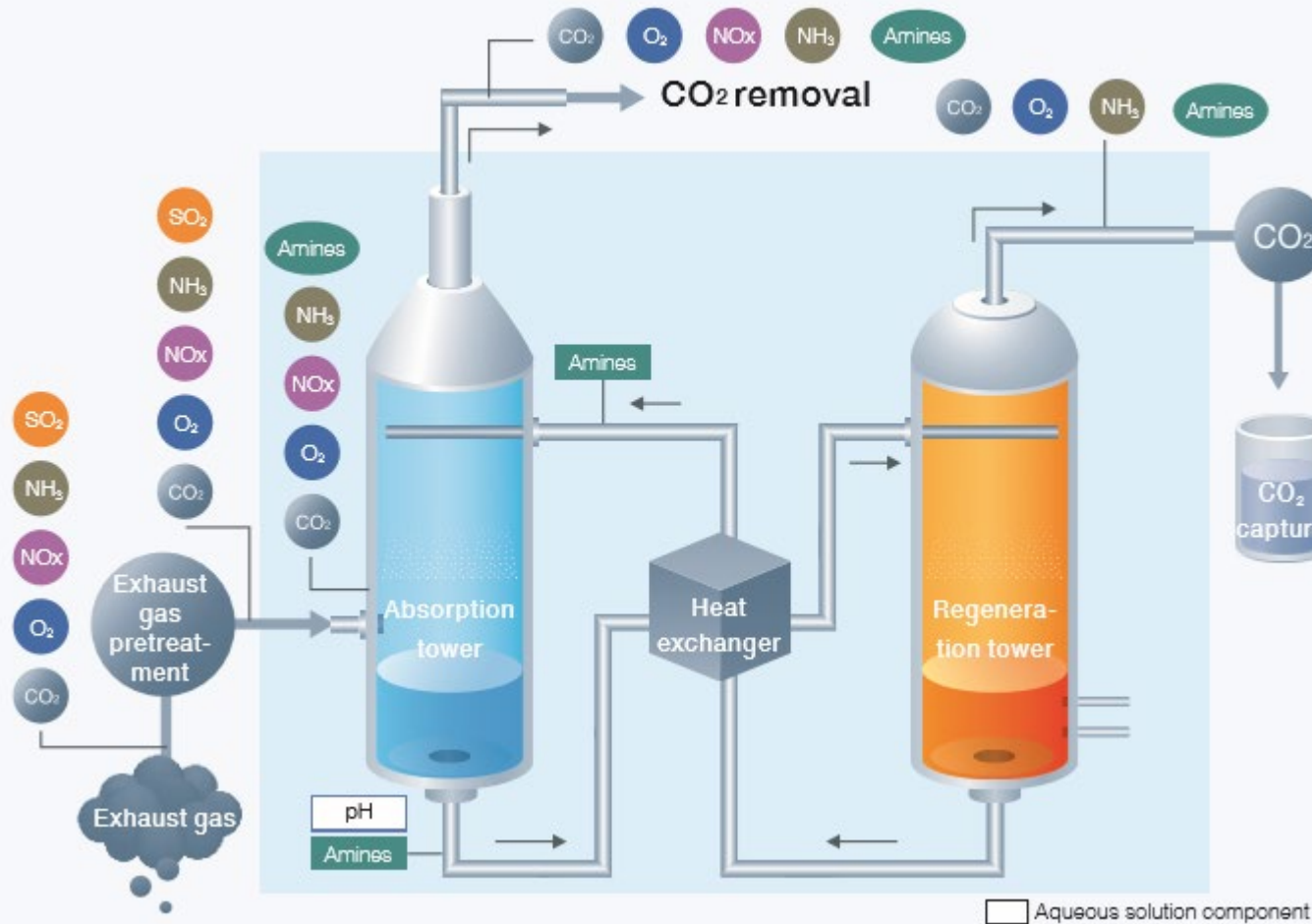


# HORIBA's Carbon Recycling Solution

CCS (Carbon dioxide Capture Storage)



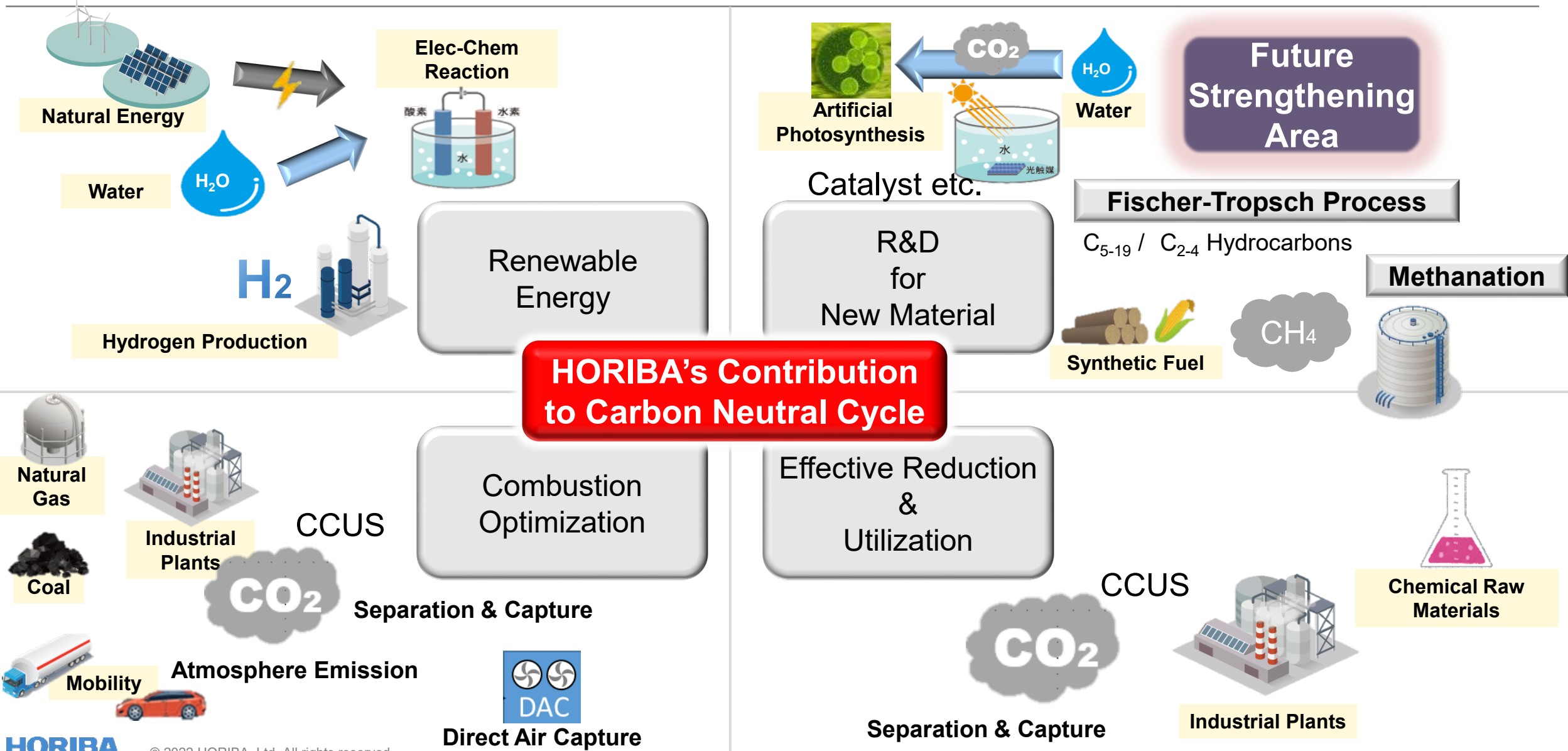
## Chemical Absorption (Amine)



## CCS Monitoring

	Points	Purpose	Items
Gas	Exhaust Gas Monitoring	Confirmation of removal of substances that inhibit carbon dioxide absorption	SO <sub>x</sub> , NO, CO <sub>2</sub> , CO HCl, Ammonia
	Absorption Tower	Confirmation of carbon dioxide absorption conditions	6 points CO <sub>2</sub>
	CO <sub>2</sub> Capture	Measurement of absorbed carbon dioxide	CO <sub>2</sub>
	CO <sub>2</sub> removal	Cleaning condition	CO <sub>2</sub> , Ammonia
Water	Amines Liquide	Amines Liquide Confirmation	pH, Conductivity, RAMAN analysis

# Keywords for Carbon Neutral Realization



# Contact Information

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Omoshiro-okashiku  
Joy and Fun



**THANK YOU**

Terima kasih  
谢谢  
Gracias  
Σας ευχαριστώ πάρα πολύ  
धन्यवाद  
شُكْرًا  
Danke  
Tack ska du ha  
Grazie  
ขอบคุณครับ  
Обольшое спасибо  
ありがとうございました  
Dziękuję  
Cảm ơn  
Merci  
감사합니다

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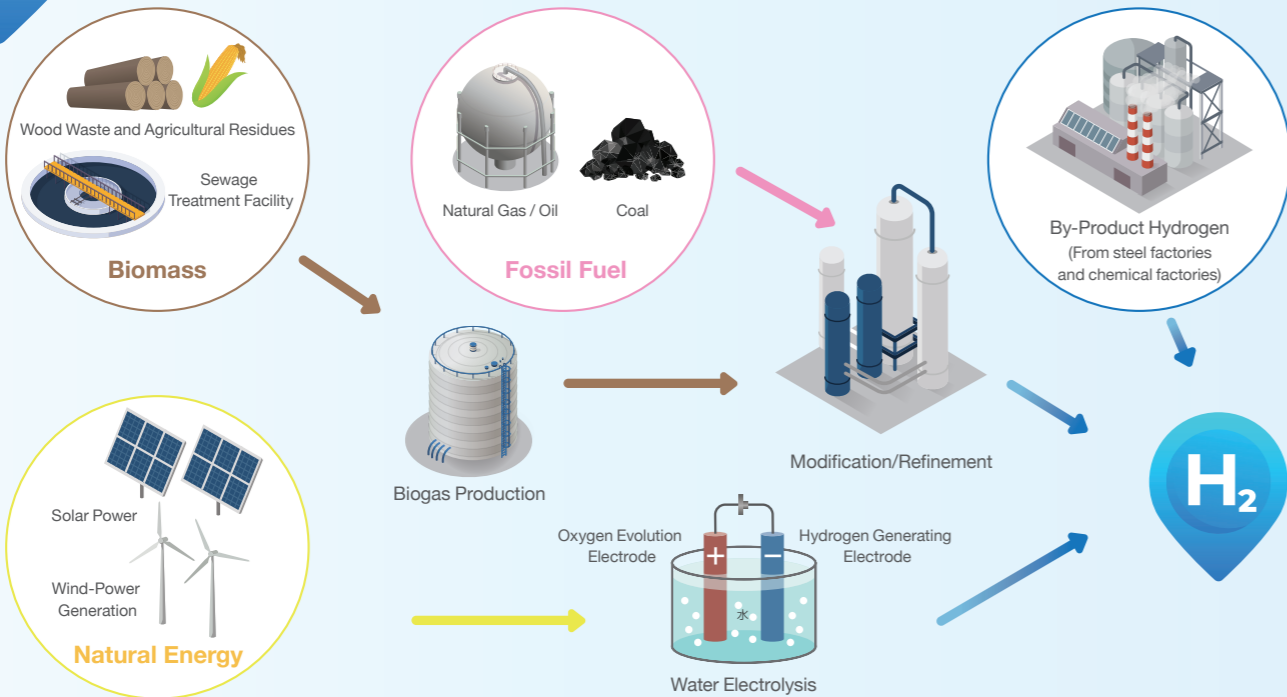
**4. Appendix**

Realize a Smart Hydrogen Society by

# Application Navi Hydrogen Navi

HORIBA Contributes to a Sustainable Hydrogen Energy Society with Analysis Technology from Research & Development to On-Site Measurement

## Generation



### Impurity Monitoring in High-Purity H<sub>2</sub>

Measures impurities such as CO and CO<sub>2</sub> during H<sub>2</sub> purification, which can lead to catalyst deterioration

Trace Gas Monitor  
GA-370



### Hydrogen Concentration Monitoring

Monitors the purity of refined H<sub>2</sub> in real time, with safe explosion-proof specifications

Thermal Conductivity Analyzer  
TCA-51 Series



### Generated Gas Monitoring

Measures CH<sub>4</sub> and CO<sub>2</sub> during biogas production and refining to optimize the production process

Multi-Component Gas Analyzer  
VA-5000



### Water Electrolysis Cell/Stack Evaluation

Optimizes water temperature and flow rate, and evaluates performance/efficiency of water electrolysis cells

Water Electrolysis Cell/Stack Evaluator  
Evaluator EC/ES



## Generation & Utilization

### Residential and Commercial Fuel Cells



### Evaluation of Fuel Cell Catalysts

Quantitatively analyzes S and C, which are catalyst poisons for fuel cells, from the ppm level

Carbon/Sulfur Analyzer  
EMIA Series



### Gas Monitoring in the Reforming Process

Real-time monitoring of desulfurization and CO removal performance in processes such as those that produce hydrogen from city gas

Multi-Component Gas Analyzer  
VA-5000



### On-Site Hydrogen Station



### SOFC Evaluation

Performs evaluation tests from single cells to full stacks  
\* SOFC: Solid Oxide Fuel Cell

Fuel Cell Evaluation System Evaluator HT Series  
Evaluator HT Series



### Monitors Exhaust Gas from FC Stacks

Monitors CO and CO<sub>2</sub> in exhaust gas in real time for R&D on FC stacks

Portable Gas Analyzer  
PG-300 Series



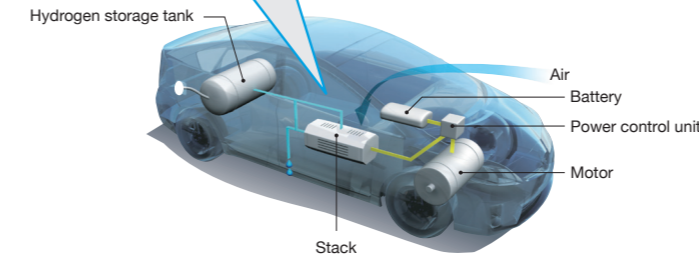
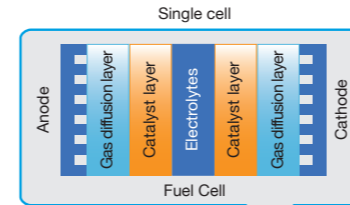
### Monitors Impurities in High-Purity Hydrogen

Monitors the concentration of impurities such as CO and CO<sub>2</sub> accurately during H<sub>2</sub> production at hydrogen stations. These impurities can degrade fuel cells

Trace Gas Monitor  
GA-370



### Fuel-Cell Vehicles



### PEFC evaluation

Performs evaluation from single cells to full stacks  
\* PEFC: Polymer Electrolyte Fuel Cell

Fuel Cell Test Station Evaluator  
Evaluator LT Series



### Battery Evaluation

Meets stringent battery test requirements and enables highly accurate performance and cycle evaluation

Battery Test Station  
Evaluator B



## Utilization

### Hydrogen Embrittlement Evaluation

Evaluates H<sub>2</sub> distribution from the material surface in the depth direction

Glow Discharge Optical Emission Spectrometer  
GD-Profiler2



Detects H<sub>2</sub> in metals at the ppm level

Hydrogen Analyzer  
EMGA-921



Generates gas of any gas concentration and enables precise gas mixing control of up to six components

Multi-Component Gas Analyzer  
MU-3000



### Catalyst/Electrolyte Evaluation

Nondestructive analysis of catalyst crystallinity that can lead to catalyst degradation

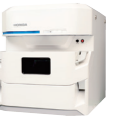
Raman Microscope  
XploRA PLUS



### Electrolyte Evaluation

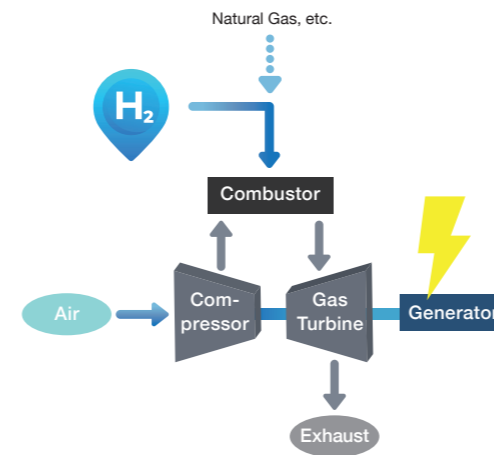
Mapping of radical quencher distribution in electrolyte membranes

X-ray Analytical Microscope  
XGT-9000



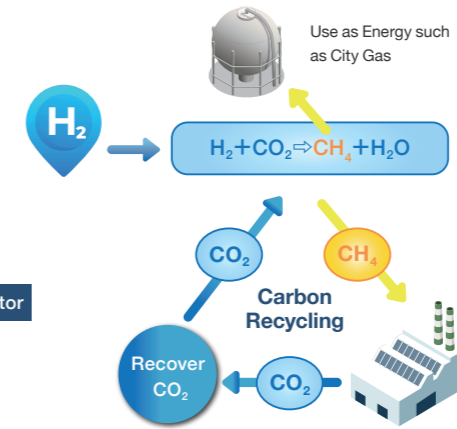
### Hydrogen Power Generation (Mixed Firing and Exclusive Firing)

Generates electricity by burning "H<sub>2</sub> and other fuel" or "H<sub>2</sub> only"



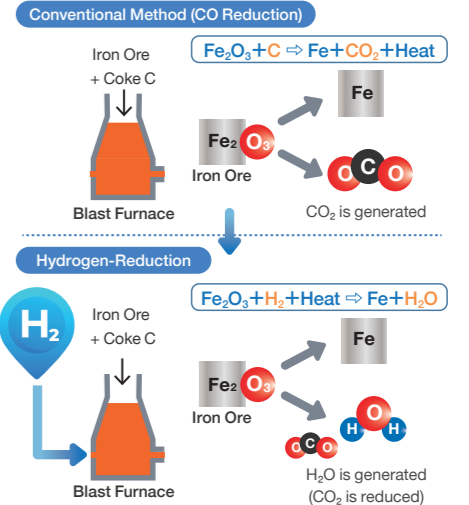
### Metanation

Contributes to carbon recycling by synthesizing "H<sub>2</sub>" with "CO<sub>2</sub>" emitted from factories for reuse in city gas and plastic materials



### Hydrogen-Reduction Steelmaking

Reduction Technology Using H<sub>2</sub>  
Achieves CO<sub>2</sub> reduction by using not only coke but also H<sub>2</sub> as a reductant



### Denitrification, Desulfurization/Flue-Gas Monitoring

Monitors denitrification and desulfurization controls as well as exhaust gas subject to environmental regulations

Stack Gas Analysis System  
ENDA Series



### Hydrogen Concentration Monitoring

Monitors H<sub>2</sub> purity in real time, with safe explosion-proof specifications

Explosion-Proof Gas Analyzer  
TCA-51 Series



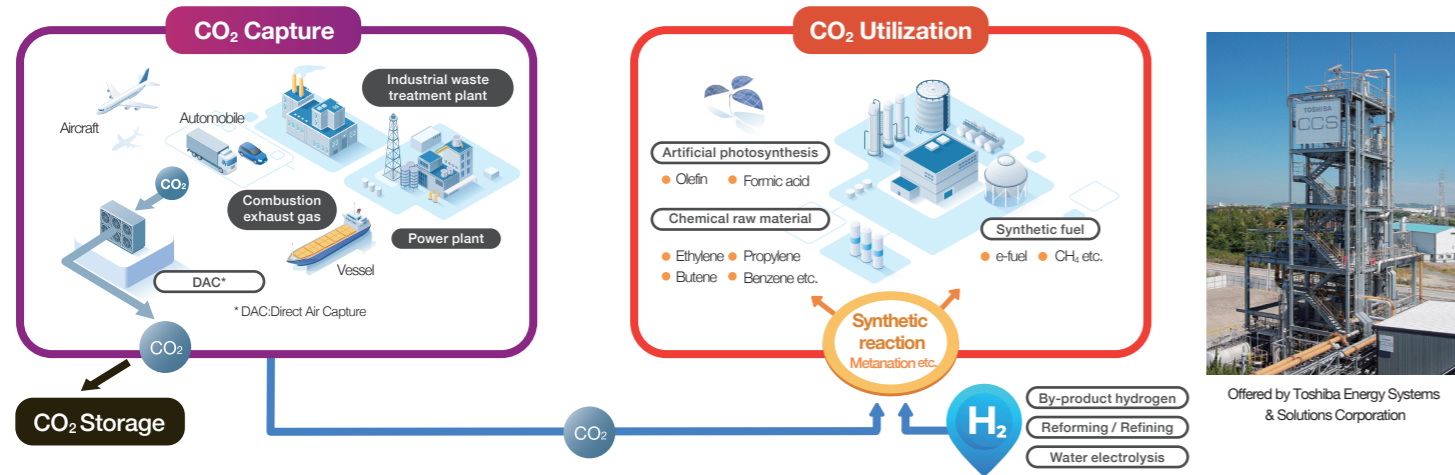
### Generated Gas Monitoring in Various Processes

Monitors gases generated in various processes, with specifications matching applications

Multi-Component Gas Analyzer  
VA-5000

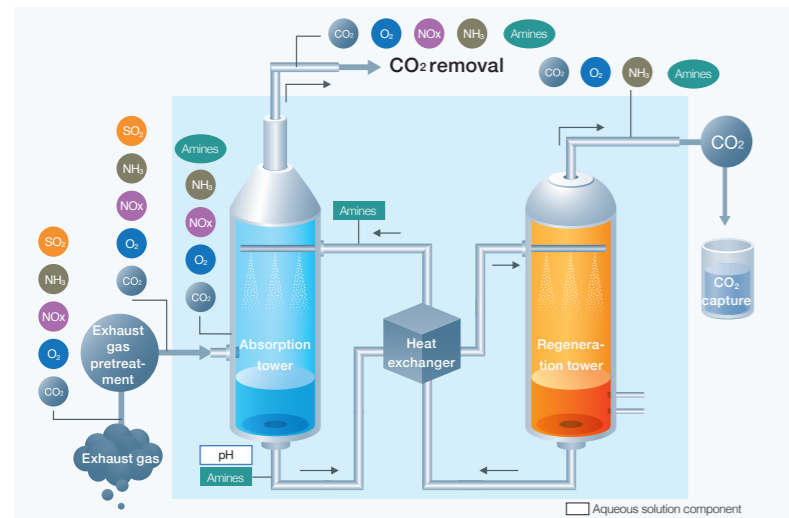


In order to achieve carbon neutrality and combat climate change, it is important to reduce carbon dioxide (CO<sub>2</sub>) emissions from thermal power generation, steel industry, chemical industry, cement industry, etc. Globally, the development and practical application of "carbon recycling technology" to recover and effectively use CO<sub>2</sub> as a resource is now underway.



**Capture** CO<sub>2</sub> is separated using the most appropriate technology based on the size, concentration, and pressure of the CO<sub>2</sub> source.

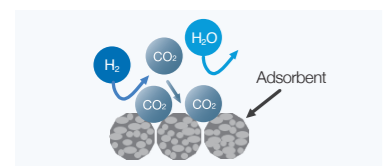
### Chemical Absorption (Amine)



"Chemical absorption" is a method of separation using a chemical solution and is widely used nowadays.

Since it is necessary to monitor various types of generated gases such as CO<sub>2</sub> in each process of the Chemical Absorption, we propose equipment systems and sampling methods that meets customer's requirements. In addition, structural analysis by water quality meters and Raman spectroscopy is effective for identifying changes in the state of amine solutions and in determining the timing of replacement or additional injection.

### Physical Adsorption



Physical Adsorption is a capturing technology in which CO<sub>2</sub> is adsorbed onto an adsorbent (porous solid such as activated carbon or zeolite) and then desorbed by decompression or heating.

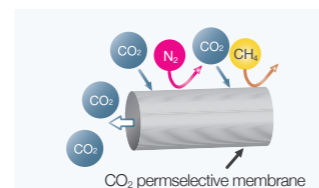
#### Evaluation of Adsorbents

Raman microscopy, which captures the bonding state of substances, can be used to observe changes in state, such as adsorption, that occur on the zeolite surface. It is useful for performance evaluation and degradation analysis of adsorbents.

Raman Microscope  
XploRA PLUS



### Membrane Separation



Membrane Separation is a technology that uses polymer membranes with CO<sub>2</sub> separation function to selectively separate and recover CO<sub>2</sub> by pressure difference.

#### Reaction Efficiency of Membrane / Evaluation of replacement time

Measuring the amount of carbon attached to the separation membrane after the reaction and the amount of sulfur in the catalyst with EMIA-Step and evaluating the degradation level of membranes and catalysts can be useful for predicting the reaction efficiency and replacement cycle of membranes.

Carbon/Sulfur Analyzer  
EMIA-Step



### Gas Measurement Solutions

#### High concentration gas measurement

Multi-Component Gas Analyzer  
VA-5000 Series



Stack Gas Analysis System  
ENDA Series



#### Low concentration gas measurement

Trace Gas Monitor  
GA-370



Ambient NOx Monitor  
APNA-370



\*Contact us for the combination of gas components to be measured and equipment.

### Amine Solution Measurement Solution

Field-installation Type pH / Conductivity Meter  
H-1 Series



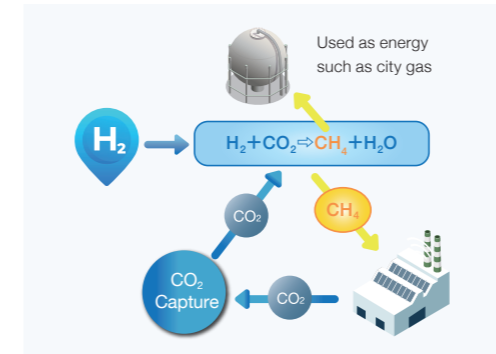
Process Raman Systems



## Utilization

By using technologies such as methanation, absorption / immobilization and artificial photosynthesis to use CO<sub>2</sub> as a synthetic raw material for chemicals and fuels, efforts are being made to reduce CO<sub>2</sub> emissions into the atmosphere and effectively use it as a resource.

### Methanation



"Methanation" is a technology for synthesizing hydrocarbon compounds such as CH<sub>4</sub>, the main component of natural gas, from H<sub>2</sub> and CO<sub>2</sub>.

#### Impurity Monitoring

HORIBA offers various gas analyzers such as CH<sub>4</sub>, CO<sub>2</sub>, etc. in combination with optimal sampling system for monitoring on different stages from R&D to real process monitoring, based on the analysis and measurement technologies we have cultivated over the years.

We also have extensive experience in monitoring desulfurization, which is necessary for the pretreatment of methanation processes.

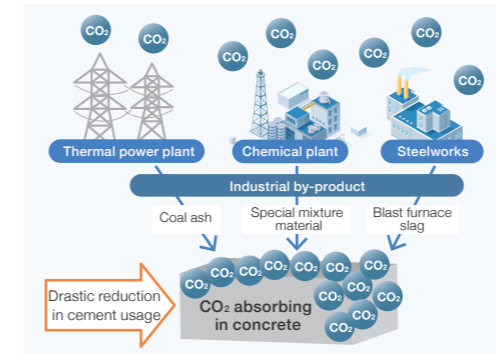
Multi-Component Gas Analyzer  
VA-5000 Series



Explosion-proof Gas Analyzer  
TIA-51d/p



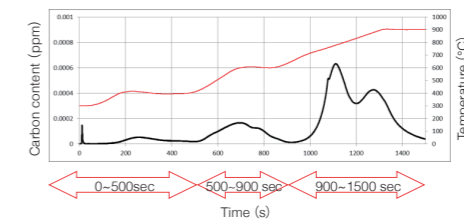
### Absorption / Immobilization in concrete materials



To reduce CO<sub>2</sub> emissions, research is being conducted on "CO<sub>2</sub> fixation": absorption and fixation of CO<sub>2</sub> in concrete.

By substituting industrial by-products for cement, which emits large amounts of CO<sub>2</sub> during production, the total amount of CO<sub>2</sub> emissions during concrete production can be reduced.

#### Measurement of CO<sub>2</sub> Fixation

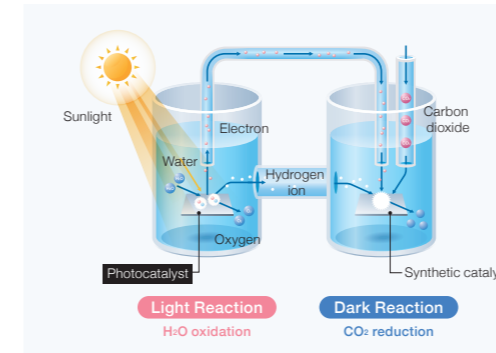


EMIA-Step is capable of temperature rising analysis of carbon amount, so changes in the amount of withdrawal depending on the temperature of the adsorbed CO<sub>2</sub> can be measured.

Carbon/Sulfur Analyzer  
EMIA-Step

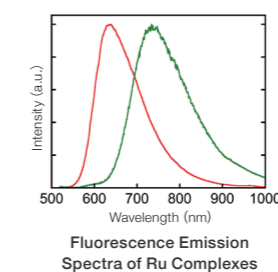


### Artificial Photosynthesis



"Artificial Photosynthesis" is a technology for synthesizing chemicals from water and CO<sub>2</sub> using solar energy and photocatalysts.

#### Evaluation of Luminescence Properties in the Near-Infrared Region



Duetta can detect spectra as long as 1,000 nm, making it possible to evaluate luminescence properties in the near-infrared region. It will contribute to improving the reaction efficiency of catalytic materials.

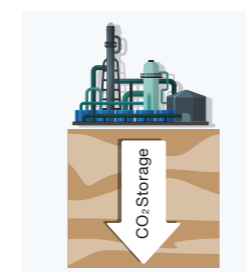
Fluorescence and Absorbance Spectrometer  
Duetta



• Data offered by Ishitani Laboratory, Tokyo Institute of Technology

## Storage

CO<sub>2</sub> separated and recovered from large-scale sources of CO<sub>2</sub> emissions is stored in underground or in strata of the ocean floor.



### CCS

"CCS" is a technology for stably storing nearly 100% of the separated and recovered CO<sub>2</sub> in a reservoir more than 1,000m deep underground.

#### Measurement of CO<sub>2</sub> storage gas concentration

Gas analyzer 51 series are explosion-proof and allows constant CO<sub>2</sub> measurement at the CO<sub>2</sub> recovery outlet (storage inlet).



Explosion-proof Gas Analyzer  
EIA-51d/p

### CCUS Related Websites

The following websites provide more detailed information about our solutions.



Process Gas



Carbon Recycling