

# Development of a Bioprocess That Uses Electrical Energy to Fix Atmospheric CO<sub>2</sub>

Presenter : Dr. KATO Souichiro, National Institute of Advanced Industrial Science and Technology (AIST)

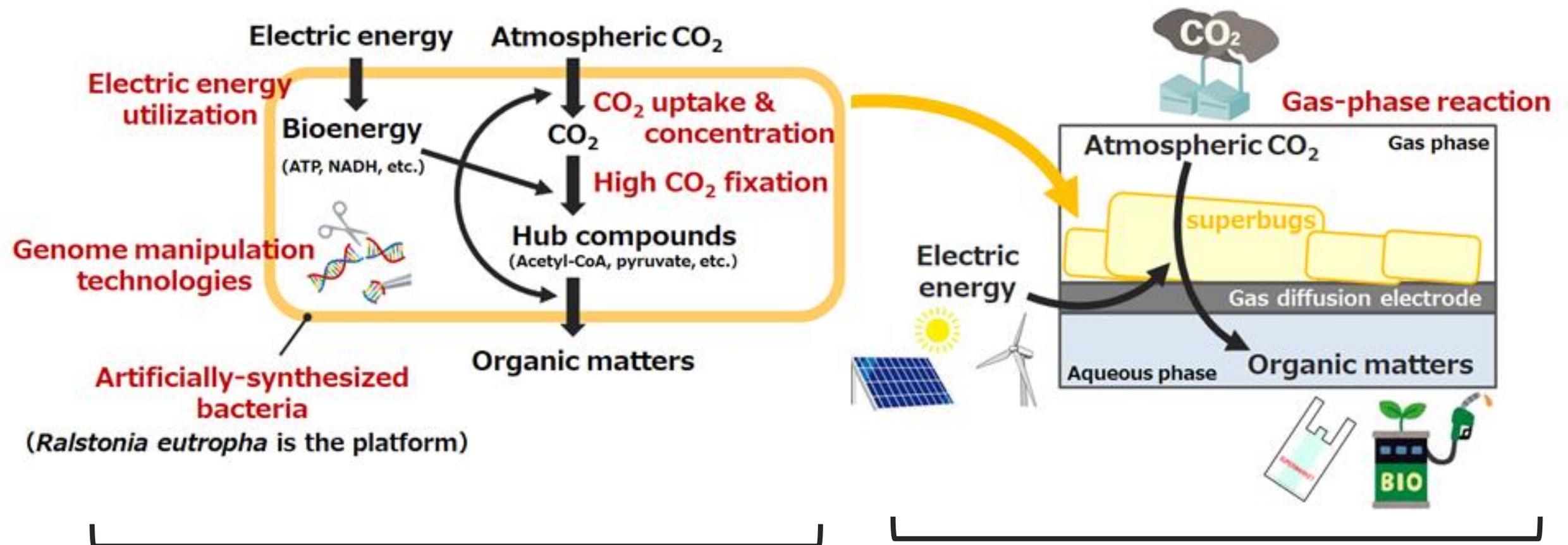
PM : Dr. KATO Souichiro, National Institute of Advanced Industrial Science and Technology (AIST)

Implementing organizations : National Institute of Advanced Industrial Science and Technology (AIST),

Tokyo Institute of Technology, Nagoya University

# Summary of our project

- Development of an innovative biotechnology for negative emission
- Utilizing electric energy to convert atmospheric CO<sub>2</sub> into organic matters
- More than 50 times more efficiently than plants (>50 kg-CO<sub>2</sub>/m<sup>2</sup>/year)



## "superbugs"

that use electric energy, uptake & concentrate atmospheric CO<sub>2</sub>, and fix CO<sub>2</sub> with high efficiency.

## "gas-phase reaction process"

that can effectively supply electricity, nutrients and CO<sub>2</sub> to superbugs.

# Development of large-scale genome manipulation technology

## Abilities of CO<sub>2</sub> uptake and concentration

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(National Institute of Advanced Industrial Science and Technology (AIST))

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# Genome manipulation (AIST)

■ Target : Construction of large-scale genome manipulation technologies for *Ralstonia*

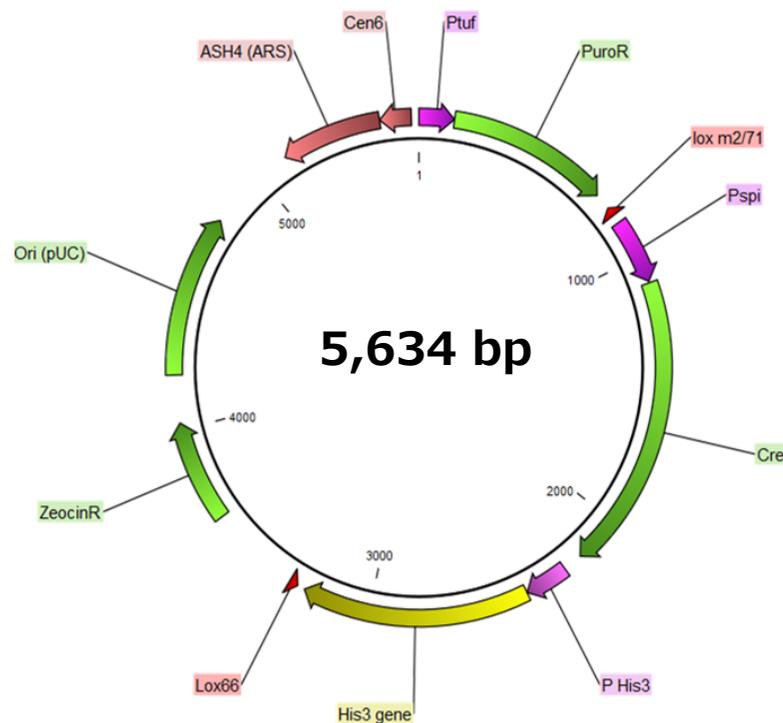
■ 1. Large-scale DNA introduction technologies for *Ralstonia*

Achievements:

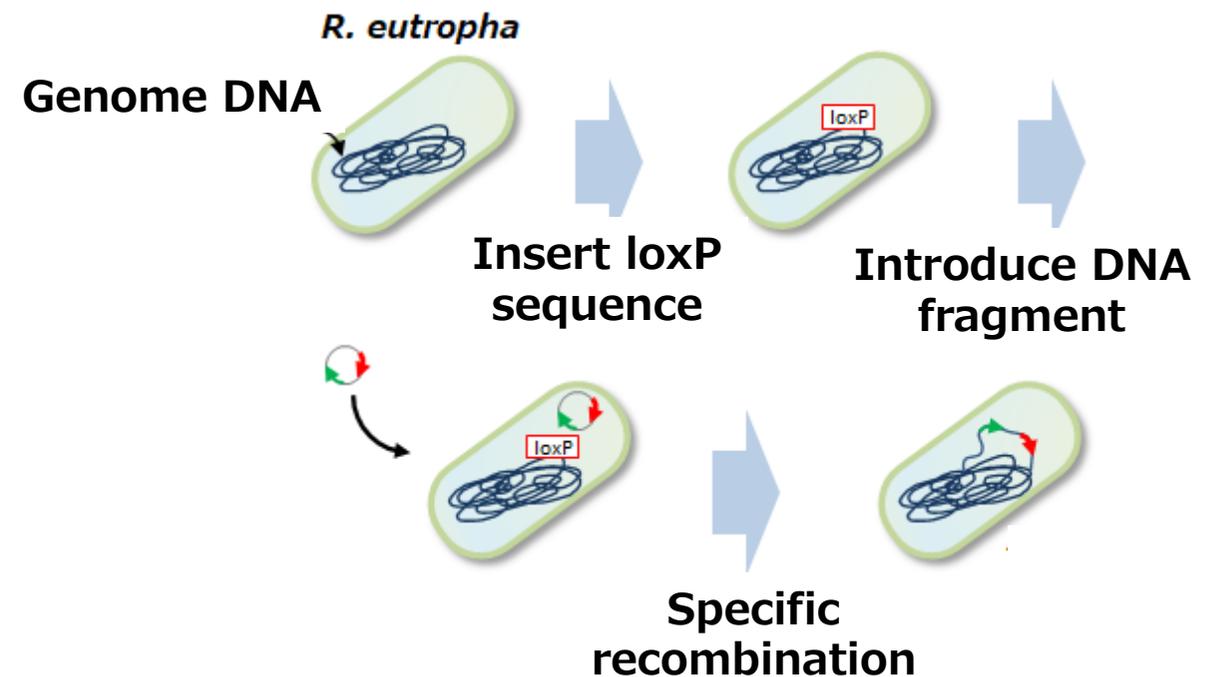
- Vectors were designed
- DNA introducing methods were examined

On-going works:

- Methods for gene insertion into the genome (Cre-Lox system)



Designed DNA vector based on yeast artificial chromosome (YAC)



Summary of Cre-Lox system

# Genome manipulation (AIST)

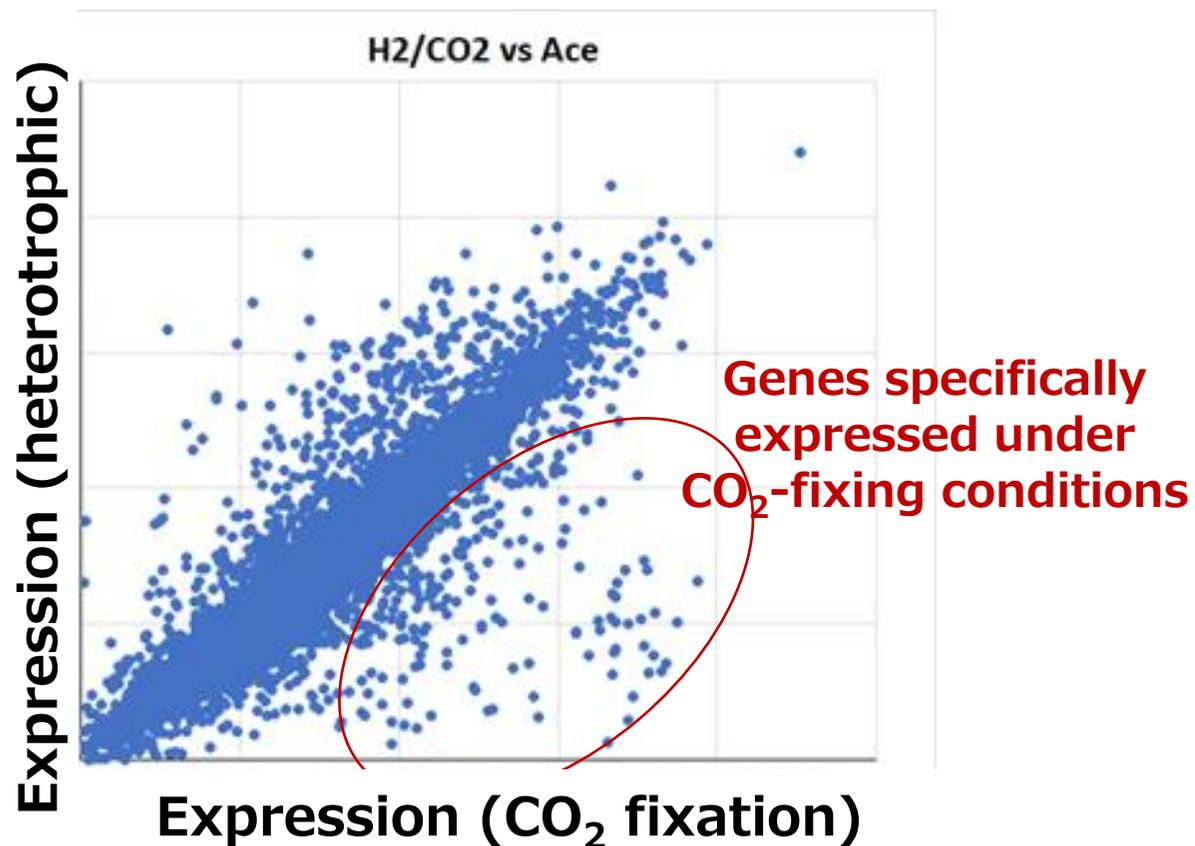
## ■ 2. Development of promoter libraries

Achievements:

- Expression analysis under CO<sub>2</sub>-fixing conditions
- Specify candidate promoters

On-going works:

- Verification of candidate promoters
- Develop promoter libraries



	Expression level			Fold change		
	H2/CO2	Ace	Fru	H2/Ace	H2/Fru	
cbb_C2	7581	21	168	368	45	Chr_20cbb
hox_pla	2138	11	23	189	95	NAD-reducing hydrogenase
selB_C2	647	5	18	125	35	
ttt_C2	362	2	4	159	88	tripartite tricarboxylate transporter substrate binding protein

Candidates for promoters specifically working under CO<sub>2</sub>-fixing conditions

Results of gene expression analysis (CO<sub>2</sub>-fixing and heterotrophic conditions)

# Ability of CO<sub>2</sub> concentration (Kobe univ.)

- Target : Introduce genes for CO<sub>2</sub> uptake and concentration into *Ralstonia*
- 1. Introduce CO<sub>2</sub>-fixing enzymes (Rubisco)

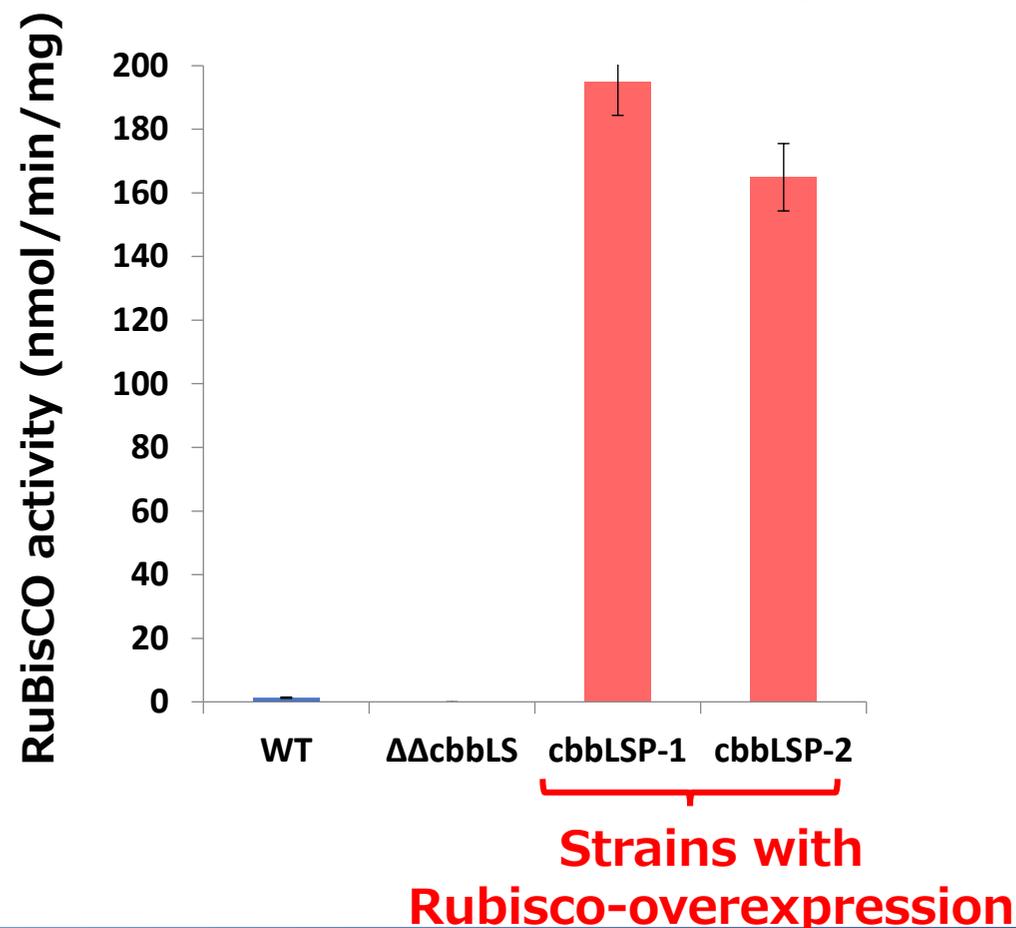
Achievements:

- Construct Rubisco-overexpression strains that showed higher Rubisco activities & growth

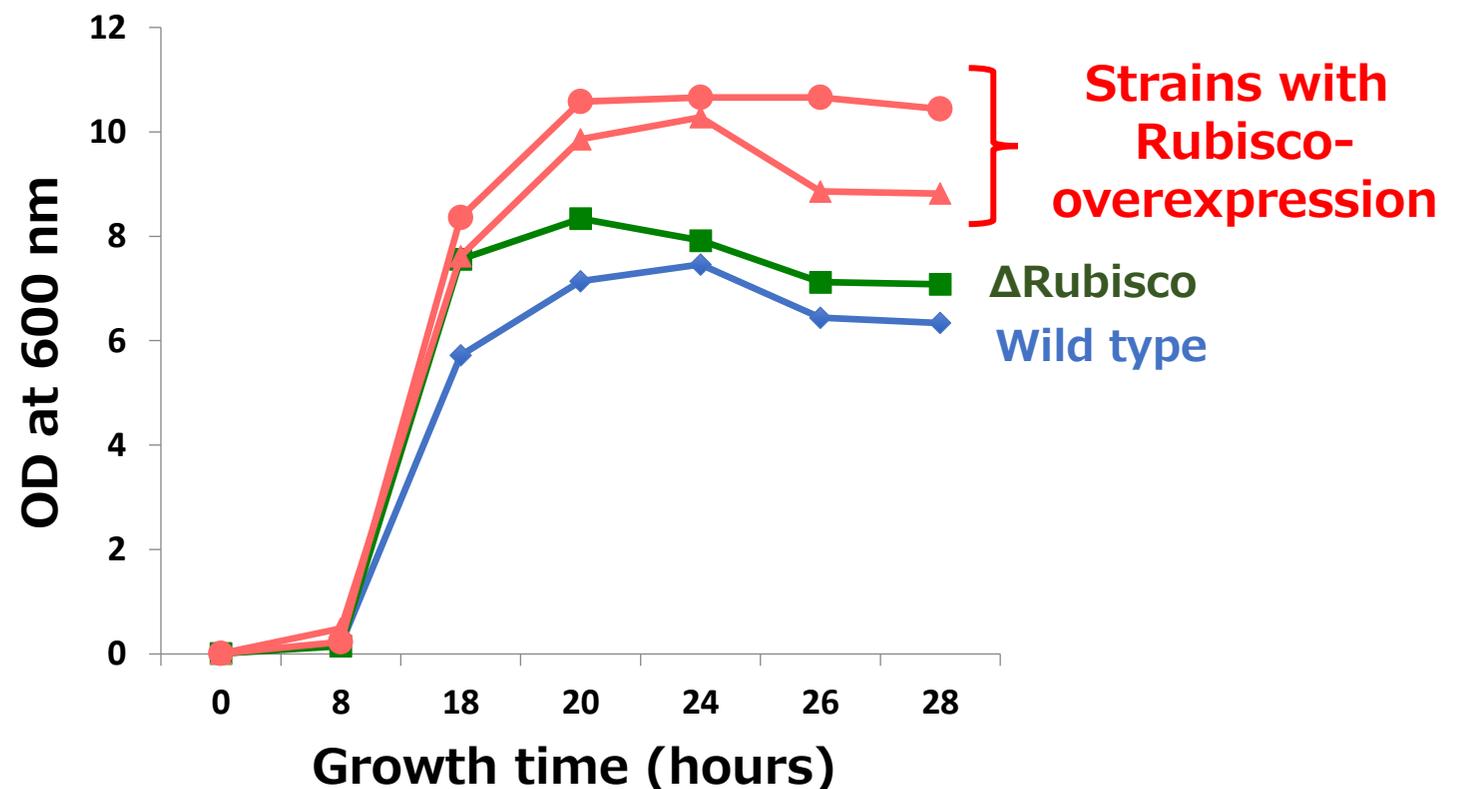
On-going works:

- Further improvement by co-introduction of CO<sub>2</sub> uptake & concentrating systems

## Rubisco activity



## Growth of *Ralstonia*



# Ability of CO<sub>2</sub> concentration (Kobe univ.)

- Target : Introduce genes for CO<sub>2</sub> uptake and concentration into *Ralstonia*
- 2. Introduction of CO<sub>2</sub>-uptake and concentrating systems

Achievements:

- Construct vectors for CO<sub>2</sub> transporters and carboxysome genes derived from cyanobacteria

On-going works:

- Introduction into *Ralstonia* to improve its CO<sub>2</sub>-fixing abilities

