Initiative Report:
Sustainable Resources Circulation for Global Environment

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Working Group 4
Moonshot International Symposium

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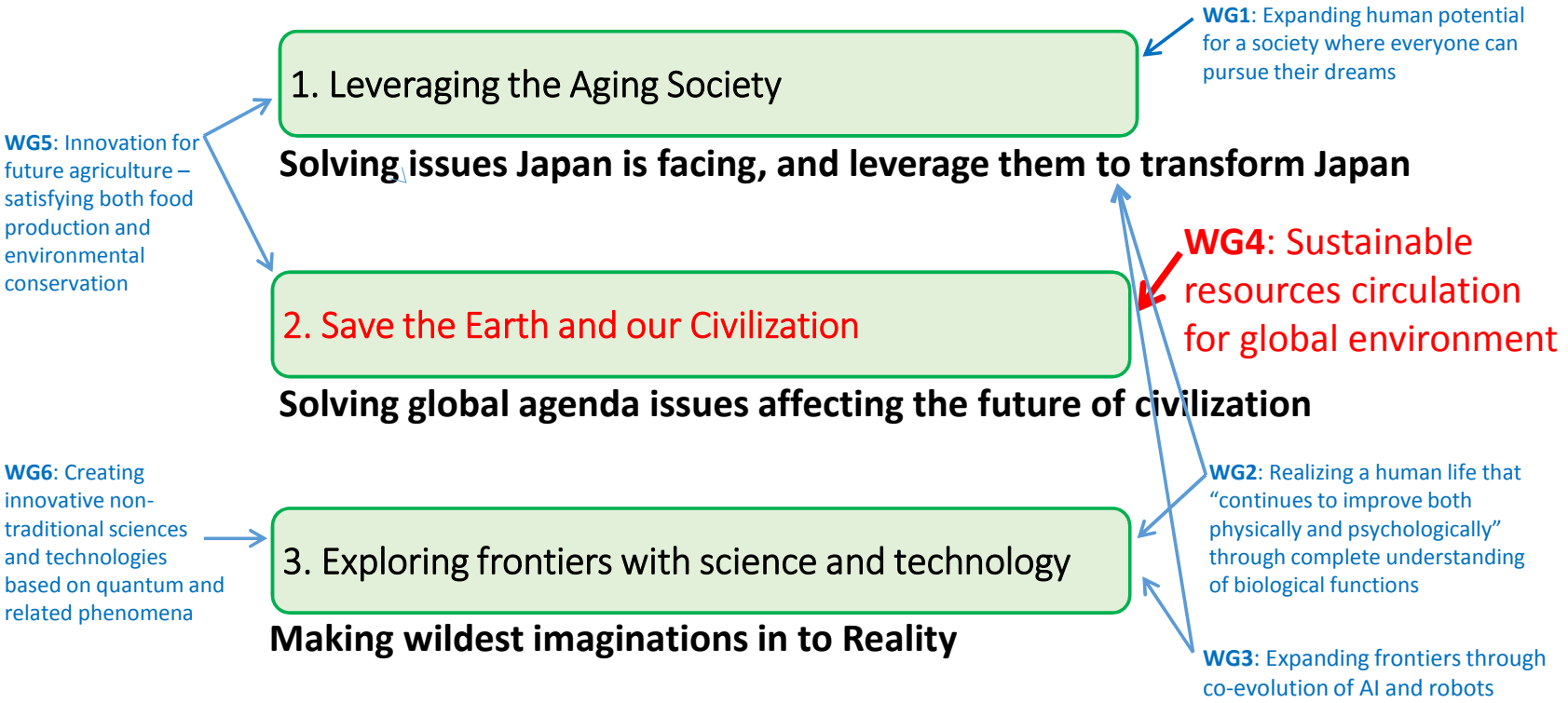
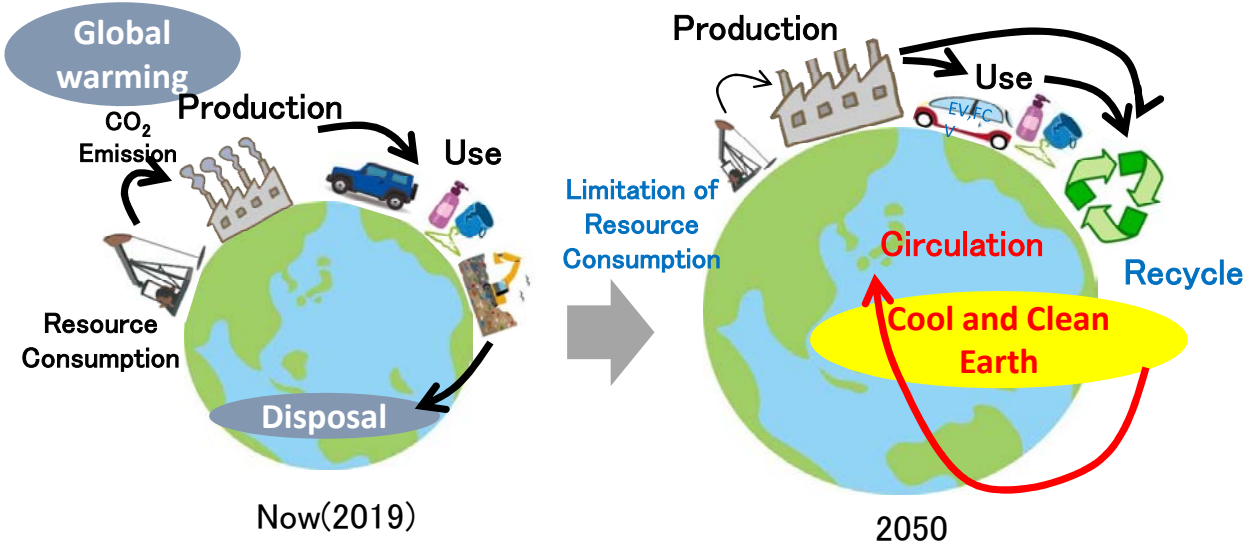
WG4 in the Mission Areas for Moonshot Program



Moonshot Goal Candidate:

Realization of Sustainable Resources Circulation to Recover the Global Environment by 2050

The mission of this Moonshot Goal Candidate is to develop technology for reducing the emissions of greenhouse gases and pollutants to contribute to the recovery from the on-going issues of global warming and environmental pollution. The concept of this theme consists of pillars of , **“Cool Earth”** and **“Clean Earth”**



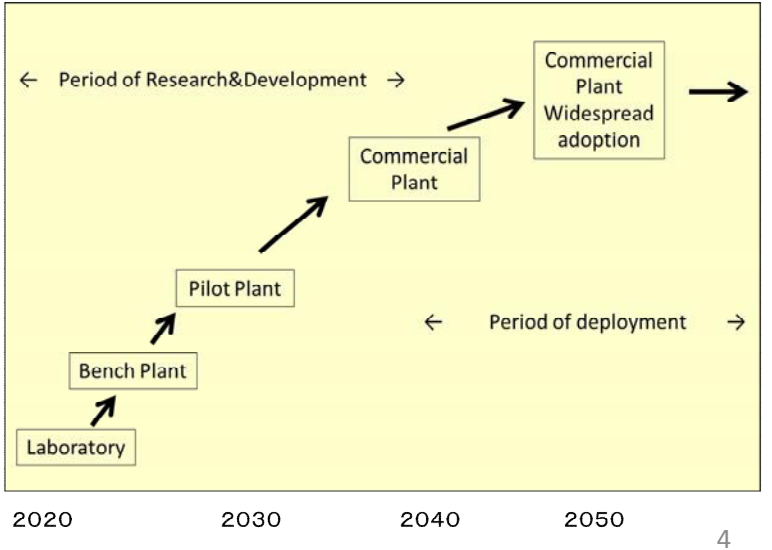
Target : Sustainable Resources Circulation for Global Environment

2030 (Output target)
<Cool Earth>Development of circulation technology for greenhouse gases, which is effective also in terms of Life Cycle Assessment (LCA) in a pilot scale.

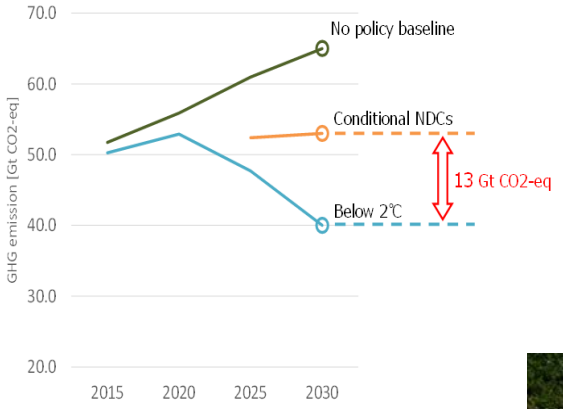
<Clean Earth>Development of technology in which environmental harmful substances are converted into valuable or harmless materials in a pilot scale or as a prototype.

2040 (Outcome)
<Cool and Clean Earth>
Several small markets for the resources circulation technology will be created.

2050 (Outcome)
<Cool and Clean Earth>
Realization of sustainable resources circulation to recover the global environment by 2050. It means commercial plants and products with circulation technology will deploy globally.



Global Threats for Cool Earth and Clean Earth



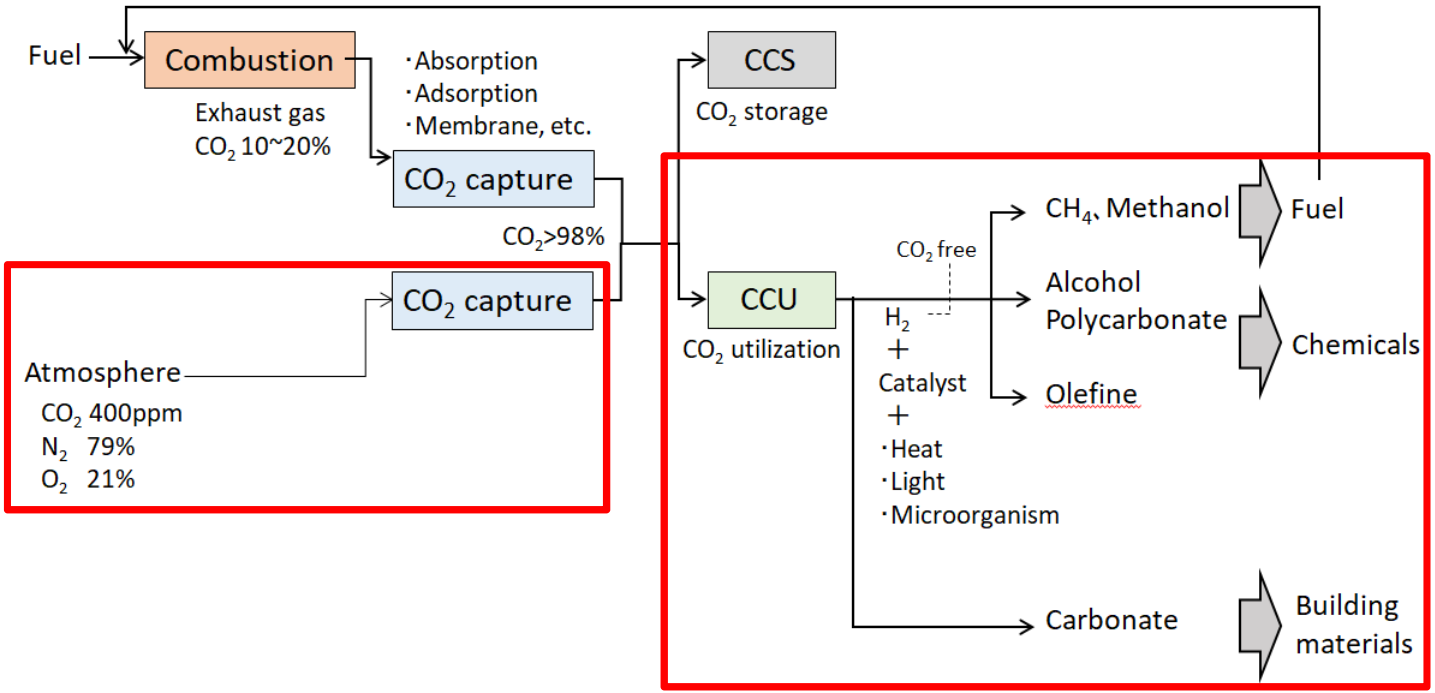
Giga-ton Gap for the Below 2℃ Target

Marine Plastic Litter

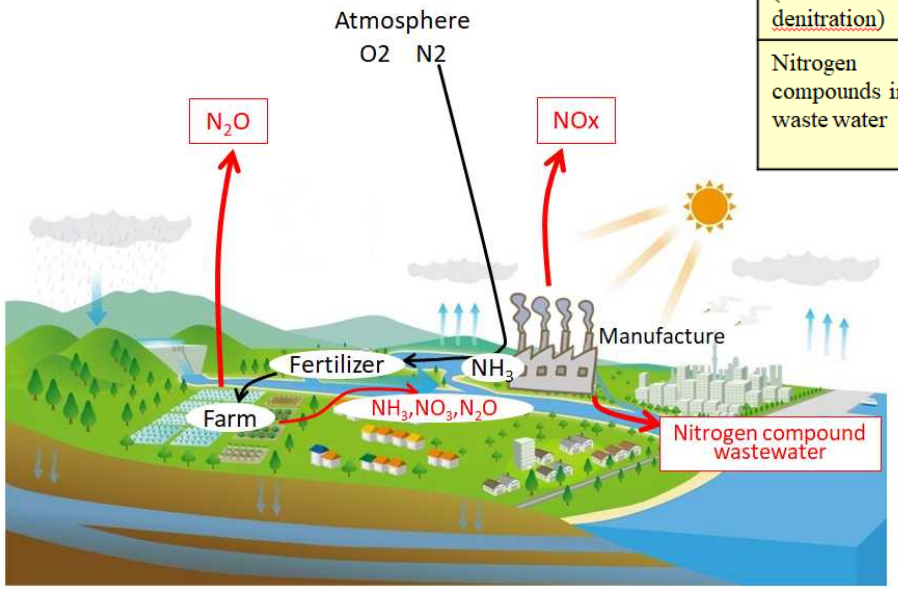
Nitrogen

Beyond Planetary Boundaries

Challenge: CO_2 recovery from atmosphere (DAC), and Recovered CO_2 can be converted into fuel and/or various chemicals as a raw material (CCU)



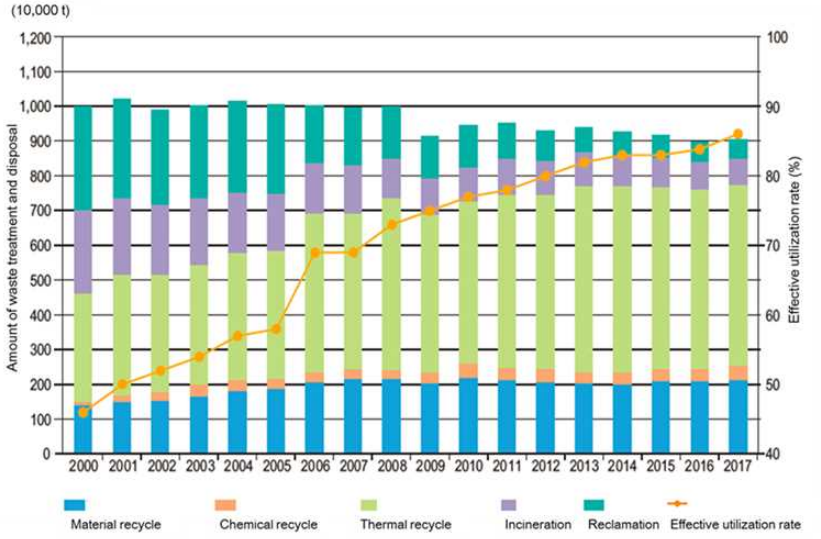
Nitrogen: N_2O as a GHG, Over Fertilization, Acid Rain, etc.



Target	Current status	Examples of technology
NOx in exhaust gas (after conventional denitration)	Laboratory	✓ Convert NOx to ammonia by chemical reaction using a catalyst ✓ Convert NOx to nitric acid by chemical reaction
Nitrogen compounds in waste water	Laboratory	✓ Convert nitrogen-containing organic to ammonia by catalytic reaction ✓ Convert nitrogen-containing organic to ammonia using microorganisms

Marine Plastic Litter: 700 species in the sea, including endangered species, have been damaged by plastic tangles or accidental ingestion of plastic

While recycling rate (incl. thermal recycle) is increasing in Japan, over **10 million tons of plastic flow into the sea** in the world.



Treatment f waste plastic in Japan

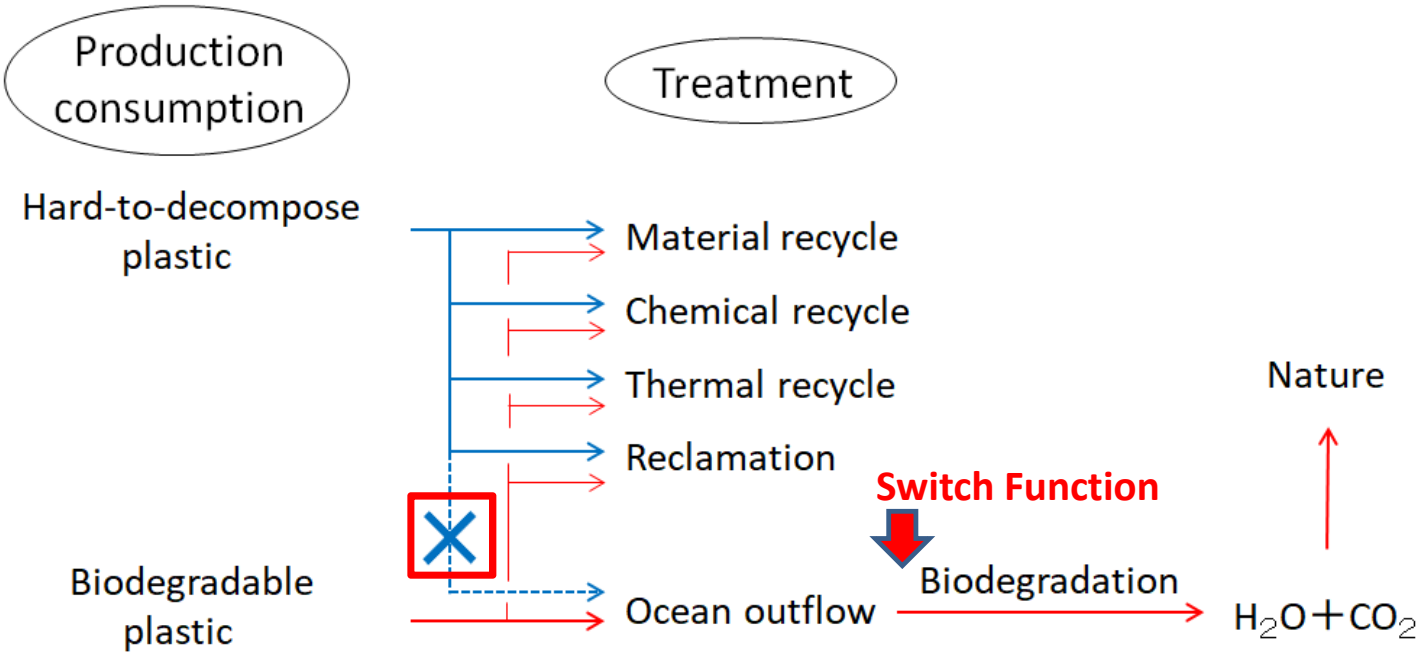
Sources of plastic pollution reaching the marine ecosystem

(thousand metric tones per annum)

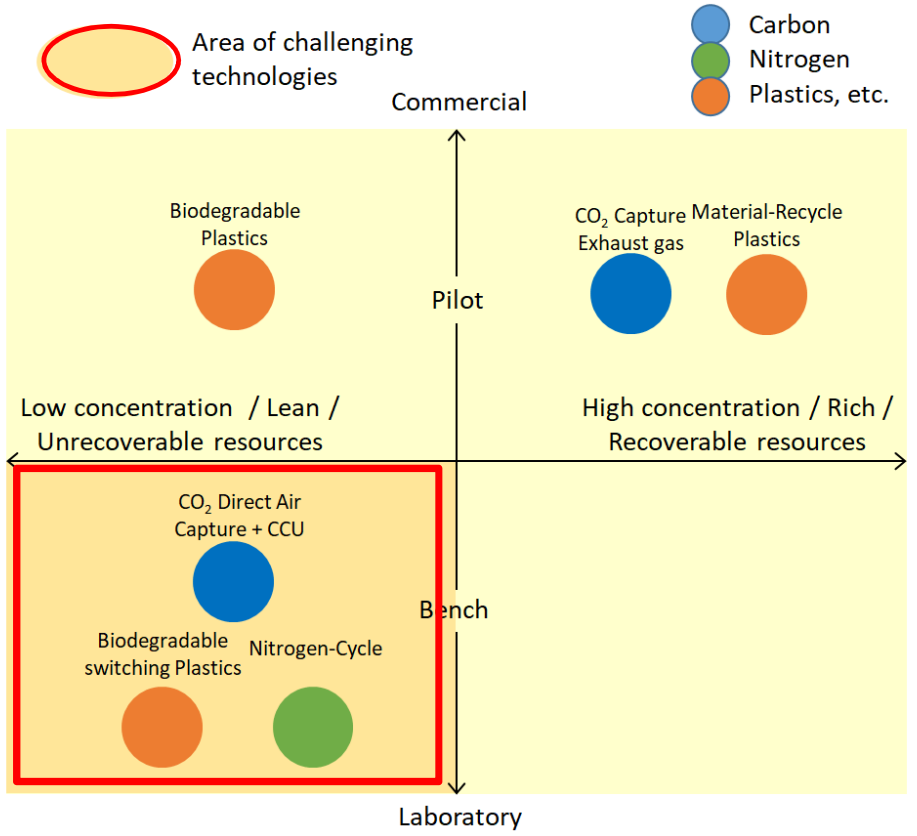
Source	Tonnage plastics estimated to be entering the ecosystem
Rivers/land run off-land based	9,000
Direct dumping	1,500
Fishing gear	640
Lost cargo	600
Vehicle tire dust	270
Industrial pellet spills	230
Road and building paint	210
Textiles	190
Cosmetics	35
Marine paint	16

(J. R. Jambeck et al. Science pp.768-771, Feb. 2015)

Challenge: **Stop ocean outflow + Switch function controlling the starting point and rate of biodegradation**



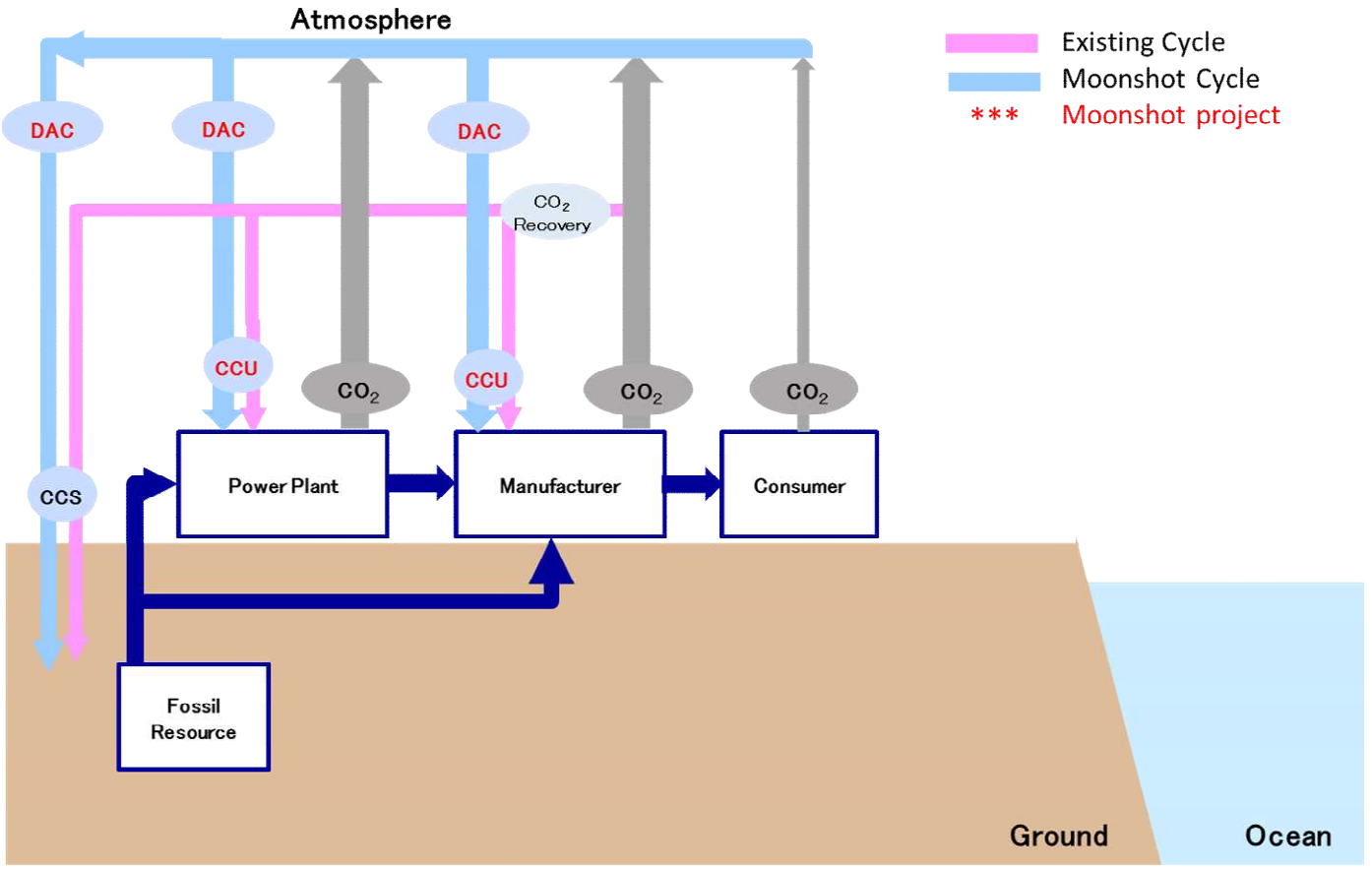
Map of Science and Technology of the Resources Circulation for Cool and Clean Earth



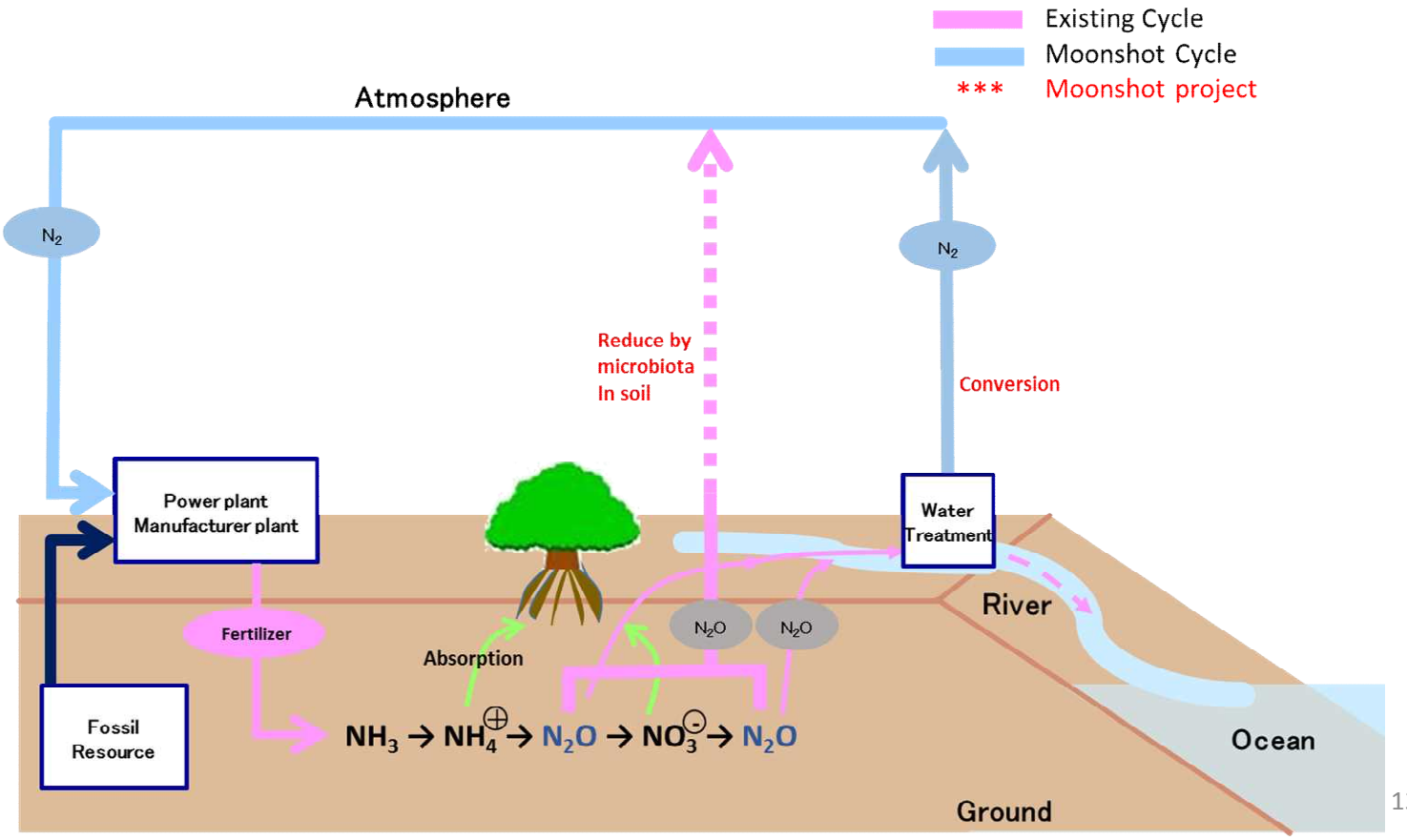
Example of Moonshot Project in Theme of Sustainable Resources Circulation for Global Environment

	Target	Background	Moonshot program examples
Cool Earth	CO_2	・Paris agreement ・IPCC 2° C scenario by United Nations	① DAC related to CCU
	N_2O		② Detoxify N_2O or suppress N_2O generation
Clean Earth	Nitrogen compounds	・Planetary boundary	③ Convert nitrogen compounds in exhaust gas and wastewater to chemicals
	Marine plastic litter	・G20 Osaka blue ocean announcement ・EU plastic regulation	④ Biodegradation plastic including switch function

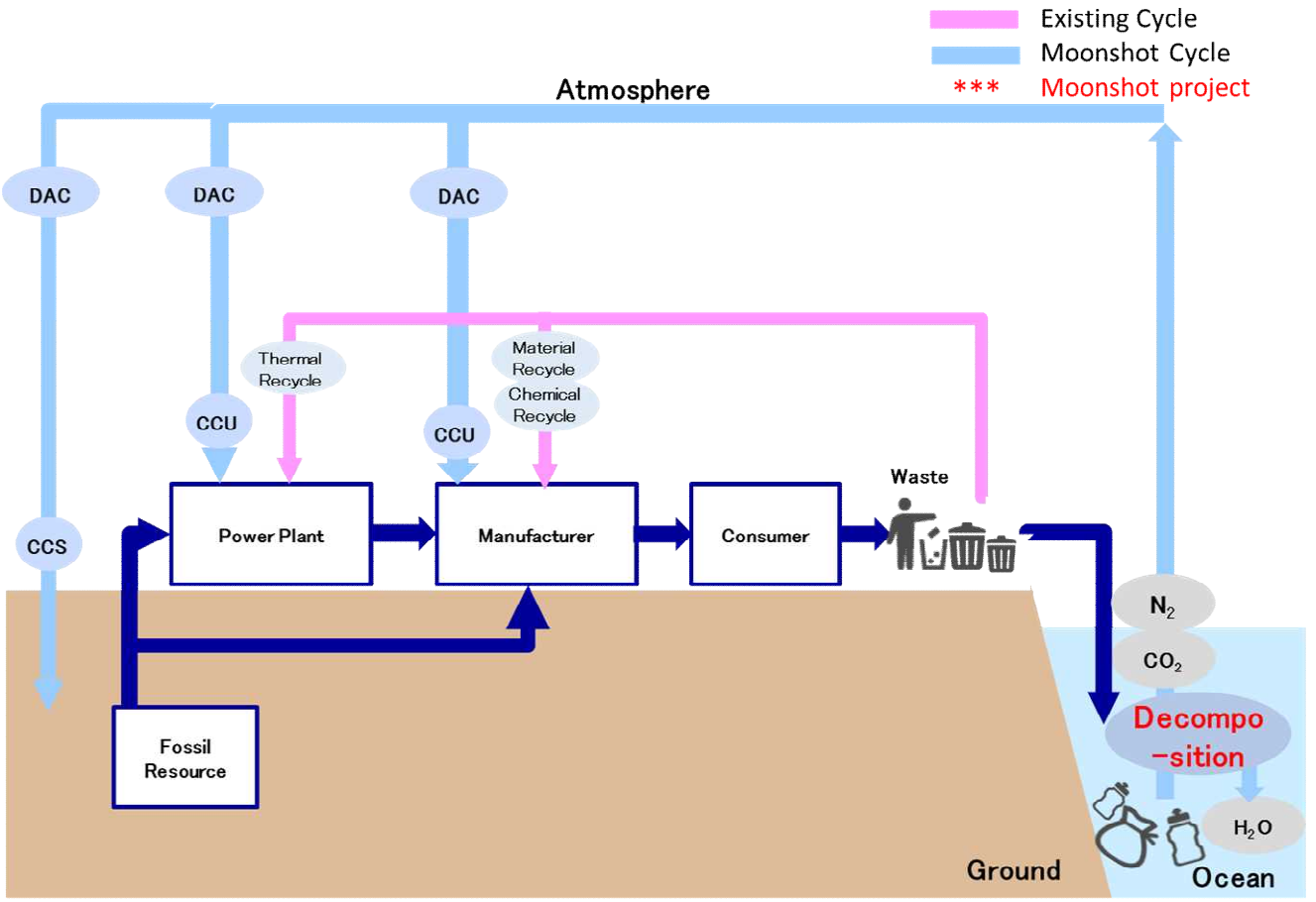
Moonshot Carbon Circulation **(materials are recycled from nature)**



Moonshot N_2O Circulation **(materials recycled from nature)**



Moonshot Waste Plastics Circulation **(materials recycled from nature)**



Conclusion of Initiative Report

Circulation of the resources that are released or disposed into the environment widely in space and thinly in concentration is clarified as an essential pathway for realizing of Cool Earth and Clean Earth.

As specific circulation methods, there are the following two methods. One is to capture thin and widespread resources and circulate them artificially, and the other is to detoxify or decompose them to be circulated by nature.

Program for WG4 Session

Time	Title	Speaker	note
Introductory & Keynote			
9:40	Introductory	Chair Prof. Kenji YAMAJI ・Outline of the Initiative Report of WG4 ・Introduction of Program for WG4 Session	20 min.
10:00	Keynote (1)	Invited Speaker: Dr. Martin Keller	30min.
10:30	Keynote (2)	Invited Speaker: Dr. Christian Thiel	30min.
11:00	Keynote (3)	Invited Speaker: Prof. Gregory Nemet	30min.
11:30	Keynote (4)	Invited Speaker: Prof. Atsushi INABA	20 min.
11:50	Summary	Prof. Kenji YAMAJI	10 min.
12:00	Lunch		
Potential Technology Session			
13:15	Introductory (2)	Sub-Chair Prof. Atsushi INABA	5 min.
13:20	Special presentation	Dr. Lynn J. Rothschild	20 min.
13:40	Short Presentation Presentation 10 + Q&A 5	Japanese researchers 3 Prof. Fuyuhiko, INAGAKI Dr. Soichiro, KATO Prof. Kenichi, KASUYA	15 min each
14:25	Panel discussion Roadmap/Scenario Moonshot Goal	Moderator : Sub-Chair, Atsushi INABA Panelists : Invited Speakers and Speakers in the afternoon Session	60 min.
15:25	Closing	Sub-Chair Prof. Atsushi INABA（Conclusion / Summary）	5 min.

Invited Speakers and their Themes in Keynote Session

Dr. Martin Keller, Director of NREL (National Renewable Energy Laboratory)
NREL: Transforming Energy through Innovation

Dr. Christian Thiel, Head of Energy Efficiency and Renewables Unit, Joint Research Centre, European Commission
Science and Research for Climate/Energy Policies and a Circular Economy

Prof. Gregory Nemet, La Follette School of Public Affairs, University of Wisconsin-Madison
Accelerating Innovation in CO_2 Removal

Prof. Atsushi INABA, School of Advanced Engineering, Kogakuin University
How to evaluate technologies?

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