Development of Agri-Bio-Based Smart Chemical Production System (ABCS)

ABCS produces a variety of chemicals and materials from agricultural bioresources such as rice straw, rice husk, Giant Miscanthus and local agri-wastes.

Major Technical Features

Utilization and physical/chemical functionalization of all the components; cellulose, hemicellulose, lignin, silica, isoprenoids/polyphenols

Integrated processes over the range from cultivation, harvesting, storage of agri-bioresources to production of platform and high value-added chemicals/materials

Major Business Feature

Integration of supply/value chains on business level, which enables to supply, for example, glucose, at a price as low as 0.3 USD/kg.

Planned Area of First Implementation

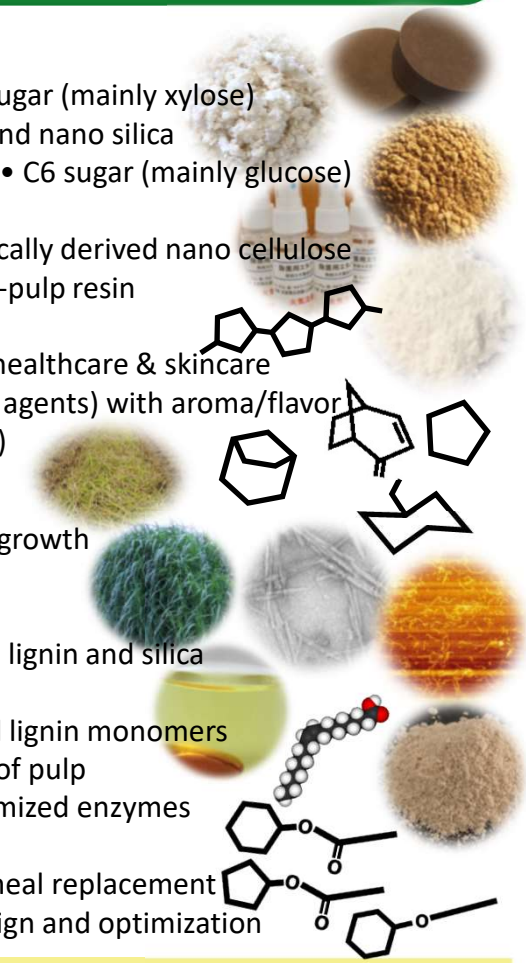
Yokote area of Akita Prefecture, Japan

Products

- Agri-pulp (high/low purities) • Xylo-oligo sugar • C5 sugar (mainly xylose)
- Silica/lignin molecular composite • High purity silica and nano silica
- High silica/carbon nano composite • lignin monomers • C6 sugar (mainly glucose)
- Levoglucosan • Levoglucosenone & derivatives
- Sugar esters and ethers (new compounds) • Enzymatically derived nano cellulose
- Cellulose nanofiber with new functional groups • Agri-pulp resin
- C18:1-rich oils • Yeast residue (fish feed/enrichment)
- Mixed isoprenoids (+ polyphenols) as multifunctional healthcare & skincare agents (bactericides anti-bacterial/-viral/-oxidant/-UV agents) with aroma/flavor (functions for healing, improvement of dementia, etc.)

Processes/systems

- New Giant Miscanthus (GM) lines with excellent early growth
- Wet storage of rice straw and GM
- Multi-stage percolation extraction with hot water
- Separation/re-integration of water-soluble oligo-sugar, lignin and silica
- Mild & wet O_2 oxidation for delignification
- Selective pyrolysis of pulp & lignin to levoglucosan and lignin monomers
- Membrane technologies for enzymatic saccharization of pulp
- Coproduction of C6 sugar and nano-cellulose by customized enzymes
- Functionalization of high-purity pulp and C6 sugar
- Oil production by yeast and its sequential use as fish meal replacement
- Web-based & Multi-agent system for supply-chain design and optimization



R/D schedule (expected **TRL** improvement)

FY2018	2019	2020	2021	2022	2023
2 ➡ 3	➡ 4	➡ 5	➡ 6	➡ 7	➡ ≥ 8
PJ start		Now, here.		PJ end	Implementation

The ABCs has been executed by **Agri-bio Chemical System Consortium** since October 2018, which consists of Kyushu University (representative), Akita Prefectural University, Kagoshima University, Kyoto University, Nagaoka University of Technology, Tohoku University, Akita Prefectural Livestock Experiment Station, Akita Research Institute for Food and Brewing, The National Agriculture and Food Research Organization, The National Institute of Advanced Industrial Science and Technology, Japan Bioindustry Association, DKS Co. Ltd., Fuji Oil Holdings Inc., Kao Corp., Mizuho Information Research Institute Inc., Shinko Sugar Co., Ltd., Toray Industries, Inc. The ABCs consortium has been in collaboration with Akita prefecture and more than 10 Japanese private organizations.

Development of Functional-Design and Production Technologies for Innovative Bio-Materials and Products

Aims and scopes

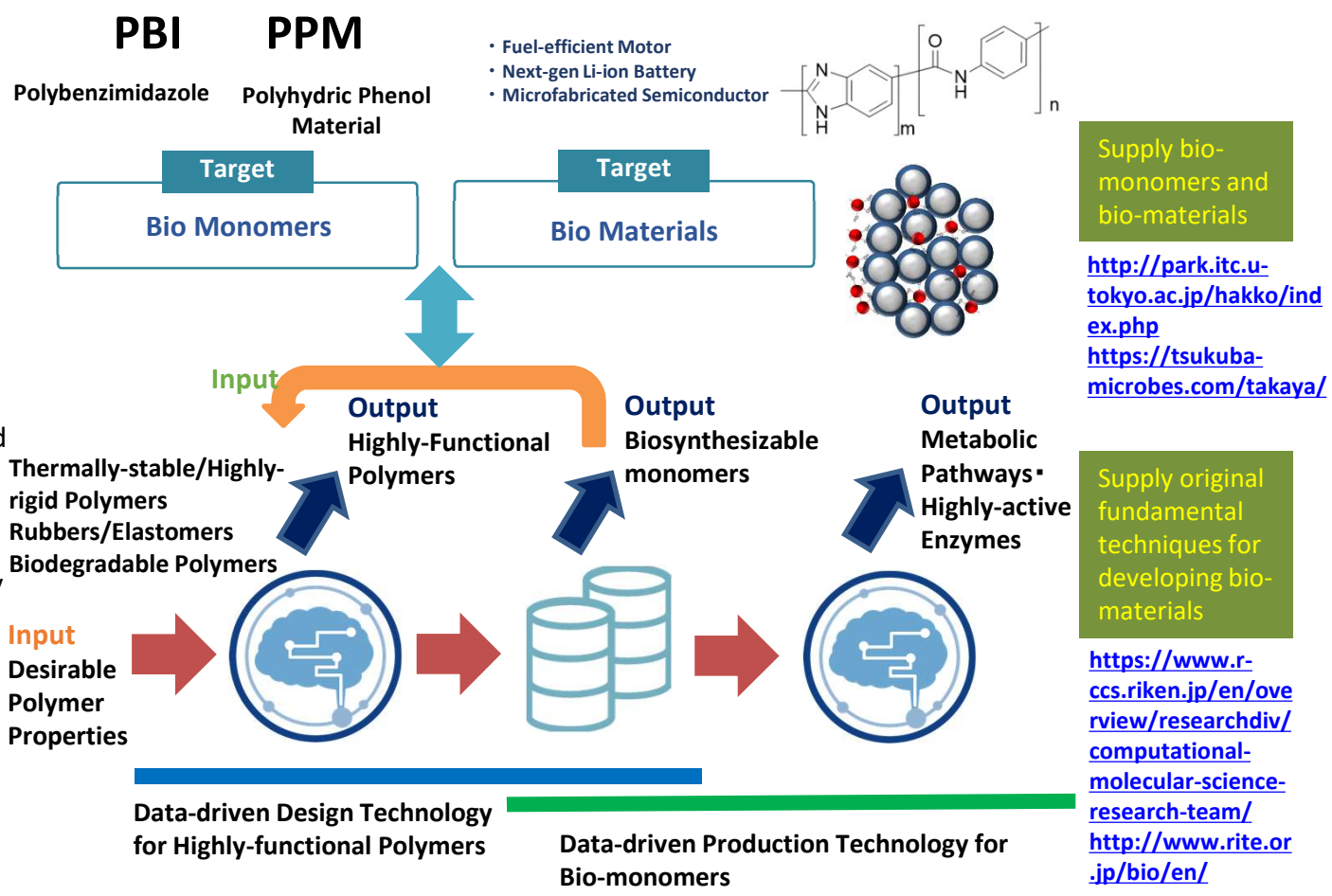
- Our goal is to provide technology to design and rationally produce high-value products using low-cost sugars obtained from non-edible parts that have been discarded as raw materials.

Major Technical Features

- Polymer design technology for such as High-performance biopolymers and eco-friendly biopolymer
- Enzyme design technology for rational and short-term improvement for monomer production efficiency by microorganisms
- Establishment of biosynthesis technology for high performance aromatic compounds and obtain of test data for target products

Major Business Feature

Realization of Sustainable chemical industry



Supply bio-monomers and bio-materials

http://park.itc.u-tokyo.ac.jp/hakko/index.php
https://tsukuba-microbes.com/takaya/

Supply original fundamental techniques for developing bio-materials

https://www.r-ccs.riken.jp/en/overview/researchdiv/computational-molecular-science-research-team/
http://www.rite.or.jp/bio/en/

R/D schedule (expected **TRL** improvement)

	FY2018	2019	2020	2021	2022	2023
Polymer design	2	3	4	5	7	≥ 8
Aromatic polymer	3	4	5	6	7	≥ 8
	PJ start		Now, here.		PJ end	Implementation

Biopolymer research Consortium since October 2018, which consists of Riken and University of Tokyo (representative), Japan Advanced Institute of Science and Technology, RITE, AIST, Synthetic Gestalt. Biopolymer research Consortium has been collaborated with many major chemical companies.

Development of an Agri-biomass-based Production System of Useful Protein and Advanced Materials using Silkworm

Silkworm can produce a variety of pharmaceutical proteins and new silk materials from agricultural bioresources such as mulberry leaves and soybean meal.

Major Technical Features

Transgenic Silkworm Expression System:
Genetically modified silkworms can stably produce pharmaceutical protein (0.1 to 20 mg) in a cocoon and new silk material. Protein extraction from cocoon is easy and the difference between lots is less. Protein with complicated structure and glycoprotein can be produced.

Silkworm-Baculovirus Expression System:
Silkworms infected with recombinant baculovirus can make useful proteins in the body fluids within a week. The expression level is 10 to 100 times higher than insect cell-culture expression system.

Major Business Feature

Some of the recombinant proteins/silks have already seen commercial use. The cost of rearing silkworm would be 0.5 to 1.0 USD/silkworm using an artificial diet.

Products

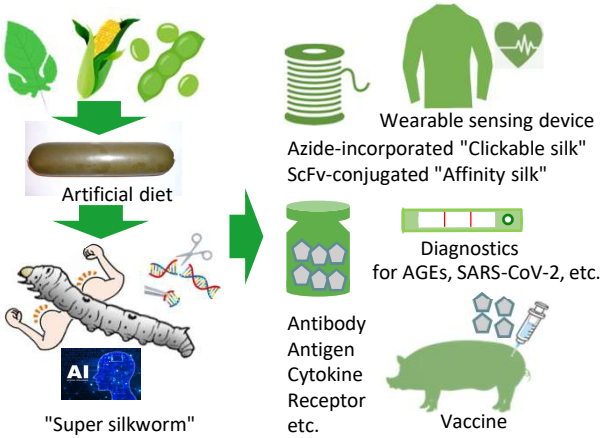
- Reagents for research use (bFGF, GM-CSF, SCF, TNF-a, Interleukin-3, VEGF, E-cadherin, etc.)
- Detection kit of AGEs (Advanced Glycation End-products) for research and diagnostic use
- Vaccine for animals (for swine, etc.)
- Antibody drug for human (Anti-HIV antibody), Antigen/Antibody for detection of SARS-CoV-2
- ScFv (Single chain antibody)-conjugated "Affinity silk" for detection of bacteria
- Azide-incorporated "Clickable silk" for chemical modification of silk and wearable sensing device

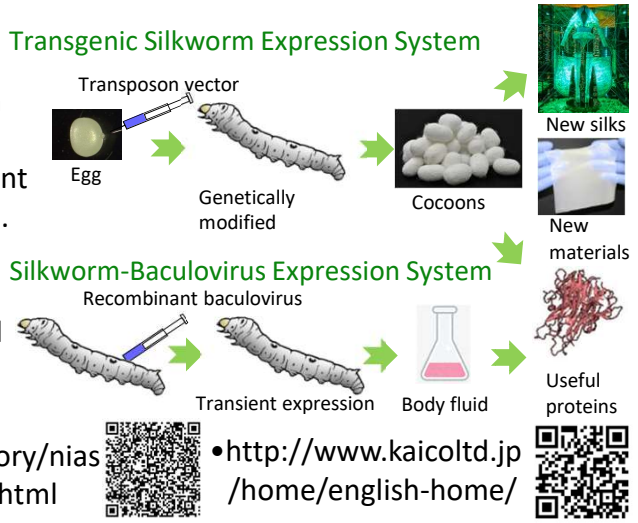
Processes

- Transgenic silkworm is obtained by injection of transposon vector. The foreign gene is integrated into the genome. The recombinant protein is easily extracted from the cocoons. Silk modification is possible, too.
- Recombinant baculovirus is inoculated and the recombinant protein is highly expressed in the body fluids after 6 days.

References

- http://www.naro.affrc.go.jp/english/laboratory/nias/research/division_of_biotechnology/index.html
- http://www.kaicoltd.jp/home/english-home/





R/D schedule (expected **Implementation**)

FY2018 **PJ start** → 2019 → 2020 → **Now** → 2021 → 2022 → **PJ end** → 2023

Reagents (2020-)
AGEs Detection kit (2020-)
Vaccine (2022-)
Affinity silk (2022-)
Wearable silk (2022-)
Antibody drug (2026-)

The project has been executed by **Insect Bioreactor Systems Consortium** since October 2018, which consists of National Agriculture and Food Research Organization (NARO, representative), Kyushu Univ., Kumamoto Univ., Kagoshima Univ., Ryukyu Univ., Tokyo City Univ., Immuno-Biological Laboratories Co., Ltd., Kyorin Co., Ltd., Nippon Bio-test Laboratories Inc., AI Silk Corporation, Atsumaru Holdings Co., Ltd., Nippon Institute for Biological Science, Nippon Zenyaku Kogyo Co., Ltd., and KAICO Ltd. The consortium has been collaborated with more than four Japanese private companies.

Development of Novel Technology for Bioprocess Optimization in Smart Bio-Industry

Aims and scopes

A large amount of organic waste and wastewater is generated from the production, processing, distribution, transportation, and consumption processes in food/beverage supply chain. Since the cost of waste/wastewater treatment is enormous, it is necessary to develop the novel technologies to minimize the negative environmental and economic impacts for upcoming circular bioeconomy-based society.

Major Technical Features

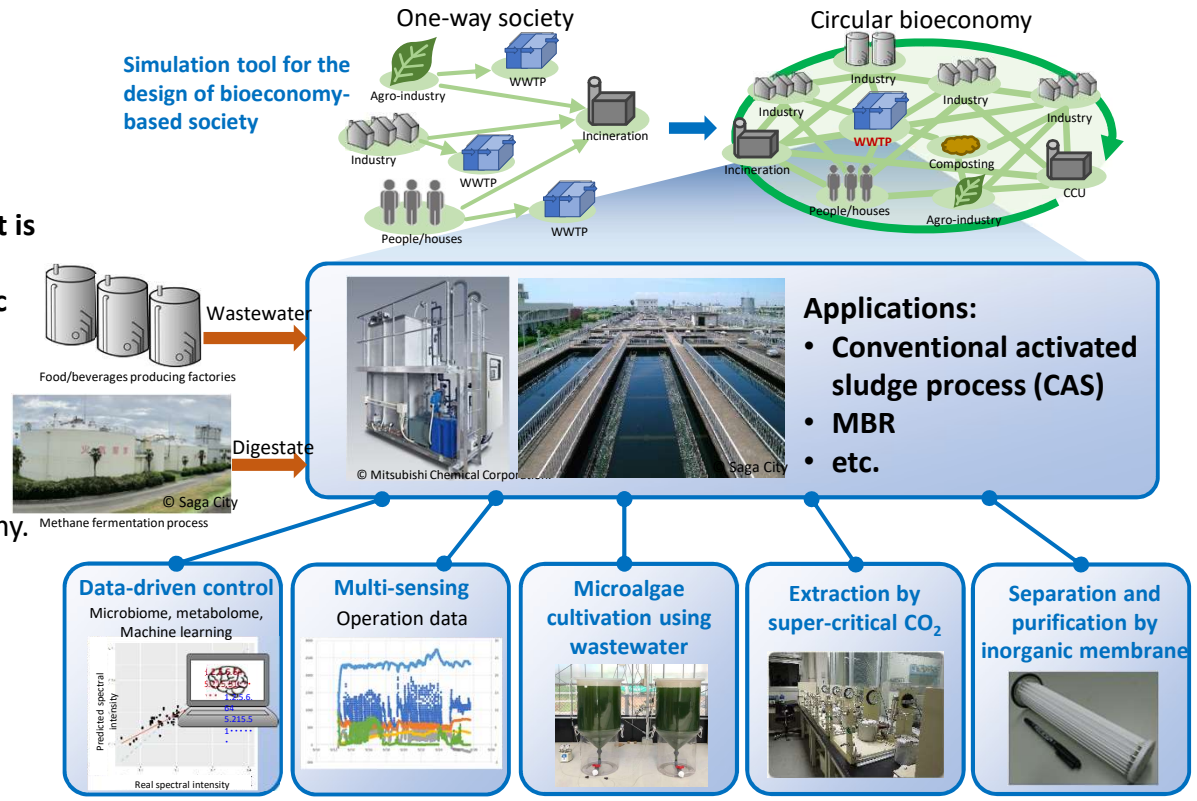
- Data-driven control for wastewater treatment.
- Simulation tool for the design of circular bioeconomy.
- Microalgae cultivation using wastewater.
- Extration by super-critical CO_2.
- Separation/purification by inorganic membranes.

Major Business Feature

Business via service provider to costmers, e.g., foor and beverage industries operate CAS to treat wastewater and new entrants to bioeconomy-related industries.

Planned Area of First Implementation

Saga City and Nagaoka City, Japan



We will implement the sophistication of wastewater treatment processes to optimize the regional circular economy from both simulation and technological development. Each technologies (e.g., advanced MBR, data-driven control, multi-sensing, algae cultivation, etc.) will be commercialized and installed based on individual situations.

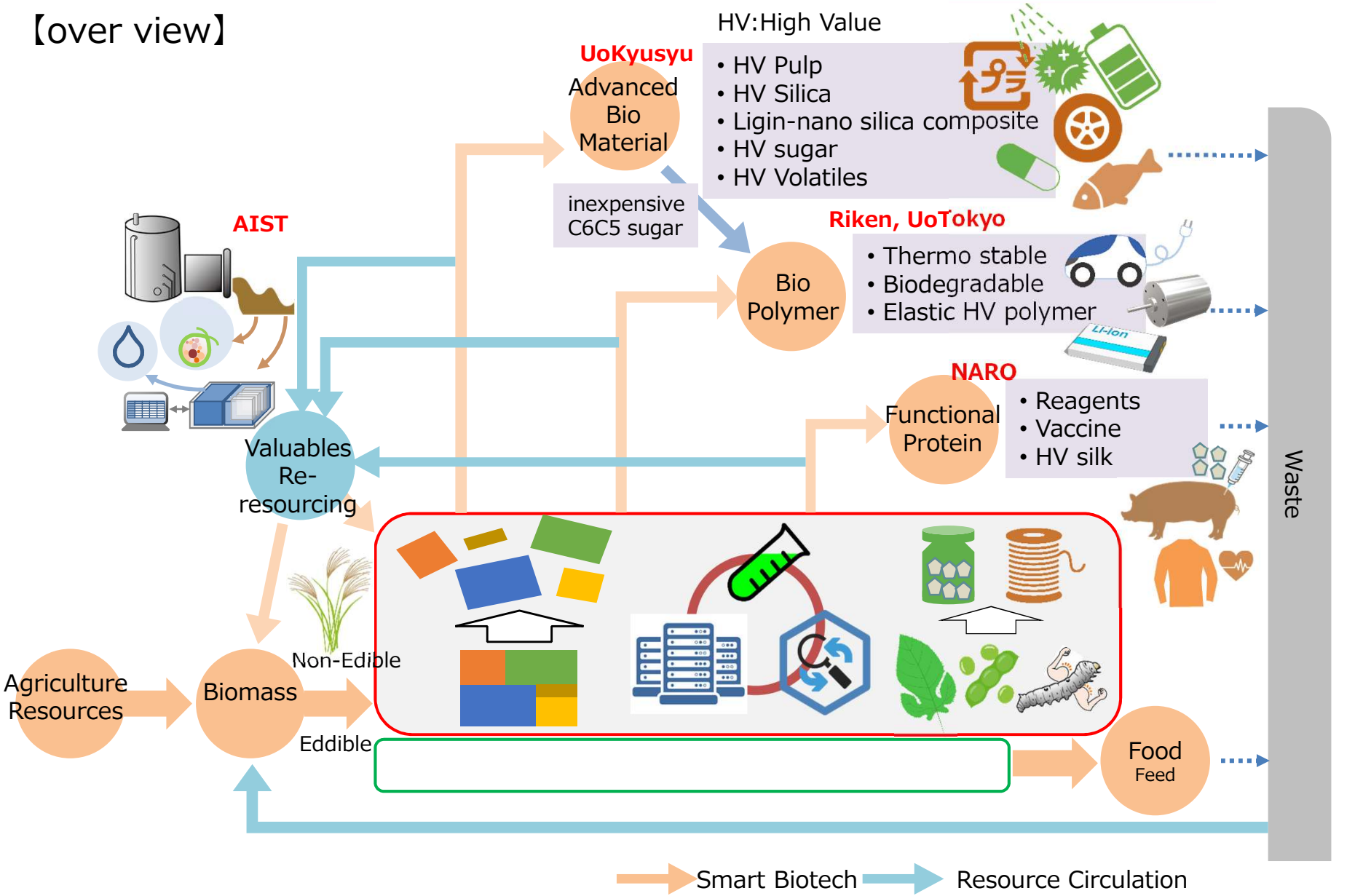
R/D schedule (expected **TRL** improvement)

FY2018	2019	2020	2021	2022	2023
2 → 3 →	4 →	5 →	6 →	7 →	≥ 8
PJ start		Now, here.		PJ end	Implementation

Smart-Bioprocess Consortium since October 2018, which consists of National Institute of Advanced Industrial Science and Technology, AIST (representative), RIKEN, Saga University, Nagaoka University of Technology, Saga City, Nagaoka City, Mitsubishi Chemical Corp., Chitose Laboratory Corp., Ajinomoto Co., Inc.. The Smart-Bioprocess Consortium has been collaborated with 3 public organizations and 8 private companies.

Food and Environmental Sustainability [Resource Circulation]

【over view】



Reference https://www.bioeconomy.fi/bioeconomy-more-than-circular-economy/