Bioeconomy Vision of Japan for 2030
Bioindustry’s Social Contribution to Enhance Adaptation to Changing World
- Creation of new key industry and provide solutions on global issues-

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Japan Association of Bioindustries Executives

Recent progress of genome editing and synthetic biology is so remarkable and expected to impact relevant industries with incomparable rate. At the same time, biotechnology is expected to contribute to social issues of population, food and water supply, climate change, environmental problems or pandemics expected in our society. In Europe or USA, biotechnology to contribute to society is viewed as “Bioeconomy” activity and policies are made, discussed and taken in to actions. In this report, we would like to forecast 2030’s industrial vision of biotechnology originating Japan contributing global issues with development of our economy. We would like to propose this as the national vision and strategy in relation to government, academia and industry’s respective measures and cooperation.
**Global level issues, National policies**

### Global issue and international agreement

**Global level problem:** 2050; 10 bil. Food water shortage

**2030 Agenda** (SDGs)
- Food: 4 bil., Water: 4 bil.

**“Paris Agreement”**
- GHG emission reduction
- 26.0% (vs 2013)

**International Agreements**
- Japan’s target for 2030: GHG emission reduction
- 26.0% (vs 2013)

**Debate Agenda**
- Latter stage elderly: 20 mil.
- Care cost: Y 20 tril.
- Av. Age: 2 years longer, Health expectancy?
- Drug/Med. Equip import exceed import?
- National Health Service System collapse?
- Employ novel tech.: genome editing etc.
- Switch from fossil to renewable resource
- Stable access to biological resource
- Contribution to 2030 Agenda
- Accomplish “Paris agreement”

### Biotech initiatives in respective nations

**The Bioeconomy to 2030** (2009, OECD) triggered emergence of “Bioeconomy” as national policies in Europe or US to enhance biotechnology for industrial promotion and problem solving.

**USA:** National Bioeconomy Blueprint (2012);
- From White House including medical application
- Utilize one billion dry ton of biomass

**EU:** Innovation for Sustainable Growth: A Bioeconomy for Europe (2012)
- Invest €79 bil over 7 yrs.

**Budget allocation at HORIZON2020**
- Aiming to lead the world and conducted
- 1st Global Bioeconomy Summit (2015)
  (German Bioeconomy Council)

### Rapid technological advancement in biotech

**Genome editing**
- Quantum leap development and IP on CRISPER-Casp and related technologies.
- DNA sequence
- CRISPR-Cas9

**Genome selection**
- DNA sequence difference (SNP) can have strong correlation to certain gene function.
- Selection is enabled by using the SNP difference on certain unknown gene with next generation sequencer.
- Economic animal or plant breeding is envisaged by Univ. of Tokyo, Livestock Improvement Assoc. and NARO.

**Synthetic Biology**
- US/UK treat in national policy
- UK: Created National strategy to 2030 Roadmap in 2012. Target area, technology element, industry and academia involvement are noted.
- Most recent plan indicates 2016 to be the year to industrialize the technology.

**Chemical Biology**
- Gene inactivation
- Gene activation
- Antagonist
- Agonist
- Approach by small molecule

**Health/Manufacturing**
- Latter stage elderly: 20 mil.
- Care cost: Y 20 tril.
- Av. Age: 2 years longer, Health expectancy?
- Drug/Med. Equip import exceed import?
- National Health Service System collapse?

**Environment/Energy**
- Switch from fossil to renewable resource
- Stable access to biological resource
- Contribution to 2030 Agenda
- Accomplish “Paris agreement”

**Foodstuff**
- Agri/fish industry worker below 65 yrs: 300 k.
- Global warming become evident worldwide
- Decline of agri/ fish productivity
- FTA (EPA) activate, middle class affected
- Gov. subsidy cont. Low food self-sufficiency
(Proposal) A long term vision be shared by industry, academia and government

**Bioindustry’s social contribution in 2030**

40 trillion yen impact by industrial growth with global issue solution

**Economical benefit:** Market size: 40 trillion yen, GDP: 20 trillion yen, Employment 80 million jobs

- **Health • medicine**
  - Better medicine • Healthcare
  - Domestic problem solving
  - Convert problems to opportunities
    - Ex: Aged society, Manufacturing, Agriculture

- **Manufacturing • Environment • Energy**
  - Maximal sustainable manufacturing, energy and better environment
  - New key industry creation
  - Affects multiple area of industry with great speed and impact

- **Agriculture/Fishery • Foodstuff**
  - Optimal efficient farming • health benefitting food
  - Provide global solution

**Traditional biotechnology industry**
- Health • Medicine/Manufacturing/Agriculture • Fishery • Food

**Genome editing, Synthetic biology, Big data**
- Life Science
  - Physiology • Brain Science
  - Bioinformatics
  - Omics (genomics)
  - Biology (animal, plant, microbe)
  - Genetic resource
- Biotechnology
  - Gene technology
  - Protein engineering
  - Bioprocess technology
  - Environment technology
  - Bio mimetics

**Fusion with others**
- Nanotechnology (material • chemical engineering)
- IOT
- Robot (Machinery)
- Technology
- Outer space • Marine
Social Contribution Vision in 2030: Health & Medical

Healthy longevity achievement by destructive innovation

• Together with latest biotech, fusion of ICT/IoT, nanotech, robot engineering create a mainstream health industry to enable healthy longevity society inclusive of elderly and handicapped.
• Become a nation that can provide worldwide solution in health and medical field

Innovation promotion

• Destructive innovation created by original and versatile R&D carried out by industry, academia and government
  Drugs (Innovative novel drug target, biomarker led drug discovery), Medical device (persuasion of Japan Biodesign), Novel therapeutic methods (regenerative medicine, gene therapy)
  • Prevention/nursing care development/integration ICT/IoT (Society5.0), Diagnosis technology, healthcare, nursing devices, functional foods, healthcare and nursing care services.

Japan style innovation ecosystem

System development for industrialization of research outcomes
• Academia: MD initiated drug studies, TLO reformation, venture education support
• Industry: Link with academia or venture, B to B connections
• Private support organization: Education tool supply, mentor system, alliance with industry
• Public support organization: Mutual support collaboration, private capital development
• Government: Fund allocation or tax exemption to start ups
⇒ Industry and ventures to promote innovation and new business

Possible problems in 2030

• Latter Stg elderly: 20 mil. Care cost: Y 20 tril.
• Av. life: 2 years longer, Health expectancy?
• Drug/Med. Equip import exceed export?
• National Health Service System collapse?

2030 Agenda Contribution

Health, medical strategic headquarters “peace and decision of the basic policy for health” (2015 Dec)
Universal Health Coverage promotion
Shift to sustainable manufacturing and new industry generation

Innovation promotion

“Sustainable manufacturing” shift with “New industry generation” by cooperation of industry, academia and government

【Important Technology】Share a long term national strategy and make progress
①Ecosystem improvement for the industry ②Originally developed methods ③Integration with manufacturing technology (such as smart cell industry)
※Genome editing, synthetic biology’s industrial usage may have IP burdens

【Unique technology development】Crosslink traditional field and emerging area
①Microbe mining and selection ②Plant, insect application for innovative manufacturing (grafting, silkworm) ③Cascade biomass utilization ④Integration with nano technology (feedstock, energy, environment application)

Possible problems in 2030

• Innovative technology development delay
• Shift of fossil to regenerative resource stagnate
• CBD to prohibit biomass stable access
⇒ Overseas products may have advantage?

Innovation support style

• Share and cooperate the vision by stakeholders
  【Technology development program】
  1. Create new genome technology
  2. GHG reduction technology
  3. Biomass conversion technology
  【Ecosystem establishment】
  Establish unique manufacturing system
  【Genetic resource security】
  Safe and sound use of imported gene resource

2030 Agenda Contribution

Japan’s target for 2030: GHG emission reduction -26.0% (vs 2013)
Social Contribution Vision in 2030: Agriculture, Fishery, Foodstuff

Key
Industrial farm involvement and food export promotion

- Industrial farm involvement to create series of new business and employment
- Agricultural reformation contributes to working population decrease, global warming and food supply
- Branded foodstuff export increase with international recognition of taste and soundness

Innovation promotion

With the aid of government action, develop new key industry in the area of agriculture and fishery and promote foodstuff export

【Technology development to increase competitiveness】
Point of focus ① Overcome the workforce decrease and global warming ② Yield and quality improvement ③ Brand establishment by health function, quality and traceability ④ Align with IOT
Development items ① Agriculture: New breeding technology and cultivation methodology ② Forestry: Handling technology and new biomass production ③ Fishery: Fish farm expansion by fish variety, productivity and quantity

【Technology element for brand value increase】
Element: Safety and soundness assurance, taste profile evaluation, processing and shipment technology

Possible problems in 2030
- Workforce below 65 yrs: 300 thousand
- Global worming become evident worldwide
- Decline of agrigram productivity
- FTA (EPA) activate, middle class affected
- Gov. subsidy cont. Low food self-sufficiency

2030 Agenda Contribution

Regional revitalization
TPP

Innovation support style

【Ecosystem establishment for industry farm involvement】
Establish systems in agriculture, forestry, fishery area and develop regional foodstuff with traditional technology improvement

【Communication promotion】
Science communication of biotechnology application in agriculture, forestry, fishery and foodstuff
(Only biotechnology can solve food needs)
## Key Technology Development for Bioindustry Promotion

**Needs industry, academia government collaboration**

### Science and Technology Basic Plan, Total Strategy for Science Technology and Innovation

<table>
<thead>
<tr>
<th>Health • Medical Strategy</th>
<th>Aggressive actions in agriculture, forestry, fishery</th>
</tr>
</thead>
</table>

### Action towards key technology

- **Key technology needs to have nationalistic strategy**
- **Common technology to catch up**
- **Collective action to pursue**

#### Genome editing • synthetic biology

**Society 5.0 (super smart society)**

#### Key technology in respective field

<table>
<thead>
<tr>
<th>Health • medical strategy</th>
<th>Manufacturing strategy</th>
<th>Agri/forest/fish foods strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genome, IT application, personalized treatment, regenerative medicine, device</td>
<td>Breeding, selection, modification for variety of production (smart cells, plants, insects)</td>
<td>New breed production, health benefit, processing, preservation, taste, safety technologies</td>
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### Technological area expected to link and develop with biotechnology

<table>
<thead>
<tr>
<th>Genome editing • synthetic biology</th>
<th>Chemical, material, analytical science</th>
<th>Nanotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid progress with monopoly cause big impact to entire biotechnology</td>
<td>Chemical biology: Regeneration • plant differentiation</td>
<td>Molecular imaging: Diagnosis, analysis</td>
</tr>
<tr>
<td>Big data • IOT: System establishment needed</td>
<td>Integrated information of organic material research: Manufacturing</td>
<td>DDS: Medical, Soil control</td>
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<tr>
<td>Health data, genome of all source, IOT infrastructure</td>
<td>New principle • Accurate analysis: All bio field</td>
<td>3D Cell structuring: Medical, manufacturing</td>
</tr>
<tr>
<td>Biology • Biomass utilization</td>
<td>Robotics • control engineering</td>
<td>Nano device, nano machine: Medical</td>
</tr>
<tr>
<td>Differentiation induction: Regeneration • plant multiplication</td>
<td>Bio ⇒ Robot: Sensor, actuator technology</td>
<td>Outer space • deep sea</td>
</tr>
<tr>
<td>Microbiome: Drug • food</td>
<td>Robot ⇒ Bio: Heavy workload reduction, nano machine</td>
<td>Foodstuff, oxygen supplying plant</td>
</tr>
<tr>
<td>Brain science: Link with robot, medicine, manufacturing</td>
<td>Omics</td>
<td>Posthuman (h+)</td>
</tr>
<tr>
<td>Plant technology: Biomass, agriculture</td>
<td>Medical: Epidemiological genetic analysis</td>
<td>Need to discuss its objective of being in several level</td>
</tr>
<tr>
<td></td>
<td>Manufacturing: Resource value and productivity increase</td>
<td></td>
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</tbody>
</table>

- **Nanotechnology**
  - Molecular imaging: Diagnosis, analysis
  - DDS: Medical, Soil control
  - 3D Cell structuring: Medical, manufacturing
  - Nano device, nano machine: Medical

- **Outer space • deep sea**
  - Foodstuff, oxygen supplying plant

- **Posthuman (h+)**
  - Need to discuss its objective of being in several level
Actions Needed for Bioindustry Promotion

Common understanding of the vision and ecosystem installment

Key National Vision Sharing on Biotech

- Innovation by biotechnology to generate new business and provide global scale solution. Such vision to be made and shared among stakeholders

  【The vision characteristics】
  - Long term (aim 2030) to have social contribution
    (Applicable area is broad hence divide in to 3 sections
    1. Health/Medical, 2. Manufacturing, environment or energy with biotech 3. Agriculture, forestry, fishery and foodstuff.
  - Actions, roles to be specified to achieve the vision
    (Below to specify the roles of industry, academia, government)
    1. Action towards key technology, 2. Innovation ecosystem establishment, 3. Action towards international trend, 4. Human resourcing and scientific communication
  ※ Several industrialized nations have their national bioeconomy, biotechnology initiatives and perusing.

Key Innovation ecosystem establishment

- Ecosystem of innovation by industry, academia and government

  【Government role】
  - Key industry technology development
  - Legislation reform
  - Encourage ecosystem to function

  【Regional governing body’s role】
  - Regional cluster formation and support

  【R&D Corporation • Administrative Institution • Public Labs role】
  - Provide support to bioventure or industry research with other organization

  【Academia role】
  - Link research at project start and completion to industry. Educate and provide human resource

  【Industry role】
  - Fortify mid-long term R&D

  【Financial institution, investor role】
  - Active investment to bioventures

Timely action for international trend change

≪ Trend grasp and opinion dispatch ≫
① International agreement/standardization on biodiversity and bioeconomy
② Retain fair environment in R&D and business conduct by grasping technological trends in genome editing and synthetic biology.

≪ International pledge and new market ≫
Participate in 2030 and contribute to reduce GHG and partnering with Asian nations

Human resource and communication promotion

≪ Human resource≫ Generate talents with future views
① Multiple interest such as biotech and information
② Entrepreneurship, willing to take risk
③ Expand the width of biobusiness

≪ Communication≫ Justify the role of biotechnology in the society for overcoming of global issues and promotion of industry by appropriate communication conduct to media and public