Highlights of the Comprehensive Review of Japan’s Science and Technology Basic Plans

NISTEP International Workshop on Comprehensive Review of Japan’s Science and Technology Basic Plans
Tokyo, Japan
September 13 - 14, 2004

Masayuki KONDO
National Institute of Science and Technology Policy (NISTEP)/Yokohama National University
Outline of Presentation

Knowledge Creation

- Input
  - S&T Budget: Total Budget, Basic Research Budget, Competitive Research Funds, and Budgets for Priority Areas
  - Facilities and Intellectual Infrastructure
  - S&T Human Resources
    - Post-doctorate Researchers and Researcher Mobility
- Output
  - Research Papers
  - Patents

Knowledge Utilization

- University-Industry Collaboration
- Regional Innovation
- S&T Impacts on Economy, Society and People’s Life
Total S&T Budget

Trends in S&T Budget

Pre-First-Plan Period (FY1991-FY1995) 12.6 trillion yen (2.5 trillion yen/yr.)
First-Plan Period (FY1996-FY2000) 17.6 trillion yen (3.5 trillion yen/yr.)
Second-Plan Period (FY2001-FY2004) 15.1 trillion yen (3.8 trillion yen/yr.)


M.KONDO, NISTEP
### Growth of S&T Budget

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;T Budget</td>
<td>5.4%</td>
<td>5.6%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Government budget (general expenditure)</td>
<td>3.6%</td>
<td>2.7%</td>
<td>-0.3%</td>
</tr>
<tr>
<td>GDP nominal value (real value)</td>
<td>2.1% (1.4%)</td>
<td>0.5% (1.4%)</td>
<td>-1.5% (0.0%)</td>
</tr>
</tbody>
</table>

*: The change in the GDP deflator between 1991-2001 was 5.8 points.  

### Share of Supplementary Budget

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of supplementary budget in S&amp;T budget</td>
<td>10.7%</td>
<td>13.4%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Share of supplementary budget in general account expenditure (additional funding)*</td>
<td>11.7%</td>
<td>13.2%</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

*: Obtained by dividing the additional funding of supplementary budget in general account expenditure by the value of (initial budget in general account expenditure + supplementary budget in general account expenditure)  

M.KONDO, NISTEP
Comparison of S&T Budgets among Japan, U.S. and EU

International Comparison (Japan = 100)

<table>
<thead>
<tr>
<th>All S&amp;T Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>U.S.</td>
</tr>
<tr>
<td>EU</td>
</tr>
</tbody>
</table>

*1: All calculations were based on the initial budget.
*2: EU consists of 15 member countries as of March, 2004. The budgets for U.S. and EU were converted into Japanese yen using Purchasing Power Parity (PPP).

Source: Calculated using the data from OECD“ Main Science and Technology Indicators 2003-2”
Industry R&D funded by Government

Pre-First Plan Period  First Plan Period  Second Plan Period

Year

Ratio of Industry R&D expenditures funded by government

U.S.  France  U.K.  Germany  Japan

Source: (Japan) MPHPT, “Report on the Survey of Research and Development”
(U.S.) NSF, “National Patterns of R&D Resources 2002 Data Update”
(Germany, France & U.K.) OECD, “Basic Science and Technology Statistics 2002/2”
For the UK data in 2001, ONS, “Gross domestic expenditure on Research and Development 2001”
Basic Research Budget

S&T Budget by Type of R&D

S&T budget by type of R&D

Pre-First Plan Period

- FY1991
- FY1992
- FY1993
- FY1994
- FY1995
- FY1996

First Plan Period

- FY1997
- FY1998
- FY1999
- FY2000

Second Plan Period

- FY2001
- FY2002
- FY2003

Basic research ratio

- Pre-First Plan Period: 6.1 Trillion Yen, 33.8%
- First Plan Period: 8.8 Trillion Yen, 37.1%
- Second Plan Period: 5.8 Trillion Yen, 38.2%

R&D expenditures

*1: Calculation methods differ for the years before and after FY2001.
*2: Of the S&T budget, R&D expenditures were classified into basic research, applied research, development research, feasibility study and testing, and unclassifiable.
*3: R&D expenditures for national and Special Public Institutions’ research institutes were calculated based on the type of R&D ratios in the “Report on the Survey of Research and Development” by Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT). R&D expenditures after FY2001 were categorized by type of R&D, using MEXT’s S&T budget database.
*4: R&D expenditures of national, public, and private universities in the S&T budget were multiplied by type of R&D ratios by sector in MPHPT, “Report on the Survey of Research and Development”.
*5: R&D expenditures for Departments of Ministries and Agencies, operating bodies of Special Public Institutions, Special Public Institutions, and others were categorized for each project based on the type of R&D classifications used in the MEXT’s S&T budget database.
*6: R&D expenditures for Departments of Ministries and Agencies, operating bodies of Special Public Institutions, and Special Public Institutions, and others were categorized for each project based on the type of R&D classifications used in the MEXT’s S&T budget database.
*7: R&D expenditures for national, public, and private universities in the S&T budget were multiplied by type of R&D ratios by sector in MPHPT, “Report on the Survey of Research and Development”.
*8: R&D expenditures for Departments of Ministries and Agencies, operating bodies of Special Public Institutions, Special Public Institutions, and others were categorized for each project based on the type of R&D classifications used in the MEXT’s S&T budget database.

Basic research ratios by sector

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan Universities</td>
<td>54.5</td>
<td>54.7</td>
<td>53.5</td>
<td>54.0</td>
</tr>
<tr>
<td>U.S. Universities</td>
<td>63.3</td>
<td>64.1</td>
<td>70.5</td>
<td></td>
</tr>
<tr>
<td>Japan Government</td>
<td>41.3</td>
<td></td>
<td>49.6</td>
<td></td>
</tr>
<tr>
<td>U.S. Government</td>
<td></td>
<td>41.3</td>
<td>46.8</td>
<td>49.6</td>
</tr>
<tr>
<td>Japan Industry</td>
<td>15.6</td>
<td>16.2</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>U.S. Industry</td>
<td>6.7</td>
<td>5.7</td>
<td>9.8</td>
<td></td>
</tr>
</tbody>
</table>

MEXT S&T Policy Bureau, “Indicators of Science and Technology” (2002)
NISTEP, “Science and Technology Indicators” (2004)
Competitive Research Funds

Trends in Competitive Research Funds

Increases in budget for competitive research funds

Pre-First Plan Period  First Plan Period  Second Plan Period


M.KONDO, NISTEP
Competitive Research Funds and Fundamental Research Funds at National Universities

*FY 2003 Data is preliminary

*: “Appropriation for basic cost of education and research” in this figure only contains the portion registered in the S&T budget under the National School Special Account.
“Competitive research funds” represent the funds allocated to national universities under various project names.
Source: Calculated by Mitsubishi Research Institute, Inc, based on data and information provided by MEXT and other government bodies
R&D Budget Ratios by Priority Areas (Life Science, ICT, Environment Science, and Nanotech & Material S&T)

Prioritization

Pre-First Plan Period

First Plan Period

Second Plan Period

Ratios of the four areas

<table>
<thead>
<tr>
<th>Period</th>
<th>Budget</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-First Plan Period</td>
<td>6.1 Trillion Yen</td>
<td>29.1%</td>
</tr>
<tr>
<td>(FY1991–FY1995)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Plan Period</td>
<td>8.8 Trillion Yen</td>
<td>37.6%</td>
</tr>
<tr>
<td>(FY1996–FY2000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second Plan Period</td>
<td>5.8 Trillion Yen</td>
<td>41.9%</td>
</tr>
<tr>
<td>(FY2001–FY2003)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: Data collection standards differ between before and after FY 2001.
*2: Data include initial and supplementary budgets, other than FY 2003 in which only the initial budget was included.
Source: Calculated by NISTEP and Mitsubishi Research Institute, Inc, using the MEXT “Budget for Science and Technology in FY 2003” and its annual issues, “Nationwide List of Research Institutes in Japan,” and data and information provided by the MEXT and other government bodies.
Facilities

Floor space of national universities by the number of years since construction

- 40 years or older
- 25-39 years
- 10-24 years
- 5-9 years
- Under 4 years

Ratios of floor space newer than 10 years old

Research cooperators council on future development of facilities at national universities, “Knowledge base – the management and operation outlines on the improvement of facilities at national universities,” July 2003

M.KONDO, NISTEP
## Intellectual Infrastructure

### Research materials

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microorganisms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(num. of stains)</td>
<td>Approx. 200,000</td>
<td>Approx. 250,000</td>
<td>Approx. 290,000</td>
<td>Approx. 600,000</td>
</tr>
<tr>
<td><strong>Animal cells</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(num of strains)</td>
<td>Approx. 4,000</td>
<td>Approx. 8,000</td>
<td>Approx. 20,000</td>
<td>Approx. 30,000</td>
</tr>
<tr>
<td><strong>Animals (Mice, num of strains)</strong></td>
<td>Approx.1,700</td>
<td>Approx.2,200</td>
<td>Approx.2,600</td>
<td>Approx.4,000 (Mouse embryos approx. 240,000)</td>
</tr>
<tr>
<td></td>
<td>(Mouse embryos approx. 60,000)</td>
<td>(Mouse embryos approx. 65,000)</td>
<td>(Mouse embryos approx. 265,000)</td>
<td></td>
</tr>
<tr>
<td><strong>Plant genetic resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Core genetic resource - Arabidopsis thaliana</td>
<td>Approx. 220,000</td>
<td>Approx. 340,000</td>
<td>Approx. 340,000</td>
<td>Approx. 600,000</td>
</tr>
<tr>
<td></td>
<td>Approx. 46,000</td>
<td>Approx. 72,000</td>
<td>Approx. 74,000</td>
<td>Approx. 90,000</td>
</tr>
</tbody>
</table>
### Measurement Standards

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference materials</td>
<td>76 species</td>
<td>119 species</td>
<td>150 species</td>
<td>Approx. 250 species</td>
</tr>
<tr>
<td>Measurement standards</td>
<td>82 species</td>
<td>136 species</td>
<td>152 species</td>
<td>Approx. 250 species</td>
</tr>
</tbody>
</table>

### Databases

#### (1) Corresponding database for creatures and organisms

<table>
<thead>
<tr>
<th>DNA sequence database (the number of annual entries of base sequences at the DNA Data Bank of Japan).</th>
<th>600Mbps</th>
<th>940Mbps (2001.10 - 2002.9)</th>
<th>1020Mbps (2002.10 - 2003.9)</th>
<th>6,000Mbps</th>
</tr>
</thead>
</table>

#### (2) Corresponding databases for materials and substances

<table>
<thead>
<tr>
<th>Material properties database</th>
<th>Approx. 600,000</th>
<th>Approx. 800,000</th>
<th>Approx. 980,000</th>
<th>Approx. 1,800,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical safety database</td>
<td>Approx. 2,000</td>
<td>Approx. 2,900</td>
<td>Approx. 3,000</td>
<td>Approx. 4,500</td>
</tr>
</tbody>
</table>

*: The data from the intellectual infrastructure plan was used for the year of 2001. Questionnaire data was used for 2003.

Source: Handout distributed at the 5th meeting (February 20, 2004) of the Intellectual Infrastructure Committee, Technology and Research Foundations Section, Council for S&T, MEXT

M.KONDO, NISTEP
 Supports for Post-Doctorates

Number of supported post-doctorates in Japan

(U.S. post-doctorates in natural sciences

Source: NSF, “Survey of Graduate Students and Postdoctorates in Science and Engineering”

*: As for 2003, the number of post-doctorates in social science and humanities employed between 2001 and 2003 was deducted from the total number of the number of post-doctorates in FY2003.

Source: MEXT S&T Policy Bureau’s budget data

M.KONDO, NISTEP
Types of Supports for Post-doctorates

Japanese (2003) *

- 37.4% Fellowships
- 18.4% Employment at Special Public Institution
- 7.0% Employment at National University
- 54.8% Program-based employment

U.S. (2001)

- 31.2% Federal government fellowships
- 8.3% Federal government traineeships
- 37.2% Research subsidies
- 5.7% Non-federal government including foundations

Source: MEXT S&T Policy Bureau, “Budget for Science and Technology in FY 2003”

Source: NSF “Survey of Graduate Students and Postdoctorates in Science and Engineering”

* : The coverage is 10,000 Post-Doctorates Program, other than Course Doctor Support Program, Program for Sending Researchers Overseas, and Foreign Researchers Invitation Program
Hiring Post-Doctorates and Doctorate Students by Private Companies in Japan

Companies’ intention to hire doctorate students and post-doctorates between 2000 and 2002

<table>
<thead>
<tr>
<th>Year</th>
<th>Doctorate Students</th>
<th>Post-doctorates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>4.6% 6.6% 29.0% 18.1% 44.8%</td>
<td>9.5% 12.9% 75.7%</td>
</tr>
<tr>
<td>2001</td>
<td>5.1% 4.3% 26.1% 21.6% 41.0%</td>
<td>12.1% 18.9% 66.8%</td>
</tr>
<tr>
<td>2002</td>
<td>3.7% 6.2% 31.0% 21.2% 37.8%</td>
<td>15.6% 19.3% 63.3%</td>
</tr>
</tbody>
</table>


M.KONDO, NISTEP
Introduction of Fixed-term Employment System

Ratios of fixed-term employment system introduction

Ratios of fixed-term researchers

Source: The materials from the Subdivision on Universities of the Central Council for Education

M.KONDO, NISTEP
Researchers’ Mobility

Number of institutes experienced by a researcher in Japan

Number of moves expected on university professors (times)

*Estimated values based on professor’s age and the number of his/her move by that age. 30-year of service duration was applied to the estimation process.

Shares of Research Papers and their Citations among Japan, U.S. and EU

Magnified Japan's Performance

*: A share in each year shows the total number of papers, published and being cited in the same five-year period. Data collected between 1981 and 1985 are marked as "1983" in Magnified data for Japan, above.

Data: ISI, "National Science Indicators 1981-2002"
Citations of Japanese Research Papers

Trends in Japanese shares in highly cited research papers

Japanese research paper distribution by citation frequency

Share of papers (with no less than one affiliation in Japan)

Top 25% of the most frequently cited papers
Top 10% of the most frequently cited papers
Top 1% of the most frequently cited papers

Share of papers (with no less than one affiliation in Japan)

*: The data of “Citation frequency rank” is the data of papers in the SCI categorized into top 1%, 10%,..., based on citation frequency. Japan’s paper shares are the share of Japanese papers categorized in the citation ranks.

Data: Collected by NISTEP based on the CD-ROM version of SCI

M.KONDO, NISTEP
Trends in Patent Applications in the World

Number of patent applications

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan</th>
<th>U.S.</th>
<th>Germany</th>
<th>U.K.</th>
<th>France</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data: WIPO

Note: The decline in Japan’s patents applications share is mainly because the ratio of the patent applications to the Japan’s Patent Office has decreased from 23.3% in 1991 to 5.1% in 2000.

M.KONDO, NISTEP

Research Papers and Patents by Priority Areas

Shares of Japan’s research papers

Shares of Japan’s U.S. patents

Data:
(Paper) ISI, “National Science Indicators 1981-2002”

M.KONDO, NISTEP
Number of Joint Research Centers at National Universities

Number of center for joint research

Cumulative total of centers

<table>
<thead>
<tr>
<th>Year</th>
<th>Pre-First Plan Period</th>
<th>First Plan Period</th>
<th>Second Plan Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 1987</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1988</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1989</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1990</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1991</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1992</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1993</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1994</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1995</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1996</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1997</td>
<td>49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1998</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 1999</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2000</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2001</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2002</td>
<td>62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: MEXT Website

M.KONDO, NISTEP
Number of Joint Research between National Universities and Industry

Pre-First Plan Period  First Plan Period  Second Plan Period


M.KONDO, NISTEP
Ratios of coauthored papers between company researchers and researchers in other sectors

Data: (Japan) Preparing by NISTEP using the CD-ROM version of SCI

M.KONDO, NISTEP

27
Ratios of Industry-Funded University R&D over All University R&D

![Graph showing ratios of industry-funded university R&D over all university R&D for Japan, U.S., Germany, France, and U.K. over the years 1986 to 2002. The graph is divided into three periods: Pre-First Plan, First Plan, and Second Plan. The data sources are listed below the graph.]

Source: <Japan> MPHPT, “Report on the Survey of Research and Development”
<U.S.> NSF, “National Patterns of R&D Resources: 2002 Data Update”
<Germany, France> OECD, “Basic Science and Technology Statistics 2002/2”

M.KONDO, NISTEP
Science Linkage in U.S. Patents

All Areas

Life Sciences

**: “Science linkage” is the number of cited scientific papers in the U.S. patent examination reports per registered patent. It indicates a frequency of the use of scientific knowledge among patents.

University Spin-Offs

Numbers of University Spin-Offs

University Spin-Offs by Industry

Start-ups have been concentrating particularly in ICT and life sciences among the four priority areas:

- ICT: 27%
- Life sciences: 21%
- Nanotechnology & materials: 10%
- Electronics and machinery: 9%
- Environment: 5%
- Chemical industry: 3%
- Energy: 2%
- Others: 23%

*: Breakdown of 614 companies as of August, 2003

M.KONDO, NISTEP
Regional Innovation

Regional Science and Technology Programs by Central Government


Former S&T Agency

- Project for promoting research exchanges between regions by JST
- Regional Science Promotion Program
  - Science and Technology Program in Advanced Region
  - Innovation Plazas (JST)
  - Collaboration of Regional Entities for the Advancement of Technological Excellence
  - Intellectual Cluster Creation

Regional development for frontier research (Institute of Physical and Chemical Science and Technology Program in Advanced Region)

Research and development of costal environment and their utilization

Establishment of Venture Business Laboratory

Academic Frontier Promotion Program (private)

Development of research infrastructure for start-ups (2000 ~ 2001)
Program for promoting industry-academia joint research (2002 ~ )
Program for technology transfer of specific universities (approved TLOs)

Regional consortium (AIST)

Industrial Cluster

Ministry of Economy, Trade and Industry: METI

Program for developing technology and research in specific regions by Agency of Industrial Science and Technology

Regional consortium (AIST)

Ministry of Agriculture, Forestry and Fisheries: MAFF

Promotion of biotechnology R&D in regions

Program for government and private joint research

Joint research with local government agricultural laboratories

Program for developing technology and research in specific regions (regional consortiums includes)

Research Project for Utilizing Advanced Technologies in Agriculture, Forestry and Fisheries

Ministry of Environment

Special R&D for Pollution Control

Research development program initiated by regions by Telecommunications Advancement Organization of

Regional cooperative research and development project (JAMSTEC)

Establishment of centers for cooperative research at national universities

M.KONDO, NISTEP
Science and Technology Programs by Local Governments


*Nagano and Oita, two prefectures with no promotion activities on the figure, have already developed promotion guidelines afterwards.
S&T Impacts on Economy, Society and People’s Life

Scales of S&T Impacts

- **ICT**
- **Life sciences**
- **Environment**
- **Nanotechnology & Materials**
- **Energy**
- **Manufacturing Technology**
- **Social Infrastructure**
- **Frontiers**

Present

Future

M.KONDO, NISTEP
## Case Studies for FY2003

<table>
<thead>
<tr>
<th>Current Technology</th>
<th>Technology</th>
<th>Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early detection of cancer by CT scanner and diagnosis technology</td>
<td>Life sciences</td>
<td></td>
</tr>
<tr>
<td>Parallel computers with high arithmetic processing speed</td>
<td>ICT</td>
<td></td>
</tr>
<tr>
<td>Manufacturing and utilizing technology of Freon and Halon substitutes, which don’t cause ozone layer destruction and global warming</td>
<td>Environment</td>
<td></td>
</tr>
<tr>
<td>Technology to increase energy density of lithium batteries</td>
<td>Nanotechnology &amp; materials</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Future Technology</th>
<th>Technology</th>
<th>Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology to utilize cultivated self-tissues, originated from stem cells, for the use of artificial organs and tissues</td>
<td>Life sciences</td>
<td></td>
</tr>
<tr>
<td>Safe waste disposal and recycle technology: gasification melting furnaces and ash melting furnaces</td>
<td>Environment</td>
<td></td>
</tr>
</tbody>
</table>