R&D strategy

- Strategies to accelerate new growth -

12th April 2010

Shigeru AZUHATA, D.Eng.
Vice President and Executive Officer,
General Manager, Research & Development Group,
Hitachi, Ltd.
Contents

1. Corporate R&D organization
2. R&D to pioneer fusion & environment business
3. Positioning for the future
4. IP strategy
5. Summary
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1. Corporate R&D organization
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1-1. R&D organization

President

Hitachi Gr. CTO

CTO: Chief Technology Officer

Research & Development Gr.

Intellectual Property Gr.

Company CTO

Power Systems Company
Industrial & Social Infrastructure Systems Co.
Information Control Systems Company
Info. & Telecommunication Systems Co.
Defense Systems Company
Battery Systems Company (2010/4 - )

Development lab/division

Energy & Environmental Systems Lab
(Power Systems Company)

Business Division

Group company CTO

Central Research Laboratory

Advanced Research Laboratory

Hitachi Research Laboratory

Systems Development Laboratory

Mechanical Eng. Research Lab.

Production Eng. Research Lab.

Design Division (integrated 2010/4 - )

Overseas R&D facilities

Technology Platforms across the Hitachi Group

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## 1-2. R&D scheme

<table>
<thead>
<tr>
<th>Business target</th>
<th>2010</th>
<th>2015</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management strategy</strong></td>
<td><strong>Focus on social innovation business</strong></td>
<td><strong>Environmental Vision 2025</strong></td>
<td></td>
</tr>
<tr>
<td>Company</td>
<td><strong>Business strategy roadmap</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Research &amp; Development</strong></td>
<td></td>
<td></td>
<td><strong>Long-term technology devt. plan</strong></td>
</tr>
<tr>
<td></td>
<td>Sponsored research</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adv. sponsored research</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Company funds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Current business /</strong></td>
<td><strong>Generate innovative</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>next-generation business expansion</strong></td>
<td><strong>&amp; disruptive technologies</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>&lt;Generate No. 1 business&gt;</strong></td>
<td><strong>&lt;Shifts in paradigm&gt;</strong></td>
<td></td>
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</tbody>
</table>

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1-3. R&D investment

■ R&D expenditure

![Graph showing R&D expenditure for Hitachi Group from 2000 to 2008. The data shows a decrease in expenditure as a percentage of revenue over the years.]

Breakdown of expenditure:
- Corporate labs: 15%
- In-house company: 20%
- Hitachi Gr. company: 65%

R&D expenditure as % of Revenue:
- 2000: 5.2%
- 2001: 5.2%
- 2002: 4.6%
- 2003: 4.3%
- 2004: 4.3%
- 2005: 4.3%
- 2006: 4.0%
- 2007: 3.8%
- 2008: 4.2%

■ R&D personnel

Corporate labs + Devt. labs

<table>
<thead>
<tr>
<th>Company</th>
<th>FY2008</th>
<th>FY2009</th>
<th>FY2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi, Ltd.</td>
<td>3,700</td>
<td>3,600</td>
<td>3,500</td>
</tr>
<tr>
<td>Hitachi Gr. co.</td>
<td>2,200</td>
<td>2,200</td>
<td>2,200</td>
</tr>
<tr>
<td>Total</td>
<td>5,900</td>
<td>5,800</td>
<td>5,700</td>
</tr>
</tbody>
</table>
1-4. Improving return on investment

R&D efficiency based on Hitachi Gr. consolidated financial data

Focus on social innovation business
1-5. Focusing on social innovation

Social innovation business

Social·Industrial·Urban development systems

Urban systems

Transport systems

Cloud

Eco-friendly data centers

Smart grid

Green mobility

Nuclear power generation

Renewable energy

Thermal power generation

Info. & Telecom. systems

Storage

Software

Network

Power systems

Fusion business

Key devices

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1-6. ① Prioritizing R&D investment

Increased appropriation of corporate funding to social innovation areas

Corporate funds

Company funds

Corporate funding portfolio

FY2009

FY2010

Social innovation
Platform
Other

25%
55%

20%

40%

40%

20%

0%

Accelerate key projects: approx. 20

① Special research project (Tokken)

- Coverage: Backbone technology for future business & products
- Term: 1-2 years
- Leader: Research Dept. Mngr.

Accelerate business•commercialization

② Strategic business project (S-PJ)

- Coverage: Important businesses to be set-up in minimum time
- Leader: Business division.
1-7. ② Convergence of IT research facilities

- Consolidate IT research facilities into the Yokohama area to increase development efficiency

<table>
<thead>
<tr>
<th>Location</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Research Laboratory</td>
<td>160 of 940</td>
</tr>
<tr>
<td>Systems Development Laboratory</td>
<td>200 researchers</td>
</tr>
<tr>
<td>Kokubunji</td>
<td></td>
</tr>
<tr>
<td>Yokohama Laboratory</td>
<td></td>
</tr>
<tr>
<td>Kawasaki Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

Yokohama area (660 researchers)

<Assignment>
- Build-up IT platform for social infrastructure
- Contribute to cloud computing business

IT business divisions
- Network / Software
- Server
- Storage
- Financial Industrial Public

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### 1-8. ③ Strengthen global R&D

#### Regional R&D synchronized with expansion of social innovation business overseas

<table>
<thead>
<tr>
<th>North America</th>
<th>Participation in NEDO pilot project in New Mexico, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>● Strengthen green mobility research</td>
</tr>
<tr>
<td></td>
<td>● Promotion of smart grid research (NEDO pilot project in NM, U.S.A.)</td>
</tr>
<tr>
<td></td>
<td>● PCS</td>
</tr>
<tr>
<td></td>
<td>● Storage batteries</td>
</tr>
<tr>
<td></td>
<td>● Amorphous transformers</td>
</tr>
</tbody>
</table>

- **Power Systems Company**, **Info. Control Systems Company**, **Hitachi Research Laboratory**
- **PCS**: Power Conditioning System
- **PCS for mega solar power systems**

<table>
<thead>
<tr>
<th>China</th>
<th>Participation in the Chinese National Development and Reform Commission project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>● Lead info. &amp; telecommunications and software business development in China</td>
</tr>
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</table>

- **Agreement with the Chinese National Development and Reform Commission (NDRC)** to collaborate in the “Low carbon society construction and Resource recycling” project (2009/11/8)

<table>
<thead>
<tr>
<th>NDRC</th>
<th>Tech. exchange Model projects Joint research Personnel management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi</td>
<td>3/19 Sub-committee theme [Highly-efficient electricity generation &amp; smart grid] [Water treatment] [Home appliance recycling] [Urban transport (subway)]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hitachi China R&amp;D Corporation</th>
<th>Research hub</th>
</tr>
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1-9. Integration of the Design Division

Contribute to business innovation

1. “Visualization” of social innovation business through innovative technology and market (people/lifestyle) focus
2. Introduction of human-centric design to Info. & Telecomm. and Power & Industrial systems fusion areas

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Exhibit

1. UK IEP (Intercity Express Programme) high-speed trains
2. Ultrasound scanner HI VISION Preirus [2009 Good Design Gold Award]
3. Application of Experience Design in information business (financial/public): Visualization of customer requirements

“Visualization” of social innovation business

Active introduction of human-centric design

Preparing requirement definition document
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# 2-1. Hitachi Group growth strategy

## Focus on social innovation business

1. Expansion of global business

2. Fusion of information & telecommunication (IT) systems and power & industrial (PIS) systems

3. Expansion of environmental business
2-2. FY2010 R&D initiatives

<table>
<thead>
<tr>
<th>To generate globally competitive business</th>
</tr>
</thead>
</table>
| **1. Build-up information platforms for social infrastructure**  
Facilitate business cooperation and contribution to fusion business by consolidate IT research facilities in the Yokohama area |
| **2. Develop platform technologies to support IT-PIS fusion environmental business**  
Eco-friendly data centers, Railway Systems, Inverter, Li-ion batteries |
| **3. New directions in electronics research for social innovation business** |
| **4. Strengthening Green Mobility R&D for environmental business expansion** |
2-3. Social infrastructure info. platforms

Collect massive volume of data from social infrastructure, transform into value-added information and control

- Social infrastructure
- Smart cities
- Urban planning
- Smart grid
- Power infrastructure
- Green Mobility
- Rail infrastructure
- Manufacturing
- Smart grid
- Plant
- Transport

Next-generation network

① Social infrastructure network layer
KaaS (Knowledge as a service) Massive data management

② Knowledge creation · system coordinated platform
Knowledge creation · system coordinated platform

③ Information processing platform
Storage Server Middleware Encryption

Collect • Control
Add value
Highly reliable information processing

Cloud computing
Eco-friendly data center

Data volume
2006 2025

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2-4. Network transport equipment

Highly reliable high quality next-generation transport equipment integrating various services in one infrastructure

- World’s first operational service via delivery to a domestic carrier (2009/8)
  - Awarded 52nd (FY2009) Best Ten New Products Prize

Features

1. Able to accommodate various services regardless of whether it is packet communication or legacy transmission
2. Providing high quality & high reliability: 99.999% availability

- Network management system
- Central control of network
  - Quality assurance
  - Identification of failure location, restoration
- Constant monitoring of transmission quality
- Instant path switching upon failure
- Set path
- Adaptor
- Mobile phone
- Landline
- Dedicated line

Packet transport

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2.5 Virtualization technology supporting information processing platforms

Storage capacity virtualization

Providing users with virtual storage capacity greater than actual capacity

- Worldwide No. 1 share in enterprise storage capacity
- 13 year sales record of No. 1 domestic share for storage

Server virtualization

Multiple business processes achieved on one server

- FY2009 Kanto local commendation for invention: Invention encouragement prize

Enterprise storage USP V

Integrated management of virtual storage ⇒ number of administrators, cost reduction

Free capacity allocation for each task ⇒ increased capacity

Virtualization mechanism

Use one physical server as if 2 or more theoretical servers exist

Central Research Laboratory & Systems Development Laboratory
2-6. Eco-friendly data centers

Verification tests conducted on prototype IT/Air conditioning Facilities collaborative control system

Prototype configuration

- IT-Facilities collaborative control
  - Optimized IT workload consolidation
  - Optimized air-conditioning control

IT equipment

Air-conditioner, etc.

Air-conditioning power savings

Outdoor air-cooling

IT power control operation status

- Power control server
  - Job monitor
  - ON/OFF control

- Operation status data

- Job 1, 2, 3

ON/OFF control synchronized with operation

Verified 20-50% power savings

Central Research Laboratory
Mechanical Engineering Research Laboratory
Systems Development Laboratory

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2-7. Global rail services

- 2009/12/13 UK high speed express (Class 395) commences operation
  - Features
    1. Designed to conform to European carriage regulations
  - Awarded Prime Minister’s Prize in the 39th Japan Industrial Technology Awards (2010/4/7)

Core technology supporting global rail systems

- Analysis-led design
- Supercomputer simulation
- MONOZUKURI technology
- Inverter & Battery technology

- Friction stir welding
- Light-weight, compact & low noise inverter
- Collision absorption block
- Li-ion battery system

- Hitachi Research Laboratory
- Mechanical Engineering Research Laboratory

- Class 395 in operation

UK IEP
(Intercity Express Programme)
2009/2 Appointed preferred bidder status

- Planned delivery: max. 1,400 cars
- Planned delivery: 2013-2018

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2-8. Fortifying inverter R&D

- R&D formation to expand business in highly efficient, compact & low cost inverters

**Inverter research organization (2010/4)**

- Hitachi Research Laboratory
- Central Research Laboratory
- Production Engineering Research Laboratory
- Mechanical Engineering Research Laboratory
- Approx. 120 people

**Main applications**

- Rail cars
- UPS*
- Ind. equip.

**Power device & modules**

- **Inverter circuits & control**
- **Inverter design platforms**

**Prototype Si chip**

- (3kV/10)
- 4.5mm

**Prototype module**

- 3kV/400A
- SHGBT
- SiC diode

**Current capacity (A)**

- 0 40 80 120 160

**Pressure resistance (kV)**

- 0 1 2 3 4

**Main applications**

- Hitachi
- Rail cars
- UPS*
- Ind. equip.

**Current capacity (A)**

- 0 40 80 120 160

**Pressure resistance (kV)**

- 0 1 2 3 4

**Prototype Si chip**

- (3kV/10)
- 4.5mm

**Prototype module**

- 3kV/400A
- SHGBT
- SiC diode

*Uninterruptible power source
2-9. Li-ion batteries

- Strengthen R&D to expand business in high output, high quality & safety Li-ion batteries for motor vehicles and industrial applications

Hitachi Research Laboratory
(Adv. Battery Research Center, estab. 2009/4)
Mechanical Engineering Research Laboratory
Production Engineering Research Laboratory

Approx. 70 people

Battery Systems Company
(est. 2010/4)

- 2x battery capacity
- 2x battery life

Green Mobility

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PHEV: Plug-in Hybrid Vehicle
EV: Electric Vehicle
HEV: Hybrid Electric Vehicle
UPS: Uninterruptible Power System

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3-1. Challenging R&D frontiers

1910
- 5HP motor
- First product with domestic tech.
- Electric locomotive ED 15 (1924)

1950
- Electron microscope (1942)
- The Chugoku Electric Power Co., Inc.
- Shimane nuclear power plant (1974)
- Electron beam holography
- Verification of the A-B Effect (1986)

1980
- MOS transistor
- Shinkansen traffic management system (1972)
- General purpose computer
- Finger vein authentication equipment (2000)
- Proton beam therapy facility
- MD Anderson cancer center Treatment started on (2002)
- Perpendicular magnetic recording HDD (2000)

2000
- Co-generation
- Global/Open innovation
  - Environment / Energy
    - Innovative materials for batteries
    - Next Generation BWR
    - New Power Device
  - IT
    - New ICT
    - Next Generation Photonic Connection
    - Innovative Technology for Database
    - Basic
    - Robotics
    - Single cell analysis
    - Brain Machine Interface

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3-2. Global / open innovation

Promotion of world-leading advanced research to pioneer next-generation industry through concentration of knowledge within Japan and overseas

**Advanced storage device**
- Hitachi Cambridge Laboratory, ARL, CRL
- Univ. of Nottingham, Univ. of Cambridge
- Paris South Univ., Charles Univ. in Prague

**Spintronics**
(2009: Nature Physics)

**Encryption**
US NIST international Cryptographic Hash Algorithm Competition (2012)
- Katholieke Universiteit Leuven
- System Development Laboratory

**Tsukuba Robot special zone**
(2010/4〜)
- University of Tsukuba
- Mechanical Engineering Research Laboratory

**Analytical technology for semiconductor characteristics**
(2008/2〜)
- IBM Watson Laboratory
- SUNY Albany Nanotech Complex
- Hitachi High-Technologies Corporation
- Central Research Laboratory

**Electron microscope**

**Atomic level resolution holography electron microscopy**
(FIRST program 2010/4〜)
- RIKEN
- MEXT
- JST
- Advanced Research Laboratory
- Central Research Laboratory

**Green nano-electronics device**
Tsukuba Innovation Arena (2010/4〜)
- AIST
- Central Research Laboratory
- METI
- Hitachi Research Laboratory

**Semiconductor inspection equipment**
(CD-SEM)

**Autonomous robot**
(Public space experiment)

**Power device**
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IP strategy

- No. 1 IP strength in social innovation business –
  Strengthening overseas patent applications
  (esp. in Asian developing nations)
4-1. Globalization of IP activity (1)

Strengthen overseas patent applications

- Total no. of patent applications: Overseas > Domestic
- Shift focus from US to developing nations in Asia
- Potential PCT patent applications for potential markets

<table>
<thead>
<tr>
<th>Domestic: 53%</th>
<th>Overseas: 47%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Japan (53%)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Europe &amp; US (22%)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Developing nations (12%)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PCT route (13%)</strong></td>
<td></td>
</tr>
</tbody>
</table>

FY2009 results

<table>
<thead>
<tr>
<th>Domestic: 50%&lt;</th>
<th>Overseas: &gt;50%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Japan (50%)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Europe &amp; USA (20% &lt;)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PCT route (30%&lt;)</strong> (Mainly in developing nations)</td>
<td></td>
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</tbody>
</table>

FY2010 target

- Anti-counterfeit measures: Reinforce local staff (numbers & education)

※ PCT (Patent Cooperation Treaty): WIPO international treaty covering international patent applications © 2010 Hitachi, Ltd. All rights reserved.
4-2. Globalization of IP activity (2)

- Strengthening portfolio in developing nations of Asia

Patent applications in China (5 year total)

- Heavy electrical
- Information & Telecommunications

Patent applications in South-East Asia (5 year total)

- Heavy electrical
- Information & Telecommunications

※Hitachi survey based on Shareresarch, PATOLIS, IFIPAT/Questel-orbit, Pat-List/CN
### Example areas of IP activity focus for social innovation business

<table>
<thead>
<tr>
<th>Company</th>
<th>FY 2010 FS/PPM theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Systems Company</td>
<td>Environmental/highly efficient thermal power generation; Nuclear power generation; Power device (SiC)</td>
</tr>
<tr>
<td>Industrial &amp; Social Infrastructure Systems Company</td>
<td>Global rail</td>
</tr>
<tr>
<td>Information Control Systems Company</td>
<td>Smart grid</td>
</tr>
<tr>
<td>Urban Planning &amp; Development Systems Company</td>
<td>Elevator</td>
</tr>
<tr>
<td>Information &amp; Telecommunication Systems Company</td>
<td>Eco-friendly data centers Next generation networks (NGN) Cloud computing</td>
</tr>
<tr>
<td>Battery Systems Company</td>
<td>Li-ion batteries</td>
</tr>
</tbody>
</table>

**FS**: Flagship  
**PPM**: Patent portfolio management

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4-4. Current state of patent acquisition (2)

Environment-related technology patent portfolio

1) Total of patents publicized patents for Japan, USA, EU (EPC), and China
2) Hitachi survey based on Shareresarch, PATOLIS, IFIPAT/Questel-orbit, Pat-List/CN
| Differentiation & prevention, contribute to orders |
| Secure degree of freedom for business (cross licensing) |
| Income from patent fees |
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### Summary

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<thead>
<tr>
<th>New corporate R&amp;D structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Shift the R&amp;D portfolio towards social innovation business</td>
</tr>
<tr>
<td>• Consolidation of IT research facilities &amp; integration of the Design Division</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reinforce development of original technology to pioneer IT-PIS fusion business</td>
</tr>
<tr>
<td>• Innovative technology to expand environmental business &amp; reinforce development of key components</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IP strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reinforce overseas (esp. in developing nations in Asia) patent applications</td>
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</table>