R&D strategy to restore a growth trajectory

- For a giant leap in the centennial year of Hitachi's foundation -

April 22, 2009

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Vice President and Executive Officer,
General Manager of Research & Development Group,
Environmental Strategy Office
Hitachi, Ltd.
Measures to restore a growth trajectory

Basic policy

Focus on social innovation business

Initiatives

1. Fusion of information & telecommunication systems and power & industrial systems

2. Transformation into a truly global company

3. Expansion of environmental business
Measures to restore a growth trajectory

Emphasis on R&D to expand social innovation business

1. Fortify R&D organization
2. Fortify environmental & power conservation technologies
3. Fortify energy technologies
4. Initiatives in global “market-in”
5. Fusion of information & telecommunication systems and power & industrial systems

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2   R&D strategy
   2.1 Fortify R&D organization
   2.2 Initiatives in global “market-in”
   2.3 Fusion of information & telecommunication systems and power & industrial systems
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   2.3 Fusion of information & telecommunication systems and power & industrial systems
1-1. Hitachi’s Environmental Vision

- Reduce CO₂ emissions in energy production
- Enhance energy efficiency of our products

Towards a Sustainable Society

Prevention of Global Warming

Conservation of Resources
- Collect products for reuse or recycling

Preservation of Ecosystem
- Reduce negative effect on air, water and soil
1-2. Framework of Hitachi’s Environmental Vision

<table>
<thead>
<tr>
<th>Year</th>
<th>Strategy Phase 1</th>
<th>Strategy Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td></td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td>Environmental Vision 2010</td>
<td>Mid-Term Plan Environmental Vision 2015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Achieve emission neutrality, etc.</td>
</tr>
<tr>
<td>05</td>
<td>3% reduction in CO₂ emissions (from '90 in Japan)</td>
<td>12% reduction in CO₂ emissions (from '90 in Japan)</td>
</tr>
<tr>
<td></td>
<td>Increase Eco-Products</td>
<td>20% reduction in waste generation (from '00)</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Completed**

**Long-Term Plan Environmental Vision 2025**
- Reduction of CO₂ emissions by 100Mt
- Making all our products Eco-Products
  - Improve products’ environment efficiency thru technology
  - Promote international collaborative projects
1-3. Contribute to curb CO₂ emission by 100M tons/year

Worldwide Annual CO₂ Emissions

- 1990: 207 million tons/year
- 2005: 270 million tons/year
- 2025: 150 million tons/year
- 2050: 620 million tons/year

100 million tons through Hitachi products

BLUE scenario

Source: Hitachi, Ltd. based on IEA Energy Technology Perspective 2008
1-4. Plan to curb CO₂ emission by 1M tons/yr

Plan for CO₂ Curbing

[base year: 2005]

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Product development according to assessment on design for environment

Assessment factors

1) reduction  2) extension of product life  3) recyclability
4) ease of disassembly/processing  5) environment preservation
6) energy efficiency  7) packaging  8) information availability

Assess “design for environment”

Various factors assessed

Eco-Products

- Below base score
- Base score or above

Redesign

Information & Telecommunication Systems

- Server
- Clinical analysis
- Hard disk drive

Electronic Devices

- CD-SEM

Power & Industrial Systems

- H25 Gas turbine
- Amorphous transformer

Digital Media & Consumer Products

- Plasma display TV
- Washing machine

Highly Functional Materials & Components

- Anisotropic conductive film
- ANISOLM
- Eco-cables

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Make all our products & services Hitachi Eco-Products by 2025

**Increase in Eco-Products**

- 2006: 32%
- 2007: 38%
- 2008: 41%
- 2010: 50%
- 2025 (FY): 100%

*Note: Before offsetting accounts between business groups (total turnover of all business groups) *

*FY2008 figure represents current estimation*

**Strategies to expand business**

- **Increase in Eco-Products**
  - Pursuit of environmental efficiency

- **Active investment in environmental business**
  - Power generation
  - Green mobility
  - Green ICT
  - Urban infrastructure, etc.

**Core business**
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2-1. Group R&D organization

Chairman, President and CEO

Group CTO

CTO: Chief Technology Officer

Research & Development Gr.

Design Group

Intellectual Property Gr.

Business Group

Central Research Laboratory

Advanced Research Laboratory

Hitachi Research Laboratory

Systems Development Lab.

Mechanical Eng. Research Lab.

Production Eng. Research Lab.

Overseas R&D facilities

Hitachi Group laboratories

Development labs/division

Energy & Environmental Systems Laboratory (Power Systems Gr.)

Business Division

Development Center

Dev. & Design Section

Technology Platforms across the Hitachi Group
2-2. Corporate Research Laboratories

1. Expand current business
2. Generate new business
3. Create innovative technology

6. Corporate Laboratories

- Central Research Lab. <950>
  Kokubunji-shi, Tokyo
  Info. & Comm., Embedded Systems, Solution LSI, Storage, Life Science

- Mechanical Engineering Research Lab. <380>
  Hitachinaka-shi, Ibaraki
  Mechatronics Application Systems

- Production Engineering Research Lab. <340>
  Yokohama-shi, Kanagawa
  Management & Production Systems and Process, Facilities

- Hitachi Research Lab. <680>
  Hitachi-shi, Ibaraki
  Public Systems, Devices, Components & Materials

- Systems Development Lab. <500>
  Kawasaki-shi, Kanagawa
  Info. Systems, Security, Ubiquitous, Storage, Service Solutions

- Adv. Research Lab. <100>
  Hatoyama-machi, Saitama

<No. of Employees as at 2009/4/1>
### Technology Platforms across the Hitachi Gr.

**Group wide enhancement & fusion of common key technology and personnel development**

<table>
<thead>
<tr>
<th>Technology Platform</th>
<th>Mechanical &amp; Electrical</th>
<th>Electronics</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Details</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>Materials</td>
<td>Embedded Systems</td>
<td>Service Science</td>
</tr>
<tr>
<td>Electronics</td>
<td>Digital Engineering</td>
<td>Solution LSI</td>
<td>Outsourcing</td>
</tr>
<tr>
<td>Environment &amp; Energy</td>
<td>Electron beam-based measurement</td>
<td>Efficient systems development</td>
<td>Initial stage consulting</td>
</tr>
<tr>
<td>New materials</td>
<td>Non-destructive measurement</td>
<td>Platforming</td>
<td>Application of advantage technology</td>
</tr>
<tr>
<td>Medical</td>
<td>Product design support</td>
<td>Project management</td>
<td>&amp; devices</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>Optimal motor development</td>
<td>Optimal inverter development</td>
<td>New Service Methodologies</td>
</tr>
<tr>
<td>Nanotechnology</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technology Platforms**

- **Materials Research Laboratory**: ’04.04
- **Mechanical Innovation Center**: ’05.03
- **Advanced Simulation Center**: ’04.04
- **Motor Innovation Center**: ’05.10
- **Adv. Measurement & Analysis Center**: ’04.04
- **Inverter Innovation Center**: ’06.04
- **Embedded System Platform Research Laboratory**: ’05.04
- **uVALUE Innovation Center**: ’05.10
- **Cooperative Creation with Customers (Lab. Open Days)**: ’02 ~

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*EA*: Enterprise Architecture

**SoA**: Service Oriented Architecture
2-4. R&D Scheme

Allocation of research resources

- Expansion of priority business (70%)
  - Priority Themes: monthly follow-up
- Innovation research (10%)
  - Strategic research for growth
- Platform research (20%)

Measures

1. Exercise Group synergy
   - Use of Tokken (Special R&D scheme)
2. Alignment of business & technology roadmaps
   - Group CTO meeting
## Core business

<table>
<thead>
<tr>
<th>Social innovation business</th>
<th>Core business</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nuclear &amp; Coal thermal power generation</td>
<td>Hitachi Gr.</td>
</tr>
<tr>
<td>2</td>
<td>Renewable energy</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>3</td>
<td>Green mobility (Rail, construction machinery, automotive systems)</td>
<td>Central Research Laboratory</td>
</tr>
<tr>
<td>4</td>
<td>Urban energy solutions</td>
<td>Hitachi Research Laboratory</td>
</tr>
<tr>
<td>5</td>
<td>Power conserving data centers</td>
<td>Mechanical Engineering Research Lab.</td>
</tr>
<tr>
<td>7</td>
<td>High performance motors &amp; inverters</td>
<td>Energy &amp; Env. Systems Lab.</td>
</tr>
<tr>
<td>8</td>
<td>Li-ion batteries</td>
<td>Adv. Battery Research Center</td>
</tr>
</tbody>
</table>
Establishment of an integrated strategic organization for battery business

Mission

1. Strengthening Hitachi Group synergy in the battery business
2. Pioneering new applications for Li-ion batteries

Hitachi Group

Build-up “Strategic integration of battery business”

Development of “Next-generation battery technology”

Promotion of business in renewable energy

Hitachi, Ltd.

2009/4/1 establish
Battery Systems Division

Research & Development Group

Hitachi Research Lab.
2009/4/1 establish
Advanced Battery Research Center

Power Systems Group

2009/4/1 establish
Renewable Energy & Smart Grid Division

2009/4/1 establish
Renewable Energy & Smart Grid Division
Batteries: 3rd Core Device in Addition to Motors & Inverters

2-7. New Business on Demand Side: Batteries
2-8. Aims & issues for Li-ion batteries

- Light & high-energy density are characteristics, suitable for a wide range of applications from consumer products to medium-large equip.
- Issues in mass distribution: safety & cost

Volume & weight of Li-ion battery

- $1/2$ NiH battery
- $1/3$ Pb battery

**Figure:**

- **Market size (trillion JPY):**
  - Cylindrical
  - Square
  - Laminate
  - Vehicle

- **Energy density by mass (Wh/kg):**
  - NiCd rechargeable battery
  - Ni-H battery

- **Energy density by volume (Wh/dm³):**

**Source:** Institute of Information Technology
【Mission】Development of high capacity, high safety Li-ion batteries for industrial applications & automotive vehicles

Organization

Battery Systems Division (est. April 2009)
Hitachi Research Laboratory
Adv. Battery Research Center
• Est. April 2009
Mechanical Engineering Research Lab. & Production Eng. Research Laboratory

Group synergy

Technology development

- Increased power
- Increased safety
- Higher quality

Target

Achieve both endurance & instantaneous force

Power density (kW/kg) = Instant force

Energy density (Wh/kg) = endurance

PHEV: Plug-in Hybrid Vehicle
EV: Electric Vehicle
HEV: Hybrid Electric Vehicle
UPS: Uninterruptible Power System
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## Mission of overseas R&D centers

1. Contribute to local business operations
2. Cooperate with world leading research centers
3. Deployment of global staff (% local staff: 75%)

### Hitachi Europe Ltd. - European R&D Centre
- **Staff:** 35
- **Manager:** David Williams
- **Fundamental physics research at the Univ. of Cambridge**
  - Hitachi Cambridge Lab.
- **Technology support for European automobile manufacturers**
  - Automotive Research & Development Lab.
- **Topics:**
  - Fundamental device physics
  - Organic electronics
  - Mobile communications
  - Security
  - Automotive systems

### Hitachi America, Ltd. - R&D Division
- **Staff:** 40
- **Manager:** George Saikalis
- **Close cooperation in development with US automobile manufacturers**
  - Automotive Products Research Lab.
- **R&D for the next-generation U.S. storage business**
  - Storage Area Network Laboratory
- **Topics:**
  - Automotive components
  - Advanced wireless systems
  - Storage area network solutions

### Hitachi (China) R&D Corporation
- **Staff:** 88
- **Vice President:** CHEN Yang-Qiu
- **Topics:**
  - IP network
  - Digital TV
  - Innovative software
  - Materials, etc.
- **Info. & Communications, Software, Environmental tech.**
- **Industry-academia cooperation with Tsinghua Univ., Fudan Univ., etc.**

### Hitachi Asia Ltd. (Singapore) - R&D Center
- **Staff:** 13
- **Establishment of India Office(2008)**
- **Topics:**
  - Storage mechanics
  - Network storage
  - Water treatment
- **R&D in line with national strategy to fortify storage technology**
- **Regional R&D hub in ASEAN region and south Asia**

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## 2-11. Initiatives in global “market-in”

<table>
<thead>
<tr>
<th>Region</th>
<th>Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>• Joint global research for low CO₂ coal-fired thermal power</td>
</tr>
<tr>
<td></td>
<td>• Technology development for UK rail business</td>
</tr>
<tr>
<td>North America</td>
<td>• Joint research with IBM for beyond 32nm node semiconductor manufg. techn.</td>
</tr>
<tr>
<td></td>
<td>• Cooperative creation with local R&amp;D and North American customers in the storage business</td>
</tr>
<tr>
<td>China</td>
<td>• Energy conserving electric system project in Yunnan Province</td>
</tr>
<tr>
<td></td>
<td>• Order received for rail wireless communication system in Chongqing</td>
</tr>
<tr>
<td>Asia</td>
<td>• Establishment of India Office, Hitachi lecture series at the Indian Institute of Technology</td>
</tr>
</tbody>
</table>

### Energy conserving electric system project in Yunnan Province

### Delivery of industrial high voltage inverter

- (For fan in iron/steel production)
- (For intake pump)
Development of an energy conservation monitoring system applying HCR&D* information & communication technology

1. Data collection, compilation, analysis, display
2. Use wireless transmission infrastructure
3. Data collection, display
4. “Visualization” of energy conservation

Kunming Steel
Boiler, fan

Yuntianhua Group - Fuduan Chemical Industry
Chemical plant, exhaust fan/industrial water pump

*HCR&D: Hitachi (China) R&D Corporation
CERNET: China Education & Research Network; ITS: Intelligent Transportation System; CDM: Clean Development Mechanism
First major European order: British CTRL*

*Channel Tunnel Rail Link

London

IEP section

High-speed hybrid test train “HAYABUSA”

World’s first commercial run (2007/7)

(East Japan Railway Company: Koumi Line)

Test run in England

Li-ion battery module for high speed diesel hybrid rail cars

Battery system

Embedded battery module

Environment-conscious hybrid technology

Appointed preferred bidder status*

(Feb. 2009): British IEP**

* British-led Agility Trains consortium; comprising of Barclays Private Equity, Hitachi, Ltd. and John Laing

**Intercity Express Programme

◇ 200km/h high-speed rail cars

Project to replace a max. of 1,400 cars

◇ 2013: Plan to commence operation

First European order: CTRL-DS line (174 carriages)
2-14. Global R&D activity

Hitachi contributions recognized in Cambridge Univ. 800th anniversary celebrations

Commence collaborative lectures at Tsinghua University

Indian Institute of Technology: Hitachi lectures

Global cooperative creation in coal thermal power generation:
Pilot tests in CO₂ recovery (2009)

- RWTH Aachen Uni.
  - Oxygen CO₂ combustion
- Stanford Univ.
  - Elementary reaction model
- Babcock-Hitachi K.K.
  - Kure Laboratory
    - 5MW test combustion
- Coal O₂ combustion boiler
  - Oxygen
  - N₂
  - Air
  - CO₂
  - H₂O
- Ruhr-Uni. of Bochum
  - Ash radiation model
- Hitachi Research Lab.
  - High temp. materials

Energy & Environmental Systems Lab.
- LES analysis
- Low NOx combustion
- Virtual Boiler analysis

Joint research with IBM

- IBM Thomas J. Watson Research Center
- State Univ. of New York
  - (Albany Nanotech Complex)
    - Basic research on beyond 32nm node semiconductors
    - Elucidate semiconductor physics at the atomic level
    - New manufacturing equip.
      - New analytical equip.
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Social innovation business that only Hitachi can provide

Fusion of information & communications and power & industrial systems

Establish Supervisory Office for Business Coordination (2009/4~)
Fortify development of environment-conscious IT equip.

Harmonious Green Plan

Reduce 5-year CO₂ emission by 330,000 tons
( Corresponding to a forest area of 746km²)

Main equipment
- Server
- Storage
- Router
- Switch

Developments to reduce power consumption in IT equipment
- Operational level (virtualization, etc.)
- Equipment level (Cooling, power, etc.)
- Component level (LSI, HDD, etc.)

Data center total energy conservation

CoolCenter50 Project

Reduce Data Center power by a max. of 50%

<IT equipment>
- Server
- Storage
- Airconditioning
- UPS*
- Transformers

<Usufructuary facilities>
*Uninterruptable Power Supply

System management/monitoring

Optimal control of air conditioning

Analysis of load on air conditioners

Optimal control of air conditioning

Info. & Telecommunication Systems Gr.
Hitachi Plant Technologies Ltd.
Central Research Laboratory
Hitachi Research Laboratory
Mechanical Engineering Research Lab.
Systems Development Laboratory

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Urban & facility maintenance based on large-scale monitoring system using net cameras

• Urban Planning & Development Systems Gr.
• Hitachi Kokusai Electric Inc.
• Central Research Laboratory
• Hitachi Research Laboratory
• Mechanical Engineering Research Lab.

<Large-scale monitoring system>
• High-speed high precision facial recognition
• Seamless search of similar images from the monitor screen
• Display tracking of specific persons

Monitoring Center
Police
Home

Accumulation of images•analysis
Wide-area IP network NGN
Social infrastructure cloud

Minimum delay•Power conserving•Scalable

Monitoring
Remote maintenance of safety (Door/elevator control)

Nuclear plant
Town & Stores
Roads & Airport
Public facilities
Monitor the operation status of over 500,000 construction machinery worldwide to improve productivity & reliability

Hitachi Construction Machinery
Hitachi Research Laboratory

On-site

Increasing operational efficiency
Construction machinery administrator

• Current location
• Operational status
• Breakdown info.

Optimal production, stock management

Increasing productivity & reliability

Accumulate

• Transfer, operation history
• Maintenance history
• Trouble history
• Technical information

Transform into knowledge

Forecast of market trends and trouble/breakdown for each region, parts and equipment

Assessment

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Achieve high efficiency & high reliability in power & energy infrastructure through the fusion of information & communication technologies and power & industrial systems technologies based on real-world businesses.

- **Wind-power storage cell hybrid system**
- **Electric power system optimal operation system**
- **Power distribution control system for dispersed power source**
- **Advanced meter infrastructure (AMI) system**
- **Microgrid monitor & control**

**Power generation**

**Power transmission**

**Power transformation**

**Power distribution**

**Dispersed power source Auto. meter reading**

**Monitoring Control PC**

**SVC for distribution system**

SVC: static var compensator
Promotion of social innovation business providing knowledge-oriented services

Social infrastructure network layer

Provision of conventional service

Provision of knowledge-oriented services

Knowledge-based platform

Platform to provide info. processing / service operation

Collect

Control

Manufacturing

Maintenance

IT service

Logistics

Plant

Power infrastructure

Rail infrastructure

2-20. KaaS based social infrastructure cloud

*KaaS: Knowledge as a Service
- For a “giant leap” in the centennial year of Hitachi's foundation -