Toshiba Group R&D Strategies

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TOSHIBA CORPORATION

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Forward-looking Statements

• This presentation contains forward-looking statements concerning Toshiba Group’s future plans, strategies and performance.

• These forward-looking statements are not historical facts, rather they represent assumptions and beliefs based on economic, financial and industry data currently available.

• As a global entity, operating a wide range of businesses in countries and regions with different market environments, Toshiba wishes to caution that actual results may differ from our expectations due to risks and uncertainties that, without limitation, relate to economic conditions, worldwide mega-competition in the electronics business, customer demand, foreign currency exchange rates, tax rules, regulations and other factors.

• The company changed the structure of its internal organization in fiscal year 2011. Prior period data relating to the consolidated segment information has been reclassified to conform with the current classification.
I. Solutions for Total Innovations
- Total Storage Innovations
- Total Energy Innovations
- Further Speed Up the Pace of Innovation / World's First and World's No. 1
- Intellectual Property Strategies

II. Global R&D Management
- Global R&D Structure
- Intellectual Property Strategies
- R&D Investment
Toshiba’s Smart Community Business

Big Data, Cloud, Ensuring security

Secure highly-efficient, stable power source

Total Storage Innovation

Data center
Server
Storage array
HDD SSD NAND

Digital products solutions

Retail solutions

Process big data, and orchestrate

Total Energy Innovation

Base power
Renewable energy
Power electronics, EV
Factory, building solutions

Smart Community

Home solutions
Healthcare solutions

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Total Storage Innovations

Applications
- Healthcare solutions
- Retail solutions
- Digital products solutions
- Personal
- Hospital
- Retail Store

System
- Cloud platform
- Data center
- Big Data process
- Orchestrator process
- Module data center
- Storage array system
  - SSD Array
  - Flash Array
  - HDD Array
- Storage device
  - HDD
  - SSD
  - NAND

Provide applications/system to meet Big Data requirements

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NAND Flash Memories

Maintain competitive edge in chip size.

- World’s most advanced 19nm process
  - New structure with air gaps that suppress interferences between memory cells
- Chip-shrinking technology
  - Shrink peripheral circuit size by altering the architecture
  - 14.5% smaller than competitor's chip (21nm 64Gb)

3D memories going beyond geometry shrinking

- High-capacity and low-bit cost solutions
  - BiCS: Memory cell stacking (≥16 layers)
  - ReRAM: Utilizes resistance changes (Development of thin-film materials)
Integrated NAND/SSD/HDD Storage

**Data Centers**
- Cloud infrastructure development and Providing application solutions

**Storage array systems**
- Storage Layering Technology
  - Optimization takes advantage of the SSD and HDD
  - Proper system configuration for speed (27 times) and power saving (reduced by 40%) (compared to HDD system)

**Storage devices**
- Large capacity HDD solutions
  - 25% increase disk capacity by using SMR*¹
- High-performance & high-reliability SSD solutions
  - Development of controllers
    (Proprietary ECC suitable for NAND and 3D memories)

*¹ Shingled Magnetic Recording: Method of overlapping the written data tracks
Big-data usage infrastructure.

- Big-data processing
  - Petabyte performance
  - Real-time event processing to accommodate censor data of over 10 millions of households

- Orchestration
  - Dynamic resource allocation of Toshiba Data Center and public cloud resources

From social infra. to BtoB and BtoC
BtoC solutions

- Lifestyle analysis
  - Analyze user actions and preferences, based on data from in-home appliances.
  - Present recommendations appropriate to situations.

- Image recognition & retrieval
  - Efficient big-data search thru. video analysis (face recognition, scene classification)

- UI ideal for cloud services
  - Consistent and easy-to-use gesture/voice UI

- Interactions among appliances
  - Seamless access to services and content thru. interactions among TVs, PCs and tablets
Retail Solutions

Solutions for retail stores

- POS big-data clouding
  - Demand predictions based on POS data and market trends
  - Online supermarket clouding: Web shopping

- Smart settlement technology
  - Merchandise object recognition and sensing

Solutions for shoppers

- Content distribution
  - High-speed close proximity wireless transfer (TransferJet™)

- Real-virtual fusion technology
  - AR technology, digital signage
  - Secure comm. for remote shopping
Healthcare Solutions

**Healthcare IT**
- Storage, distribution and analysis of huge clinical data
  - Expansion of healthcare cloud services and clinical applications

**Diagnostic imaging**
- High-safety medical sensing
  - Single-heartbeat CT heart scan (0.275 seconds)
  - Low-dose image reconstruction (75% less radiation dose)

**Treatment & treatment assistance**
- Heavy ion beam transportation and control
  - 3D spot scanning (Φ1cm) irradiation (World’s first)
  - 3D image diagnosis of cancer & irradiation control

**Medical Checkup**
- Health Maintenance
- Diagnosis
- Treatment
- Prognosis Rehabilitation
- Home Care

**Cloud**
- External Medical Image Storage Services
  - Healthcare @Cloud™

**Collaboration**
- Vital, Amazon

**External Medical Image Storage Services**
- Medical Center
- Clinic
- Home Care

**Healthcare**
- Medical Checkup
- Diagnosis
- Treatment
- Prognosis Rehabilitation
- Home Care

**External Medical Image Storage Services**
- Medical Center
- Clinic
- Home Care

**ECG Scanning**
- ECG Scanning

**CT Scanning**
- CT Scanning

**Robotic Couch**
- Robotic Couch

**CT Beams Scanning coil**
- Beams Scanning coil

**Heavy ion beams Source**
- Heavy ion beams Source

**Heavy ion Pencil Beam**
- Heavy ion Pencil Beam

**ONE Aquilion**
- ONE Aquilion

**Collimator**
- Collimator

**Cancer**
- Cancer

**Spot**
- Spot

**Temporal Pencil Beam**
- Temporal Pencil Beam

**Temporal Spot**
- Temporal Spot
Total Energy Innovations

1: Factory Energy Management System
2: Building Energy Management System
3: Home Energy Management System

Optimal use of energy by No.1 technology and solutions
Thermal and Nuclear Power Generation

Thermal: High efficiency & low emission
- High-efficiency combined cycle (Efficiency 59% → 62% *1)
  - Minimal steam loss by 3D design
- Supercritical CO₂ thermal power gen.
  - Supercritical CO₂ turbine, high-temp, high-pressure combustor
  - 100% CO2 collection + Combined power generation class efficiency
- CCS(Carbon Capture and Storage)
  Demonstrated recovered energy consumption of 2.6 GJ/t-CO₂ (world's highest)

Nuclear: Improved safety
- SMR (Small Module Reactor), 4S*2
  - Passive safety features, modular design

*1 Low heating Value
*2 Super-Safe, Small and Simple

Toshiba’s technologies
Demonstrated recovered energy consumption of 2.6 GJ/t-CO₂ (world's highest)

Pressure: 30 MPa
Temp: 1150℃

Simplifies collection and reuse of CO₂ due to high purity.
Renewable and New Energy

**Geothermal**
- Flash/binary combined plants
  - 30% improvement in power output
- • High efficient and environmentally friendly heating medium
- • Heat balance design

**Wind**
- Lightweight and high-efficiency power generation system
- • Introduction of Direct drive type power generator
- • Optimized blade shape (Annual generated electricity +10%)

**Photovoltaic**
- High-performance PCS + Grid stabilization technology
  - PCS conversion efficiency: 97.7%

**Fuel Cell**
- Self-sustaining operation during blackout + HEMS linkage
  - World’s highest efficiency: 94% *1

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*1 Low heating Value

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**Power Electronics, EV**

**Energy-efficient and low-emission transportation**

- **Inverter and motor**
  - High-voltage purely SiC devices
  - 60% Smaller inverter
  - 20% more energy-efficient and lower life cycle cost (SiC-PMSM combinations)

- **Storage cell technology**
  - Quick Charging, Life Cycle=6,000 charges (maintaining over 80% capacity),
  - Visualization of remaining value of SCiB™

- **Station energy solutions**
  - Storage of regenerated and improve 5 to 15% in regenerated ratio*3
  - Optimal energy use at or by station buildings, trains and EV buses
  - Environmental consciousness (60% reduction in CO₂ emission*4)

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*1 Developed as part of the demonstration project "R&D on Small Power Conversion Systems Using High-Voltage SiC Devices" for the "Innovative Energy-Saving Technology Development Project" consigned by the New Energy and Industrial Technology Development Organization (NEDO).

*2 Approved by the U.S. Environmental Protection Agency (EPA)

*3 The above effects may vary depending on line conditions and operating conditions

*4 TEPCO’s emission factor (2010)
Home Solutions

Visualization 10% energy-savings / DR *¹ 5 to 10% peak shift

ECHONET Lite-compliant HEMS platform
- Launch energy measuring unit & IT access point ahead of competitors
- Control of smart home appliances and alternative-energy appliances and its visualization.

HEMS cloud engine
- Demand response for peak power suppression without sacrificing user comfort.

*¹ Demand Response, *² Home Power Manager
Toshiba's Technology Network for Smart Community

Big Data, Cloud, Ensuring security

Secure highly-efficient, stable power source

Total Storage Innovation
- High-Speed Data Processing
- Dynamic IT Resource Allocation
- Improved Array Reliability
- Smaller-Geometry Process / 3D Stacking
- Storage Virtualization
- HDD, SSD, NAND
- Human Interface
- Real/Virtual Fusion
- POS Clouding
- Content Distribution
- Lifestyle Analysis

Total Energy Innovation
- High-Efficiency Combined Cycle
- Supercritical CO₂ Thermal Power Generation
- SMR
- Flash/Binary
- High-Voltage Purely SiC Devices
- SCiB™
- Regeneration & Energy Storage
- HEMS Cloud Engine
- ECHONET Lite
- Huge 3D Image Data Analysis
- Heavy-Ion Beam Control
- Medical Sensing
- Human Interface
- Real/Virtual Fusion
- POS Clouding
- Content Distribution
- Lifestyle Analysis

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Further Speed Up the Pace of Innovation / World’s First and World’s No. 1 Products and Services

Creative Lighting
- Lighting that satisfies both sensitivity and energy-saving needs

Human Sensitivity
- World’s first, No. 1 products

Quantum Cryptographic Communications
- Ultimate security based on quantum mechanics

Society Security
- World's first, No. 1 products

High-Temp. Superconductivity
- 3D superconducting coil*

Earth Sustainability
- Contributed to the large accelerator for European Organization for Nuclear Research (CERN)

Cultivate new technologies in three areas.

* As part of the Strategic Innovation Program” of the A-STEP Project of the Japan Science and Technology Agency (JST)
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II. Global R&D Management

- Global R&D Structure
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- R&D Investment
Major Laboratories Around the World

Corporate
- Corporate Research & Development Center
- Corporate Software Engineering Center
- Corporate Manufacturing Engineering Center

Business Divisions
- Platform & Solution Development Center (Digital Products)
- Center For Semiconductor Research & Development
- Power and Industrial Systems Research and Development Center

- Toshiba Research Europe Limited
  Cambridge Research Laboratory
  Telecommunications Research Laboratory (Bristol)

- Toshiba China R&D Center

- Toshiba Embedded Software (India) Pvt. Ltd.

- Toshiba America R&D Center

- Toshiba Software Development (Vietnam) Co., Ltd.
Strengthen Global R&D Activities (2011 to 2014)

- Promote international collaboration among facilities to ensure optimum R&D for products tailored to local needs.
- Acquire and utilize world-class R&D personnel.

Europe

R&D personnel: 1,100⇒1,110
- Smart community technology/demonstration
- Imaging • Voice • Quantum cryptographic communications

U.S.

R&D personnel: 1,380⇒1,390
- Sensors • Networking
- Healthcare • Storage

India, Vietnam, etc.

R&D personnel: 980⇒1,450
- Cloud software for social infrastructure
- Technology and product development for emerging markets

China

R&D personnel: 720⇒980
- Smart community technology for China
- Technology and product development for the Chinese market

- Increase the number of basic research personnel in cooperation with major foreign universities. Researchers: 280⇒335
  (Included in the numbers in each region)

Basic Research:
- 280 researchers

Total Energy Innovation:
- 2,100 R&D personnel

Total Storage Innovation:
- 1,800 R&D personnel

Basic Research:
- 335 researchers

Total Energy Innovation:
- 2,375 R&D personnel

Total Storage Innovation:
- 2,220 R&D personnel

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Intellectual Property Strategy

**IP Portfolio Enhancement**
- Enhance Global IP Portfolio
- Retain in position of yearly Top 10 US Patent Assignees
  ⇒ 2010: 6th, 2011: 5th

**IP Portfolio Utilization**
- Secure Business Advantage
- Proper Evaluation and License Revenue Expansion

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**Global PAT Application Ratio**

- 2011: 51%
- 2014: 70%

**License Revenue**

- Increase Rty Profit

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**Global PAT Application Ratio**

- Japan: 49%
- U.S.: 24%
- Europe: 6%
- China: 7%
- Others: 4%

- PCT: 10%

**2011**

- Japan: 30%
- U.S.: 27%
- Europe: 8%
- Others: 16%
- China: 14%

**2014**

- Japan: 30%
- U.S.: 27%
- Europe: 8%
- Others: 16%
- China: 14%

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*1 Global PAT Application Ratio = No. of Foreign Application / (No. of Domestic Application + No. of Foreign Application)

*2: PCT: Patent Cooperation Treaty

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Consistent investment in R&D to sustain future business

Sales

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales (¥billions)</th>
<th>CAGR: 9% (11-14)</th>
</tr>
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<tbody>
<tr>
<td>FY11</td>
<td>6,100.3</td>
<td></td>
</tr>
<tr>
<td>FY12</td>
<td>6,400</td>
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<tr>
<td>FY13</td>
<td>7,100</td>
<td></td>
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<tr>
<td>FY14</td>
<td>7,800</td>
<td></td>
</tr>
</tbody>
</table>

R&D Expenditure

<table>
<thead>
<tr>
<th>Year</th>
<th>R&amp;D Expenditure (¥billions)</th>
<th>Innovation Management</th>
<th>Storage Innovation</th>
<th>Total Energy Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY11-13</td>
<td>1,020</td>
<td>24%</td>
<td>33%</td>
<td>43%</td>
</tr>
<tr>
<td>FY12-14</td>
<td>1,080</td>
<td>24%</td>
<td>33%</td>
<td>45%</td>
</tr>
</tbody>
</table>

Emerging Economies: 24%
USA, Europe: 31%
Japan: 45%

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Committed to People, Committed to the Future. TOSHIBA

We will become an even stronger global contender by unleashing our powers of imagination to anticipate, ahead of others, and capitalize on the coming trends in the world business environment.