Residential Fuel Cell System of Toshiba

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Toshiba Corporation
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- Toshiba’s Residential Fuel Cell
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# Toshiba’s Profile

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<th>Established</th>
<th>1875, by Hisashige Tanaka</th>
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<tr>
<td>President and CEO</td>
<td>Atsutoshi Nishida</td>
</tr>
<tr>
<td>Employees</td>
<td>198,000 worldwide</td>
</tr>
<tr>
<td>Total Assets</td>
<td>$59,356 million</td>
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<tr>
<td>Shareholders’ Equity</td>
<td>$10,223 million</td>
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<tr>
<td>Paid-in Capital</td>
<td>$2,801 million</td>
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</tbody>
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- **Net Sales (million)**: $58,361, $63,435, $71,164, $76,681
- **Operating Income (million)**: $1,548, $2,406, $2,584, $2,381
- **Net Income (million)**: $460, $782, $1,374, $1,274

As of March 31, 2008, consolidated basis, 100¥/$

![President & CEO Atsutoshi Nishida](image)
Toshiba’s Products

As of March 31, 2008

Home Appliances

Digital Products

Electronic Devices

Social Infrastructure

36%

29%

21%

9%

5%

Others

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# Main Energy System Products of Toshiba

| Nuclear Power | Reactors: ABWR, BWR, PWR, Fast Breeder Reactor  
Steam turbine and auxiliary equipment  
Operating plant service maintenance engineering  
Reprocessing facilities  
Nuclear fuel etc. |
|---|---|
| Thermal & Hydro | Steam turbine, Gas turbine  
Turbine generator  
Information & control system  
Hydro turbine, Pump-turbine etc. |
| T&D | High voltage switchgear  
Power transformer  
Surge arrester  
Protection relay  
Network control systems for electric power system  
High Voltage DC transmission system etc. |
| New energy | Residential fuel cell co-generation  
Solar power generation  
Renewable geothermal etc. |
Environment and Energy Approach of Toshiba

Over 3500 GW Energy demands by 2030

Increase CO₂ emission causes climate change

CO₂ Reduction

TOTAL: 8.2 MT/Y

Energy Approach

Contribute by Nuclear, Thermal, Hydro Power Generation System & Renewable Energy System Development To “Reliable Energy Supply” and “Mitigation of Climate Change”
**CO₂ Reduction in Energy Production**

Toshiba will promote the following measures in energy production.

- LWR nuclear power plants
- FBR & its fuel cycle system

- Plant efficiency enhancement of thermal power plants
- Zero CO₂ emissions e.g. CCS*)

- Zero power loss of transmission & distribution systems
- Micro-grid for stable dispersed energy operation

- Dispersed power systems e.g. Residential fuel cell
- Renewable energy systems

*) Carbon dioxide Capture & Storage
Contribute to Worldwide Nuclear Development

- 110 operating plants in 10 Countries Worldwide

**TOSHIBA**

Leading Innovation

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- **BWR**
- **PWR**
- **ABWR**
- **Toshiba Group 28%**
- **391GWe 433 Plants**

**AP1000**

**PWR 86 Plants**

**BWR 24 Plants**

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**Countries and Plants**

- **U.S.A.** 62 Plants
- **Japan** 19 Plants
- **Sweden** 10 Plants
- **South Korea** 6 Plants
- **Spain** 5 Plants
- **Taipei** 2 Plants
- **Switzerland** 2 Plants
- **Finland** 2 Plants
- **Slovenia** 1 Plants
- **Brazil** 1 Plants
- **10 Countries 110 Plants**

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As of Jan. 2009

Plant: Main Contractor
(Installed Capacity Ratio)

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Residential Fuel Cell

- Supplying city gas or LP gas for fuel cell.
- Electricity and hot water are supplied.
- Significant improvement of energy consumption and CO$_2$ emission in household.
Main Components of Residential Fuel Cell

Setup of Fuel Cell Unit

Display Model of Fuel Cell Unit
Advantage of Residential Fuel Cell

- High Energy Efficiency & Environmental friendliness by combined Heat and Power Supply

- Effective utilization of energy (86% of fuel energy is available)

  - Chemical Energy of Fuel 100%
  - Reforming to H₂
  - Fuel Cell Stack
  - Electric power 36%
  - Thermal power 50%
  - Loss 14%
  - Available Energy = 86%

(Example of a house)

- High CO₂ Emission Reduction (30% of CO₂ reduction)

  - Before Introduction
  - After Introduction

- 30% CO₂ Emission
  (ton/year)
Fuel cell is a device that generates **Electric power & Heat from Hydrogen & Air**
## Overall Scenario for Commercialization in Japan

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<tbody>
<tr>
<td>Technology verification</td>
<td>Introduction</td>
<td>Popularization</td>
<td>Real Commercialization</td>
<td></td>
</tr>
<tr>
<td>FY2010 2.1GW for Stationary</td>
<td>FY2020 10GW for Stationary</td>
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### Progress
- **FY2002** - Field test
- **FY2005-2008** - Large scale demonstration PJ

### Future Scenario
- **Enlarge market size with cost reduction by mass production & technology breakthrough**
- **From Verification to Market**
  - Introduction: Several k-units to several ten k-units
  - Establishment: several ten k-units to several hundred k-units
  - Real Commercialization: More than several hundred k-units
- **w/ subsidy**

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Large Scale Demonstration Project (FY2005 - FY2008)

- 4 years project by supporting of METI’s budget in Japan.
- Total installation is 3,307 units (including Toshiba 748 units)
- High energy-savings and CO₂ reduction were verified.
- Cost reduction and reliability improvement were promoted.

A number of installation of each fiscal year

A house under the demonstration
“ENE FARM” Commercialization has started

- Commercialization for domestic market has started since FY 2009.
- Residential fuel cell CHP system is named “ENE FARM” (Unified product name of Japanese companies.)
- Governmental subsidy to end-users for “ENE FARM” Promotion.
Toshiba’s Fuel Cells

Residential CHP Fuel Cell
“ENE FARM”
(700W, PEFC)

Fuel Cell for Note PC
(20W DMFC)

Fuel Cell for mobile devices
(100mW DMFC)
History of Stationary Fuel Cell in Toshiba

30 years experiments of FC development in Toshiba

1980
- 50kW Pilot plant

1990
- TEPCO 11MW Plant (23k hrs.)
- Onsite 1MW Plant (16khrs)

2000
- NEDO 1 MW Plant
- Onsite 200kW PC25C

FY1999
- FC vending machine
- The initial Development of 1kW PEFC

FY2000
- Residential
- The first residential PEFC

FY2001
- FY2001 model
- Downsizing and cost reduction

FY2005
- FY2005 model
- Reliability improvement

FY2006
- FY2006 model
- Cost reduction, Maintainability

FY2007
- FY2007 model
- Further Cost reduction,

FY2008
- to FY2009 model

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Features of Toshiba’s Residential Fuel Cell

- Rated power of 700 W (suitable for Japanese general house)
- High Electric Efficiency (36% at rated power)
- City gas or LP gas can be used as a fuel
- Learning-control program (analyzing demand patterns for optimal operation)
- The lightest weight (100kg) for easy installation
- Low noise design (40dB)

Rated power of 700 W
(suitable for Japanese general house)

High Electric Efficiency
(36% at rated power)

City gas or LP gas can be used as a fuel

Learning-control program
(analyzing demand patterns for optimal operation)

The lightest weight (100kg) for easy installation

Low noise design (40dB)
Environmental Friendliness is verified by the demonstration project

**Primary Energy Reduction**
- 12 GJ/year
- Equivalent to 27% reduction for Japanese average house

**CO₂ Emission Reduction**
- 1.2 ton-CO₂/year
- Equivalent to absorption by 2,200 m² of forest

* Japanese general house primary energy = 45 GJ/year

* Absorption rate by forest area = 5.4 ton-CO₂/ha · Year
(Data from the demonstration PJ of FY2007)
Toshiba’s Total Power Network Support

- Micro-grid is composed of multiple distributed generation and load, operating independently from the utility grid.
- Energy is generated and use effectively by IT control to reduce the environmental impact.

- Distributed Generation
  - Photovoltaic Power
  - Fuel Cell

- Micro-Grid
  - Energy is generated and use effectively by IT control to reduce the environmental impact.

- Utility Grid
- Power Plant
- Grid-Interconnected Equipment
- FEMS: Factory Energy Management System

- Monitor and Control
- Power Storage
- Co-generation Unit
- Office, Hospital, Store
- Thermal Demand

- Electric Vehicle, Light Rail
- New Transit System
- Residence, School

- Rooftop Photovoltaic Panel
- Battery
- Power Conditioning System
Image of energy supply in the hydrogen society

- Fuel cell will become a key technology in approaching hydrogen society.

Solar Power
Wind Power
Hydro Power

Water Electrolysis
Biomass Power Generation
Fermentation/Gasification
Waste Reforming

H₂

Fuel Cell

Electricity & heat

Reforming
Reforming/Pyrolysis

Bi-products

Natural Gas
Petroleum
LPG

Soda Plant
Steelworks

Nuclear Plant Residual Heat
Hydrogen Production utilizing Waste Heat

Dimethyl Ether *(DME)*

\[ \text{Steam reforming} \rightarrow \text{H}_2 \]

\[ \text{Waste heat} \sim 300 \degree \]

- Thermal power
- Nuclear power
- Waste processing
- Steelworks, etc.

Use of H₂

- Fuel cell
- H₂ engine power generation
- Add to vehicle fuel (Diesel, LNG)
- H₂ station

Merit

- Energy conservation
- Reduction of CO₂ emission

Small scale field test at a thermal power station

The hydrogen production of 1m³/h has been confirmed.
Fuel cell CHP system is expected to contribute CO$_2$ reduction in civilian sector because of its superiority in energy saving ability.

Toshiba has started commercialization of residential fuel cell CHP system “ENE FARM” for Japanese domestic market since FY2009.

We would like to make all efforts to enlarge market size with cost reduction by mass production and technology breakthrough.

Also, we would like to contribute to prevent global warming by spreading superior environmental-friendly technology of fuel cells for overseas market.
END