Green ICT toward Low Carbon Society
-Green R&D Activities in NTT-

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NTT Energy and Environment Systems Laboratories
1. Trends in global warming
2. Environmental impact reduction using ICT
3. NTT R&D Toward Reducing Environmental Impact
   3.1 Overview
   3.2 Green of ICT
   3.3 Green by ICT
4. Summary
### World Trends in Global Warming

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<tbody>
<tr>
<td><strong>World</strong></td>
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<tr>
<td>CO₂ produced by humans is increasing</td>
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<td><strong>Japan</strong></td>
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#### 2006
- Bali Road Map adopted by COP13 (Indonesia)

#### 2007
- No progress at COP14 (Poland)

#### 2008
- Kyoto Protocol period (2008 to 2012)
  - COP15 (Denmark): Post-Kyoto is postponed
  - G-8 Summit (Towada)
  - Shared long-term target to reduce global emissions by 50% by 2050

#### 2009
- COP16 (Mexico)

#### 2010
- No progress at COP14 (Poland)

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**Global reduction obligations**

- June 2006: “Fukuda Vision” for global warming
- Publication (June) of mid-term target (15% reduction from 2005)
- Revision of energy conservation law and global warming law
- Revision of Tokyo Prefecture Environmental Protection Law

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*Source: IPPC4 Report*

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**New proactive utilization of ICT is indispensable.**
The IT (ICT) sector accounts for approximately 2% of emissions and contributes to reductions in the other sectors, which account for 98% of all emissions.

The IT (ICT) sector is drawing attention from its own energy savings (of ICT) and from its contribution to CO₂ reductions in society (by ICT).
Several issues addresses under each project supported by METI, NEDO and MIC of Japan. Typical example of the issues are listed.

**METI: Next-Generation Energy and Social System Committee**
- the Study Group on the Scheme for Next-Generation Power Transmission and Distribution Networks
- the Study Group on the Smart Meter Scheme
- the Study Group on the international standardization related to Next-Generation Energy Systems
- The Forum on Smart Community-Related Systems, including the Demonstration of Next-Generation Energy and Social Systems in Yokohama City, Toyota City, Kansai Science City and Kitakyushu City

**NEDO: Japan Smart Community Alliance (JSCA)**
- JSCA was launched as Public-private partnership project pursuant to the recommendation of The Forum on Smart Community-Related Systems of METI

**MIC: The Project of Promotion of Standardization of Integrated Network Management System**
- The Requirement for Interfaces of ICT Systems, including home network, mobile network, AMI, to reduce environmental impact in cooperation with the standardization activity of JSCA
- The Requirement for Wireless Systems to reduce environmental impact
- The Demonstration in Local Area about Verification of Communication Protocol to reduce environmental impact
- Several Study Groups on LCA and standardization in ITU
Relationships between environmental issues and ICT

Environmental protection (air, water, soil, etc.)
Preservation of biodiversity
Mitigation of chemical damage
Prevention of global warming (reducing CO₂ emissions)
Sustainable society (reducing use of resources)

Green ICT
Green of ICT
- Reducing CO₂ emissions
- Reducing use of resources

Green by ICT
- Reduction of environmental impact through increasing lifestyle and industrial efficiency

Governance by Green
- Making results visible
- Governance Policy

Scope of NTT-R&D
(classified by environmental white paper)

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NTT R&D Toward Reducing Environmental Impact

Access, terminals
- ONU, OLT, HGW
- Reduce resource use, recycle fiber optic cables

Cloud computing
- CBoC (Common IT Base over Cloud Computing)

PF, Applications
- 4k digital cinema, etc.

Energy-conserving procurement
- Set methodology, create guidelines

Equipment
- Fiber optic integrated packet routers, etc.

Devices
- Low-consumption fiber optic devices, nanoelectronics

Network
- NGN, future networks

Smart grids
- HEMS, EV, etc.

Energy
- Energy-conserving procurement

Electric supply
- High voltage DC supply technology

Air conditioning
- Aisle capping
Technology overview of R&D topics related to reducing CO₂ emissions

Energy-saving
- HVDC
- Smart grid, smart houses
- Energy-saving systems
- Air-con, etc.

Clean energy
- Fuel cell
- Novel battery
- High efficiency solar
- Hydrogen etc.

CO₂ reuse
- Chemical fixation
- Biofixation, etc.
**Approach for reducing power consumption based on DC power supply**

- HVDC does not require as many power conversion steps with high system effectiveness.
- HVDC lowers drain and reduces facility cost.

**Alternate current (AC)**

1. AC/DC
2. DC/AC

**Direct current (48-V type)**

1. AC/DC
2. DC/DC

**High-voltage direct current (HVDC)**

1. AC/DC
2. DC/DC

- Decreases the number of steps required for power conversion
- Fuel cells

15% reduction

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Advantages of DC power supply system

Rectifier — Current distribution device

- DC 48-V power supply (Left)
- HVDC power supply (Right)

Using high voltage results in thinner cable wires, which improves workability

Current distribution device — ICT device

- DC 400-V grade
- DC 48-V power supply (Left)
- HVDC power supply (Right)

Using high-voltage enables efficient use of space

For DC 48-V rectifier

For HVDC rectifier

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Approach to on-premise DC power supply system

- With household energy demand increasing over the years, CO₂ emissions in 2006 were 1.3 times more than in 1990.
- With the spread of FTTH and the increase in CO₂ emissions from household communication devices, if the number of subscribers reaches 20 million, one-third of all CO₂ emissions of the NTT Group will be due to household communication devices.

Large number of low conversion efficiency AC adapters in use
- Large power loss
- Problem with cables and heat

Current state of power supply for household communication devices

CO₂ emissions of fiber-optic broadband subscribers and communication devices (NTT estimate)
Advantages to on-premise DC power supply system

- CO₂ reduction effect (over 10%) based on household DC power supply
- Backup during power outage

Research topics
- Filter technology (Lightning, EMC)
- DC power supply lines and communications technology
- Control protocol
- Standardization of voltage and connectors
Approach for energy networking system

Demonstrative study on the new energy system at Expo 2005 (NEDO)

Supply to Pavilions

Japan Pavilion Nagakute

NEDO Pavilion

Electric power & heat

Control room

Energy control system
(NTT FACILITIES, Inc.・NTT Labs.)

Commercial Power

Sodium–sulfur (NAS) batteries

Molten carbonate fuel cells (MCFC)

Phosphoric acid fuel cells (PAFC)

Solid oxide fuel cells (SOFC)

Photovoltaic cells (PV)

New energy system

The power generation plan can be optimized to achieve predetermined priority conditions such as "reduced CO2 emission."

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Optimal control of next-generation energy network to minimize CO\textsubscript{2} emissions and cost

- Energy optimal control in the community
- Energy management by home-ICT
Test-bed of EMS are going to be developed by connecting 5 simulated environment of house or office located in Japan by network. Interoperability is going to be verified by standardizing network interfaces, and the effect of the power consumption reduction are going to be improved.

( The project supported by the Ministry of Internal Affairs and Communications in Japan)

- Interoperability
- Collection and control of sensor information
- Providing and controlling power energy-saving information
- Multi-protocol gateways
- Interference diagnosis from antenna placement conditions
To revolutionize lifestyles and move toward a low-carbon society, quantification and visibility of ICT effects on environmental impact reduction are important issues.

Making CO₂ emissions visible across the entire supply chain to service provision

- Manufacturing
- Construction
- Operation
- Removal
- Disposal / Recycling

Making effects visible

- Manufacture of NW devices, terminals NW installation
- Electricity used by device, air conditioning, service etc
- Removal of equipment, recycling etc.

Make comparison possible and objective

Standardization allowing international comparison and objectivity

- Determine environmental impact assessment range
- Reduction effect calculation methodology, etc.

Ex: Video-conference

<table>
<thead>
<tr>
<th>CO₂ emission(t)</th>
<th>Use</th>
<th>End of life treatment (EoL)</th>
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<tr>
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Conventional means

ICT service

Reduction volume = energy reduced per person per kilometer (J)

\[ \text{Reduction volume} = \text{energy reduced per person per kilometer (J)} \times \text{Reduced movement distance} \times \text{reduced number of persons transported} \times \text{Work efficiency (human workload, etc.)} \]

Reduction volume = Energy consumption unit per sq. meter of office space

\[ \text{Reduction volume} = \text{Energy consumption unit per sq. meter of office space} \times \text{sq. meters of space used per person} \times \text{amount of work made efficient (people/year)} \]
Results of Environmental Impact Evaluation -IP Network-

Internet Service Provider

Boundary for evaluation

LAN switch

Router

LAN switch

Subscriber Module

DSLAM

OLT

Access network equipment

DSU

ADSL Modem

ONU

Subscriber station

Metallic cable

Metallic cable

Optical cable

CO₂ emissions [kg-CO₂/year/subscriber]

Disposal/recycling

Use

89.1

Production

-5.9

Recovery by recycling

-6.0

(Family Type)

112.6

(Family Type)

Recover by recycling

-6.0

-5.8

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Direction of R&D in green ICT

**Green of ICT**
- Lower power consumption of ICT equipment (e.g. server, router, terminal device)
  
  Example: Ultra low power device, optical router, sleep mode
- Creation of applicable clean energy in the ICT sector
  
  Example: DC power supply, fuel cell, PV generation, energy network
- Waste recycling in ICT sector
  
  Example: Material recycling, closed recycling

**Green by ICT**
- Contribution by ICT services in reducing society's energy consumption
  
  Example: E-commerce, video conferencing, paperless office, BEMS, HEMS, smart grid
- Standardization of environment impact assessment methods
Thank you for your kind attention.