Global to local effort toward sustainable energy use

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Sustainable Earth System

Renewable energy (solar, wind, hydro, bio-mass, …)

Solar constant 1,366 W/m²

Energy consumption 518 EJ/yr (2008)

Renewable energy surplus

Solar radiation 5.5x10⁶ EJ/yr

Non-renewable energy (fossil fuel, uranium, …)

Reduce

Recycle

Materials

Products

Reduce

Reuse

Earth

Resources
Sustainable Energy Use

- **Ultimate goal:** Sustainable earth system

- **Near future objectives as a transition:**
  - **Consumption:**
    - Energy saving (effective energy use)
  - **Supply:**
    - Lower carbon-intensity fuels (LNG, LPG, …)
    - Renewable energy (solar, wind, hydro, geothermal, biomass, …)
    - Unused energy (waste, …)
Change of Energy Consumption by Sector


Ratio of GDP in 1973 & 2008 FY 2.4 times

Transportation
Office & Residential
Industry

Trillion JPY in 2000

Ratio in 1973 & 2008 FY

1.9 times
2.5 times
0.9 times
Increase of Renewable Energy in Generating Capacity

- PV data: Agency for Natural Resources and Energy
- Wind data: NEDO

![Chart showing the increase of renewable energy in generating capacity from 1994 to 2008. The chart compares photovoltaic and wind energy production. The chart indicates a significant increase in both energy sources over the years, with photovoltaic energy showing a steady rise and wind energy peaking in 2008.]
Investigation of Failure/Breakdown of WTGS

☆ Actual Failure/Breakdown Causes

☆ Most significant cause of failure/breakdown:
  “Environmental causes”
  ● Strong wind (e.g. Typhoon)
  ● Lightning

Investigated by New Energy Development Organization (NEDO)

* from the Report of “Committee for Increase in Availability/Capacity Factor of Wind Turbine Generator System and Failure/Breakdown Investigation of Wind Turbine Generator System Subcommittee” by NEDO
## Technological Development for Asian Climate

<table>
<thead>
<tr>
<th>Asian Climate</th>
<th>Impact for WTG</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhoon</td>
<td>Heavy Load by Wind</td>
<td>Tough Design</td>
</tr>
<tr>
<td>Complex Terrain</td>
<td>High Turbulence</td>
<td>Fatigue Strength</td>
</tr>
<tr>
<td>Lightning</td>
<td>Blade Destruction</td>
<td>Lightning Protection</td>
</tr>
<tr>
<td>Low Wind Speed</td>
<td>Drive with Low Wind</td>
<td>Low Wind Speed Model</td>
</tr>
<tr>
<td>Mountain Region</td>
<td>Difficult to Transport</td>
<td>Proper Blade Size</td>
</tr>
<tr>
<td>Not Strong Grid</td>
<td>Fluctuation Control</td>
<td>Combination with Battery</td>
</tr>
</tbody>
</table>

Necessary to Modify European Code, IEC61400-1, for Asian Climate
- Research project based on partnership of 11 universities
- External research fund
Transdisciplinary Initiative for Global Sustainability (TIGS)

Serve as a common foundation on research topics:

① Research into global warming and energy issues
② Research into population, water and food supplies
③ Research into the amalgamation of urban and rural areas
④ Research into environmental risk management

- Sustainability Education Program

http://tigs.ir3s.u-tokyo.ac.jp/
Todai (UT) Sustainable Campus Project (TSCP) - Effort of UT for energy saving -

Todai = To (Tokyo) + dai (University) = University of Tokyo (UT)
CO₂ Emission of UT (2008)

<table>
<thead>
<tr>
<th>Members Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total members</td>
<td>36,193</td>
</tr>
<tr>
<td>Board, Faculty &amp; Staff</td>
<td>7,603</td>
</tr>
<tr>
<td>Undergraduate students</td>
<td>14,394</td>
</tr>
<tr>
<td>Graduate students</td>
<td>14,196</td>
</tr>
</tbody>
</table>

Floor area: 1,369,000 m²

CO₂ emission: 132,626 (ton-CO₂/yr)

CO₂ emission per floor area:
- Average: 0.10 (ton-CO₂/m²yr)
- Hongo: 0.10 (ton-CO₂/m²yr)
- Komaba 1: 0.05 (ton-CO₂/m²yr)
- Komaba 2: 0.07 (ton-CO₂/m²yr)
- Shirokane: 0.19 (ton-CO₂/m²yr)
- Kashiwa: 0.09 (ton-CO₂/m²yr)

Five main campuses:
- Tokyo
- Saitama
- Ibaraki
- Kanagawa
- Chiba

For more detailed information, please refer to the University of Tokyo's official documents.
Todai Sustainable Campus Project (TSCP)

- Global importance
  - Importance of sustainability
  - Global warming issues

- Social responsibility of university
  - UT should be the model of future society
  - Provide information to society (including overseas)

- Education of next generation

- Implementation of facility plan
  - Plan of saving energy and cost
  - Involvement of various actors: faculties, staffs and students

Holistic approach

(Top priority: creating a low-carbon campus)
Development of TSCP Organizations
Framework

- UT Presidential Committee
- TSCP office
  - Steering Committee
  - Industry-University Cooperation WG
  - Administrative Staffs Liaison WG
  - Departments Liaison WG
Holistic approach

Research: Structuring knowledge

Education: Develop human resources for future Education program in Sustainability Science (IR3S)

Practice: Create Sustainable campus as a new social model

(Top priority: creating a low-carbon campus)
Co-evolution Concept of TSCP

Social collaboration towards Sustainable society
Model of low-carbon society
Utilization of research results and feedback of action

Co-evolution of three elements

Independent, decentralized and cooperating system for energy demand and supply (Visualization)
Leveling of energy supply
Total optimization

Saving energy, generating energy (Low-carbon)
Equipments for saving energy and non-CFC
Introduction of flow-type energy

TSCP
TSCP Action Plan

- **TSCP 2012 (2008-2012)**
  - **15% CO\textsubscript{2} emission reduction from 2006 level by 2012** (excluding laboratory)
    - Replacement to higher-efficiency equipments
    - To each department, initial cost to be recovered over 4 years is granted by fund pooled by overhead charge for electricity and fuels
    - Visualization of energy consumption (electricity meter, etc.)
    - Cost saving by bulk procurement

- **TSCP 2030 (2030)**
  - **50% CO\textsubscript{2} emission reduction from 2006 level by 2030** (for total emission)
    - Renewal to higher-efficiency equipments
    - Introduction of renewable energy (Solar power, etc.)
    - Automatic control of equipments based on monitoring
    - Detailed plan will be made by 2012
Replacement to More Efficient Lighting Equipments

- 80% of all lamps in UT had already been replaced to high-frequency fluorescent lamps
- Replaced the remaining 38,605 units
- Investment recovery years shortened from 9.1 to 6.9 years due to cost-saving by bulk procurement
- Reduced 2,000 ton-CO$_2$ / yr

Before

F L R fluorescent lamp
100Watt

After

H f fluorescent lamp
56Watt
×38,605 units
High-efficiency Chiller in Hospital

- University of Tokyo Hospital: 25% of total energy consumption
- Renewal of heat source at energy center of hospital in Hongo campus
- Introduction of turbo chiller with heat recovery

Replacement of screw chiller by turbo chiller
Reduced 2,000 ton-CO₂ / yr
TSCP Promotion Mechanism
(Initial Cost Supporting Fund)

- Charge overhead to utility cost to all departments as TSCP promotion fund
- Offer fund for initial cost over 4 years pay-back time
- In a long run, ensure equity among departments
Preliminary Result of TSCP

Decrease since TSCP initiation

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual CO₂ emission (ton·CO₂/year)</th>
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<tbody>
<tr>
<td>2003</td>
<td>120,816</td>
</tr>
<tr>
<td>2004</td>
<td>130,933</td>
</tr>
<tr>
<td>2005</td>
<td>133,548</td>
</tr>
<tr>
<td>2006</td>
<td>135,739</td>
</tr>
<tr>
<td>2007</td>
<td>143,535</td>
</tr>
<tr>
<td>2008</td>
<td>143,927</td>
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<tr>
<td>2009</td>
<td>141,662</td>
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It is important to:

Q1: Consider resource, natural condition and social system specific in each region
Q2: Develop and disseminate technologies for energy saving and renewable energy use
Q3: Continue research on sustainable countermeasures for global warming, Asian recycling-oriented society, global sustainability, and development of various energies through IR3S, TSCP etc.
Q4: Exchange information on research, education and practice among member universities
Q5: Seek for resources both by each university’s independent and joint efforts
Q6: Expand partnerships developed by existing projects (IR3S, TSCP)
Q7: Overcome limited terms of financial support to continue activities