LCA in Japan
Progresses and Challenges
in the past quarter century

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Chiba University

- Established in 1949
- 11 Graduate Schools (Law School, Graduate School of Engineering, Science, Advanced Integration Science, Medicine, Nursing, Pharmaceutical Science, Humanities and Social Science, Education, Horticulture, etc.)
- 10 Undergraduate Schools, 4 Affiliated Schools
- 1,335 Faculty (Professors, Ass. Professors)
- 3,461 Graduate students
- 10,702 Undergraduate students
Yasunari Matsuno

• Graduated from The University of Tokyo with Dr. Eng. in 1996
• Joined AIST in 1996-2004
• Joined The University of Tokyo 2004-2015
• Joined Chiba University in 2016
• Board member of Institute LCA, Japan since 2005
Driving forces for LCA

- Reduction of GHGs emissions
  - Kyoto protocol, Paris Agreement, etc.
  - Recycling laws of plastic wastes, etc.
- ISO standardization (ISO14040s, 14205 etc.)
- Scientific interests
  - Methodology, LCI, Database, LCIA, etc.
- Business model based on life cycle concepts
  - Hybrid vehicles, Electric Vehicles
- Environmental profile declaration for B to B
  - EPD, Eco-Leaf for LEED
Methods of Recycling Plastic Wastes

Mechanical Recycling

Feedstock Recycling
- Coke Oven
- Blast Furnace
- Feedstock Recycling

Energy Recovery
- Refuse Derived Fuel
- Cement Kilns
LCA in Japan and its driving forces

Interests

- Kyoto Protocol
- Paris Agreement
- ISO Standardization
- LCA Project by MITI
- ILCAJ
- LEED
- TOYOTA Eco-VAS
Driving forces for LCA

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Development Life Cycle Inventory for electricity

Matsuno Y. and Betz M. (2000) Int. J LCA

-Fuel supply chain inventory
-Fuel Characteristics like
• heat value (higher and lower)
• ash content
• water content

-Chemical characterization
• sulfur content
• minerals and heavy metals

Individual Inventory of the Energy product:
Primary Energy Consumption
Aux. material use (limestone...)
Water Consumption
Calculated Emissions:
• CO$_2$
• NO$_x$
• SO$_2$
• Dust
• heavy metals
• Hg

Characteristics/Parameters of Energy Transformation Unit:
Types (PP, CHP, Boiler)
Products/Allocations
Efficiency
Cooling system
Combustion Chamber
Abatement Technologies
dry/wet scrubbing (efficiency)
SCR...

Methodology is based on Mass & Energy conservation!
Development of Life Cycle Inventories for Electricity Grid Mixes in Japan

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Abstract. Since most industrial processes consume electricity, it is quite important to develop reliable inventory data for electricity. There is, however, a problem that only a few figures concerning emissions related to electricity have been reported. In this work, process models of power plants were developed for the Japanese situation which simulate the mass flows and estimate the missing figures of emissions dependent on technical parameters of the plants and fuels. In Japan, electricity is supplied to the various regions by 10 electric companies. Therefore, life cycle inventories for the electricity grid mixes of the 10 electric companies in 1997 were developed. The functional unit is 1 kWh of electricity distributed to electricity users in each region. The emission of CO₂, SO₂, NOₓ, CH₄, CO, non-methane volatile organic compound (NMVOC), dust (all particulates) and heavy metals (Ni, V, As, Cd, Cr, Hg, Pb, Zn) from power stations as well as those from fuel production and transport were investigated. Other pollutants into air, emis-

Introduction

In accordance with progress in the standardization of methodologies in the ISO-14040s, life-cycle assessment (LCA) has received much attention in Japanese industries. Most industrial processes consume electricity. It is often found that electricity consumed during use of electrical appliances predominates in the total primary energy consumption and emissions of these products’ life cycles [1-2]. Thus, the results of inventory analyses of industrial products are usually sensitive to data on electricity. So, it is quite important for LCA practitioners to develop reliable life-cycle inventories (LCI) for electricity. There is, however, a problem that only a few figures concerning emissions related to electricity have been reported. One solution is to develop process models for power plants which simulate the mass flows and esti-
Less mercury in Fluorescent lamps enhances more mercury emissions from coal fired power plants.

Data for 2010 from the 2013 UNEP Global Mercury Assessment
Accidents at the Fukushima nuclear power plants following the Great East Japan Earthquake March 2011
GWP for electricity grid mix in Japan during 2004-2015

GWP for 1 kWh of electricity grid mix in Japan (kg-CO2 eq./kWh)
Fig. Disability-adjusted life year, DALY, caused by the Fukushima accident of Nuclear Power Plant (I131 and Cs137)

Driving forces for LCA

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  — Methodology, LCI, Database, LCIA, etc.
• Business model based on life cycle concepts
  — Hybrid vehicles, Electric Vehicles
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TOYOTA Eco-VAS since 2005
### Environmental labeling programmes

#### Indicators of Product Evaluation

<table>
<thead>
<tr>
<th>Performance +</th>
<th>Price +</th>
<th>Function +</th>
<th>Design +</th>
<th>Environmental Info</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

#### Environmental labelling and declarations

<table>
<thead>
<tr>
<th>Type I (ISO14024)</th>
<th>Type II (ISO14021)</th>
<th>Type III (ISO14025)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment label with a set of criteria</td>
<td>Self-declared environmental claims by businesses</td>
<td>Disclosure of quantified data on environmental impacts of products</td>
</tr>
</tbody>
</table>

#### Users (consumers and institutional purchasers)

- Which product is environmentally preferable?
- What is environmentally superior about the product?
- What are the environmental impacts of the product?

#### Providers (businesses)

- 3rd party certified (fulfillment of criteria)
- 3rd party verified (verification of data)

#### Examples

- Eco Mark (Japan)
- Blue Angle (Germany)
- Canon (Japan)
- Hitachi (Japan)
- Int'l EPD System (Sweden)
- EcoLeaf (Japan)
- CFP Program (Japan)
Quantification of environmental impacts by LCA

LCA is a method of quantitatively evaluating the inputs (resources), the outputs (environmentally harmful substances), and the potential impacts of a product on the earth and ecosystem throughout the product life cycle.

**Life Cycle Inventory Analysis (LCI)**

- **Input (inventory)**
  - Natural resources
  - Energy
    - Crude oil
    - Phosphate ore
    - Iron
    - Groundwater
    - etc

- **Product life cycle**
  - Extraction of raw materials
  - Manufacturing
  - Distribution
  - Use/Maintenance
  - Disposal/Recycle

- **Output (inventory)**
  - Release to the atmosphere
  - Release to water bodies
  - Solid waste, product, co-product

- **Inventory amount per unit amount**
  - CO2
  - SOx
  - COD
  - Landfill

**Activity Data x Base unit**

- Amount of materials or energy quantity that causes environmental impacts.
- Providers obtain activity data such as material usage, power consumption, landfill amount.

- Inventory amount per unit amount (amounts of crude oil, iron ore, CO2 emissions, etc.)

**Life Cycle Impact Assessment (LCIA)**

- **Classification**
- **Characterization**
- Multiply by characterization factor

- **Impact Assessment**
  - Global warming
  - Acidification
  - Eutrophication

**EcoLeaf**

- * aggregated dataset (accumulated system dataset)
Number of verified EPD for construction products (EN15804 EPD)

Jane Anderson et al., BRE’s Green Guide to Specification
Incentives in obtaining EPD

• California Bill To Require EPDs for Building Materials in State Projects from January 2019.
• Focusing on steel, rebar, flat glass and mineral wool board insulation

LEED: **Leadership in Energy & Environmental Design**

- LEED is one of the most popular green building certification programs developed by U.S. Green Building Council (USGBC).
- It includes a set of rating systems for Building Design and construction, Interior Design and Construction, etc.
- LEED-certified spaces use fewer energy and water resources; save money for families, businesses and taxpayers; reduce carbon emissions; and prioritize environmental and human health.
- EPDs for more than 5 companies and 20 products can contribute to some points.
# LEED: Leadership in Energy & Environmental Design

Table Countries in terms of cumulative LEED-certified GSM space as of December 2016

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country name</th>
<th>Gross Square Meters (million m(^2))</th>
<th>Number of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States of America</td>
<td>336.84</td>
<td>27,699</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>34.62</td>
<td>931</td>
</tr>
<tr>
<td>3</td>
<td>Canada</td>
<td>34.39</td>
<td>2,586</td>
</tr>
<tr>
<td>4</td>
<td>India</td>
<td>15.90</td>
<td>644</td>
</tr>
<tr>
<td>5</td>
<td>Brazil</td>
<td>7.43</td>
<td>380</td>
</tr>
<tr>
<td>6</td>
<td>Republic of Korea</td>
<td>5.95</td>
<td>97</td>
</tr>
<tr>
<td>7</td>
<td>Taiwan</td>
<td>5.66</td>
<td>99</td>
</tr>
<tr>
<td>8</td>
<td>Germany</td>
<td>5.03</td>
<td>215</td>
</tr>
<tr>
<td>9</td>
<td>Turkey</td>
<td>4.78</td>
<td>191</td>
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<tr>
<td>10</td>
<td>Sweden</td>
<td>3.88</td>
<td>210</td>
</tr>
<tr>
<td>11</td>
<td>United Arab Emirates</td>
<td>3.64</td>
<td>180</td>
</tr>
</tbody>
</table>

[Table Link](https://www.usgbc.org/articles/usgbc-announces-international-ranking-top-10-countries-leed)
### EPDs in Japan (JEMAI)

<table>
<thead>
<tr>
<th>Assessment</th>
<th>EcoLeaf</th>
<th>Carbon Footprint (CFP)</th>
</tr>
</thead>
</table>
|            | • Global warming  
             • Acidification  
             • Eutrophication (must include more than 3 impact categories) | • Global warming |

<table>
<thead>
<tr>
<th>Declaration</th>
<th>EcoLeaf</th>
<th>Carbon Footprint (CFP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type III environmental declaration (EPD)</td>
<td>CFP (Carbon Footprint of Products)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conforming international standards</th>
<th>EcoLeaf</th>
<th>Carbon Footprint (CFP)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Programmes specifying above international standards</th>
<th>EcoLeaf</th>
<th>Carbon Footprint (CFP)</th>
</tr>
</thead>
</table>
| EPEAT (Electronic Product Environmental Assessment Tool)  
LEED (Leadership in Energy & Environmental Design) | EPEAT (Electronic Product Environmental Assessment Tool) |
Thank you for your attention!

https://www.youtube.com/watch?v=3wBwfZvcY3U