# GHG 10
# GHG Mitigation Measures in Transportation Sector

15th February 2011

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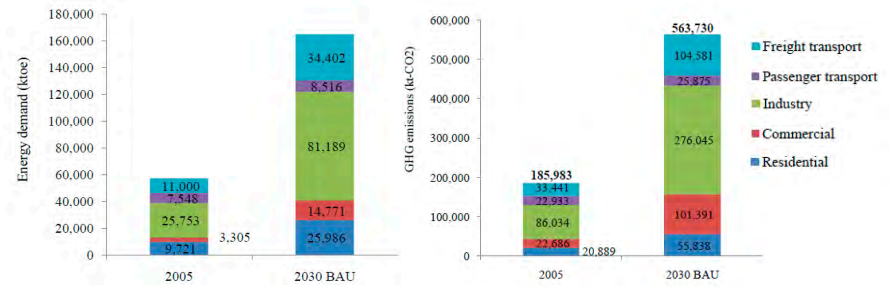
## Characteristic of GHG emissions in Transportation Sector (WG.3, IPCC-AR4)

- Transport activity, which is a key of economic development and human welfare, is increasing around the world as economies grow.
- Transport relies on a single fossil resource, petroleum that accounts 95% of total energy use of world transport.
- If there is not a major shift away from current patterns of energy use, world transport energy use is projected to increase at the rate of about 2% per year, with the highest rates of growth in the emerging economies.
- Total transport energy use and carbon emissions is projected to be about 80% higher than current levels by 2030.



## Status of Transportation Sector
### - Share of Energy Demand & GHG emission -

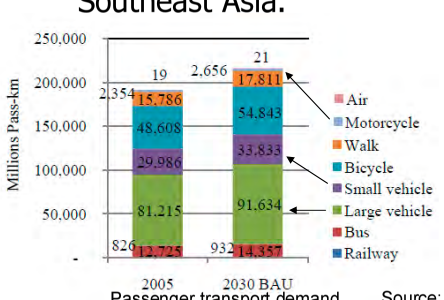
- Share of Energy Demand：32% in 2005, 26% in 2030, 2.3 times of 2005 in 2030
- Share of GHG emission：30% in 2005, 23% in 2030, 2.3 times of 2005 in 2030



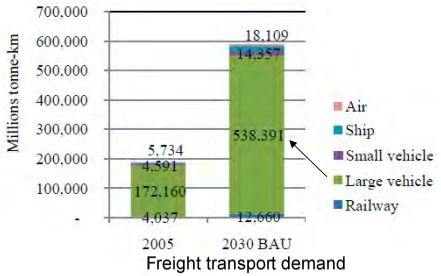

Source: Low-Carbon Society Vision 2030,Thailand,October, 2010

# Status of Transportation Sector
## -Share of Mode-

- Vehicles and motorcycle are the main mode of mobility in passenger transport in Thailand.
- The freight transport demand in Thailand is much greater than the passenger transport demand because Thailand is the largest market of pick-up vehicles in Southeast Asia.




Passenger transport demand




Freight transport demand

Source: Low-Carbon Society Vision 2030,Thailand,October, 2010



# Key mitigation measures in Road Transport

- Reducing vehicle loads
- Improving drive train efficiency
- Alternative fuels
- Mode shifts
- Improving driving practices (eco-driving)

Source:WG.3,IPCC-AR4



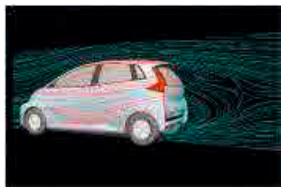


# Reducing vehicle loads

- Lightweight materials
  - Switching to High strength steels (HSS)
  - Replacing steel by lighter materials : Al, Mg, Plastic
  - Evolution of lighter design concepts and forming technologies

**Example of lightweight using Aluminum**

- Aerodynamics improvement
  - Adoption of curved surface shape and flush surfaced design by which air can flow effectively along surface of vehicle in order to reduce CD (coefficient of drag)



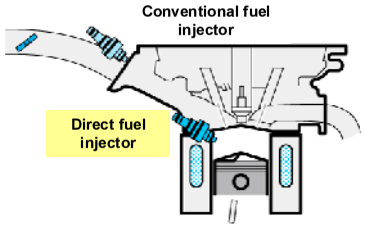
**Simulation for CD reduction**

JAMA (Japan Automobile manufactures Association)



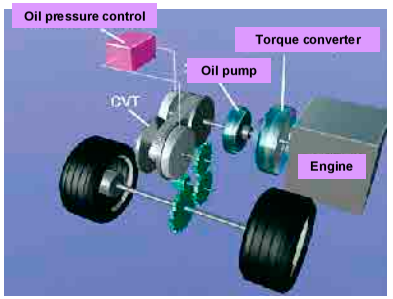
# Improving drive train efficiency

- Advanced Direct Injection Gasoline/ Diesel Engines and transmissions




Direct injection Gasoline Engine

(18% fuel consumption is reduced)



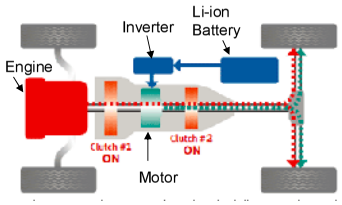

Continuous Variable Transmitter (CVT)

(Fuel economy is improved at 4-8% over a 4-speed automatic and at 13% over a manual)

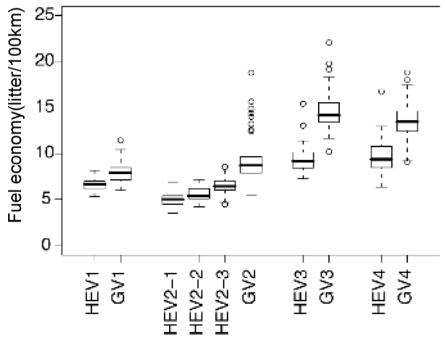
JAMA (Japan Automobile manufactures Association)

# Improving drive train efficiency

- Hybrid-electric vehicle




Hybrid system




Fuel economy of hybrid-electric vehicle (HEV) and gasoline vehicle (GV)

"Statistical Analysis of Fuel Consumption of Hybrid Electric Vehicles in Japan", (The World Electric Vehicle Association Journal,2007)

- Hybrid-electric engine obtains 40% better fuel efficiency than conventional gasoline engine.



# Alternative fuels

- Bio-fuels (Ethanol, Bio-diesel)
- Natural Gas (CNG / LNG / GTL / DME)
- Hydrogen / Fuel Cells
- Electric vehicles

Note: DME (Di-Methyl Esters), GTL (Gas To Liquids)

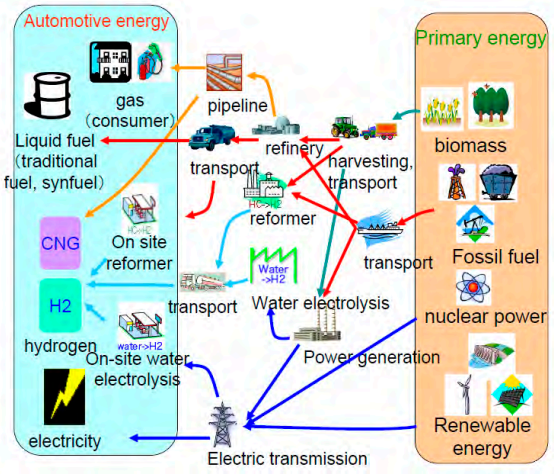
– It is important to consider Well-to-wheels $CO_2$ emission of each technologies.





# Overview of conversion routes from primary energy to automobile fuels

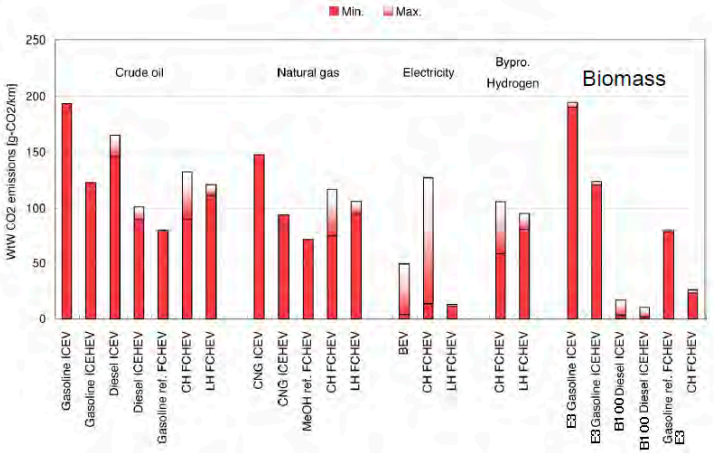
- Many paths exist to produce the final automobile fuels.




Source: "Transportation in Low Carbon Society", Yuichi Moriguchi, *"Path toward Low-Carbon Society: Japan and Asia1st session: "The results of 'Japan Low-Carbon Society Scenarios toward 2050'Project"(Feb. 12th 2009)"*



# Well to Wheel $CO_2$ Emission by technology




ICEV: Internal Combustion Engine Vehicle

ICEHEV: Internal Combustion Engine Hybrid Electric Vehicle

FCHEV: Fuel Cell Hybrid Electric Vehicle

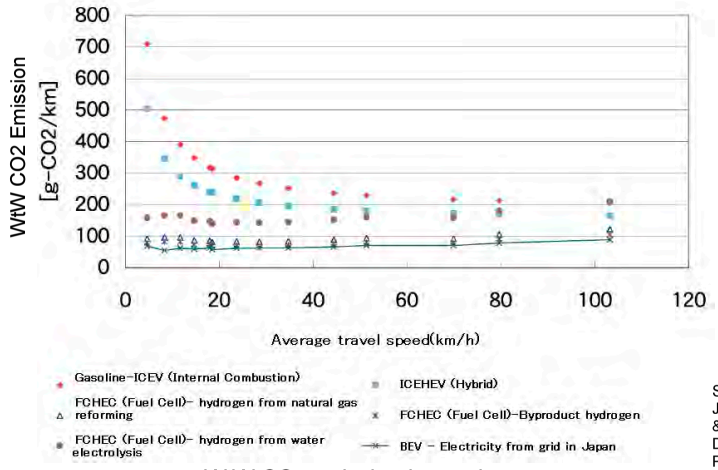
BEV: Battery Electric Vehicle( : electricity from Japan Grid)

CH: Compressed Hydrogen

LH: Liquid Hydrogen

Source: Japan Hydrogen & Fuel Cell Demonstration Project(2007)

# Well to Wheel $CO_2$ Emission by travel speed




WtW $CO_2$ emission in running

Source: Japan Hydrogen & Fuel Cell Demonstration Project(2007)



# Mode shifts

- Public transport (LRT, BRT)
  - Public transport can contribute to the social sustainability to give higher mobility to people who do not have access to car.
  - Public transport is more attractive economically because of providing more capacity at less marginal cost.

BTS

BRT

MRT

Source: global Transport Knowledge Partnership





# Load factor and $CO_2$ emission of transportation mode

- It is better to change to high load factor (occupancy rate) type of transportation to reduce vehicle fuel consumption.
- For example, passenger car change to bus, railway

| Type | Load factor (average occupancy) | CO2-eq emissions per passenger-km (full energy cycle) |
|---|---|---|
| Car (gasoline) | 2.5 | 130-170 |
| Car (diesel) | 2.5 | 85-120 |
| Car (natural gas) | 2.5 | 100-135 |
| Scooter (two-stroke) | 1.5 | 60-90 |
| Scooter (four-stroke) | 1.5 | 40-60 |
| Minibus (gasoline) | 12.0 | 50-70 |
| Minibus (diesel) | 12.0 | 40-60 |
| Bus (diesel) | 40.0 | 20-30 |
| Bus (natural gas) | 40.0 | 25-35 |
| Rail Transit | 75% full | 20-50 |

Source: Sperling and Salon,2002, WG.3,IPCC-AR4



# Case of Bogota BRT Project

- TransMilenio phase II-IV (CDM registered)
- Expected number of passengers:
  - 147 mil. (2006) to 547 mil. (2012)
- Applied technology
  - Dedicated bus lanes
  - Euro II and Euro III new buses (160 persons capacity)
  - Equipped with GPS linked to the operation centre
  - Fare system using magnetic ticketing
- Completed Infrastructure (as of 2009)
  - Americas, NQS, Suba route in Phase II (Totally 42.3km)

Source: PDD of BRT Bogotá, Colombia: TransMilenio Phase II-IV, grütter consulting

# Case of Bogota BRT Project

- Monitoring has been conducted from year 2006

| year | Number of Passengers | Fuel consumption (litters) | CO2 reduction (tCO2e) |
|---|---|---|---|
| 2006 | 94 million | 14 million | 59,020 |
| 2007 | 114 million | 17 million | 70,109 |
| 2008 | 118 million | 19 million | 68,813 |
| 2009 | 134 million | 20 million | 79,326 |

Source: Monitoring report of BRT Bogotá, Colombia: TransMilenio Phase II-IV, grütter consulting

- Monitoring items
  - Fuel consumption of bus measured in filling stations managed by operators
  - Actual travel distance of bus measured by GPS
  - Number of passengers measured by ticketing system
  - Baseline average trip distance of passengers measured by interview survey in station
  - Baseline share of passenger cars using fuel type measured by interview survey in station
  - Baseline share of transport mode used by passengers measured by interview survey in station



# Improving driving practices (eco-driving)

- Fuel consumption of vehicles depends on driving practices.
- Following fuel-efficient driving practices can reduce fuel consumption.
  - Smoother deceleration/ acceleration
  - Keeping engine revolution low
  - Shutting off the engine when idling
  - Reducing maximum speeds
  - Maintaining proper tyre pressure

source: IEA,2001





# How to estimate $CO_2$ emission in road transport

- Equation

$$\frac{CO_2}{capita} = \frac{TransServ}{capita} \times \frac{Pkm(Tkm)}{TransServ} \times \sum_{Mode}\left(\frac{Vkm}{Pkm(Tkm)} \times \frac{Fuel}{Vkm} \times \frac{CO_2EF}{Fuel}\right)$$

(a) (b) (c) (d) (e) (f)

**Note: TransServ:transport-service, Pkm:passenger-km, Tkm:ton-km, Vkm:vehicle-km**

Viewpoint of mitigation:

a) Demand management (ex. Information/communication technology to optimize the move for commuting, shopping, and freight transport)
b) Improve accessibility (ex. change to compact city)
c) Mode shift (ex. change to bus or railway from passenger car)
d) Improve load factor (ex. increase number of passenger/freight per one vehicle)
e) Improve fuel economy (ex. change to higher fuel economy car like hybrid-car, eco-driving)
f) Introduce low carbon energy (ex. change to bio-fuels, natural gas, electric car)

Source: "Transportation in Low Carbon Society", Yuichi Moriguchi, *"Path toward Low-Carbon Society: Japan and Asia1st session: "The results of 'Japan Low-Carbon Society Scenarios toward 2050'Project"(Feb. 12th 2009)"*



# Let's try to estimate $CO_2$ reduction in Blue Line Project

- Project description:
  - Route: Hua Lamphong - Bang Kae (14km) and Bangsue - Tapra (13km)
  - Expected Traffic: 443,000 passengers/day in 2016
- Data/ information for estimation

| Traffic mode | Emission Factor (gCO2/km) *1 | Occupancy Rate (passengers) *2 | Emission Factor per Passenger-Km (gCO2/PKM) | Share of mode (%) |
|---|---|---|---|---|
| Bus | 1,034 | 40.59 | 25.47 | 53.4 |
| Private car | 192 | 1.93 | 99.48 | 23.9 |
| Taxi | 175 | 0.77 | 227.27 | 4.1 |
| Motorcycle | 49 | 1.37 | 35.77 | 5.4 |

*1 Based on measurement of chassis dynamo test study(2003)
*2 Based on JBIC interview survey

| | | |
|---|---|---|
| Electricity consumption of MRT per passenger | 0.39 | kWh/passenger (Based on current blue line) |
| CO2 EF of Thai National Grid | 0.5812 | tCO2/MWh |

Source: PDD of blue Line, OTP, Khon Kaen University

# Result of estimation

- Baseline emission

| Traffic mode | Emission Factor per Passenger-Km (gCO2/PKM) | Number of Passenger (passengers/day) | Share of mode (%) | Baseline trip distance using traffic mode *1 (km) | BEy ($tCO_{2e}$/yr) |
|---|---|---|---|---|---|
| Bus | 25.47 | | 53.4 | 7.3 | |
| Private car | 99.48 | | 23.9 | 7.3 | |
| Taxi | 227.27 | | 4.1 | 7.3 | |
| Motorcycle | 35.77 | | 5.4 | 7.3 | |
| Total | | 443,000 (in year 2016) | | | |

*1 Based on interview survey by MRTA

- Project emission
  $=443{,}000 \times 0.39 \times 0.5812 \times 365/1000$ = [ ] $tCO_{2e}/y$
- Emission reduction
  = [ ] − [ ] = _____ $tCO_{2e}/y$

Source: PDD of blue Line, OTP, Khon Kaen University



# Key mitigation measures in Rail Transportation

- Reducing aerodynamic resistance
  - Optimum shape of train using computer simulation
- Reducing train weight
  - Aluminum car bodies, lightweight bodies and lighter propulsion equipment
- Regenerative braking
- Higher efficiency propulsion system

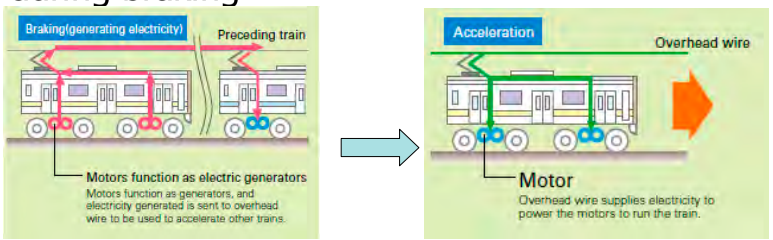
Source:WG.3,IPCC-AR4





# Regenerative braking

- Regenerative brake system generates electricity during braking



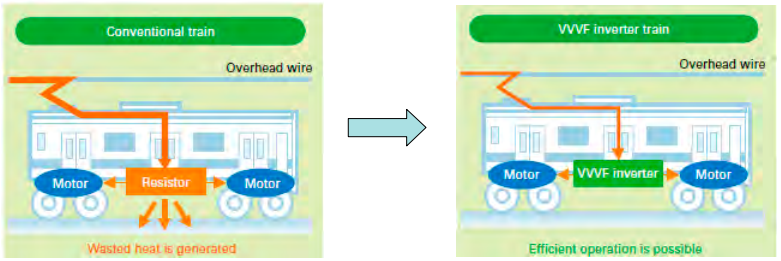

Motors of an energy-efficient railcar function as electric generators when brakes are applied, and electricity generated in this process is transmitted to the overhead wire, making more efficient use of this energy.
In case of a conventional railcar, energy generated by applying brakes is simply discharged as heat.

Source: JR East Group Sustainability Report 2009, Japan



# Higher efficiency propulsion system

- VVVF (variable voltage/ variable frequency) inverter control




In train running, resistors control voltage for motor. It generates waste heat.

A VVVF (variable voltage/variable frequency) inverter can control electricity without generating waste heat.
It makes train operation more efficient.

Source: JR East Group Sustainability Report 2009, Japan

# Case of low GHG emitting rolling stock in Delhi Metro

- Installing regenerative brake to 70 rolling stock
- CDM registered, Monitoring started from December,2007
- Monitoring items
  - Total Energy consumed in rolling stock (kWh) measured by TIMS (Train Integration and Management System)
  - Total energy regenerated in rolling stock (kWh) measured by TIMS
  - Total distance covered (km) measured by TIMS
- $CO_2$ emission reduction calculation
  = Total energy regenerated (kWh) * Emission Factor of grid (0.8t$CO_2$/MWh) /1000

| Monitoring period | Total Energy consumed (kWh) | Total energy regenerated (kWh) | CO2 reduction (tCO2) |
|---|---|---|---|
| 1st Feb 2008 – 31th Dec 2008 | 127,120,021 | 44,118,987 | 35,295 |
| 1st Jan 2009-31th Dec 2009 | 154,212,454 | 54,689,155 | 43,751 |

Source: Monitoring report of Installation of Low Green House Gases (GHG) emitting rolling stock cars in metro system, DELHI METRO RAIL CORPORATION (DMRC)



# Key mitigation measures in Aviation

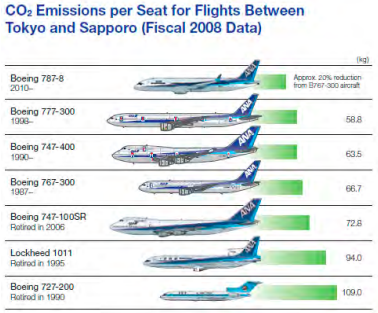
- Improving energy efficiency in engine and aircraft
  - introducing fuel-efficient engines with the latest technologies,
  - reducing air resistance through improved wing designs, and
  - reducing fuselage weight through the use of composite materials.
- Making flight more fuel efficient
  - taxiing with engines shut down
  - Use of ground sourced power and ground based air-conditioning (GPU)
  - Use of navigation system

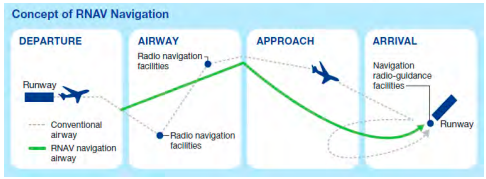




# GHG mitigation measures of Aviation


Source: JAL CSR Report 2009, Japan




Source: ANA CSR Report 2009, Japan

RNAV: aRea NAVigation)



# Key mitigation measures in Shipping

- Improving energy efficiency in engine and ship:
  - Reuse of lost energy from the swirl flow
  - Reduction of abrasion resistance of ship body

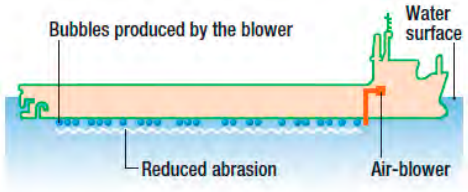
# GHG mitigation measures of Shipping

MHI-ASI attached just forward of the propeller

**Energy conservation device:**
Multi blade device can be attached to the ship's hull just in front of the propeller.

It can catch the lost energy from the swirl flow generated by propeller rotation.

It can save 5% of fuel consumption.




**Air lubrication system:**

System has an air blower at the front of the ship's hull. It blows the air over the ship bottom.

The ship bottom is covered with bubbles that lubricate against the seawater and resultantly reduce abrasion resistance.

It can reduce CO2 on the order of 10%.

Source: NYK Group CSR Report 2010, Japan



# International Shipping

- Implementation of mitigation measures of international shipping is in charge of the International Maritime Organization (IMO).
- IMO has started to consider the Implementation of mitigation measures of international shipping under UNFCCC/KP.
- However, there is no target setting for the international shipping until COP16.
- 870 mt-CO2/year in 2007 (2.7%)





International Shipping:

# Technological operational potential for reduction of GHG emissions

- Improving energy efficiency by ship design
  - Hull and superstructure
  - Propeller
- Energy saving by operations
- Renewable energy sources
  - biofuels, LNGs



International Shipping:

# Technological operational potential for reduction of GHG emissions

Figure A2.3 A CFD analysis of wind resistance (CFD Norway)


Source:
Second IMO GHG Study 2009

# International aviation

- Implementation of mitigation measures of international aviation is in charge of the International Civil Aviation Organization (ICAO).
- ICAO has started to consider the Implementation of mitigation measures of international aviation under UNFCCC/KP.
- However, there is no target setting for the international shipping until COP16.
- 600 mt-CO2/year (domestic and international) in 2006 (2.0%)



International Shipping:

# Technological operational potential for reduction of GHG emissions

- Improvement in fleet fuel efficiency
  - 0.8% per annum in the period to 2050
- Use of biofuels in aviation
- GHG management at airports
- Modal shift and videoconferencing.....

# Carbon Footprint 1 and 2:

# Overview of carbon footprint concept, current situation of the system in the world, and LCA related issues

12th October 2010

Deputy Chief Advisor of JICA Expert Team
**Kazuhito YAMADA**

JICA Expert Team
**Mariko FUJIMORI**



## Objectives of this section

**Objectives of this section are:**

- To understand basic concept of carbon footprint,
- To understand applied carbon footprint systems in other organizations/countries,
- To understand carbon footprint system in Thailand,
  **(by Ms. Phakamon Supappunt)**
- To understand LCA related issues, and
- To discuss future issues to improve the carbon footprint system in Thailand.

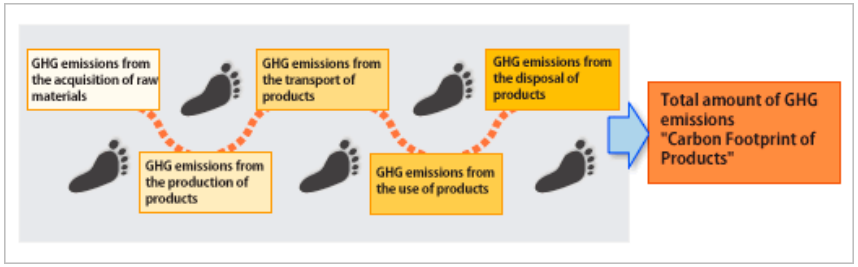


## What is "Carbon Footprint (CFP)"?

- Concept
  Lifecycle $CO_2$ (GHG) emissions of goods and services.
  - Lifecycle: from cradle to grave
  - Footprint: load (to the earth) by human activities
- Structure
  - Targeted product or service
  - Calculation methodology (Product Category Rules: PCR)
  - Certification
  - Label



## What is "Carbon Footprint (CFP)"?





http://www.cfp-japan.jp/english/about/about.html

# What is “Carbon Footprint (CFP)”?

## History

1990s: Ecological Foot Print (EF)

Footprints to: Cropland, Fishing grounds, Forest land, Built-up land, Grazing land, and Carbon

EFc(consumption)

= EFp(production) + (EFi(import) - (EFe(export))

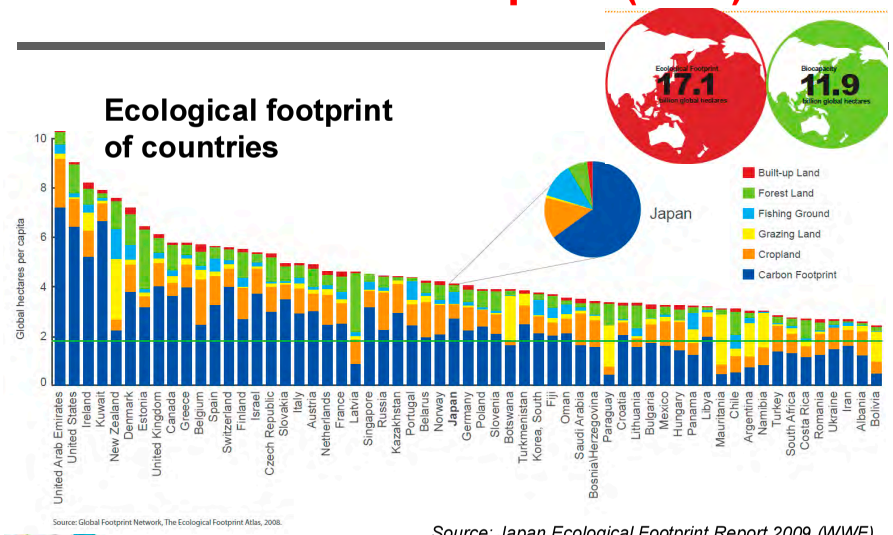
∨

Biocapacity (indicates the regeneration of resources and the waste absorption that land can provide)

*Source: Japan Ecological Footprint Report 2009 (WWF)*



# What is “Carbon Footprint (CFP)”?




*Source: Japan Ecological Footprint Report 2009 (WWF)*



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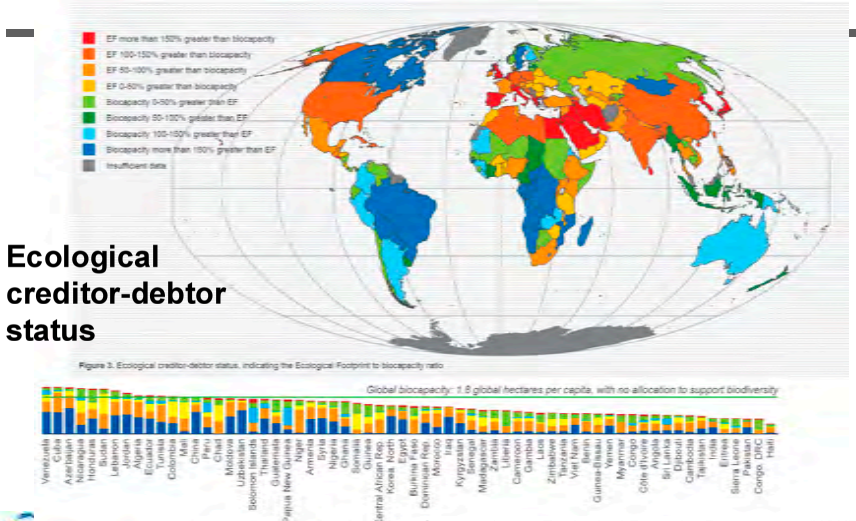
# What is “Carbon Footprint (CFP)”?




*Source: Japan Ecological Footprint Report 2009 (WWF)*



# What is “Carbon Footprint (CFP)”?

After 1997 (COP3), and until IPCC AR4 (2007):

- Difficulties of ecological footprint, including multi sectors,
- Awareness raising about the importance of climate change,
- - -

2006: DEFRA* in UK has established Carbon Trust (Non-profit company)

2007: DEFRA, Carbon Trust and BSI* have started Publicly Available Specification: PAS 2050

2007: ISO has started discussion for standardization

*DEFRA: Department for Environment, Food and Rural Affairs*
*BSI: British Standards Institution*

# Present condition of CFP in the world

## ISO

- ISO 14040/44: Environment management - LCA
- ISO 14025: Environmental labels and declarations
- ISO 14067: Carbon footprint of products (under Committee Draft)
- ISO 14069: Carbon footprint of organizations (under Working Draft)

--> They will be established until November 2011 or 2012.

NWIP: New Work Item Proposal
PWI: Preliminary Work Item
AWI: Approved Working Item
WD: Working Draft
CD: Committee Draft
DIS: Draft International Standard
FDIS: Final Draft International Standard

Source: http://www.iso.org/



# Present condition of CFP in the world

## PCF* World Forum

*PCF: Product Carbon Footprints

- A platform for the most notable of initiatives from Europe, the United States and Asia to come together and share their experiences,
- By developing standards for assessing carbon footprints and overall environmental performance of goods and services,
- By providing frameworks for reducing GHG emissions related to life cycles of goods and services,
- By working on suitable instruments for informing consumers and customers about climate-conscious consumption,
- Austria, EU, Germany, Japan, Korea, NZ, Sweden, Thailand, UK, USA, etc.

Source: http://www.pcf-world-forum.org/





# Present condition of CFP in the world

## United Nations

### UN system facilities and travel

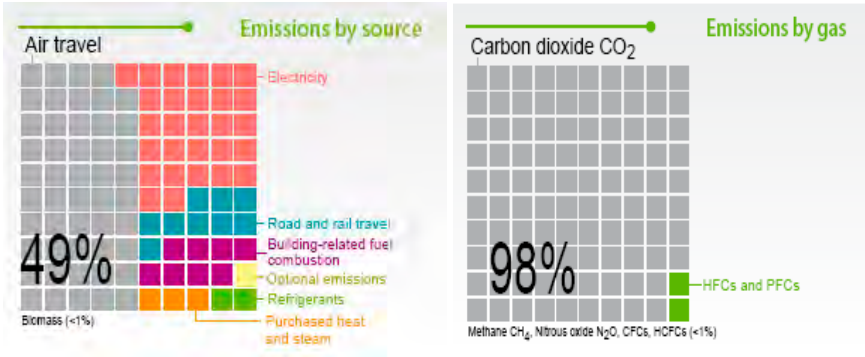
| | key figures 2008 |
|---|---|
| Total emissions | 769'108 t $CO_2$eq |
| Emissions per staff member | 8.3 t $CO_2$eq |
| Air travel per staff member | 4.0 t $CO_2$ |
| Number of staff | 92'748 |

Source: Moving Towards a Climate Neutral UN The UN system's footprint and efforts to reduce it (UNEP, 2009)



# Present condition of CFP in the world

## United Nations




Source: Moving Towards a Climate Neutral UN The UN system's footprint and efforts to reduce it (UNEP, 2009)

# Present condition of CFP in the world

## UNFCCC

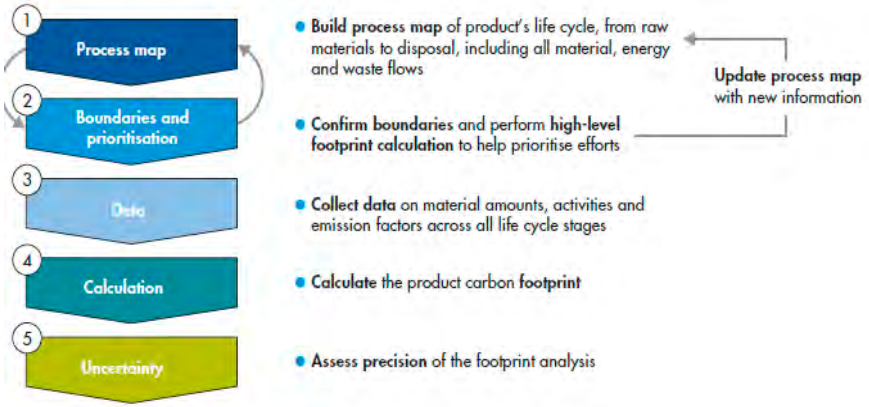
| Key figures | |
|---|---|
| Total emissions | 1'687.2 t $CO_2$eq |
| Emissions per staff member | 4.5 t $CO_2$eq |
| Air travel per staff member | 3.6 t $CO_2$ |
| Air travel per staff member | 22'010 km |
| Office-related emissions per m² | 0.5 kg $CO_2$eq |

Source: UNEP, 2009




# Present condition of CFP in the world

## United Kingdom




Source: Guide to PAS 2050



# Present condition of CFP in the world

## United Kingdom

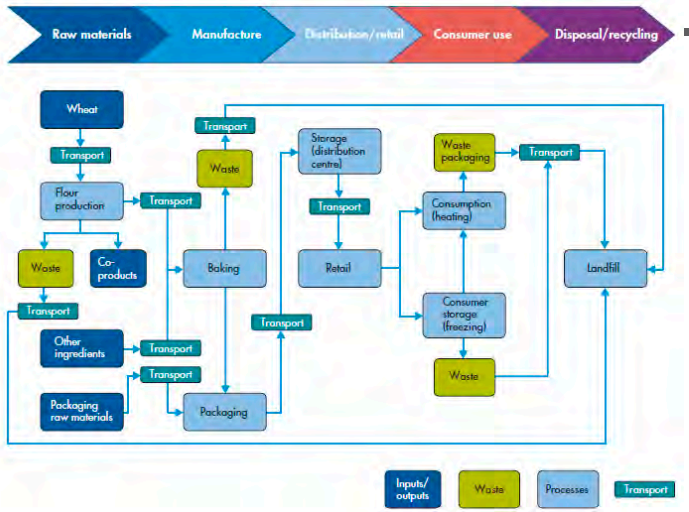

*Process map steps for business-to-consumer goods*


*Process map steps for business-to-business goods*

Source: Guide to PAS 2050



# Present condition of CFP in the world




Source: Guide to PAS 2050

# Present condition of CFP in Japan (1)

2008
- June; Cabinet decision "Japan As a Low-Carbon Society"
- METI started the pilot project

2009
- National Pilot Project has started
  "Basic Guideline of the Carbon Footprint of Products"
  "Guide of Establishing Product Category Rules"

2010
- 2nd year of the Pilot Project - revision of the general instructions.

2011
- Final year of the Pilot Project.

Source: Prof. Inaba: Carbon Footprint of Products in Japan (2010)



# Present condition of CFP in Japan (2)
## *- How to apply for CDP label*

Phase 1: Application for Registration of Draft PCR Development Plan

- PCR defines the criteria for the CFP calculation and labeling method.
- A company propose a PCR development plan and submit it to the secretariat.
- If it is registered, the plan is released through the website.


*http://www.cfp-japan.jp/english/about/about.html*



# Present condition of CFP in Japan (3)
## *- How to apply for CDP label*

Phase 2: Application for PCR Approval

- A company propose a developed PCR.
- The PCR will be approved through public comment and review by the PCR committee.
- The approved PCR is released on the website.


*http://www.cfp-japan.jp/english/about/about.html*



# Present condition of CFP in Japan (4)
## *- How to apply for CDP label*

Phase 3: Application for PCR Verification

- A company calculates the CFP based on the approved PCR, and applies for the verification.
- The PCR Committee verifies the submitted results.


*http://www.cfp-japan.jp/english/about/about.html*

## Present condition of CFP in Japan (4) - *How to apply for CDP label*

Phase 4:

- If it is considered appropriate, the permission to use the CFP label is granted to the applicant.
- The CFP label can be used for the product in the market.




## Present condition of CFP in Japan (4) - *How to apply for CDP label*

Support tools:

- CFP Calculation Kit: Programme and Operation Manual
- Database of GHG Emission Factors for the CFP Pilot Project

Results as of September 2010:

- Registered PCR Plans: 83
- Approved PCRs: 72
- Permitted products/services: 94





## Present condition of CFP in Thailand

*Please enjoy the presentation by Phakamon-san!*



## Agenda of LCA Part

- What is Life Cycle Assessment (LCA) ?
- What is the relationship between LCA and Carbon Foot Print (CFP) ?
- Examples of LC-$CO_2$

# What is LCA ? (1)

- Life Cycle Assessment (LCA) is method to compare **environmental impacts** of products/ technologies or services with a view to their whole life cycle;
- The emissions to all components of environment such as **$SO_2$**, **COD**, **hazardous wastes**, and **$CO_2$** during product production, use and disposal are considered;
- Processes of raw material mining, energy/material production, additional processes or sub-processes are also involved.



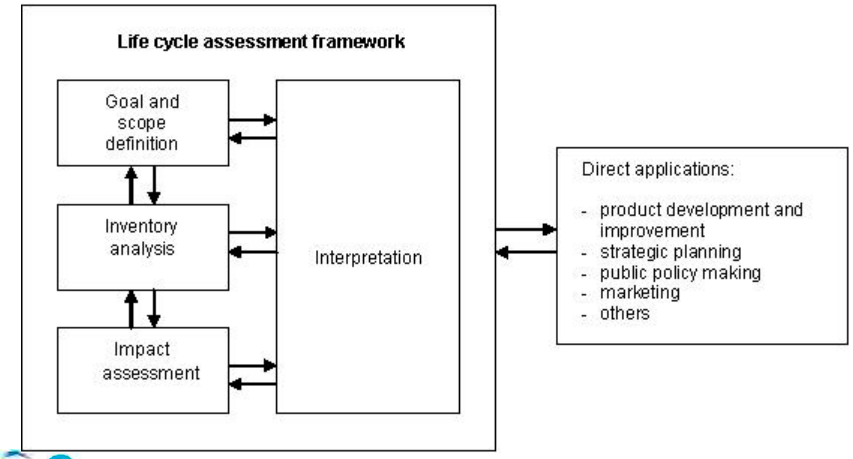
# What is LCA ? (2)

- First LCA was implemented by Coca Cola in the USA, as a comparison of returnable bottle with PET-bottle.
- LCA method has fixed structure and is practiced according to international standards **ISO 14040 and 14044** from 2006.
- The LCA method is one of the most important information tools of environmentally sound product policy.



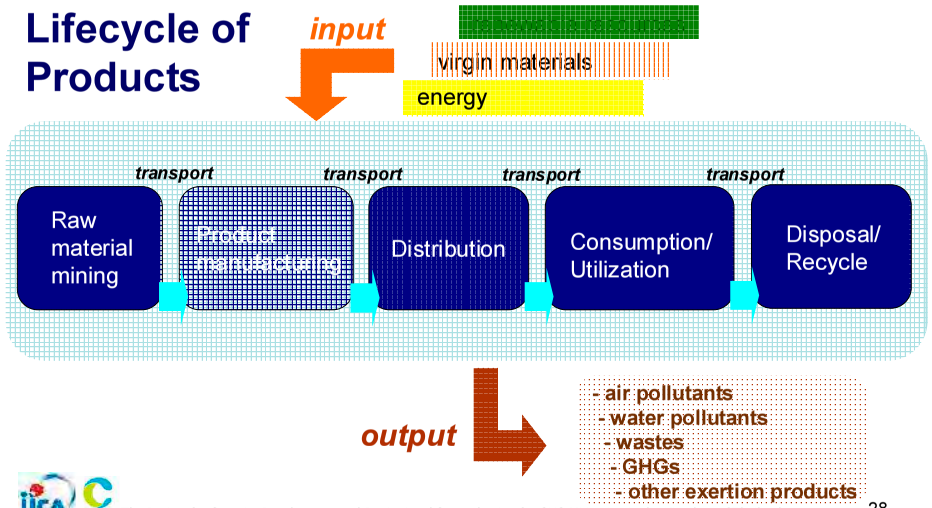


# What is LCA ? (3)






# What is LCA ? (4)



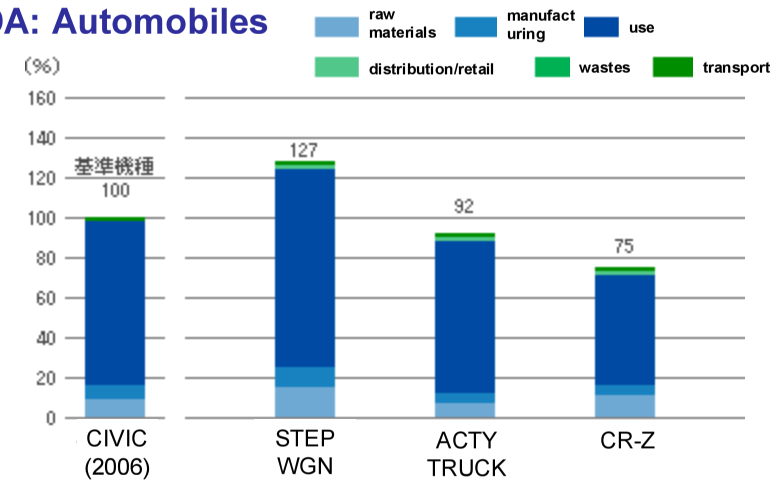
# What is the relationship between LCA and CFP ?

- LCA includes **inventory analysis** of the emissions to all components of environment such as $SO_2$, COD, hazardous wastes, and $CO_2$;
- In general, inventory analysis work of $CO_2$ in LCA is called '**LC-$CO_2$**';
- In the processes of LC-$CO_2$, the emissions to all components of $CO_2$ during raw material mining, product production, transport, use and disposal are considered;
- Therefore, we can consider the **LC-$CO_2$ as a part of technical work of 'Carbon Foot Print'**.



# Examples of LC-$CO_2$ (1)

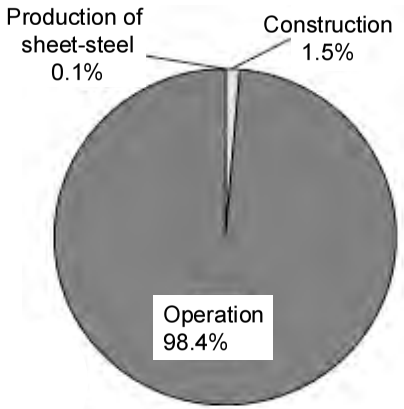
## HONDA: Automobiles






# Examples of LC-$CO_2$ (2)

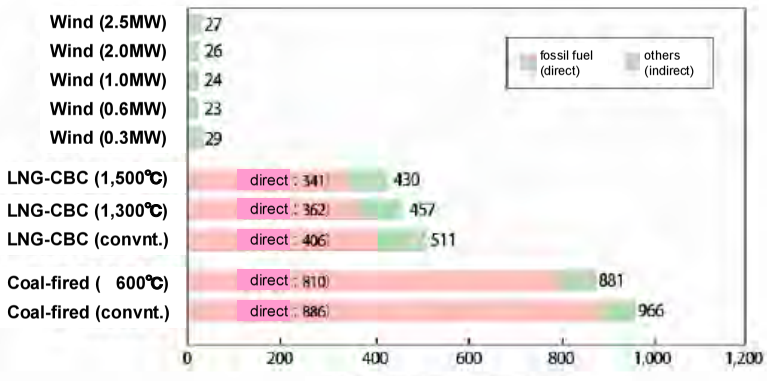
## Ships:





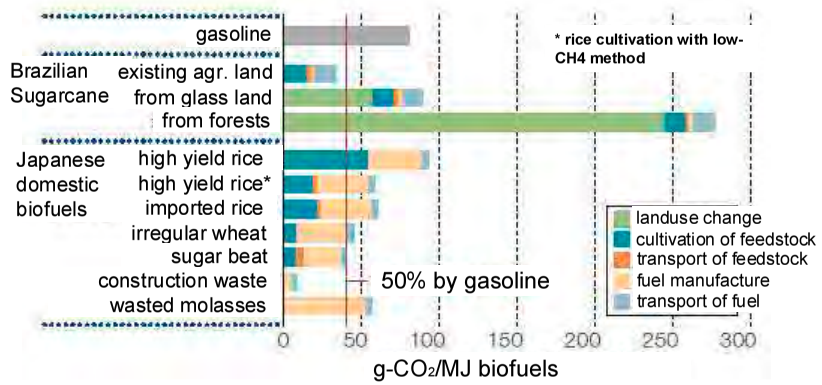

# Examples of LC-$CO_2$ (3)

## Power Plants:



# Examples of LC-$CO_2$ (4)

## Biofuels:



# Carbon Footprint 3: Calculation of Carbon Footprint

12th October 2010

Chief Advisor of JICA Expert Team
Masahiko FUJIMOTO



# Contents





## Guideline of Carbon Footprint Calculation

- **General Principles for the Assessment and Labeling of Carbon Footprint of Products (TS Q 0010) in Japan**
  - "Basic Guideline of the Carbon Footprint of Products (CFP)" which provides the calculation and communication method of the CFP etc. was compiled by the Ministry of Economy, Trade and Industry (METI) in Japan.
  - The guideline was issued as TS Q 0010 by the Japanese Industrial Standards Committee (JISC) in April 2009.



# Target GHGs

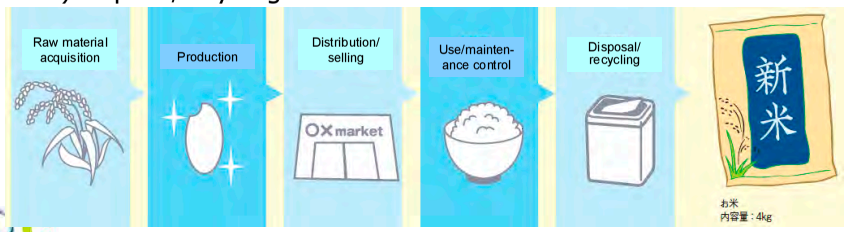
- Target GHGs:
  6 types of GHGs covered by the Kyoto Protocol, i.e.
  - $CO_2$,
  - $CH_4$,
  - $N_2O$,
  - HFCs,
  - PFCs,
  - SF6
- Emission source: all anthropogenic emission sources
- GWP (global warming potential): a 100-year time horizon of Second Assessment Report (SAR, IPCC)

Source: METI, Japan

# Calculation Coverage

- A calculation shall be basically made on throughout the whole life cycle.
  - a) Raw material acquisition,
  - b) Production,
  - c) Distribution/selling,
  - d) Use/maintenance control and
  - e) Disposal/recycling

A calculation coverage should cover the process that might be included in a range of functional unit of a product and could not be ignored from the viewpoint of the effect to whole GHG emissions.






# Calculation Method

- Equation

  GHG emissions = $\Sigma$ (activity $_i$ × GHG emission factor $_i$)
  - where "I" stands for a process
- Activity Amount
  - Primary data should be collected.
  - If unavailable, secondary can be used.
    - primary data, which are collected by organization
    - secondary data, which are referred to the common data, reference data and other LCA studies
- GHG emission factor (in case of Japan)
  - Existing LCA Database can be used.
    - LCA Japan forum, LCA database
    - JEMAI, LCA database
    - Eco leaf, emission factor data (Japan environmental management association for industry)

Source: METI, Japan



# Example Activity and Emission Factor

| Calculation stage | Example Activity | Example Emission Factor |
|---|---|---|
| **Raw material acquisition** | Quantity of material consumption | GHG emission factor to produce material per kilogram |
| **Production** | Weight as assembled | GHG emission factor to assemble material per kilogram. |
| | Consumption of electricity | GHG emission factor to generate electricity per kilowatt hour (kWh) |
| **Distribution/ selling** | Car loadings (kg × km) = transport distance × load ratio × loading capacity | GHG emission factor for product transport per kilogram × kilometer (kg × km) |
| **Use/ maintenance control** | Electricity consumption of usage | GHG emission factor to generate electricity per kilowatt hour (kWh) |
| **Disposal/ recycling** | Reclaimed mass/ recycled mass | GHG emission factor to reclaim per kilogram<br>GHG emission factor to recycle per kilogram. |

Source: METI, Japan



# Calculation Procedure

1. Life Cycle Flow Preparation:
   Describe the life cycle flow and clarify each process in stage
2. Activity Data Collection in Each Process in Stage:
   Collect Input/output data in each process in stage, clarify prior condition
3. CO2 Emission Calculation in Each Process in Stage:
   Calculate CO2 emission in stage by multiplying activity data in each process by emission factor
4. Total CO2 Emission Calculation in whole Life Cycle:
   Calculate Total CO2 Emission in whole Life Cycle.

Source: METI, Japan

# Basic Calculation Rules (1)

- **Data Collection**
  - The following items should be identified in primary data collection.
    - Target process in stage
    - Boundary of data
    - Sites (farm, field, factory, market, disposal site, etc)
    - Periods( day, month, year, season)
  - If secondary data is used, data source should be described.
  - If there are difficulties in obtaining primary and secondary data, the analogous or estimated data can be adopted with its reasonableness carefully.

Source: METI, Japan



# Basic Calculation Rules (2)

- Criterion relating to procurement of raw materials from two or more suppliers
  - In case organizations collect primary data of a specific raw material procured from two or more suppliers, the data should be collected from all the suppliers.
  - If it is difficult to do so, in case the primary data collected from a principal supplier is more than 50% of total suppliers data, it may be used as another supplier's secondary data.
- Handling of regional differences and seasonal variations
  - In case there are regional differences and seasonal variations in activity, the weighted average of primary regional and seasonal data should be applied.
  - If impossible, secondary data can be used.

Source: METI, Japan





# Basic Calculation Rules (3)

- Handling of information related to production equipment
  - The information related to production equipment should be collected only in the sections directly involved in production (direct sections).
  - In case the related indirect sections, such as an office, R&D section, etc exist at the same site of direct sections, and there are some difficulties in being cut out of emission of direct sections from all sections emission, organizations can allocate the emission of direct sections from the total emissions of site.

Source: METI, Japan



# Basic Calculation Rules (4)

- Recycled materials and reused products
  - If recycled materials or reused products are used as inputs, the GHG emissions accompanying the recycling processes (collection, preprocessing, regeneration, etc.) and reuse processes (collection, washing, etc.) should be included in the GHG emissions related to the recycled materials and reused products in the raw material acquisition stage.
  - Any emissions from recycling process and reuse process should not be double-counted in the calculation coverage.

Source: METI, Japan

# Basic Calculation Rules (5)

- Cut-off Criteria
  - The parts and materials of a certain product may be omitted from the calculation coverage, considering that they do not have a significant impact on a result of calculating GHG emissions as a whole (Cut-off Criteria)
  - A cut-off criteria is less than 5% of total CO2 emission of each stage.
- Handling of biomass
  - CO2 emissions, which are emitted upon combustion of the biomass like wood or agricultural waste, should not be included.
  - GHG emissions emitted from biomass production, transport, etc should be included.

Source: METI, Japan



# Basic Calculation Rules (6)

- Scenario setting
  - If a variety of cases in activity is assumed in stage, the common scenario can be set up in considering the following points.
    - In setting common scenario related to transportation of raw materials, products, waste, recycled materials and reused materials, it is needed to clarify the means of transport and transport distance, loading ratio by the transportation route.
    - In setting common scenario related to sales, it is needed to clarify the selling form and selling hours, turnover ratio of products.
    - In setting common scenario related to the use and maintenance control, it is needed to clarify the use and maintenance form and used hours and years, use and maintenance periods.
    - In setting common scenario related to the disposal/recycling, it is needed to clarify the method and ratio of disposal/recycling/reuse.

Source: METI, Japan





# Basic Calculation Rules (7)

- Allocation
  - In case products of two or more categories are handled in same stages of production and distribution/selling, organizations should allocate the emission of an individual product from the total emissions in each stage.
  - Allocation method is to be established according to a product and process characteristic.

    For example,
    - Physical quantity (weight) should be used for allocating energy.
    - If it is difficult to measure only the quantity (weight) of an individual product , the energy may be allocated by the sales amount.

Source: METI, Japan



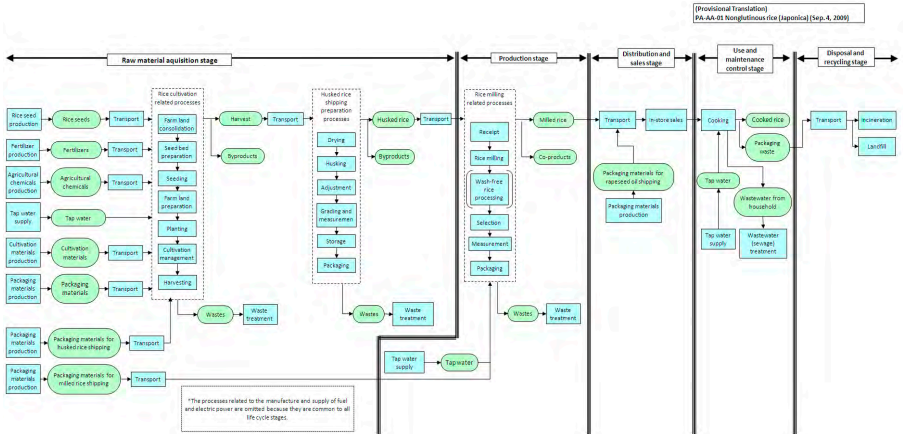
# Sample Calculation Non-glutinous Rice

- Non-glutinous rice (Japonica), AEON Co., Ltd.
  - Name of product: milled rice
  - Production site: Akita prefecture
  - Rice variety: Akita-komachi (100%)
  - Net weight: 4kg
  - Style: bagged in a plastic bag

| stages | Emission |
|---|---|
| Raw material acquisition | 3.54kg CO2e |
| Production | 0.227kg CO2e |
| Distribution/sales | 1.37kg CO2e |
| Use/maintenance control | 1.23kg CO2e |
| Disposal/recycling | 0.0516kg CO2e |
| **Total** | **6.4kg CO2e** |


Source: Detailed Information (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009

# Life Cycle Flow
(for non-glutinous rice)




Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009



# Data Collection Items 1
(for non-glutinous rice)

- Raw Material Acquisition Stage

| Process | Primary Data Items | | |
|---|---|---|---|
| **1.Rice cultivation related processes** | <Input><br>1. Rice seeds input amount<br>2. Fertilizer input amount<br>3. Agricultural chemicals input amount<br>4. Tap water input amount<br>5. Cultivation materials input amount<br>6. Packaging materials input amount<br>7. Fuel and electric power input amount | < Output and discharge><br>8. Husked rice (before adjustment) production output<br>9. By-product production output<br>10. Waste materials discharge amount | <Others><br>11. Farm land area |
| **2.Husked rice shipping preparation process** | <Input><br>1. Husked rice (before adjustment) input amount<br>2. Fuel and electric power input amount<br>3. Packaging materials input amount | < Output and discharge><br>4. Husked rice (after adjustment) production output<br>5. Byproduct production output<br>6. Wastes discharge amount | |
| **3.Husked rice transport process** | 7. Husked rice (after adjustment) transport amount<br>8. Fuel method: Fuel input amount<br>9. Fuel cost method: GHG emissions by fuel consumption per distance covered | | |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009



# Data Collection Items 2
(for non-glutinous rice)

| Process | Primary Data Items |
|---|---|
| **4.Waste treatment processes** | 10. Wastes discharge |
| **5.Common** | Life cycle GHG emissions related to the supply and use of fuel and electric power for in-house production |

| Items | Primary or Secondary Data Items |
|---|---|
| **1. Emissions from rice cultivation related processes** | 1. Methane (CH4) from soil<br>2. Nitrous oxide (N2O) from nitrogenous fertilizer |
| **2.GHG emissions by fuel consumption at the husked rice transport process** | 3. Improved ton-kilometer method: GHG emissions by fuel consumption per transport ton kilometer<br>4. Improved ton-kilometer method: Loading ratio<br>5. Common: Transport distance |
| **3.Life cycle GHG emissions related to the manufacture and transport of inputs to the rice cultivation related processes** | 6. Life cycle GHG emissions related to the manufacture and transport of rice seeds<br>7. Life cycle GHG emissions related to the manufacture and transport of fertilizers<br>8. Life cycle GHG emissions related to the manufacture and transport of agricultural chemicals<br>9. Life cycle GHG emissions related to the supply of tap water<br>10. Life cycle GHG emissions related to the manufacture and transport of cultivation materials (wooden, plastic, metallic, and stone materials) |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009



# Data Collection Items 3
(for non-glutinous rice)

| Items | Primary or Secondary Data Items |
|---|---|
| **4.Life cycle GHG emissions related to the manufacture and transport of inputs to the shipping preparation processes** | 11. Life cycle GHG emissions related to the manufacture and transport of packaging materials for shipping husked rice |
| **5.Life cycle GHG emissions related to the manufacture and transport of inputs to the rice milling related processes at the production stage** | 12. Life cycle GHG emissions related to the manufacture and transport of packaging materials for shipping milled rice |
| **6.Life cycle GHG emissions related to the treatment of discharge** | 13. Life cycle GHG emissions related to the treatment of wastes |

| Process | Secondary Data Items |
|---|---|
| **Common** | Life cycle GHG emissions related to the supply and use of fuel and electric power acquired from outside |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009

# Data Collection Items 4 (for non-glutinous rice)

- Production Stage

| Process | Primary Data Items | | |
|---|---|---|---|
| **Common** | <Input><br>1. Husked rice input amount<br>2. Packaging materials input amount<br>3. Fuel and electric power input amount<br>4. Tap water input amount<br>5. Other materials input amount | < Output and discharge><br>6. Milled rice production output<br>7. Co-product (cracked rice, etc.) production output<br>8. Wastes discharge<br>9. Wastewater discharge amount | <Others> |

| Process | Primary or Secondary Data Items |
|---|---|
| **Common** | Life cycle GHG emissions related to the supply of tap water<br>Life cycle GHG emissions related to the treatment of wastes<br>Life cycle GHG emissions related to the treatment of sewage |

| Process | Secondary Data Items |
|---|---|
| **Common** | Life cycle GHG emissions related to the supply and use of fuel and electric power acquired from outside |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009



# Data Collection Items 5 (for non-glutinous rice)

- Distribution and Sales stage

| Process | Primary Data Items |
|---|---|
| **Transport process** | - Common: Milled rice transport amount<br>- Fuel method: Fuel input amount<br>- Fuel cost method: GHG emissions by fuel consumption per distance covered<br>- Common: Usage of materials used for transport |
| **Store sales process** | - Waste materials used for transport generation amount |

| Process | Primary or Secondary Data Items |
|---|---|
| **Transport process** | -Improved ton-kilometer method: GHG emissions by fuel consumption per transport ton kilometer<br>-Improved ton-kilometer method: Loading ratio<br>-Common: Transport distance<br>-Common: Life cycle GHG emissions related to the manufacture and transport of materials used for transport |
| **In-store sales process** | -Life cycle GHG emissions related to the supply of fuel and electric power necessary for the in-store sales process<br>-GHG emissions accompanying the transport and disposal of packaging waste |

| Process | Secondary Data Items |
|---|---|
| **Common** | Life cycle GHG emissions related to the supply and use of fuel and electric power |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009





# Data Collection Items 6 (for non-glutinous rice)

- Use and Maintenance Control Stage

| Process | Primary Data Items |
|---|---|
| **Common** | 1. Milled rice input amount |

| Process | Secondary Data Items | | |
|---|---|---|---|
| **Common** | <Input><br>2. Power input amount to rice cooker 3. Water input amount (washing)<br>4. Water input amount (cooking) | < discharge><br>5. Discharge amount (washing) | <Others><br>6. Life cycle GHG emissions related to the supply of tap water<br>7. Life cycle GHG emissions related to the treatment of household wastewater<br>8. Life cycle GHG emissions related to the supply and use of power |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009



# Data Collection Items 7 (for non-glutinous rice)

- Disposal and Recycling Stage

| Process | Primary Data Items |
|---|---|
| **Common** | 1. Amount of packaging waste disposed of at home |

| Process | Primary or Secondary Data Items |
|---|---|
| **Common** | 2. GHG emissions related to the transport of packaging waste to treatment facilities<br>3. Amount of packaging waste incinerated at treatment facilities<br>4. Amount of packaging waste landfilled at treatment facilities<br>5. GHG emissions derived from packaging waste by incineration |

| Process | Secondary Data Items |
|---|---|
| **Common** | 6. GHG emissions related to the incineration of wastes at treatment facilities<br>7. GHG emissions related to the landfill of wastes at treatment facilities |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009

# Data collection method (for non-glutinous rice)

- **Primary data** can be obtained by the following two methods:
  - (a) Collecting data of the input and output items in each process and calculating their emissions by the unit of work or equipment/facilities operation (operating hours, area, distance, etc.)
    - (e.g., Agricultural machine operating time by produce x fuel consumption/hour = fuel input amount)
  - (b) Allocating total amount of the input and output items in each process in a specified period among products
    - (e.g., Allocating the total amount of annual fuel input among harvested produces)

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009



# Transportation Scenario Setting (for non-glutinous rice)

| Stage | Scenario |
|---|---|
| **Raw material Acquisition stage** | 1.Manufacturer of input for rice cultivation to Rice cultivator (e.g., Fertilizer manufacturer to Farmer)<br><Transport distance> 500 km<br><Means of transport> 10-ton truck (Light oil)<br><Loading ratio> 62 % |
| | 2. Rice cultivator to Drying and adjustment facilities<br><Transport distance> 50 km<br><Means of transport> 2-ton truck (Light oil)<br><Loading ratio> 58 % |
| | 3.Drying and adjustment facilities to Rice mill<br><Transport distance> 500 km<br><Means of transport> 10-ton truck (Light oil)<br><Loading ratio> 62 % |
| | 4. Manufacturer of input (other than husked rice) for rice milling to Rice mill (e.g., Manufacture of packaging materials for shipping to Rice mill)<br><Transport distance> 500 km<br><Means of transport> 10-ton truck (Light oil)<br><Loading ratio> 62 % |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009





# Transportation Scenario Setting (for non-glutinous rice)

| Stage | Scenario |
|---|---|
| **Distribution and sales stage** | Transport from rice mill to stores or consumers<br><Transport distance> 1,000 km<br><Means of transport> 10-ton truck (Light oil)<br><Loading ratio> 62 % |
| **Disposal and recycling stage** | Transport from garbage dump place to treatment facilities<br><Transport distance> 50 km<br><Means of transport> 10-ton truck (Light oil)<br><Loading ratio> 62 % |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009

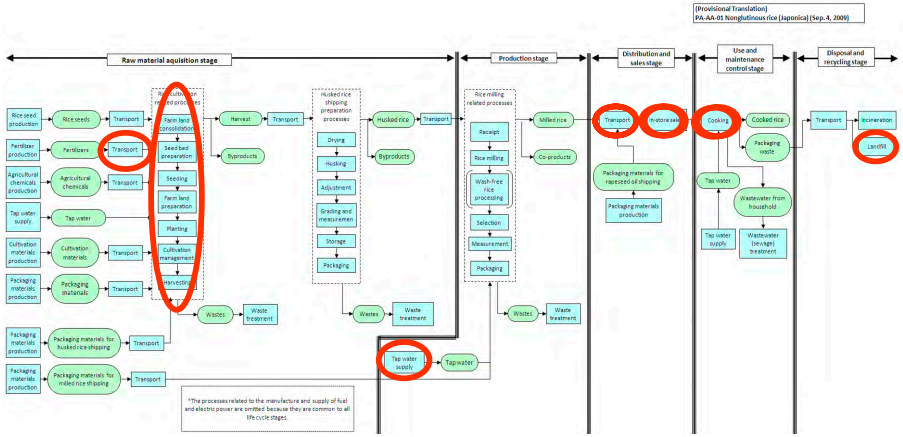


# Emission Factors (examples for non-glutinous rice: abstract)

| Stage | Description | Emission Factor |
|---|---|---|
| **Raw material acquisition** | **Rice cultivation related processes**<br>(rice seed production through rice harvesting) | 0.403 kg-CO2e/ kg (of rice seed) |
| | **Transport of fertilizer**<br>(from fertilizer manufacturer to rice cultivator; 10-ton truck at 62% load) | 0.174 kg-CO2e/ tkm |
| **Production** | **Use of tap water for rice milling** | 0.000211 kg-CO2e/ kg |
| **Distribution/ sales** | **Transport of rice product**<br>(from rice mill to stores; 10-ton truck at 50% load) | 0.174 kg-CO2e/ tkm |
| | **Sales of rice product at stores**<br>(related to electricity/ fuel consumption at stores) | 0.556 kg-CO2e/ 1,000 yen (sales of rice product) |
| **Use/ maintenance control** | **Cooking of rice**<br>(related to electricity consumption by rice cooker) | 0.484 kg-CO2e/ kWh |
| **Disposal/ recycling** | **Landfill of rice packaging waste**<br>(at managed landfill site) | 0.00364 kg-CO2e/ kg (of waste) |

Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009
http://www.cfp-japan.jp/common/pdf/nintei/nintei_001.pdf (Japanese)

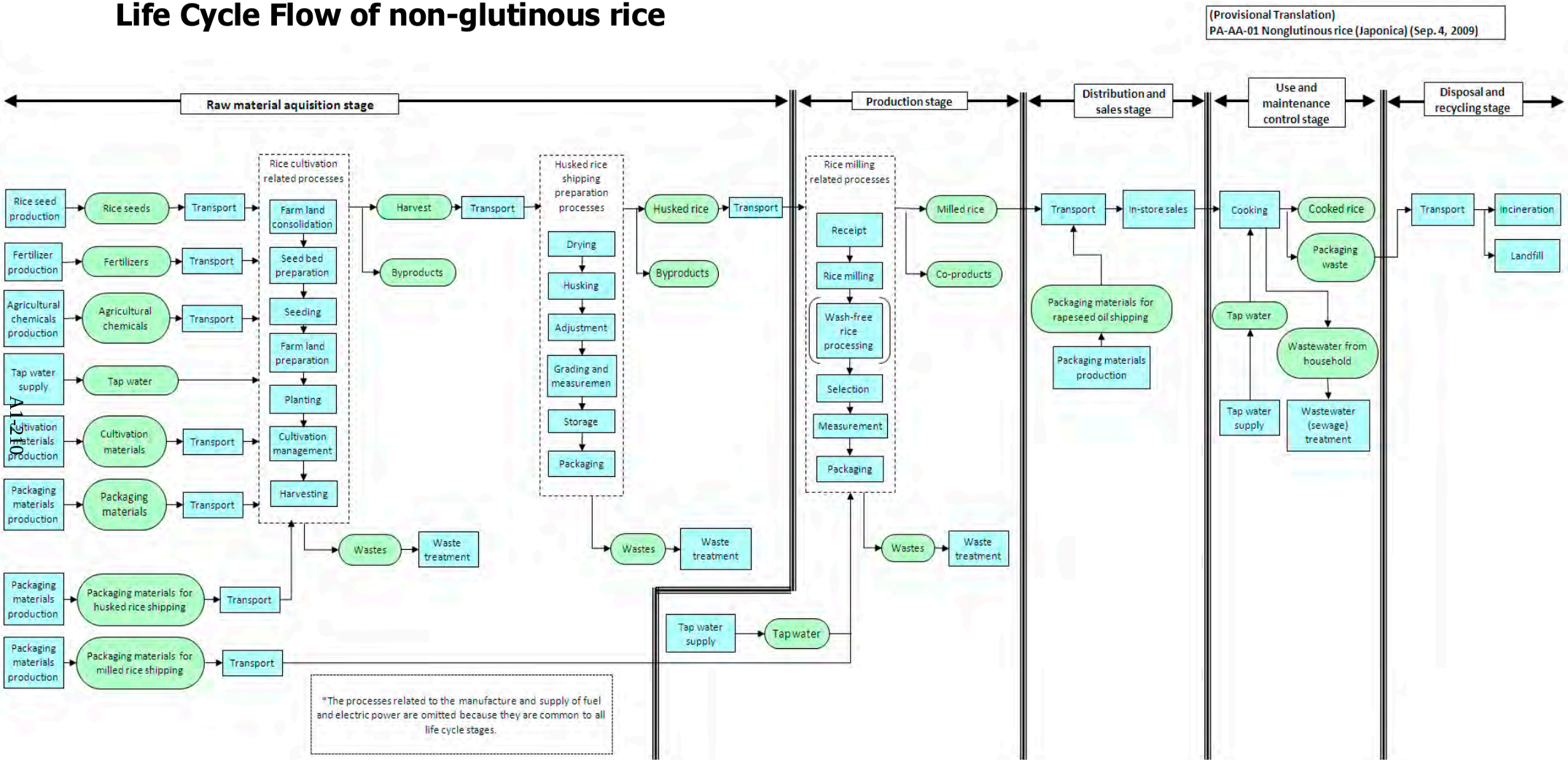
# Emission Factors
## (examples for non-glutinous rice: abstract)




Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009

# CF03 Appendix

## Life Cycle Flow of non-glutinous rice




Source: Product Category Rules (PCR) (Approved PCR ID: PA-AA-01) AEON Co., Ltd. 2009

# Carbon Footprint 4: Issues in Implementation & Dissemination of Carbon Footprint System

20, October, 2010

JICA Expert Team

**Mariko FUJIMORI**



## Objectives of this section

**Objectives of this section are:**

- To understand benefits and barriers of carbon footprint system,
- To understand examples of benefits, barriers, and ways to overcome the barriers, and
- To discuss future issues to improve the carbon footprint system in Thailand.



## Benefits by Carbon Footprint (CFP)

- What would have occurred if there is no CFP system? (--> Baseline scenario)
- What are the benefits by CFP?
  - Manufacturer: We have high concern to environment!
  - Consumer: We hope to select environmental-friendly products!
- CFP and price - Where is the critical limit of price, if products with CFP are higher than normal one?
  - Food, clothes, TV, car, house, etc...

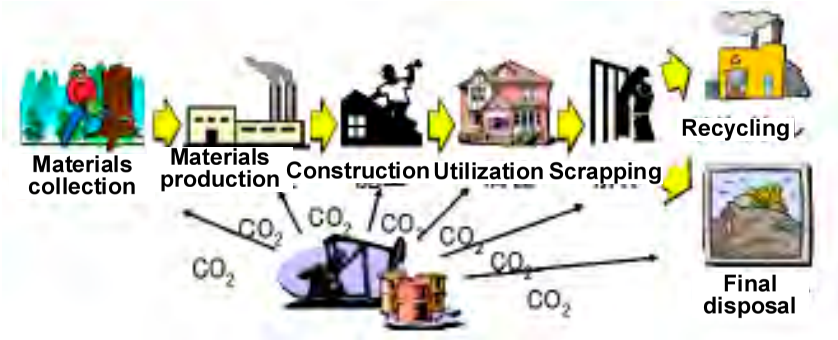


## Issues of Carbon Footprint (CFP)

- How does CFP contribute to $CO_2$ reduction?
- What are the differences between CFP and other low-carbon activities?
  - Energy efficiency laws/regulations, CDM, T-VER, etc.
  - National/local, public/private, organization/person, etc.
- Do CFP and other activities have consistency?
- If such consistency is required, how can we achieve it?
- **What kind of CFP system is ideal?**

# Example of CFP: Low Carbon Houses

- Energy consumption at households

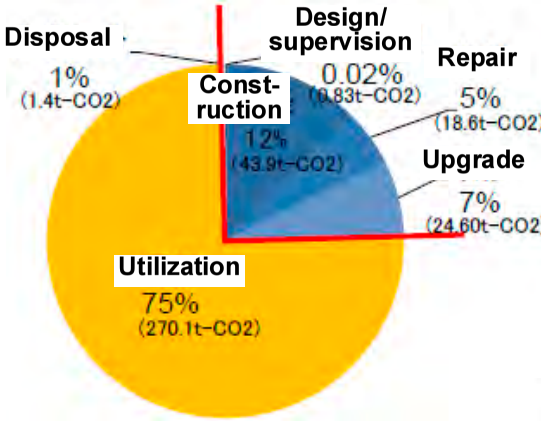



Source: METI, Japan 2010



# Example of CFP: Low Carbon Houses

- LCCO2 for a detached house



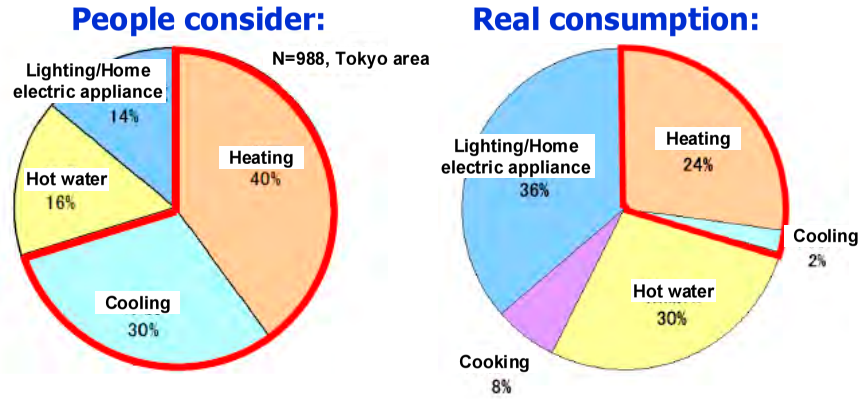

Source: METI, Japan 2010





# Example of CFP: Low Carbon Houses

- Energy consumption at households

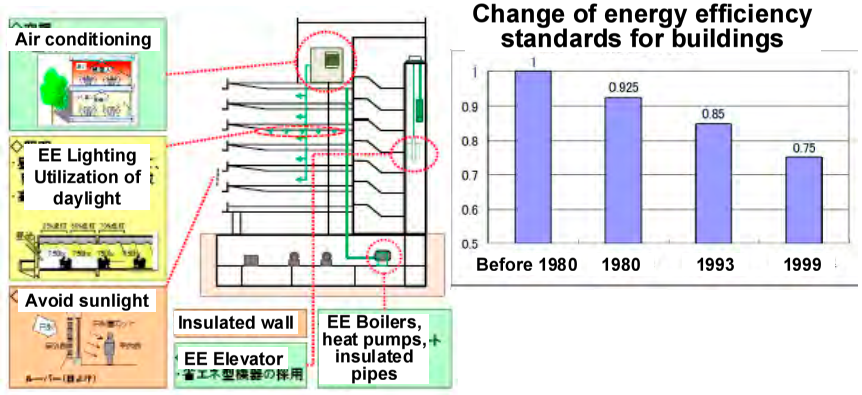



Source: METI, Japan 2010



# Example of CFP: Low Carbon Houses

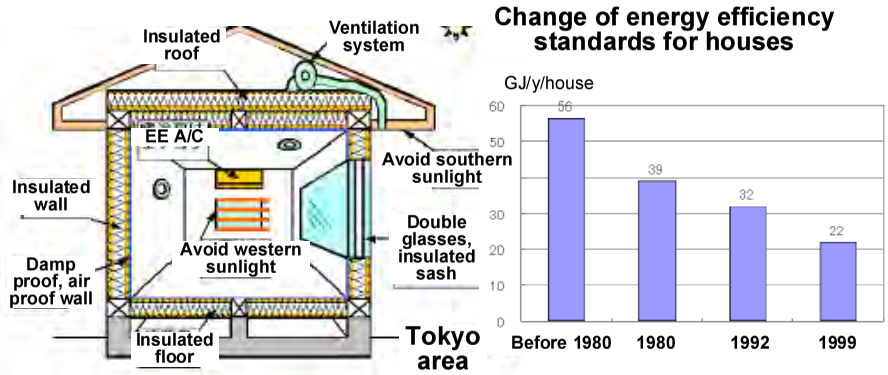
- Energy Efficiency Standard for Buildings




Source: METI, Japan 2010

# Example of CFP: Low Carbon Houses

- Energy Efficiency Standard for Houses




Source: METI, Japan 2010



# Energy Efficiency Label for Houses

| | Assessed by third party | Self assessment only |
|---|---|---|
| Conform to both self judgment by client and EE standard |  |  |
| Conform to self judgment by client only |  |  |

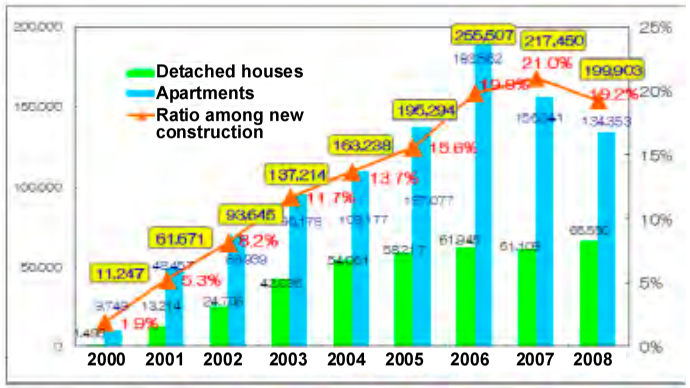


Source: METI, Japan 2010



# Energy Efficiency Label for Houses

- Past record of the system

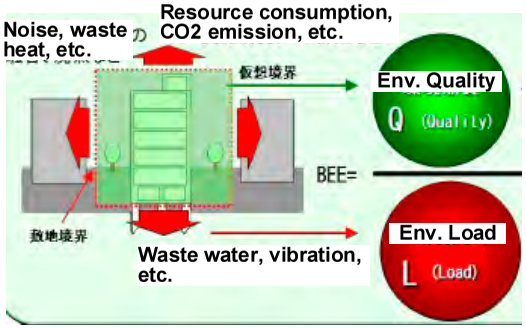



Source: METI, Japan 2010



# Comprehensive Asssessment System for Houses

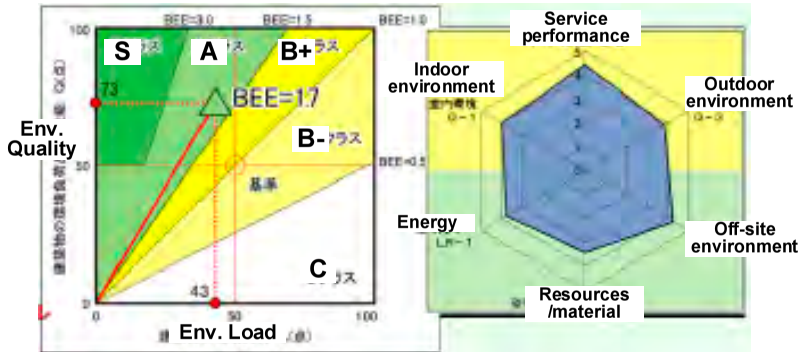
- CASBEE: Comprehensive Assessment System for Building Environmental Efficiency




Source: METI, Japan 2010

# Comprehensive Assessment System for Houses

- CASBEE: Comprehensive Assessment System for Building Environmental Efficiency

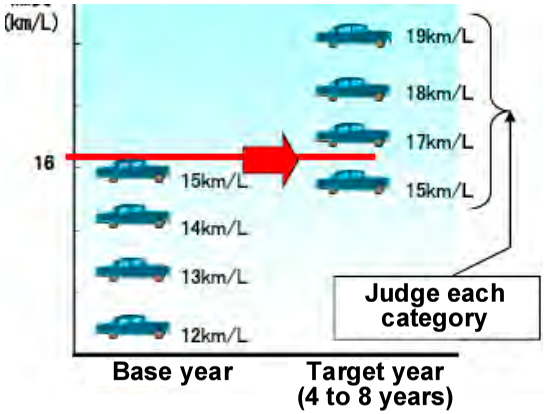



Source: METI, Japan 2010



# Top Runners Approach (1998-)

- Select the EE of best product as target for all manufacturers (Covered products:23)



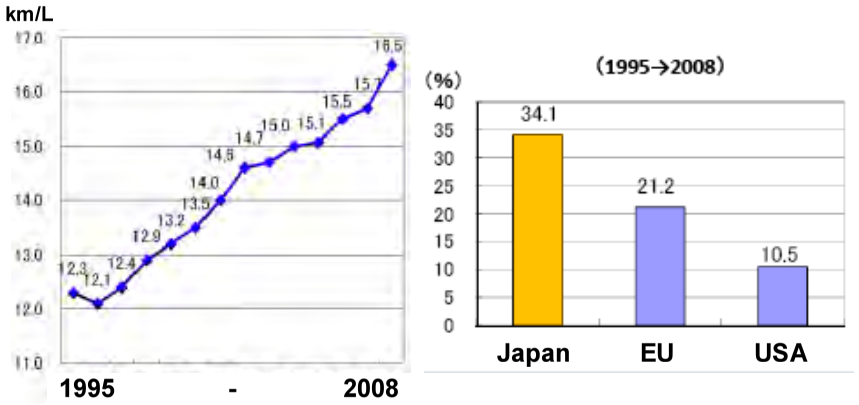

Source: METI, Japan 2010





# Top Runners Approach (1998-)

- EE improvement of passenger cars

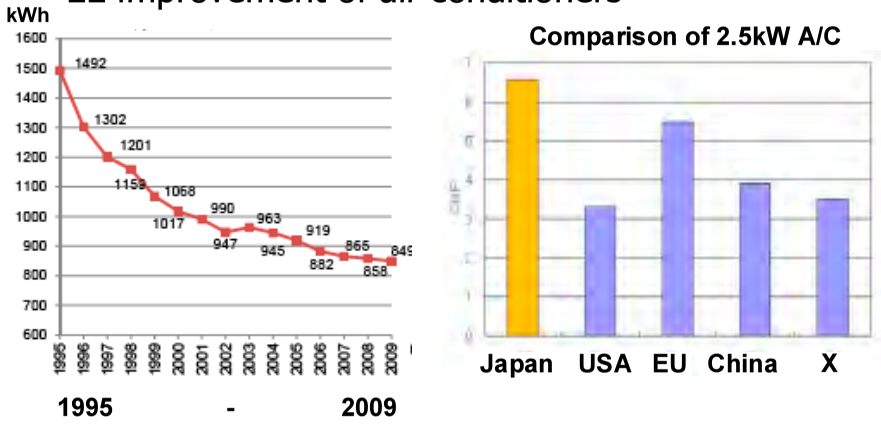



Source: METI, Japan 2010



# Top Runners Approach (1998-)

- EE improvement of air conditioners




Source: METI, Japan 2010

# Issues of Carbon Footprint (CFP)

- How does CFP contribute to $CO_2$ reduction?
- What are the differences between CFP and other low-carbon activities?
  - Energy efficiency laws/regulations, CDM, T-VER, etc.
  - National/local, public/private, organization/person, etc.
- Do CFP and other activities have consistency?
- If such consistency is required, how can we achieve it?
- **What kind of CFP system is ideal?**

# Carbon Footprint 5: Issues in carbon footprint (CFP) system for services - Example of printing services -

22, February, 2011

JICA Expert Team

**Mariko FUJIMORI**

A1-216

## CFP for services

- What is the difference between CFP for "goods" and "services"?
  - Goods: Carbon emission of goods = final products.
  - Services: Carbon emission from the process to produce goods or the process itself.
- For which points should we be cautious?
  - Structure of the process: How does the process work?
  - Boundaries: What kind of activities are included to calculate the CFP?
  - Basis (standard) of comparison: How will the CFP be used?



## CFP for paper printing services

***Please refer to the Annex A***

- Process of printing:

(Material acquisition)
1: Raw material acquisition
2: Prepress
3: Printing
4: Surface Treatment
5: Cutting and binding, and Packaging
6: Disposal at production stage
(Distribution)
(Use)
(Disposal & recycling)



## CFP for paper printing services

***Please refer to the Annex A***

- Process of printing:

1: Raw material acquisition
2: Prepress
  - DTP process
  - Plate making process
  - Press plate factory process
3: Printing
4: Surface Treatment
5: Cutting and binding, and Packaging
6: Disposal at production stage

# CFP for paper printing services

*Please refer to the Annex A*

Example: Prepress

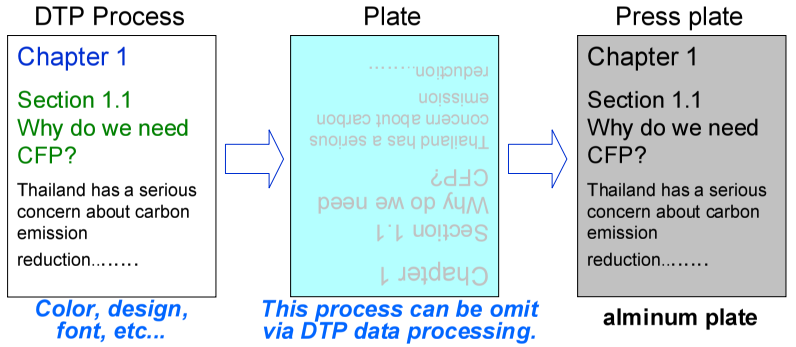
- DTP process
  - Design and edit the products
  - Using computers, electricity, paper, ink, water, etc.
- Plate making process
  - Providing layout paper (transparent film)
  - DTP can skip this process
- Press plate factory process
  - Expose layout papers to press plates (alminum plates)



# CFP for paper printing services

*Please refer to the Annex A*

## Prepress stage



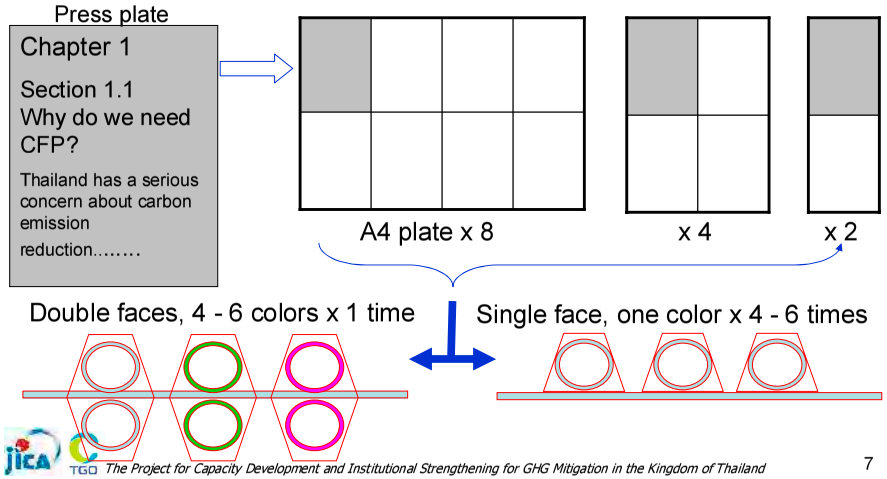





# CFP for paper printing services

*Please refer to the Annex A*

## Printing stage






# CFP for paper printing services

*Please refer to the Annex A*

- Who can do all of these processes?

1: Raw material acquisition
2: Prepress
3: Printing
4: Surface Treatment
5: Cutting and binding, and Packaging
6: Disposal at production stage

- Each process has professional entities.
- Only huge companies can cover all processes.

# CFP for paper printing services

***Please refer to the Annex A***

What are the differences between big companies and small/medium entities?

- Compared to small/medium entities, major big companies tend to have latest (efficient) facilities.
- Major printing services are "divided work" or "team work" processes by small/medium entities, who have expertise to their own processes.
- These professionals select partners according to the goods/products they are going to produce.
- What should be the criteria of "effort" process to produce best quality goods?



# PCR for paper printing services

PCR: Product Category Rule

- Common rule to calculate the CO2 emission by a certain category
- Proposal - experts input and public comments - evaluation - authorization - utilization - revision
- Processes included in the flow chart and emission from each process should be clarified and calculated very carefully.
- Decision of the boundary is one of the most important points.





# PCR for paper printing services

In case of establishing PCR for printing in Japan:

- Meeting and input from member companies of printing associations
- Committee decision under the association
- Proposal to the national authority (METI)



# PCR for paper printing services

Agreed issues:

- Continuous data collection/upgrading
- Revision of PCR according to necessity
- Avoid too much load to companies
- Avoid misleading information to consumers
- Raise awareness of consumers about relationship of CO2 emission and recycled material.

# PCR for paper printing services in Thailand

What should be noticed in the case of Thailand?

- Simple
- Transparent
- Fair
- Realistic/practical

How can we establish/evaluate such PCR?

Appropriate expert input is essential to consider "challenging" PCR.

# Carbon Footprint 6: Carbon Footprint for Organization

10th, May 2011

JICA Expert Team

**Mariko FUJIMORI**

A1-220

## Objectives of this section

**Objectives of this section are:**

- Current status and trend of CFP (Carbon Foot Print) in the world, in major countries and in Japan
- GHG Protocol: Scope 3 and Product standards
- Discussions in Japan about these standards
- Discussion: What kind of conditions are required for implementing Carbon Footprint for Organizations in Thailand?



## Present condition of CFP in the UK (1)

**PAS 2050 (Publicly Available Specification)**

- Developed in 2008 (revision until early 2011)
- Established by:
  - DEFRA (Department of Environment, Food and Rural Affairs)
  - BSI (British Standards) and
  - Carbon Trust
- Sales of the goods with the label in 2010

  → 200 billion pounds (99 billion THB)


Source: METI CFP Report (in Japanese)



## Present condition of CFP in the UK (2)

**PAS 2050 (cont.)**

- Application of PAS 2050: within and outside of the UK
  - Australia and New Zealand: Olive oil and wine, from 2010
  - Korea: MOU in 2009 between Carbon Trust and KEITI (Korea Environmental Industry & Technology Institute) to apply the Carbon reduction label to goods exported from Korea to UK
- Incentive for private entities by the UK government:
  - Preparation of user friendly guidance, free access to standards and data, etc.
  - Funding only to Carbon Trust but not to the private entities – dissemination based on market mechanisms
- Consumers who know about the CFP: **60%** knows about the "word" only.

Source: METI CFP Report (in Japanese)

# Present condition of CFP in Germany (1)

**Product related climate protection strategies: Understanding and using Product Carbon Footprints**

- Developed in 2010 by:
  - BMU (Federal Ministry of Environment) and
  - BDI (Federation of German Industries)
- Neither beneficial nor reliable for communication with consumers (technical issues, inconsistency of data and conditions, lack of standard methodologies)
- $CO_2$ label for consumers: Not very useful/meaningful (without standard for comparison, any suggestion for the use of goods, lack of information about impact to other environment, confusion by too much labels)

Source: METI CFP Report (in Japanese)



# Present condition of CFP in Germany (2)

**Blue Angel**

- Developed in 1978
  (11,500 goods in 90 categories as of 2010)
- Lead by Federal Minister of Interior
- Operation by one independent review committee, two governmental organizations and a private entity
- Comprehensive environmental performance
- Four priority target: Climate, Health, Resource, Water

Source: METI CFP Report (in Japanese)





# Present condition of CFP in Japan

2008
- June; Cabinet decision "Japan As a Low-Carbon Society"
- METI started the pilot project

2009
- National Pilot Project has started
  "Basic Guideline of the Carbon Footprint of Products"
  "Guide of Establishing Product Category Rules"

2010
- 2nd year of the Pilot Project - revision of the general instructions.

2011
- Final year of the Pilot Project.

Source: Prof. Inaba: Carbon Footprint of Products in Japan (2010)



# Japan's Carbon Footprint of Products Pilot Project

Four Main Activities
1. CFP calculation and labeling pilot program
2. Database construction
3. Building verification scheme
4. Contribution to international standardization
   → Harmonization with ISO 14067 (under development)

New Approach
- Demonstration project of CFP calculation and verification study by using "Broadly-applicable PCR"
- Considering verification schemes
- Considering various communication methods for CFP
- Launching discussions on CFP of services

Source: Material for METI Committee Special Session

# Present condition of CFP in the world

## ISO

- ISO 14040/44: Environment management - LCA
- ISO 14025: Environmental labels and declarations
- ISO 14067: Carbon footprint of products (under Committee Draft)
- ISO 14069: Carbon footprint of organizations (under Working Draft)

--> They will be established until November 2011 or 2012.

NWIP: New Work Item Proposal
PWI: Preliminary Work Item
AWI: Approved Working Item
WD: Working Draft
CD: Committee Draft
DIS: Draft International Standard
FDIS: Final Draft International Standard

Source: http://www.iso.org/



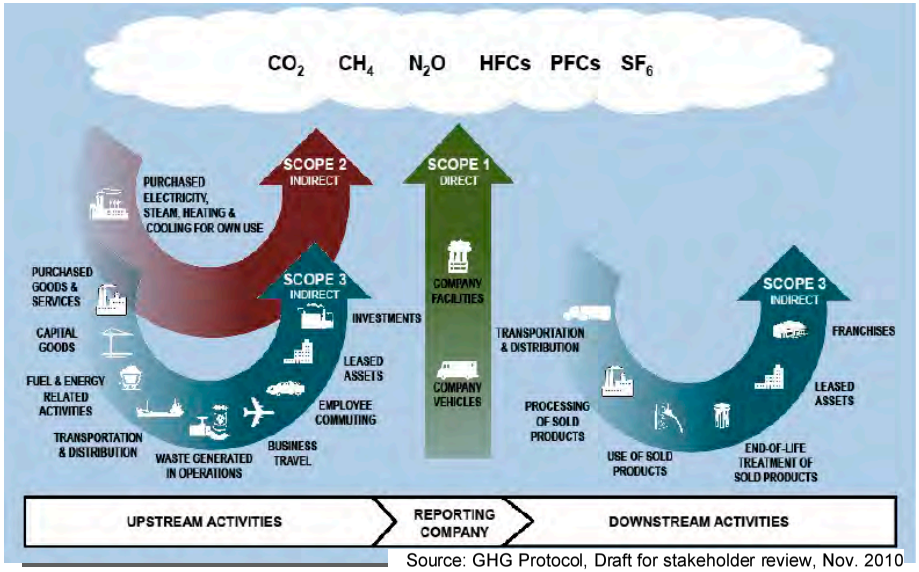


# Present condition of CFP in the world

GHG emissions through the supply chain



# GHG emissions through the supply chain




Source: GHG Protocol, Draft for stakeholder review, Nov. 2010

# GHG Protocol

## Greenhouse Gas Protocol Initiative

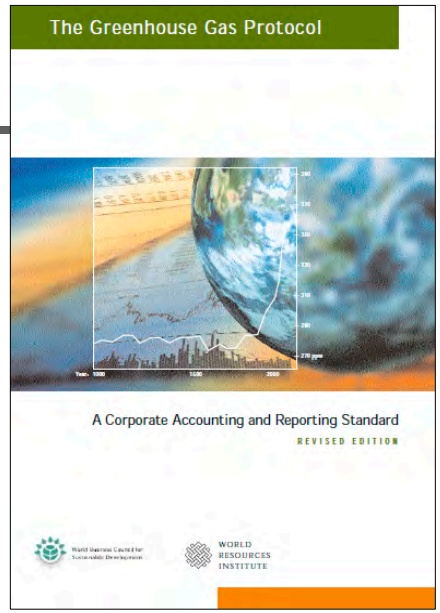
- Established in 1998 by:
- WRI (World Resource Institute) and
- WBCDS (World Business Council for Sustainable Development)
- Multi-stakeholder partnership of businesses, NGOs, governments and others

Source: Material for METI Committee Special Session

# GHG Protocol

The GHG Protocol
Corporate Standard
Released in 2001
Revised in 2004

Available free on:
www.ghgprotocol.org






# GHG Protocol Corporate Standard

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# Programs Based on GHG Corporate Protocol

- Carbon Disclosure Project (CDP)
- The Climate Registry
- California Climate Action Registry
- Chicago Climate Exchange
- Dow Jones Sustainability Index
- EU Emissions Trading Scheme
- French REGES Protocol
- Global Reporting Initiative
- METI, Japan
- Mexico GHG Program
- Respect Europe Business Leaders Initiative for Climate Change
- International Trade Associations (Aluminum, IPIECA, ICFPA, Cement, Iron and Steel)
- UK Emissions Trading System
- U.S. EPA Climate Leaders Initiative
- World Wildlife Fund Climate Savers
- World Economic Forum Global GHG Registry
- ISO 14064 Part 1
- U.S. Department of Energy

- Many programs apply the Protocol
  → ***It's framework has worldwide impact.***



# GHG Protocol Corporate Standard

Chapter 4: Setting Operational Boundaries

- Introducing the concept of "scope"

Scope 1: Direct GHG emissions

Emissions from sources owned or controlled by the company, i.e., combustion in owned or controlled boilers, furnaces, vehicles, etc.

Scope 2: Electricity indirect GHG emissions

Emissions from the generation of purchased electricity consumed by the company.

# GHG Protocol Corporate Standard

## Scope 3: Other indirect GHG emissions

An optional reporting category,

Emission by the activities of the company, but occur from sources not owned or controlled by the company, i.e., extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

***Option → Standard.....***



# New Standards under Development

## Scope 3 (Value Chain) Accounting and Reporting Standard

- Corporate value chain GHG emissions (Scope 3)

→Build on the GHG Protocol Corporate Standard

## Product Life Cycle Accounting and Reporting Standard

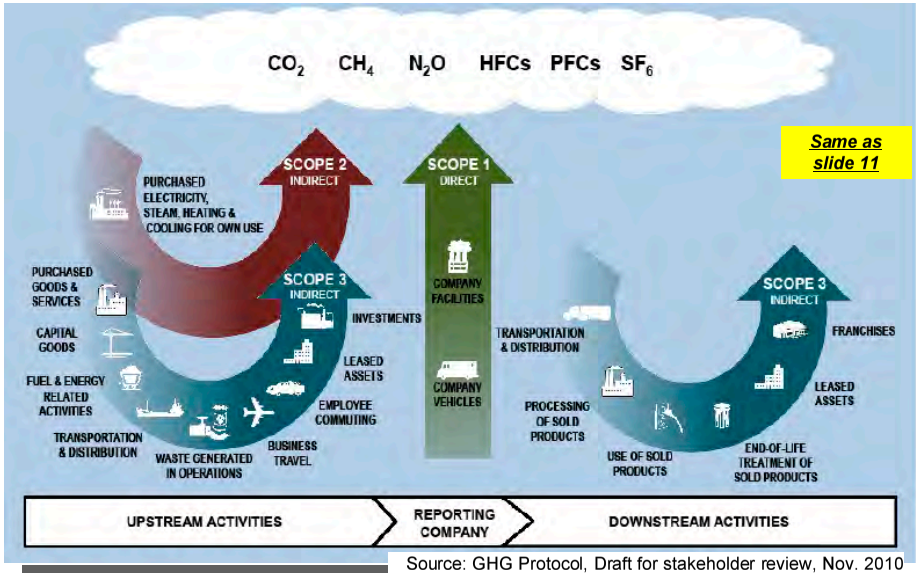
- Product life cycle GHG emissions

→Build on existing life cycle assessment methods (ISO 14044)



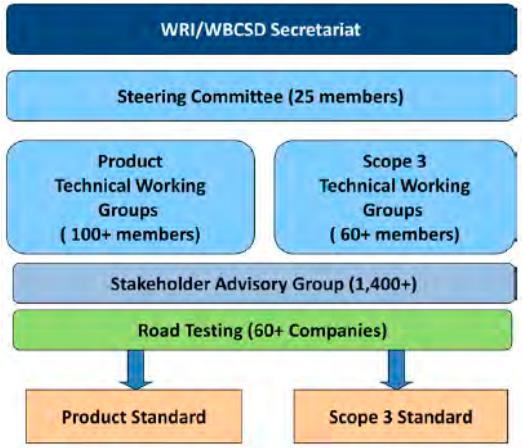


# Scope 1, 2 and 3




Source: GHG Protocol, Draft for stakeholder review, Nov. 2010

# Structure for the development




Source: GHG Protocol, Draft for stakeholder review, Nov. 2010



Source: Material for METI Committee Special Session

# Scope 3: Categories

**Upstream Activities**

1. Purchased goods & services
2. Capital goods
3. Fuel & energy related activities
4. Transport & distribution
5. Waste generated in operations
6. Business travel
7. Employee commuting
8. Leased Assets
9. Investments

**Downstream Activities**

10. Transport &distribution
11. Processing of sold products
12. Use of sold products
13. Disposal of sold products
14. Leased assets
15. Franchises



Source: Material for METI Committee Special Session

# Scope 3: Second draft

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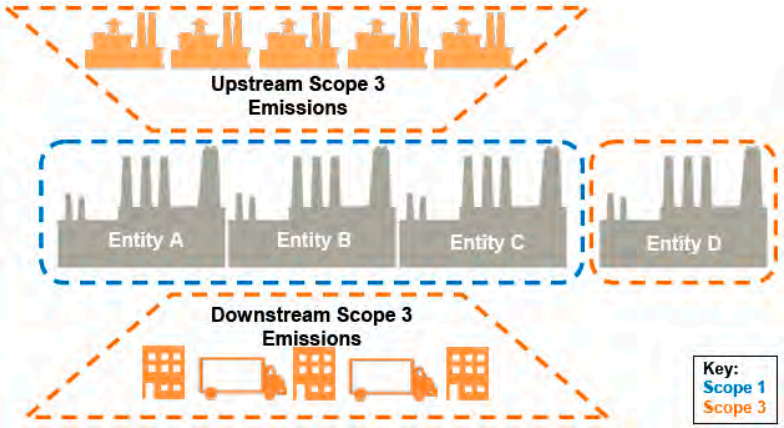
Source: GHG Protocol, Draft for stakeholder review, Nov. 2010



# Scope 3: Organizational boundary

With (blue) or without (orange) operational control

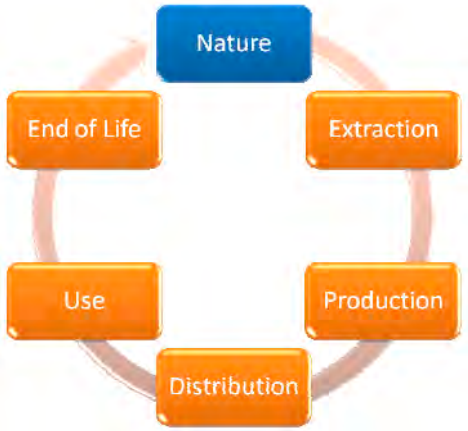



Source: GHG Protocol, Draft for stakeholder review, Nov. 2010



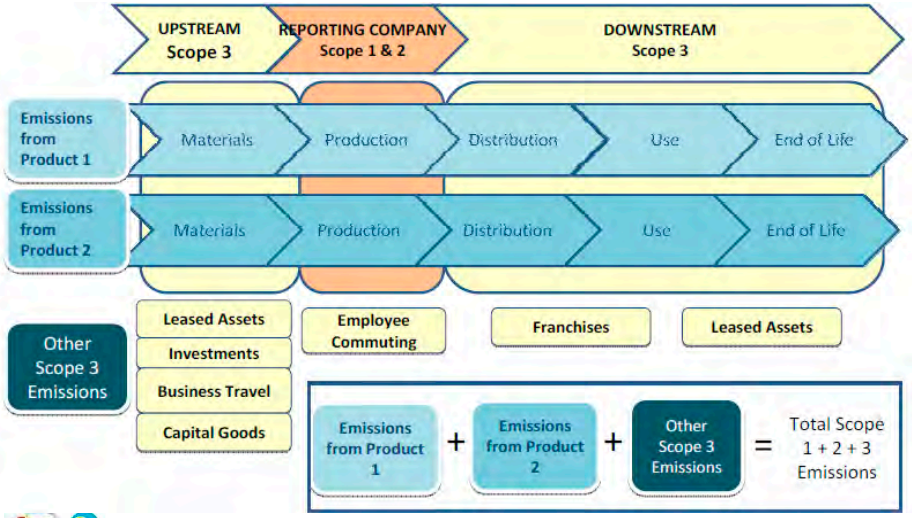
# Product Standard

- Quantify GHG emissions of a product over its lifetime
- Understand, manage, and publically report the life cycle GHG emissions associated with individual products




Source: Material for METI Committee Special Session

# How the Standards Work Together




Source: GHG Protocol, Draft for stakeholder review, Nov. 2010



# Schedule in near future

January – March, 2011

Revision of drafts based on public comments and steering committee feedback

April, 2011

Text of the standards finalized

May – July, 2011

Editing and publishing

September, 2011

Official launch of new standards

Source: Material for METI Committee Special Session





# Issues and problems of Scope 3

- Why Scope 3 is necessary?

  → To avoid carbon leakage in the world
- Is it possible to collect such a huge amount of data?

  → To collect all related carbon footprint will be most reasonable way *(if they are available)*
- Is it applicable to all types of businesses?
- How is the consistency with ISO 14069?

Source: Material for METI Committee Special Session



# Discussions in Japan about Scope 3

Research/Study Committee on Standards for Accounting and Reporting Organization's GHG emissions throughout the Supply Chain

Objectives:

For a successful response to the standards to be finalized under the GHG Protocol in 2011, the Committee aims to discuss possible issues in applying such standards to Japanese companies, and to share information and opinions related to the standards, including challenges and means to use them.

Source: Material for METI Committee Special Session

## Issues regarding Scope 3 standard - Raised in Japan (1)

Examples of opinions provided by the Committee and its working groups members

### Chapter 3: Business Goals & Inventory Design

- It is good that the second draft suggests benefits for companies to estimate Scope 3 emissions, by giving examples such as:
  - "to understand opportunity/risk associated with GHG emissions from entire value-chain,"
  - "to recognize potentials to reduce GHG emissions," etc.



## Issues regarding Scope 3 standard - Raised in Japan (2)

Examples of opinions provided by the Committee and its working groups members

### Chapter 4: Overview of Scope 3 Emissions

- Capital Goods

→ GHG emissions associated with capital goods should be evaluated by comparison between emissions from construction and mitigations through operation. What's the purpose to add up emissions from construction only?

- Transportation & Distribution (Upstream)

→ Would it really be possible to estimate this category other than transport services for which reporting companies pay.





## Issues regarding Scope 3 standard - Raised in Japan (3)

Examples of opinions provided by the Committee and its working groups members

### Chapter 4: Overview of Scope 3 Emissions

- Business Travel
- Employee Commuting

→ Estimation is possible for this category if approximation based on payment amount is acceptable.

→ For heavy industry, this category is negligible in overall Scope 3 emissions. Coverage of this category should be determined depending on industries.



## Issues regarding Scope 3 standard - Raised in Japan (4)

Examples of opinions provided by the Committee and its working groups members

### Chapter 4: Overview of Scope 3 Emissions

- Processing of Sold Products

→ It seems not realistic for intermediaries to request their clients to provide data for processing the sold products.

- Use of Sold Products

→ GHG emission reductions by using sold products should also be covered in estimation. For companies, the biggest opportunity to cut their emissions other than Scopes 1 & 2 is by replacing existing products with their own products.

# Issues and problems of Scope 3

- Why Scope 3 is necessary?

  → To avoid carbon leakage in the world

  ***Same as slide 27***

- Is it possible to collect such a huge amount of data?

  → To collect all related carbon footprint will be most reasonable way *(if they are available)*

- Is it applicable to all types of businesses?
- How is the consistency with ISO 14069?



# Discussion

What kind of conditions are required

for establishing and implementing the scheme

of Carbon Footprint for Organizations in Thailand?

# Overview of IPCC Guidelines

7 September, 2010

Chief Advisor of JICA Expert Team
**Masahiko FUJIMOTO**



## Training Program of GHG Inventory (1)

Topic 1: Overview of **IPCC Guidelines**

Topic 2: Introduction of **GHG inventory of Japan and Thailand**

Topic 3: Overview of **energy sector** including **transportation**, example of Thailand and Japan

Topic 4: Overview of **industrial process sector**, example of Thailand and Japan

Topic 5: Overview of **agriculture, land-use change sector**, example of Thailand and Japan



## Training Program of GHG Inventory (2)

Topic 6: Overview of **waste management** sector, example of Thailand and Japan

Topic 7: Overview of **QA/QC** of IPCC Guidelines and example of QA/QC measures taken in Japan

Topic 8: Analysis of **key categories and assessment of uncertainties**, example from Japanese cases

Topic 9: **Exercise**: Calculation of emission of energy sector in Thai inventory

Topic 10: **Exercise**: Calculation of key category and uncertainty in Thai inventory



## Contents of today's training program

1. Why does Thailand have to make the GHG inventories?
2. How are the GHG inventories made?
3. What are the guidelines for GHG inventory preparation?

# Questions!

- Q1: Why Thailand needs to provide GHG inventory?



# Reporting under UNFCCC

- UNFCCC Article 4 1. and Article 12
  - **All Parties** develop, periodically update, publish and make available to the Conference of the Parties a **national inventory**, a general description of steps and any other information.
- UNFCCC Article 4 2(c)
  - Calculations should take into account the best available scientific knowledge.
  - COP shall consider and agree on methodologies at its first session and review them regularly thereafter.





# Requirement in Copenhagen Accord

- Draft decision -/COP15 (Copenhagen Accord) 5.
  - Mitigation actions subsequently taken and envisaged by **Non-Annex I Parties**, including **national inventory reports**, shall be communicated though **national communication** consistent with Article 12.1(b) every two years on the basis of guidelines adopted by the Conference of the Parties.



# Useful in developing rational policy and its monitoring

- Inventories are very useful for the rational policy development for Low Carbon Society.
- Inventories can be used
  - to identify the major sectors where abatement will have a real impact.
  - To predict and compare impacts of various policies.
  - To choose cost-effective options.
- Inventories are very useful to monitor the impacts of mitigation policies and measures.

Source: National GHG Inventory Development - Background and Key Factors for Success
Mr. Kiyoto Tanabe

# Questions!

- Q2: How are the GHG inventories made?



# How are the GHG inventories made?

- GHG emission is **estimated based on statistical data**, etc.;
- the concentration of GHG in the atmosphere is not measured directly.

**Emissions** = Activity Data x Emission Factor x Global Warming Potential





# Greenhouse Gases related to each Sector

| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs, etc |
|---|---|---|---|---|
| Energy | Fuel Combustion | Fuel Combustion<br>Fugitive emissions from fuels | Fuel Combustion | |
| Industrial Process | Cement Production, etc | Chemical Industry, etc | Chemical Industry, etc | Semiconductors, Solvent, Refrigerant, etc |
| Agriculture, Forestry and Other Land Use | | Intestinal Fermentation, Rice cultivation, Manure management, etc | Agricultural soils, Manure management, etc | |
| Waste | Waste incineration | Landfill, Wastewater treatment, Waste incineration, etc | Landfill, Wastewater treatment, Waste incineration, etc | |



# Activity Data

- Activity Data:

  Data related to activities resulting in GHG emissions or removals

  For example; Energy use (coal, heavy oil, diesel, gasoline, natural gas) in sector, Number of cattle, Land area, Municipal solid waste amount, etc

Emissions = **Activity Data** x Emission Factor x Global Warming Potential

## Approaches to Activity Data Collection

1) Gathering existing data
   - National and international statistics agencies
   - Sectoral experts, national experts, researchers of universities
   - Reference libraries
   - Web search for organisations & specialists
2) Checking and Screening collected data
3) If data not available, methods like splicing/ surrogates/interpolation/extrapolation are used.

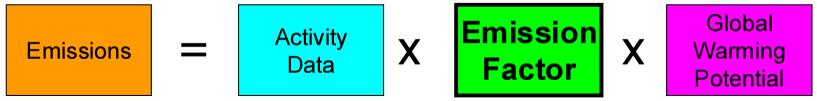


## Emission Factor

- Emission Factor:

  - A coefficient that quantifies GHG emissions or removals per unit activity.

  - Emission factors are based on measurement data, or average of representative emission rates under a given set of operating conditions








## Methods of setting emission factor

- Actual measurement in factories etc.
- Results of research (set from the actual measurements etc.)
- Default values of IPCC Guideline
- Calculation from the scientific theoretical value ($CO_2$ from fuel combustion)



## Other Possible Data Sources (from 2006 IPCC GL p 2.13)

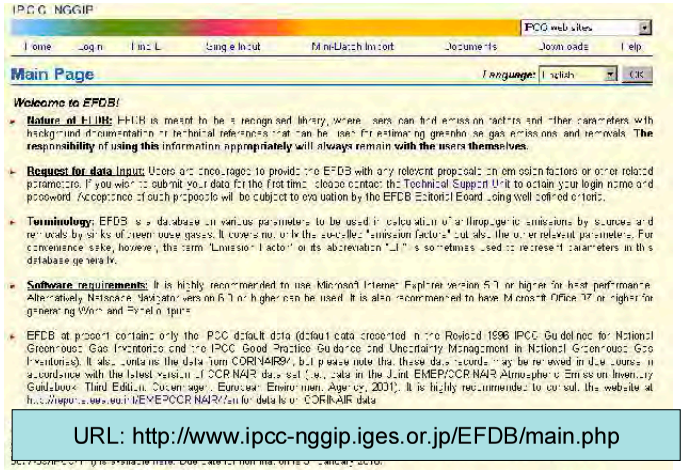
- EMEP/CORINAIR Emission Inventory Guidebook
- International Emission Factor Database: USEPA
- Country-specific data from international or national peer reviewed journals
- National testing facilities
- Emission regulating authority records and papers, or pollution release and transfer registries
- Industry, technical and trade paper
- Other specific studies, census, survey, measurement and monitoring data
- International Emission Factor Database: OECD
- Emission factors or other estimation parameters for other countries

# Outline of EFDB

- Supporting Material: The EFDB complements IPCC Guideline.
- It is designed as a platform for experts and researchers to provide new emission factors or other parameters to a worldwide audience of potential end users
- The EFDB invites experts and researchers all over the world to populate the EFDB with their data.
- The criteria for inclusion of data
  - Robustness: The value would be unlikely to change.
  - Applicability: An emission factor can only be applicable if the source and its mix of technology are clear.
  - Documentation: Access information to the original technical reference is provided to evaluate the robustness and applicable.



# IPCC Emission Factor Database




URL: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php





# Global Warming Potential

- Global Warming Potential:

  <in the first Commitment Period>
  - $CO_2$ 1
  - $CH_4$ 21
  - $N_2O$ 310
  - HFCs 1300 etc.
  - PFCs 6500 etc.
  - SF6 23900

Emissions = Activity Data x Emission Factor x **Global Warming Potential**

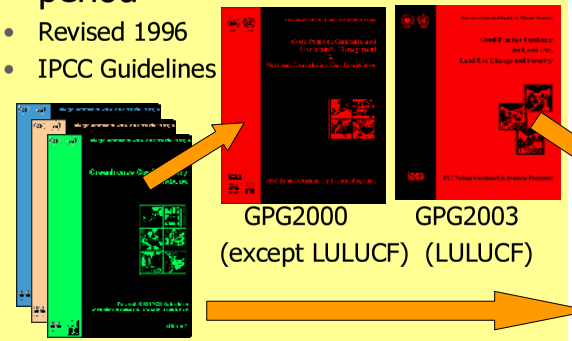


# Questions!

- Q: What are the guidelines for GHG inventory preparation?

# Process of revision and evolution of IPCC Inventory Guideline

- Used in the 1st commitment period
  - Revised 1996
  - IPCC Guidelines



GPG2000 (except LULUCF)



GPG2003 (LULUCF)

- Used in the 2nd commitment period
  - 2006 IPCC Guidelines



# Revised 1996 IPCC Guidelines

- First version in 1995, Revised in 1996
  - Nationally approved calculation and reporting methodology related to GHG emission and removal
  - 6 sectors: 1) Energy, 2) Industrial process, 3) Solvent and other product use, 4) Agriculture, 5) Land use change and forestry, 6) Waste
  - Target gases: $CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, SF6, NOX, CO, NMVOC, $SO_2$



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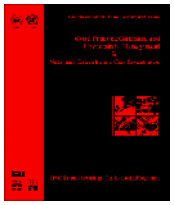
# GPG (Good Practice Guidance)

- Good Practice related to GHG inventory preparation in each country, which is useful to;
  - Avoid over- or under-estimation to a maximum extent
  - Decrease uncertainty in a practical extent
- GPG2000: except Land use, Land use change and forestry
- GPG2003-LULUCF: Land use, Land use change and forestry



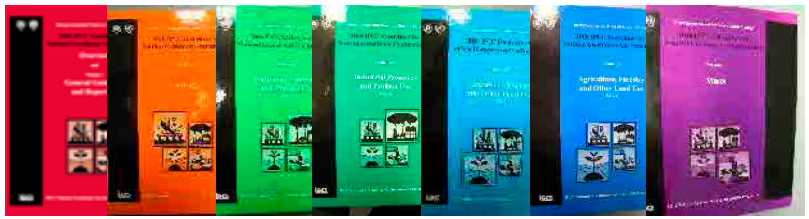
GPG2000

GPG2003-LULUCF



# 2006 IPCC Guidelines

- Guidelines have evolved from 1996 to 2006, which have developed and improved as knowledge and experience increased.
- The same basic methodological approaches are used from 1996 Guidelines, through GPG 2000 & GPG LULUCF to 2006 Guidelines



# Outline of Modification in 2006 IPCC Guidelines (1)

- Consolidated to 4 sectors: Energy, IPPU (Industrial Processes and Product Use), AFOLU (Agriculture, Forestry and Other Land Use), Waste
- More greenhouse gases: **$NF_3$, $SF_5CF_3$**
- Energy:
  - Improved defaults for fossil fuel combustion
  - Some additional categories;
    ex. CCS, Road Transport Urea Catalysts, uncontrolled burning of coal dumps,abandoned coal mines
- Waste:
  - Significant improvement to default method for landfills
  - Tier 1 FOD method to estimate $CH_4$ from SWDSs
  - Open burning
- All estimates are now of actual annual emissions
  ("potential" emissions not needed)



# Outline of Modification in 2006 IPCC Guidelines (2)

- IPPU:
  - In IPPU sector, recently there has been rapid expansion of knowledge about sources and gases, so there are many new categories.
  - Some additional categories; ex. Production of Titanium Dioxide, Lead Production, Production of PV cells and LCD etc.
  - Non-energy uses of Fossil Fuel was demarcated with "Energy" sector
  - Actual emission of F gases is used as Tier 1
- AFOLU:
  - 2006 IPCC Guidelines integrate "Agriculture" and "Land Use, Land Use Change and Forestry" sector
  - Managed land is used as a proxy for identifying anthropogenic emissions by sources and removals by sinks.
  - $CH_4$ from managed flooded land was added in "Appendix – Basis of future methodological development"





# Requirements under UNFCCC

- 1996 Guidelines (GPG2000, GPG2003-LULUCF)
  - Annex I Parties "shall" use 1996GLs and GPG2000, 2003-LULUCF
  - Non-Annex I Parties:
    - "should" use 1996GLs [Dec 17/CP.8]
    - "are encouraged to" use GPG2000 and GPG2003-LULUCF [Dec 13/CP.9]
- 2006 Guidelines
  - Not yet approved by UNFCCC for use as a whole
  - Nevertheless, 2006GLs may assist Parties in fulfilling their inventory reporting requirements under the UNFCCC

Source: National GHG Inventory Development - Background and Key Factors for Success
Mr. Kiyoto Tanabe



# Relevance of 2006 IPCC Guidelines

- Individual methods in 2006GLs can be used within the 1996/UNFCCC reporting guidelines
  - The 2006GLs are:
    - An evolutionary development
    - Authors' best methodologies available (accepted by IPCC)
    - For the use of all countries

Source: National GHG Inventory Development - Background and Key Factors for Success
Mr. Kiyoto Tanabe

# Introduction of GHG Inventories of Japan and Thailand

14, September, 2010

Deputy chief advisor of JICA Expert Team
**Kazuhito YAMADA**



## Today's Agenda

- Why do we need GHG inventories? - confirmation -
- GHG Emission/Removal Sectors
- What is the most important GHG Inventory Work?
- GHG Emission trend:
  Japan, Germany, New Zealand, and Canada
- National System of Japan to develop GHG Inventory
- Characteristics of Japanese GHG Inventory:
  - Transport, Paddy field, and Waste
- ***Introduction of GHG Inventories of Thailand***
- Discussions



## Why do we need GHG inventories? - confirmation -

- GHGs released by human activities enhance the radiative forcing of the climate system;
- Social and economic systems of human beings are affected by climate change such as temperature rise, sea-level rise, and precipitation pattern changes;
- Therefore, mitigation/adaptation measures of climate change are essential for human beings to survive;
- In order to mitigate anthropogenic GHG emissions at a national level, we need to know the following facts:
  - How much GHGs are emitted in each sector, and in total?
  - Which are the key sectors to reduce GHG emissions?



## GHG Emission/Removal Sectors

- Energy
- Industrial processes
- Solvent and other product use

Industrial Processes and Product Use (IPPU)

- Agriculture
- Land-use Change and forestry
- Waste
- Other

Agriculture, Forestry and Other Land Use (AFOLU)

Source: Revised from Tanabe (2010)

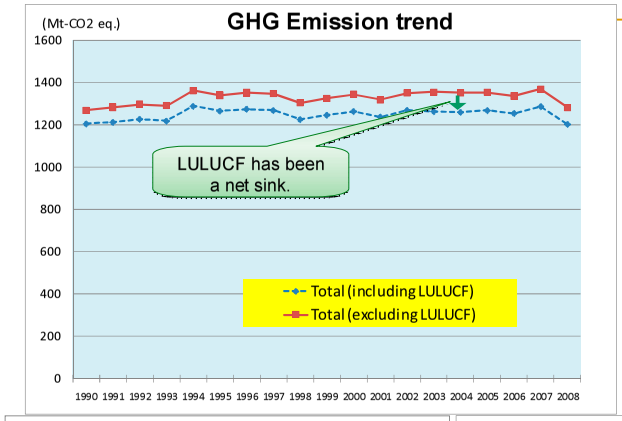
# What is the most important GHG Inventory Work?

**Data collection and methodology choice**

I think this is the most important work!

- Uncertainty assessment
- Identification of key categories
- Quality assurance and quality control
- Verification
- Ensuring time series consistency






## Japan

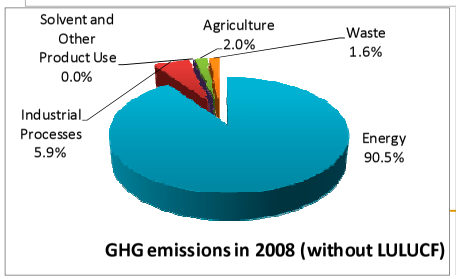
Emission trend: Increasing
(1.0% higher in 2008 than in 1990 [without LULUCF]
= 1.6% higher than KP Base Year)

LUCF: constantly sink

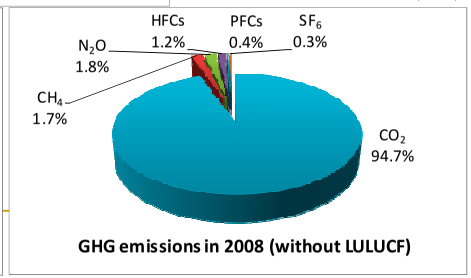
90.5% from Energy

94.7% of total GHG is $CO_2$
(89.9% = $CO_2$ from Energy)

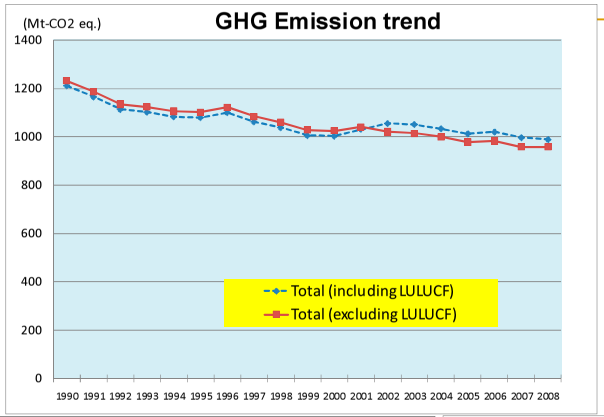
Source: Tanabe (2010)




GHG emissions in 2008 (without LULUCF)




GHG emissions in 2008 (without LULUCF)




## Germany

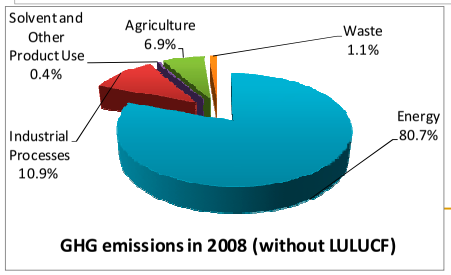
Emission trend: Decreasing
(22.2% lower in 2008 than in 1990 [without LULUCF]
= 22.3% lower than KP Base Year)

LUCF: sink in 1990-2001
source in 2002-2008

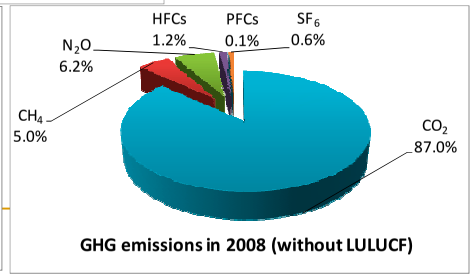
80.7% from Energy
10.9% from Industrial P.

87.0% of total GHG is $CO_2$
(78.5% = $CO_2$ from Energy)

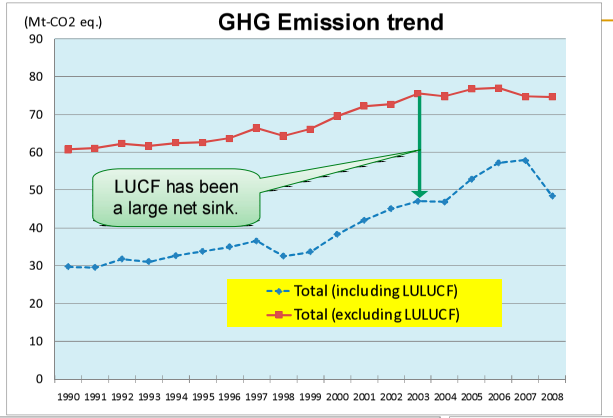
Source: Tanabe (2010)




GHG emissions in 2008 (without LULUCF)




GHG emissions in 2008 (without LULUCF)




## New Zealand

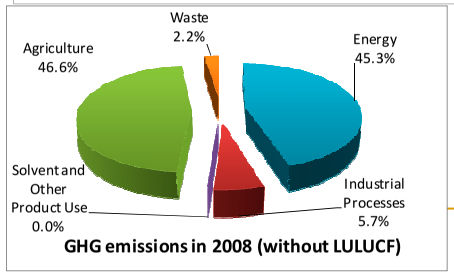
Emission trend: Increasing
(22.8% higher in 2008 than in 1990 [without LULUCF]
= 20.6% higher than KP Base Year)

LUCF: constantly large sink

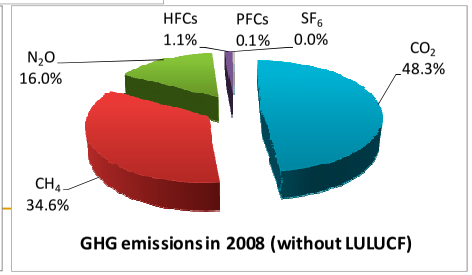
46.6% from Agriculture

34.6% of total GHG is $CH_4$
(30.3% = $CH_4$ from enteric fermentation (livestock))

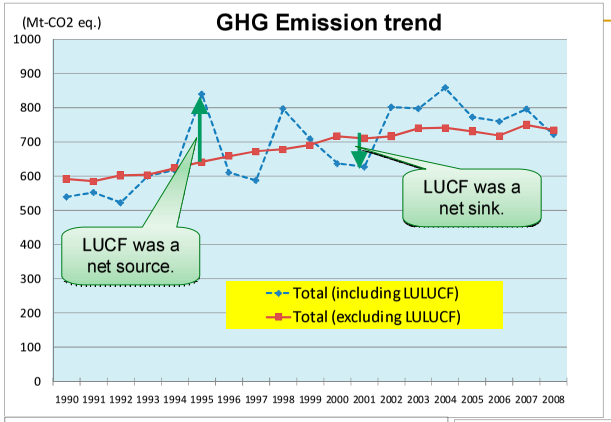
Source: Tanabe (2010)




GHG emissions in 2008 (without LULUCF)




GHG emissions in 2008 (without LULUCF)




## Canada

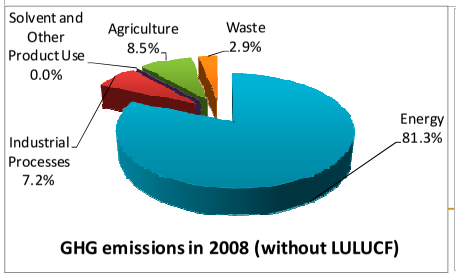
Emission trend: Increasing
(24.1% higher in 2008 than in 1990 [without LULUCF]
= 23.6% higher than KP Base Year)

LUCF: notably fluctuated year by year

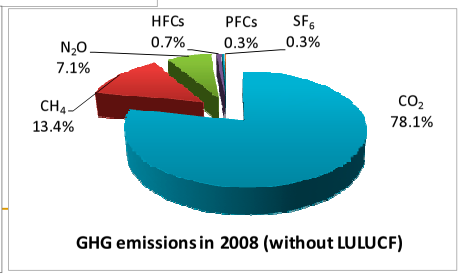
81.3% from Energy
8.5% from Agriculture

78.1% of total GHG is $CO_2$
(72.8% = $CO_2$ from Energy)

Source: Tanabe (2010)

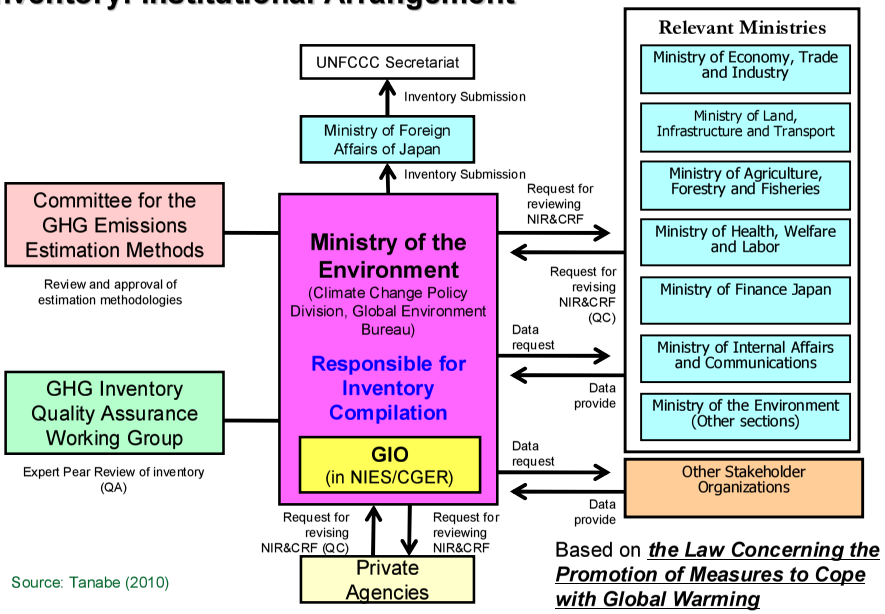



GHG emissions in 2008 (without LULUCF)




GHG emissions in 2008 (without LULUCF)

## National System of Japan to develop GHG Inventory: Institutional Arrangement




Source: Tanabe (2010)

Based on ***the Law Concerning the Promotion of Measures to Cope with Global Warming***

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## Characteristics of Japanese GHG Inventory: Transport

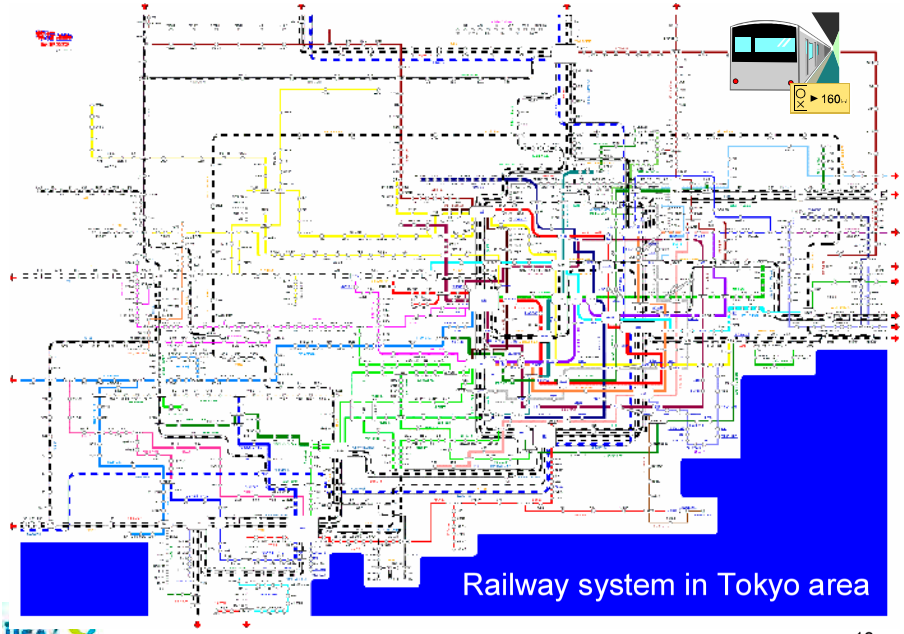
### Introduction of Japanese Transport sector

- Main emitters: Civil Aviation, Road Transportation, Railways, and Navigation;
- The sector emitted 20.1% (228 mil. t-$CO_2$) of total GHG emission(2008).
- There are good public railway systems like 'SHINKANSEN'.

### Characteristics of the sector (2008)

- Road Transportation is the biggest emitter (90.1%) in the sector;
- Railways emitted only 0.3% of the sector's GHG emission;
- Civil Aviation and Navigation emitted 9.6% of the sector's GHG emission.





## Characteristics of Japanese GHG Inventory: Transport

### Methodology adopted by Japan

- $CO_2$:

  Emission Factors (original data and IPCC2006) × Activity data (= 'General Energy Statistics')

  *The statistics has categories related to 'Transport Sector' such as 'Civil Aviation', 'Road Transportation', 'Railways' and 'Navigation'.

- $CH_4$, $N_2O$ (Road Transportation):

  Emissions have been calculated distance travel per type of vehicle by emission factors using the Tier 3 method, in accordance with the GPG (2000).
  The country-specific emission factors (Japan Automobile Manufacturers Association data) were used for the other category of vehicle, and the default emission factors were used for the other category of vehicle. The activity data was estimated by using running mileage and fuel efficiency which were provided from the MLIT's Statistical Yearbook of Motor Vehicle Transport.



## Emission factors for CH4 and N2O

### The country-specific emission factors (CH4)

| Fuel | Vehicle Type | Unit | 2007 | 2008 |
|---|---|---|---|---|
| Gasoline | Light Vehicle | $gCH_4/km$ | 0.006 | 0.006 |
| | Passenger Vehicle | $gCH_4/km$ | 0.010 | 0.009 |
| | Light Cargo Truck | $gCH_4/km$ | 0.010 | 0.009 |
| | Small Cargo Truck | $gCH_4/km$ | 0.012 | 0.011 |
| | Regular Cargo Truck | $gCH_4/km$ | 0.035 | 0.035 |
| | Bus | $gCH_4/km$ | 0.035 | 0.035 |
| | Special Vehicle | $gCH_4/km$ | 0.035 | 0.035 |
| Diesel | Passenger Vehicle | $gCH_4/km$ | 0.013 | 0.013 |
| | Small Cargo Truck | $gCH_4/km$ | 0.009 | 0.008 |
| | Regular Cargo Truck | $gCH_4/km$ | 0.013 | 0.013 |
| | Bus | $gCH_4/km$ | 0.017 | 0.017 |
| | Special Vehicle | $gCH_4/km$ | 0.013 | 0.013 |





## Emission factors for CH4 and N2O

### How do they decided the emission factor?

- 10.15 mode provided by Japan Automobile Manufacturers Association
  - Measuring the emissions by 10.15 mode chosen as a running pattern of the average in the city in Japan under conditions, such as a certain specific temperature and humidity
- IPCC default value, GPG2000 data
- Actual measuring data



## Activity data of the vehicle

### The activity data: Distance traveled per type of vehicle

| vehicle type | fuel type | Unit | 2007 | 2008 |
|---|---|---|---|---|
| Light vehicle | Gasolin | $10^6$ vehicles km | 116,442 | 121,327 |
| Passenger vehicle | Gasolin | $10^6$ vehicles km | 363,707 | 351,943 |
| | Diesel Oil | $10^6$ vehicles km | 21,445 | 17,692 |
| | LPG | $10^6$ vehicles km | 13,427 | 12,864 |
| Bus | Gasolin | $10^6$ vehicles km | 69 | 73 |
| | Diesel Oil | $10^6$ vehicles km | 6,658 | 6,503 |
| Light cargo truck | Gasolin | $10^6$ vehicles km | 73,382 | 73,312 |
| Small cargo truck + Cargo passenger truck | Gasolin | $10^6$ vehicles km | 27,051 | 26,345 |
| | Diesel Oil | $10^6$ vehicles km | 38,064 | 36,295 |
| Regular cargo truck | Gasolin | $10^6$ vehicles km | 993 | 1,059 |
| | Diesel Oil | $10^6$ vehicles km | 80,516 | 77,887 |
| Special vehicle | Gasolin | $10^6$ vehicles km | 1,690 | 1,726 |
| | Diesel Oil | $10^6$ vehicles km | 20,185 | 19,851 |

## Activity data of the vehicle

### How do they decided the activity data?

- the proportion of running mileage for each fuel, which was calculated from fuel consumption and fuel efficiency
- the running distance for each category of vehicle given in the Statistical data (published by Ministry of Land, Infrastructure, Transport and Tourism)



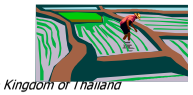
## Characteristics of Japanese GHG Inventory: Paddy field

### Introduction of Japanese paddy field

- Paddy field: 1,621,000 ha (2008), 4.3% of total area
  GHG emission: 5.6 million t-$CO_2$/y (0.4%)

### Characteristics of Japanese paddy field

- Intermittently and continuously flooded paddy fields are targeted in this category. In Japan, Rice cultivation is practiced mainly on intermittently flooded paddy field.
- The general practice of intermittent flooding (single aeration) by paddy farmers in Japan is different in nature from the intermittently flooded paddy field (complex drainage of ponded water) concept in the IPCC Guidelines.







## Characteristics of Japanese GHG Inventory: Paddy field

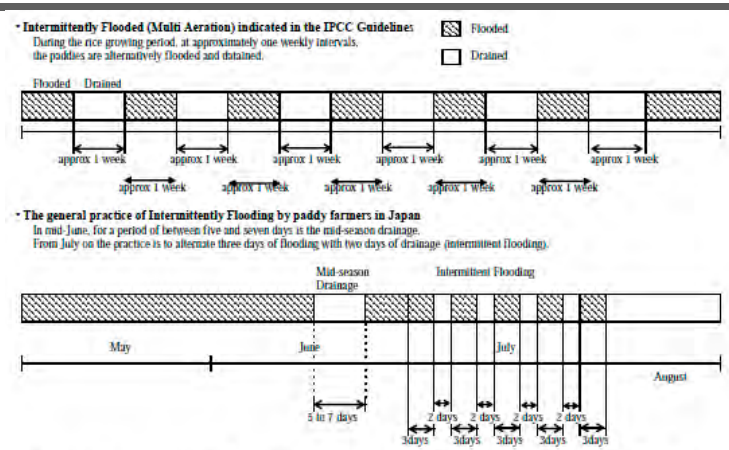



Figure 6-3 Comparison of water management regime in Japan and intermittent flooding (single aeration) indicated in the *IPCC Guidelines*



## Characteristics of Japanese GHG Inventory: Paddy field

### Methodology adopted by Japan

- $CH_4$, $N_2O$

$CH_4$ emission from intermittently flooded paddy fields (single aeration) (kg-$CH_4$) = Σ (EF for organic matter management method n for soil type m [kg-$CH_4$/$m_2$] × Area of paddy fields [$m_2$] × % of intermittently flooded paddy field × % of soil type m × % of organic matter management method n)

Table 6-25 Methane emission factor for intermittently flooded paddy fields (single aeration)

| Type of soil | Straw amendment [$gCH_4/m^2$/year] | Various compost amendment [$gCH_4/m^2$/year] | No-amendment [$gCH_4/m^2$/year] |
|---|---|---|---|
| Andosol | 8.50 | 7.59 | 6.07 |
| Yellow soil | 21.4 | 14.6 | 11.7 |
| Lowland soil | 19.1 | 15.3 | 12.2 |
| Gley soil | 17.8 | 13.8 | 11.0 |
| Peat soil | 26.8 | 20.5 | 16.4 |

Source: Haruo Tsuruta (2000) (Reference 33)

## Characteristics of Japanese GHG Inventory: Waste

### Introduction of Japanese waste

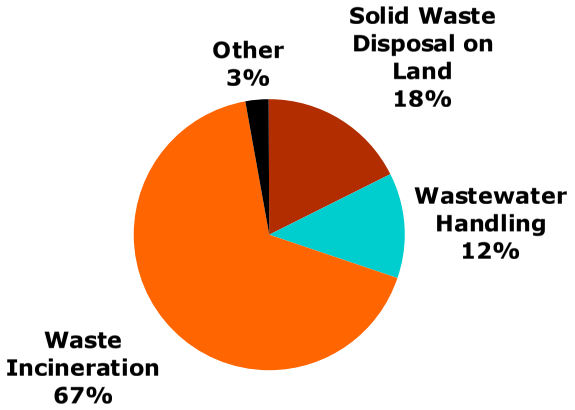
- In Japan, annual waste generation is amounted to around 600 Mt-$CO_2$/y and it has hardly changed since FY 1990.
- Waste of biogenic-origin, waste of fossil-origin, and metal and nonmetallic mineral wastes accounted respectively for 54%, 3% and 43% of total amount of waste.

### Characteristics of Japanese waste

- In Japan, waste disposed of has been reduced in volume primarily by incineration.
- GHG emissions from waste incineration were 1,339,800 t-$CO_2$ and accounted for 1.0% of the national total emissions.



## Characteristics of Japanese GHG Inventory: Waste








## Characteristics of Japanese GHG Inventory: Waste

### Methodology adopted by Japan

- $CO_2$ from municipal solid waste incinerated at facilities with energy recovery:

$E = EF \times A \times R$

E : Emission of $CO_2$ from the incineration of various types of waste (kg $CO_2$)

EF : Emission factor for the incineration of various types of waste (dry basis) (kg $CO_2$/t),

EF (dry basis) = 1000 [kg] × Carbon content × efficiency of combustion × 44/12

Examples of carbon content: plastics = 75.1%, synthetic textile = 63.0%

A: Volume of each type of waste incinerated (dry basis) (t)

R: % of municipal solid waste incinerated at facilities with energy recovery



## Introduction of GHG Inventories of Thailand

Thank you very much for the contribution of

Ms. Wsinee Cheunban (Note-san)!!

# Discussions

How to address the following major issues:

1. Lack of data
2. Inconsistency of data
3. Confidentiality of data
4. Incompleteness of data
5. Inconsecutiveness of data

# Practice
# Calculation : $CO_2$ emission
# From Crude Oil
# in Thailand (2008 IEA)





# Calculation $CO_2$ emission

1.Energy Consumption
- A. Consumption
  (Mass, Volume or Energy unit)
- B. Conversion Factor (TJ/unit)
- C. Consumption (TJ)

2.$CO_2$ emission
- D. $CO_2$ Emission Factor (kg $CO_2$/TJ)
- E. $CO_2$ Emissions ($GgCO_2$)



# 1. Energy Consumption



# Energy Consumption

- C=A X B

- A. Consumption
  (Mass, Volume or Energy unit)
- B. Conversion Factor (TJ/unit)
  (2006 IPCC Guideline default value)
- C. Consumption (TJ)

# A. Consumption

- A. Consumption (Crude Oil)
(Mass, Volume or Energy unit)
- Final consumption :2,888
(1000tonnes)

(Source: P.Ⅱ.409, ENERGY STATICS OF NON-OECD COUNTRIES (2010Edition), IEA)



# B. Conversion Factor

- B. Conversion Factor (TJ/unit)
(Crude Oil)
- Net calorific Value : 42.3(TJ/Gg)

(Note: unit 1Gg=1000tonnes)
(Source: Table1.2, P.1.18, Chap.1 Volume 2: Energy, 2006 IPCC Guidelines)





# C. Consumption

- C. Consumption (TJ) (Crude Oil)
C=A X B=2,888 X 42.3
=122,162.4 (TJ)



# 2. $CO_2$ Emission

# $CO_2$ Emission

- $E=C \times D / 10^6$
- C. Energy Consumption (TJ)
- D. $CO_2$ Emission Factor (kg $CO_2$/TJ)
- E. $CO_2$ Emissions ($GgCO_2$)



# D. $CO_2$ Emission Factor

- D. Effective $CO_2$ emission factor (Crude Oil)
- : 73,300 (kg/TJ)

(Source: Table1.4, P.1.23, Chap.1 Volume 2: Energy, 2006 IPCC Guidelines)





# E. $CO_2$ Emissions

- E. $CO_2$ Emission ($GgCO_2$) (Crude Oil)

$E=C \times D / 10^6 =$ 122,162.4 X 73,300 / $10^6$

$=$ 8,954.5 ($GgCO_2$)



Thank you!

# Tier1 Method

- Tier1 : Energy (Fuel) Consumption =

  "National Energy Statistics"

  x "Emission Factor"



# What is TJ??

- TJ =1, 000, 000, 000, 000J

J is a standard unit of heat energy.
1Cal equals the heat energy to make 1g pure water from 14.5℃ to 15.5℃
1Cal = 4.1855J





# What is Net calorific value?

- **Quantity of heat liberated by the complete combustion of a unit of fuel with evaporative latent heat.**
- **For coal and oil, the difference between net calorific values (NCVs) and gross calorific values (GCVs) is approximately 5%. In Japanese Energy Statistics, We use GCVs.**
- **For most natural gas and manufactured gases, the difference is approximately 9-10%.**

# Overview of Energy Sector

14 September, 2010

GHG Inventory

**Fumihiko KUWAHARA**



## Contents of "Energy Sector" Training Program

1. Introduction of GHG Inventory
2. Outline of Energy Sector
3. The general method of calculating the GHG of Energy Sector
4. The method of calculating the GHG of Energy Sector in Japan
5. Issues of Energy Sector in Thailand
6. Practice



## 1. Introduction of GHG Inventory

- At first I have a common comment of the development of GHG inventories.
- In order to promote the development of high quality national greenhouse gas inventories, a collection of methodological principles, tasks and procedures were defined in the "Good Practice Guidance" and "Guidelines".



## Introduction of GHG Inventory

- In order to produce high quality inventories, despite the varying experience and resources of inventory compilers, the "2006 Guidelines" uses the "Tiers", "Key categories" and "Decision trees".

# What are "Tiers"?

- Tiers
  - A tier represents a **level** of methodological **complexity**.
  - Tier1 is the basic method and default factors are supplied in IPCC Guidelines.
  - Tier2 requires country-specific information.
  - Tier3 is most demanding in terms of complexity and data requirements usually involving detailed modeling.



# What are " Key Categories"?

- Key Categories
  - The concept of key category is used to identify the categories that have a significant influence on a country's total inventory of GHG.
  - Key categories should be the priority for countries during inventory resource allocation for data collection, compilation and quality assurance/ quality control.
  - "Key Categories" will be explained in detail in the later lecture.





# What are "Decision trees"?

- Decision trees
  - Decision trees for each category help the inventory compiler navigate through the guidance and select the appropriate tiered methodology for their circumstances based on their assessment of **key categories** and data availability.
  - In general, it is good practice to use higher tier methods for **key categories**, unless the resources requirements to do so are prohibitive.



# 2. Outline of Energy Sector

- The energy sector mainly comprises of:
  - Exploration and exploitation of primary energy sources,
  - Conversion of primary energy sources into more useable energy forms in refineries and power plants
  - Transmission and distribution of fuels
  - Use of fuels in stationary and mobile applications (Stationary Combustion and Mobile Combustion)

# Introduction of Energy Sector

- Energy Sector is usually the MOST important sector
  - Typically contributes; 90% of CO2 emissions and 75% of total GHG emissions (in developed countries)
  - CO2 accounts typically for 95% of energy sector emissions (other balance are CH4 and N2O)
  - Stationary combustion is usually responsible for about 70% of GHG emissions from the energy sector.
  - Mobile combustion (road and other traffic) causes about one quarter of the emissions in the energy sector.



# Activity and Source Structure in the Energy Sector

- 1A Fuel Combustion Activity
  - 1A1 Energy Industries
  - 1A2 Manufacturing industries and Construction
  - 1A3 Transport
  - 1A4 Other Sectors
  - 1A5 Non-Specified
- 1B Fugitive emissions from Fuels
  - 1B1 Solid Fuels
  - 1B2 Oil and Natural Gas
  - 1B3 Other emissions from Energy Production
- 1C Carbon dioxide Transport and Storage
  - 1C1 Transport of CO2
  - 1C2 Injections and Storage
  - 1C3 Other





# Fuel types (2006 IPCC Guidelines)

- Liquid (Crude oil and petroleum products)
  - Crude Oil, Gasoline, Kerosene, Diesel Oil, Residual Fuel Oil, Naphtha, Refinery Feedstocks, …etc.
- Solid (Coal and Coal Products)
  - Anthracite, Coking Coal, Other Bituminous Coal, Lignite, Coke, Coke Oven Gas, Blast Furnace Gas, …etc.
- Gas (Natural Gas)
- Other Fossil Fuels (Waste, Peat)
- Biomass
  - Wood, Sulphite Lyes (Black Liquor), …etc.



# Basic Information of Energy Sector

- The basic equation : Emissions = Activity Data x Emission Factor
- Emissions arise from "Energy Sector" by combustion and as fugitive emissions, or escape without combustion.
- In the Energy Sector the changes are minimal.

# Transition of Energy Sector from the Revised 1996 IPCC Guidelines

- No "real" changes since the revised 1996 IPCC Guidelines
- What is new?
  - Clear separation of Sectoral Approach and Reference Approach
  - Clear treatment of non-energy use of fuel
  - New chapter on CO2 Capture and Storage
  - Methods for abandoned coal mines
  - New methodologies and emission factors to reflect developing country circumstances as well
  - Improved decision trees facilitating more accurate emission estimation
  - Uncertainty information for all default values



# "Sectoral Approach" vs "Reference Approach"

| Sectoral Approach | Reference Approach |
|---|---|
| Sectoral Approach is based on fuel consumption by fuel type and user. | Reference Approach is based on national energy balances at a summary level. |
| Sectoral Approach should be used for estimating emissions. | Reference Approach should be used as a QA/QC check. |
| <All gases> | <CO2 only> |





# Definition of Emissions from Fuel Combustion and from Industrial Process

| | |
|---|---|
| Fuel Combustion | The internal oxidation of materials within an apparatus that is designed to provide heat or mechanical work to process, or for use away from the apparatus.<br>If the derived fuels are transferred for combustion in another source category, the emissions should be reported in the Energy Sector. |
| Industrial Process | Combustion emissions from fuels obtained directly or indirectly from the feedstock for Industrial Processes are allocated to the Industrial Processes. |



# Some Questions

- Q1; If a blast furnace gas is combusted entirely with the Iron and Steel Plant, which sector are emissions reported in?
- A1; Industrial Processes and Product Use (IPPU) Sector. Because seeing this process in broad perspective, the fuels usage is closed on site.
- Q2; If part of this gas is delivered to a nearby brick work for heat production, which sector are emissions reported in?
- A2; Energy Sector. Because the "brick work" gets "Energy" from blast furnace gas and the "brick work" emits CO2.

# Some Questions

- Q3; If surplus methane or hydrogen from the steam cracking of naphtha is combusted within the petrochemical site for another process, which sector are emissions reported in?
- A3; IPPU Sector. Because fuels are only used on site.
- Q4; If the gases are passed to a nearby refinery for fuel use, which sector are emissions reported in?
- A4; Energy Sector. Because these gases are source of "Energy" in the refinery.



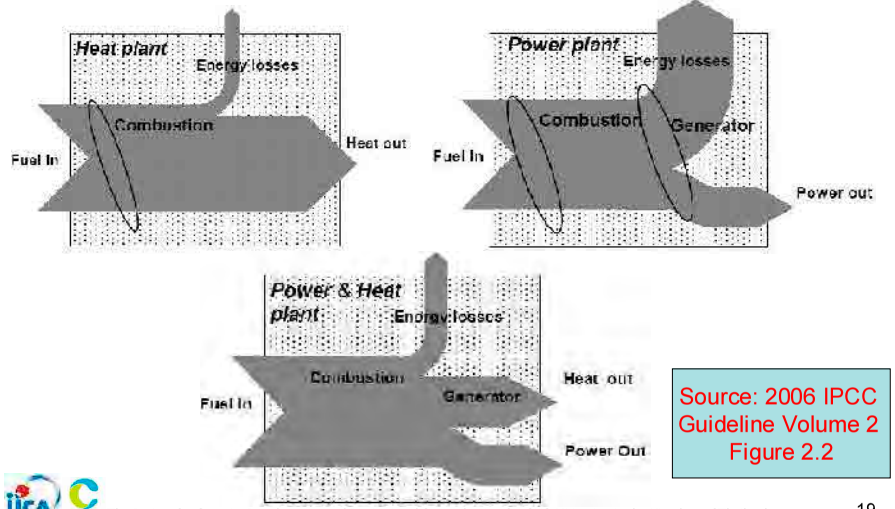
# Outline of Stationary Combustion

- What is "Stationary Combustion" ?
- Energy Industries (for example; Electrical Power Plants, Heat Plants, Petroleum Refining…)
- Manufacturing Industries and Construction (for example; Iron and Steel, Non-Ferrous Metals, Chemical, Pulp, Paper and Print, Food, …etc.)
- Other Sector (for example; Commercial, Residential, Agriculture, …etc.)
- Non-Specified (for example; military, …etc.)





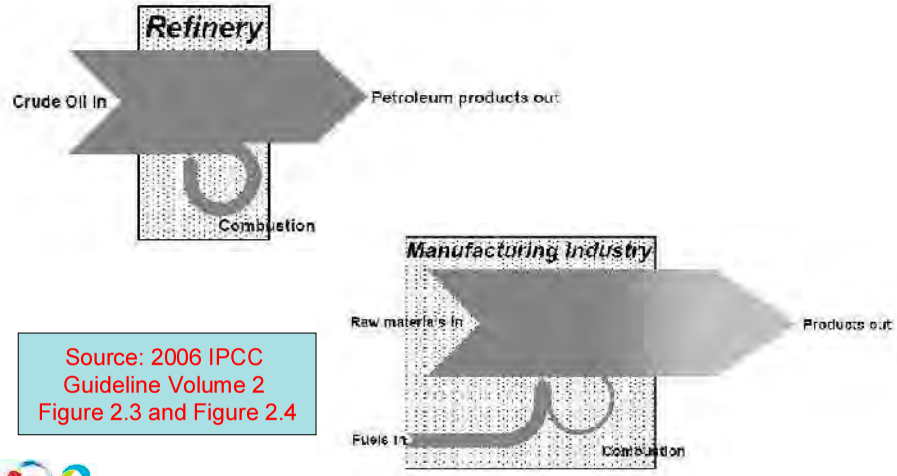
# Example of Energy Flows (Power and Heat Plants)




Source: 2006 IPCC Guideline Volume 2 Figure 2.2



# Example of Energy Flows (Refinery and Manufacturing Industry)




Source: 2006 IPCC Guideline Volume 2 Figure 2.3 and Figure 2.4

## 3. The general method of calculating the GHG of Energy Sector

- Tier1 : Fuel Consumption
  (National Energy Statistics) x EF (Default)
- Tier2 : Fuel Consumption
  (National Energy Statistics) x EF (Country-specific)
  - Compare any country-specific EF with the default EF
- Tier3 : Fuel Consumption
  (fuel, technology) x EF (GHG, fuel, technology)
  - Technology ; any device, combustion process, fuel property, quality of maintenance…etc…



## Activity Data and Emission Factor

- Main Activity Data : "Energy Statistics"
- Sub Activity Data : "Other Statistics"
- Main Emission Factor Source : IPCC Guidelines for National Greenhouse Gas Inventory or the IPCC Emission Factor Database
- Sub Emission Factor Source : Country-specific EFs (very important)



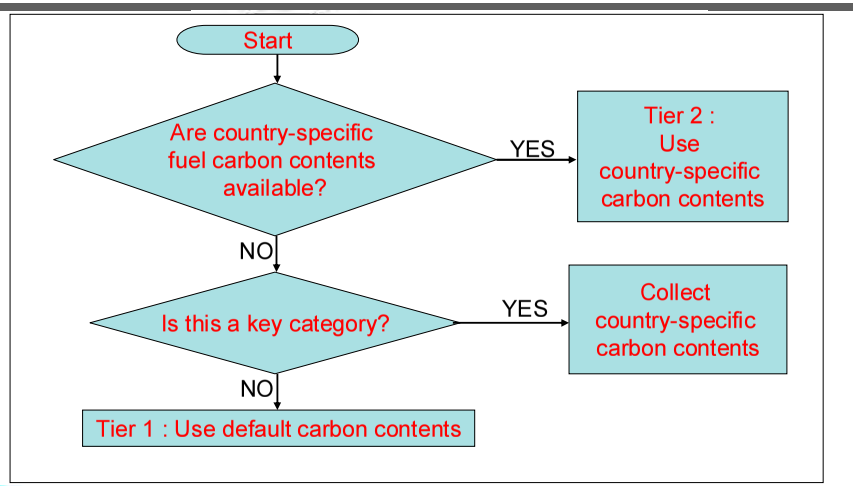


## Introduction of Mobile Combustion

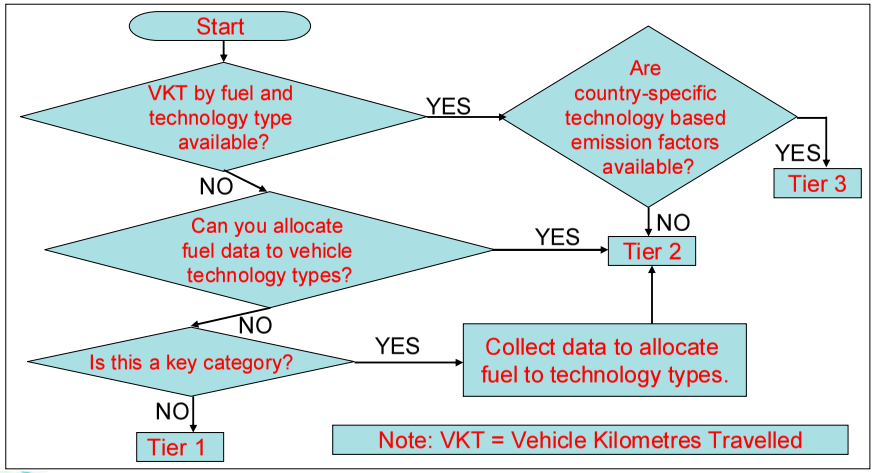
- Sources : road, off-road, air, railways, and water-borne navigation
- Emissions : CO2, CH4, N2O
- Characteristics is very important (such as vehicle types, ageing on catalytic control, age of fleet, maintenance, fuel sulphur content, patterns of use,…etc.)



## Example of Decision Tree for CO2 Emissions from fuel combustion in road vehicles



## Example of Decision Tree for CH4 & N2O Emissions from fuel combustion in road vehicle






## Tier1, Tie2 and Tier3 (Road Transportation)

- Tier1: CH4 and N2O, CO2(Tier1 and Tier2)
- $\text{Emission} = \sum_{a} [\text{Fuel}_a \cdot \text{EF}_a]$ a: fuel type
- Tier2: CH4 and N2O
- $\text{Emission} = \sum_{a,b,c} [\text{Fuel}_{a,b,c} \cdot \text{EF}_{a,b,c}]$
- b: vehicle type, c: emission control technology
- Tier3: CH4 and N2O
- $\text{Emission} = \sum_{a,b,c,d} [\text{Distance}_{a,b,c,d} \cdot \text{EF}_{a,b,c,d}] + \sum_{a,b,c,d} \text{C}_{a,b,c,d}$
- d: operating conditions, Distance = distance travelled,
- C = emissions during warm-up phase





## Railway and Water-Borne Navigation

- Tier1 : $\text{Emission} = \sum_{j} [\text{Fuel}_j \cdot \text{EF}_j]$ j = fuel type
- : $\text{Emission} = \sum_{a,b} [\text{Fuel}_{a,b} \cdot \text{EF}_{a,b}]$
- a = fuel type, b = water-borne navigation type
- Tier2 : $\text{Emission} = \sum_{i} [\text{Fuel}_i \cdot \text{EF}_i]$ i = locomotive type
- : $\text{Emission} = \sum_{a,b} [\text{Fuel}_{a,b} \cdot \text{EF}_{a,b}]$
- country-specific emission factors
- Tier3 : skip



## Question (About Fuel Combustion)

- Q: Generally, CO2 emissions from fuel combustion are the most important category in the GHG inventory. Therefore we should calculate in Tier3 (Detailed Method). (Is it true?)
- A: Using a Tier 3 approach to estimate emissions of CO2 is often unnecessary because emissions of CO2 do not depend on the combustion technology. However, plant-specific data on CO2 emissions are increasingly available and they are of increasing interest because of the possibilities for emission trading.

# Fugitive Emissions (Coal Mines)

- Underground Coal Mines ; Tier1 and Tier2 (basic equation)
  - Greenhouse gas emissions = "Raw Coal Production" x "Emission Factor" x "Units Conversion Factor"
- Surface Coal Mining ; Tier1 and Tier2 (basic equation)
  - CH4 = Surface mining + Post-mining
  - CH4 emissions = "CH4 Emission Factor" x "Surface Coal Production" x "Conversion Factor"
- Abandoned Underground Coal Mines ; Tier1 and Tier2 (basic equation)
  - Greenhouse gas emissions = "Number of Abandoned Coal Mines remaining unflooded" x "Fraction of Gassy Coal Mines" x "Emission Factor x "Units Conversion Factor"



# Fugitive Emissions (Oil and NG)

- Emission Sources : Venting, Flaring, Equipment leak, Storage losses, Exploration, Production and Upgrading, Transport, Refining, Distribution, …etc.
- Tier1: Emissions = "Activity Value" x "Emission Factor"
  - EF : Tier 1 default emission factors are presented in 2006 IPCC Guideline.
  - Activity Data : typical national oil and gas statistics (limited information)





# Question (About Fugitive Emissions )

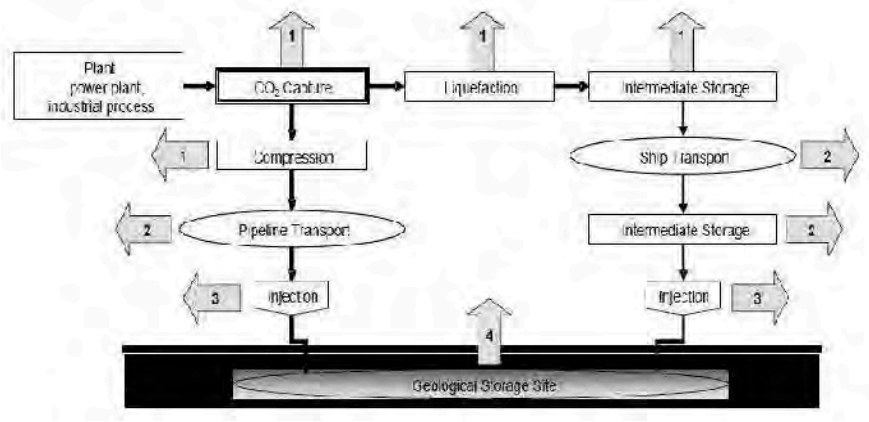
- Q: If the surplus CH4 of the natural gas field are combusted in on-site power plant, should these emissions be calculated in the "Fugitive Emissions" category?
- A: No. These Emissions should be calculated in the "Fuel Combustion" category, because emissions from fuel combustion for production of useful heat or energy by stationary sources are reported in "Fuel Combustion" category.
- The emissions from the flaring and the venting should be in the "Fugitive Emissions" category.



# Carbon Dioxide Transport, Injection and Geological Storage

- Carbon Dioxide Capture and Storage (CCS)
  - CO2 Capture ("1"): The system boundary for capture includes compression and any dehydration or other conditioning of the CO2 that takes place before transport.
  - Emissions from Transport of Captured CO2 ("2"): Pipelines, ships and so on.
  - Emissions from Injection of Captured CO2 ("3"): At the injection site. (storage facilities, any distribution manifold, distribution pipelines to wells, injection well, etc.)
  - Geological Storage of Captured CO2 ("4"): Deep saline formations, Depleted or partially depleted oil fields, Depleted or partially depleted Natural Gas field, Coal seam

# Schematic Representation of the Carbon Capture and Storage Process




Source: 2006 IPCC Guideline Volume 2 Figure 5.1



# Question (About Carbon Dioxide Capture and Storage)

- Q: Are there some projects of CCS in Thailand? (I do not know. So, I want to know!)
- A: There are some projects…or no projects.
- A: There are some projects in Japan.
  - Sumitomo Chemicals Plant, Chiba, Japan/Kokusai Carbon Dioxide
  - RITE R&D Projects for Geological Sequestration of Carbon Dioxide
  - IGCC Demonstration Plant, Nakoso Power Station, etc.





# 4. The method of calculating the GHG of Energy Sector in Japan

- Emissions = "Activity Data" x "Emission Factor" x "Global Warming Potential"
- Activity Data: (Mainly) "Japan's General Energy Statistics"
- Emission Factor: Country-specific emission factors
- 1,160,455 Gg-CO2 (90.5% of Japan's total GHG emissions)
- Data source is "National Greenhouse Gas Inventory Report of JAPAN (Ministry of the Environment, Japan, Greenhouse Gas Inventory Office of Japan (GIO), CGER, NIES)"



# Characteristics of Japan's General Energy Statistics

- Matrix ("Columns" (energy sources) x "Rows" (sectors))
  - 11 major energy source categories, Sub-categories and a more detailed breakdown of the sub-categories (about 160 categories)
  - 3 major sectors, Sub-categories and a more detailed breakdown of the sub-categories ( about 200 categories)

# For Example : Japan's Energy Statistics



# Japanese Emission Factor of "Fuel Combustion Category"

- CO2 emission factors: Default value and Country-specific value
  - 2006 IPCC Guideline default value
  - Adopted value of other fuel
  - Country-specific value
- CH4 and N2O emission factors: Tier 2 country-specific emission factors
  - based on data obtained from surveys conducted in Japan





# Setting method of the emission factor

- Setting from scientific theory value (CO2 from energy Combustion, …etc.)
- Measurement made at the factories (Mainly CH4 and N2O)
- The results of surveys in Japan (Mainly Agricultural Sector and Waste Sector)
- The default value of the IPCC guideline (N2O from civil aviation, …etc.)



# The method of calculating the GHG Emissions of other categories in Japan

- Fugitive Emissions
  - This category is not important in Japan.
    - 446 Gg-CO2/year (0.03 % of Japan's total GHG emissions)
    - The emissions have decreased by 85% compared to 1990.
- Carbon dioxide Transport and Storage
  - This category is not estimated yet.

## 5. Issues of Energy Sector in Thailand

- Which categories is the key categories? Which categories is important? (Sub-category is not clear.)
- Is there overestimated sub-category?
- Is there underestimated sub-category?
- Is there double counting sub-category?
- Is there omitted sub-category?



## The energy statistics candidate in Thailand

- First : Thailand Energy Situation (http://www.dede.go.th/ded[illegible])
- Second : Energy Statistics of Non-OECD Countries (International Energy Agency)
- Third : Energy Balances and Electricity Profiles (United Nations)
- Fourth :U.S. Energy Information Administration (EIA; http://www.eia.doe.gov/)
- Fifth : Enerdata (http://www.enerdata.net/)

Top priority energy statistics

Use in cross-checking or QA/QC process





## 6. Practice

- The simple energy balance table is distributed.
- And, the emission factors of IPCC default value is distributed, too.
- Please make an inventory in energy sector from these.
- Please calculate in Tier1 (simple) method.
- Let's proceed with this work while you discuss it in your group.
- Please discuss which category is suitable for allocating CO2 emissions from the electric powers.



- ありがとうございました
- ขอบคุณ มาก ครับ/ค่ะ
- Thank you very much

# Appendix

- "Japanese Energy Statistics" and "Common Reporting Format (CRF)"
- Emission factors (CH4 and N2O)
- Others





# Correspondence between sectors of General Energy Statistics and of the CRF

| CRF | | General Energy Statistics |
|---|---|---|
| 1A1 | Energy Industries | |
| 1A1a | Public Electricity and Heat Production | #2011 Power Generation, General Electric Utilities<br>#2911 Own use, General Electric Utilities<br>#2353 Power Generation, Independent Power Producing<br>#2912 Own use, Independent Power Producing<br>#2355 District Heat Supply<br>#2013 Own use, District Heat supply |
| 1A1b | Petroleum Refining | #2016 Own use, Oil Refinery |
| 1A1c | Manufacture of Solid Fuels and Other Energy Industries | #2914 Own use, Town Gas<br>#2915 Own use, Steel Coke<br>#2917 Own use, Other Conversion |
| 1A2 | Manufacturing Industries and | |
| 1A2a | Iron and Steel | #2217 Auto: Iron & Steel<br>#2307 Steam Generation: Iron & Steel<br>#6580 Final Energy Consumption, Iron & Steel<br>#9680 Non-Energy, Iron & Steel<br>#2218 Auto: Non-Ferrous Metal |
| 1A2b | Non-Ferrous Metals | #2308 Steam Generation: Non-Ferrous Metal<br>#6590 Final Energy Consumption, Non-Ferrous Metal<br>#9690 Non-Energy, Non-Ferrous Metal |
| 1A2c | Chemicals | #2212 Auto: Chemical Textiles<br>#2302 Steam Generation: Chemical Textiles<br>#6530 Final Energy Consumption, Chemical Textiles<br>#9620 Non-Energy, Chemical Textiles<br>#2214 Auto: Chemical<br>#2304 Steam Generation: Chemical<br>#6550 Final Energy Consumption, Chemical<br>#9650 Non-Energy, Chemical |
| 1A2d | Pulp, Paper and Print | #2211 Auto: Pulp & Paper<br>#2301 Steam Generation: Pulp & Paper<br>#6520 Final Energy Consumption, Pulp & Paper<br>#9640 Non-Energy, Pulp & Paper |
| 1A2e | Food Processing, Beverages and Tobacco | #6510 Final Energy Consumption, Food<br>#9610 Non Energy, Non-Manufacturing Industry (Food) |



# Correspondence between sectors of General Energy Statistics and of the CRF

| | | | |
|---|---|---|---|
| 1A2f | Other | | |
| | Mining | #6120 | Final Energy Consumption, Mining |
| | | #9610 | Non-Energy, Non-Manufacturing Industry (Mining) |
| | Construction | #6150 | Final Energy Consumption, Construction |
| | | #9610 | Non-Energy, Non-Manufacturing Industry (Construction) |
| | Oil Products | #2213 | Auto: Oil products |
| | | #2303 | Steam Generation: Oil products |
| | | #6540 | Final Energy Consumption, Oil products |
| | | #9640 | Non-Energy, Oil products |
| | Glass Wares | #2215 | Auto: Glass Wares |
| | | #2305 | Steam Generation: Glass Wares |
| | | #6560 | Final Energy Consumption, Glass Wares |
| | | #9660 | Non-Energy, Glass Wares |
| | Cement&Ceramics | #2216 | Auto: Cement & Ceramics |
| | | #2306 | Steam Generation: Cement & Ceramics |
| | | #6570 | Final Energy Consumption, Cement & Ceramics |
| | | #9670 | Non-Energy, Cement & Ceramics |
| | Machinery | #2219 | Auto: Machinery & Others |
| | | #2309 | Steam Generation: Machinery & Others |
| | | #6600 | Final Energy Consumption, Machinery |
| | | #9700 | Non-Energy, Machinery |
| | Duplication Adjustment | #2220 | Auto: Duplication Adjustment |
| | | #2310 | Steam Generation: Duplication Adjustment |
| | | #6700 | Final Energy Consumption, Duplication Adjustment |
| | | #9710 | Non-Energy, Duplication Adjustment |
| | Other Industries & SMEs | #2250 | Auto: Others |
| | | #6900 | Final Energy Consumption, Other Industries & SMEs |
| | | #9720 | Non-Energy, Other Industries & SMEs |



# Correspondence between sectors of General Energy Statistics and of the CRF

| CRF | | | General Energy Statistics |
|---|---|---|---|
| 1A3 | | Transport | |
| | 1A3a | Civil Aviation | #8140 Final Energy Consumption, Passenger Air |
| | | | #8540 Final Energy Consumption, Freight Air |
| | | | #9850 Non-Energy, Transportation (Air) |
| | 1A3b | Road Transportation | #8110 Final Energy Consumption, Passenger Car |
| | | | #8510 Final Energy Consumption, Freight Freight, Truck & Lorry |
| | | | #8115 Final Energy Consumption, Passenger Bus |
| | | | #8190 Final Energy Consumption, Passenger, Transportation fraction estimation |
| | | | #8590 Final Energy Consumption, Freight, Transportation fraction estimation error |
| | | | #9850 Non-Energy, Transportation (Car, Truck & Lorry, Bus) |
| | 1A3c | Railways | #8120 Final Energy Consumption, Passenger Rail |
| | | | #8520 Final Energy Consumption, Freight Rail |
| | | | #9850 Non-Energy, Transportation (Rail) |
| | 1A3d | Navigation | #8130 Final Energy Consumption, Passenger Ship |
| | | | #8530 Final Energy Consumption, Freight Ship |
| | | | #9850 Non-Energy, Transportation |
| | 1A3e | Other Transportation | - - |
| 1A4 | | Other Sectors | |
| | 1A4a | Commercial/Institutional | #7500 Final Energy Consumption, Commercial & Others |
| | | | #9800 Non-Energy, ResCom & others (Commercial & Others) |
| | 1A4b | Residential | #7100 Final Energy Consumption, Residential |
| | | | #9800 Non-Energy, ResCom & others (Residential) |
| | 1A4c | Agriculture/Forestry/Fisheries | #6110 Final Energy Consumption, Agriculture, Forestry & Fishery |
| | | | #9610 Non-Energy, Non-Manufacturing Industry |
| 1A5 | | Other | |
| | 1A5a | Stationary | - - |
| | 1A5b | Mobile | - - |

## Fuel type of Japan's General Energy Statistics and Trends in gross calorific value of each fuel type (part1)

| | Fuel | Unit | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|
| Coal | Steel Making Coal | MJ/kg | 31.8 | 31.84 | 28.40 | 29.00 | 29.00 | 29.00 | 29.00 |
| | Coking Coal | MJ/kg | 31.8 | 30.73 | 28.13 | 29.0 | 29.10 | 29.10 | 29.10 |
| | PCI Coal | MJ/kg | 31.8 | 30.73 | 28.23 | 29.20 | 28.50 | 28.50 | 28.20 |
| | Imported Steam Coal | MJ/kg | 25.95 | 25.95 | 26.30 | 25.70 | 25.70 | 25.70 | 25.70 |
| | imported Coal for general use | MJ/kg | 25.95 | 25.95 | 26.30 | 25.70 | 25.70 | 25.70 | 25.70 |
| | imported Coal for power generation | MJ/kg | 21.92 | 26.13 | 26.39 | 25.49 | 25.65 | 25.52 | 25.27 |
| | Indigenous Steam Coal | MJ/kg | 21.28 | 21.28 | 22.50 | 22.50 | 22.50 | 22.50 | 22.50 |
| | Underground | MJ/kg | 24.98 | 24.98 | 23.92 | 23.96 | 23.85 | 23.85 | 23.91 |
| | Open Pit | MJ/kg | 18.70 | 18.70 | 18.71 | 18.70 | 18.70 | 18.70 | 18.71 |
| | Hard Coal & Anthracite & Lignite | MJ/kg | 27.21 | 27.21 | 27.20 | 26.90 | 26.850 | 26.85 | 26.90 |
| Coal Products | Coke | MJ/kg | 30.14 | 30.14 | 30.10 | 29.40 | 29.40 | 29.40 | 29.43 |
| | Coal Tar | MJ/kg | 37.26 | 37.26 | 37.26 | 37.26 | 37.26 | 37.26 | 37.25 |
| | Coal Briquette | MJ/kg | 23.90 | 23.90 | 23.90 | 23.90 | 23.90 | 23.90 | 23.90 |
| | Coke Oven Gas | MJ/m³N | 21.54 | 21.57 | 21.27 | 21.42 | 21.08 | 21.28 | 21.20 |
| | Blast Furnace Gas | MJ/m³N | 3.81 | 3.78 | 3.64 | 3.41 | 3.41 | 3.41 | 3.41 |
| | Converter Furnace Gas | MJ/m³N | 8.37 | 8.37 | 8.4 | 8.41 | 8.41 | 8.41 | 8.41 |
| Oil | Crude oil for Refinery | MJ/l | 38.34 | 38.27 | 38.12 | 38.11 | 38 | 38.16 | 38.15 |
| | Crude Oil for Power Generation | MJ/l | 38.05 | 38.15 | 38.02 | 38.50 | 38.26 | 38.76 | 38.54 |
| | Bituminous Mixture Fuel | MJ/kg | 30.05 | 30.81 | 29.80 | 22.11 | 22.41 | 22.42 | 22.41 |
| | Natural Gas Liquid & Concensate | MJ/l | 35.74 | 35.91 | 35.41 | 35.33 | 35.01 | 35.46 | 35.30 |



## Fuel type of Japan's General Energy Statistics and Trends in gross calorific value of each fuel type (part2)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Oil Products | Stock Gasoline | MJ/l | 34.73 | 34.69 | 34.57 | 34.50 | 34.55 | 34.54 | 34.53 |
| | Stock Kerosene | MJ/l | 36.79 | 36.79 | 36.76 | 36.74 | 36.71 | 36.74 | 36.72 |
| | Stock Diesel Oil or Gas Oil | MJ/l | 38.09 | 38.09 | 38.05 | 38.07 | 38.03 | 38.07 | 38.06 |
| | Stock Fuel Oil | MJ/l | 41.92 | 41.77 | 41.75 | 41.75 | 41.79 | 41.91 | 41.80 |
| | Crudest Gasoline | MJ/l | 33.38 | 33.63 | 33.57 | 33.56 | 33.55 | 33.54 | 33.56 |
| | Crudest Diesel Oil or Gas Oil | MJ/l | 38.04 | 38.03 | 38.01 | 38.05 | 38.03 | 38.07 | 38.06 |
| | Feedstock Oil for Refinery use, Mixing | MJ/l | 38.14 | 38.27 | 38.23 | 38.13 | 38.13 | 38.11 | 38.12 |
| | Naphtha | MJ/l | 31.91 | 33.03 | 33.02 | 33.02 | 33.05 | 33.04 | 33.03 |
| | Refermed Municipal Oil | MJ/l | 38.05 | 38.03 | 38.00 | 38.03 | 38.03 | 38.05 | 38.03 |
| | Gasoline | MJ/l | 34.57 | 34.61 | 34.60 | 34.59 | 34.58 | 34.58 | 34.58 |
| | Premium Gasoline | MJ/l | 34.09 | 34.08 | 34.08 | 34.08 | 34.08 | 34.08 | 34.08 |
| | Regular Gasoline | MJ/l | 34.48 | 34.48 | 34.48 | 34.48 | 34.48 | 34.48 | 34.48 |
| | Jet Fuel | MJ/l | 36.82 | 36.82 | 36.76 | 36.76 | 36.76 | 36.76 | 36.76 |
| | Kerosene | MJ/l | 36.75 | 36.72 | 36.76 | 36.74 | 36.74 | 36.74 | 36.75 |
| | Gas Oil & Diesel Oil | MJ/l | 38.11 | 38.08 | 38.05 | 38.05 | 37.99 | 37.86 | 37.90 | 37.91 |
| | Coal Oil A | MJ/l | 37.71 | 38.01 | 38.05 | 38.05 | 38.05 | 38.05 | 38.05 | 38.05 |
| | Coal Oil B | MJ/l | 42.69 | 42.78 | 41.83 | 42.00 | 41.98 | 42.10 | 42.17 |
| | Coal Oil C | MJ/l | 42.69 | 42.78 | 41.83 | 42.00 | 41.98 | 42.10 | 42.17 |
| | Coal Oil C for Power Generation | MJ/l | 41.69 | 41.78 | 41.83 | 41.83 | 41.83 | 41.83 | 41.83 |
| | Light Oil | MJ/l | 39.18 | 39.18 | 39.20 | 39.20 | 39.20 | 39.20 | 39.20 |
| | Naphtha | MJ/kg | 44.84 | 44.15 | 44.05 | 43.97 | 43.96 | 44.13 | 44.15 |
| | Semi-Asphalt Heavy Oil Products | MJ/kg | 41.64 | 41.16 | 40.95 | 43.97 | 43.96 | 44.13 | 44.15 |
| | Tar | MJ/kg | 35.58 | 35.56 | 35.60 | 35.60 | 35.60 | 35.60 | 35.60 |
| | Refinery Furnace Gas | MJ/m³N | 38.87 | 38.87 | 38.41 | 38.41 | 38.41 | 38.41 | 38.41 |
| | Refinery Gas | MJ/m³N | 39.28 | 39.28 | 44.90 | 44.90 | 44.89 | 44.95 | 44.90 |
| | Liquified Petroleum Gas | MJ/kg | 50.25 | 50.25 | 50.20 | 50.60 | 50.69 | 50.66 | 50.56 |
| Natural Gas | Liquified Natural Gas | MJ/kg | 54.66 | 54.87 | 54.85 | 54.57 | 54.69 | 54.58 | 54.58 |
| | Indigenous Natural Gas | MJ/m³N | 45.06 | 45.08 | 45.06 | 45.67 | 45.67 | 44.91 | 44.71 |
| | Indigenous Natural Gas | MJ/m³N | 45.06 | 45.08 | 45.06 | 45.67 | 45.67 | 44.91 | 44.71 |
| | Coal Mining Gas | MJ/m³N | 39.98 | 39.60 | 39.56 | 39.56 | 39.56 | 39.56 | 39.56 |
| | Gas from Crude Oil | MJ/m³N | 45.06 | 45.08 | 45.06 | 45.67 | 45.67 | 44.91 | 44.71 |
| Town Gas | Town Gas | MJ/m³N | 41.86 | 41.86 | 41.76 | 44.80 | 44.80 | 44.80 | 44.80 |
| | Town Gas | MJ/m³N | 41.86 | 41.86 | 41.10 | 44.80 | 44.80 | 44.86 | 44.80 |
| | Small Scale Town Gas | MJ/m³N | 100.50 | 100.50 | 100.57 | 100.50 | 100.50 | 100.50 | 100.50 |



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## CH4 Emission Factors for different fuels and furnaces

| Furnace type | Fuel type | Emission factor | Remarks |
|---|---|---|---|
| Boiler | Fuel oils B and C, crude oil | 0.26 | Average of 19 facilities |
| Boiler | Fuel oil A, diesel oil, kerosene, naphtha, other liquid fuels | 0.26 | Average of 2 facilities |
| Boiler | Gaseous fuel | 0.23 | Average of 5 facilities |
| Boiler | Steam coal, coke, other solid fuels | 0.13 | Average of 7 facilities |
| Boiler | Harvested wood, charcoal | 72 | Average of 14 facilities |
| Boiler | Pulping waste liquor | 4.2 | Average of 2 facilities |
| Sintering furnace for smelting of metals (except copper, lead, zinc) | Solid fuel, liquid fuel, gaseous fuel | 51 | Average of 6 facilities |
| Refining furnace (steel and non-ferrous metal) | Solid fuel, liquid fuel, gaseous fuel | 1.7 | Average of 2 facilities |
| Metal melting furnace, metal treating furnace, metal forging furnace | Liquid fuel, gaseous fuel | 3.47 | Average of 11 facilities |
| Petroleum and gas furnaces | Liquid fuel, gaseous fuel | 3.16 | Average of 27 facilities |
| Catalyst regenerator | Coke, carbon | 0.054 | Average of 11 facilities |
| Brick kiln, ceramic kiln, and other kiln | Solid fuel, liquid fuel, gaseous fuel | 1.5 | Average of 5 facilities |
| Aggregate drying kiln, cement raw material drying kiln, brick raw material drying kiln | Solid fuel, liquid fuel, gaseous fuel | 29 | Average of 6 facilities |
| Other drying kiln | Solid fuel, liquid fuel, gaseous fuel | 5.6 | Average of 8 facilities |
| Electric arc furnace | Electricity | 1.6 | Average of 6 facilities |
| Other industrial furnaces | Solid fuel | 1.2 | Average of 14 facilities |
| Other industrial furnaces | Liquid fuel | 0.85 | Average of 14 facilities |
| Other industrial furnaces | Gaseous fuel | 2.3 | Average of 6 facilities |
| Gas turbine | Liquid fuel, gaseous fuel | 0.83 | Average of 11 facilities |
| Diesel engine | Liquid fuel, gaseous fuel | 0.58 | Average of 4 facilities |
| Gas engine, petrol engine | Liquid fuel, gaseous fuel | 54 | Average of 6 facilities |
| Household equipment | Solid fuel | 290 | IPCC default value converted to higher heating value |
| Household equipment | Liquid fuel | 9.5 | IPCC default value converted to higher heating value |
| Household equipment | Gaseous fuel | 4.3 | IPCC default value converted to higher heating value |
| Household equipment | Biomass fuel | 290 | IPCC default value converted to higher heating value |



## N2O Emission Factors for different fuels and furnaces

| Furnace type | Fuel type | Emission factor | Remarks |
|---|---|---|---|
| Boiler | Fuel oils B and C, crude oil | 0.22 | Average of 10 facilities |
| Boiler | Fuel oil A, diesel oil, kerosene, naphtha, other liquid fuels | 0.13 | Average of 2 facilities |
| Boiler | Gaseous fuel | 0.17 | Average of 5 facilities |
| Boiler (other than fluidized bed boiler) | Solid fuel | 0.35 | Average of 9 facilities |
| Bubbling pressure fluidized bed boiler | Solid fuel | 54 | Average of 11 facilities |
| Pressurized fluidized bed boiler | Steam coal | 5.2 | Data from 1 facility |
| Boiler | Pulping waste liquor | 0.17 | Average of 2 facilities |
| Blast furnace | Coke oven gas, blast furnace gas, other gaseous fuel | 0.317 | Average of 2 facilities |
| Petroleum furnace, gas furnace | Liquid fuel, gaseous fuel | 0.21 | Average of 27 facilities |
| Catalyst regeneration | Coke, carbon | 7.3 | Average of 12 facilities |
| Electric arc furnace | Electricity | 3.3 | Average of 6 facilities |
| Coke oven | Town gas, coke oven gas, blast furnace gas, converter gas, oil gas, other gaseous fuels | 0.11 | Average of 3 facilities |
| Other industrial furnace | Solid fuel | 1.1 | Average of 20 facilities |
| Other industrial furnace | Liquid fuel | 1.8 | Average of 31 facilities |
| Other industrial furnace | Gaseous fuel | 1.2 | Average of 18 facilities |
| Gas turbine | Liquid fuel, gaseous fuel | 0.58 | Average of 12 facilities |
| Diesel engine | Liquid fuel, gaseous fuel | 2.2 | Average of 9 facilities |
| Gas engine, petrol engine | Liquid fuel, gaseous fuel | 0.88 | Average of 7 facilities |
| Household equipment | Solid fuel | 1.3 | IPCC default value converted to higher heating value |
| Household equipment | Liquid fuel | 0.57 | IPCC default value converted to higher heating value |
| Household equipment | Gaseous fuel | 0.090 | IPCC default value converted to higher heating value |
| Household equipment | Biomass fuel | 5.8 | IPCC default value converted to higher heating value |

# Notes of Stationary Combustion

- Useful source of information
  - "Energy Statistics Manual" (IEA, downloaded free)
  - National data of IEA energy statistics (country's data free of charge)
- Avoiding Double Counting Activity Data
  - IPPU : Synthesis gas, By-product fuels (coke oven gas and blast furnace gas, etc.)…
  - AFOLU : Wood chips, charcoal
  - WASTE : Waste Incineration (energy is recovered from waste combustion.)



# Others

- Uncertainty information is written clearly such as the default value, lower limit value and upper limit value as 95% confidence interval (uncertainty).
- New chapter of CO2 Capture and Storage is set up.
  - This category is positioned as outside category of "Stationary Combustion" and "Industrial Processes & Product Use". CO2 Capture and Storage include CO2 Transport.
- Closed, or abandoned, underground coal mines may continue to be a source of greenhouse gas emissions for some time.
- Tier 1 and Tier 2 methods, based on a database of abandoned mines are provided and default emission factors are given.

# Overview of Industrial Processes and Product Use (IPPU) Sector

14 September, 2010

GHG Inventory

**Fumihiko KUWAHARA**

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## Contents of "IPPU Sector" Training Program

1. Outline of Industrial Processes and Product Use (IPPU) Sector
2. The general method of calculating the GHG of IPPU Sector
3. The method of calculating the GHG of IPPU Sector in Japan
4. Issues of IPPU Sector in Thailand
5. Practice



## 1. Outline of IPPU Sector

- Dynamic sector with rapid technological change
- GHG emissions are produced from a wide variety of industrial activities.
- It is important to understand what kind of process is target.
- It is important to visualize and understand the industrial processes.
- Greatly improved user-friendliness – many simplifications including new Tier 1 methods → Tier 1 methods are shown as follows;



## 2. The general method of calculating the GHG of IPPU Sector

- Chapter 1: Introduction
- Chapter 2: Mineral Industry
- Chapter 3: Chemical Industry
- Chapter 4: Metal Industry
- Chapter 5: Non-Energy Products from Fuels and Solvent Use
- Chapter 6: Electronics Industry
- Chapter 7: Emissions for Fluorinated Substitutes for Ozone Depleting Substances
- Chapter 8: Other Product Manufacture and Use

# Chapter 2: Mineral Industry

- Consistent approaches are based on carbonate content of inputs for all sources.
- Main source categories are Cement Production, Lime Production and Glass Production.
- The use of carbonate raw materials in the production and use of a variety of mineral industry products.



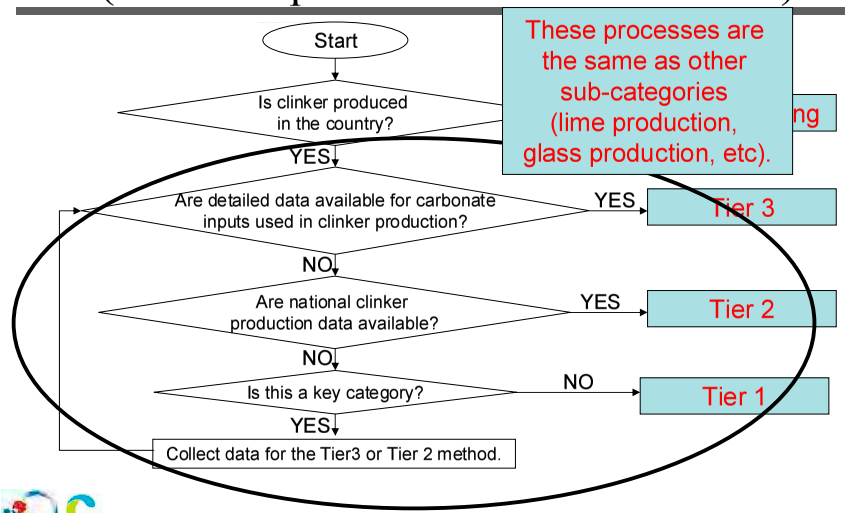
# Basic Approach (Basic Method of Thinking)

- Equation example
  - CaCO3 + heat → CaO + **CO2**
  - CaCO3 + H2SO4 → CaSO4 + H2O + **CO2**
- Tier1 methods (Basic Equation)
  - Cement Production : CO2 Emissions = [("Cement Production" x "Clinker Fraction of Cement") – "Import of Clinker" + "Export of Clinker"] x "Emission Factor"
  - Lime Production : CO2 Emissions = "Lime Production" x "Emission Factor"
  - Glass Production : CO2 Emissions = "Glass Produced" x "Emission Factor" x (1 – "Cullet Ratio for Process")





# Basic Decision Tree of "Mineral Industry" (For example : "Cement Production")






# Question (Mineral Industry)

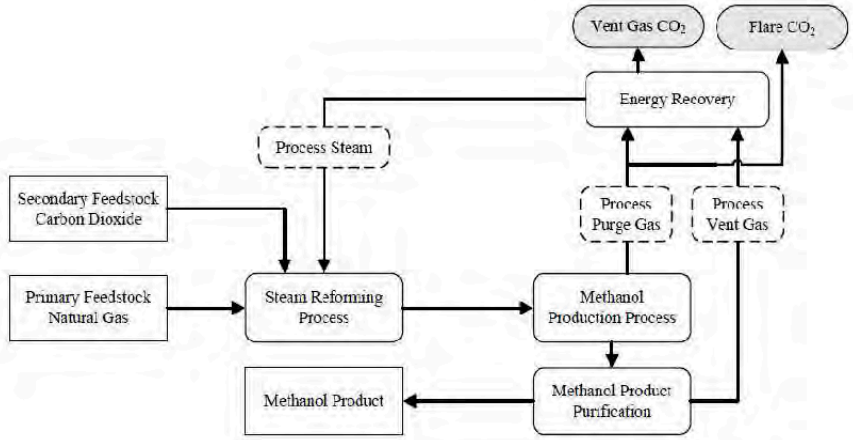
- Q: What are the Main Sources of GHG Emissions?
- A: The INPUTS (Raw Materials) are the main sources of GHG emissions.
- A: The process-released CO2 emissions are the results from the use of carbonate raw materials in the production and use of a variety of mineral industry production.

# Chapter 3: Chemical Industry

- Ammonia Production
- Nitric Acid Production
- Adipic Acid Production
- Production of Caprolactam, Glyoxal, and Glyoxylic Acid (New Sources)
- Production of Carbide
- Production of Titanium Dioxide (New Sources)
- Production of Soda Ash
- CO2 from various Petrochemical Processes (New Sources)
- Fluorochemical Production (fugitive and by-product emissions)



# Example: Methanol Production feedstock-product flow diagram




Reference: Figure 3.11 of "2006 IPCC Guidelines"





# Please check these figures

- 2006 IPCC Guidelines present some figures of "Chemical Industry Emissions".
- Figure 3.12 "Ethylene dichloride production feedstock-product flow diagram"
- Figure 3.13 "Ethylene oxide production feedstock-product flow diagram"
- Figure 3.14 "Acrylonitrile production feedstock-product flow diagram"
- Figure 3.15 "Carbon black production feedstock-product flow diagram"



# Example : Tier 1 methods (Chemical Industry)

- Ammonia : CO2 Emissions
  = "Ammonia Production"
  x "Fuel Requirement per unit of output"
  x "Carbon content Factor of the Fuel"
  x "Carbon Oxidation Factor of the Fuel"
  x "44/12"
  – "CO2 Recovered"
  - * Fuel is a raw material of ammonia : Mainly Natural Gas (CH4) or Hydrocarbon (Coal or oil)…
- Nitric Acid : N2O Emissions
  = "Nitric Acid Production"
  x "Emission Factor"
- Carbide : CO2 Emissions
  = "Petroleum Coke Consumption or Carbide Production"
  x "Emission Factor"
- And so on…

# Questions (Chemical Industry)

- Q1 What is the INPUT (raw material)?
- A1 Ammonia : Hydrocarbon (CH4, or other fossil fuels)
- A1 Nitric Acid : Ammonia
- A1 Carbide : Silica sand or quartz and petroleum coke
- Q2 What is the OUTPUT (production)?
- A2 Ammonia, Nitric Acid, Silicon Carbide, Calcium Carbide, Titanium dioxide, etc.
- Q3 What is the GHG?
- A3 CO2, CH4, N2O, HFCs, …



# Chapter 4: Metal Industry

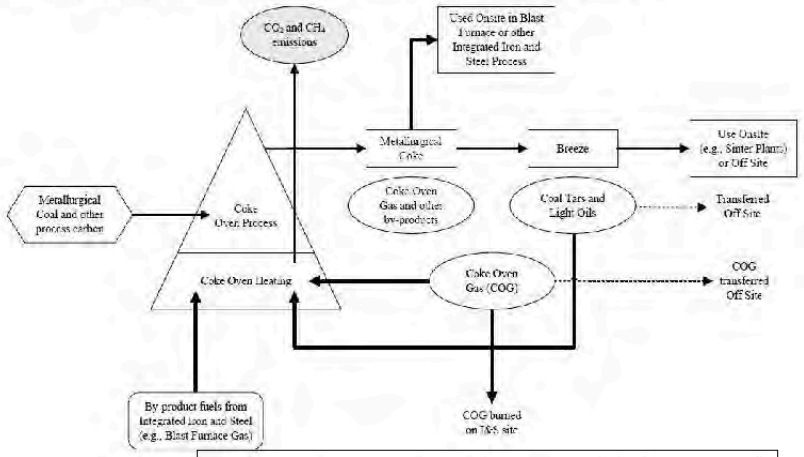
- Iron and Steel, and Metallurgical Coke Production
- Ferroalloy Production
- Aluminium Production
- Magnesium Production
- Lead Production (New Sources)
- Zinc Production (New Sources)





# For example: Illustration of coke production process

Figure 4.2 Illustration of coke production process (emissions reported in Category 1A of the Energy Sector)




Reference: Figure 4.2 of "2006 IPCC Guidelines"



# Please check these figures.

- 2006 IPCC Guidelines present some figures of "Iron & Steel and Metallurgical Coke Production".
- Figure 4.3 "Illustration of sinter production process"
- Figure 4.4 "Illustration of pig iron production processes"
- Figure 4.5 "Illustration of steel production processes"

# For example : Tier 1 methods (Metal Industry)

- Coke Production (Iron, etc.) : CO2 or CH4 Emissions = "Quantity of Coke produced nationally" x "$EF_{CO2}$ or $EF_{CH4}$ "
- Ferroalloy : CO2 Emissions = "Production of ferroalloy" x "Emission Factor"
- Aluminum : CO2 Emissions = "Metal Production from Prebake Process" x "$EF_P$" + "Production from Soderberg Process" x "$EF_S$"
- Magnesium : CO2 Emissions = "Magnesium Production from dolomite" x "$EF_d$" + "Magnesium Production from magnesite" x "$EF_{mg}$"



# More detailed information (Metal Industry)

- Coke is primarily used in the blast furnace to make iron. Coke is also used in other metallurgical process, such as the manufacture of cast iron, ferroalloys, lead, and zinc, and in kiln to make lime and magnesium.
- Many iron and steel facilities are integrated with on-site coke production.
- There is a risk of double counting or omission in either the "Industrial Processes" or the "Energy Sector", because the coke production is "Energy", iron and steel production is "IPPU".





# Questions (Metal Industry)

- Q1: Which sector are the emissions reported in, if the CO2 are emitted from iron and steel production?
- A1: These emissions should be reported in the IPPU Sector, because the primary use of carbon sources is to produce pig iron.



# Questions (Metal Industry)

- Q2: Which sector are the emissions reported in, if CO2 are emitted from coke production?
- A2: Though metallurgical coke is produced either at the iron and steel facility or at separated facilities, these emissions should be reported in the Energy Sector, because the coke production is labeled as "Energy" Sector.

## More detailed information (Metal Industry)

- Creating potential double counting issues, because there may be flows of by-products (e.g. coke oven gas, blast furnace gas, coke oven by-products) between the coke production facility and the iron and steel production facility.



## Questions (Metal Industry)

- Q3: Which sector are the emissions reported in, if CO2 are emitted from coke oven gas at an iron and steelmaking facility?
- A3: These emissions should be reported in the IPPU Sector, because the carbon is consumed in the form of coke oven gas at an **iron and steelmaking facility**. It depends on where they are consumed.





## Questions (Metal Industry)

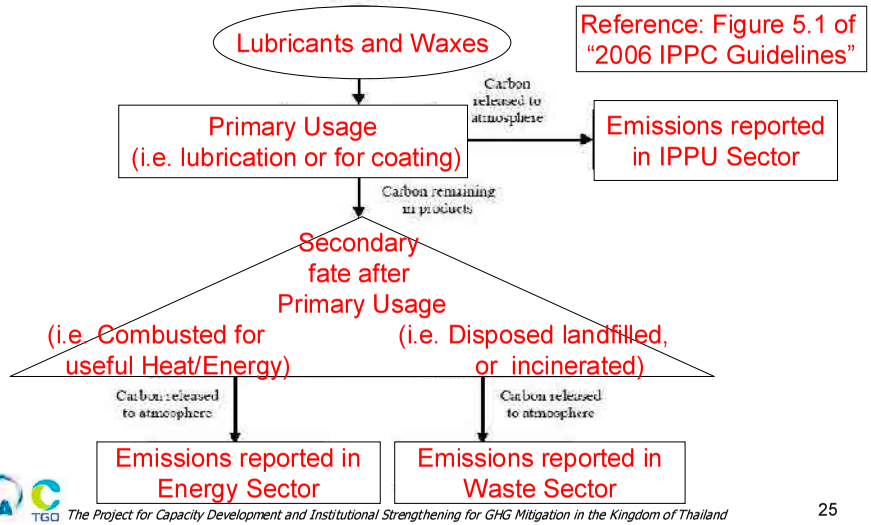
- Q4: Which sector are the emissions reported in, if CO2 are emitted from blast furnace gas at an onsite coke production facility?
- A4: These emissions should be reported in the Energy Sector, because the carbon is consumed in the form of blast furnace gas at an onsite **coke production facility**. It depends on where they are consumed.



## Chapter 5: Non-Energy Products from Fuels and Solvent Use

- The First Use of Fossil Fuels as a Product for Primary Purposes other than
- i) combustion for energy purposes and
- ii) use as feedstock or reducing agent. (lubricants, paraffin waxes, bitumen/asphalt, and solvents)

## For example : Illustration of "Sectoral allocation of emissions from Lubricants and Waxes"






## For example : Tier 1 methods (Non-Energy Products from Fuels and Solvent Use)

- Lubricant Use : CO2 Emissions = "Lubricant consumption" x "Carbon content" x "Oxidised During Use (ODU) factor" x 44/12
- Paraffin Was Use : CO2 Emissions = "Wax consumption" x "Carbon content" x "ODU factor" x 44/12





## Questions (Non-Energy Products from Fuels and Solvent Use)

- Q1 If the waste Lubricants or Waxes are combusted for useful Heat/Energy, which sector are emissions reported in?
- A1 Energy Sector.
- Q2 If the waste Lubricants or Waxes are disposed, landfilled or incinerated, which sector are emissions reported in?
- A2 Waste Sector.
- Q3 If the Lubricants or Waxes are used primarily, which sector are emissions reported in?
- A3 IPPU Sector.



## Chapter 6: Electronics Industry

- Semiconductor, thin-film transistor flat panel display (TFT-TPD), and photovoltaic (PV) manufacturing
- The gases include $CF_4$, $C_2F_6$, $C_3F_8$, c-$C_4F_8$, c-$C_4F_8O$, $C_4F_6$, $C_5F_8$, $CHF_3$, $CH_2F_2$, $NF_3$ and $SF_6$.
- Process i) Plasma etching silicon containing materials
- Process ii) Cleaning chemical vapour deposition (CVD) tool chamber-walls where silicon has deposited

## For example : Tier 1 methods (Electronics Industry)

- Etching and CVD Cleaning
  - GHG Emissions = "GHG Mass per Unit Area ($m^2$) of Substrate in each Electronics Industry Category" (EF) x "Quantity of substrate consumed during electronics manufacture" (Activity Data)
- Heat Transfer Fluids
  - GHG Emissions = "GHG Emissions per $Gm^2$ silicon consumed" (EF) x "Silicon consumed of Semiconductor Manufacturing Facilities" (Activity Data)



## Chapter 7: Emissions for Fluorinated Substitutes for Ozone Depleting Substances

- Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs)
  - Refrigeration and air conditioning
  - Fire suppression and explosion protection
  - Aerosols
  - Solvent cleaning
  - Foam blowing
  - Other applications
- Actual Emissions ("Potential emission method" is now presented only as a reference scenario in the QA/QC section.)





## What is the "Potential Emissions"?

- In the "Revised 1996 IPCC Guideline", Potential Emission methods are regarded as the basic methodology (Tier 1) for HFCs and PFCs emission estimates.
- Potential Emissions = "Production" + "Imports"– "Exports" – "Destruction"
- This method does not take into account accumulation or possible delayed release of chemicals over the short term (e.g., 10-15 years).



## For example : Tier1 (Emissions for Fluorinated Substitutes for Ozone Depleting Substances)

- Emission-factor approach : Annual Emissions = "Net Consumption" x "Composite EF" (Net Consumption = Production + Import – Exports – Destruction)
- Mass-balance approach : Emissions = "Annual Sales of New Chemical" – ("Total Charge of New Equipment" – "Original Total Charge of Retiring Equipment")

## Chapter 8: Other Product Manufacture and Use

- Section 8.2: SF6 and PFC emissions from electrical equipment
- Section 8.3: emissions from the manufacture and use of a wide variety of other industrial, commercial, and consumer products that contain SF6 and PFCs
- Section 8.4: Methods for estimating N2O emissions from anaesthetics, propellants, and other product uses



## For example : Tier1 (Other Product Manufacture and Use)

- SF6 and PFCs from Electrical Equipment : Emissions = "EF" x "Activity"
- SF6 and PFCs from Other Use : SF6 Emissions = 740 (kg) x "Number of Planes"
- N2O from Product Uses : N2O Emissions = (0.5 x "Total Quantity of N2O supplied year t" + 0.5 x "Total Quantity of N2O supplied year t-1") x "EF"





## Conclusions: general method of calculating the GHG of IPPU sector

- Industry has participated strongly in the IPCC Sector. Industry has good access to sector knowledge.
- Policies and voluntary actions already show an impact on emissions from several sources.
- Since 1996, there has been rapid expansion of knowledge about sources and gases, including emission trading schemes and voluntary reporting.
- The inventory compilers can have immediate benefit and wealth from a lot of information.



## 3. The method of calculating the GHG of IPPU Sector in Japan

- The emissions from Mineral Products are relatively large.
- Under the voluntary action plan, the emissions of some sub-categories have been reduced.
- An IPPU sector is the wide sector where all GHGs are related to.
- Data source is "National Greenhouse Gas Inventory Report of JAPAN (Ministry of the Environment, Japan, Greenhouse Gas Inventory Office of Japan (GIO), CGER, NIES)"

# Emissions of IPPU in Japan (FY 2008 ; Gg $CO_2$-eq)

| | CO2 | CH4 | N2O | HFCs | PFCs | SF6 |
|---|---|---|---|---|---|---|
| Mineral | 47,076.0 | | | | | |
| Chemical | 2,744.0 | 106.5 | 1,262.1 | | | |
| Metal | 155.8 | 15.0 | | | 14.7 | 652.5 |
| Solvent and other Product Use | | | 160.4 | | | |
| Production of F-gas | | | | 701.4 | 523.8 | 1,288.2 |
| Consumption of F-gas | | | | 14,564.0 | 4,077.6 | 1,820.6 |



# The characteristic of the Japan's GHG Inventory (Industrial Process Sector : Part1)

- Mineral products
  - In 2008, emissions from this category occupied 3.7% of total GHG emissions (excluding LULUCF). (very important category !)
    - Japan's emission factors of Cement Production
    - EFcp = ( CaO content in clinker exclude waste origin CaO ) * 0.785
    - ( Average CaO content in clinker –
    - Waste Origin CaO content in clinker ) * 0.785





# The characteristic of the Japan's GHG Inventory (Industrial Process Sector : Part2)

- Chemical products
  - In 2008, emissions from this category occupied 0.3% of total GHG emissions (excluding LULUCF).
    - N2O decomposition units were installed in adipic acid production plants in March 1999, and emissions since then have decreased dramatically.
- Metal production
  - CO2 generated by the oxidation of the coke used as a reduction agent is calculated in fuel Combustion Category (1.A.).



# The characteristic of the Japan's GHG Inventory (Industrial Process Sector : Part3)

- Industrial Processes (HFCs, PFCs, SF6) Sectors have a larger uncertainty than other sector relatively.
- Production of halocarbons and SF6
  - This category covers HFCs, PFCs and SF6 emissions from the manufacturing processes of Halocarbons and SF6.
    - 2,513 Gg-CO2/year (0.2 % of Japan's total GHG emissions)
- Consumption of halocarbons and SF6
  - This category covers HFCs, PFCs and SF6 emissions from the manufacturing, utilization and disposal processes.
    - 20,462 Gg-CO2/year (1.6 % of Japan's total GHG emissions)
    - Important category

## The characteristic of the Japan's GHG Inventory (Solvent and Other Product Use Sector)

- Overview of Sector
  - CO2 and N2O
    - Paint solvents ("NA")
    - Degreasing and dry-cleaning (CO2;"NE", N2O;"NA")
    - Other
      - Use of Nitrous Oxide for Anesthesia (N2O; 160 Gg-CO2, 0.01 % of total national emissions )
      - Fire Extinguishers (CO2;"IE", N2O;"NO")
      - Aerosol Cans (CO2;"IE", N2O;"NA")



## Question (about the GHG of IPPU Sector in Japan)

- Q; In the "Industrial Process Sector" of Japan's GHG Inventory, are the emissions from the "Mineral Products" category calculated under the "Fuel Combustion" Category?
- A; No. The emissions from the "Iron and Steel Production" category are calculated under the "Fuel Combustion" Category, because the volume of coke used has been included under consumption of fuel in the Fuel Combustion Category.





## Way of thinking of sector arrangement in Japan

- The following categories should be calculated under IPPU sector originally but are calculated under an energy sector.
  - The Emissions of CO2 from "Coke Production"
  - Iron and Steel Production: CO2 emissions from the oxidization of coke used as a reduction agent
  - Ferroalloys Production: CO2 emissions from the oxidization of coke used as a reduction agent
  - Aluminum Production: CO2 emissions from the oxidization of coke used as a reduction agent
  - The CO2 used in the process of manufacturing foods and drinks, is a by-product gas of petrochemical products, and as such emissions are incorporated into the "Fuel Combustion Sector".



## 4. Issues of IPPU Sector in Thailand

- I think that the GHG inventory of Industrial process is insufficient.
- I need more detailed breakdown of information.

## GHG Emissions from Major Industrial Processes in Thailand; 1994

| | CO2 (Gg) | CH4 (Gg) |
|---|---|---|
| Cement | 14,920.0 | |
| Glass | 63.6 | |
| Lime | 918.0 | |
| Pulp and Paper | 49.3 | |
| Iron and Steel | 19.5 | |
| Pertochemicals | | 0.3 |
| Total | 15,970.4 | 0.3 |



## GHG from Industrial Process (ASEAN Countries)

| | |
|---|---|
| Thailand | CO2 : 15,970 (Gg) CH4 : 0.31 (Gg) N2O : - |
| Malaysia | CO2 : 4,973 (Gg) CH4 : - N2O : - |
| Indonesia | CO2 : 19,120 (Gg) CH4 : - N2O : - |
| Philippine | CO2 : 10,596 (Gg) CH4 : 0.33 (Gg) N2O : - |
| Vietnam | CO2 : 3,807 (Gg) CH4 : - N2O : - |





## 5. Practice

- I think that the data collection is generally the most important and difficult in IPPU Sector.
- So, please discuss the sources "Activity Data" in Thailand.
- Worksheets for practice (work and discussion) are distributed.



- ありがとうございました
- ขอบคุณ มาก ครับ/ค่ะ
- Thank you very much

# Practice (Not Use)

- The data of Thailand's industrial production are delivered.
- The emission factors of IPCC default value is distributed, too.
- And the worksheets of IPCC guideline are distributed, too.
- Please calculate some emissions of IPPU sector with Tier 1 method.
- Let's proceed with this work while you discuss it in your group.