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GHG Emissions from Wastewater Treatment and Discharge in Japan

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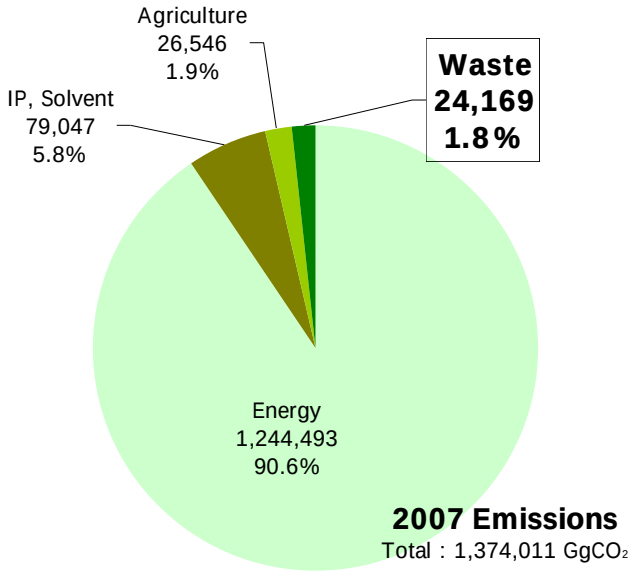
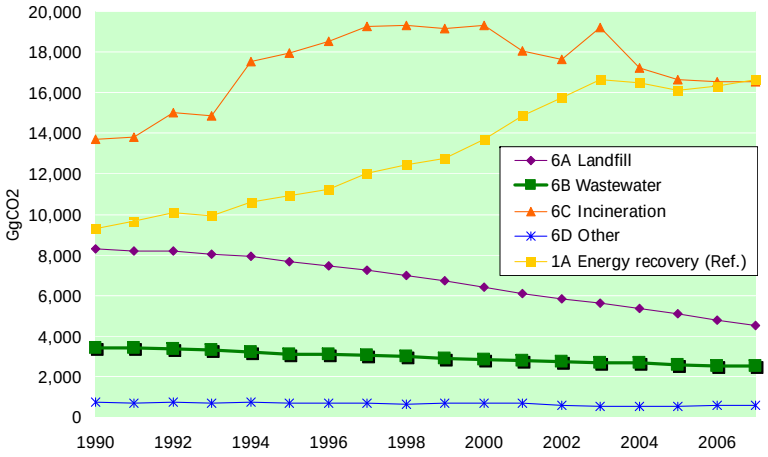
Outline

- **Introduction of Japan's emission estimations from wastewater treatment and discharge (WWTD, 6.B)**
  - Structure of 6.B WWTD category* in Japan's inventory
  - CH_4 and N_2O emission sources in 6.B
  - EFs, AD and methodologies
- **Sharing experience and information exchange**
  - Early and well-planned preparation
  - Prioritization of targets
  - Process for improvement

* In the annual inventory, Japan reports GHG emissions as "6.B wastewater handling" according to FCCC/CP/2002/8. However, this presentation uses more appropriate definition of "wastewater treatment and discharge (WWTD)" from 2006GL instead.

Overview of GHG emissions in Japan





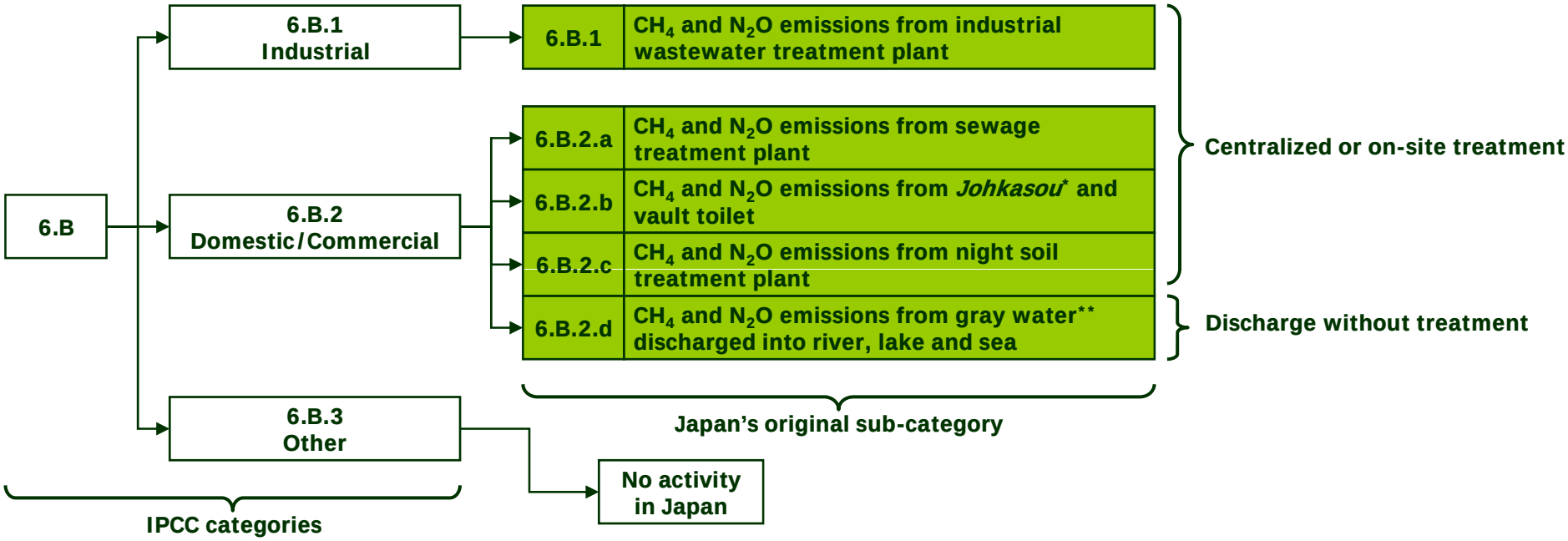
GHG Emissions in the waste sector

- **Japan's 2007 inventory***
  - **Emissions from the waste sector amounted 24,169 $GgCO_2$ or 1.8 per cent of total.**
  - **Emissions from 6.B amounted 2,528 $GgCO_2$ or 10.5 per cent of the waste sector.**
  - **Emissions from 6.B decreased by 25.9 per cent from 1990 to 2007. The key driver was the decrease of emission from gray water discharged into river, lake and sea.**

*** Japan has submitted 2007 data inventory to UNFCCC in April 2009.**

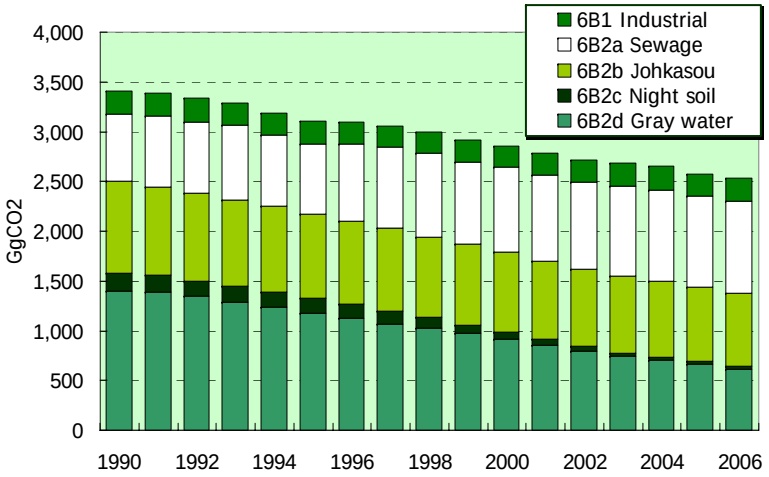
Structure of Japan's 6.B inventory

- **5 sub-categories in 6.B**
  - **Japan divides IPCC 6.B category into 5 original sub-categories according to methodologies for GHG emission estimations.**

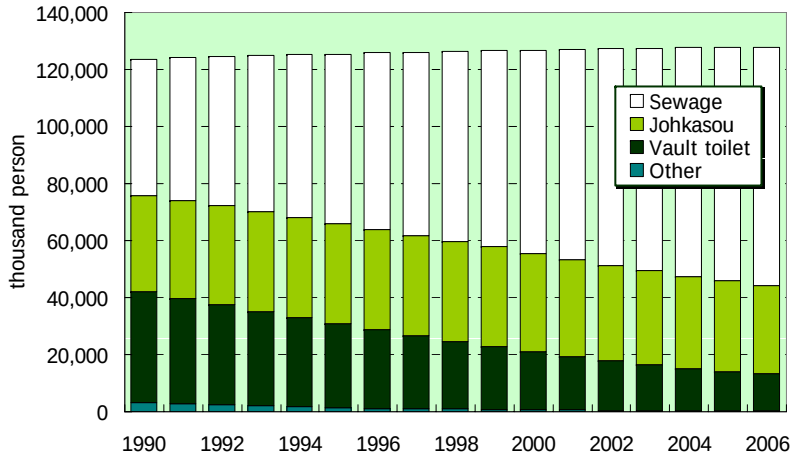


* *Johkasou* : Japan's original on-site domestic wastewater treatment system
**Gray water: Miscellaneous domestic wastewater except night soil

Emissions of Japan's 6.B inventory



GHG Emissions from each sub-category in the waste sector

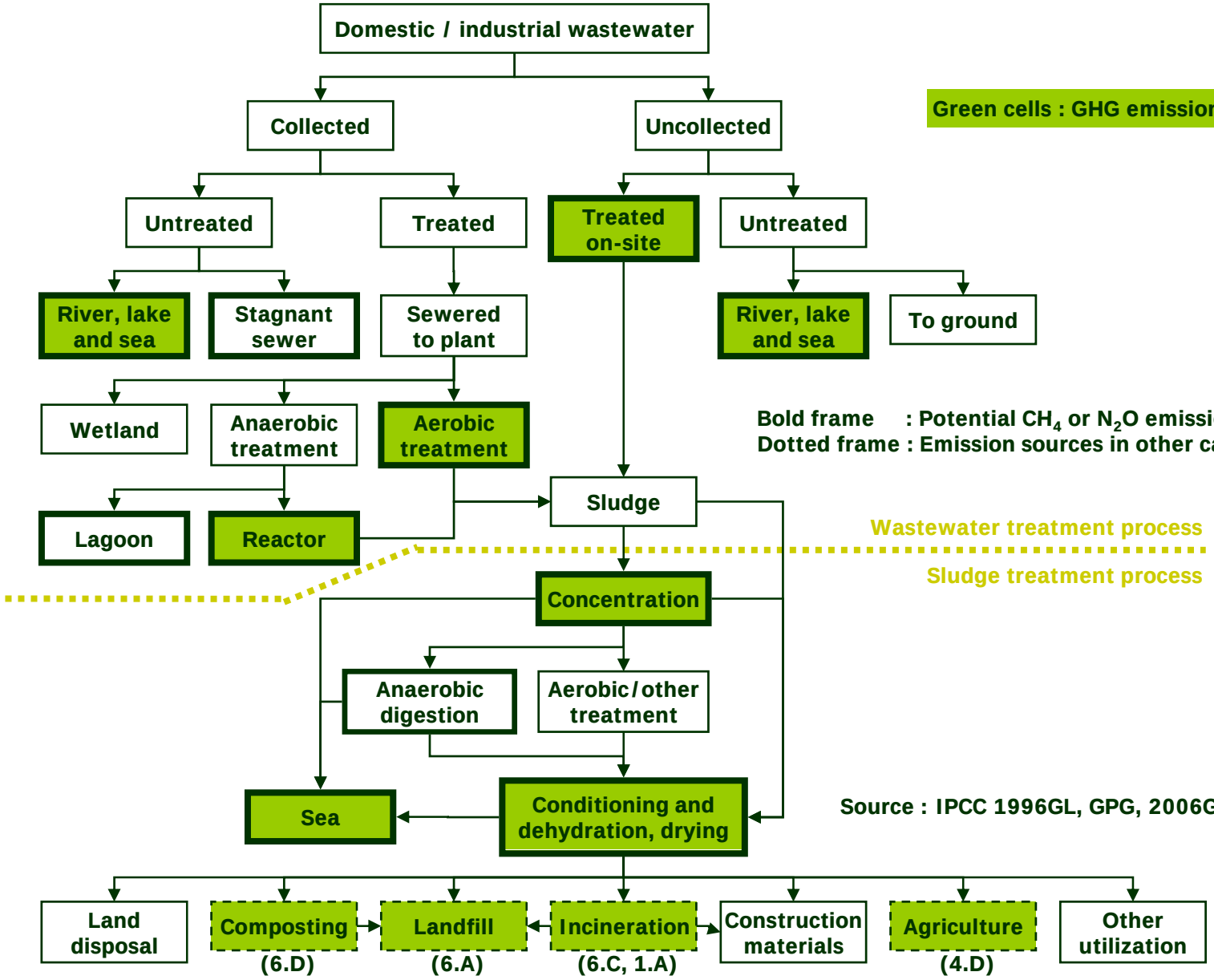


Domestic wastewater treatment population in Japan

- **Continuous decrease since 1990**
  - In 1990, the largest emission source in 6.B was 6.B.2.d, however, decreased by 785 $GgCO_2$ or 56.0 per cent between 1990 and 2006*.
  - This decline has contributed to the decrease of 6.B total emissions (882 $GgCO_2$ from 1990 to 2006).
  - The key driver for the decline of 6.B.2.d was the progress of conversion of vault toilet to sewage system.

* In 2009 inventory, 2007 data is in preparation and 2006 data was substituted.

Typical emission sources in 6.B



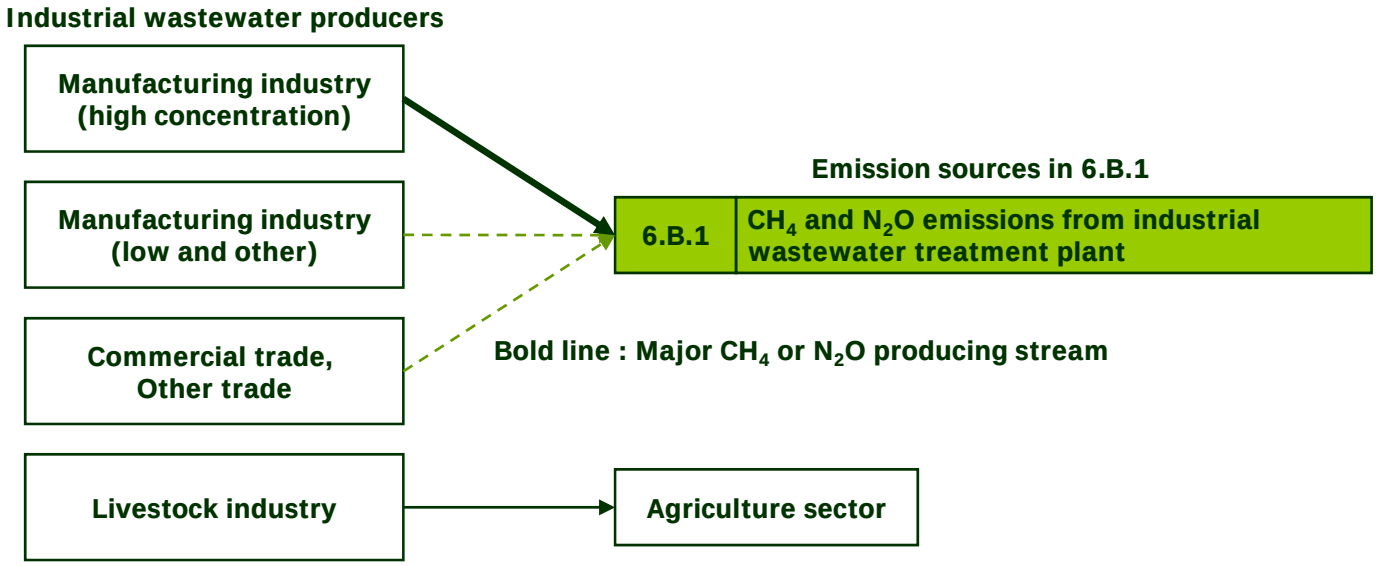
Green cells : GHG emission sources in Japan

Bold frame : Potential CH_4 or N_2O emission sources in 6.B
Dotted frame : Emission sources in other categories / sectors

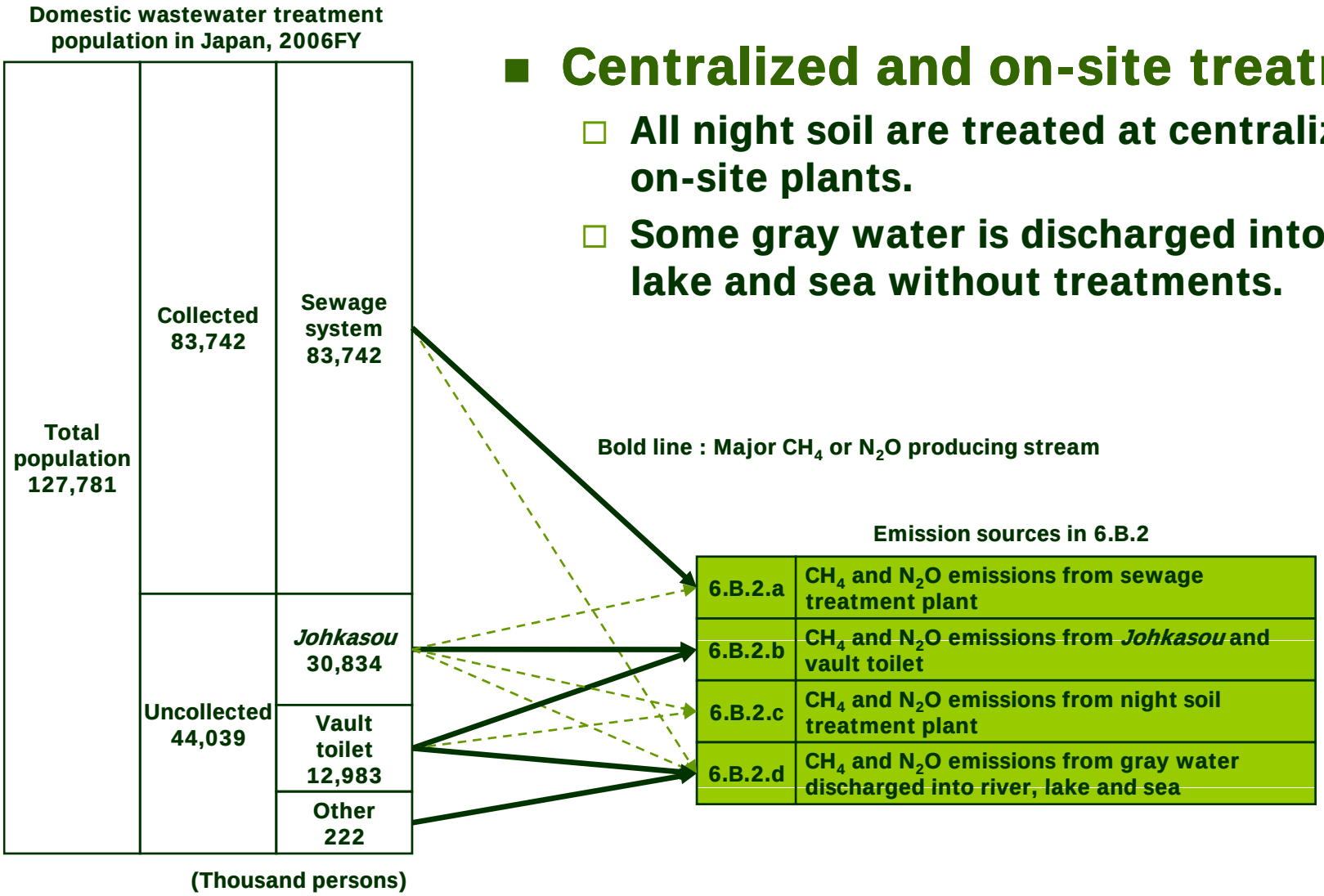
Source : IPCC 1996GL, GPG, 2006GL and Japan's NIR

Industrial WWT system in Japan

- **On-site treatment**
  - Every industries that produce polluted wastewater are required to treat the polluted wastewater by on-site plants according to the Water Pollution Control Law.
  - Wastewater from livestock industry is considered in the agriculture sector, not in 6.B, according to IPCC GL.



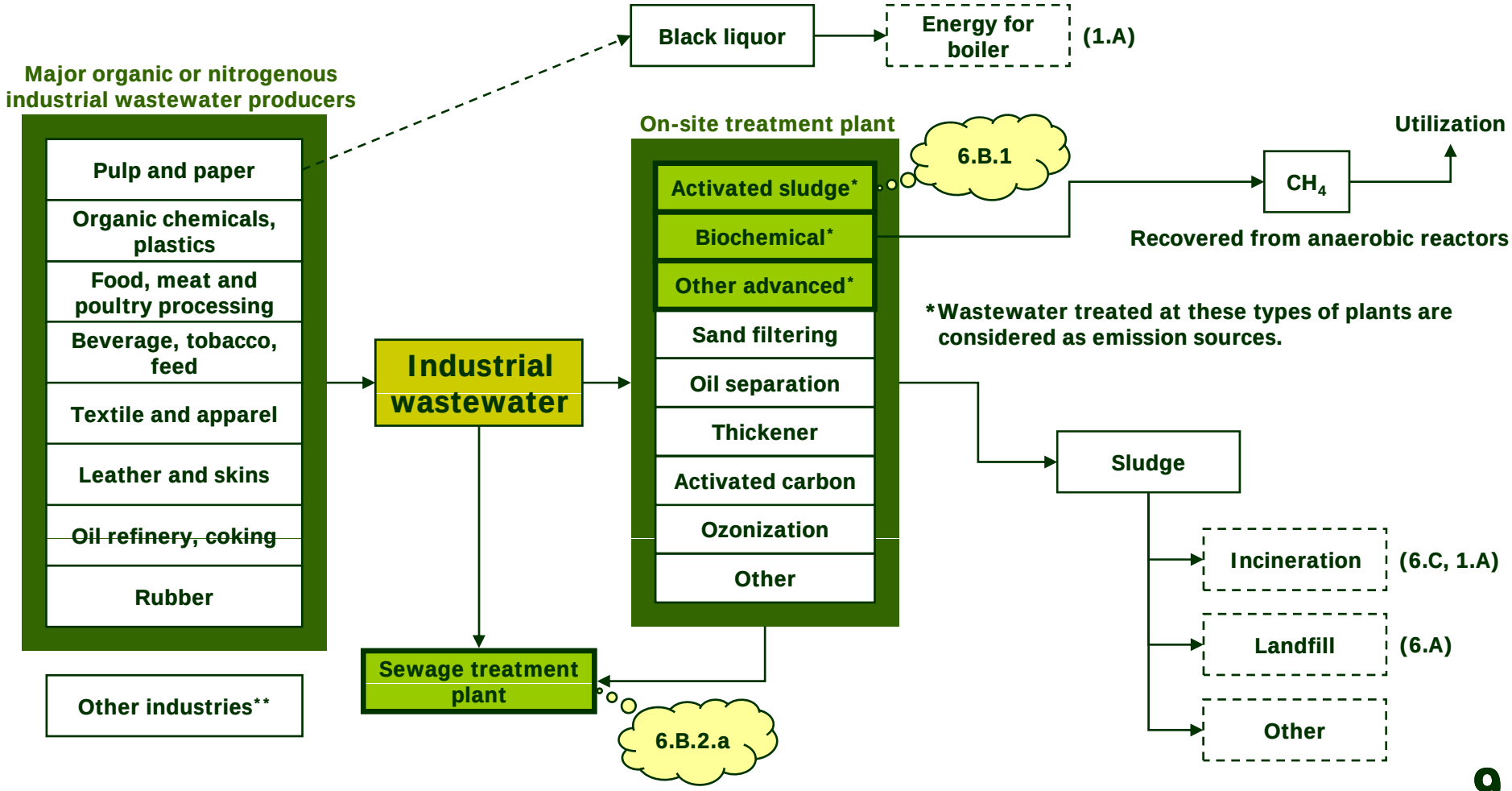
Domestic WWT system in Japan



- **Centralized and on-site treatment**
  - All night soil are treated at centralized or on-site plants.
  - Some gray water is discharged into river, lake and sea without treatments.

GHG sources in Industrial wastewater treatment system

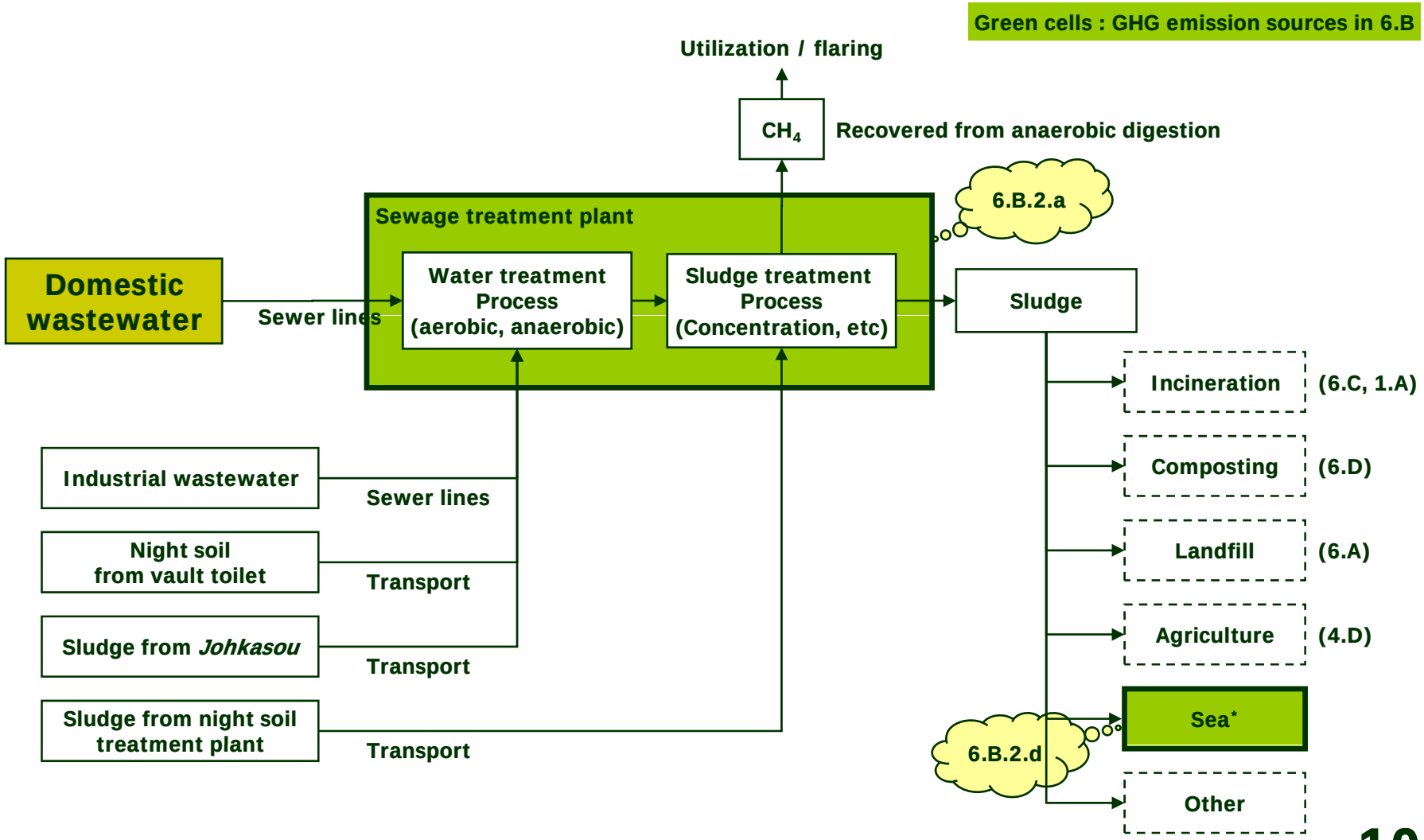
Green cells : GHG emission sources in 6.B



**Other industries are not considered as an emission source.

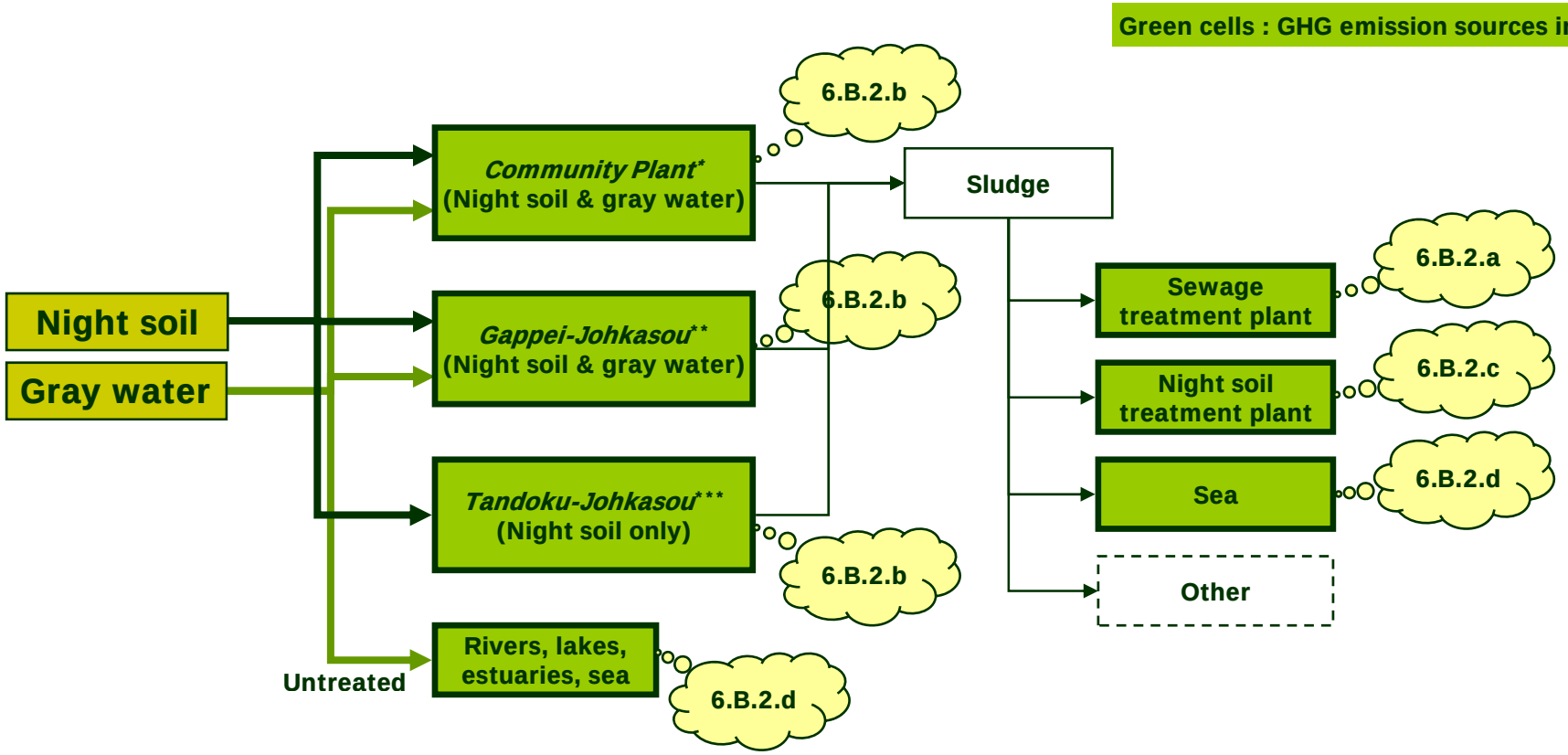
Dotted frame : GHG sources in other categories / sectors

GHG sources in Sewage treatment system



Dotted frame : GHG sources in other categories / sectors

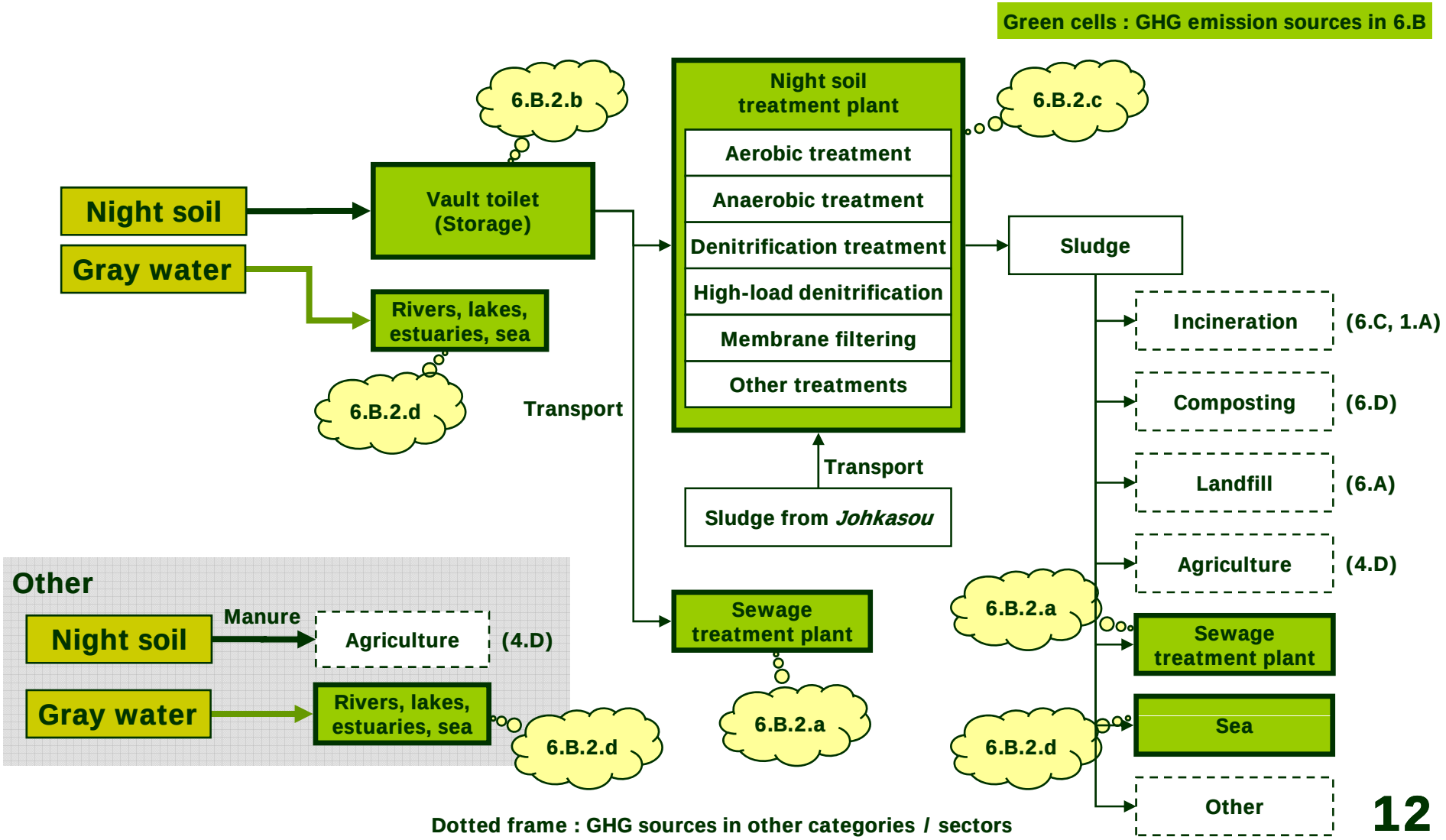
GHG sources in *Johkasou* system



* *Community Plant* : collectively treats domestic wastewater and have similar features to a large-scale *Gappei-Johkasou*.
** *Gappei-Johkasou* : is designed for both night soil and gray water treatment at household.
*** *Tandoku-Johkasou* : is an old-type *Johkasou* and treats only night soil. Newly installation has been prohibited since 2001.

Dotted frame : GHG sources in other categories / sectors

GHG sources in
Vault toilet and other system



Equation for CH_4 estimation

- **Japan's country specific equation for CH_4 is as follows.**
  - Japan's country specific equation for 6.B.2.a, 6.B.2.b and 6.B.2.c uses m^3 or person as AD, according to domestic research.
  - Basic theory is almost the same with IPCC equation*, that uses kg of organic matter (BOD or COD) as AD.
  - Recovered CH_4 from anaerobic reactor or digestion are not used for CH_4 because country specific EF is not "CH_4 production" but "CH_4 emission".

*Equation 5.5 in GPG and 6.1, 6.4 in 2006GL

$$CH_4\ \text{Emission} = EF \bullet AD$$

EF : CH_4 emissions per m^3 ($kgCH_4/m^3$) or person ($kgCH_4$/person)

AD : treated wastewater (m^3) or person (person)

Summary for method, AD and EF of CH_4 estimation in Japan

Sub-category		Method	AD	EF
6.B.1	Industrial wastewater treatment plant	D	kg BOD	CS
6.B.2.a	Sewage treatment plant	CS	m^3	CS
6.B.2.b	*Johkasou* and vault toilet	CS	person	CS
6.B.2.c	Night soil treatment plant	CS	m^3	CS
6.B.2.d	Gray water discharged into river, lake and sea	D	kg BOD	D

CS: Country Specific
D : Default value or method of IPCC GL, GPG.

Equation for N_2O estimation

- **Japan's country specific equation for N_2O is as follows.**
  - Japan's country specific equation for 6.B.2.a and 6.B.2.b uses m^3 or person as AD, according to domestic research.
  - Basic theory is almost the same with IPCC equation*, that uses kg of nitrogen or person as AD.

*Equation 6.7, 6.9 in 2006GL

$$N_2O\ Emission = EF \bullet AD$$

EF : N_2O emissions per m^3 (kgN_2O/m^3) or person (kgN_2O/person)

AD : treated wastewater (m^3) or person (person)

Summary for method, AD and EF of N_2O estimation in Japan

Sub-category		Method	AD	EF
6.B.1	Industrial wastewater treatment plant	D	kg N	CS
6.B.2.a	Sewage treatment plant	CS	m^3	CS
6.B.2.b	*Johkasou* and vault toilet	CS	person	CS
6.B.2.c	Night soil treatment plant	D	kg N	CS
6.B.2.d	Gray water discharged into river, lake and sea	D	kg N	D

CS: Country Specific
D : Default value or method of IPCC GL, GPG.

6.B.1 GHG from Industrial wastewater treatment plant

- **Methodology, EFs and AD**
  - Emissions from activated sludge or anaerobic treatment of industrial wastewater that contain high concentration of organic matter or nitrogen are estimated due to domestic research.
  - As country specific EF for CH_4 or N_2O from industrial wastewater treatment are unavailable, EFs of domestic wastewater are substituted.
  - As the concentration of industrial wastewater differs from domestic, EFs ($kgCH_4/m^3$, kgN_2O/m^3) are converted to ($kgCH_4/kgBOD$, kgN_2O/kgN).
  - Statistical data of the volume (m^3) of industrial wastewater treated with activated sludge or anaerobically, multiplied by BOD or nitrogen concentration of each industry, are used as AD.

$$\text{Emission} = EF \bullet AD$$

EF : CH_4 or N_2O emissions per kg or BOD ($kgCH_4/kgBOD$) or N (kgN_2O/kgN)

AD : BOD or N in the wastewater treated with activated sludge or anaerobically (kgBOD, kgN)

Summary for method, AD and EF of industrial wastewater treatment plant

GHG	Method	AD	EF
CH_4	D	kg BOD	CS
N_2O	D	kg N	CS

6.B.2.a GHG from Sewage treatment plant

- **Methodology, EFs and AD**
  - IPCC GL indicates aerobic system may not be CH_4 sources. However, Japan has detected CH_4 production and regarded it as the emission source as well as anaerobic (AO, A2O and A2) system.
  - EF is the mean value of measured EFs at 14 plants (CH_4) and 8 plants (N_2O). Both wastewater and sludge treatment process are considered.
  - Statistical data of the volume (m^3) of all wastewater treated at sewage treatment plants except primary treatment are used as AD.

$$\text{Emission} = EF \bullet AD$$

EF : CH_4 or N_2O emissions per m^3 ($kgCH_4/m^3$, kgN_2O/m^3)

AD : Volume of all wastewater treated at sewage treatment plants (m^3)

Summary for method, AD and EF of sewage treatment plant

GHG	Method	AD	EF
CH_4	CS	m^3	CS
N_2O	CS	m^3	CS

6.B.2.b GHG from *Johkasou* and vault toilet

- **Methodology, EFs and AD**
  - Emissions are calculated by 3 types of *Johkasou* including *Community Plant*, *Gappei-Johkasou* and *Tandoku-Johkasou*. EFs are the mean value of measured EFs at each *Johkasou*.
  - Vault toilet is not *Johkasou* but storage tank of night soil. Its GHG producing process is unknown but seems to be similar with *Tandoku-Johkasou*, therefore, emission from vault toilet is calculated by the same method and EF of *Tandoku-Johkasou*.
  - Statistical data of the treatment population (person) of each types of *Johkasou* and vault toilet are used as AD.

$$\text{Emission} = \sum (EF_i \bullet AD_i)$$

EF_i : CH_4 or N_2O emissions per person at *Johkasou* i ($kgCH_4$/person, kgN_2O/person)

AD_i : Treatment population at *Johkasou* i (person)

Summary for method, AD and EF of *Johkasou* and vault toilet

GHG	Method	AD	EF
CH_4	CS	m^3	CS
N_2O	CS	m^3	CS

6.B.2.c GHG from Night soil treatment plant

- **Methodology, EFs and AD**
  - Emissions are calculated by every types of treatment methods in the night soil treatment plant*.
  - CH_4 EF for anaerobic, denitrification and high-load denitrification are set from domestic research results. EF for the rest are substituted by the average of denitrification and high-load denitrification.
  - N_2O EF for high-load denitrification and membrane filtering are set from domestic research results**. EF for the rest are substituted by the EF of high-load denitrification because of lack of research output.
  - Statistical data of the volume of night soil treated at plants (CH_4) and the amount of nitrogen included in the night soil (N_2O) are used as AD.

$$\text{Emission} = \sum (EF_l \bullet AD_l)$$

EF_l : CH_4 emissions per m^3 ($kgCH_4/m^3$) and N_2O per nitrogen in human waste (kgN_2O/kgN)

AD_l : Volume of all wastewater (m^3) and nitrogen in human waste (kgN)

Summary for method, AD and EF of night soil treatment plant

GHG	Method	AD	EF
CH_4	CS	m^3	CS
N_2O	D	kg N	CS

* Treatment of aerobic, anaerobic, denitrification, high-load denitrification, membrane filtering and other.

**EF of recent plant decreased because of progress of structure standard and maintenance technology.

6.B.2.d GHG from Gray water discharged into river, lake and sea

Methodology, EFs and AD

- Emissions from gray water and sludge discharged into river, lake and sea without treatment are estimated by IPCC default method* and EFs, because country specific method and EF is unavailable.
- Gray water from household which use *Tandoku-Johkasou*, vault toilet or self-treatment and sludge from *Johkasou*, sewage treatment plant and night soil treatment plant are regarded as GHG producing activity.
- Statistical data of the volume (m^3) of discharged gray water and sludge, multiplied by BOD or nitrogen concentration of each activity are used as AD.

$$\text{Emission} = EF \bullet \sum (AD_i)$$

EF : CH_4 or N_2O emissions per kg or BOD ($kgCH_4/kgBOD$) or N (kgN_2O/kgN), default value

AD_i : BOD or N in gray water and sludge discharged without treatment (kgBOD, kgN)

Summary for method, AD and EF of gray water and sludge discharged into river, lake and sea

GHG	Method	AD	EF
CH_4	D	kg BOD	D
N_2O	D	kg N	D

Sharing experience 1:
Importance of early and planned preparation

- **Category 6.B has some specific problems compared with other categories in the waste sector.**
  - Few or no statistics are available for activity data.
  - Country specific methodologies and EFs are not sufficiently developed.
  - The extent of emission sources are diverse and obscure.
  - Condition and mechanism of GHG production are not sufficiently cleared.
  - The amount of emissions in 6.B are likely to be much smaller than other categories in the waste sector.

As it takes a long time to make accurate 6.B inventory, early and well-planned preparation is important.

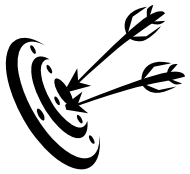
Sharing experience 2 :

Importance of prioritization of targets

- **Human, institutional and financial resources are often limited. However, many things are to be resolved for accurate 6.B inventory.**

Prioritization of targets is important.

- Estimate major (or all) GHG emissions
- Estimate GHG emissions in both urban and rural areas
- Estimate GHG emissions back to the past year
- Improve accuracy of EFs, AD and methodologies
- Make detailed and transparent documents
- Apply quality assurance and quality control (QA/QC)
- Estimate uncertainty
- Other



Sharing experience 3 :
Procedure for improving 6.B inventory

One of the way to improve 6.B inventory is as follows.

1. **Understand all emission sources in 6.B (slide 6)**
2. **List all industrial and domestic WWT system (slide 7 and 8)**
3. **List all emission sources in each system (slide 9 to 12)**
4. **Consider methodologies, EFs and AD (slide 13 to 19)**
   - Collect available statistics for AD
   - Collect candidates for EF (CS, default, EFDB and other countries)
   - Decide methodology (Tier 1, 2 or 3) according to AD and EF
5. **List problems to be improved in the future**
   - List problems on EF, AD, methodologies in terms of transparency, comparability, completeness, consistency and accuracy
   - Share the experience and exchange information (in the future WGIA)

Thank you for your attention.

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