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PROTECTION OF CABLES AND OTHER ELEMENTS
OF OUTSIDE PLANT

ITU-T L.1410 – Case studies

ITU-T L-series Recommendations – Supplement 2

Supplement 2 to ITU-T L-series Recommendations

ITU-T L.1410 – Case studies

Summary

Supplement 2 to ITU-T L-series Recommendations has been developed to provide examples to assess the life cycle environmental impact of ICT goods, networks and services (GNS) based on Recommendation ITU-T L.1410. This Supplement focuses on illustrating the results of reduced greenhouse gas (GHG) emissions that have been achieved through increased efficiency in ICT services. These results represent a small number of the many examples that are expected to supplement Recommendation ITU-T L.1410 in the future.

This Supplement is intended for implementers and organizations developing ICT services, and persons responsible for the deployment of sustainable ICT services, including office workers, policy makers and those in academia.

History

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Supplement 2 to ITU-T L-series Recommendations

ITU-T L.1410 – Case studies

1 Scope

Information and communication technology (ICT) has a major role to play in addressing the world's environmental challenges. Indeed, [ITU-T L.1410] and [ITU-T L.1400] have been developed to identify ICT potential to enable significant efficiencies in lifestyle and all sectors of the economy through digital solutions. Such solutions can improve energy efficiency, storage management and business efficiency by reducing travel and transportation, e.g., through teleworking and video conferencing, and by substituting physical products with digital information, e.g., e-commerce.

This Supplement provides examples to assess the life cycle environmental impact of ICT goods, networks and services based on [ITU-T L.1410]. It focuses on illustrating the results of reduced greenhouse gas emissions that have been achieved through increased efficiency in ICT services. These cases represent a small number of the many examples that are expected to supplement [ITU-T L.1410] in the future. To overcome complexity, the case studies adopt a so-called 'hybrid approach' where both process sum and economic input-output are used for the assessment. [ITU-T L.1410] recommends that, as a rule, preference be given to the process sum approach, but acknowledges the use of a hybrid approach to overcome restrictions related to scale and complexity. This approach is explained in [ITU-T L.1410] (see clause 5.2.3.1.1 of [ITU-T L.1410]).

To implement environmental impact assessments based on [ITU-T L.1410] and to utilize the results of such assessments, implementers would need to refer to some best-case practices showing examples of efforts to reduce environmental impact and their related performance assessment.

This Supplement is intended for implementers and organizations developing ICT services, and persons responsible for the deployment of sustainable ICT services, including office workers, policy makers and those in academia.

2 References

- [ITU-T L.1400] Recommendation ITU-T L.1400 (2011), *Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies*.
- [ITU-T L.1410] Recommendation ITU-T L.1410 (2012), *Methodology for the assessment of the environmental impact of information and communication technology goods, networks and services*.
- [ISO 14040] ISO 14040:2006, *Environmental management – Life cycle assessment – Principles and framework*.
- [ISO 14044] ISO 14044:2006, *Environmental management – Life cycle assessment – Requirements and guidelines*.

3 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

CO₂ Carbon Dioxide

EoLT End-of-Life Treatment

FEPCO Federation of Electric Power Companies of Japan

GHG Greenhouse Gas

GNS Goods, Networks and Services

JEMAI Japan Environmental Management Association for Industry

ICT Information and Communication Technology

LCA Life Cycle Assessment

LCI Life Cycle Inventory

4 Conventions

None.

5 Framework of case studies

Table 5-1 describes the cases covered in this Supplement. Since these examples cover limited areas, additional examples are expected to reinforce this supplement in the future. Clauses referenced in Table 5-1 are from [ITU-T L.1410].

Table 5-1 – Mapping of case studies

Title of case study	Goal (see clauses 5.2.2.1 and 6.2.2)	Effect of ICT usage (see clauses 5.2.2.3.5 and 6.1.2)	Boundary (clauses 5.2.2.3 and 6.2.2.2)			Used inventory (see clauses 5.2.3 and 6.2.3)		Environmental impact category
			Life cycle stage covered (see clause 5.2.2.3.6)	Category covered (see clauses 5.2.2.3.2 and 6.2.2.3.2)	Assessment period (see clauses 5.2.2.1 and 6.2.2.1)	Primary data	Secondary data	
Office work efficiency	To show an assessment of reduction of greenhouse gas (GHG) emissions through office work efficiency.	Reduction in paper use and increase in work efficiency	All	All except for: – transport – travel	One year	Price of hardware Operating time Office space Weight of end-of-life hardware	CO ₂ conversion factors Power consumption	Climate change (GHG)
Supply chain management system	To show an assessment of reduction of GHG emissions in supply chain management systems.	Efficient management system of inventory control and transport	All except for: – raw material acquisition, production and end-of-life treatment (EoLT) of transport	All except for: travel	One year	Transport weight Transport distance Weight of end-of-life hardware	CO ₂ conversion factors	Climate change (GHG)

Table 5-1 – Mapping of case studies

Title of case study	Goal (see clauses 5.2.2.1 and 6.2.2)	Effect of ICT usage (see clauses 5.2.2.3.5 and 6.1.2)	Boundary (clauses 5.2.2.3 and 6.2.2.2)			Used inventory (see clauses 5.2.3 and 6.2.3)		Environmental impact category
			Life cycle stage covered (see clause 5.2.2.3.6)	Category covered (see clauses 5.2.2.3.2 and 6.2.2.3.2)	Assessment period (see clauses 5.2.2.1 and 6.2.2.1)	Primary data	Secondary data	
Waste disposal	To show an assessment of reduction of GHG emissions in waste disposal.	Visualization of weight of waste	All except for: – raw material acquisition, production and EoLT of transport – raw material acquisition, production and EoLT of storage of goods	All except for: – travel – work environment	One year	Weight of waste Price of hardware Weight of end-of-life hardware	CO ₂ conversion factors	Climate change (GHG)
Building energy management system (BEMS)	To show an assessment of reduction of GHG emissions in building energy management systems.	Automatic power saving control and visualization of office equipment	All except for: – raw material acquisition, production and EoLT of the working environment; the unaltered processes before and after introduction of ICTs	All except for: – consumables and other support products – site infrastructure – transport – travel – storage of goods	One day	Value of electric power consumption Price of hardware Weight of end-of-life hardware	CO ₂ conversion factors	Climate change (GHG)

Table 5-1 – Mapping of case studies

Title of case study	Goal (see clauses 5.2.2.1 and 6.2.2)	Effect of ICT usage (see clauses 5.2.2.3.5 and 6.1.2)	Boundary (clauses 5.2.2.3 and 6.2.2.2)			Used inventory (see clauses 5.2.3 and 6.2.3)		Environmental impact category
			Life cycle stage covered (see clause 5.2.2.3.6)	Category covered (see clauses 5.2.2.3.2 and 6.2.2.3.2)	Assessment period (see clauses 5.2.2.1 and 6.2.2.1)	Primary data	Secondary data	
Home energy management system	To show an assessment of reduction of GHG emissions through home energy management system.	Automatic power saving control and visualization of household appliances	All except for: – raw material acquisition, production and EoLT of site infrastructure; the unaltered processes before and after introduction of ICTs	All except for: – consumables and other support products – transport – travel – storage of goods – working environment	One week	Electricity consumptions Value of specification Price of hardware Weight of the end-of-life hardware	CO ₂ conversion factors	Climate change (GHG)
NOTE – All clause references refer to [ITU-T L.1410].								

The following areas are covered by case studies:

- General requirements (see clauses 5.2.1 and 6.2.1 of [ITU-T L.1410])
- Goal and scope (see clauses 5.2.2 and 6.2.2 of [ITU-T L.1410])
- Life cycle inventory (see clauses 5.2.3 and 6.2.3 of [ITU-T L.1410])
- Assessment results and analysis (see clauses 5.3 and 6.3 of [ITU-T L.1410])
- Discussion (see clauses 5.4 and 6.4 of [ITU-T L.1410]).

Assessments were carried out on the basis of [ITU-T L.1410], [ISO 14040] and [ISO 14044].

6 Case study 1: Assessment of GHG emissions reduction through improved office work efficiency

6.1 Goal and scope

6.1.1 Goal of the study

The goal of this study was to provide an assessment of the reduction in greenhouse gas (GHG) emissions through work efficiency in the office.

For business entities to implement suitable environmental impact assessments based on [ITU-T L.1410] they would need to refer to best-case practices, used to reduce environmental impact, as well as relevant performance assessments. This case study is intended as an example of the calculation of reduction of GHG emissions on the basis of [ITU-T L.1410]. [ITU-T L.1410] requires the calculation of six GHGs, but only carbon dioxide (CO₂) emissions were calculated in this study, mainly because of the difficulty in acquiring adequate high-quality data.

6.1.2 ICT services

As shown in Table 6-1, this study focused on administrative tasks, financial and contracting tasks, general document management tasks, and business document circulation tasks (refer to Table 1) set at the Nakano Ward Office in Tokyo, Japan, which uses about 2,000 computer terminals operated by 2,281 employees.

The company's old client-server system was replaced by a new web-server system to increase work efficiency and to reduce the amount of paper used. Previously, with the client-server system, the entire book-keeping system was paper-based. This was labour intensive and required storage space for paper documents (i.e., hard copies). A web-server system was installed that made it possible for over 90 per cent of document circulation and approval to be done electronically, thus improving work efficiency. The new electronic archival system also made the retrieval of essential documents simpler and reduced storage space. Replacement of the server and assessment of the results of its installation were conducted from February to March 2012.

Table 6-1 – Subject of the study

Tasks	Example
Administrative	Time management of workers
Financial and contracting	Management of budgets, expenditures and account settlement
General document management	Electronic archival, locating of necessary documents
Business document circulation	Electronic submission and approval of documents

6.1.3 Functional unit

Annual service usage.

6.1.3.1 System boundaries

Table 6-2 shows the assessment range according to the ITU-T L.1410 checklist (see Table 1 of clause 5.2.2.3.2 of [ITU-T L.1410]).

Table 6-2 – Checklist

Category	Items	Raw material acquisition	Production	Use	End-of-life treatment
ICT hardware	Servers, PCs, multifunction printers, network appliances	√	√	√	√
ICT software	Software	√	√	√ See Note 1	√ See Note 1
Consumables and other supportive products	Papers	√	√	See Note 2	√
Site infrastructure	Facilities for client PC and servers	√	√	√	√
Transport (movement of goods)	See Note 3				
Travel (movement of people)	See Note 3				
Storage of goods	Paper	√	√	√	√
Working environment	Office building	√	√	√	√
NOTE 1 – This case study did not consider use and end-of-life treatment of software as it was assumed that this was included in the relevant hardware. NOTE 2 – The use phase of paper was not counted since there was no emission. NOTE 3 – The study did not take into account the environmental impact of transportation, as this was considered irrelevant on the basis of the interviews.					

6.2 Life cycle inventory

Table 6-3 shows the assessment calculation method and data collected for the calculation of the CO₂ emissions per category, and data sources.

Table 6-3 – How to calculate the CO₂ emissions from collected data

Category	How to calculate the CO ₂ emissions from collected data	Collected data and sources
ICT hardware	<Raw material acquisition and production> Price of hardware (servers, PCs, monitors, network equipment) × emission factor of hardware in CO₂ Number of printers × Emission factor of the printer in CO₂ <Use> Power consumption printer in CO₂ PCs emission factor of electric power in CO₂. <End-of-life treatment> Total weight of the hardware × Emission factor of transportation, fracturing and landfill Number of printers × emission factor of the printer in CO₂	Prices of old and new hardware (source: survey) Emission factor of old hardware in CO₂ (source: Japanese Input-Output Table) (See Note 1) Number of printers (source: survey) Emission factor of the printer (source: EcoLeaf) (See Note 2) Operating time (source: survey) Power consumption (source: catalogue) Emission factor of electric power (source: The Federation of Electric Power Companies of Japan (FEPCO)) Total weight of the hardware (source: survey) Emission factor of transportation (source: Japanese Ministry of Land, Infrastructure, Transport and Tourism), fracturing and landfill (source: Japanese Society of Civil Engineers (an academic society))
ICT software	<Raw material acquisition and production> software prices × emission factors in CO₂	Price of old software (source: survey) Emission factor of old software (source: Japanese Input-Output Table) Price of new software (source: survey) Emission factor of new software (source: Japanese Input-Output Table) (See Note 3)
Consumables and other supportive products	On the basis of interviews, this case study registered the volume of paper consumed before and after the new system was installed. <Raw material acquisition and production> Weight of paper iEmission factor in CO₂ This case study assumed that all paper is incinerated and did not take into account paper recycling. <End-of-life treatment> Total weight of paper × hEmission factor of transportation, combustion and landfill in CO₂.	Weight of paper consumed before installation of new system (source: survey) Weight of paper consumed after installation of new system (source: survey) Emission factor of raw material acquisition and paper production (source: National Institute for Environmental Studies in Japan) Emission factor of transportation (source: FEPCO), combustion (source: Plastic Waste Management Institute and Nomura Research Institute) and landfill. (source: Japan Society of Civil Engineers (an academic society))

Table 6-3 – How to calculate the CO₂ emissions from collected data

Category	How to calculate the CO ₂ emissions from collected data	Collected data and sources
Site infrastructure	On the basis of interviews, this case study estimated the space used for hardware before and after the new system was installed. <from raw material acquisition to end-of-life treatment> Installation space of the client PCs × annual hours of use × emission factor in CO ₂ /m ² /year. Exclusive space for the servers × emission factor in CO ₂ emission/m ² /year.	Installation space (m ²) of the client PCs (source: survey) Exclusive space (m ²) for the servers (source: survey) Emission factor of office space (m ² /year) (source: Architectural Institute of Japan)
Storage of goods	<from raw material acquisition to end-of-life treatment> Space for storage of papers in the warehouse × emission factor in CO ₂ /m ² /year.	Space (m ²) for storage of papers in the warehouse (source: estimated from volume of paper) Emission factor of office space (m ² /year) (source: Architectural Institute of Japan) * Since warehouse storage exists within the same building in the Nakano Ward Office, this case study used the emission factor for office space
Working environment	This case study assumed that reduction of workload leads to reduction of office space resulting in the reduction of CO ₂ emissions from cooling and heating systems and lighting, etc. <from raw material acquisition to end-of-life treatment> Workloads × office space per worker (m ² /man) × emission factor of office space in CO ₂ /m ² /year.	Workload before new system was installed (source: survey) Workload after new system was installed (source: survey) Office space per worker ((m ² /man) (source: Japan Building Owners and Managers Association) Emission factor of office space (m ² /year) (source: Architectural Institute of Japan).

NOTE 1 – It was difficult to collect process sum data of GHG emission for the old ICT hardware because it was manufactured before 2005 when data to assess environmental impact of the product were not yet available. Although such indices were available for the new system, for the purpose of comparison this case study used the emission factor from the Japanese Input-Output Table where data for both systems are available.

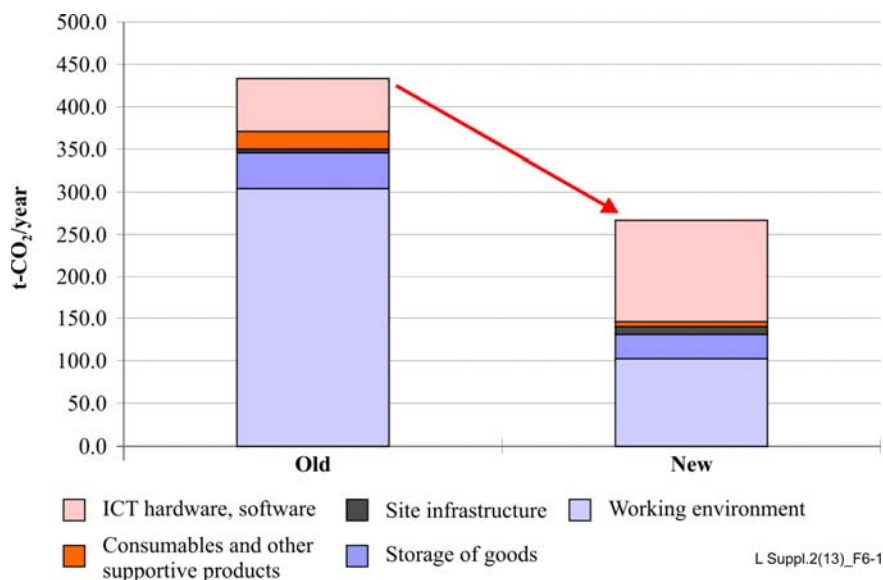
NOTE 2 – As for multifunction printers, there were no available LCA data. Therefore, this case study used the data of "EcoLeaf" on RICOH's imagio MP7500RC which were available in the Japanese environmental label and 'EcoLeaf' and have similar function with the printer used in the Nakano Word office.

NOTE 3 – It was difficult to collect data process sum data of GHG emission for the old software because it was produced before 2005 when data to assess environmental impact of the product was not yet available. Although such indices were available for the new system, for the purpose of comparison, this case study used the emission factors from the Japanese Input-Output Table where data for both systems are available.

6.3 Assessment results and analysis

6.3.1 Results

The assessment results showed a 38 per cent reduction when the ICT-based systems is used instead of paper (i.e., 165 t-CO₂/year) at the Nakano Ward Office. From Figure 6-1, it can be seen that the different categories highly influence the volume of CO₂ emission, with the largest reduction in emission through the incorporation of the new system coming from the reduction in consumables (i.e., paper), at 77 per cent.



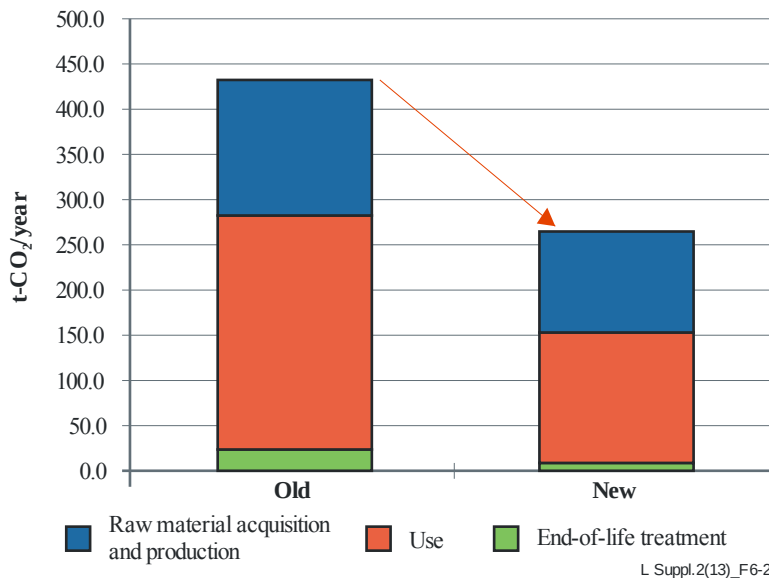
	ICT hardware, software	Consumables and other supportive products	Site infrastructure	Storage of goods	Working environment	Total t-CO ₂ /year
The old system	61.0	20.4	4.6	43.6	303.7	433.3
The new system	122.5	4.7	9.4	28.3	103.3	268.2
Rate of reduction	-100.8%	77.0%	-104.3%	35.1%	66.0%	38.1%

NOTE – This case study reports only total figures of ICT hardware and software because details of revenue and investment are confidential.

Figure 6-1 – Assessment results by category (unit: t-CO₂/year)

Looking at the results by life cycle phase in Figure 6-2, the reduction rate in the end-of-life phase was the largest at 63 per cent. This is assumed to be influenced by the reduction of paper use. The usage phase had the second-highest reduction and was the result of the decline in the use of electricity in the working environment for amenities such as air conditioning and lighting.

NOTE –Some emission factors include both raw material acquisition and production, and thus the reduction amount due to each life cycle stage is shown by raw material acquisition and production, usage, and end-of-life treatment.



	Raw material acquisition and Production	Use	End-of-life treatment	Total (t-CO ₂ /year)
The old system	147.6	257.7	28.1	433.4
The new system	110.4	147.4	10.3	268.1
Rate of reduction	25.2%	42.8%	63.3%	38.1%

Figure 6-2 – Assessment results by life cycle analysis (unit: t-CO₂/year)

6.3.2 Sensitivity analysis

Based on interviews with workers, this case study collected data on workload, volume of paper consumption and volume of stored documents. Among these data, workload differs depending on the work type, on the respondent's capability in task processing and even on the worker's subjective perception. Improvement in efficiency as workers become more familiar with system operations is another prevailing factor. Taking these issues into account, this case study compared the old and new systems in two scenarios to analyse the effect of reduction in workload on CO₂ emission reduction rates.

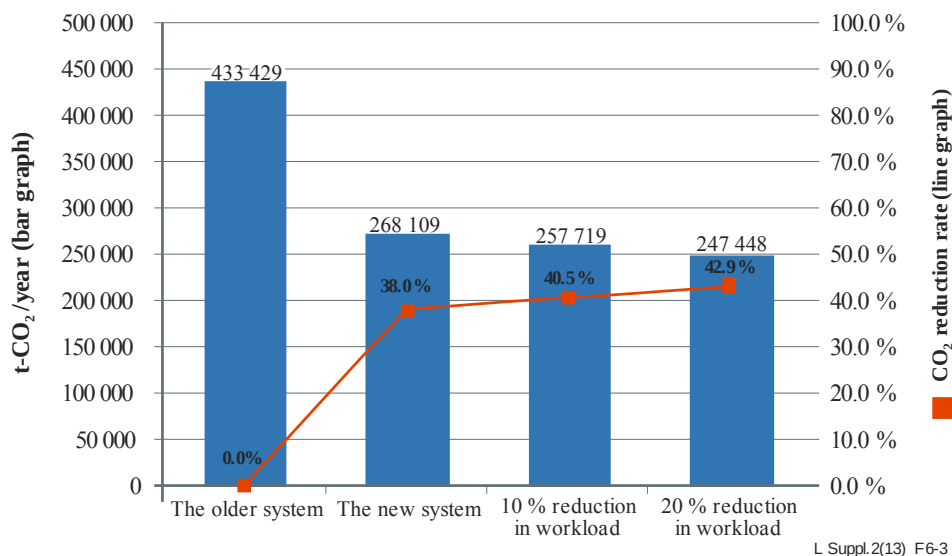


Figure 6-3 – Results of sensitivity analysis

Figure 6-3 shows the volume (blue bar graphs) and reduction rate (red line graph) of CO₂ emissions of the new system as compared with the old system. A ten per cent workload reduction case would

reduce emissions by 41 per cent and a 20 per cent workload reduction case would reduce emission by 43 per cent. Based on this, it can be seen that a 10 per cent workload reduction contributes to only a two per cent reduction rate of CO₂ emission. These differences were considered to be insignificant. The results indicate that when changes in the volume of workload are subjectively reported through interviews, they are not a significant influencing factor.

The results may be sensitive to other parameters such as lifetime, but this was not tested.

6.3.3 Cut-off

No definite cut-off rule was taken into consideration and the possibility to avoid cut-offs is one of the advantages of the hybrid approach.

6.3.4 Potential

Table 6-4 shows the potential effect of CO₂ emission reductions in this case study.

Table 6-4 – Potential effect

Potential	Field test and results		
	(1) old system (kg-CO ₂ /year)	(2) new system (kg-CO ₂ /year)	Difference (1)-(2) (kg-CO ₂ /year)
Travel (movement of people)	–	–	–
Transport (movement of goods)	–	–	–
Site infrastructure	Space for client PC 1,183	Space for client PC 1,547	Space for client PC –363
Storage of goods	Paper storage at warehouse and offices 43,465	Paper storage at warehouse and offices 28,299	Paper storage at warehouse and offices 15,166
Working environment	Space for office 303,720	Space for office 103,306	Space for office 200,414

6.4 Critical review

This case study was reviewed internally, as well as by an external panel to ensure the objectivity of the assessment.

6.4.1 Discussion

The following features are noted in the assessment:

- This case study calculated CO₂ emissions based on [ITU-T L.1410] and took into account the life-cycle analysis of the raw material acquisition phase, production phase, use phase and end-of-life treatment phase. A hybrid approach was taken applied to overcome complexity.
- This case study showed a potential 38 per cent reduction when the ICT based systems is used instead of paper at Nakano Ward Office. Emissions under the old system measured 433 t-CO₂/year, whereas those of the new system measured 268 t-CO₂/year; this represents a reduction of 165 t-CO₂/year.
- Japan has approximately 1,700 municipal organizations. If this solution is tailored to 20 per cent of these offices, this could lead to a reduction of 56,134 t-CO₂/year. On the basis that the emission factor of a 4-ton size truck is 0.1502 kg-CO₂/tkm, according to the Japan