Content

General framework

Procedure

Screening phase (step 1)

Calculation of emissions

Validation of scope

Allocation of emissions

Step 3.1: Development of sub-sets of emissions

Step 3.2: Consolidation to allocation coefficients

Step 3.3: Calculation of allocated emissions

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Definition of allocation objectives

If the reporting company wants to communicate emissions on a level other than the total quantity of emissions (balance scope), it shall choose between four allocation objectives:

- **Client:**
  - Partial emissions that can be allocated to specific clients with their specific starting and delivery points, purchased services etc.

- **Logistics service:**
  - Partial emissions that are caused by specific logistics services of the reporting company, e.g. national shipment, international shipment, express service, refrigerated shipment.

- **Geographical unit:**
  - Partial emissions of geographical units of the reporting company, e.g. region, country, continent.

- **Organizational unit:**
  - Partial emissions of organizational units of the reporting company, e.g. road services, warehouse services, contract logistics services.
The allocation procedure (step 3) covers

- **Step 3.1: Development of sub-sets of emissions**
  - Depending on the data used for calculating emissions in step 1 & 2, the emissions might refer to multiple sub-services (e.g. ambient and refrigerated warehousing), that need to be differentiated within allocation.
  - The more complex the logistics system (balance scope) is, i.e. the more different logistics sub-services and modes it covers, the more sub-steps within step 3.1 are required.
  - Depending on the data available some “simplified” rules might be irrelevant for companies.

- **Step 3.2: Consolidation to allocation coefficients**
  - The sub-sets of emissions developed are transferred to allocation coefficients that express emissions per defined logistics unit (e.g. transport performance [tkm] [TEU-km], weight [t], outgoing logistics items [-]).

- **Step 3.3: Calculation of allocated emissions depending on allocation objectives**
  - Each allocation objective (e.g. client i) and its specific extent of “use” of the logistics system (balance scope) is represented by the objective’s relevant quantity of the logistics units. The latter is multiplied with the relevant allocation coefficients for calculating the objective’s emissions.
### Step 3 - Allocation procedure

#### Overview (simplified)

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Total emissions of defined logistics system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Calculated emissions for less relevant sub-aspects</td>
</tr>
<tr>
<td>2.</td>
<td>Calculated emissions for relevant sub-aspects</td>
</tr>
</tbody>
</table>

#### Development of sub-sets of emissions

- **General emissions**
- **Emissions of logistics sites**
- **Emissions of transport**
- **Emissions of freight transport**
- **Emissions of transshipment sites**
- **Emissions of warehouses**

#### Consolidation to allocation coefficients

- **Emissions per ...**
- **Emissions per ...**
- **Emissions per ...**
- **Emissions per ...**
- **Emissions per ...**
- **Emissions per ...**
- **Emissions per ...**

#### Calculation of allocated emissions

- **E.g. clients**
- **Client 1**
- **Client 2**
- **...**

### Step 1 & Step 2

- **Total emissions of defined logistics system**

### Step 3.1

- **Development of sub-sets of emissions**
  - **General emissions**
  - **Emissions of logistics sites**
  - **Emissions of transport**
  - **Emissions of freight transport**
  - **Emissions of transshipment sites**
  - **Emissions of warehouses**

### Step 3.2

- **Consolidation to allocation coefficients**
  - **Emissions per ...**
  - **Emissions per ...**
  - **Emissions per ...**
  - **Emissions per ...**
  - **Emissions per ...**
  - **Emissions per ...**
  - **Emissions per ...**

### Step 3.3

- **Calculation of allocated emissions**
  - **E.g. clients**
  - **Client 1**
  - **Client 2**
  - **...**
Content

General framework

Procedure

Screening phase (step 1)

Calculation of emissions

Validation of scope

Allocation of emissions

- Step 3.1: Development of sub-sets of emissions
- Step 3.2: Consolidation to allocation coefficients
- Step 3.3: Calculation of allocated emissions
Step 3.1 - Development of sub-sets of emissions (1)

The objective of the first step of the allocation procedure is to develop sub-sets of emissions, i.e. emissions from:

- Warehouses
- Goods shipping / dispatch
  - Without order-picking
  - With order-picking
- Transshipment sites per mode outbound
  - Road
  - Rail
  - Air
  - Maritime
  - Inland waterway

Transport per mode
- Road
- Rail
- Air
- Maritime
- Inland waterway

No differentiation concerning temperature

No differentiation concerning temperature
The development of sub-sets of emissions, as defined before, needs to cover the following issues:

- General emissions need to be sub-divided and allocated to these sub-sets.
  - General emissions are defined as those caused by:
    - Administration, employee commuting and business travel
    - Less relevant sub-aspects (Step 1: < 1 %)
- Emissions of combined freight and passenger transport\(^{(1)}\) need to be allocated to their respective component units (freight / passenger).
  - Thus, emissions of passenger transport are excluded from further allocation.
- Emissions of combined ambient and refrigerated transport need to be allocated to their respective component units (ambient / refrigerated).
- Emissions of combined logistics sites (e.g. sites with warehousing and transshipment, multimodal transshipment sites, sites with refrigeration and ambient warehousing) need to be allocated to their respective component units.
  - Warehouses: With or without order-picking
  - Transshipment sites: One mode or multi-modal sites
- If no combined services are covered in the logistics system (balance scope), these steps can be neglected.

\(^{(1)}\) Only relevant if approach A has been applied.
Step 3.1 - Development of sub-sets of emissions (3)

Exclusion of emissions from passenger transport (e.g. belly freight), either before or after the allocation of general emissions. Depending on whether general emissions are relevant for both, freight and passenger transport, or just freight transport (only relevant, if approach A has been applied).
General emissions are defined as those caused by
- Administration $E_{\text{admin}}$, employee commuting $E_{\text{employee}}$ and business travel $E_{\text{travel}}$
- Less relevant sub-aspects (Step 1: $< 1\%$) $\sum E < 1\%$

The general emissions are allocated to the relevant sub-aspects of the logistics system, i.e. transport modes and logistics sites. The emissions of the relevant sub-aspects (step 2), i.e. $E_{\text{site}}$ and $E_{\text{mode}}$, are extended by the allocated general emissions accordingly, expressed by * in the diagram, i.e. $E_{\text{site}}^*$ and $E_{\text{mode}}^*$.
In a first step, general emissions are subdivided into:
1. General emissions for logistics sites $E_{\text{site}}^{\text{general}}$
2. General emissions for transport $E_{t}^{\text{general}}$

In a second step, these subdivided general emissions are allocated to:

a) Relevant logistics sites covered in the logistics system (balance scope)

b) Relevant transport sub-sets in the logistics system (balance scope), e.g. per mode, leg$^{(1)}$. 

---

Step 3.1 - Sub-division and allocation of general emissions (2)
### Step 3.1 - Sub-division of general emissions

In the first step, general emissions $E_{general}$ are subdivided into general emissions for logistics sites $E_{site}$ and for transport $E_{t}$ by means of a simplified approach using weight.

- **Logistics sites:** Quantity of outgoing freight [t] $m_{g,out}^j$
- **Transport:** Quantity of freight [t] $m_{g,t}^i$

#### General emissions for logistics sites

$$E_{site}^{general} = \%_{site, total}^{general} \times E_{general}$$

#### General emissions for transport

$$E_{t}^{general} = \%_{t, total}^{general} \times E_{general}$$

---

<table>
<thead>
<tr>
<th>Logistics sites</th>
<th>Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 $m_{g,out}^1$</td>
<td>Sub-set 1</td>
</tr>
<tr>
<td>2 $m_{g,out}^2$</td>
<td>2 $m_{g,t}^1$</td>
</tr>
<tr>
<td>3 $m_{g,out}^3$</td>
<td>3 $m_{g,t}^2$</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>$j$ $m_{g,out}^j$</td>
<td>$i$ $m_{g,t}^i$</td>
</tr>
</tbody>
</table>

$$m_{g,3.1}^{total} = \sum m_{g, out}^j + \sum m_{g,t}^i$$

---

**Allocation share**

- **Logistics sites**
  
  \[
  \%_{site, total}^{general} = \frac{\sum m_{g, out}^j}{m_{g,3.1}^{total}}
  \]

- **Transport**
  
  \[
  \%_{t, total}^{general} = \frac{\sum m_{g, t}^i}{m_{g,3.1}^{total}}
  \]
Step 3.1 - Allocation of general emissions (1)

In the second step, these sub-divided emissions $E_{\text{site}}$ and $E_{t}^{\text{general}}$ are allocated by using either weight ($m_{g,\text{out}}^{j} \ [t]$) or transport performance ($tkm_{g}^{i} \ [tkm]$).

Logistics sites: Quantity of outgoing freight $m_{g,\text{out}}^{j} \ [t]$ for each logistics site

$\sum m_{g,\text{out}}^{j} = m_{g,\text{out}}^{\text{total}}$

Allocation share of the logistics sites (site-specific)

\[
\%_{\text{general}}^{\text{site}} = \frac{m_{g,\text{out}}^{j}}{m_{g,\text{out}}^{\text{total}}}
\]

Emissions of logistics sites (incl. allocated general emissions)

\[
E_{\text{site}}^{*} = \%_{\text{general}}^{\text{site}} * E_{\text{site}}^{\text{general}}
\]
Step 3.1 - Allocation of general emissions (2)

- In the second step, these sub-divided emissions $E_{site}^{general}$ and $E_t^{general}$ are allocated by using either weight ($m_{g, out}^j$ [t]) or transport performance ($tkm_g^j$ [tkm]).

- Transport: Transport performance $tkm_g^j$ [tkm] per mode and/or mode-specific sub-sets (e.g. legs\(^{(1)}\)).

\[ tkm_g^{total} = \sum tkm_g^i \]

Allocation share for transport (sub-set specific)

\[ \%_t^{general} = \frac{tkm_g^i}{tkm_g^{total}} \]

Emissions transport per mode (incl. allocated general emissions)

\[ E_{mode}^* = \%_t^{general} \times E_t^{general} \]

(1) As used in [DIN EN 16258]
Step 3.1 - Exclusion of passenger transport emissions (1)

In case of approach A calculation, emissions might have been calculated for combined freight and passenger transport (e.g. belly freight), i.e. $E_{g&p}^{mode}$.

Emissions of combined freight and passenger transport need to be allocated to their respective component units (freight / passenger). Thus, emissions of passenger transport are excluded from further allocation.

The exclusion of emissions from passenger transport is realized either before or after the allocation of general emissions, i.e. using $E^{mode}$ or $E^{mode*}$ as input emissions. This is done depending on whether general emissions are relevant just for freight transport ($E^{mode}$) or for both freight and passenger transport ($E^{mode*}$).
Step 3.1 - Exclusion of passenger transport emissions (2)

Emissions of combined freight and passenger transport \( E_{g\&p}^\text{mode} \) are allocated to freight transport and passenger transport by means of transport performance [tkm] per transport mode, with \( tkm_{g,\text{mode}} = m_{g,\text{mode}} * d_{g,\text{mode}} \) and \( tkm_{p,\text{mode}} = m_{p,\text{mode}} * d_{p,\text{mode}} \).

The reporting company shall use the parameters for \( m_{p,\text{mode}} = \sum m_{\text{passenger},\text{mode}} + m_{v,\text{mode}} \) as specified in the »Supplement«.

\[
\begin{align*}
\text{Allocation share mode-specific} & = \frac{tkm_{g,\text{mode}}}{tkm_{g,\text{mode}} + tkm_{p,\text{mode}}} \\
\%_g^\text{mode} & = \frac{tkm_{g,\text{mode}}}{tkm_{g,\text{g\&p}}} \\
\%_p^\text{mode} & = \frac{tkm_{p,\text{mode}}}{tkm_{g,\text{g\&p}}}
\end{align*}
\]

Emissions for freight transport
\[
E_{\text{mode}}^{\text{mode}} = \%_g^\text{mode} \times E_{g\&p}^\text{mode}
\]

Emissions for passenger transport (1)

(1) Not further considered within Green Logistics method
Focus: Differentiation between ambient and refrigerated transport

Refrigerated transport causes additional emissions due to an enhanced fuel or electricity consumption and the possible loss of refrigerants.

Therefore, companies that offer both ambient and refrigerated transport require an allocation of emissions to both service areas. This is realized by

a) Direct allocation of measured values (additional fuel consumption, emitted refrigerants) or
b) Indirect allocation, using the relevant transport performance [tkm] and the allocation factor $\gamma$
The indirect allocation of emissions of combined ambient and refrigerated transport uses the relevant transport performance \([\text{tkm}]\) \(tkm_{g,\text{amb}}^{\text{mode}}, tkm_{g,\text{refr}}^{\text{mode}}\) and the mode-specific allocation factor \(\gamma\).

**Step 3.1 - Differentiation between ambient and refrigerated transport (2)**

\[
tkm_{g,Y}^{\text{mode}} = \sum tkm_{g,\text{amb}}^{\text{mode}} + \gamma_{\text{mode}} * tkm_{g,\text{refr}}^{\text{mode}}
\]

\[
\%_{g,\text{amb}}^{\text{mode}} = \frac{tkm_{g,\text{amb}}^{\text{mode}}}{tkm_{g,Y}^{\text{mode}}}
\]

\[
\%_{g,\text{refr}}^{\text{mode}} = \gamma_{\text{mode}} * tkm_{g,\text{refr}}^{\text{mode}} / tkm_{g,Y}^{\text{mode}}
\]

\[
E_{*,\text{amb}}^{\text{mode}} = \%_{g,\text{amb}}^{\text{mode}} * E_{*}^{\text{mode}}
\]

\[
E_{*,\text{refr}}^{\text{mode}} = \%_{g,\text{refr}}^{\text{mode}} * E_{*}^{\text{mode}}
\]
Step 3.1 - Selection of allocation factor refrigeration $\gamma$

The allocation factor $\gamma$ considers the increased transport emissions for the refrigeration of goods due to the additional energy consumption caused by running the cooling unit(s).

The reporting company shall either use $\gamma = c_{refr}^{mode}$ or derive and declare a company-specific $\gamma_{spec}$.

Two possible procedures for identifying a company-specific allocation factor $\gamma_{spec}$:

- The company measures the consumption of (auxiliary) engine(s) $Q_{ec,aux}$ required for cooling and define the relation to the consumption of the (main) engine $Q_{ec,main}$.

$$\gamma_{spec} = \frac{Q_{ec,aux} + Q_{ec,main}}{Q_{ec,main}}$$

- If one engine feeds both, the cooling system and the drive/propulsion, the company measures its specific fuel/electricity consumption with cooling unit activated $Q_{ec,refr}$ as well as deactivated $Q_{ec,amb}$.

Requirements on data quality:

- Minimum of 10 representative trips/tours
- Recording of underlying distances with cooling activated and deactivated: $d_{refr}$ and $d_{amb}$
- Check if the measurement is representative of the annual average

Calculation of the allocation factor:

$$\gamma_{spec} = \frac{Q_{ec,refr}/d_{refr}}{Q_{ec,amb}/d_{amb}}$$
Logistics sites can be classified according to their main activities and the corresponding financial processing (to customers), i.e. either transshipment or warehousing of goods\(^1\). Transshipment and warehousing activities may also be pooled at one logistics site, i.e. a combined logistics site. The emissions at combined logistics sites need to be allocated to those two types in a first step. This is done using the relevant floor area \(A\) [m\(^2\)].

Remark: The company shall use the gross floor area of the building, i.e. if relevant, for the number of floors the logistics building has.

The company shall measure the following areas at combined logistics sites:

<table>
<thead>
<tr>
<th>Areas dedicated to warehousing and order-picking activities (only)</th>
<th>(A_s) [m(^2)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areas dedicated to transshipment activities (only)</td>
<td>(A_{ts}) [m(^2)]</td>
</tr>
<tr>
<td>Mixed areas (e.g. goods incoming area, corridors, administration offices)</td>
<td>(A_{mixed}) [m(^2)]</td>
</tr>
</tbody>
</table>

\(^1\) If relevant, including order-picking activities
Emissions at combined logistics sites (warehousing and transshipment) are allocated to the activities using the relevant floor area ($A_s$ and $A_{ts}$ [m$^2$]). Therefore, the company shall identify mixed zones $A_{mixed}$ [m$^2$], that are excluded for identifying the allocation share for warehousing and transshipment emissions.

**Step 3.1: Differentiation between warehousing and transshipment (2)**

\[ A_{gross} = A_s + A_{ts} + A_{mixed} \]

\[ \%_{ts} = \frac{A_{ts}}{A_s + A_{ts}} \]

\[ E^{ts}_s = \%_{ts} \times E^{site}_s \]

\[ \%_{s} = \frac{A_s}{A_s + A_{ts}} \]

\[ E^{s}_s = \%_{s} \times E^{site}_s \]
Emissions at multimodal transshipment sites are allocated to transport modes by means of a simplified approach using the quantity of outgoing freight $m_{g,ts}^{mode}$ [t] per transport mode.

**Step 3.1: Differentiation between mode-specific transshipment**

Multimodal transshipment site (here: relevant modes road and air)

- $m_{g,ts}^{road}$
- $m_{g,ts}^{air}$

**Allocation share (mode-dependent)**

$$\%_{ts}^{mode} = \frac{m_{g,ts}^{mode}}{m_{g,ts}^{total}}$$

**Site emissions for transshipment on road**

$$E_{ts,road}^{*} = \%_{ts}^{road} * E_{ts}^{*}$$

**Site emissions for transshipment on air**

$$E_{ts,air}^{*} = \%_{ts}^{air} * E_{ts}^{*}$$
Step 3.1: Differentiation between warehouse activities (1)

Combined warehouses cover more than one of the four warehouse types defined, i.e.

<table>
<thead>
<tr>
<th>Warehouse types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient warehouses without order-picking</td>
</tr>
<tr>
<td>Ambient warehouses with order-picking</td>
</tr>
</tbody>
</table>

Emissions of combined warehouses (e.g. sites with refrigeration and ambient warehousing) need to be allocated to their respective component units (warehouse activities), i.e.

<table>
<thead>
<tr>
<th>Warehouse activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient warehousing</td>
</tr>
<tr>
<td>Goods shipping with order-picking</td>
</tr>
</tbody>
</table>
Step 3.1: Differentiation between warehouse activities (2)

Emissions at combined warehouses are allocated to warehouse activities relevant at logistics sites by means of three approaches:

- In case of combined ambient and refrigerated warehousing:
  1. Direct allocation of
     - Emissions caused by heating ⇒ 100 % ambient
     - Emissions caused by refrigerants ⇒ 100 % refrigerated
  2. Indirect allocation, using the relevant floor area:
     Used for emissions caused by (a) the consumption of electricity, and by (b) further energy carriers (not related to heating) and general emissions (e.g. administration)

- In case of combined shipping of picked and non-picked logistics units:
  3. Indirect allocation, using the relevant quantity of outgoing logistics units/items (dispatch): Used for emissions caused by packaging materials (e.g. transport security) and waste fractions

\[
E^s_{\text{amb}}, E^s_{\text{refr}}, E^{dc, mw}, E^{s,mw}
\]
Step 3.1: General allocation procedure at combined warehouses

In case of a combined warehouse, with all warehouse activities relevant, i.e. ambient and refrigerated goods are stored and order-picked.

The allocation rules are explained step-by-step for the emissions categories.
Step 3.1: Differentiation between ambient and refrigerated warehousing (1)

(1) In case of combined ambient and refrigerated warehousing:
Direct allocation of

- Emissions caused by heating $E_{s}^{ec(heating)}$ $\Rightarrow$ 100 % ambient
- Emissions caused by refrigerants $E_{s}^{refr}$ $\Rightarrow$ 100 % refrigerated
Step 3.1: Differentiation between ambient and refrigerated warehousing (2)

(2) a) In case of combined ambient and refrigerated warehousing:
Indirect allocation of emissions caused by electricity consumption generally\(^{(1)}\) using the relevant floor area \(A \text{ [m}^2\text{]}\) and the allocation factor \(\alpha\).

- The allocation factor represents the additional consumption of electricity caused by running the cooling unit(s) for refrigeration of goods.

\(\frac{\%_{\text{amb}}}{\alpha_{\text{amb}}}\) and \(\frac{\%_{\text{refr}}}{\alpha_{\text{refr}}}\)

\(E^s_{3.1}\)
Step 3.1: Differentiation between ambient and refrigerated warehousing (3)

(2) b) In case of combined ambient and refrigerated warehousing: 
Indirect allocation of 
- $E_s^{ec(\text{other})}$ and $E_{\text{general}}$ using the relevant floor area $A$ [m²], with $E_s^{3.1} = E_s^{ec(\text{other})} + E_{\text{general}}$
- $E_s^{\text{elec}}$ using the relevant floor area $A$ [m²] and allocation factor $\alpha$

// The company shall identify mixed zones $A_{\text{mixed}}$ [m²], that are excluded for identifying the allocation share for ambient and refrigerated warehousing emissions.

Combined warehouse (depending on space use)
- $A_s^{\text{amb}}$
- $A_s^{\text{refr}}$
- $A_s^{\text{mixed}}$

\[ A_{\text{gross}} = A_s^{\text{amb}} + A_s^{\text{refr}} + A_s^{\text{mixed}} \]

**a) Allocation share**

- $\%_{m^2}^{\text{amb}} = \frac{A_s^{\text{amb}}}{A_s^{\text{amb}} + A_s^{\text{refr}}} * E_s^{3.1}$
- $\%_{m^2}^{\text{refr}} = \frac{A_s^{\text{refr}}}{A_s^{\text{amb}} + A_s^{\text{refr}}} * E_s^{3.1}$

**b) Allocation share**

- $\%_{m^2,\alpha}^{\text{amb}} = \frac{A_s^{\text{amb}}}{A_s^{\text{amb}} + \alpha * A_s^{\text{refr}}} * E_s^{\text{elec}}$
- $\%_{m^2,\alpha}^{\text{refr}} = \frac{\alpha * A_s^{\text{refr}}}{A_s^{\text{amb}} + \alpha * A_s^{\text{refr}}} * E_s^{\text{elec}}$
Step 3.1: Selection of allocation factor refrigeration at warehouses $\alpha$

- The reporting company shall either use $\alpha = \alpha_{\text{default}}$ (see »Supplement«) or derive and declare a company-specific allocation factor $\alpha_{\text{spec}}$.

- Procedure for identifying a company-specific allocation factor $\alpha_{\text{spec}}$
  - The company shall measure (at least for 4 weeks)
    - The overall electricity consumption of the whole warehouse $Q_{\text{elec}}$ [kWh]
    - The electricity consumption of cooling unit(s) $Q_{\text{elec,refr}}$ [kWh]
  - and specify the underlying floor area $A$ [m²]: refrigerated area $A_{\text{refr}}$ and ambient area $A_{\text{amb}}$
  - The company shall check if the measurement is representative of the annual average.
  - Calculation of the allocation factor
    $$\alpha_{\text{spec}} = \frac{Q_{\text{elec,refr}}/A_{\text{refr}} + (Q_{\text{elec}} - Q_{\text{elec,refr}})/A_{\text{amb}}}{(Q_{\text{elec}} - Q_{\text{elec,refr}})/A_{\text{amb}}}$$
Step 3.1: Differentiation between picked and non-picked items

(3) In case of combined shipping of picked and non-picked logistics items: Indirect allocation of $E^m_S$ and $E^w_S$, using

- The relevant quantity of outgoing logistics items (dispatch) $item_{out}$ [-] and
- Allocation factor $\beta$
The final sub-sets of emissions for ambient and refrigerated warehousing are calculated according to

\[ E_{s,amb}^s = E_{s}^{ec(heating)} + E_{s,amb}^{3.1} + E_{s,amb}^{elec} \quad \text{and} \quad E_{s,refr}^s = E_{s}^{refr} + E_{s,refr}^{3.1} + E_{s,amb}^{elec} \]

Step 3.1: Differentiation between ambient and refrigerated warehousing (4)
Step 3.1: Differentiation between picked and non-picked items

Order-picking requires additional material consumption $Q_m$ (e.g. securing of cargo) and causes additional waste $Q_w$.

However, a basic amount of packaging materials and waste is required/generated even without order-picking (e.g. for reasons of additional securing of cargo, common waste generation). This is covered by the use of the allocation factor $\beta$.

Thus, dispatch emissions without $E_{s,mw}$ and with order-picking $E_{dc,mw}$ are differentiated, here.

Combined warehouse (1)
(depending on outgoing logistics items)

$\text{item}_{out}^s$

$\text{item}_{out}^{dc}$

$\text{item}_{out}^{site,total} = \text{item}_{out}^s + \text{item}_{out}^{dc}$

Allocation share (1)

$\%_{item}^s = \frac{\text{item}_{out}^s}{\text{item}_{out}^s + \beta \cdot \text{item}_{out}^{dc}}$

$\%_{item}^{dc} = \frac{\beta \cdot \text{item}_{out}^{dc}}{\text{item}_{out}^s + \beta \cdot \text{item}_{out}^{dc}}$

$E_{s,mw} = \%_{item}^s \cdot E_{s,mw}^{mw}$

$E_{dc,mw} = \%_{item}^{dc} \cdot E_{s,mw}^{mw}$

(1) Default or simplified approach
Step 3.1: Selection of allocation factor order-picking $\beta$

The reporting company shall either use $\beta = \beta_{\text{default}}$ (see »Supplement«) or derive and declare a company-specific allocation factor $\beta_{\text{spec}}$.

Procedure for identifying a company-specific allocation factor $\beta_{\text{spec}}$

- The company may choose between two approaches
  a) Simplified approach: no further specification of picked items
  b) Extended approach: in case a company aims at more detailed figures on picked items, it may differentiate between specific logistics units, e.g. pallets, parcels\(^{(1)}\)

---

\(^{(1)}\) Recommendation: A company should consider the relevance of the emission category "packaging and waste" in respect to the total emissions of the warehouse to decide whether a more detailed allocation is beneficial.
Step 3.1: Identification of allocation factor $\beta$

**Simplified approach**

The company shall measure (at least for 4 weeks):

- The consumed quantity of plastic $Q_{m}^{\text{plastic}}$ and cardboard $Q_{m}^{\text{cardboard}}$ [kg] for both non-picked as well as picked logistics items.

- The produced quantity of plastic waste $Q_{w}^{\text{plastic}}$ and cardboard waste $Q_{w}^{\text{cardboard}}$ [kg] for both non-picked, as well as, picked logistics items.

and specify the underlying outgoing quantity of picked $item_{out}^{dc}$ and non-picked $item_{out}^{s}$ logistics items (dispatch) [-].

The company shall check if the measurement is representative of the annual average.

Calculation of the allocation factor

$$\beta_{\text{spec}} = \frac{e_{dc}}{e_{s}}$$

with

for picked items:

$$e_{dc} = \frac{\sum_{dc} Q_{m}^{i} \cdot EFA_{m}^{i} + \sum_{dc} Q_{w}^{i} \cdot EFA_{w}^{i}}{item_{out}^{dc}}$$

for non-picked items:

$$e_{s} = \frac{\sum_{s} Q_{m}^{i} \cdot EFA_{m}^{i} + \sum_{s} Q_{w}^{i} \cdot EFA_{w}^{i}}{item_{out}^{s}}$$
Part V - p. 34

Step 3.1: Identification of allocation factor $\beta$

Extended approach (1)

---

Extended procedure for identifying relevant company-specific allocation factors $\beta^{j}_{spec}$

- The company shall specify the relevant logistics units/items to be differentiated ($j$), e.g. concerning
  - Sizes: pallets, parcels etc. and/or
  - Extent of relevant material consumption and/or waste production: special foil, coating etc.

- The company shall measure (at least for 4 weeks)
  - The consumed quantity of plastic $Q_{c_{m}}^{plastic}$ and cardboard $Q_{c_{m}}^{cardboard}$ [kg] for all non-picked, as well as, the differentiated picked logistics items
  - The produced quantity of plastic waste $Q_{w}^{plastic}$ and cardboard waste $Q_{w}^{cardboard}$ [kg] for all non-picked, as well as, the differentiated picked logistics items

and specify the underlying outgoing quantity of picked $item_{out}^{dc,j}$ and non-picked $item_{out}^{s}$ logistics items (dispatch) [-].

- The company shall check if the measurement is representative of the annual average.
Extended procedure for identifying relevant company-specific allocation factors $\beta_{spec}$ (continued)

- Calculation of the allocation factor $\beta_{spec}^j = \frac{e_{dc}^j}{e_s}$ with

picked items: $e_{dc}^j = \frac{\sum_{d_{c,j}} q^i_m \cdot EFA^i_m + \sum_{d_{c,j}} q^i_w \cdot EFA^i_w}{item_{out}^{d_{c,j}}}$ and non-picked items: $e_s = \frac{\sum_s q^i_m \cdot EFA^i_m + \sum_s q^i_w \cdot EFA^i_w}{item_{out}^s}$

Combined warehouse$^{(1)}$
(depending on outgoing logistics items)

- Item $s_{out}$
- Item $d_{c,1}_{out}$
- Item $d_{c,2}_{out}$
- ...  
- Item $d_{c,j}_{out}$

$\text{item}_{out}^s + \sum \text{item}_{out}^{d_{c,j}}$

Allocation share$^{(1)}$

$\%_{item}^s = \frac{\text{item}_{out}^s}{\text{item}_{out}^s + \sum \beta_{spec}^j \cdot \text{item}_{out}^{d_{c,j}}}$

$\%_{dc}^1 = \frac{\beta_{spec}^1 \cdot \text{item}_{out}^{d_{c,1}}}{\text{item}_{out}^s + \sum \beta_{spec}^j \cdot \text{item}_{out}^{d_{c,j}}}$

$\%_{item,j} = \frac{\beta_{spec}^j \cdot \text{item}_{out}^{d_{c,j}}}{\text{item}_{out}^s + \sum \beta_{spec}^j \cdot \text{item}_{out}^{d_{c,j}}}$

Extended approach (2)

$E_{s,mw} = \%_{item}^s \cdot E_{s,mw}$

$E_{1,d_{c,mw}} = \%_{dc}^1 \cdot E_{d_{c,mw}}$

$E_{j,d_{c,mw}} = \%_{item,j} \cdot E_{d_{c,mw}}$

$E_{j} = \%_{item,j} \cdot E_{d_{c,mw}}$

$\text{item}_{total}^s = \text{item}_{out}^s + \sum \text{item}_{out}^{d_{c,j}}$
Content

- General framework
- Procedure
- Screening phase (step 1)
- Calculation of emissions
- Validation of scope

Allocation of emissions

- Step 3.1: Development of sub-sets of emissions
- Step 3.2: Consolidation to allocation coefficients
- Step 3.3: Calculation of allocated emissions
Step 3.2 - Consolidation to allocation coefficients

(1) In case of the assessment of networks with various transshipment sites, sub-sets of emissions of individual sites shall be aggregated in order to create an average value for the network.
Step 3.2 - Consolidation to allocation coefficients for transport

Transport emissions $E_{*,amb}$ and $E_{*,refr}$ are consolidated to allocation coefficients for transport using the relevant transport performance $tkm_{g,amb}^{mode}$ and $tkm_{g,refr}^{mode}$ [tkm or TEU-km] as reference basis.

The mode-specific transport performance is defined by cargo quantity $Q_g$ [t or TEU] multiplied with real transport distance $d_g$ [km] with $tkm = m_g * d_g$.

The mode-specific requirements on data quality as defined in step 2 “Calculation of emissions” shall be used.

In case of multi-modal transport chains, one single reference basis shall be chosen, i.e. either [tkm] or [TEU-km].

\[
\begin{align*}
e_{t,amb}^{road} &= \frac{E_{*,amb}^{road}}{tkm_{g,amb}^{road}} \\
e_{t,amb}^{rail} &= \frac{E_{*,amb}^{rail}}{tkm_{g,amb}^{rail}} \\
e_{t,amb}^{air} &= \frac{E_{*,amb}^{air}}{tkm_{g,amb}^{air}} \\
e_{t,amb}^{sea} &= \frac{E_{*,amb}^{sea}}{tkm_{g,amb}^{sea}} \\
e_{t,amb}^{barge} &= \frac{E_{*,amb}^{barge}}{tkm_{g,amb}^{barge}} \\
e_{t,refr}^{road} &= \frac{E_{*,refr}^{road}}{tkm_{g,refr}^{road}} \\
e_{t,refr}^{rail} &= \frac{E_{*,refr}^{rail}}{tkm_{g,refr}^{rail}} \\
e_{t,refr}^{air} &= \frac{E_{*,refr}^{air}}{tkm_{g,refr}^{air}} \\
e_{t,refr}^{sea} &= \frac{E_{*,refr}^{sea}}{tkm_{g,refr}^{sea}} \\
e_{t,refr}^{barge} &= \frac{E_{*,refr}^{barge}}{tkm_{g,refr}^{barge}}
\end{align*}
\]
Step 3.2 - Consolidation to allocation coefficients for transshipment (1)

**Assumptions**

- The allocation coefficients for transshipment represent mode-specific average values for the whole logistics network (balance scope).
- Each transport order shall obtain transshipment emissions based on the weight of shipments (step 3.3).
- It is a one-time burden, regardless of the actual number of transshipment activities a transport order had.

In a first step, the overall mode-specific transshipment emissions for the logistics network shall be calculated with $E_{*, \text{total}}^{ts, \text{mode}} = \sum_{\text{mode}} E_{*}^{ts, \text{mode}}$.

Transshipment emissions $E_{*, \text{total}}^{ts, \text{mode}}$ are, then, consolidated to allocation coefficients for transshipment using the assigned (mode-specific) transport quantity $Q_{g}^{\text{mode, total}}$ [t or TEU] as reference basis.
Step 3.2 - Consolidation to allocation coefficients for transshipment (2)

// Definition of assigned transport quantity $Q_{g,mode, total}$ [t or TEU]

- The assigned transport quantity refers to the contract of transportation. Here, the amount of goods is usually specified in gross weight of the good [t] or [TEU].
- In case of intermodal transport chains the assigned transport weight needs to be mapped to the main mode, i.e. to the mode with the longest transport distance.
- The mode-specific requirements on data quality as defined in step 2 “Calculation of emissions” shall be used.

\[
\begin{align*}
    e_{ts,road}^{ts} &= \frac{E_{*,total}^{ts,road}}{Q_{g,road, total}} \\
    e_{ts,rail}^{ts} &= \frac{E_{*,total}^{ts,rail}}{Q_{g,rail, total}} \\
    e_{ts,air}^{ts} &= \frac{E_{*,total}^{ts,air}}{Q_{g,air, total}} \\
    e_{ts,sea}^{ts} &= \frac{E_{*,total}^{ts,sea}}{Q_{g,sea, total}} \\
    e_{ts,barge}^{ts} &= \frac{E_{*,total}^{ts,barge}}{Q_{g,barge, total}}
\end{align*}
\]
Step 3.2 - Consolidation to allocation coefficients for warehousing (1)

Warehousing emissions $E_{s,amb}^*$ and $E_{s,refr}^*$ are consolidated to allocation coefficients for warehousing using the relevant average stock level $stock_{amb}$ and $stock_{refr}$.

Procedure for identifying the relevant average stock level:
- Simplified procedure: no further differentiation between goods required, $stock$ [-]
- Differentiated procedure: differentiation between goods required, whereas the company may choose between to options
  - Specification of the average stock level based on floor area, $stock$ [$m^2$]
  - Specification of the average stock level based on volume $stock$ [$m^3$]

The company shall declare the choice made, which shall be used consistently for the warehouse.

Simplified procedure
- Only one type of good is stored in the warehouse or the company assumes an average type of good.
- The company specifies the relevant average stock level $stock_{amb}$ and $stock_{refr}$ [-]

\[
e_{s}^{amb} = \frac{E_{s,amb}^*}{stock_{amb}} \quad e_{s}^{refr} = \frac{E_{s,refr}^*}{stock_{refr}}
\]

(1) No significant differences in e.g. size, stackability or other clients’ requirements
(2) Due to e.g. significant differences in goods sizes (e.g. pallet, box), stackability or other clients' requirements (e.g. blocked areas)
Step 3.2 - Consolidation to allocation coefficients for warehousing (2)

// Differentiated procedure: There are various types of goods stored in the warehouse, that need to be differentiated\(^{(1)}\). Depending whether the types of goods \(i\) differ in area or volume used, the company may choose between two options using the average stock level of the warehouse.

// Besides, the company should elaborate on the appropriate level for describing stock for each type of good \(i\) (e.g. article, group of articles, boxes, loading units).

// For each type of good \(i\) the company shall specify stock levels with:

- Basic information on
  - The amount of material withdrawal per year \(Q_i\) [-]
  - The average storage time \(T_i\) [days] or inventory turnover ratio \(R_i\) [1/ days]

- Derived information on:
  - Stock levels: \(stock_i = \frac{Q_i * T_i}{365 \text{ days}}\) or \(stock_i = \frac{Q_i}{R_i * 365 \text{ days}}\)

// Notes:

- For defining a sub-quantity \(k\) of the total stock levels, the amount of material withdrawal need to specified for each type of good \(i\), in regard to the withdrawal profile of \(k\), i.e. \((Q_i)_k\).

  - \(k\)-specific stock levels: \((stock_i)_k = \frac{(Q_i)_k * T_i}{365 \text{ days}}\) or \((stock_i)_k = \frac{(Q_i)_k}{R_i * 365 \text{ days}}\)

- Storage times or inventory turnover ratios shall represent annual averages of the warehouse.

- Calculation principles apply to ambient and refrigerated warehousing.

---

\(^{(1)}\) E.g. significant differences in goods sizes (e.g. pallet, box), stackability or other clients’ requirements (e.g. blocked areas)
Differentiated procedure (continued):
Depending whether the types of goods $i$ differ in area or volume used, the company may choose between two options.

(1) Specification of the average stock level based on floor area $stock_{m^2}$ [m$^2$]

- The company specifies for each type of good $i$ the relevant floor area per good $A_i$ [m$^2$] and the average stock level $stock_{i}^{amb}$ and $stock_{i}^{refr}$ [-].

- Calculation of the average stock level based on floor area:
  
  $stock_{m^2}^{amb} = \sum stock_{i}^{amb} \cdot A_i$ and $stock_{m^2}^{refr} = \sum stock_{i}^{refr} \cdot A_i$

(2) Specification of the average stock level based on volume $stock_{m^3}$ [m$^3$]

- The company specifies for each type of good $i$ the relevant volume per good $V_i$ [m$^3$] and the average stock level $stock_{i}^{amb}$ and $stock_{i}^{refr}$ [-].

- Calculation of the average stock level based on volume:
  
  $stock_{m^3}^{amb} = \sum stock_{i}^{amb} \cdot V_i$ and $stock_{m^3}^{refr} = \sum stock_{i}^{refr} \cdot V_i$

---

(1) E.g. significant differences in goods sizes (e.g. pallet, box), stackability or other clients’ requirements (e.g. blocked areas)
Step 3.2 - Consolidation to allocation coefficients for dispatch

Dispatch emissions $E_{s,mw}$ and $E_{dc,mw}$ are consolidated to allocation coefficients for dispatch using the relevant quantity of outgoing logistics items $item^s_{out}$ and $item^dc_{out}$. The differentiated picked logistics items $item^dc_{out}$ shall be consistent with the decisions of step 3.1(1), i.e. if the company uses

a) $\beta = \beta_{default}$ or the simplified approach for $\beta_{spec} \Rightarrow$ simplified consolidation
b) Extended approach for $\beta_{spec} \Rightarrow$ extended consolidation

**Simplified consolidation**
- The company specifies the relevant quantity of outgoing logistics items $item^s_{out}$ and $item^dc_{out}$. 

**Extended consolidation**
- The company specifies for each type of outgoing picked logistics item $j$ the relevant quantity of outgoing logistics items $item^s_{out}$ and the total number of outgoing non-picked logistics items $item^dc_{out}$.

\[
\begin{align*}
e^m_{dc} &= \frac{E_{dc,mw}}{item^dc_{out}} \\
e^s_{mw} &= \frac{E_{s,mw}}{item^s_{out}} \\
e^m_{dc,j} &= \frac{E^dc,mw_{j}}{item^dc_{out}} \\
e^s_{mw} &= \frac{E^s,mw_{j}}{item^s_{out}}
\end{align*}
\]

(1) Cf. step 3.1: Selection of allocation factor order picking $\beta$
Content

- General framework
- Procedure
- Screening phase (step 1)
- Calculation of emissions
- Validation of scope

**Allocation of emissions**

- Step 3.1: Development of sub-sets of emissions
- Step 3.2: Consolidation to allocation coefficients
- Step 3.3: Calculation of allocated emissions
Step 3.3 - Allocation to defined allocation objectives

Calculation of allocated emissions for \( k \)

- Allocated emissions of warehousing and dispatch: \( E_{AO-k}^S \)
- Allocated emissions of transshipments: \( E_{AO-k}^{ts} \)
- Allocated emissions of transport: \( E_{AO-k}^t \)

Data basis for individual allocation objective (AO)\(^{(1)}\)

- Average stock
- Logistics items (dispatch)
- Transport quantity (main mode of transport)
- Transport performance

Total allocated emissions of allocation objective: \( E_{AO-k} \)

\(^{(1)}\) i.e. for individual clients, logistics services, geographical units, organizational units
For the allocation on clients’ level, the relevant data basis covers client-specific $k$ information on

- Transport: 
  \[ (tkm_{g,amb}^{\text{mode}})_k \quad \text{and} \quad (tkm_{g,refr}^{\text{mode}})_k \quad [\text{tkm}] \quad [\text{TEU-km}] \]

- Transshipment: 
  \[ (Q_{g}^{\text{mode,total}})_k \quad [\text{t}] \quad [\text{TEU}] \]

- Warehouse:
  
  - Warehousing
    \[ (stock_{amb}^{\text{amb}})_k \quad \text{and} \quad (stock_{amb}^{\text{refr}})_k \quad [-] \quad \text{or} \]
    \[ (stock_{m^2,i}^{\text{amb}})_k \quad \text{and} \quad (stock_{m^2,i}^{\text{refr}})_k \quad [m^2] \quad \text{or} \]
    \[ (stock_{m^3,i}^{\text{amb}})_k \quad \text{and} \quad (stock_{m^3,i}^{\text{refr}})_k \quad [m^3]. \]
  
  - Dispatch
    \[ (item_{out}^{s})_k \quad \text{and} \quad (item_{out}^{dc})_k \quad [-] \quad \text{or} \]
    \[ (item_{out}^{s})_k \quad \text{and} \quad (item_{out}^{dc,j})_k \quad [-]. \]

  with $i$ types of goods stored in warehouse and with $j$ types of outgoing picked logistics items.
Step 3.3 - Allocation to individual clients

The client-specific emissions \( k \) shall be calculated as follows

\[
E_{\text{client}\_k} = E_{\text{client}\_k}^t + E_{\text{client}\_k}^{ts} + E_{\text{client}\_k}^s
\]

\[
E_{\text{client}\_k}^t = \sum_{\text{mode}} \left( tkm_{g,\text{amb}}^\text{mode} \right)_k \ast e_{t,\text{amb}}^\text{mode} + \sum_{\text{mode}} \left( tkm_{g,\text{refr}}^\text{mode} \right)_k \ast e_{t,\text{refr}}^\text{mode}
\]

\[
E_{\text{client}\_k}^{ts} = \sum_{\text{mode}} \left( Q_{g}^\text{mode, total} \right)_k \ast e_{ts}^\text{mode}
\]

\[
E_{\text{client}\_k}^s = E_{\text{client}\_k}^{s,\text{amb}} + E_{\text{client}\_k}^{s,\text{refr}} + E_{\text{client}\_k}^{s,mw} + E_{\text{client}\_k}^{dc,mw}
\]

with

- \( E_{\text{client}\_k}^{s,\text{amb}} = \left( \text{stock}_{\text{amb}} \right)_k \ast e_{s}^{\text{amb}} \) or \( E_{\text{client}\_k}^{s,\text{amb}} = \sum_i \left( \text{stock}_{m^2,i}^{\text{amb}} \right)_k \ast e_{s,m^2,i}^{\text{amb}} \) or \( E_{\text{client}\_k}^{s,\text{amb}} = \sum_i \left( \text{stock}_{m^3,i}^{\text{amb}} \right)_k \ast e_{s,m^3,i}^{\text{amb}} \)

- \( E_{\text{client}\_k}^{s,\text{refr}} = \left( \text{stock}_{\text{refr}} \right)_k \ast e_{s}^{\text{refr}} \) or \( E_{\text{client}\_k}^{s,\text{refr}} = \sum_i \left( \text{stock}_{m^2,i}^{\text{refr}} \right)_k \ast e_{s,m^2,i}^{\text{refr}} \) or \( E_{\text{client}\_k}^{s,\text{refr}} = \sum_i \left( \text{stock}_{m^3,i}^{\text{refr}} \right)_k \ast e_{s,m^3,i}^{\text{refr}} \)

- \( E_{\text{client}\_k}^{s,mw} = \left( \text{item}_{\text{out}}^s \right)_k \ast e_{s}^{\text{mw}} \)

- \( E_{\text{client}\_k}^{dc,mw} = \left( \text{item}_{\text{out}}^{dc} \right)_k \ast e_{s}^{\text{dc,mw}} \) or \( E_{\text{client}\_k}^{dc,mw} = \sum_j \left( \text{item}_{\text{out}}^{dc,j} \right)_k \ast e_{s}^{\text{dc,j}} \)
Step 3.3 - Allocation to allocation objectives

The procedure for all other allocation objectives are equivalent: Relevant specific $k$ data basis covers

- Transport: \((tkm_{g,amb}^{mode})_k\) and \((tkm_{g,refr}^{mode})_k\) [tkm] [TEU-km]
- Transshipment: \((Q_{g}^{mode,total})_k\) [t] [TEU]
- Warehouse:
  - Warehousing
    \((stock_{amb}^{amb})_k\) and \((stock_{refr}^{refr})_k\) [-] or
    \((stock_{m^2,i}^{amb})_k\) and \((stock_{m^2,i}^{refr})_k\) \([m^2]\) or
    \((stock_{m^3,i}^{amb})_k\) and \((stock_{m^3,i}^{refr})_k\) \([m^3]\).
  - Dispatch
    \((item_{out}^{s})_k\) and \((item_{out}^{dc})_k\) [-] or
    \((item_{out}^{s})_k\) and \((item_{out}^{dc,j})_k\) [-].

with $i$ types of goods stored in warehouse and with $j$ types of outgoing picked logistics items
Step 3.3 - Allocation to allocation objectives

The emissions $k$ for all other allocation objectives (AO) shall be calculated as follows:

$$E_{AO-k} = E_{AO-k}^t + E_{AO-k}^{ts} + E_{AO-k}^s$$

$$E_{AO-k}^t = \sum_{mode}(tkm_{g,amb})_k * e_{t,amb}^mode + \sum_{mode}(tkm_{g,refr})_k * e_{t,refr}^mode$$

$$E_{AO-k}^{ts} = \sum_{mode}(Q_{g,mode,total})_k * e_{ts}^mode$$

$$E_{AO-k}^s = E_{AO-k}^{s,amb} + E_{AO-k}^{s,refr} + E_{AO-k}^{s,mw} + E_{AO-k}^{dc,mw}$$

with:

- $E_{AO-k}^{s,amb} = (stock^{amb})_k * e_{s}^{amb}$ or $E_{AO-k}^{s,amb} = \sum_i(stock^{amb}_{m^2,i})_k * e_{s,m^2,i}^{amb}$ or $E_{AO-k}^{s,amb} = \sum_i(stock^{amb}_{m^3,i})_k * e_{s,m^3,i}^{amb}$

- $E_{AO-k}^{s,refr} = (stock^{refr})_k * e_{s}^{refr}$ or $E_{AO-k}^{s,refr} = \sum_i(stock^{refr}_{m^2,i})_k * e_{s,m^2,i}^{refr}$ or $E_{AO-k}^{s,refr} = \sum_i(stock^{refr}_{m^3,i})_k * e_{s,m^3,i}^{refr}$

- $E_{AO-k}^{s,mw} = (item^{s}_{out})_k * e_{s}^{mw}$

- $E_{AO-k}^{dc,mw} = (item^{dc}_{out})_k * e_{dc}^{mw}$ or $E_{AO-k}^{dc,mw} = \sum_j(item^{dc}_{out})_k * e_{dc,j}^{mw}$

Green Logistics
Parameters and factors

See »Supplement« for the following parameters and factors:

- Passenger transport
  - Average weight parameters $m_{p\ mode}$, $m_{passenger\ mode}$, $m_v^{\ mode}$

- Allocation factor
  - Refrigerated transport $\gamma$, $c_{refr}^{\ mode}$
  - Electricity consumption at combined warehouses $\alpha$, $\alpha_{default}$
  - Order-picking $\beta$, $\beta_{default}$