ENERGY EFFICIENCY AND GHG EMISSION INTENSITY VALUES FOR LOGISTICS SITES

Webinar – 3 February 2022

Andrea Fossa
Greenrouter

Jan-Philipp Jarmer
Fraunhofer IML

Kerstin Dobers
Fraunhofer IML

Sara Perotti
Politecnico di Milano

German, Italian and Latin American consortium for resource efficient logistics hubs & transport
## Agenda webinar 03-02-2022
Moderator: Andrea Fossa

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The GILA project is designed to contribute to global efforts in reducing the environmental impact of logistics sites: with view to sustainability in general & GHG emissions in specifically.

The GILA project addresses two main areas of research:

- Best practices & future requirements, services and concepts for sustainable logistics sites within an energy & resource efficient transport chain
- Methodological framework for describing detailed the environmental performance of logistics sites

Involvement of external partners

Project duration 07 / 2020 – 07 / 2023
GILA’s scope for “sustainable logistics sites”

life cycle of a logistics site

Selection of premises, land acquisition & development
- Building shell
- Technical building equipment

Layout & construction (premise, real estate, yard etc.)
- Yard logistics
- Material handling

Operation of site
- Resources & materials
- Emissions

Refurbishment, retrofitting, …
- Renewable energies
- Refrigerants

Revitalization, reuse, recycling & remediation
- Water & waste
- Surface sealing

Sustainable logistic sites aim at realising…
- Carbon neutrality (if not even carbon negative)
- No accidents
- No losses
- Reduced emissions
- Waste reduction via prevention, reduction, recycling, reuse
- Resilient to external effects
- Less surface sealing
- Raised sustainability awareness & behaviour
- Sustainability monitoring & reports

Combines data from WMS and material handling to develop KPIs
MEASURING SUSTAINABILITY PERFORMANCE AT LOGISTICS SITES & OBJECTIVE OF GILA MARKET STUDY 2021

Jan-Philipp Jarmer
Fraunhofer IML

German, Italian and Latin American consortium for resource efficient logistics hubs & transport
Measuring sustainability performance at logistics sites

Life cycle of a logistics site

Selection of premises, land acquisition & development
- building shell
- technical building equipment

Layout & construction (premise, real estate, yard etc.)
- yard logistics
- material handling

Operation of site
- resources & materials
- emissions

Refurbishment, retrofitting, …
- renewable energies
- refrigerants

Revitalization, reuse, recycling & remediation
- water & waste
- surface sealing

Greenhouse gas emissions of site, service, client
Share of renewable energy
Share of on-site generated electricity
Embedded carbon of infrastructure or equipment

Circular products
Share of renewable, recyclable materials
Energy and material efficiency

Share of sealed area

Water footprint of site
Modal split of commuting, inbound transport

Indicators used in relation to relevant functional unit, e.g. throughput, m², employee

…
Focus: GHG emissions of operating logistics sites

Life cycle of a logistics site:

Selection of premises, land acquisition & development
- building shell
- technical building equipment

Layout & construction (premise, real estate, yard etc.)
- yard logistics
- material handling

Operation of site
- resources & materials
- emissions

Refurbishment, retrofitting, …
- renewable energies
- refrigerants

Revitalization, reuse, recycling & remediation
- water & waste
- surface sealing

kg CO₂e of site (annual carbon footprint)

kg CO₂e per m² logistical area

kg CO₂e per m³ temperature controlled area

kg CO₂e per defined service

kg CO₂e per client

kg CO₂e per throughput (tonne, m³, pallet, parcel, TEU …)
Greenhouse gas emission accounting of logistics chains

ISO 14083 scope

transport (all modes) & transhipment sites

ISO/DIS title:
Quantification and reporting of GHG emissions arising from operations of transport chains

planned 11/2022
Greenhouse gas emission accounting of logistics chains

ISO 14083 scope
transport (all modes) & transhipment sites

GILA project’s focus
all logistics sites: terminals, transhipment sites, distribution/fulfilment centres, warehouses, ...

Credit: © Kadmy, William Wang, th-photo, 4th Life Photography, Gui Young Nian, Marco2811, Udo Kroener, Africa Studio, dinostock, Alfonsodetomas, ake1150 - fotolia.com
Categorizing of logistics hubs with view of relevant activities

- Stock-keeping requirement: transhipment, with storage
- Site conditions: ambient, temperature controlled
- Operations: with or without order picking

<table>
<thead>
<tr>
<th>Site type</th>
<th>Ambient</th>
<th>Temperature controlled/mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transhipment site</td>
<td>1.2 kg CO₂e/tonne</td>
<td>(4)* n/a</td>
</tr>
<tr>
<td>Storage + transhipment</td>
<td>5.4 kg CO₂e/tonne</td>
<td>(34)* 11.7 kg CO₂e/tonne</td>
</tr>
<tr>
<td>Maritime container terminal</td>
<td>30.1 kg CO₂e/container moved</td>
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Dobers, Ehrler et al. (2019)

- sample size of Fraunhofer IML market study 2015

Extension of the data base (sample sizes, geographical coverage)
Average values for further sub-categories (related to activities)

see also GLEC framework version 2.0 (2019)
Greenhouse gas emission accounting of logistics chains

ISO 14083 scope: transport (all modes) & transhipment sites

GILA project’s focus: all logistics sites: terminals, transhipment sites, distribution/fulfilment centres, warehouses, ...

today’s focus: transhipment sites, distribution/fulfilment centres, warehouses, ...
Market study „Energy efficiency and GHG emission intensity values for logistics sites“

Objective
- Identify main influencing parameters on energy efficiency and GHG emissions at sites
- Elaborate average GHG emissions intensity values for sites and a reasonable classification scheme for sites

Data collection via questionnaire* (May – November 2021)
- Core information to calculate GHG emissions
- Voluntary approach for more detailed information

“Very little data is available on GHG emissions from the buildings and terminals in which goods are stored, handled and transhipped.”
Alan McKinnon – Decarbonizing Logistics – 2018

Let’s overcome this gap!
Market study „Energy efficiency and GHG emission intensity values for logistics sites“

- Global scope, focus Germany
- Focus Italy
- Focus Latin America

Contact & communication with contact point*
Elaboration of one GILA database (anonymised data)
Overall analysis and elaboration of classification scheme, average values

* All confidential information stays with the chosen contact point of GILA
GILA MARKET STUDY: APPROACH, DATA BASE & RESULTS

Kerstin Dobers
Fraunhofer IML

German, Italian and Latin American consortium for resource efficient logistics hubs & transport
Date base of GILA market study 2021

In total 159 sites

152 sites refer to balance year 2020

2.58 Mio. m² logistical area indoors

110 Mio. tonnes outgoing goods

Selection of main activities:

“At the site ….

► … transhipment is the main service (>80% of volume)”

► … both transhipment and warehousing are relevant services”

► … warehousing is the main service (>80% of volume)”
Date base of GILA market study 2021

In total 159 sites
152 sites refer to balance year 2020
2.58 Mio. m² logistical area indoors
110 Mio. tonnes outgoing goods

Data availability varies across participants
Only few provide fully answered additional information & sustainable measures at place
Challenge for interpretation:
- No answer/data could mean both “not relevant” or “not available”
Date base of GILA market study 2021

Number of sites offering …

- Sites with storage offer order picking of goods and supplementary activities

Number of sites per temperature level

- >56% of the participating sites have ambient site conditions
63% of the participating sites are Logistics Service Providers (LSP) and offer their services in multiple sectors.
Which data is needed for calculating GHG emissions?

**Collected data**
- Consumption data
  - Electricity & fuels
  - Refrigerants
  - Transport packaging & waste
- Logistics data
  - Logistics units outbound
  - Size & height of real estate
  - Location

**Annual carbon footprint (CF)**
- Total annual CF of logistics site
  - kg CO₂e / a

**Emission intensity values**
- Average values
  - kg CO₂e / tonne
  - kg CO₂e / m²
  - kg CO₂e / m³ real estate

**Emission factors (ef)**
- Electricity (IEA 2021)(1)
  - Location based approach (national electricity mix)
    - a. Location based approach (national electricity mix)
      - Sweden
      - Italy
      - Germany
      - EU-28
      - World
      - [g CO₂e/kWh]
- Other fuels (EN 16258, propane BAFU 2019)(2)
- Heating fuels (EcoTransIT: ifeu calculation based on ecoinvent)(2)
- Refrigerants (IPCC 2013*; own calculations for mixtures)(3)
- Transport packaging (Defra conversion factors 2021)(4)

(1) indirect emissions from generation; (2) direct & indirect emissions from supply; (3) direct emissions; (4) indirect emissions from material use & waste disposal
What are relevant greenhouse gas (GHG) emission sources at logistics sites?

- **88% of the carbon footprint**\(^{(1)}\) of the logistics sites result from **energy use** (electricity, heating, material handling).
- **4%** of the GHG emissions result from **leakage of refrigerants** (estimated by refills).
- **8%** of the GHG emissions are caused indirectly by the use of **transport packaging**\(^{(2)}\).

\(^{(1)}\) national electricity mix
\(^{(2)}\) emissions refer to transport packaging from plastics and cardboard
Energy consumption at sites

Electricity is the main energy source used. Followed by natural gas used for heating, diesel/biodiesel and district heating.
What is the electricity used for?

Allocation to activity clusters

► 50% of the total electricity consumption of the market study has not been allocated to any activity cluster

► 27% of the sites have allocated their electricity consumption to main activity clusters*

Share of electricity consumption per activity cluster [MJ]

- Lighting: 16%
- Goods handling: 11%
- Yard logistics: 22%
- Refrigeration of goods: 0%
- HVAC: 0%
- Data center: 0%
- Other or not allocated: 50%

Temperature level

- Ambient: 90
- Chilled: 21
- Mixed: 34
- Frozen: 3

* i.e. for those site "other or not allocated" is less than 25% of the total kWh of site
Allocation of energy use to energy clusters

- Electricity is the main energy source used
- Further allocation of electricity use is key for identifying efficiency measures
What share do renewable energies have?

- **67% of the total electricity** consumed bases on **greener energy sources** than the national electricity mix
  - 81 sites use electricity that is “greener” than the national mix
- **57 sites** purchase green certificates
- **32 sites** generate their own electricity

- Little info was specified, which “green” electricity is used
41 sites confirmed the use of refrigerants
- thereof 19 ambient sites

**Ammonia** (R-717) is the **most commonly refilled refrigerant**

Share of refilled refrigerant types [kg] regarding site type and temperature level
Use of transport packaging & waste

Number of sites specifying use of transport packaging

- 25% of the sites specified the use of transport packaging
  - with regard to weight: pallets are the dominant material stream used (90%)
  - plastic and cardboard material equal (5%)

Number of sites specifying waste from transport packaging

- 35% of the sites specified waste from transport packaging
  - with regard to weight: cardboard is the main waste stream (68%)
  - wood waste (22%)
  - plastic (10%)
Emission intensity values for logistics sites

**Annual carbon footprint (CF)**
- Total annual CF of logistics site
  - kg CO₂e / a

**Emission intensity values**
- based on throughput
  - kg CO₂e / tonne
  - kg CO₂e / pallet
  - kg CO₂e / m³ goods

- based on site parameters
  - kg CO₂e / m²
  - kg CO₂e / m³ real estate

- ISO 14083:
  - kg CO₂e / tonne

**Suggested categorization of logistics hubs**
- Stock-keeping requirement:
  - transhipment
  - transhipment + storage
  - warehouses

- Site conditions:
  - ambient
  - frozen
  - chilled
  - mixed

**Median values of the GILA market study 2021** (European sites)

<table>
<thead>
<tr>
<th>Work in progress!!</th>
<th>Ambient</th>
<th>Chilled</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transhipment</td>
<td>3.78 kg CO₂e / t</td>
<td>11.14 kg CO₂e / t</td>
<td>3.82 kg CO₂e / t</td>
</tr>
<tr>
<td>Storage + transhipment</td>
<td>2.96 kg CO₂e / t</td>
<td>5.21 kg CO₂e / t</td>
<td>15.56 kg CO₂e / t</td>
</tr>
<tr>
<td>Warehouse</td>
<td>6.11 kg CO₂e / t</td>
<td>6.39 kg CO₂e / t</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*Work in progress!!*
Interim conclusion of the market study 2021

- Approach of the GILA market study* is applicable
  - scope should cover energy consumed, leakage of refrigerants, transport packaging used
  - KPIs feasible (if all relevant data provided)

- Data collection is partly still a challenge
  - electricity: capacity to allocate consumption to activity clusters recommended

- Open tasks for GILA markets study 2022 (balance year 2021)
  - review of survey regarding lessons learnt → focussed/shorter survey
  - clear differentiation of “not available” & “not specified” → better analysis
  - use of online survey planned → enhance accessibility of participants
  - extension of geographical scope, participating companies → larger data base
  - analysis of emissions and sustainability measures at place → recommendations

* aligned with ISO 14083 scope
ENERGY EFFICIENCY MEASURES

Sara Perotti
Politecnico di Milano

German, Italian and Latin American consortium for resource efficient logistics hubs & transport
Energy efficiency measures

23 design variables referred to 6 different areas of intervention

Green building
1) Thermal insulation
2) Loading docks with insulated doors
3) Cool roof
4) Green roof

Utilities
5) Photovoltaic in self-consumption
6) Rainwater collection and reuse systems
7) Solar panels
8) Smart HVAC systems

Lighting
9) LED lamps
10) Natural lighting and white walls
11) Solar tubes
12) Sensors for reducing lighting consumption

Material handling & Automation
13) Lithium-ion batteries
14) Hydrogen forklifts
15) Hybrid forklifts
16) High frequency battery charging
17) Sensors for reducing MHS consumption
18) Energy recovery during braking

Materials management
19) Packaging reduction
20) Packaging reuse / recycle
21) Use of renewable / biological materials

Operational practices
22) Travel distance optimization for MHS
23) Optimal planning for MH activities and battery charging
The solutions adopted mainly refer to **Lighting**, **Green building** and **Utilities**.

Considering the prospective scenario for future investments, **Materials** represent the most promising area, followed by **Operational practices** and **Lighting**.
Energy efficiency measures: «as is» vs. «to be»

- At present, investments are mainly concentrated on **Lighting** technologies (58%), mostly related to LED lamps.
- For the near future, companies are mostly looking at **Operational practices** (i.e., travel distance optimisation for MH systems, optimal scheduling of MH activities and battery charging) and **Materials** management.

* More than one solution can be in place within the same logistics site.
**Green Building**

- **Thermal insulation** and **loading docks with insulated doors** are the most widespread solutions (56%).

- Innovative solutions such as **cool roof** and **green roof** are still scarcely adopted, but are among the priorities for future interventions (26% and 30%, respectively).

![Bar chart showing the adoption rates of different green building solutions.](chart)
Utilities

- **Photovoltaic panels for self-consumption** and **solar panels** are particularly widespread (32%)
- Priorities for **future** interventions seem to **confirm** a marked interest in the implementation of photovoltaic panels (31%), together with smart HVAC systems (29%)

![Bar chart showing utilities distribution]

**AS IS**

<table>
<thead>
<tr>
<th>System</th>
<th>AS IS</th>
<th>TO BE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photovoltaic panels</td>
<td>32%</td>
<td>31%</td>
</tr>
<tr>
<td>Solar panels</td>
<td>32%</td>
<td>19%</td>
</tr>
<tr>
<td>Smart HVAC systems</td>
<td>17%</td>
<td>29%</td>
</tr>
<tr>
<td>Rainwater collection and reuse</td>
<td>20%</td>
<td>21%</td>
</tr>
</tbody>
</table>
Material Handling & Automation systems

- Current adoption is mainly concentrated on forklifts, especially high frequency charging (42%) and energy recovery during braking (29%)

- For the future, growing interest towards hydrogen and hybrid forklifts which, to date, do not appear to be adopted by the companies of the sample
Lighting

- LED lighting is by far the most adopted (44%), followed by sensors for reducing consumption (27%).
- For the future, an increasing attention also towards more recent solutions such as solar tubes (30%).
One of the main levers for companies consists in the **improvement of packaging materials used**, according to two main strategies: adopting more sustainable materials, and working on processes, for instance by enhancing materials reuse and recycle.
Energy efficiency measures
Generated impact vs. criticalities related to implementation

![Diagram showing generated impact vs. criticalities related to implementation]
GILA’S ROADMAP 2022 AND POSSIBILITIES FOR FUTURE PARTICIPATION

German, Italian and Latin American consortium for resource efficient logistics hubs & transport
Parallel market study 2021 with focus on terminals
- publish and discuss results (Uni Andes)

Preparation of next market study 2022
- review of survey
- elaboration of different (more specified) surveys focussing site types (e.g. frozen storage, liquid bulk terminals, …)
- establish online survey
- aim at
  - elaborating average KPI values for selected site types
  - identifying interdependencies of sustainability measures and carbon footprint results
Interested in participating in GILA market study 2022?

► Please contact one of us:

GreenRouter
andrea.fossa@greenrouter.com
sara.perotti@polimi.it

Fraunhofer IML
kerstin.dobers@iml.fraunhofer.de

Universidad de los Andes
Colombia
g.wilmsmeier@uniandes.edu.co

► No matter …

− how many sites you want to contribute
− which country the site(s) is/are located
− which site type the site(s) can be allocated to
− how experienced you may be regarding carbon accounting

Data collection planned for ~ May to September
GILA’s roadmap 2022

► Development of an **online platform “Sustainable Logistics Sites”**
  - Basic information on sustainability measures
  - Provision of templates for data collection (market study) and checklists to self-assess status quo of own sites

► **Site visits** to validate drafted templates and identify best practices

► **Working groups** focussing specific topics (e.g. green IT, green yard)

► **Pilot studies** to e.g. identify impact factors on sustainability performance
  - influence of storage time on energy consumption of single shipment
  - allocation approaches (e.g. at client level)

► **Update of “Guide for GHG emissions accounting at logistics sites”***
  - regarding coming ISO 14083
  - elaborate examples for easier implementation
ENERGY EFFICIENCY AND GHG EMISSION INTENSITY VALUES FOR LOGISTICS SITES

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Thank you for your participation!

Andrea Fossa
Greenrouter

Jan-Philipp Jarner
Fraunhofer IML

Kerstin Dobers
Fraunhofer IML

Sara Perotti
Politecnico di Milano

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References

Dobers, Kerstin; Ehrler, Verena; Davydenko, Igor; Rüdiger, David; Clausen, Uwe (2019): Challenges to Standardizing Emissions Calculation of Logistics Hubs as Basis for Decarbonizing Transport Chains on a Global Scale. In: Transport Research Record 2673 (9). DOI: 10.1177/0361198119844252.


LinkedIn Group of project GILA: https://www.linkedin.com/groups/13969874/