# ENERGY EFFICIENCY AND GHG EMISSION INTENSITY VALUES FOR LOGISTICS SITES

Webinar – 3 February 2022


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# Agenda webinar 03-02-2022

Moderator: Andrea Fossa



| | |
|---|---|
| Welcome and introduction of the project GILA | Andrea Fossa |
| How to measure sustainability performance at logistics sites | Jan-Philipp Jarmer |
| Objective of the GILA market study | |
| GILA market study: approach, data base, challenges | Kerstin Dobers |
| GHG emission results and KPIs | |
| Energy efficiency measures | Sara Perotti |
| GILA's roadmap 2022 and possibilities for future participation | |

# German, Italian and Latin American consortium for resource efficient logistics hubs & transport

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.

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POLITECNICO MILANO 1863

ARCADIS Design & Consultancy for natural and built assets

FERCAM Logistics & Transport

Fraunhofer IML

FLEXILOG SERVIZI LOGISTICI

Prysmian Group

CONAD

P3 LOGISTIC PARKS

Universidad de los Andes Colombia

Involvement of external partners

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

Project duration 07 / 2020 – 07 / 2023

SPONSORED BY THE Federal Ministry of Education and Research

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# GILA's scope for "sustainable logistics sites"

life cycle of a logistics site

| Selection of premises, land acquisition & development | Layout & construction (premise, real estate, yard etc.) | Operation of site | Refurbishment, retrofitting, … | Revitalization, reuse, recycling & remediation |
|---|---|---|---|---|
| building shell | yard logistics | resources & materials | renewable energies | water & waste |
| technical building equipment | material handling | | refrigerants | |
| | | | emissions | surface sealing |

Sustainable logistic sites aim at realising…

- carbon neutrality (if not even carbon negative)
- raised sustainability awareness & behaviour
- no accidents
- use of energy efficient solutions
- reduced emissions
- no losses
- sustainability monitoring & reports
- charging infrastructure for e-vehicles
- less surface sealing
- waste reduction via prevention, reduction, recycling, reuse
- resilient to external effects
- combines data from WMS and material handling to develop KPIs

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# MEASURING SUSTAINABILITY PERFORMANCE AT LOGISTICS SITES & OBJECTIVE OF GILA MARKET STUDY 2021

**Jan-Philipp Jarmer**
Fraunhofer IML

# Measuring sustainability performance at logistics sites

life cycle of a logistics site

| Selection of premises, land acquisition & development | Layout & construction (premise, real estate, yard etc.) | Operation of site | Refurbishment, retrofitting, … | Revitalization, reuse, recycling & remediation |
|---|---|---|---|---|
| | building shell<br>technical building equipment | yard logistics<br>material handling | resources & materials<br>emissions | renewable energies<br>refrigerants | water & waste<br>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

single vs. multiple use

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

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# Focus: GHG emissions of operating logistics sites

life cycle of a logistics site

| Selection of premises, land acquisition & development | Layout & construction (premise, real estate, yard etc.) | Operation of site | Refurbishment, retrofitting, … | Revitalization, reuse, recycling & remediation |
|---|---|---|---|---|
| building shell | yard logistics | resources & materials | renewable energies | water & waste |
| technical building equipment | material handling | emissions | refrigerants | surface sealing |

kg $CO_2$e of site
(annual carbon footprint)

kg $CO_2$e per m² logistical area

kg $CO_2$e per m³ temperature controlled area

kg $CO_2$e per defined service

kg $CO_2$e per client

kg $CO_2$e per throughput
(tonne, m³, pallet, parcel, TEU …)

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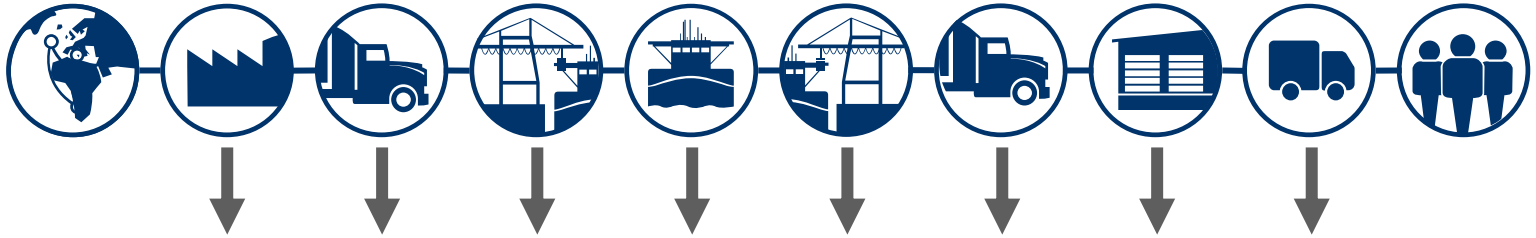
# Greenhouse gas emission accounting of logistics chains





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

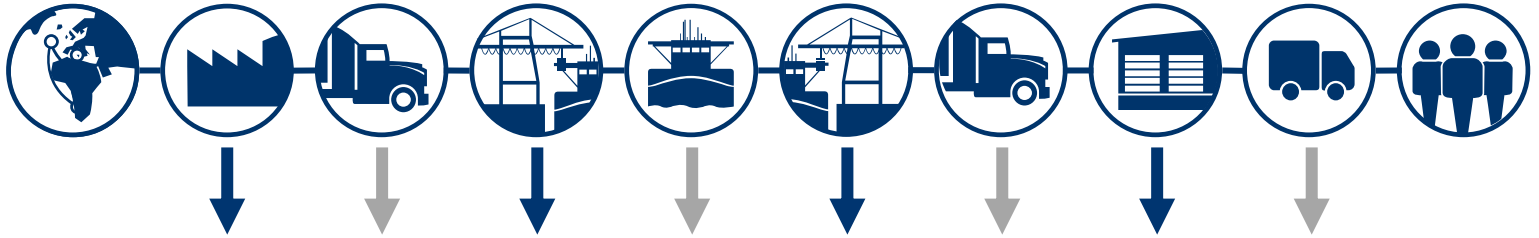
planned 11/2022

**ISO 14083**

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

# 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, … |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# 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


**»Guide for GHG emissions accounting at logistics sites«**

**ISBN 978-3-8396-1434-1**

| Site type | Ambient | | Temperature controlled/mixed | |
|---|---|---|---|---|
| Transhipment site | 1.2 kg $CO_2$e/tonne | (4)* | n/a | |
| Storage + transhipment | 5.4 kg $CO_2$e/tonne | (34)* | 11.7 kg $CO_2$e/tonne | (15)* |
| Maritime container terminal | 30.1 kg $CO_2$e/container moved | | | |

Europe

Dobers, Ehrler et al. (2019)

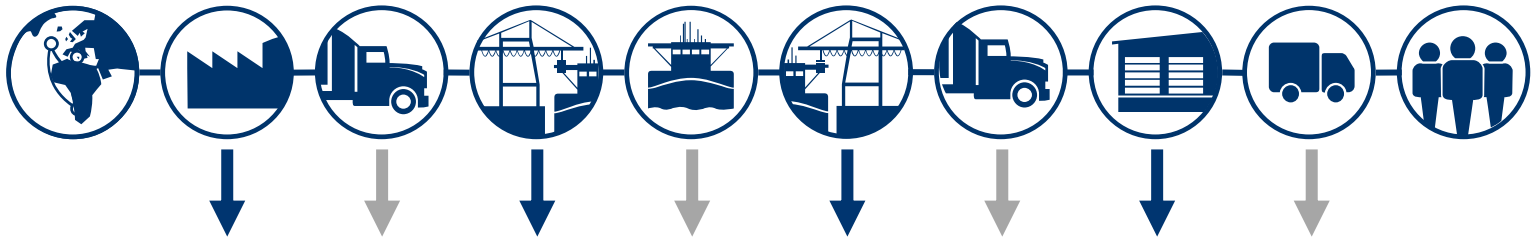
* sample size of Fraunhofer IML market study 2015

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, ... |

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# 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

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Italy

Fraunhofer IML
Germany

Universidad de los Andes
Colombia

“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

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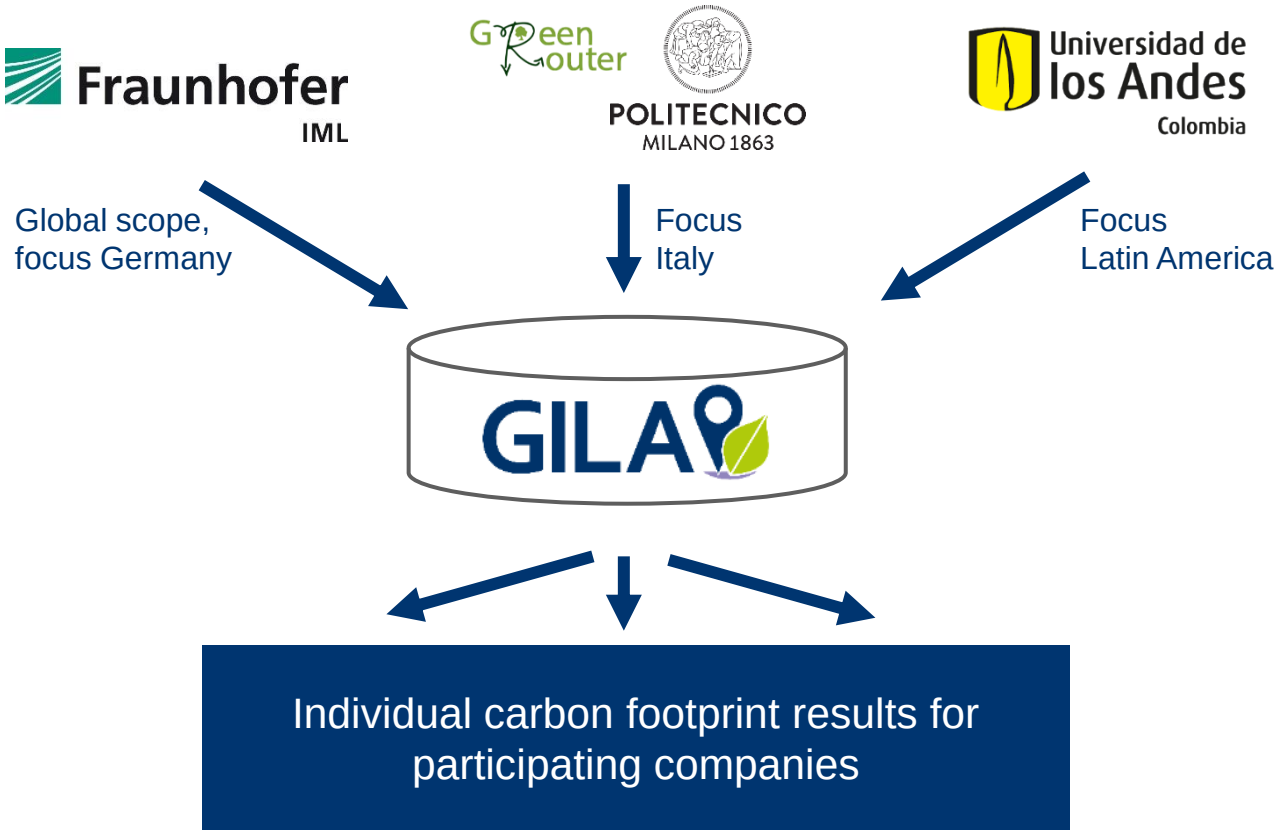
**Let‘s overcome this gap!**

provided languages. English, German, Italian, Spanish

# Market study „Energy efficiency and GHG emission intensity values for logistics sites“




Contact & communication with contact point*

Elaboration of one GILA database (anonymised data)

Overall analysis and elaboration of classification scheme, average values

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* All confidential information stays with the chosen contact point of GILA

# GILA MARKET STUDY: APPROACH, DATA BASE & RESULTS



**Kerstin Dobers**
Fraunhofer IML

# Date base of GILA market study 2021

In total 159 sites

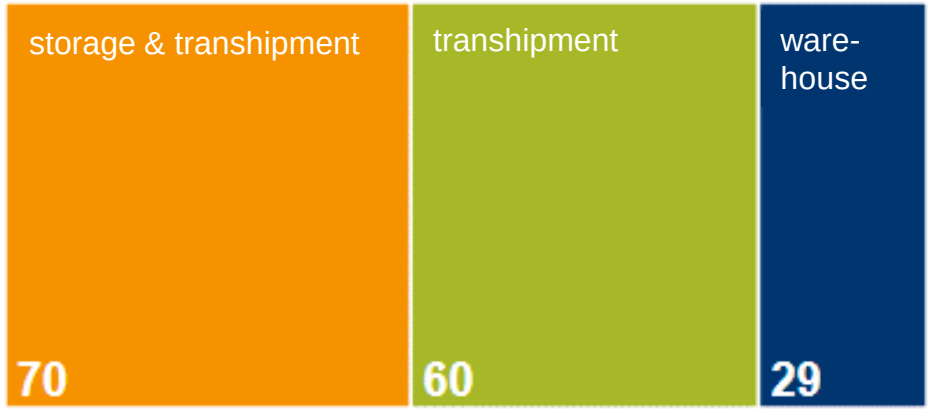
152 sites refer to balance year 2020

2.58 Mio. m² logistical area indoors

113

110 Mio. tonnes outgoing goods

111





159

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)”

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# Date base of GILA market study 2021

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152 sites refer to balance year 2020

2.58 Mio. m² logistical area indoors

113

110 Mio. tonnes outgoing goods

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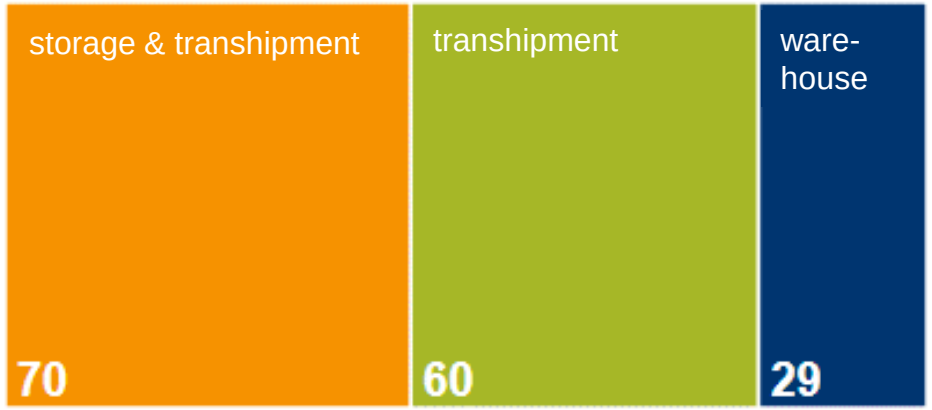



159

- 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**”

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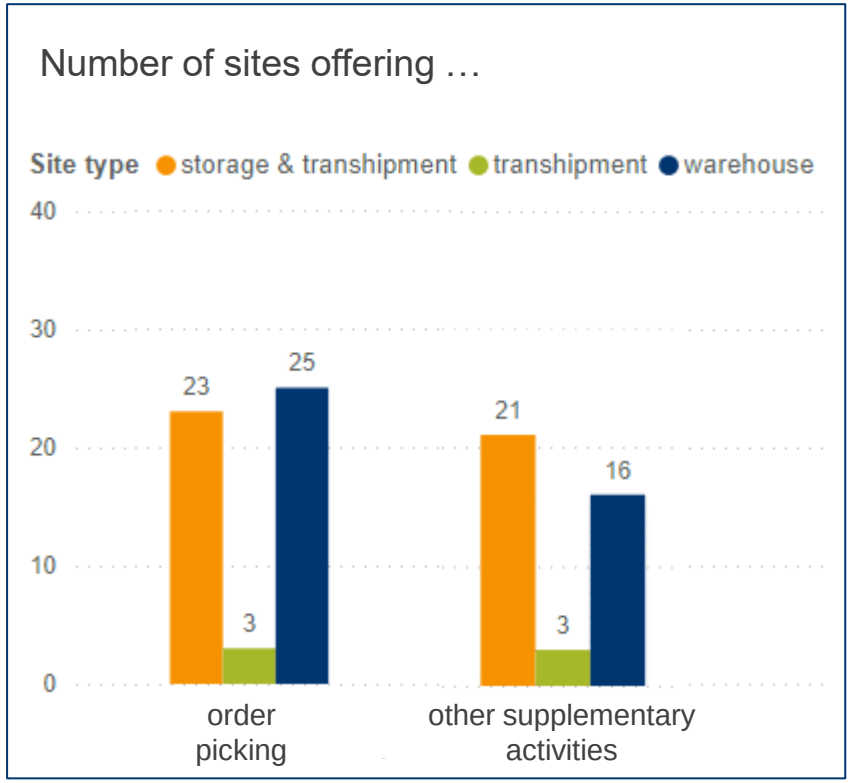
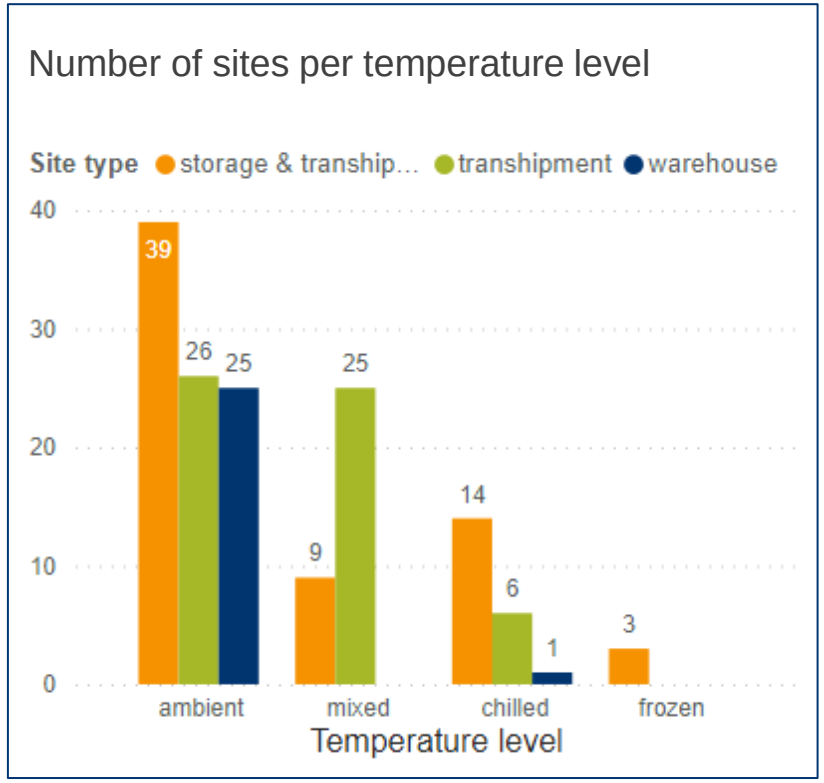
# Date base of GILA market study 2021




118

61

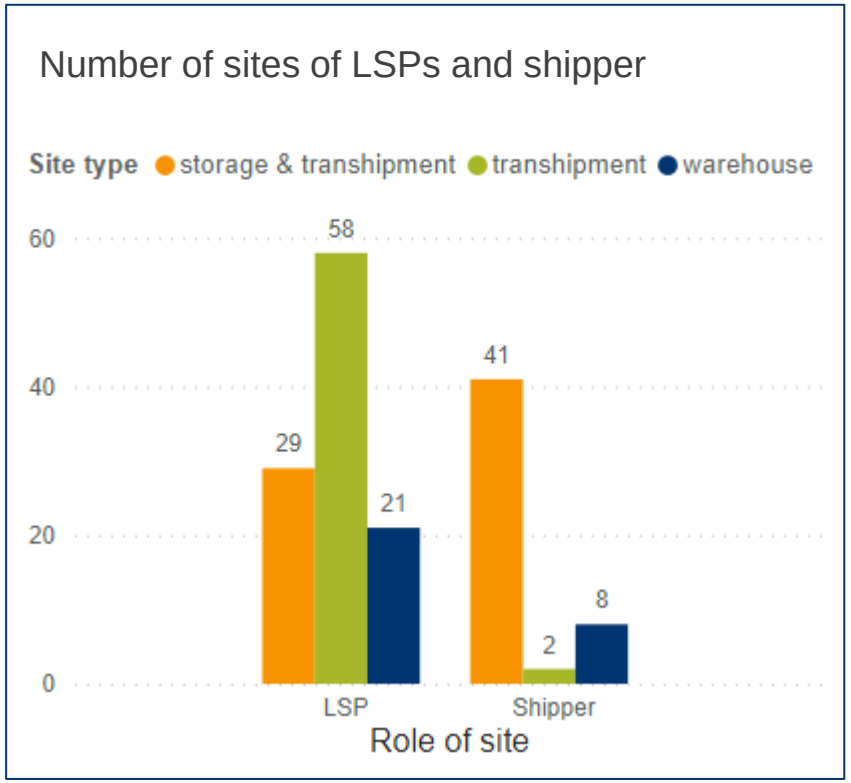
- Sites with storage offer order picking of goods and supplementary activities




148

- >56% of the participating sites have ambient site conditions

# Date base of GILA market study 2021

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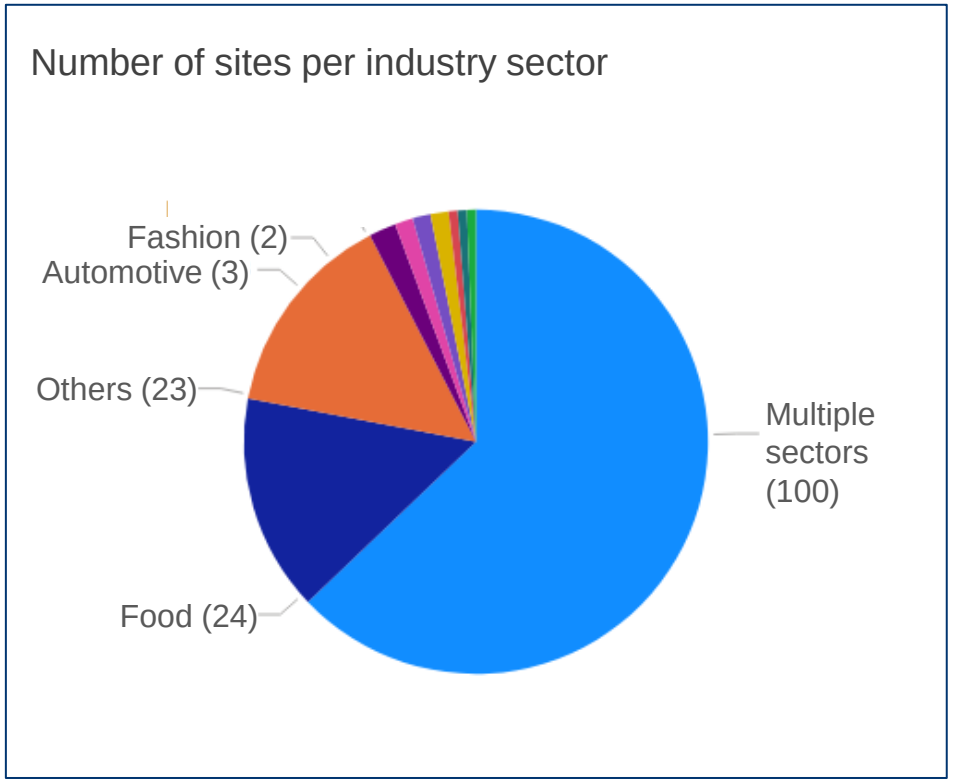


159

- 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 $CO_2$e / a

$$CF = consumption \times ef$$

## Emission intensity values

- Average values

  kg $CO_2$e / tonne

  kg $CO_2$e / m²

  kg $CO_2$e / m³ real estate

## Emission factors (ef)

- Electricity (IEA 2021)(1)
  a. Location based approach (national electricity mix)


- 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)

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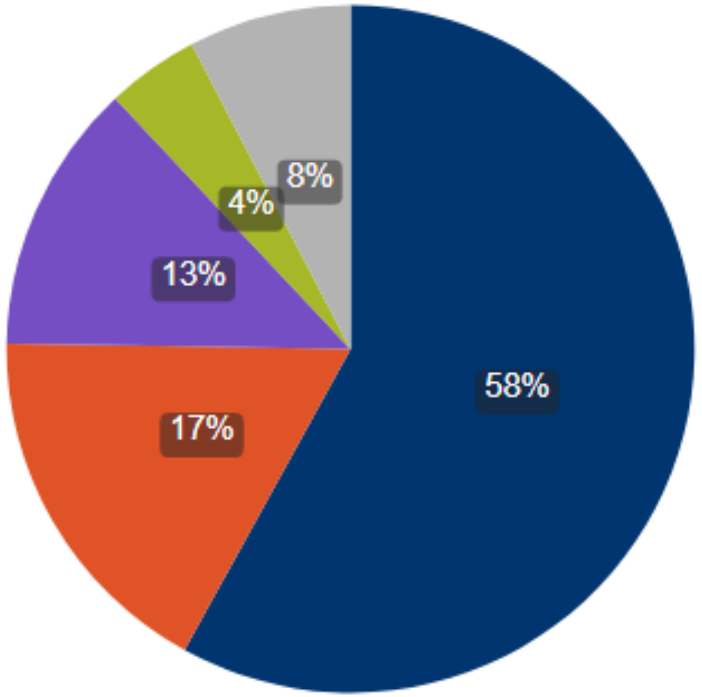
(1) indirect emissions from generation; (2) direct & indirect emissions from supply; (3) direct emissions; (4) indirect emissions from material use & waste disposal

# What are relevant greenhouse gas (GHG) emission sources at logistics sites?




156

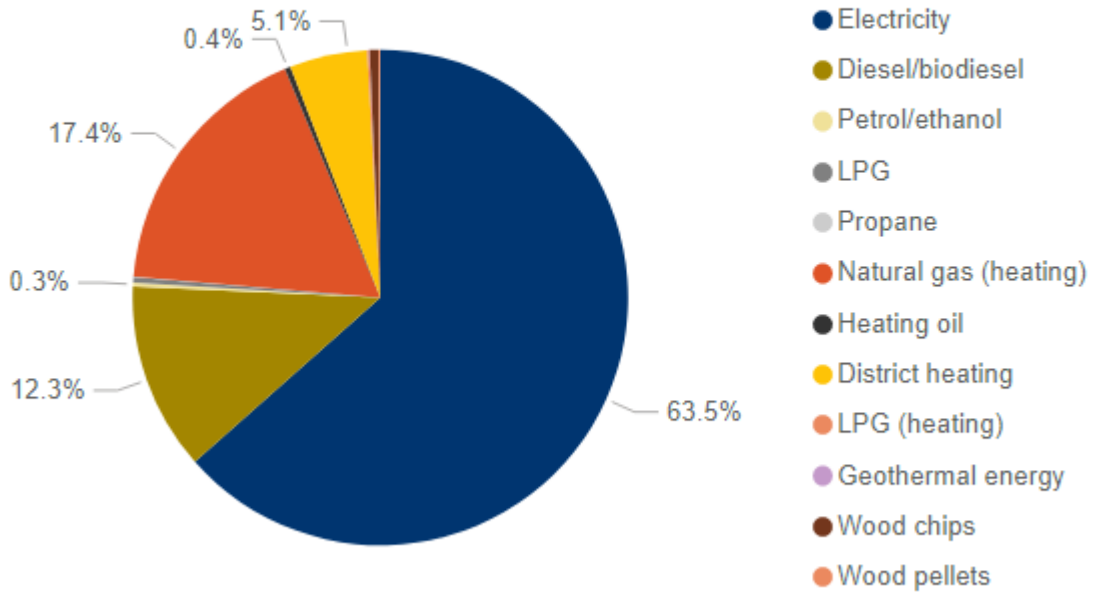
- **88% of the carbon footprint**(1) of the logistics sites result from **energy use** (electricity, heating, material handling)
- **4%** of the GHG emissions result from **leakage of refrigerants** (estimated by refills)
- **8%** of the GHG emissions are caused indirectly by the use of **transport packaging**(2)

Electricity
Material handling (excl. electricity)
Heating fuels (excl. electricity)
Refrigerants
Transport packaging

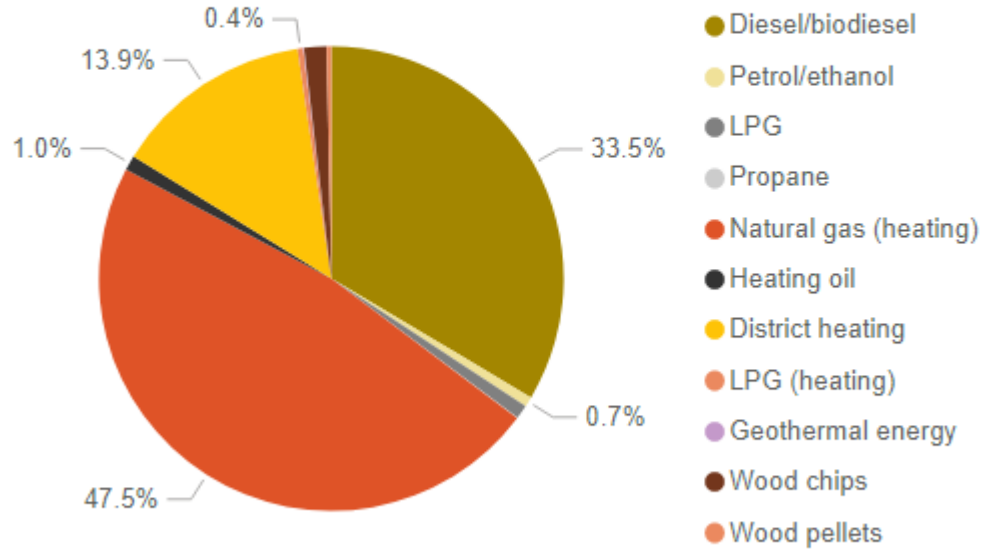
(1) national electricity mix
(2) emissions refer to transport packaging from plastics and cardboard

# Energy consumption at sites

Share of energy consumption [MJ]



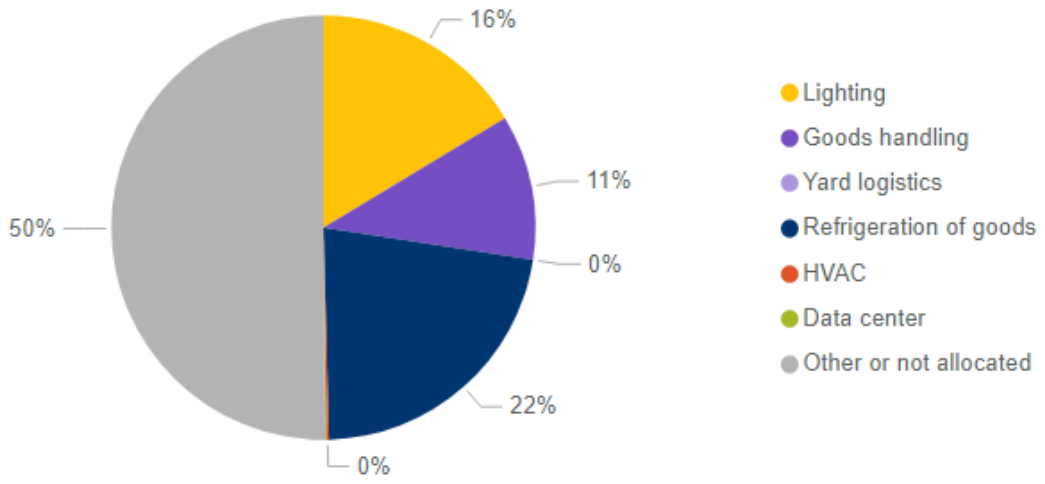

Share of energy consumption excl. electricity [MJ]




- **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

Share of electricity consumption per activity cluster [MJ]




156

- **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*

42

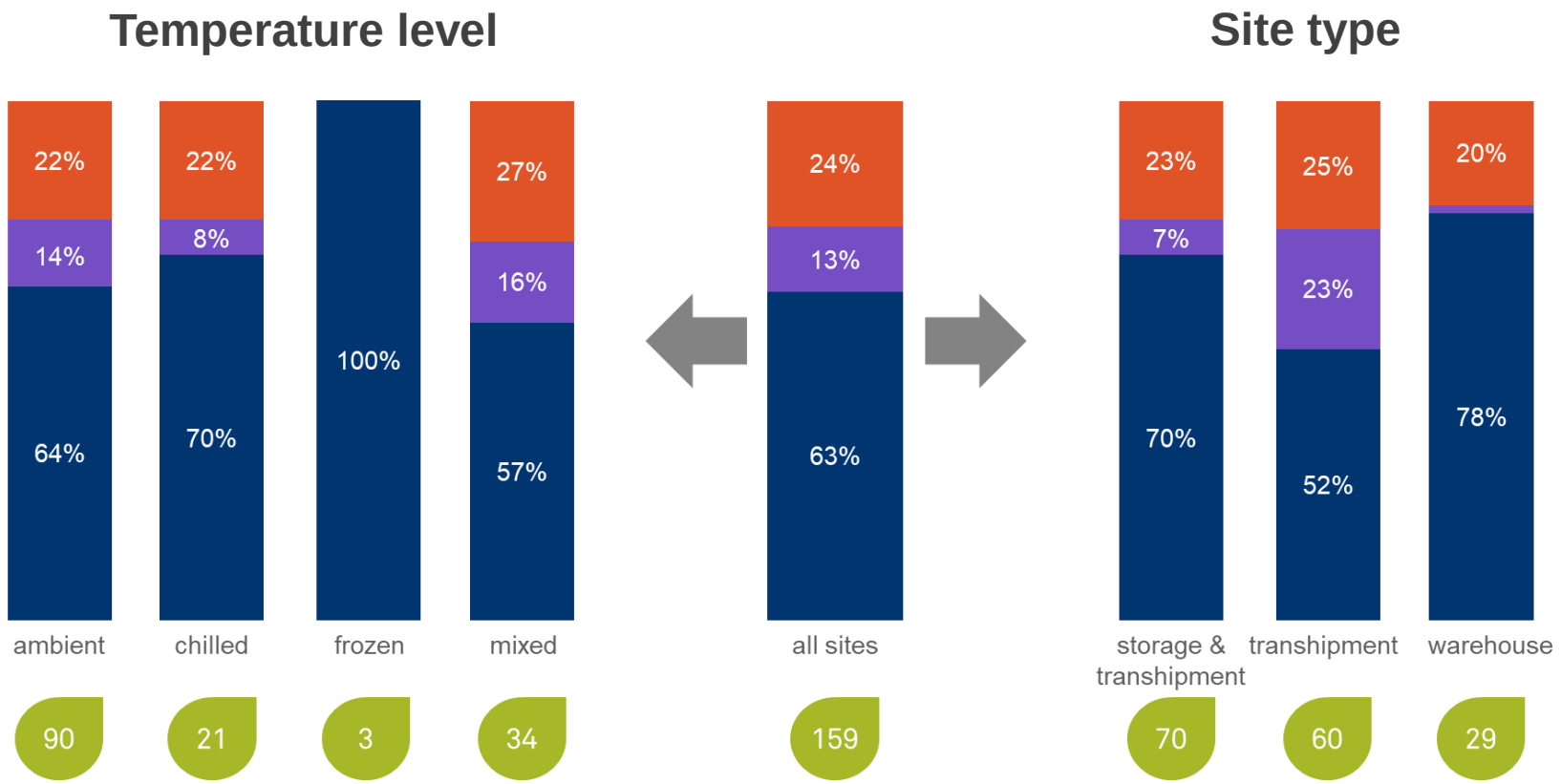
Temperature level


90
21
34
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

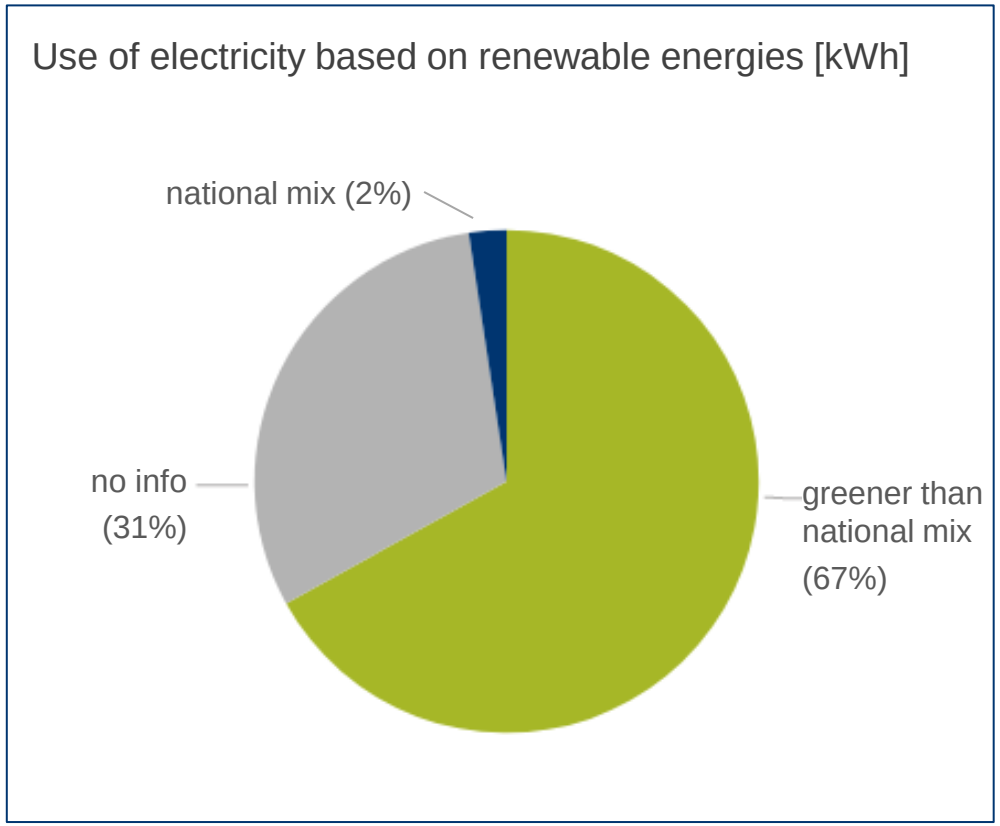





- Electricity is the main energy source used
- Further allocation of electricity use is key for identifying efficiency measures

# What share do renewable energies have?





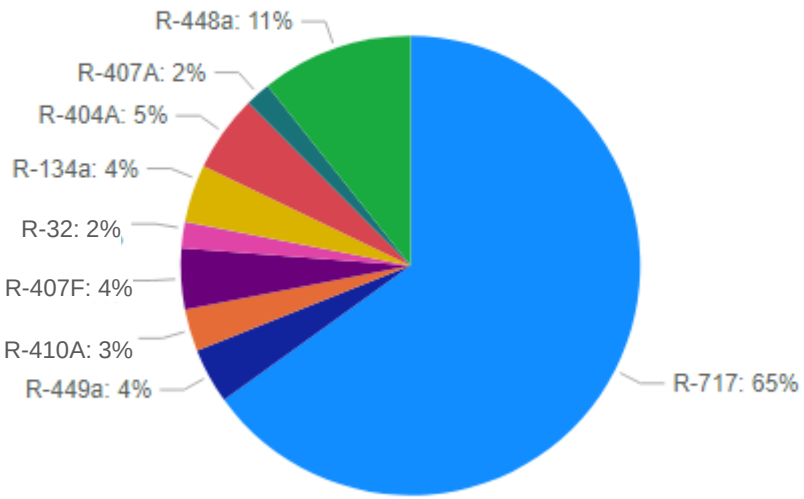

157

- **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

# Use of refrigerants



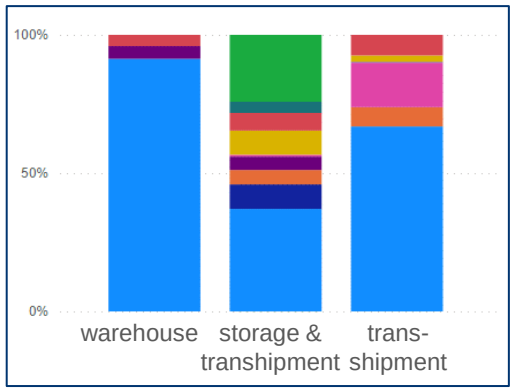
Share of refilled refrigerant types [kg]



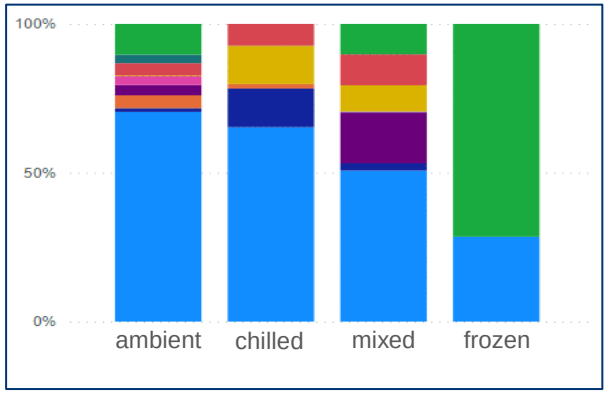

159

- 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



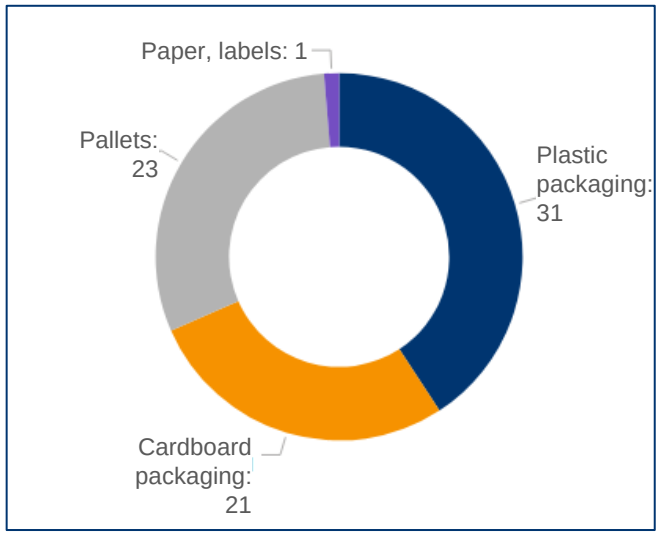

Share of refilled refrigerant types [kg] regarding temperature level



# Use of transport packaging & waste



Number of sites specifying
**use of transport packaging**

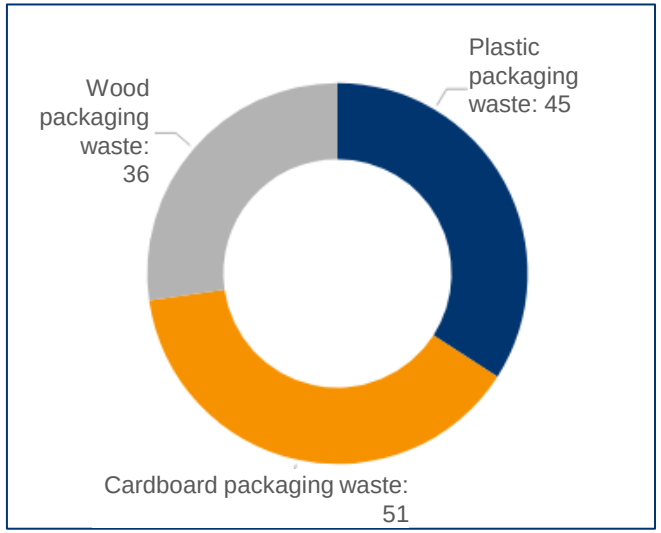



39

- 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**




55

- 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%)

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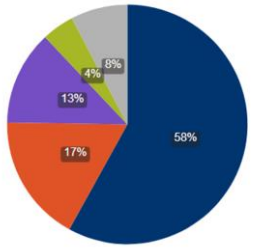
# Emission intensity values for logistics sites




**Annual carbon footprint (CF)**

- Total annual CF of logistics site

  kg $CO_2$e / a

**Emission intensity values**

- based on throughput

  kg $CO_2$e / tonne
  kg $CO_2$e / pallet
  kg $CO_2$e / m³ goods

**Emission intensity values**

- based on site parameters

  kg $CO_2$e / m²
  kg $CO_2$e / m³ real estate

**Suggested categorization of logistics hubs**

- Stock-keeping requirement:
  - transhipment
  - transhipment + storage
  - warehouses
- Site conditions:
  - ambient
  - frozen
  - chilled
  - mixed

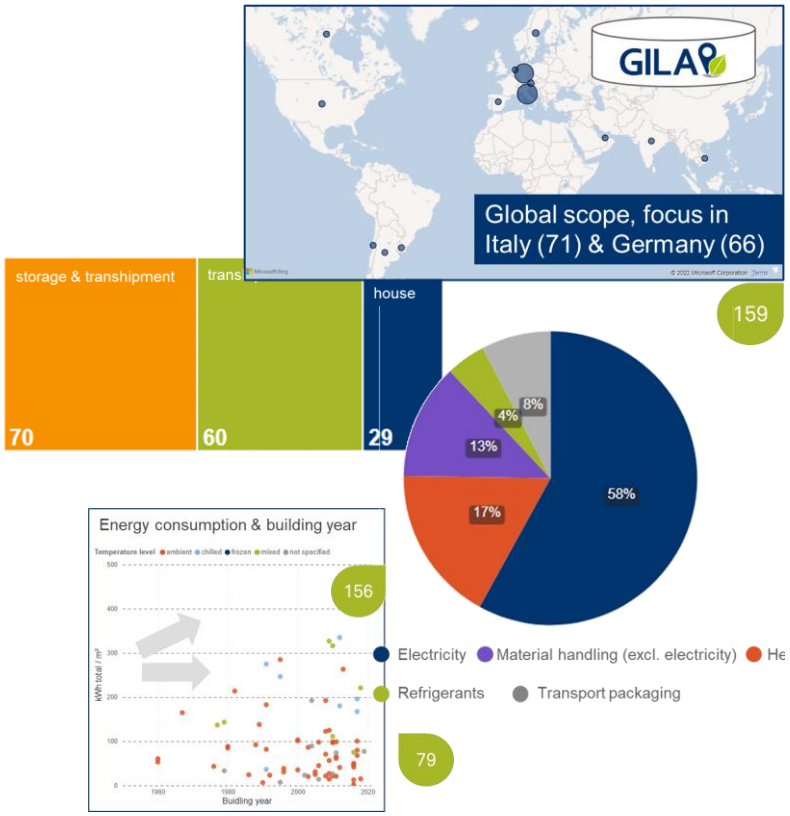
- ISO 14083:
  kg $CO_2$e / tonne

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

| *Work in progress!!* | Ambient | | Chilled | | Mixed | |
|---|---|---|---|---|---|---|
| Transhipment | 3.78 kg $CO_2$e / t | 26 | 11.14 kg $CO_2$e / t | 6 | 3.82 kg $CO_2$e / t | 25 |
| Storage + transhipment | 2.96 kg $CO_2$e / t | 12 | 5.21 kg $CO_2$e / t | 3 | 15.56 kg $CO_2$e / t | 5 |
| Warehouse | 6.11 kg $CO_2$e / t | 19 | 6.39 kg $CO_2$e / t | 1 | n/a | |

# 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

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* aligned with ISO 14083 scope

# ENERGY EFFICIENCY MEASURES



**Sara Perotti**
Politecnico
di Milano

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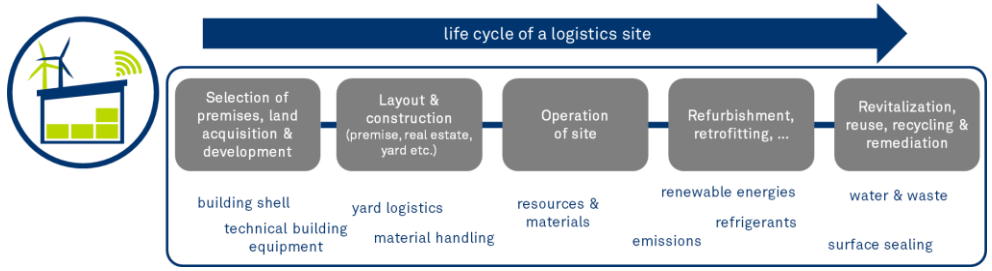
# Energy efficiency measures

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

## Lighting

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

## Materials management

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

## Utilities

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

## 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

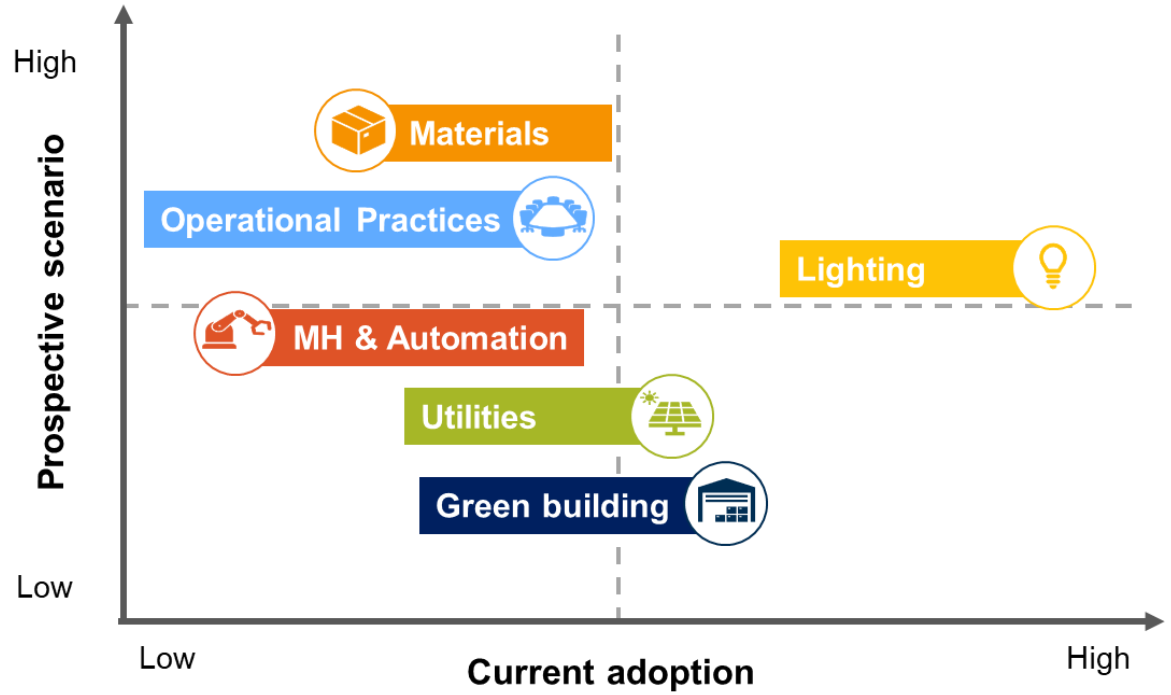
## Operational practices

22) Travel distance optimization for MHS
23) Optimal planning for MH activities and battery charging

HVAC – Heating, ventilation, air conditioning MH .- material handling, MHS – material handling systems

# Energy efficiency measures
# Current adoption vs. Prospective scenario

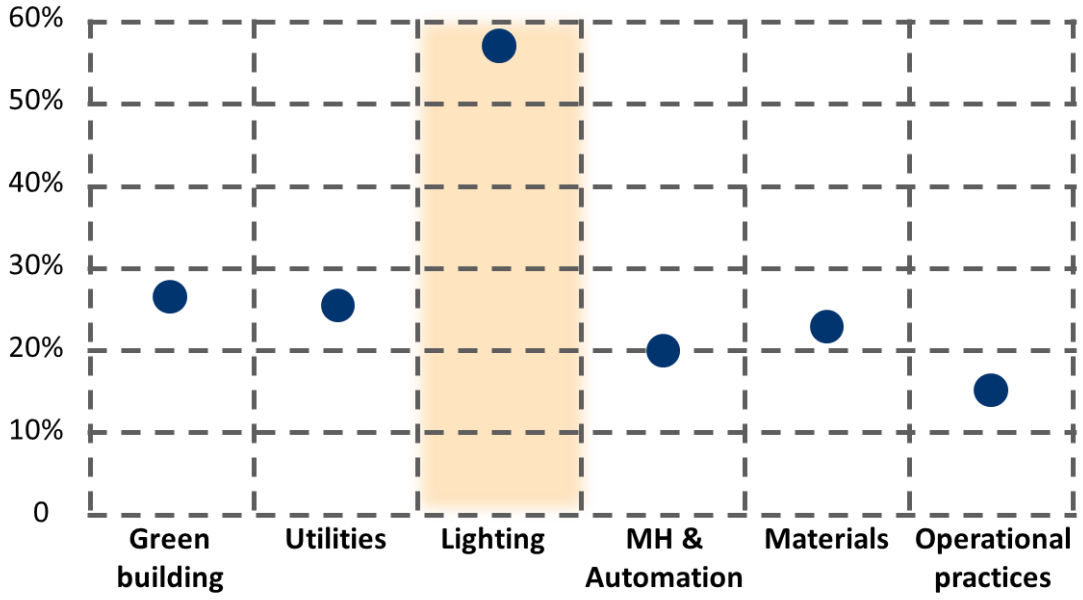
- The solutions adopted mainly refer to **Lighting**, **Green building** and **Utilities**
- Considering the prospective scenario for future investments, **Materials** represent the most promising area, followed by **Operational practices** and **Lighting**



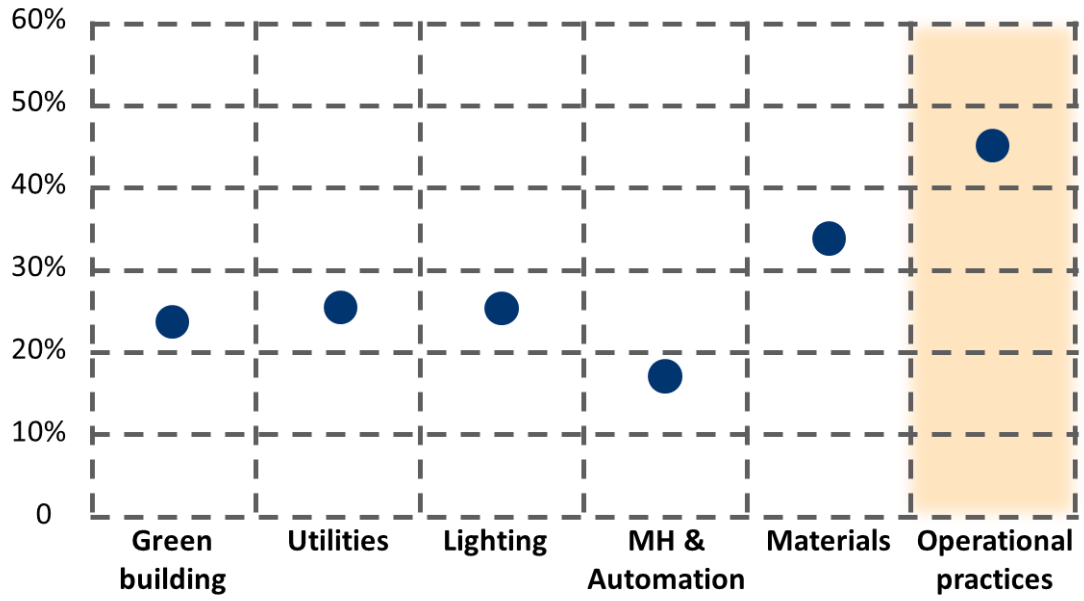
# Energy efficiency measures: «as is» vs. «to be»

- 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

*Current adoption*



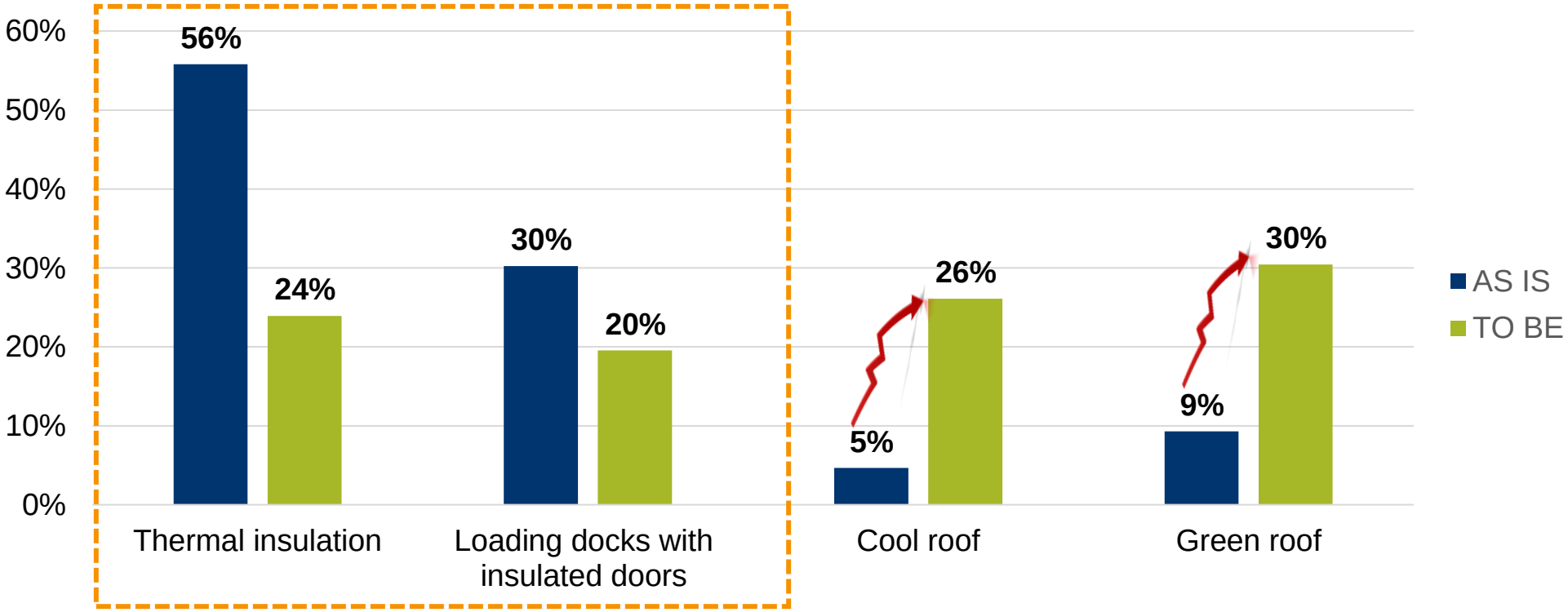

*Prospective interest*




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

# Green Building

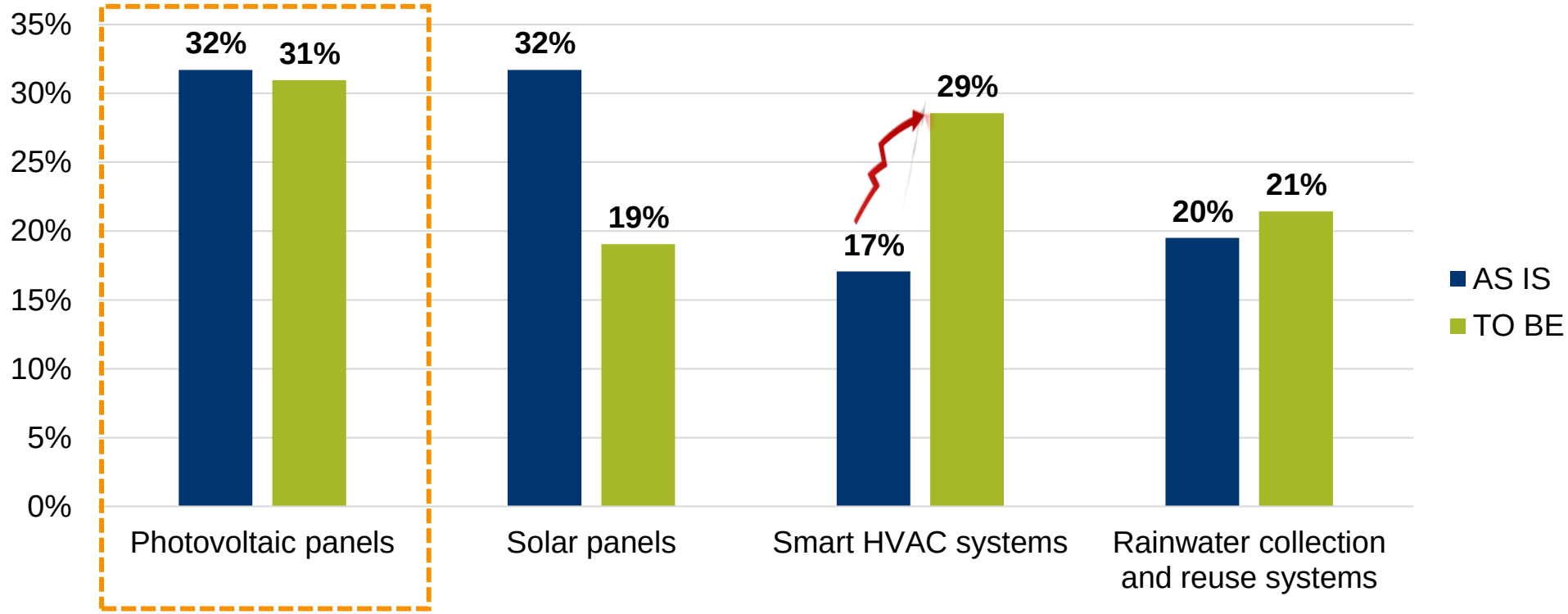
- **Thermal insulation** and **loading docks with insulated doors** are the most widespread solutions (56%)
- Innovative solutions such as **cool roof** and **green roof** are still scarcely adopted, but are among the priorities for future interventions (26% and 30%, respectively)



# Utilities



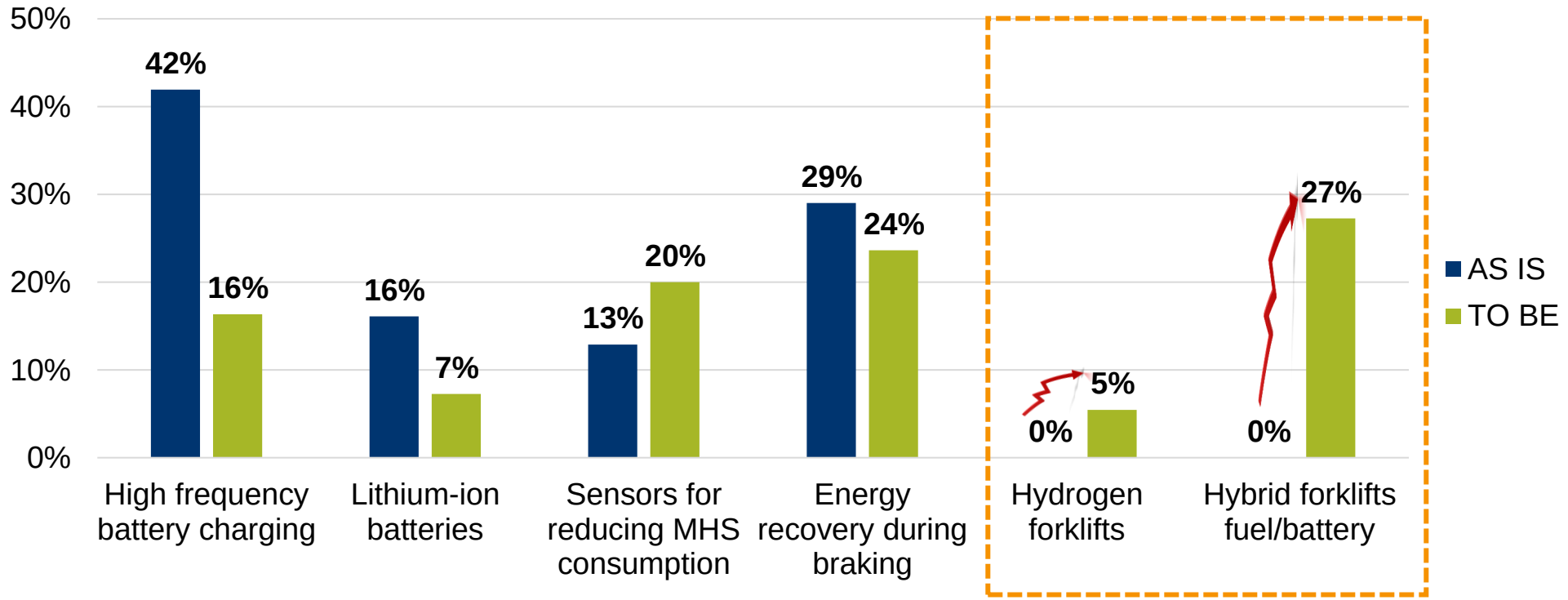
- **Photovoltaic panels for self-consumption** and **solar panels** are particularly widespread (32%)
- Priorities for **future** interventions seem to **confirm** a marked interest in the implementation of photovoltaic panels (31%), together with smart HVAC systems (29%)



# Material Handling & Automation systems

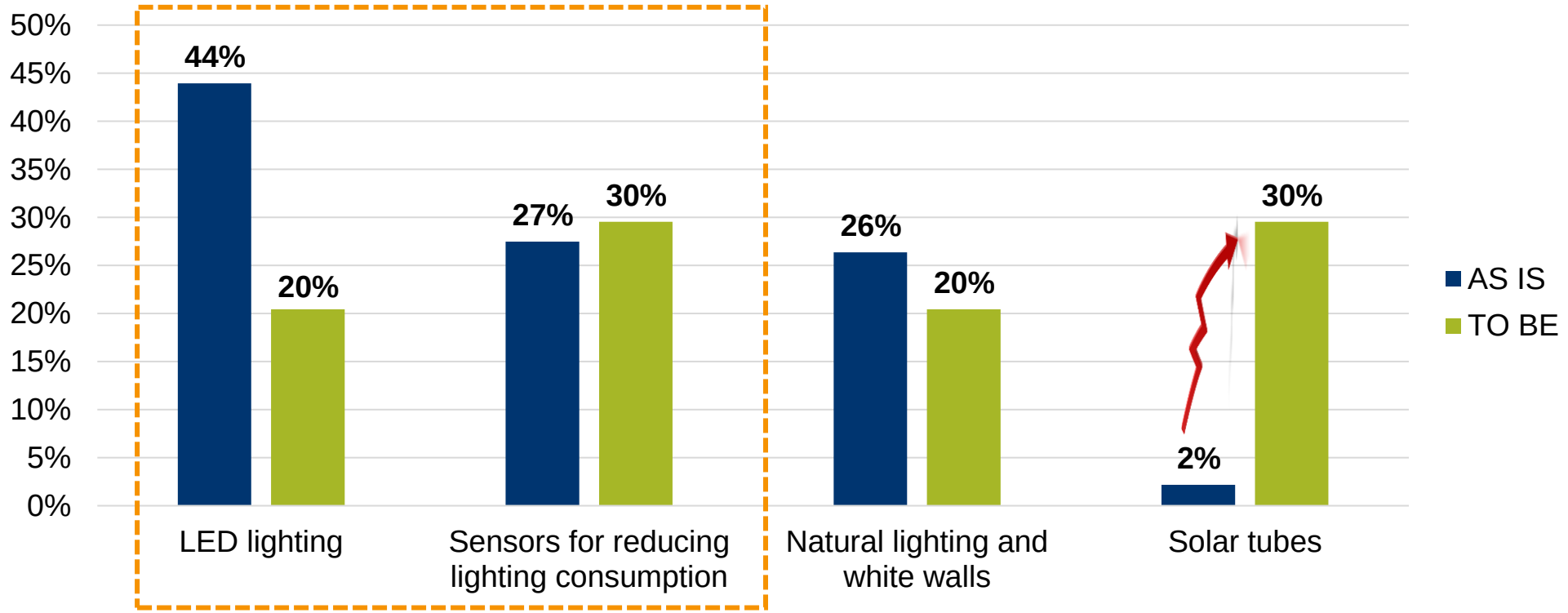


- Current adoption is mainly concentrated on **forklifts**, especially high frequency charging (42%) and energy recovery during braking (29%)
- For the future, growing interest towards **hydrogen and hybrid forklifts** which, to date, do not appear to be adopted by the companies of the sample



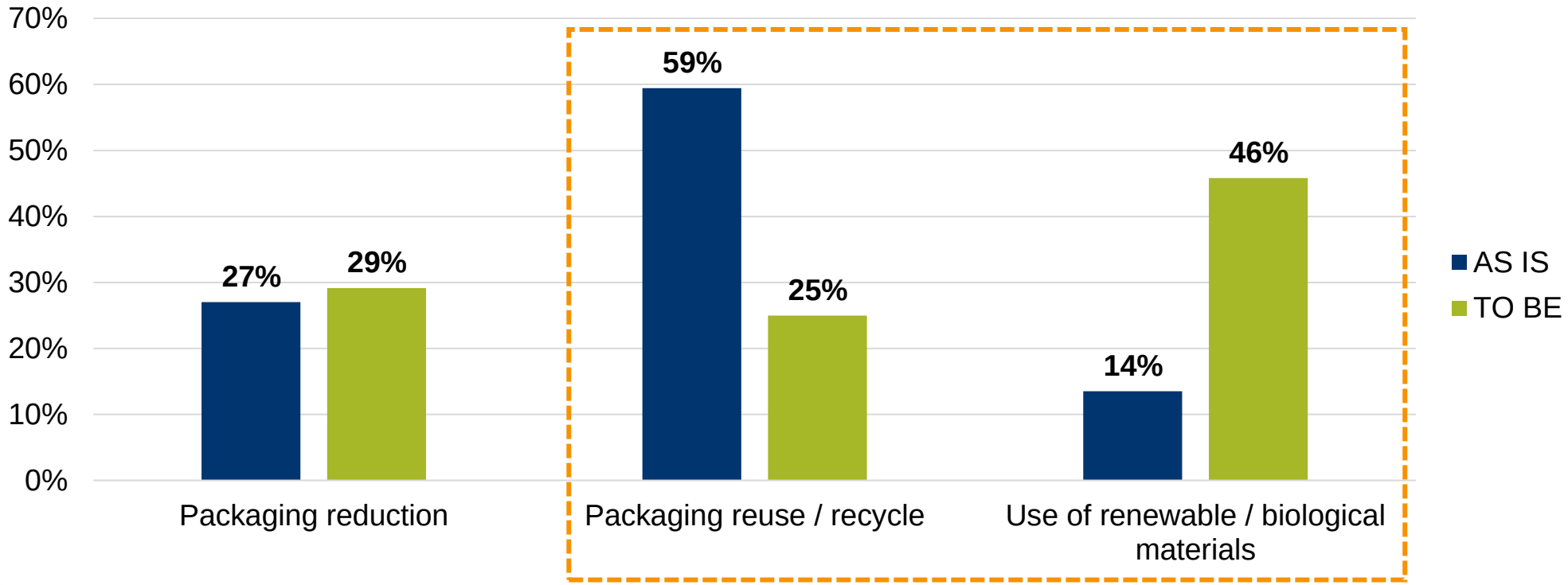
# Lighting

- **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%)**



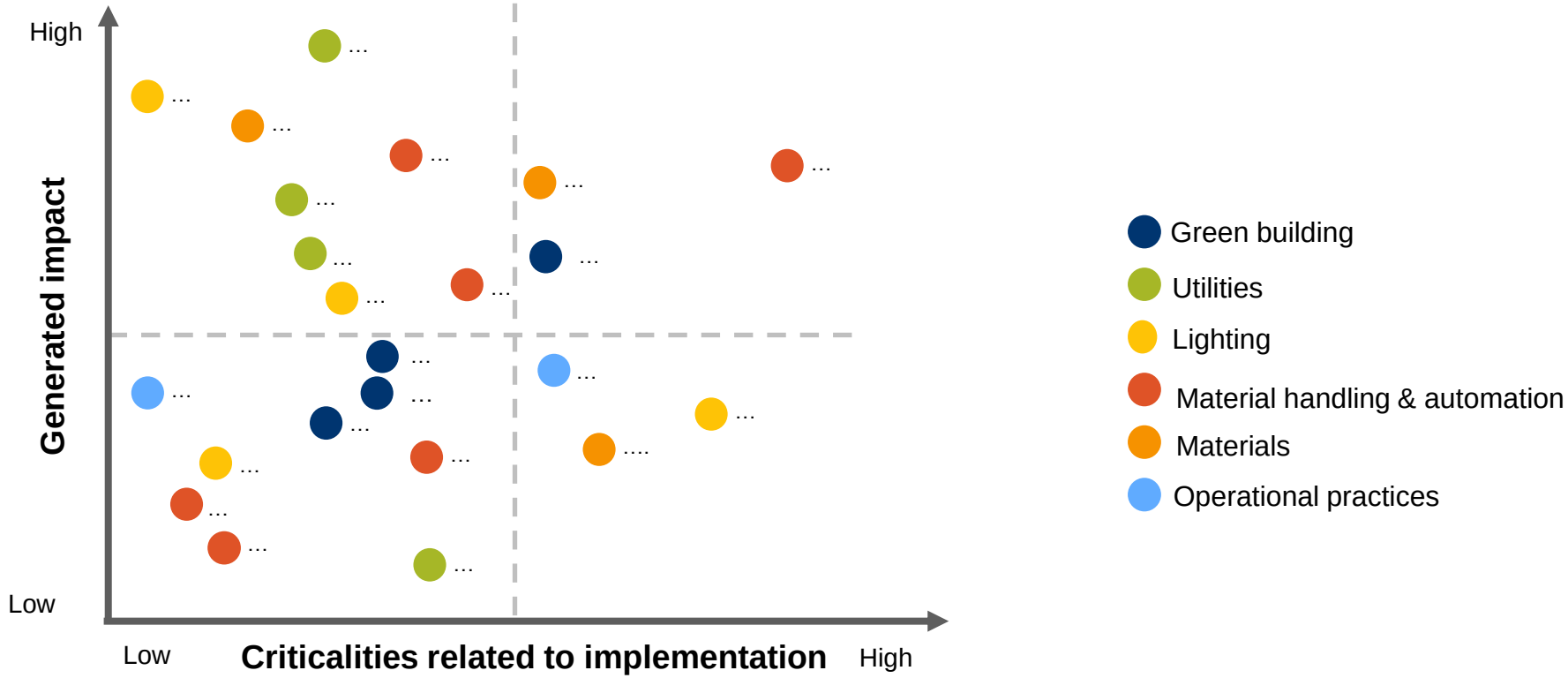
# Materials Management

- 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



# GILA'S ROADMAP 2022 AND POSSIBILITIES FOR FUTURE PARTICIPATION

# GILA market studies

- 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:

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- 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




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# ENERGY EFFICIENCY AND GHG EMISSION INTENSITY VALUES FOR LOGISTICS SITES

Webinar – 3 February 2022

Thank you for your participation!

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