# ENERGY EFFICIENCY AND GHG EMISSION INTENSITY VALUES FOR LOGISTICS SITES

GILA Webinar – 2 February 2023


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Arcadis Deutschland


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# Agenda GILA webinar 02-02-2023

Moderator: Andrea Fossa

| | |
|---|---|
| Welcome and setting the scene:<br>Project GILA & sustainability performance of logistics hubs | Andrea Fossa |
| Set up of the GILA's market studies: Objectives & scope | Jan-Philipp Jarmer |
| Data base and results on GHG emissions and KPIs | Kerstin Dobers |
| Energy efficiency measures | Sara Perotti |
| Sustainable asset tool: Dashboard for logistics hubs | Scarlet Romano |

# 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.

Green Router
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

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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

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 |

**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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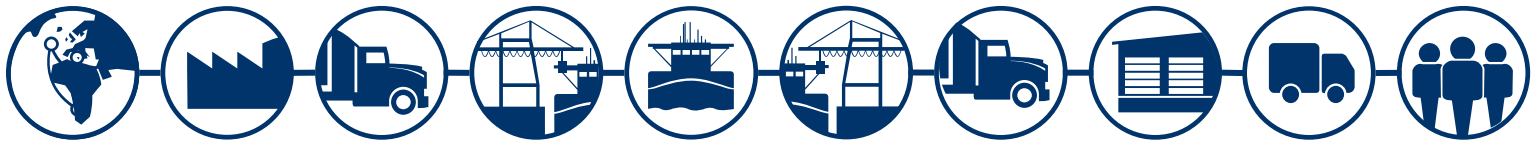
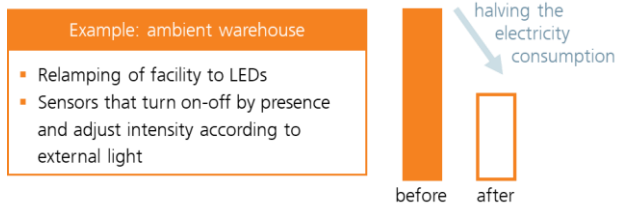
# Motivation for measuring sustainability performance of logistics sites

- Fulfil legal requirements → Avoid that the site becomes a stranded asset !
- Prepare for certification requirements
- Understand own resource consumption for sound investment decisions
- Internal / external benchmarking
- Reduce environmental impact → resource consumption and emissions
- Prepare for clients' requests → GHG KPIs for supply chain calculations






planned 05/2023

**ISO 14083**

ISO/FDIS title:
Quantification and reporting of GHG emissions arising from transport chain operations

# SET UP OF THE GILA'S MARKET STUDIES: OBJECTIVES & SCOPE

**Jan-Philipp Jarmer**
Fraunhofer IML

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

There is still very little data available on environmental performance and GHG emissions reduction potential of logistics sites.

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Italy

Fraunhofer IML

Germany

Universidad de los Andes

Colombia

Thanks to all participating in and supporting this market study!

Let’s overcome this gap!

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

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# Date base of GILA market study 2021 & 2022

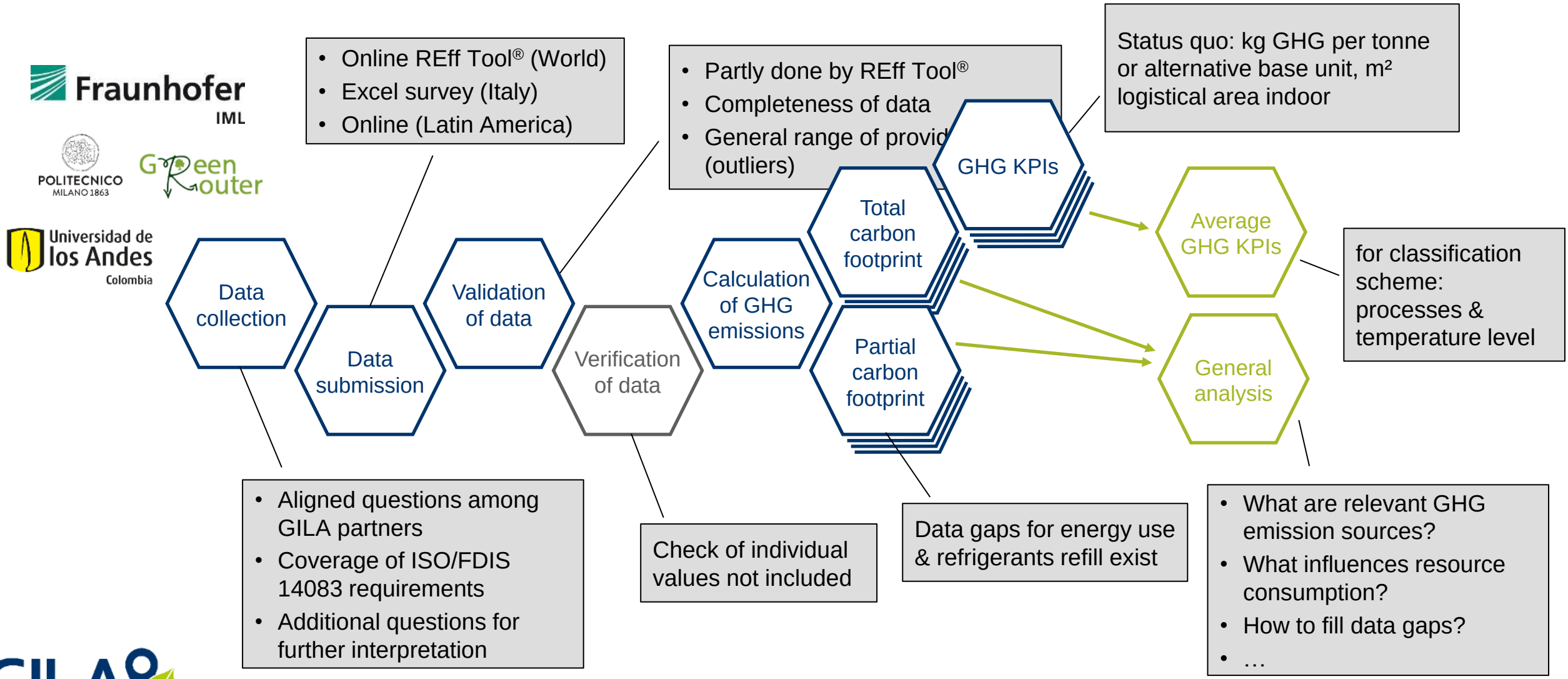


**2021**

- 159 sites
- 14 countries
- > 2.58 Mio. m² logistical area indoors
- > 110 Mio. tonnes outgoing goods
- no terminals


- Changes in market study 2022
  - online survey offering individual questionnaires
  - thus, focus on site type specific questions
  - extension by liquid/dry bulk and RoRo terminals
  - inclusion of qualitative questions
  - introduction of mandatory questions
- Improvement of data base and analysis scheme
- Increase of participating sites by almost factor 4 (market study 2021 → 2022)

# Set-up of GILA‘s market studies

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# From measuring to reducing emissions

Part A

Focus on GHG emissions accounting aligned with ISO/FDIS 14083

Data collection

Data submission

Validation of data

Verification of data

Calculation of GHG emissions

Total carbon footprint

Partial carbon footprint

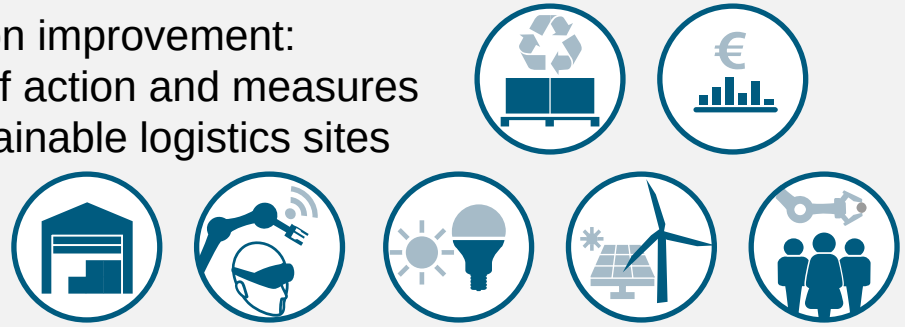
GHG KPIs

Average GHG KPIs

General analysis

Part B

Focus on improvement:
Fields of action and measures for sustainable logistics sites



Share of implement-tation

Status quo

Template for collecting examples

GILA's roadmap

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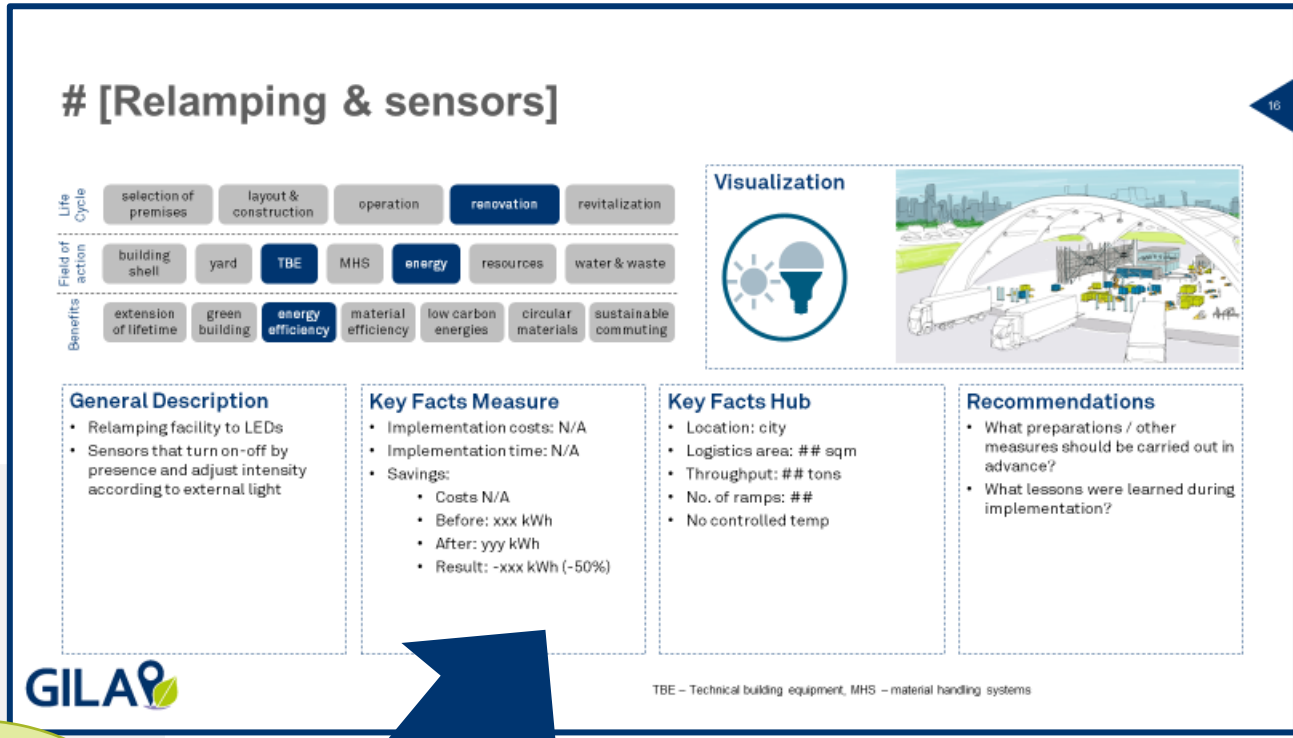
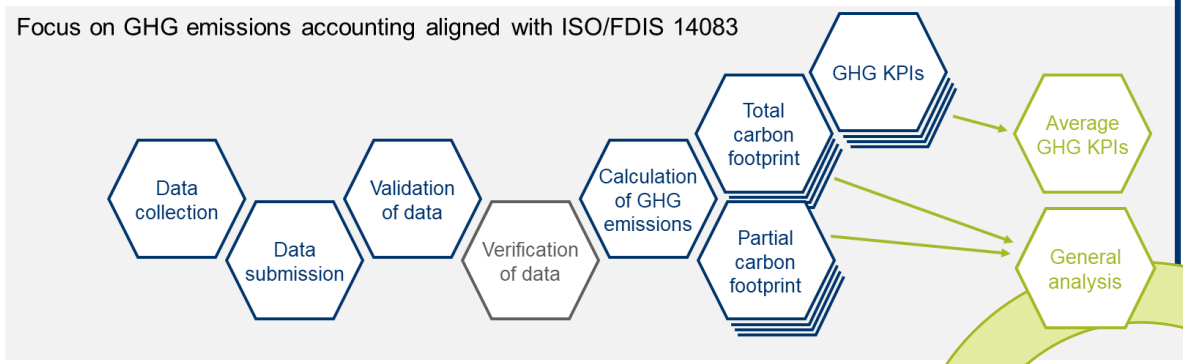
# From measuring to reducing emissions




Let's learn from each other!

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# Which data was submitted by companies?

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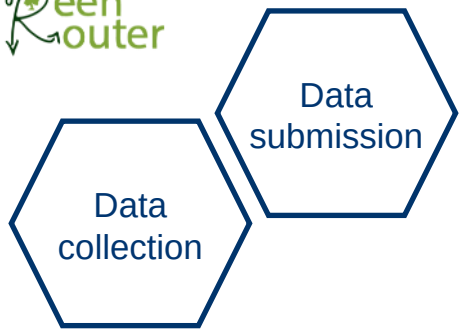


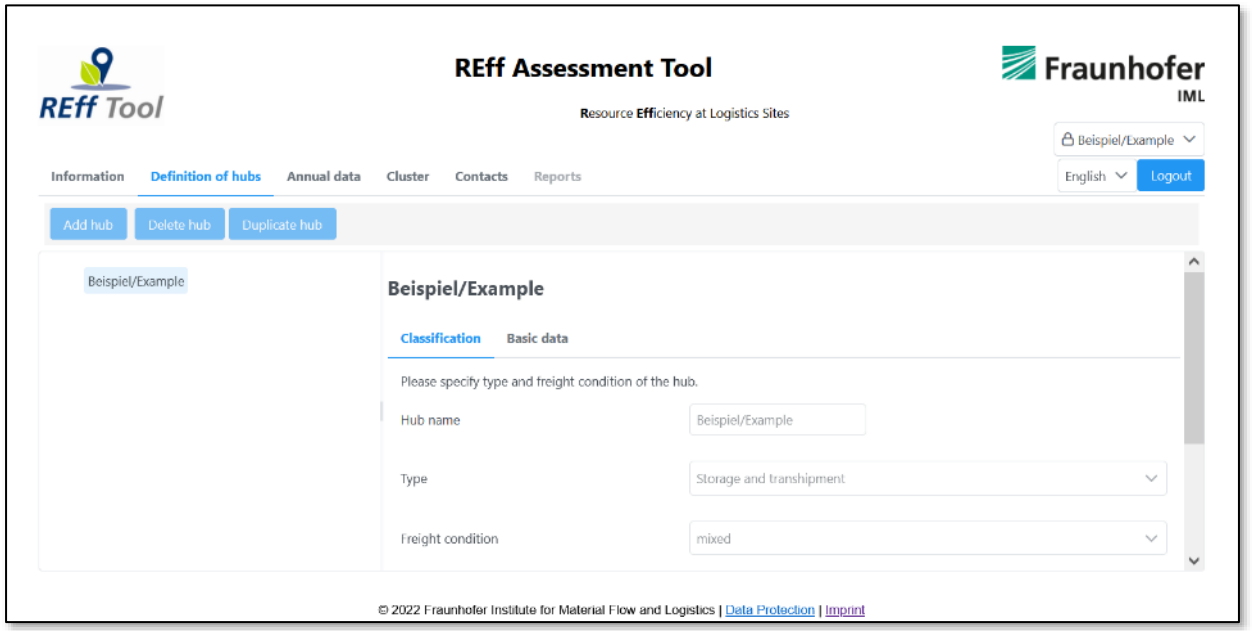


## Classification of site

- **Type**: Transhipment, warehouse, storage and transhipment, container terminal, liquid bulk terminal etc.
- **Temperature level**: ambient, chilled, frozen, mixed

## Basic data

- Location (country), building year, size, operation

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# Which data was submitted by companies?

Fraunhofer IML

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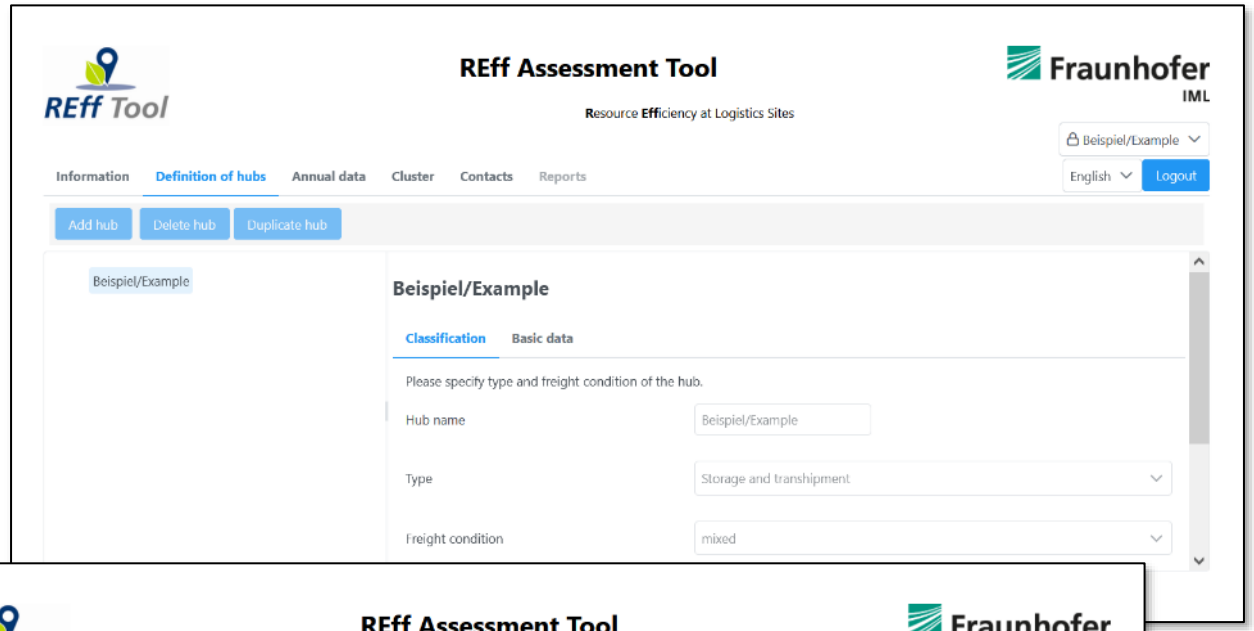
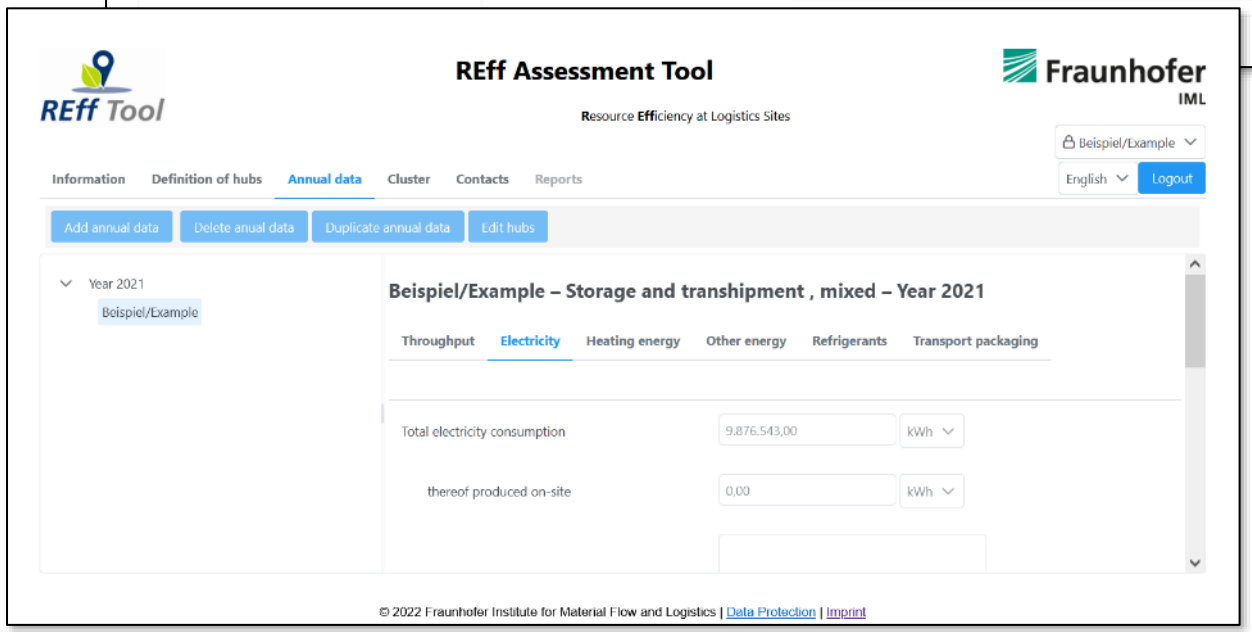
## Annual data

- **Throughput**
- **Consumption**: electricity, heating energy, other energy, refill of refrigerants, (transport packaging)

## Sustainability measures

- Implementation or priorities of 31 measures

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# GILA MARKET STUDY 2022:
# DATA BASE AND RESULTS ON GHG EMISSIONS AND KPIS

**Kerstin Dobers**
Fraunhofer IML

# Date base of GILA market study 2021 & 2022

| 2021 | | | 2022 |
|---|---|---|---|
| 159 sites | 14 countries | x 3.8 | 605 sites | 44 countries |
| > 2.58 Mio. m² logistical area indoors | | x 3.7 | > 9.45 Mio. m² logistical area indoors |
| > 110 Mio. tonnes outgoing goods | | x 0.4 | sites(1): > 44 Mio. t outgoing goods |
| no terminals | | | terminals(2) : > 213 Mio. t outgoing goods |


(1) warehouses & transhipment sites
(2) terminals (container, liquid bulk)

# Sample size: From total number of participants to final KPIs

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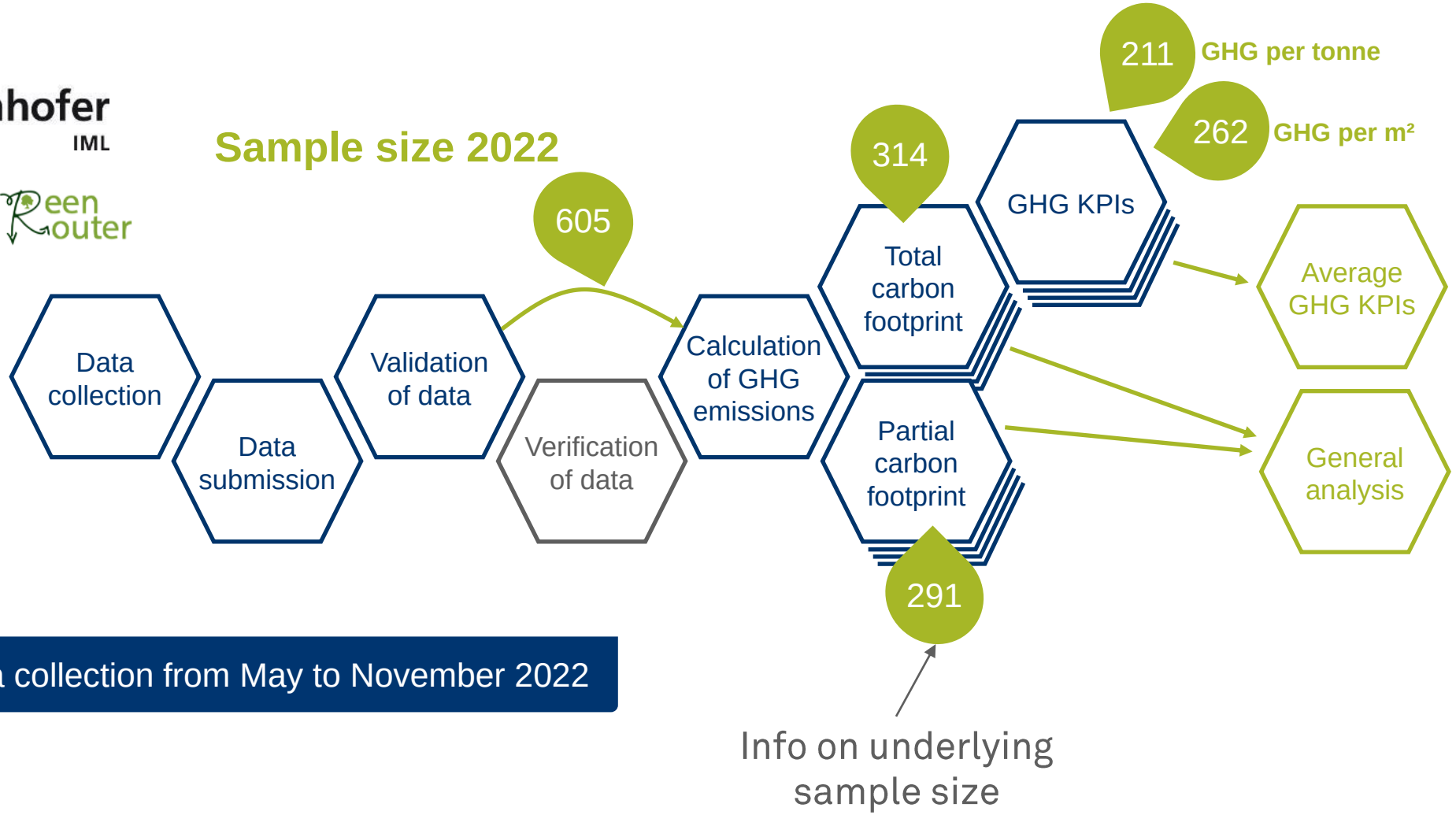
## Sample size 2022




Data collection from May to November 2022

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# Data base of GILA market study 2022

In total 605 sites

44 countries worldwide

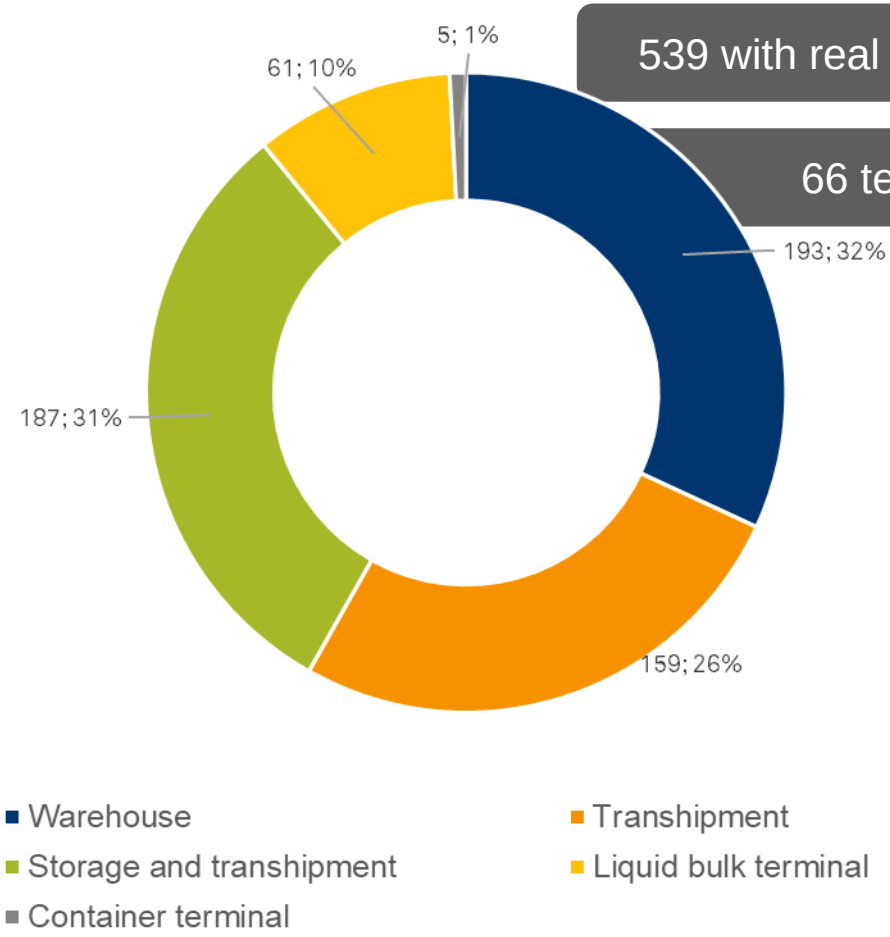
> 9.45 Mio. m² logistical area indoors(1) — 459

sites(1): > 44 Mio. tonnes outgoing goods — 289

terminals(2) : > 213 Mio. tonnes outgoing goods — 56

539 with real estates (1)

66 terminals (2)




## Completeness of data sets(3)

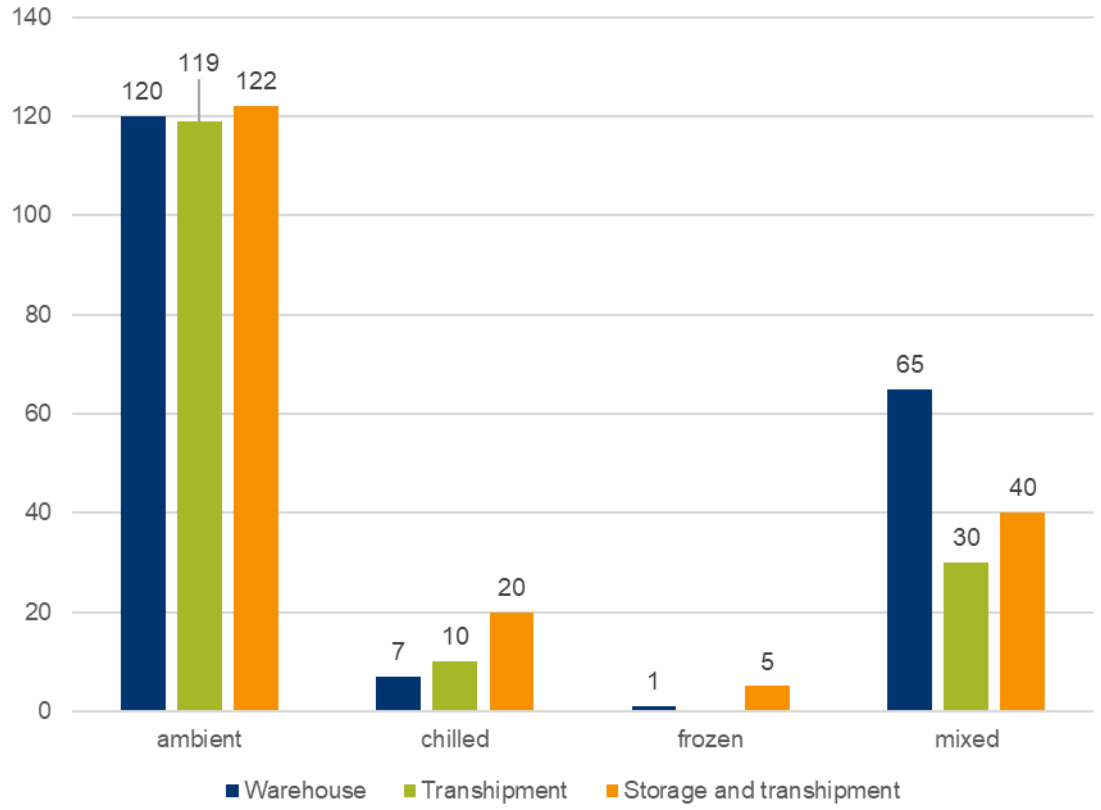
| KPI sample size | kg $CO_2$e/tonne | kg $CO_2$e/m² |
|---|---|---|
| W, T, S+T (1) | 159 | 262 |
| Terminals (2) | 52 | n/a |
| **All** | **211** | **262** |

(3) total carbon footprint, throughput, logistical area indoors

(1) warehouses & transhipment sites
(2) terminals (container, liquid bulk)

# Data base of GILA market study 2022

## Number of sites per category (type, temperature level)

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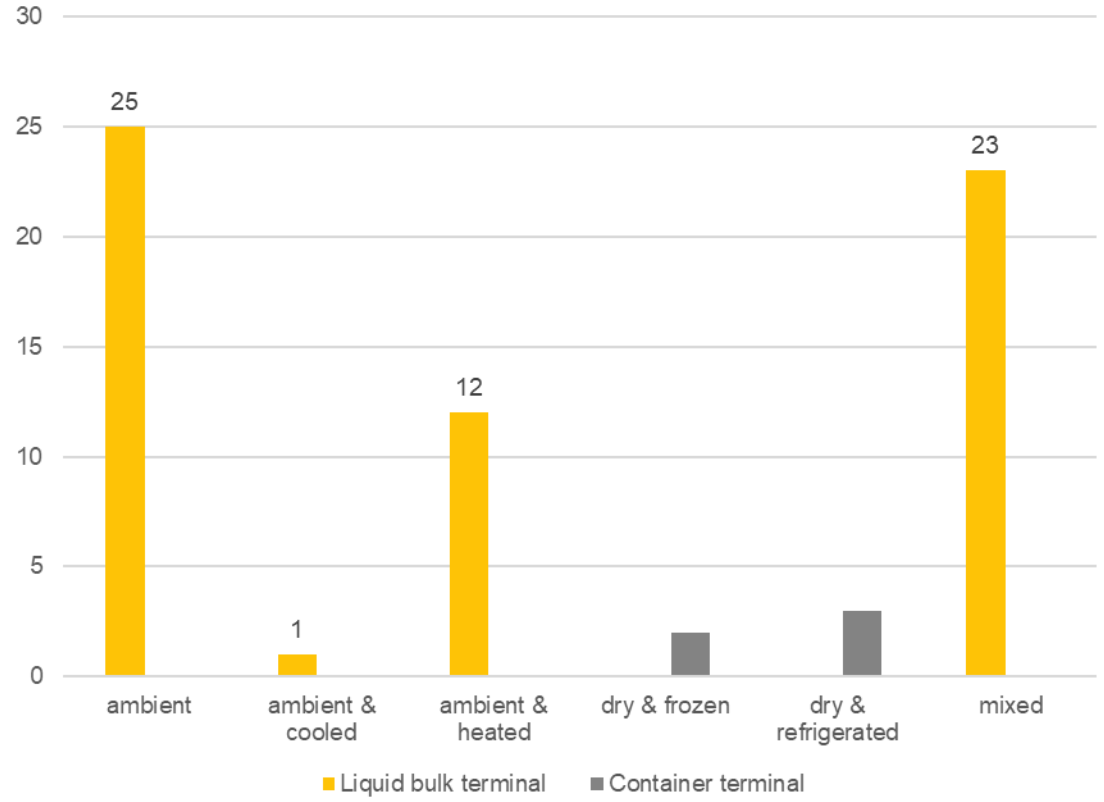
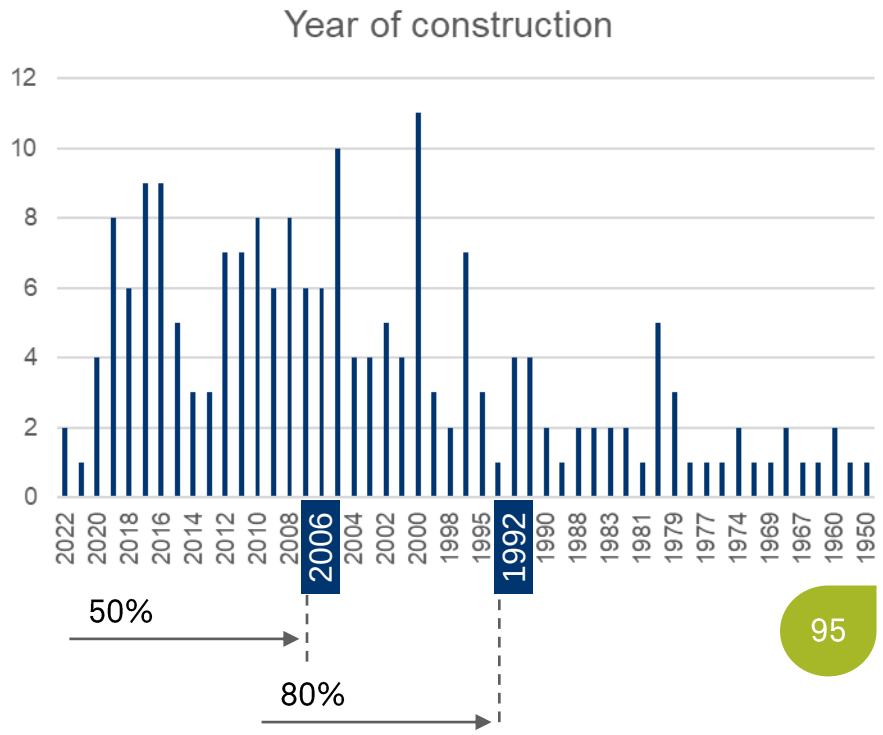



70

# Data base of GILA market study 2022

## Age, size, height, throughput and dwell time

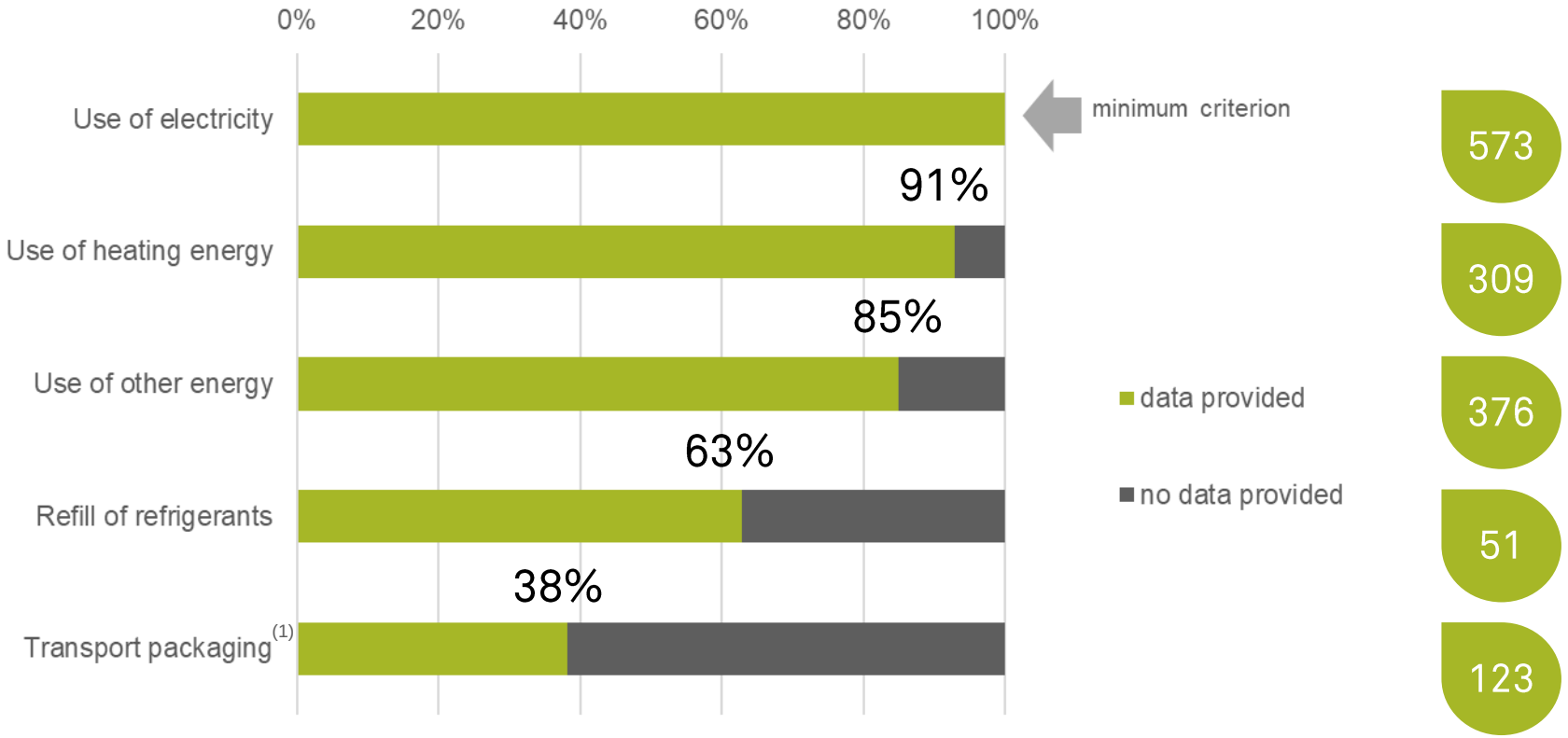



50% of the sites were built in 2006 or later

| | Min | Median | Max |
|---|---|---|---|
| Logistic area indoor | 180 m² | **12,000 m²** | 750,000 m² |
| Building height | 3 m | **10.7 m** | 31 m |
| <u>Throughput</u> | | | |
| Storage & transhipment | 18 t | **70,000 t** | 1.3 Mio t |
| Liquid bulk terminals | 500 t | **700,000 t** | 108 Mio t |
| <u>Dwell time</u> | | | |
| Warehouses | 1 d | **20 d** | 12 a |
| Liquid bulk terminals | 1 d | **30 d** | 1 a |

# Data base of GILA market study 2022

## Data availability

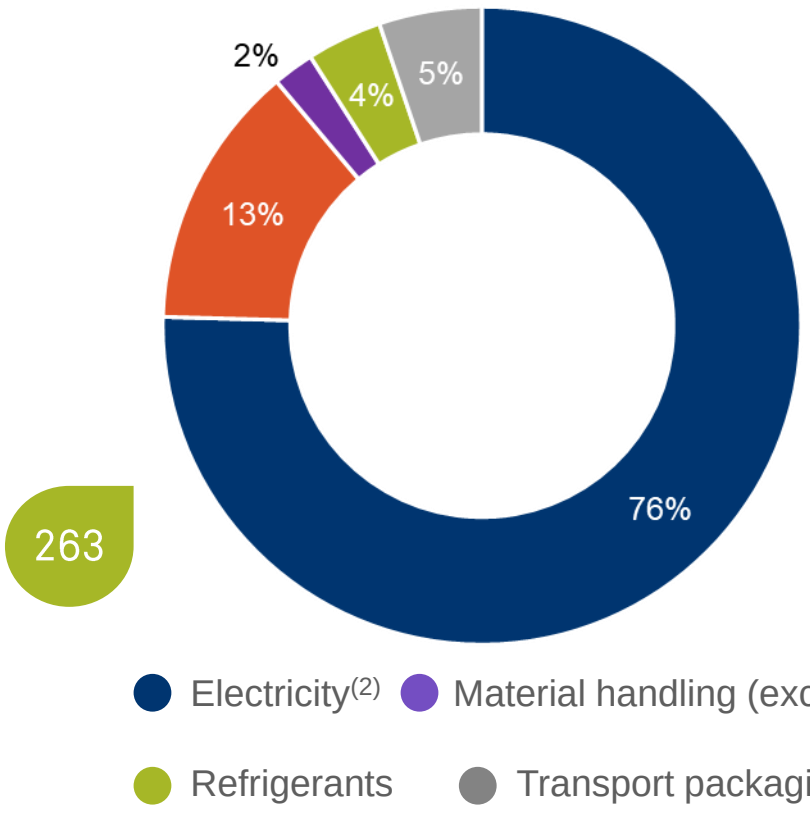



(1) at warehouses and transhipment sites (excl. terminals)

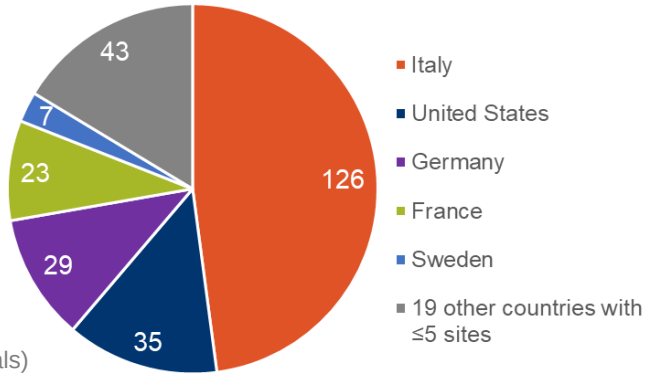
# What are relevant GHG emission sources at logistics sites?



Storage & transhipment sites (1)

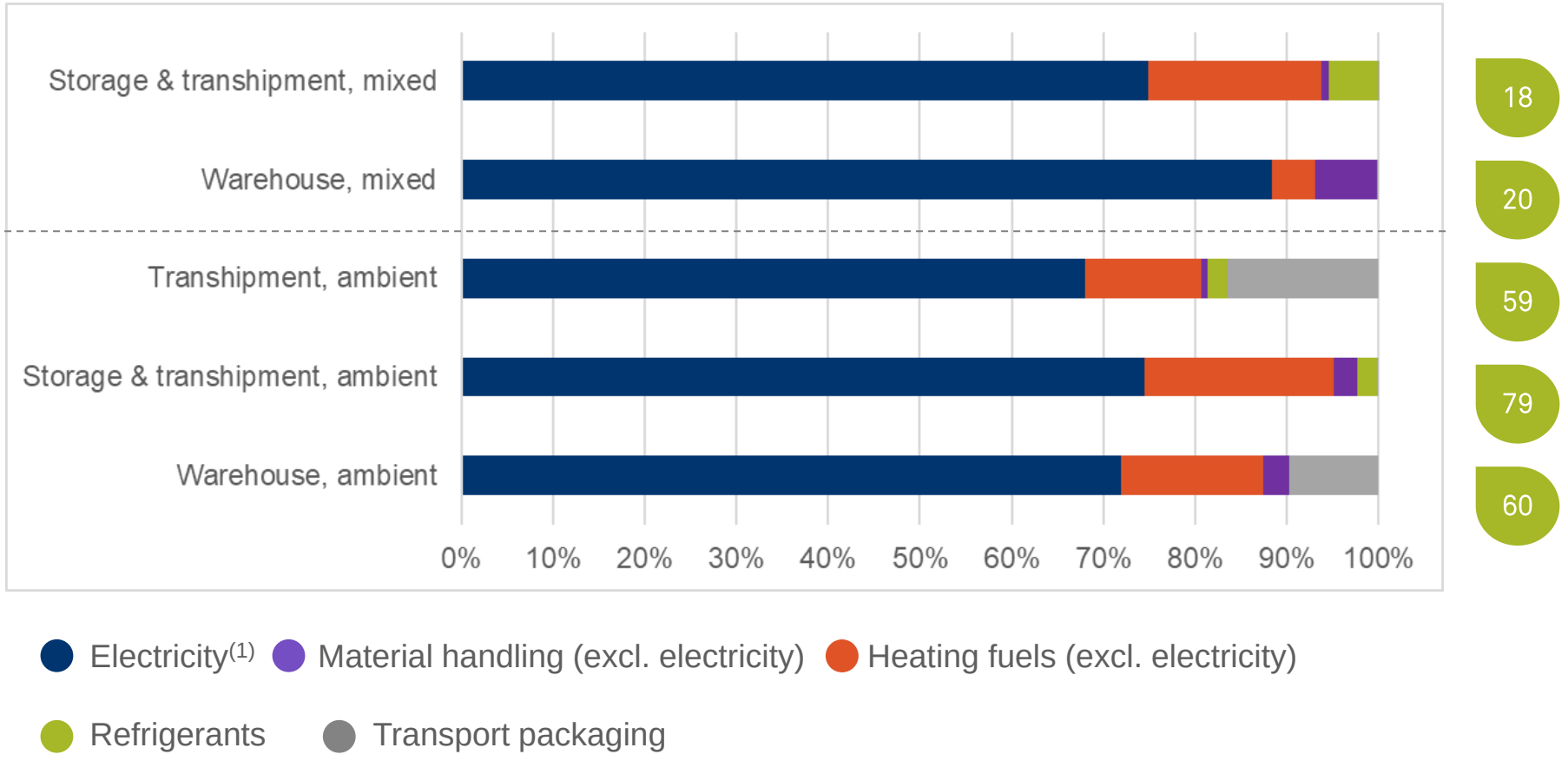



- Reduced database: analysis of site with total carbon footprint
- **91% of the carbon footprint**(2) of the logistics sites result from **energy use**
  (75% electricity, 13% heating, 2% material handling)
- **4%** of the GHG emissions result from **leakage of refrigerants** (estimated by refills)
- **5%** of the GHG emissions are caused indirectly by the use of **transport packaging**(3)




(1) warehouses, and transhipment sites (excl. terminals)
(2) national electricity mix (location based)
(3) emissions refer to transport packaging from plastics and cardboard

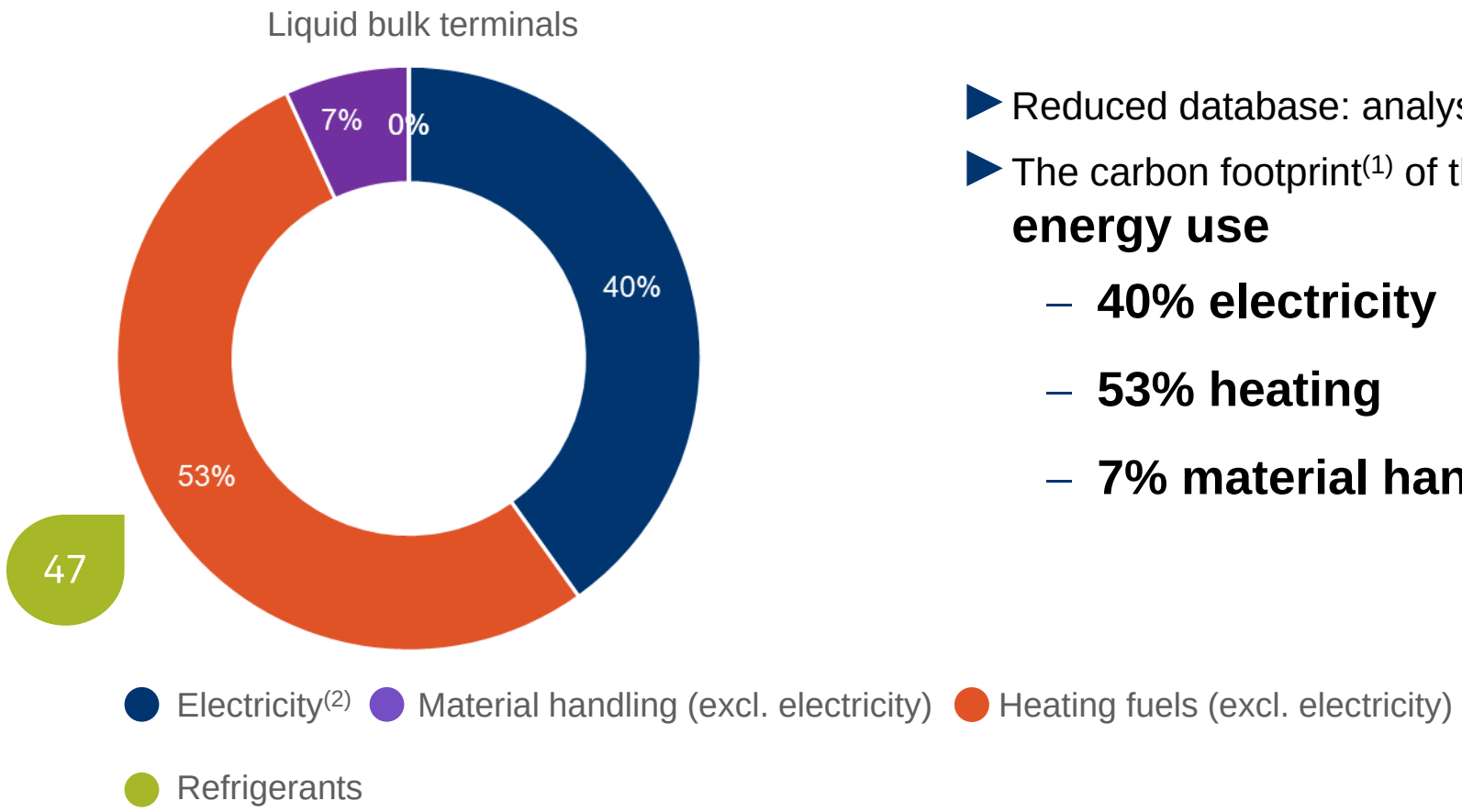
# What are relevant GHG emission sources at logistics sites?



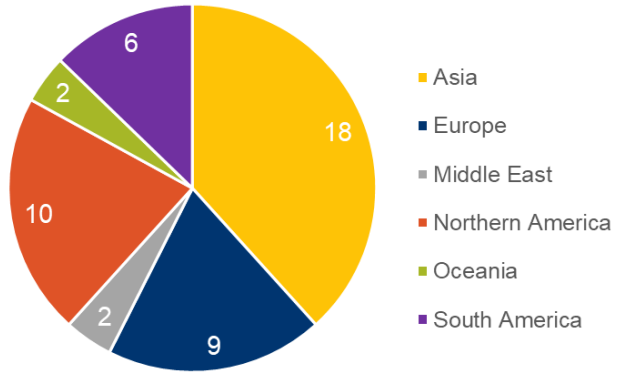

(1) national electricity mix (location based)
(2) emissions refer to transport packaging from plastics and cardboard

# What are relevant GHG emission sources at liquid bulk terminals?





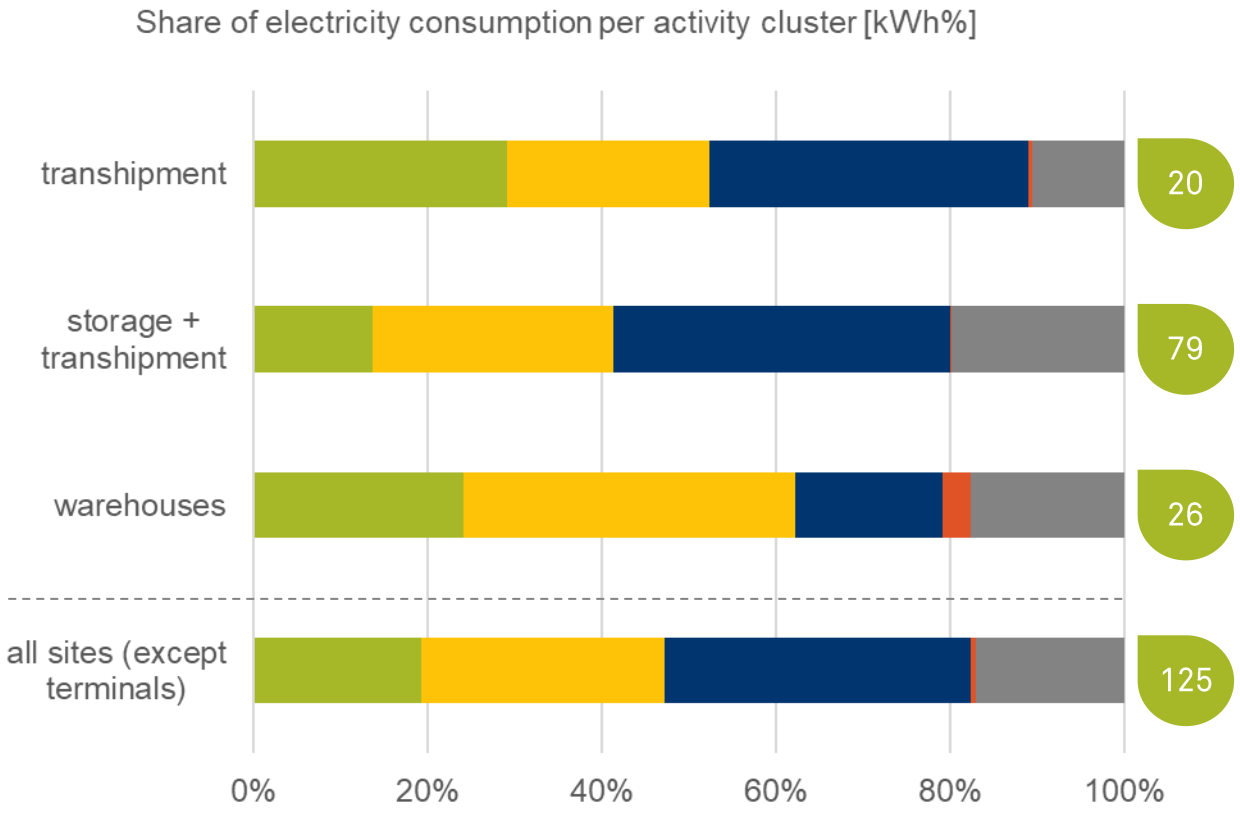

- Reduced database: analysis of terminals with total carbon footprint
- The carbon footprint(1) of the liquid bulk terminals result from **energy use**
  - **40% electricity**
  - **53% heating**
  - **7% material handling**




(1) national electricity mix (location based)

# What is the electricity used for?

## Allocation to activity clusters for site types

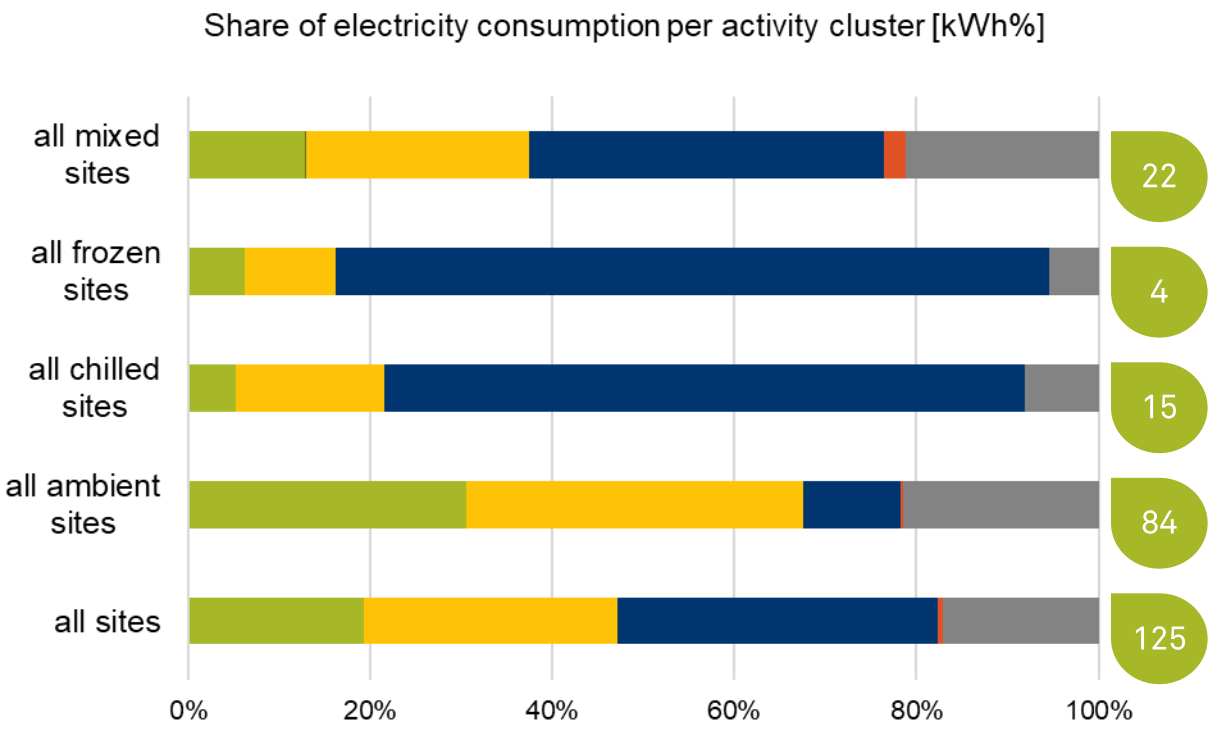



- **23% of the sites** allocated their electricity consumption to activity clusters
- They represent **11%** of the **total electricity consumption** of the market study
- They allocated **83% of their consumption** to the predefined activity clusters, i.e. 9% of the total market study

- Overall shares per activity cluster:
  - Chilling of goods 35%
  - Lighting indoors 28%
  - Material handling 19%

# What is the electricity used for?

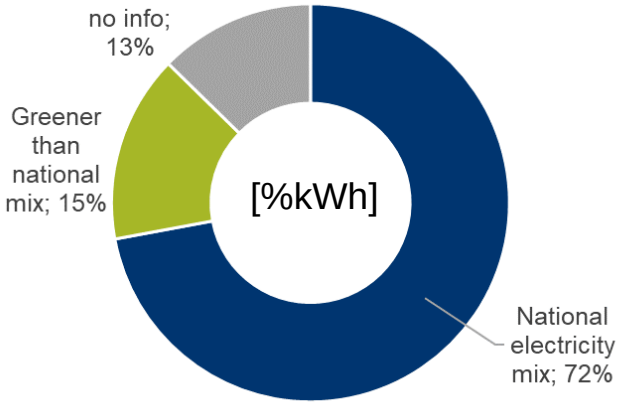
## Allocation to activity clusters for temperature level




- Frozen and chilled sites use most electricity for **temperature control**
  - **78% and 70%** respectively
  - remark: small sample size

# How renewable is the electricity used?

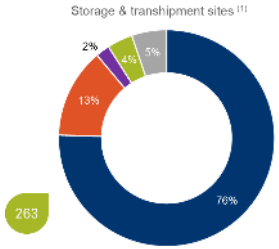
- At least **15% of the total electricity** consumed bases on **greener energy sources** than the national electricity mix
  - 193 sites use electricity that is “greener” than the national mix
  - [2021 study: 67% of the total was greener than national mix]
- **More than 70%** of the total consumption **bases on national electricity mix**




- **43 sites**(1) (7%) **produce electricity on-site** with PV panels,
  - representing 10% of the total electricity consumption of market study
  - with a share from 0,04% to 100% of the site’s total electricity consumption

(1) located in Italy (34), Germany, Sweden, UK, Taiwan and Thailand

# 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

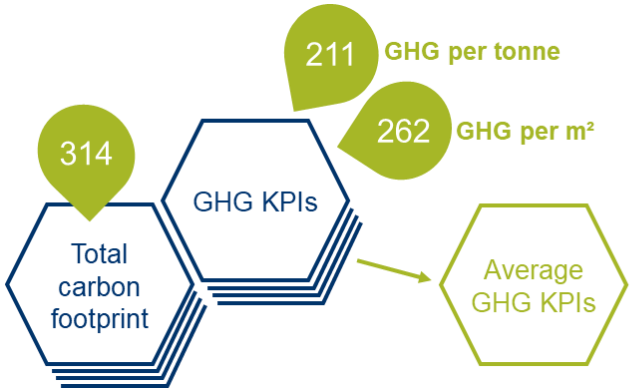
  kg $CO_2$e / tonne
  kg $CO_2$e / pallet
  kg $CO_2$e / m³ goods

**Emission intensity values**

- based on site parameters

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

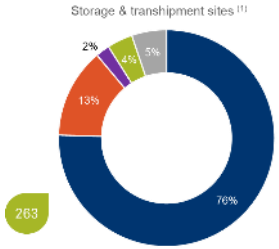
- ISO 14083:
  kg $CO_2$e / tonne




**Suggested categorization of logistics hubs**

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

# Emission intensity values for logistics sites

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- ISO 14083:
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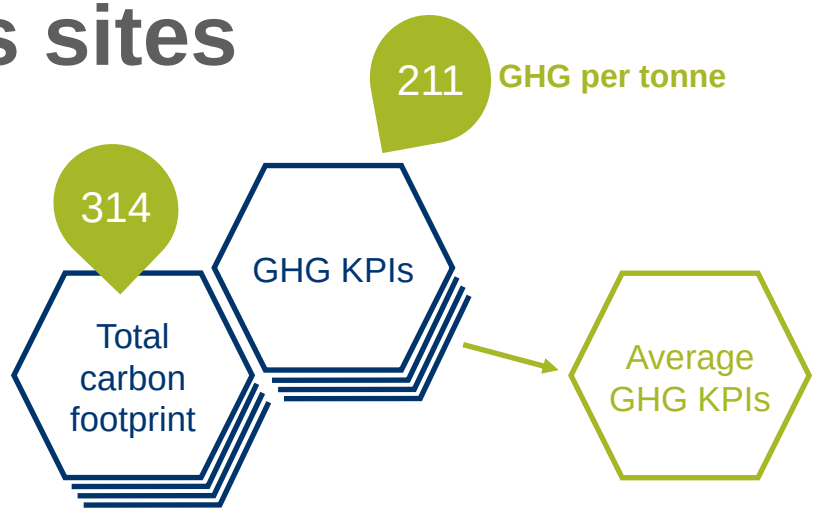
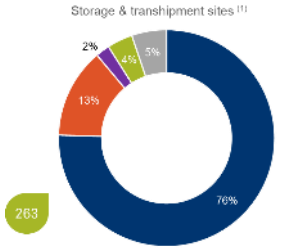



| *Work in progress!!* | Ambient | | Mixed | |
|---|---|---|---|---|
| Transhipment | 0.5 kg $CO_2$e / t | n=55 | 3.6 kg $CO_2$e / t | n=4 |
| Storage + transhipment | 2.1 kg $CO_2$e / t | n=45 | 11.1 kg $CO_2$e / t | n=7 |
| Warehouse | 27.8 kg $CO_2$e / t | n=36 | 26.8 kg $CO_2$e / t | n=8 |
| Liquid bulk terminal | 3.7 kg $CO_2$e / t | n=21 | 6.4 kg $CO_2$e / t | n=26 |

Remark: A comparison with initial KPI values from 2021 market study is not reasonable as 2021 sample size included sites with partial carbon footprint which may reduce values decisively.

# Emission intensity values for logistics sites




**Annual carbon footprint (CF)**

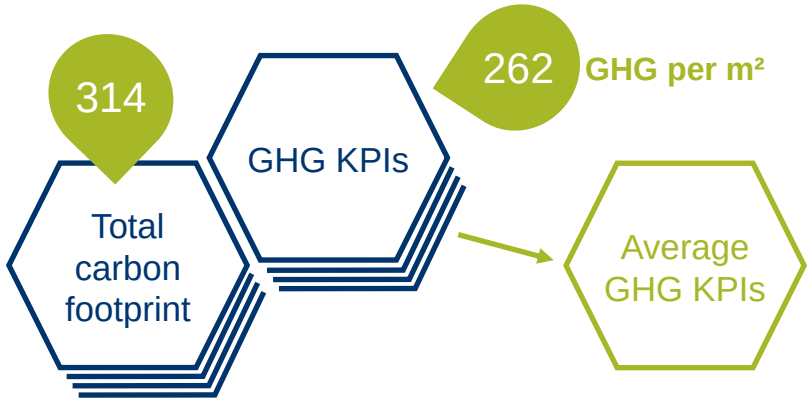
- Total annual CF of logistics site

  kg $CO_2$e / a

**Emission intensity values**

- based on site parameters

  kg $CO_2$e / m²




Remark:

Due to low sample size, m²-based KPIs were not elaborated in 2021 market study.

| *Work in progress!!* | Ambient | | Mixed | |
|---|---|---|---|---|
| Transhipment | 10.2 kg $CO_2$e / m² | n=58 | 55.3 kg $CO_2$e / m² | n=7 |
| Storage + transhipment | 14.4 kg $CO_2$e / m² | n=79 | 22.6 kg $CO_2$e / m² | n=18 |
| Warehouse | 12.6 kg $CO_2$e / m² | n=60 | 14.9 kg $CO_2$e / m² | n=20 |

| *Work in progress!!* | Chilled | | Frozen | |
|---|---|---|---|---|
| Storage + transhipment | 58.8 kg $CO_2$e / m² | n=13 | 61.9 kg $CO_2$e / m² | n=4 |

# What to do if not all data is available?

Partial CF

**Annual carbon footprint (CF)**

- ~~Total~~ annual CF of logistics site

  kg $CO_2$e / a

Total carbon footprint

Partial carbon footprint

Idea:
Data base on average resource use

Resource clusters

| Site type | Electricity | Heating | Material handling | Refrigerants |
|---|---|---|---|---|
| T, a | Ø | Ø | Ø | Ø |
| S+T, a | Ø | Ø | Ø | Ø |
| W, a | Ø | Ø | Ø | Ø |
| ... | | | | |

Individual GHG KPI

x% primary data
y% secondary data

✓ Electricity & heating energy

− Energy for material handling

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# Interim conclusions & short outlook

**Initial set of average KPIs**

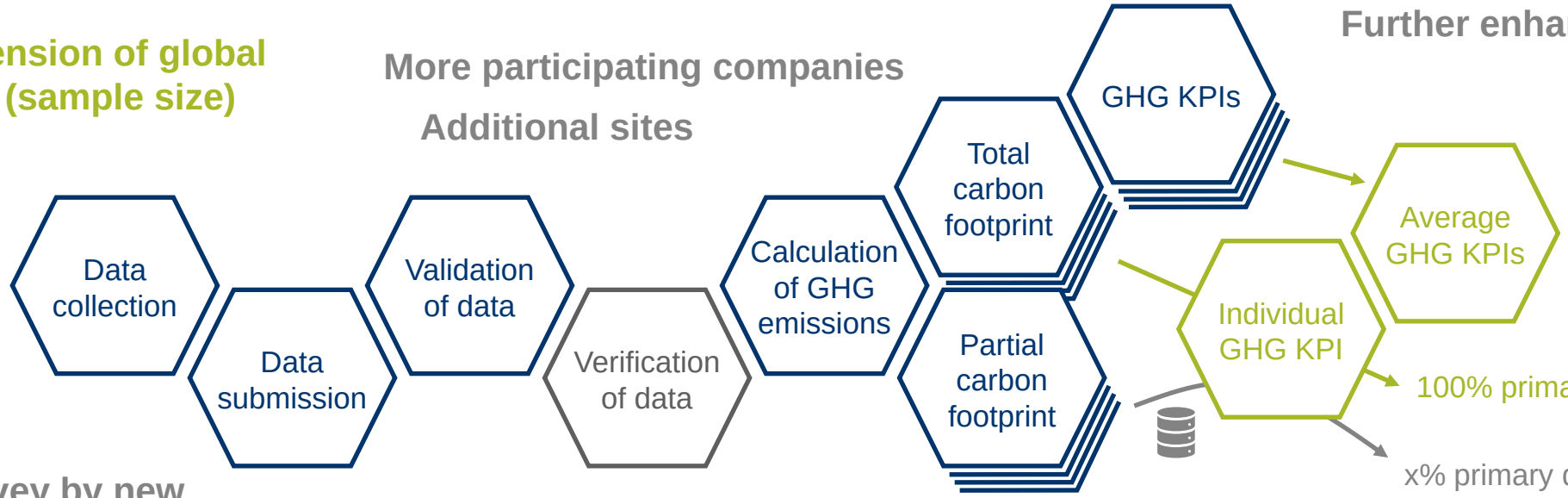
**Aligned with ISO/FDIS 14083**

**Great extension of global data base (sample size)**

**More participating companies**

**Additional sites**

**Further enhance quality of KPIs**




**Include further site types**

**Extend survey by new resources** (e.g. steam)

**Update of provided data by duplication of data sets online**

**Online calculation of**

- **total carbon footprint & individual KPIs**
- **partial carbon footprint**

**Increase share of complete data sets**

**Further analysis on influencing factors**
(e.g. implemented measures)

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# ENERGY EFFICIENCY MEASURES



**Sara Perotti**
Politecnico
di Milano

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# Energy efficiency measures

Analysis of 31 design variables referred to 6 different areas of intervention

## Green building & yard

Thermal insulation, loading docks with insulated doors, cool roof, green roof, unsealing of yard, biodiversity, climate resilience, inclusive design

## Utilities

Self-generated power, photovoltaic, solar panels, wind power, fuel cells or batteries for energy provision, smart HVAC systems, rainwater collection & reuse systems, smart metering /data collection

## Lighting

LED lamps, natural lighting & white walls, solar tubes, sensors for reducing lighting consumption

## Materials management

Packaging reduction, separation of waste fractions for better recycling, packaging reuse & recycle, use of renewable & biobased materials, use of recycled materials, local sourcing of materials

## Material handling & automation

Lithium-ion batteries, hydrogen powered fuel cell forklifts, hybrid forklifts, high frequency battery charging, sensors for reducing MHS consumption, energy recovery during braking

## Operational practices

Travel distance optimization for MHS, optimal planning for MH activities & battery charging, optimized location of charging equipment, energy efficient behavior, support of sustainable commuting

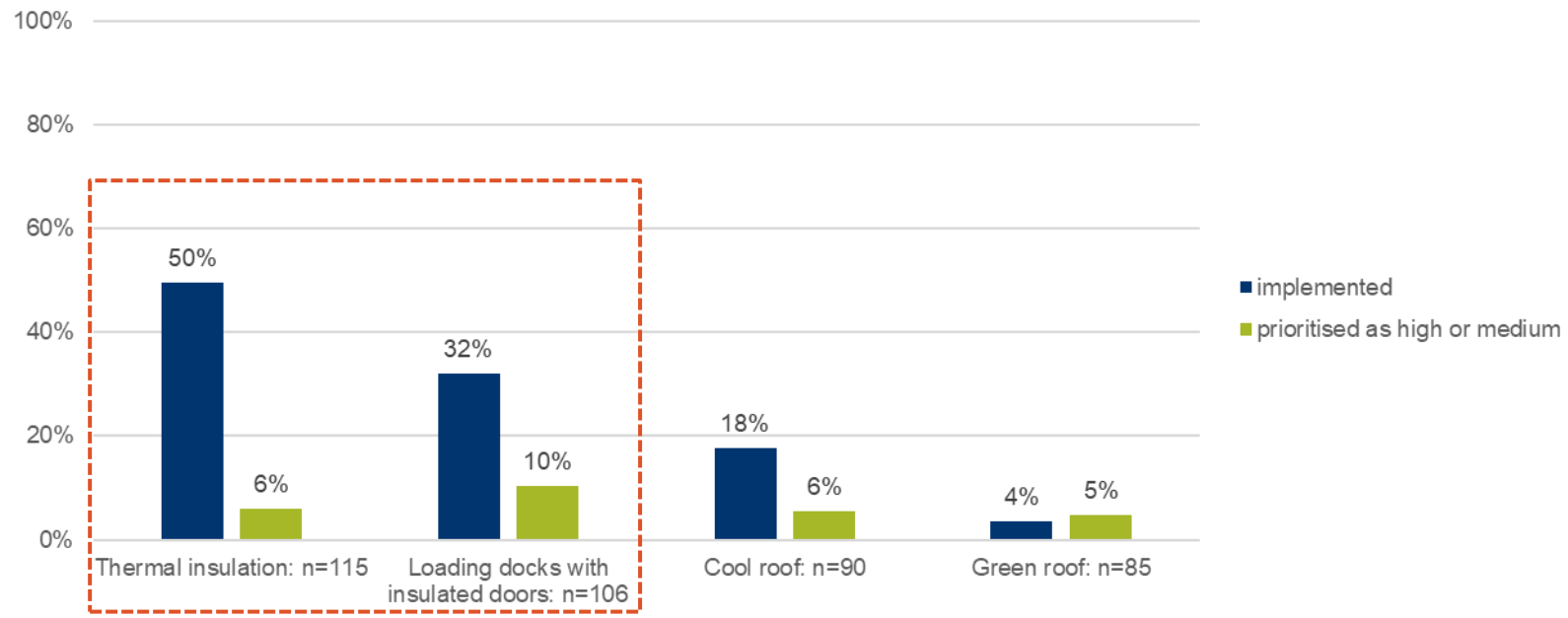


HVAC – Heating, ventilation, air conditioning, MH - material handling, MHS – material handling systems

# Green building

## Current adoption vs. prospective scenario

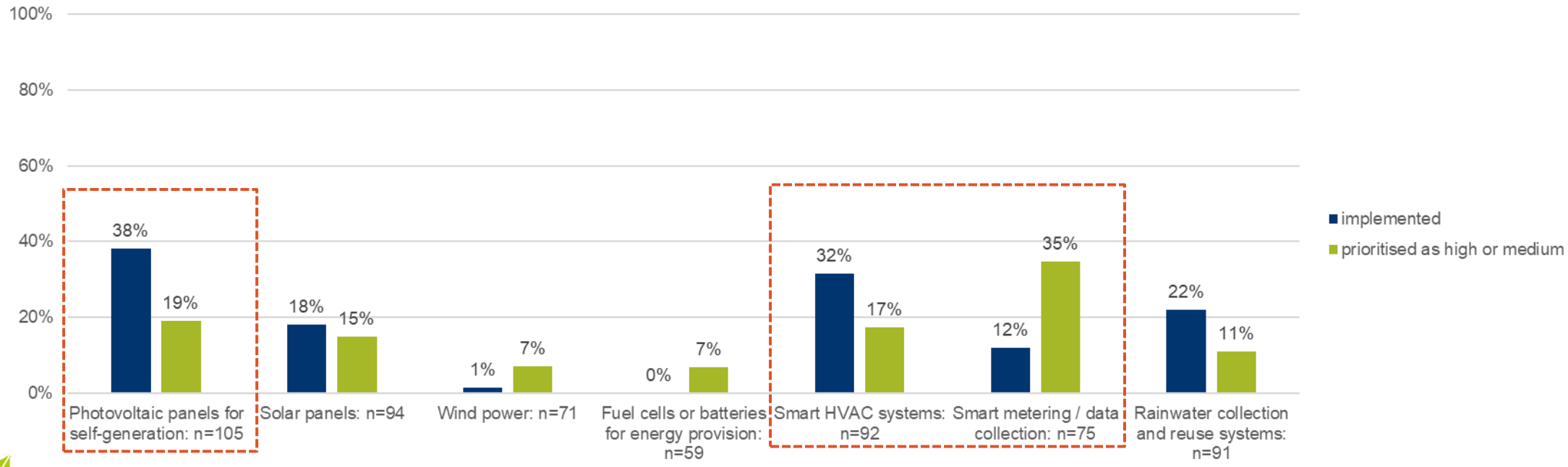
- 115 sites provided answers on the measure "**Thermal insulation**", half of which have implemented it.
- **Loading docks with insulated doors** is another widespread solution (33 sites).
- Innovative solutions such as **cool roof** and **green roof** are still scarcely adopted.



# Utilities

## Current adoption vs. prospective scenario

- **Photovoltaic panels** for own use and **smart HVAC systems** are particularly widespread (40 resp. 29 sites).
- Priorities for **future** interventions seem to **confirm** a market interest in both (16-20 sites) as well as **smart metering** (26 sites).

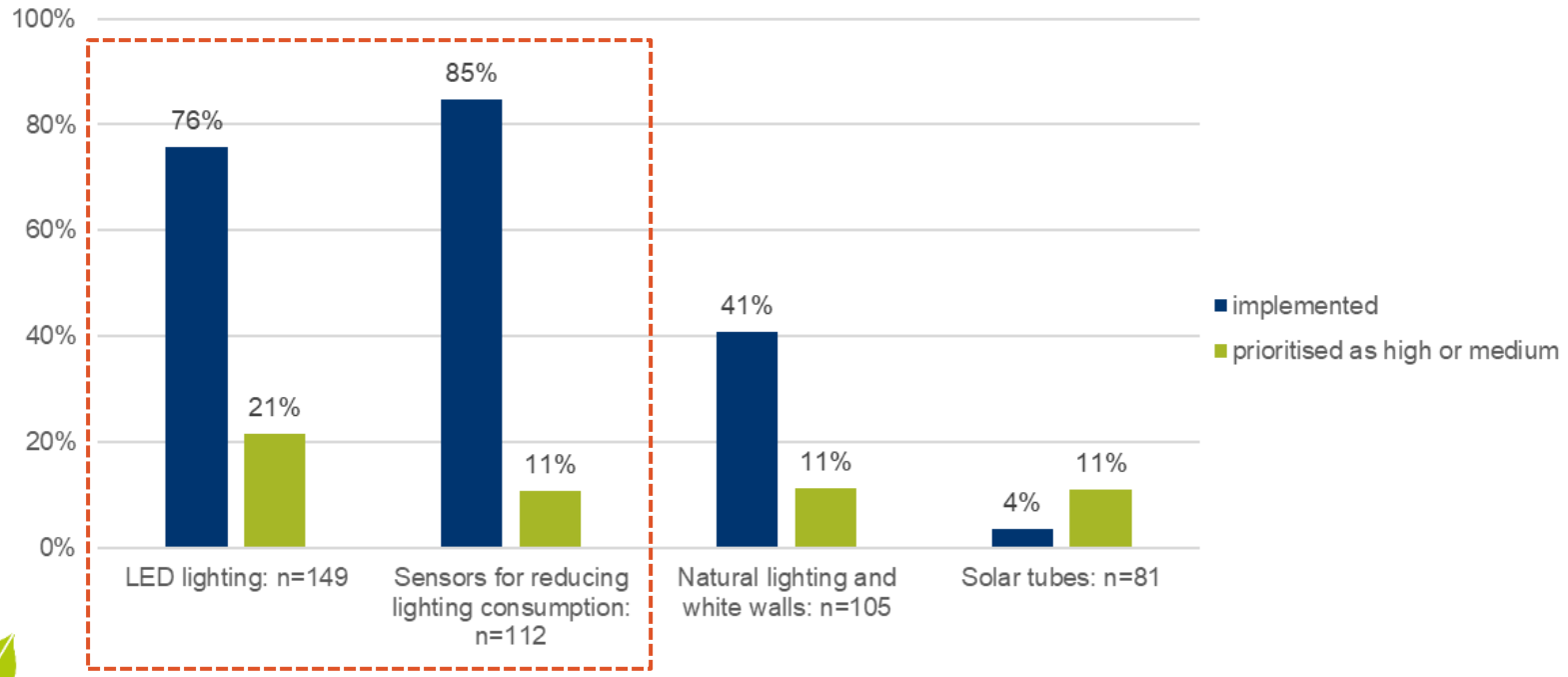



HVAC – Heating, ventilation, air conditioning

# Lighting

## Current adoption vs. prospective scenario

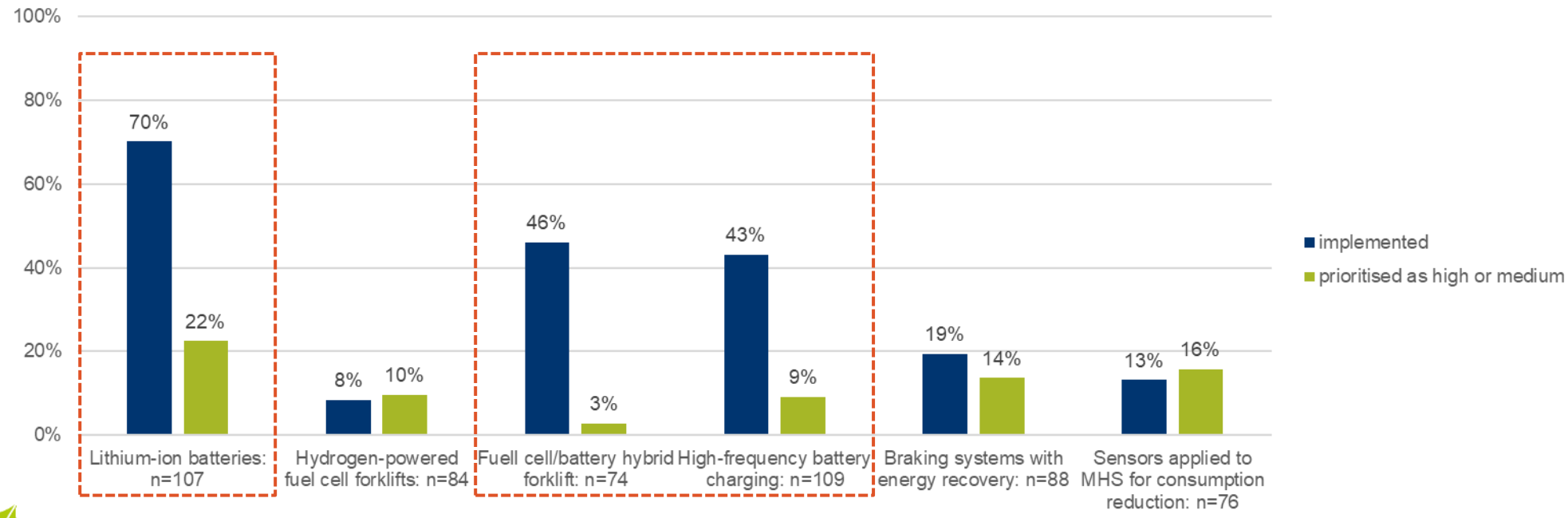
- LED lighting is the most implemented solution by far (113 sites), followed by **sensors for reducing consumption** (95 sites).
- A relevant share also uses natural lighting and white walls (41%) for energy efficient working conditions.



# Material handling and automation

## Current adoption vs. prospective scenario

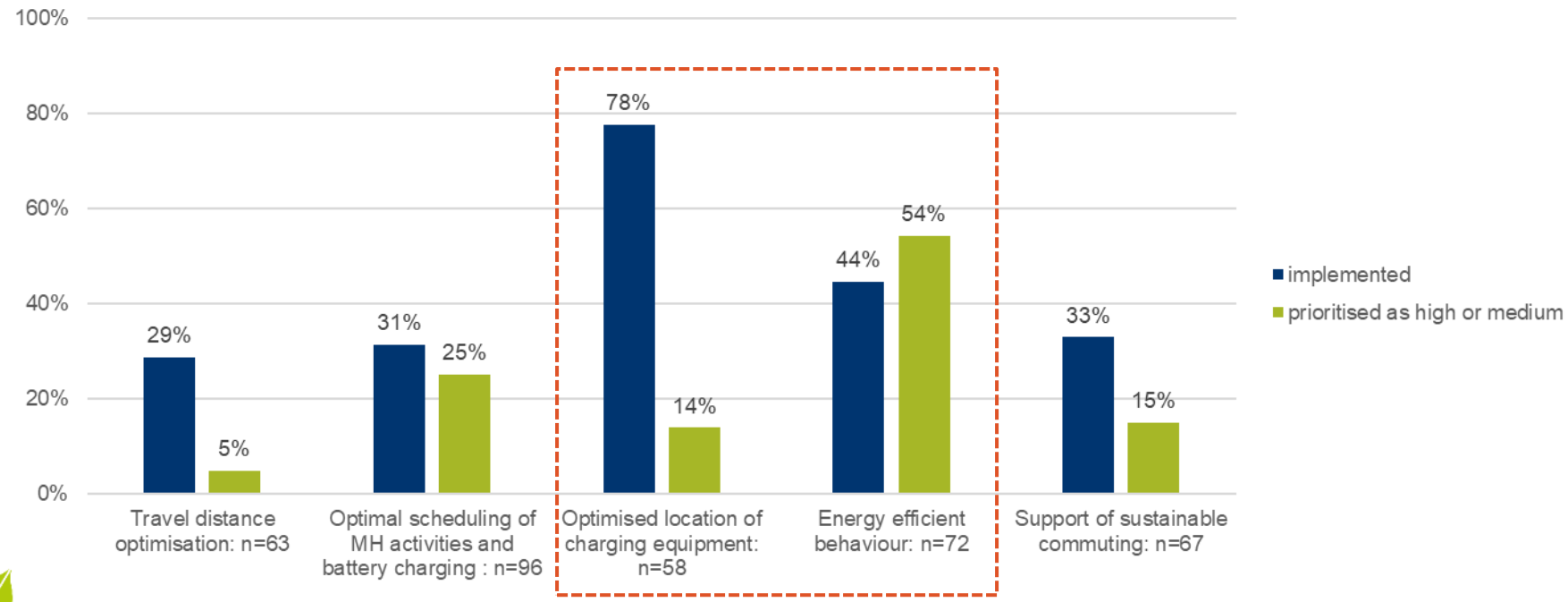
- Current adoption is mainly concentrated on **forklifts**,
  - especially lithium-ion batteries (75 sites), **high-frequency battery charging** (47 sites) or **fuel cell/battery hybrid forklift** (34 sites).



# Operational practices

## Current adoption vs. prospective scenario

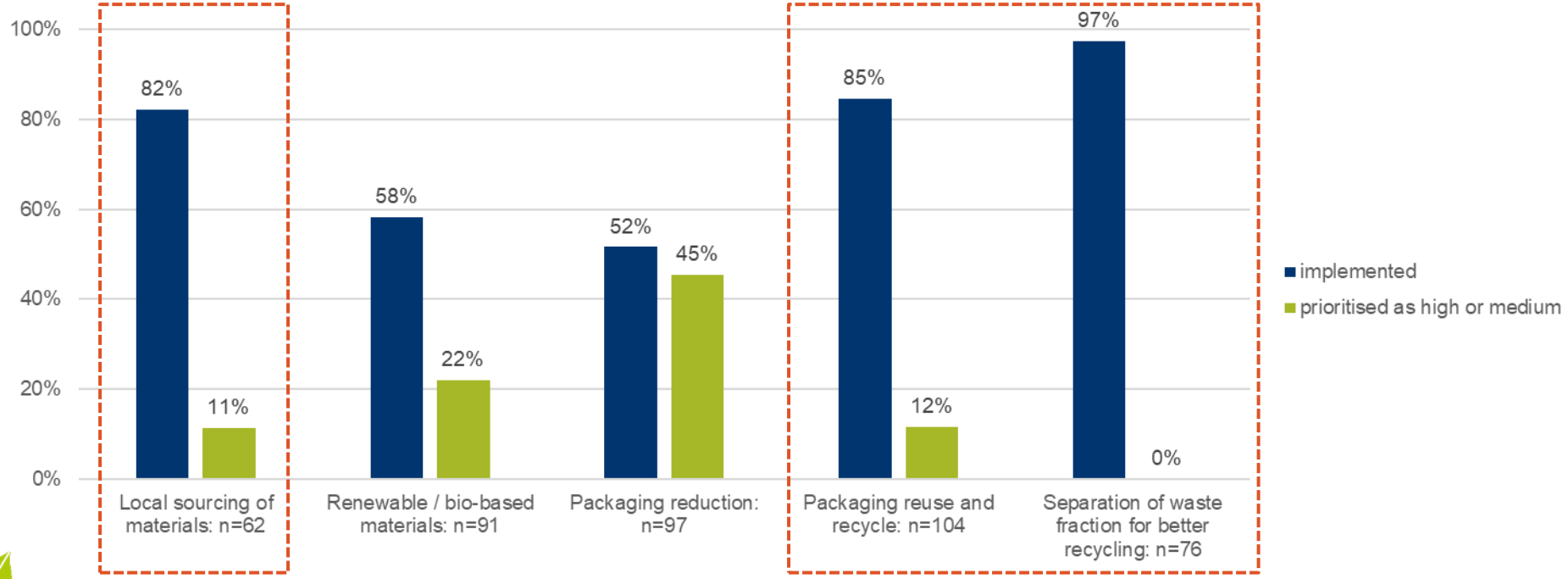
- Improvement by **optimising the location of charging equipment** of material handling system has been adopted by 45 sites.
- Almost all sites already support or plan to encourage **energy efficient behaviour** (44% resp. 54%), one third of the sites support **sustainable commuting**.



# Material management

## Current adoption vs. prospective scenario

- High adoption: One of the main levers for companies consists in the **improvement of packaging materials used**, according to two main strategies:
  - adopting more sustainable materials (local sourcing, renewable/bio-based materials), and
  - working on processes (packaging reduction, enhancing materials reuse and recycle)



# Summary on energy efficiency measures

- The solutions adopted mainly refer to
  **Green Building, Lighting**,
  **Materials management** and **Operational practices**.
- Increasing interest in existing and new sustainability measures can be stated.
- Industry ask for best practice and implementation guidance.

# GILA market study 2023
## Interested in participating?

- Please contact one of us:

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

kerstin.dobers@iml.fraunhofer.de

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 is from March 1st to May 30th 2023 !**

No deadline extension for market study possible as the GILA project ends in summer.
[REff Tool® can further be used!]

# GILA's tasks for remaining months

- GILA market study 2023 (data collection March – May)
- Consolidated analysis of market studies (2021, 2022, 2023)
  - elaborating average KPI values for selected site types
  - identifying interdependencies of sustainability measures and carbon footprint results
- Collection of implementation examples of sustainable measures (→ template)
- Development of an **online platform "Sustainable Logistics Sites"**
  - Basic information on sustainability measures
  - Provision of templates for examples of sustainable measures
- Support of implementing coming ISO 14083 (planned for May 2023)
  - by market study, update of guidelines(1), elaboration of examples.




(1) Fraunhofer Guide on logistics sites (ISBN 978-3-8396-1434-1), GLEC Framework

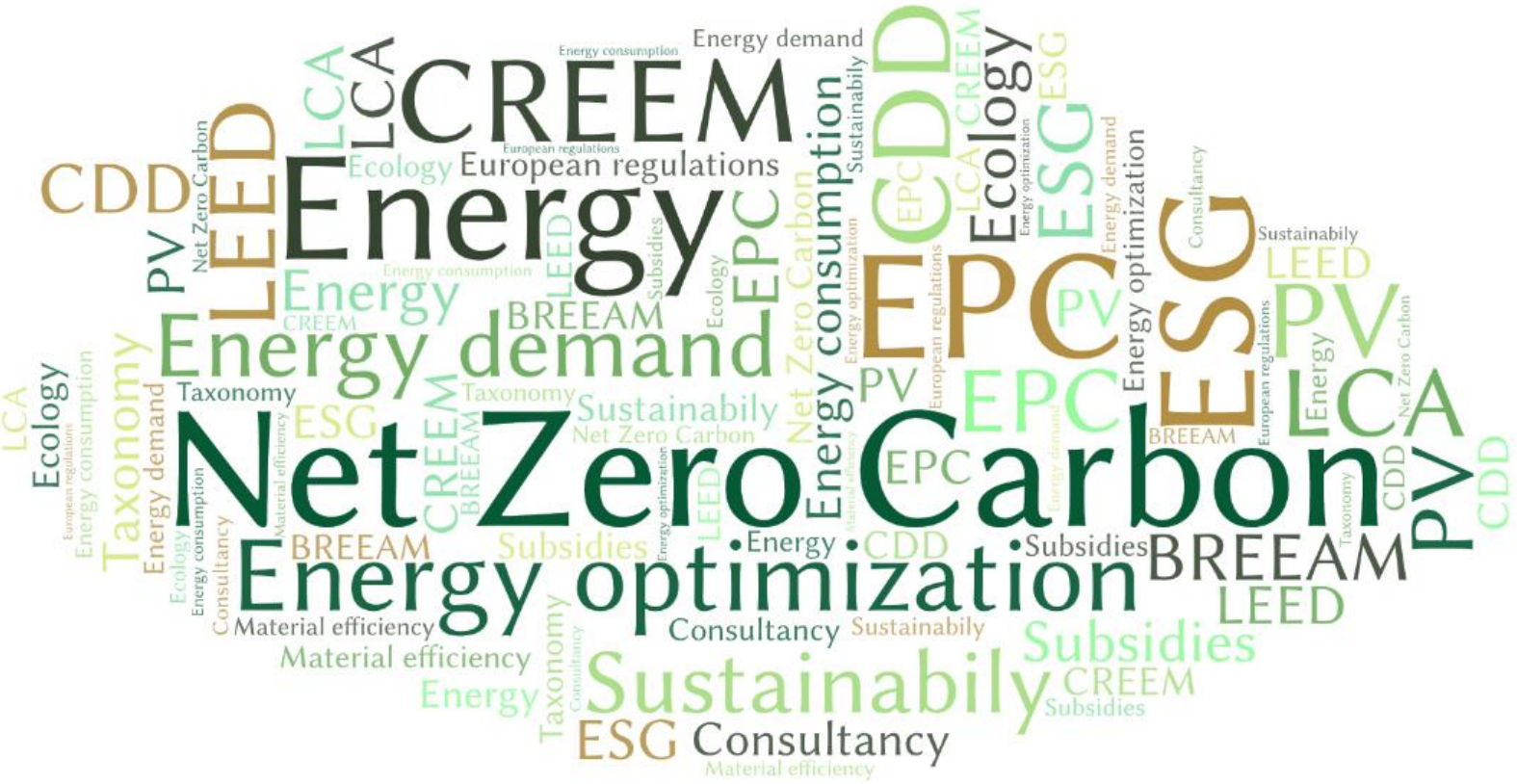
# SUSTAINABLE ASSET TOOL

## Dashboard for Logistics Hubs

**Scarlet Romano**
Arcadis Deutschland

# Sustainable services required by the market

**Most required sustainable services in 2022**




There is a demand for predictive **energy management**, **net zero carbon** strategies and **costs** associated in logistic hubs

# Dashboard concept

**Integrating sustainability KPIs to help our clients to make informed decisions and to realize your sustainability ambitions.**

*“A dashboard is a way of displaying various types of visual data in one place. Usually, a dashboard is intended to convey different, but related information in an easy-to-digest form”*

- Easy to use and understand
- Can showcase numerous data visualizations side by side
- Provide a general transparent summary information (quality related to the amount of information available)
- Higher investment of resources at the beginning to systematize and organize the information compared to a manual process but this is reduced over time

**Objective:**

1. Provide a platform “Sustainable Assessment tool” for owners, FM, researchers, etc., to make better, more informed and data-driven decisions.

The outcome are:

A. Embodied carbon benchmark
B. Summary Report on Capex (Maintenance Technical Expenditures) and CarbEx (Carbon Expenditures)
C. Summary Report on inflation rates

# EXAMPLE:

# A model for single-building /single-use facilities

**To estimate electric and fuel usage, as well as estimate potential areas for savings**

**Please fill out your Facility Profile:**

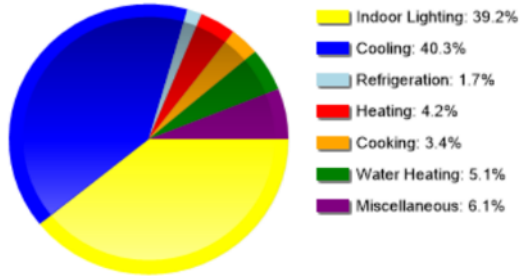
| | |
|---|---|
| Business Type | Warehouses |
| Building Type | Warehouses |
| Building Age | 0 - 9 years |
| Annual Operating Hours | 3120 |
| SqFt Heat/Cool | 2000 |
| Total SqFt Parking | 0 |
| Heating Type | Electric |
| Heat Setting (F.) | 70 |
| Cooling Type | Electric (Typical) |
| Cool Setting (F.) | 72 |
| Lighting (Watts/SqFt) | 2.39 |
| Water Heat Type | Electric |
| Windows (Panes) | Double Pane |
| Cooking Equipment | Electric |
| Refrigeration | Yes |
| Elevator / Escalator | Yes |

Calculate

Annual Electric Cost Table

| | Base Facility |
|---|---|
| | Average Efficiency |
| Indoor Lighting | $533 |
| Outdoor Lighting | $0 |
| Air Conditioning | $547 |
| Refrigeration | $23 |
| Space Heating | $57 |
| Cooking | $46 |
| Water Heating | $70 |
| Miscellaneous | $82 |
| **Annual Total** | **$1,359** |
| **Average Electric Cost** | **$0.0774** |
| **Average Load Factor** | **33.2%** |

Annual Electric Cost Chart




https://c03.apogee.net/mvc/home/comcalc/eac?utilityname=union-power

# Methodology

## 3 steps to achieve Sustainability Asset tool


STEP 1

Data Collection

+

STEP 2

Definition of Benchmark

+

STEP 3

Visualization Dashboard

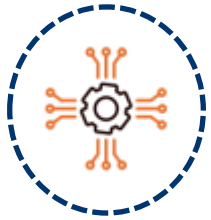
GILA

# Data collection

- What information is required?

STEP 1

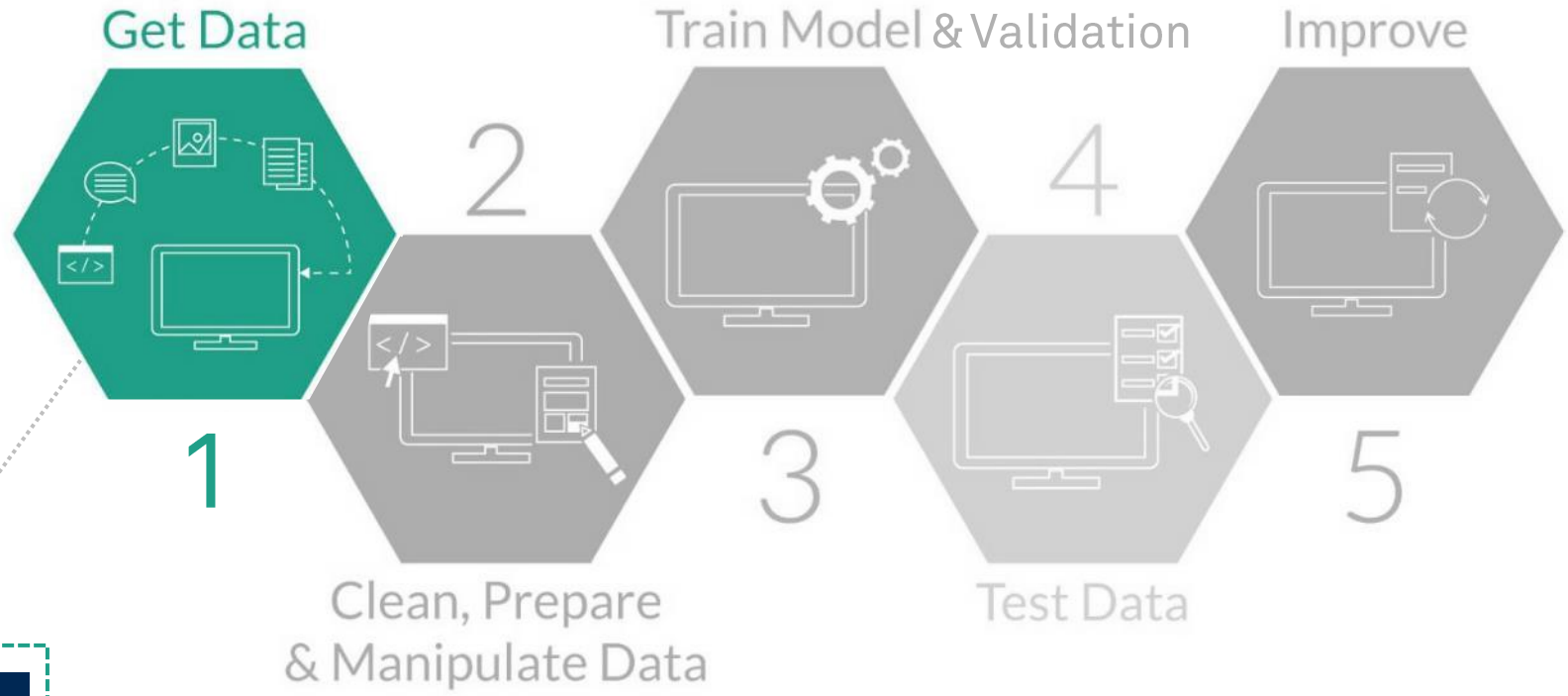
Data Collection



Collection → Extraction → Summary

# HOW OUR SOLUTION WORKS?






ESG CDD

**Reports**
**Manual DataSet**

**+ information =**
**+ % of reliability of the results**

**Data collection**

Who owns the customer details?

Who has the authority to decide the next steps?

Who is most impacted by data accuracy?

Training is required

**Data ownership & Custody**

Anonymous information available to the public

**Data access**

Conditions included in the contracts & implementation of constant revisions of the available information

**Agreement**

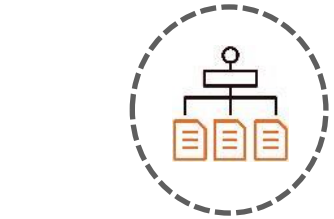
# Definition of benchmark

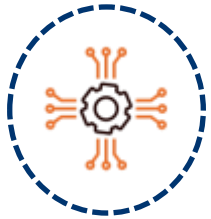
## How Do We Extract the Key Data?

STEP

2

Definition of Benchmark





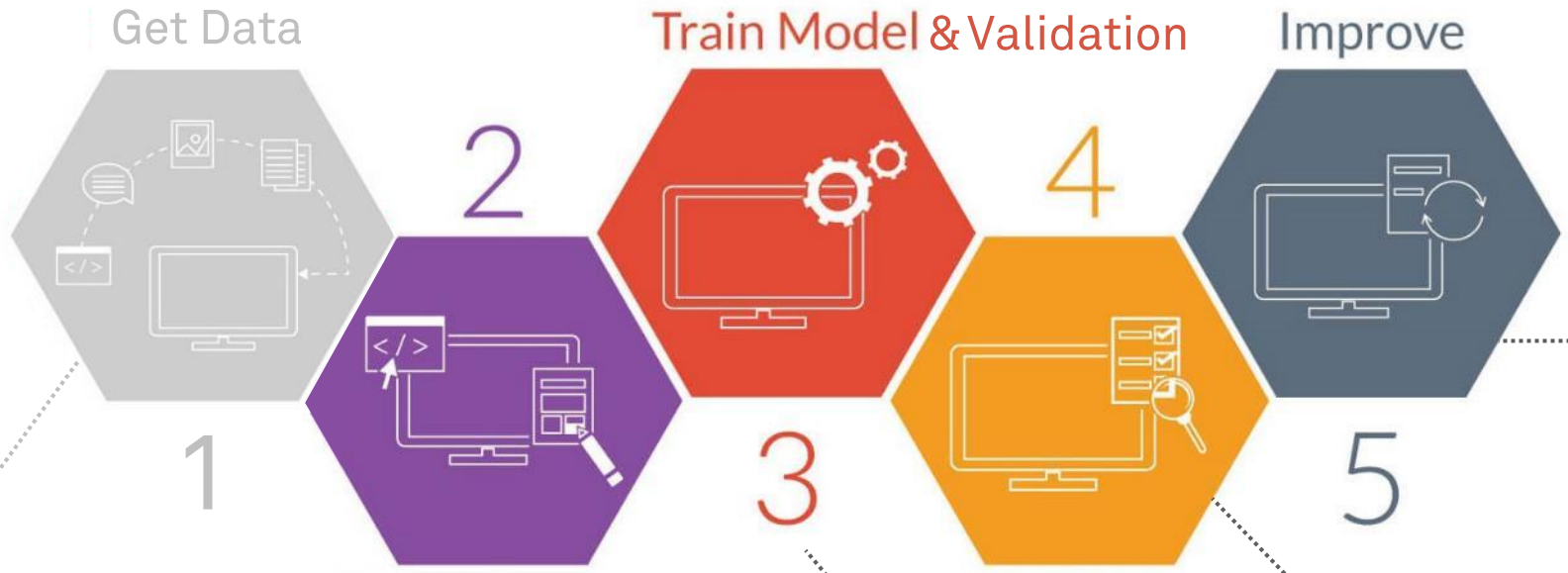
Preparation

Test

Improvement

# HOW OUR SOLUTION WORKS?






ESG

CDD

Reports

Benchmark/ Data Set creation

Dashboard creation

User input- test run

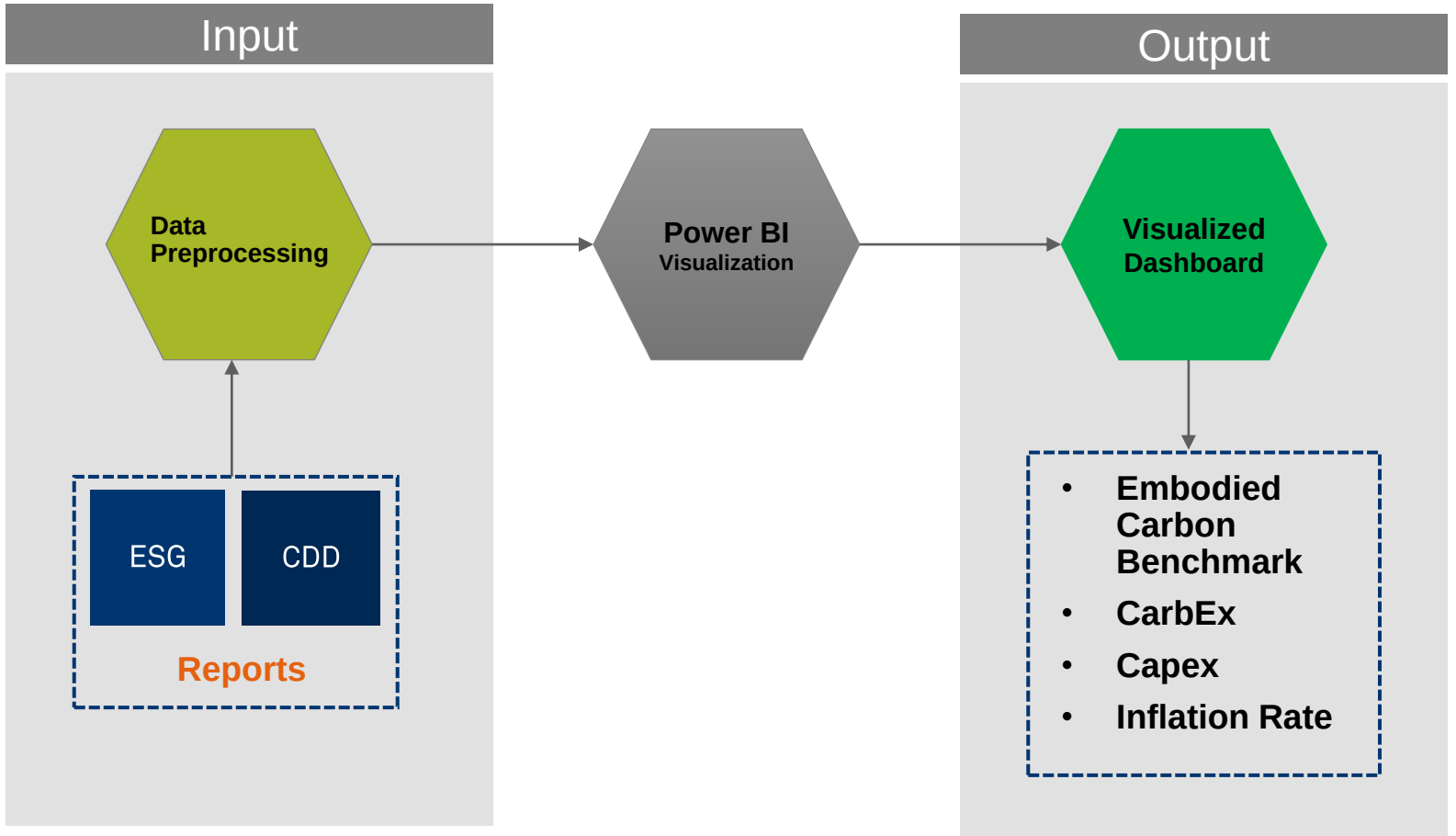
Benchmark expansion + Machine Learning

# Dashboard visualization

## Information Required from User

STEP 3

Visualization Dashboard



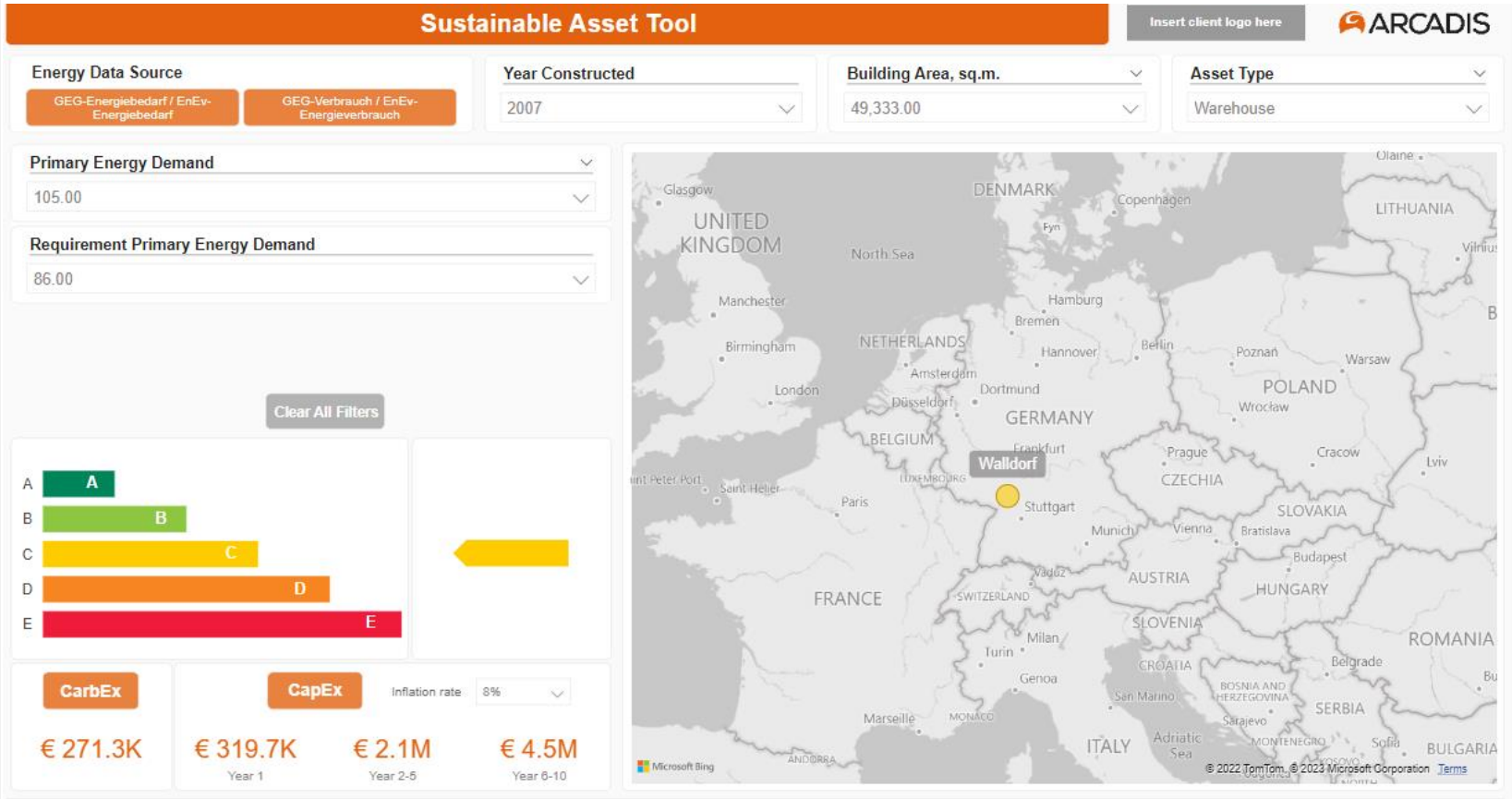
# Dashboard visualization

## Information Required from User

STEP

3

Visualization Dashboard



# ENERGY EFFICIENCY AND GHG EMISSION INTENSITY VALUES FOR LOGISTICS SITES

GILA Webinar – 2 February 2023

Thank you for your participation!

**Andrea Fossa**
Greenrouter

**Jan-Philipp Jarmer**
Fraunhofer IML

**Kerstin Dobers**
Fraunhofer IML

**Sara Perotti**
Politecnico di Milano

**Scarlet Romano**
Arcadis Deutschland

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

**Project duration**
07 / 2020 – 07 / 2023

**Project lead**
Fraunhofer IML

**Contact**
Kerstin Dobers
kerstin.dobers@iml.fraunhofer.de

The GILA project is designed to contribute to global efforts in reducing the environmental impact of logistics sites.

It addresses two main areas of research:

(1) Best practices & future requirements, services and concepts for sustainable logistics sites within an energy & resource efficient transport chain

(2) Methodological framework for describing detailed the environmental performance of logistics sites

The work is performed collaboratively by 10 international partners.

SPONSORED BY THE Federal Ministry of Education and Research

# References




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