GILA

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

alice | Alliance for Logistics Innovation through Collaboration in Europe

SUSTAINABILITY AND GHG PERFORMANCE AT LOGISTICS HUBS

Joint webinar of the GILA project and ETP ALICE
12 October 2023 | 15:30 – 17:00 CET

- GHG emissions quantification of logistics sites aligned with ISO 14083
  Jan-Philipp Jarmer, Fraunhofer IML
- Annual market studies & overall GHG performance indicators for logistics hubs
  Andrea Fossa, GreenRouter & Kerstin Dobers, Fraunhofer IML
- Possible solutions for decarbonising logistics hubs
  Sara Perotti, Politecnico di Milano
- Sustainability of hubs: a key driver for maintaining value over time
  Scarlet Romano, Arcadis Germany

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Calculation of GHG emissions from logistics chains

The path to an international standard

2012

EN 16258

Methodology for calculation & declaration of energy consumption & GHG emissions of transport services (freight & passengers)

2015

IWA 16

International harmonized method(s) for a coherent quantification of CO_2e emissions of freight transport

2016 & 2019

GLEC Framework

Global Logistics Emission Council Framework for Logistics Emissions Accounting & Reporting

2019

Fraunhofer Guide

Guide for GHG emissions accounting at logistics sites

2023

ISO 14083

Greenhouse gases - Quantification and reporting of greenhouse gas emissions arising from transport chain operations

EN 16258 · IWA 16 · ISO 14083

2012 · 2015 · 2020 · 2023 · 2025

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Calculation of GHG emissions from logistics chains

Status quo and future developments

ISO 14083:2023 ***Greenhouse gases - Quantification and reporting of greenhouse gas emissions arising from transport chain operations***

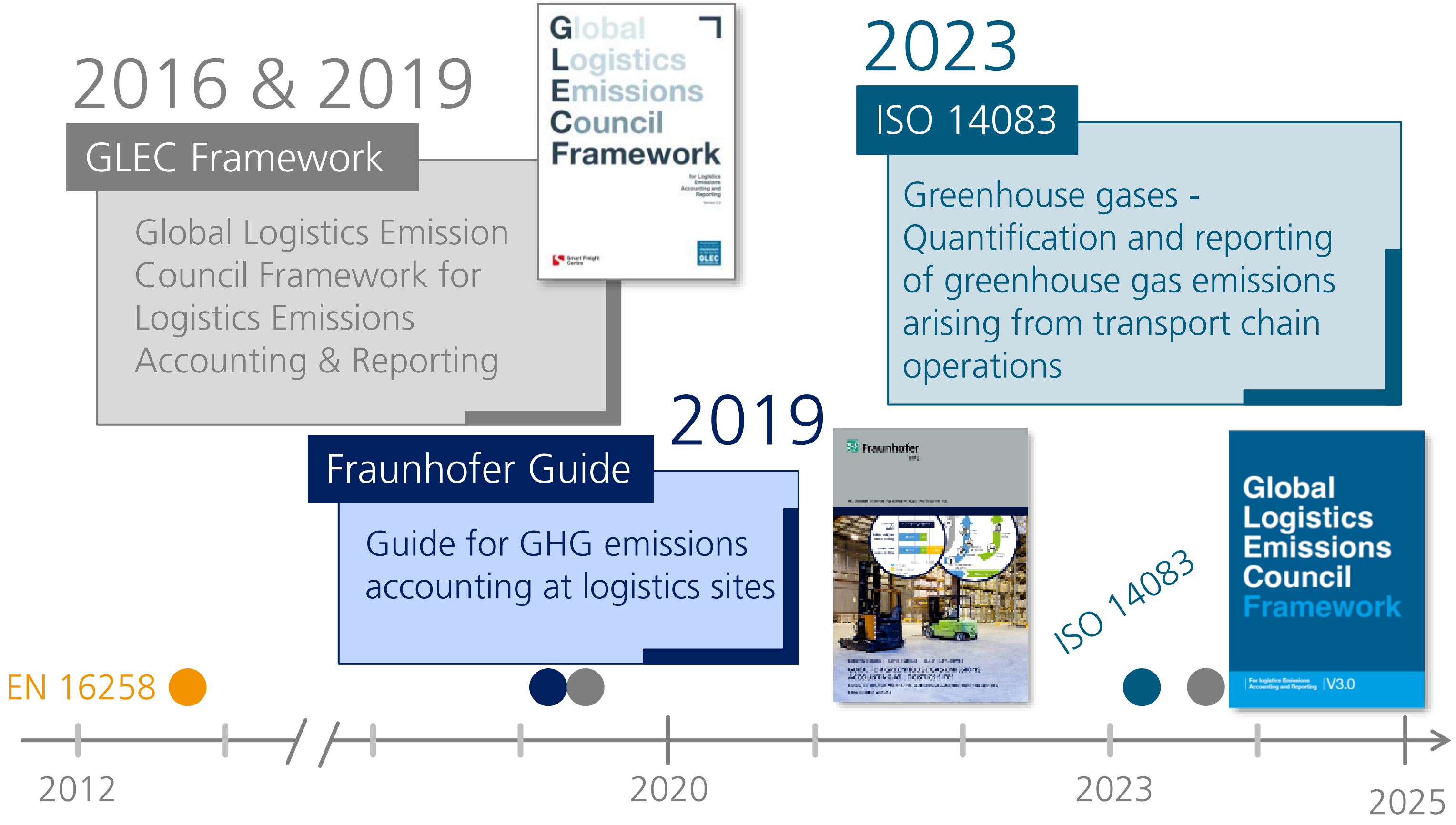
- Published in March 2023 and replaces EN 16258:2012
- Translations, e.g. in German (DIN EN ISO 14083)

GLEC Framework (Version 3)

- Publication was at the end of September 2023

Fraunhofer Guide on logistics hubs

- The update is scheduled for the end of 2023



There is a knowledge gap for logistics hubs regarding environmental performance, GHG emissions & reduction potentials

GreenRouter

POLITECNICO MILANO 1863

Fraunhofer IML

Universidad de los Andes Colombia

Thanks to all participating in and supporting this market study!

Let's overcome this gap!

Market studies in the project GILA on energy efficiency & GHG emission intensities at logistics hubs

- 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

Project **GILA - German, Italian & Latin American consortium for resource efficient logistics hubs & transport**

07 / 2020 – 07 / 2023

Project lead: Fraunhofer IML

Fraunhofer IML · P3 Logistic Parks · Politecnico Milano 1863 · FERCAM Logistics & Transport · Prysmian Group · Universidad de los Andes Colombia · ARCADIS · GreenRouter · CONAD · FLEXILOG

Gefördert vom Bundesministerium für Bildung und Forschung

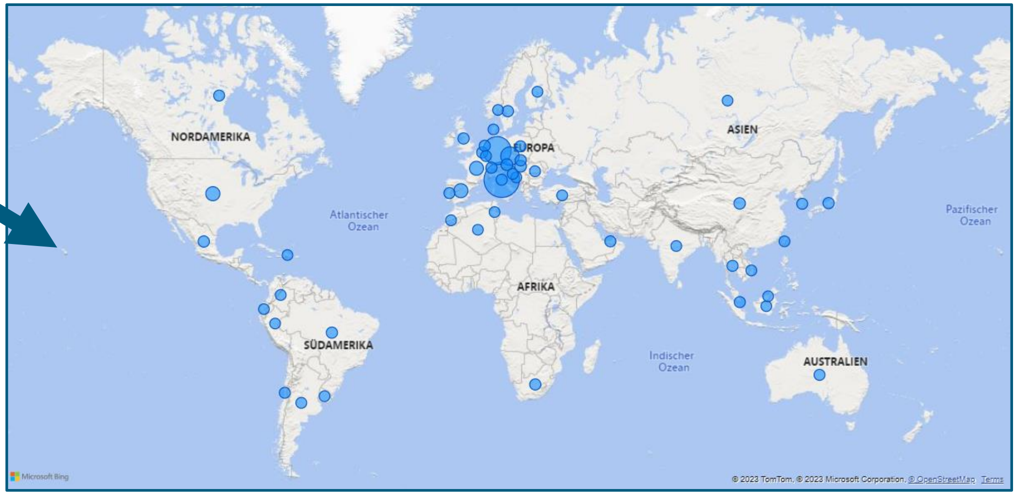
GILA · Fraunhofer IML

Market studies in GILA project

Extension of global coverage

1st study (2021)

2021	2023
159 hubs	843 hubs
14 countries	33 countries
93% in Europe	85% in Europe



after 3rd study (2023)

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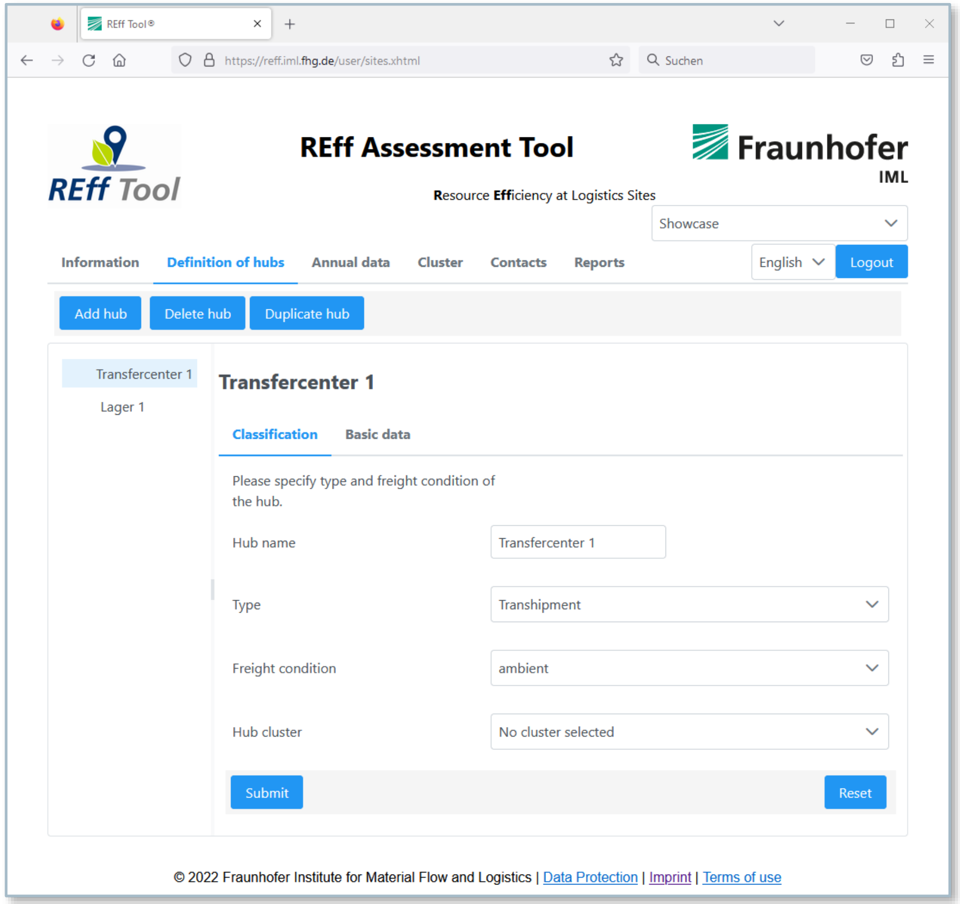
KPI for companies and individual logistics hubs

supported by REff Tool®

Online tool for GHG assessment with primary data	Generally, use at no cost possible https://reff.iml.fhg.de/ Each company uses its individual database
Surveys for data collection	Updated surveys per site type for manual data input online
Aligned with ISO 14083	GHG emissions aligned with international harmonized method regarding scope, emission factors and reports
Data base with more than 900 sites	Annual market studies and update of average KPIs with anonymised data base of logistics sites worldwide

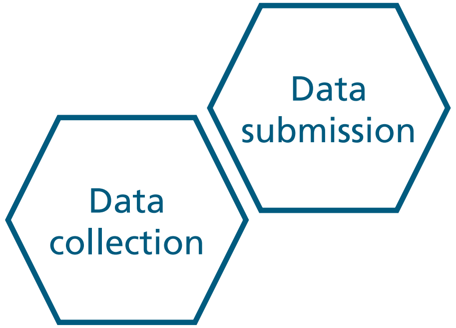


DE EN IT ES

planned

Input data needed

Online platform REff Tool®

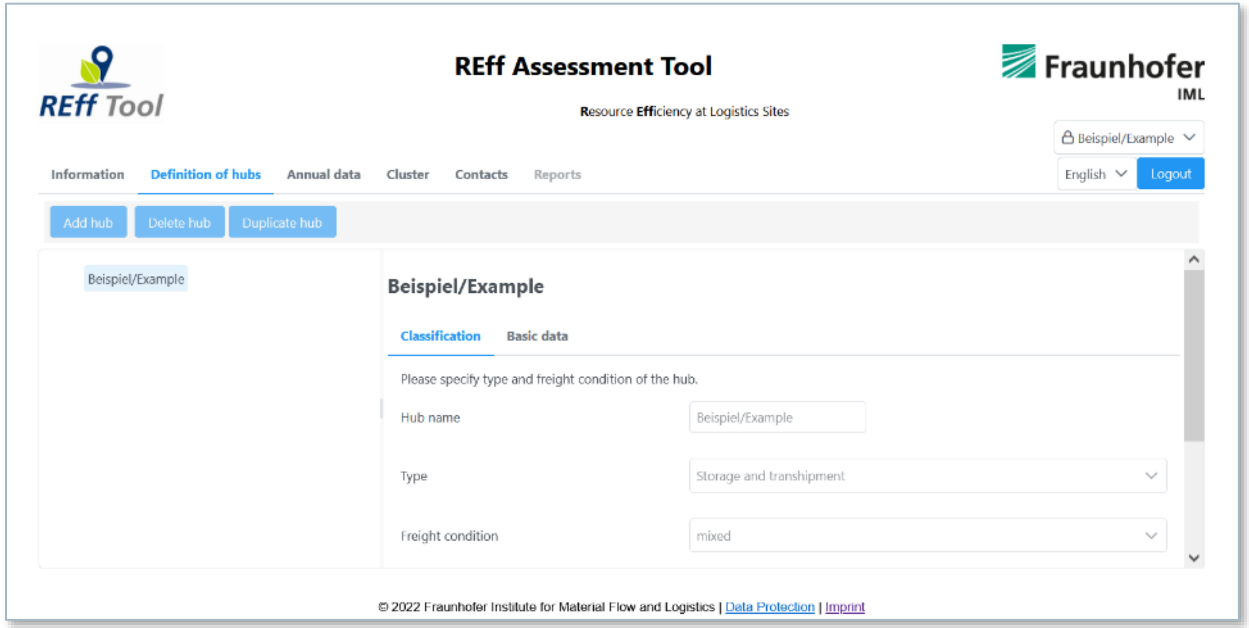


Classification of site

- 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



REff Tool® is available via: https://reff.iml.fraunhofer.de/

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Fraunhofer IML

Input data needed

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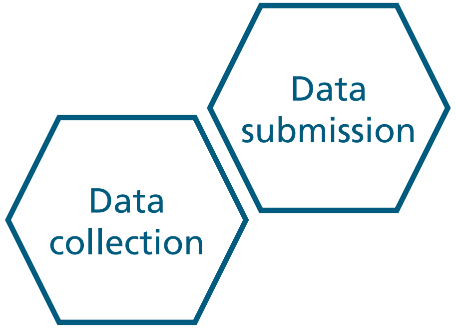


Classification of site

Basic data

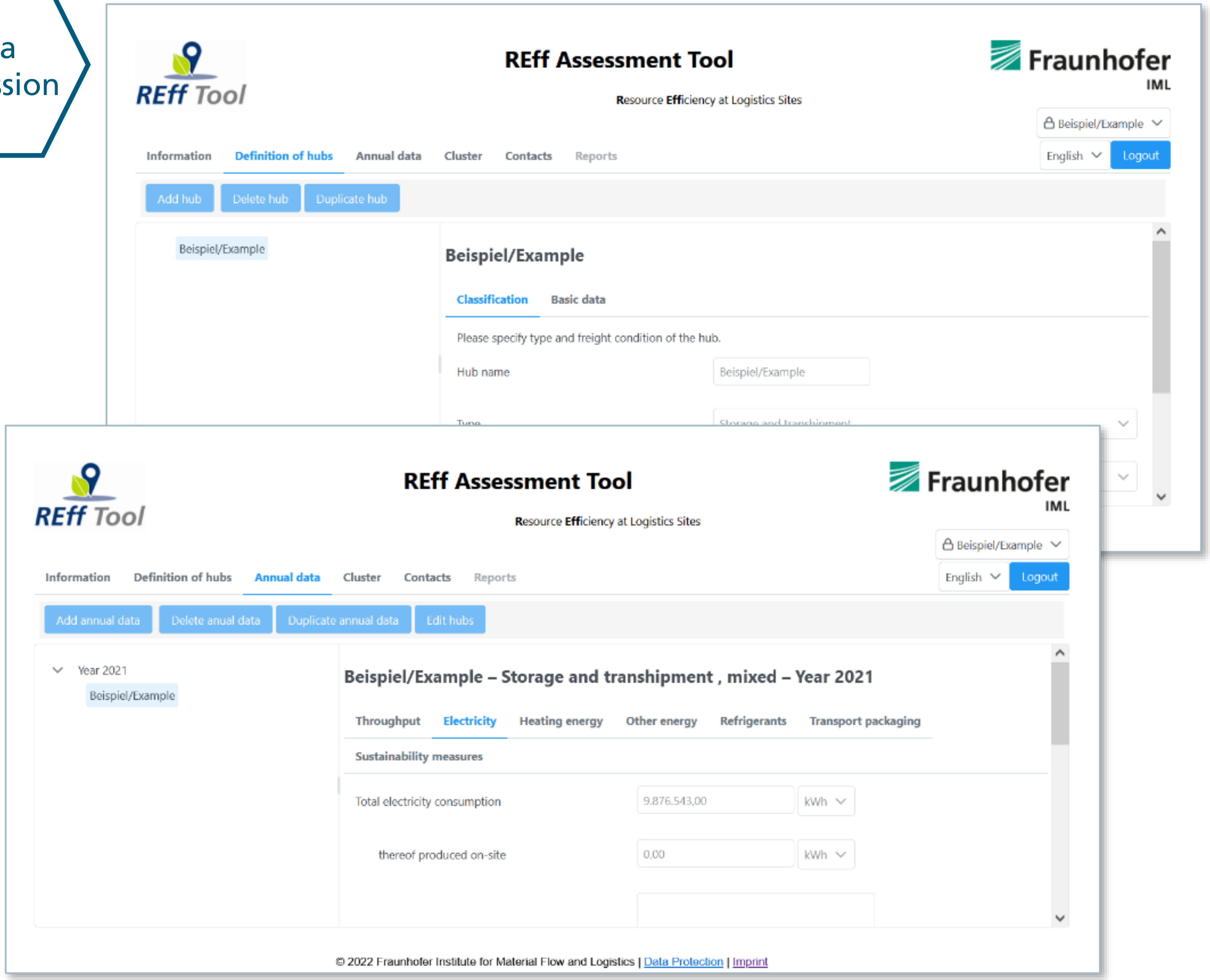
Annual data

- Throughput (tonnes or alternative unit)

Annual consumption

- Electricity,
- Heating energy (natural gas, district heating, steam etc.)
- Other energy (diesel, petrol, LPG etc.)
- Leakage of refrigerants (estimated by annual refill)
- Optional: transport packaging

Sustainability measures
Implementation or priorities of 31 measures



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Data base for the elaboration of average key performance indicators

based on three GILA market studies[1] consolidated

Info on sample size

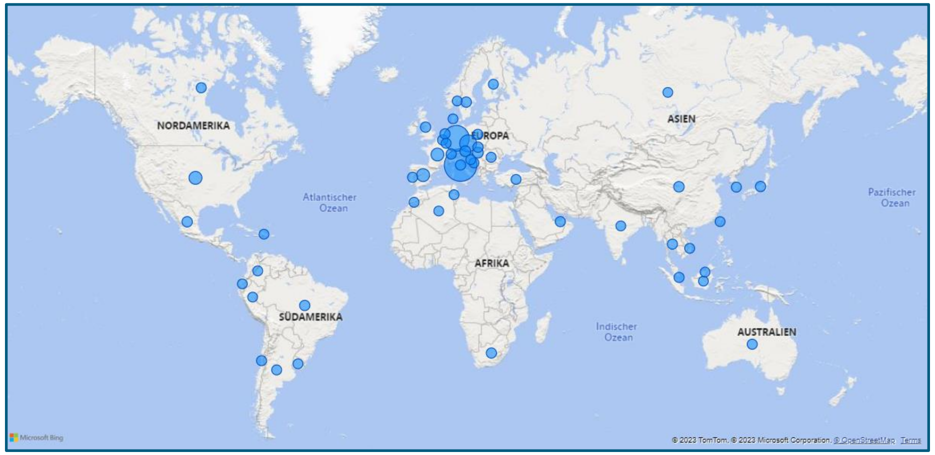
843 hubs

51 countries worldwide

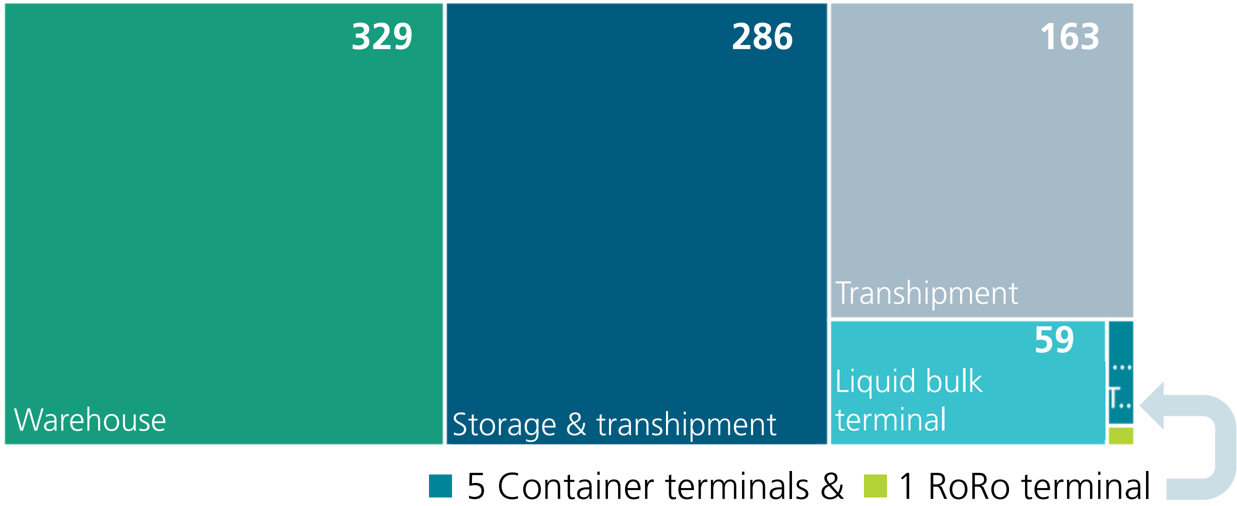
> 15.48 Mio. m² logistical area (indoors)[2] — 696

Real estates[2]: > 5.1 bill. tons (outbound) — 334

Terminals[3] : > 2.4 bill. tons (outbound) — 60



Countries with >50 hubs: Germany, Italy, Czech Republic, Spain, France, USA



(1) conducted in 2021, 2022 and 2023
(2) Hubs with storage and/or transhipment
(3) Terminals (container, liquid bulk)

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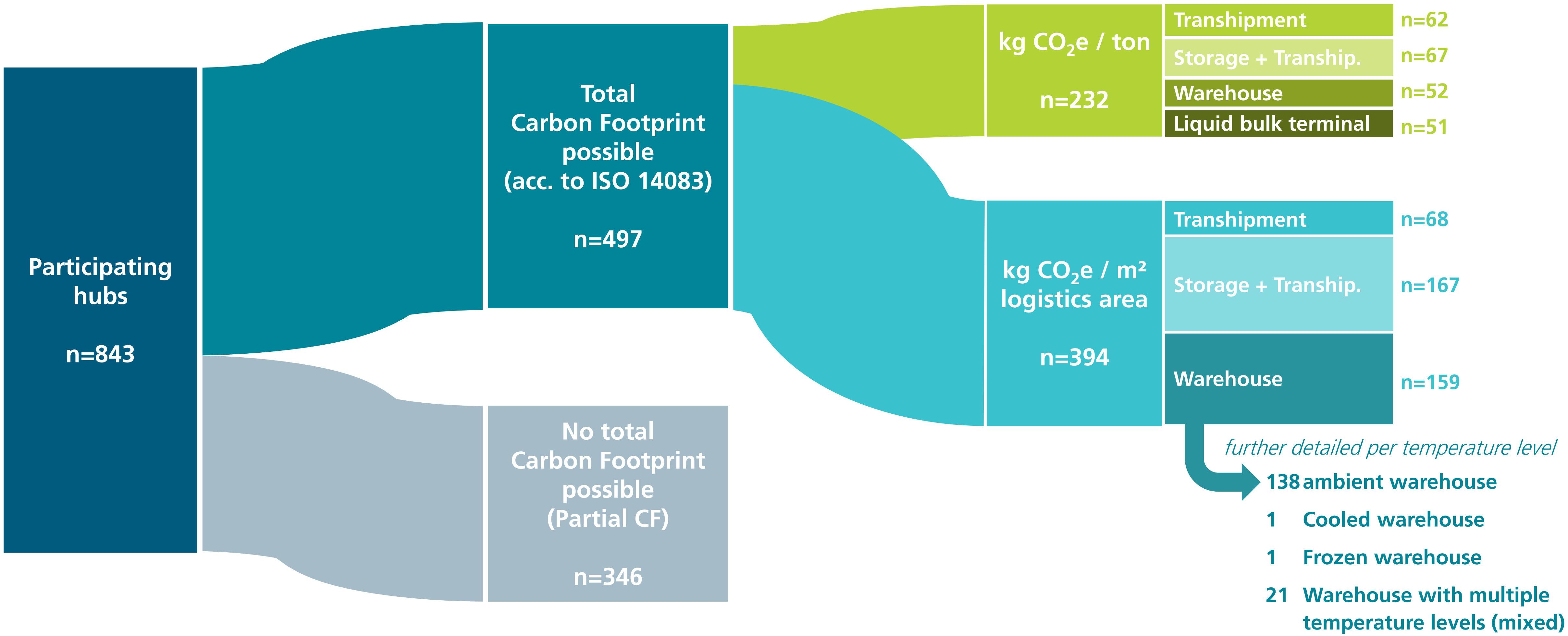
Completeness of provided data

Number of participating hubs & sample size for KPIs



Conclusion: Further market studies necessary

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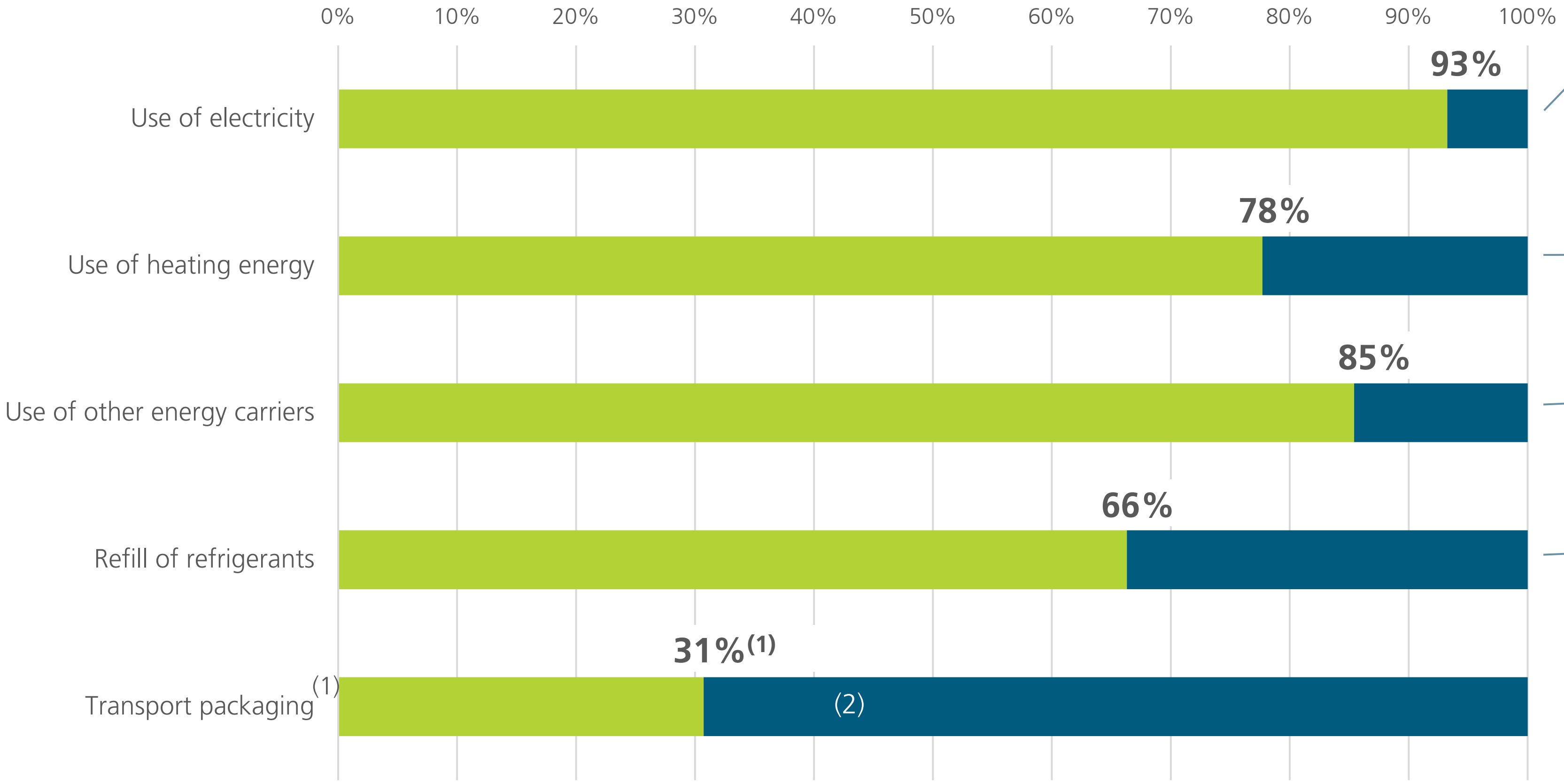
GILA Fraunhofer IML

Where do data gaps exist?

Availability of data



60% of hubs use national electricity mix
32% purchase „green" tariff, though do not now the underlying mix

esp. natural gas (83% of hubs), district heating and heating oil

esp. diesel/biodiesel (91%), petrol/ethanol and propane

esp. R-410A, R-717 (ammoniac), R-404A, R-134a, R-448a and R-744

843

(1) optional information in market study
(2) no information or explicitly stated that no information available

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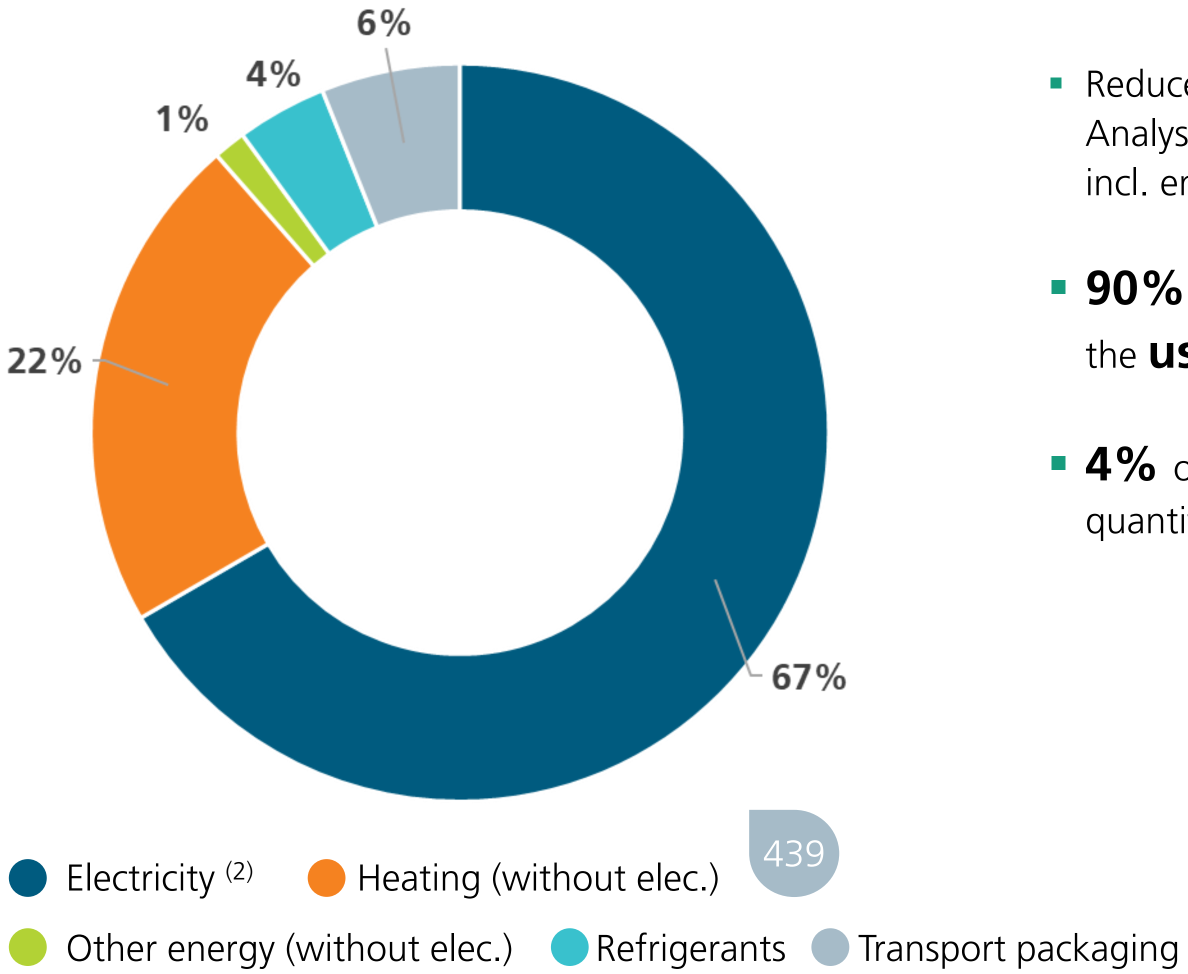
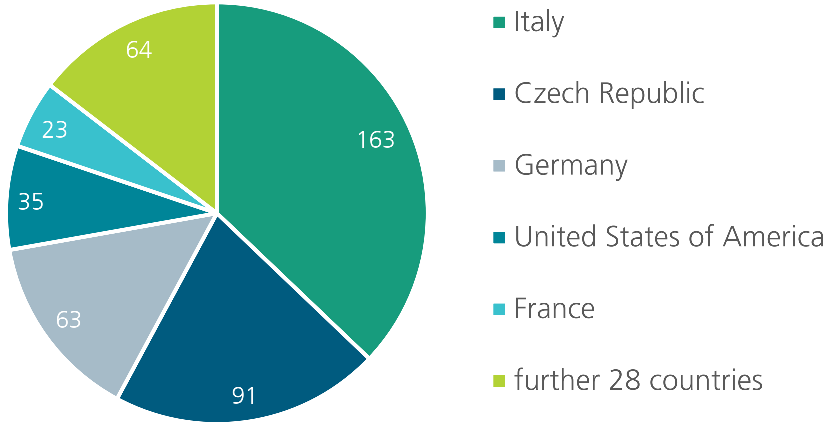
Sources of GHG emissions at logistics hubs

Focus logistics real estates(1)



- Reduced data base:
  Analysis of hubs with an ISO aligned GHG emissions quantification (n=439); incl. emissions related to storage and use of transport packaging
- **90% of GHG emissions** of logistics real estates origin from the **use of energy**: 67% electricity, 22% heating, 1% other energy
- **4%** of GHG emissions relate to **refrigerant leakage** (estimated by the quantity of refill)



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(1) Hubs offering storage and/or transhipment (no terminals)
National electricity mix (so-called »location based«)

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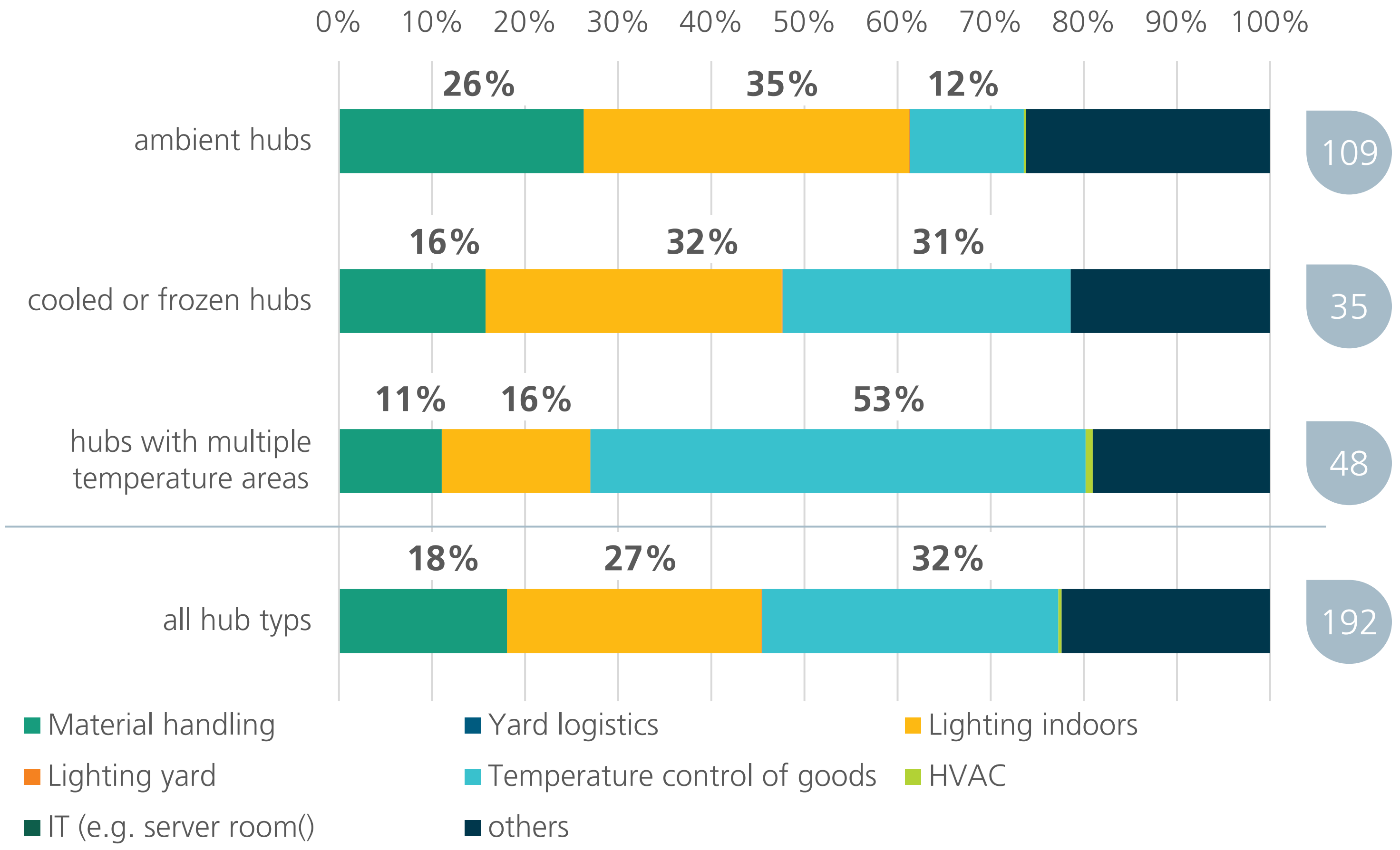
What is the electricity used for?

Allocation to predefined activity clusters



- **25% of hubs**(1) have further detailed their electricity consumption.
- Theses hubs consume 43% of total electricity consumption of the study.
- 70% of hubs specified explicitly, that they do not have any transparency on detailed electricity use.

- Almost 80% of the electricity consumption has been allocated to pre-defined activity clusters.

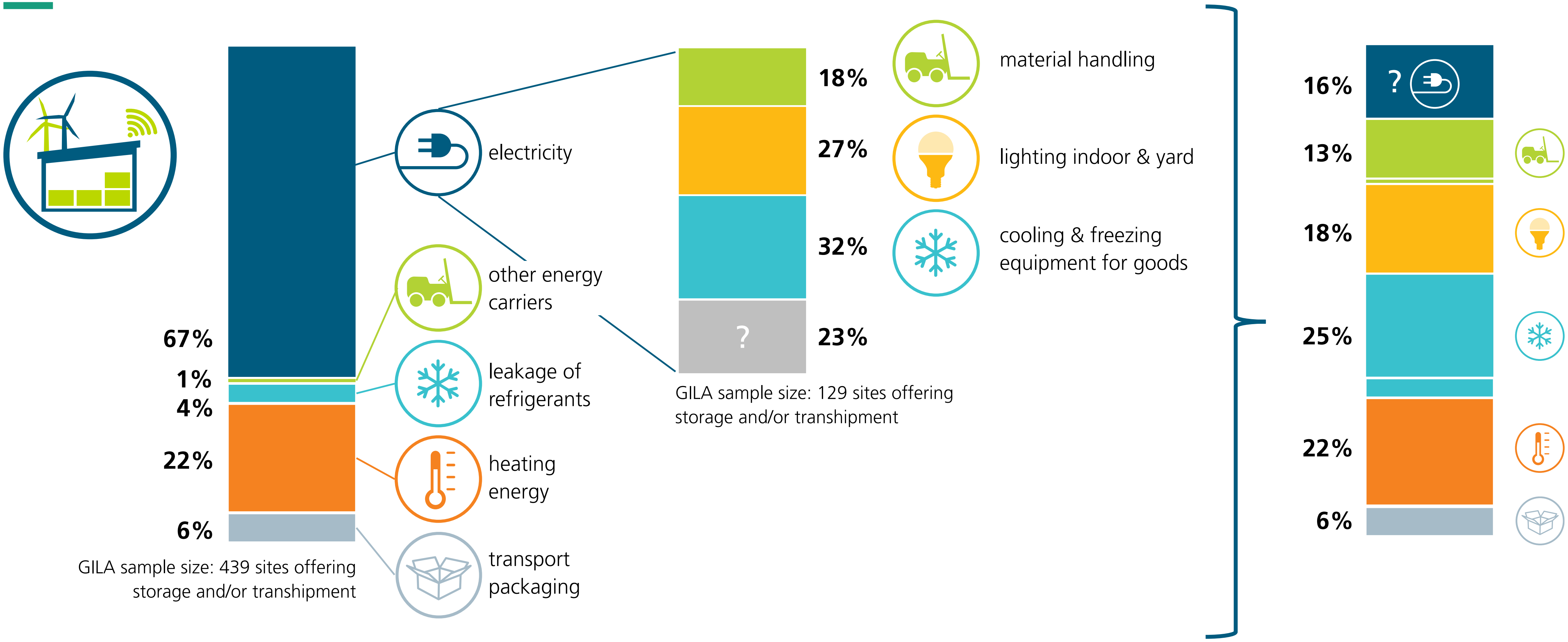
Overall allocation of electricity:

- 32% for temperature control of goods
- 27% for lighting indoors
- 18% for material handling

(1) Focus logistics real estates (without terminals)

GHG emissions arising at logistics sites

Shares derived by GILA market studies (2021-2023)



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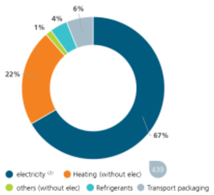
Emission intensity values for logistics hubs

- Work in progress -



Carbon Footprint (CF)

- Total CF of hubs

  kg CO_2e / a

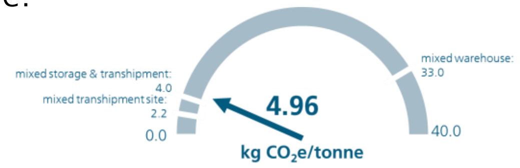
Emission intensity

- based on throughput

  kg CO_2e / tonne

▶ ISO 14083:
kg CO_2e / tonne

- Use as default value
  - if e.g., no primary data is available
  - in tools in combination with transport emissions
  - in GLEC Framework (version 3.0)
- option for the future: use as benchmark



Work in progress!!	ambient		mixed	
Transhipment	0.6 kg CO_2e / t	n=65	2.2 kg CO_2e / t	n=6
Storage + transhipment	2.1 kg CO_2e / t	n=58	4.0 kg CO_2e / t	n=9
Warehouse	17.5 kg CO_2e / t	n=49	33.0 kg CO_2e / t	n=3
Liquid bulk terminal	3.1 kg CO_2e / t	n=22	8.1 kg CO_2e / t	n=29

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Emission intensity values for logistics hubs

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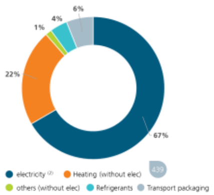

Carbon Footprint (CF)

- Total CF of hubs

  kg CO_2e / a

Emission intensity

- based on logistical area (indoors)

  kg CO_2e / m²

Work in progress!!	ambient		mixed	
Transhipment	16.7 kg CO_2e / m²	n=61	19.5 kg CO_2e / m²	n=7
Storage + transhipment	28.0 kg CO_2e / m²	n=124	64.4 kg CO_2e / m²	n=43
Warehouse	23.6 kg CO_2e / m²	n=138	22.8 kg CO_2e / m²	n=21

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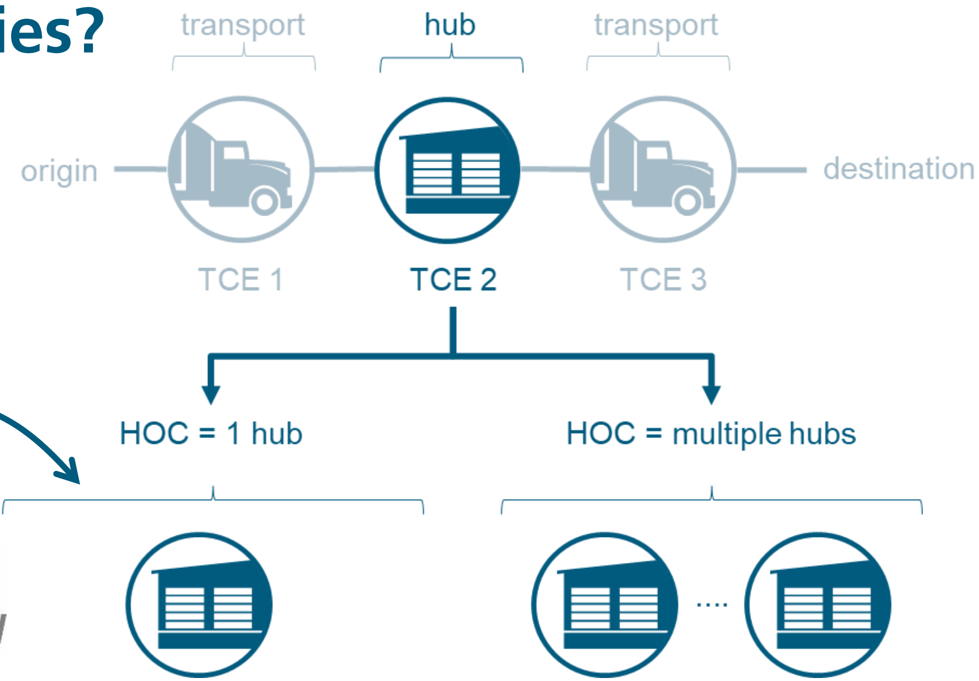
Why participating in the market studies?

Transparency & own values



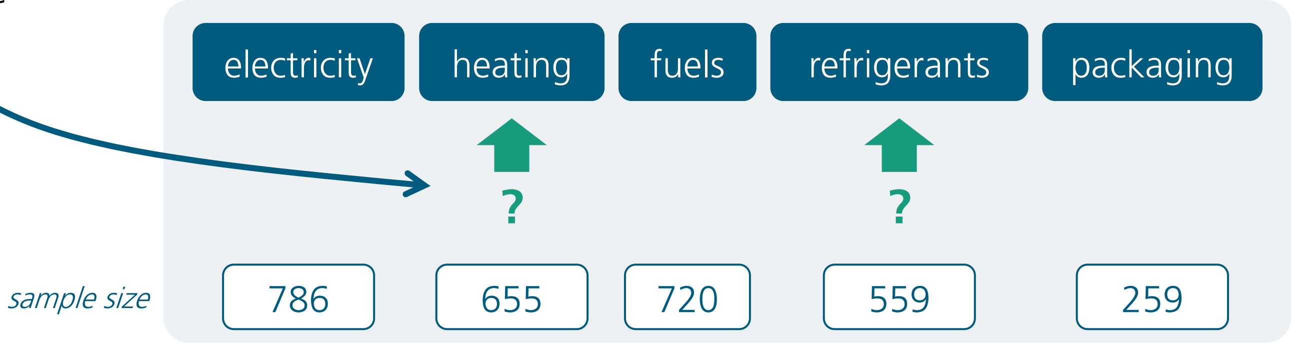
Participating companies receive their individual GHG emission intensity values

- aligned with ISO 14083
- one hub = 1 HOC (hub operation category)

Use of the REff Tool® prepares for calculating total CF & elaborating more specific KPIs, e.g.

- elaboration of emission intensity values covering a number of comparable hubs (= HOC with multiple hubs)
- allocation at activity level, e.g., two KPIs per hub
- support in case of data gaps using KPIs of anonymised data base

Support of overall research on sustainability of logistics hubs & elaboration of average emission intensity values



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Market studies in GILA project

Extension of global coverage

1st study (2021)

after 3rd study (2023)

2021	2023
159 hubs	843 hubs
14 countries	33 countries
93% in Europe	85% in Europe

Annual market studies will continue!

Timeline

- Collection of annual data continuously possible
- Deadline: May 31st
- Start of analysis: June 1st
- Publication of values: August
  online: https://reff.iml.fhg.de/

Participation via

- Osservatorio Contract Logistics "Gino Marchet" of Politecnico di Milano
- REff Tool® of Fraunhofer IML

Support our annual market studies

It is more than just receiving a single KPI

ISO 14083 (normative scope)

- Transhipment sites
- Energy & refrigerant related GHG emissions
- For electricity: location-based approach

ISO 14083 (optional scope)

- Warehouses
- Energy & refrigerant & (re)packing related GHG emissions

→

- GHG emissions per tonne
- GHG emissions per m², …

Individual electricity mix at hubs

- Market-based emission factors
- Self-generation of power on-site

Allocation of consumption

- Transparency for identifying fields of action & elaborating decarbonisation roadmap

→

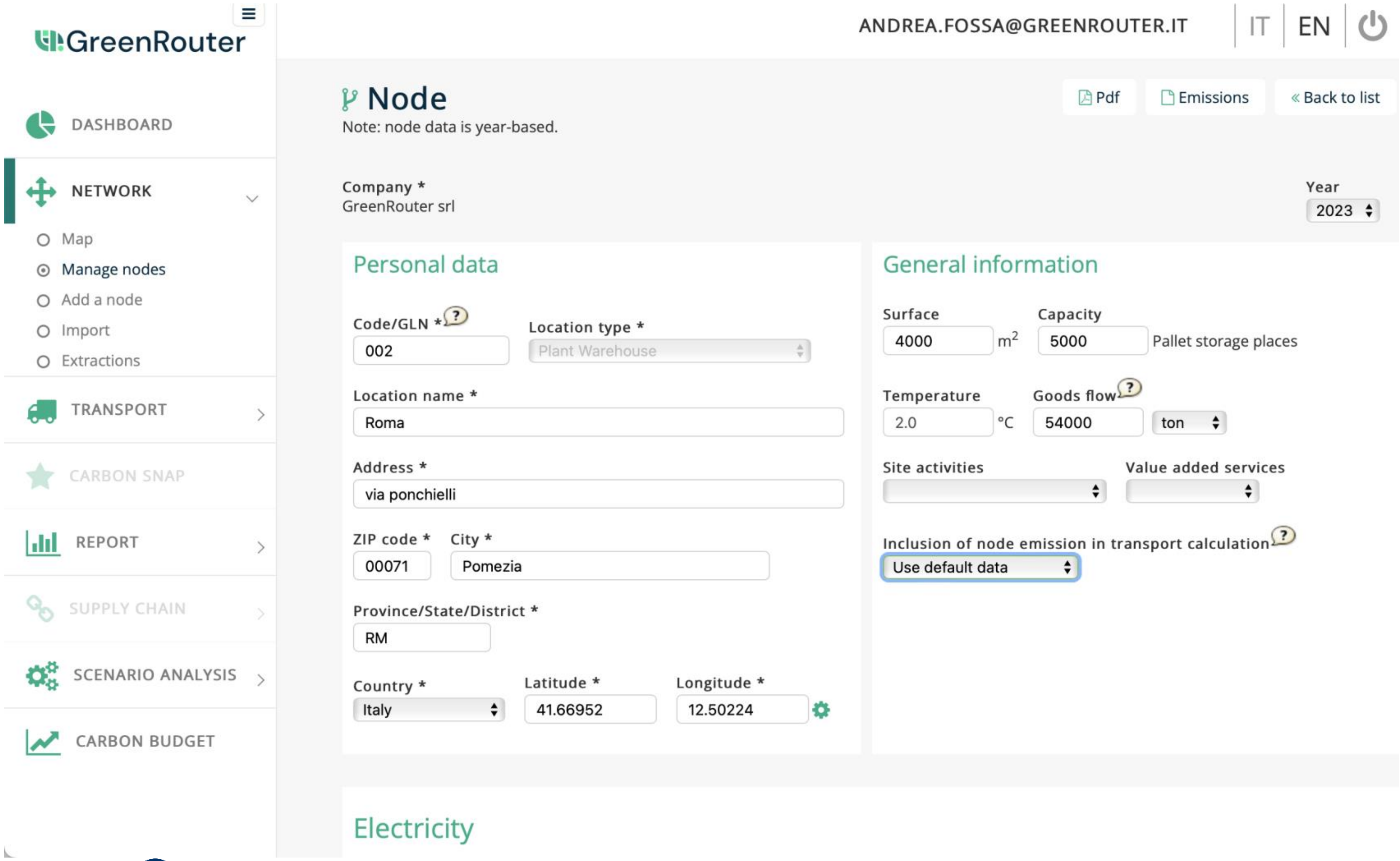
- Decarbonised KPIs
- Estimates for decarbonisation potentials & successes

GHG assessment of logistics networks

- Direct use of provided data
- Import of individual KPIs in other tools
- Publishing of average KPIs in standards and other tools
- Quantitative basis for cost vs. CO2e redesign

Support our annual market studies

It is more than just receiving a single KPI



Structuring data over time allows for further outcomes

- GILA growing database will allow for segmentation + YoY analysis
- Internal benchmarks on specific activities enriched by GILA values
- Quantitative support while defining priorities of action

GreenRouter

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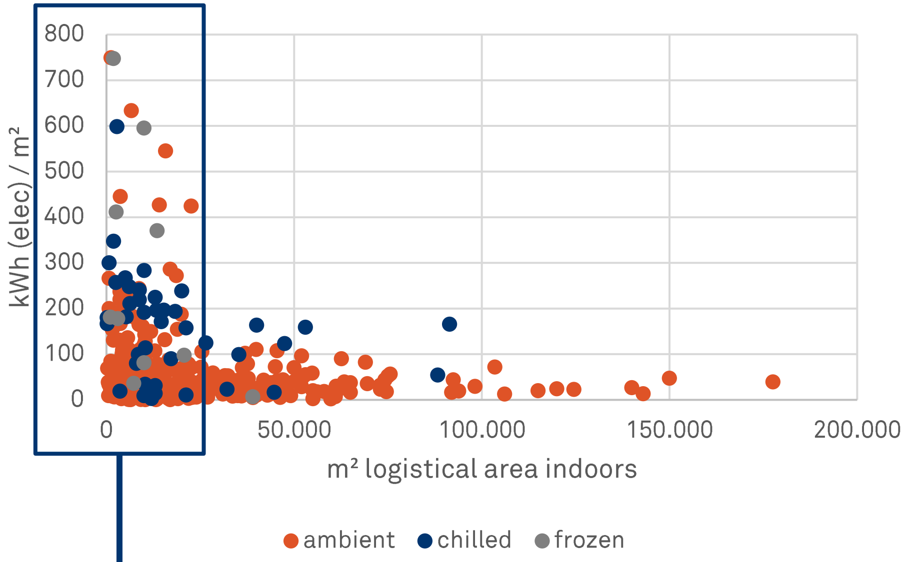
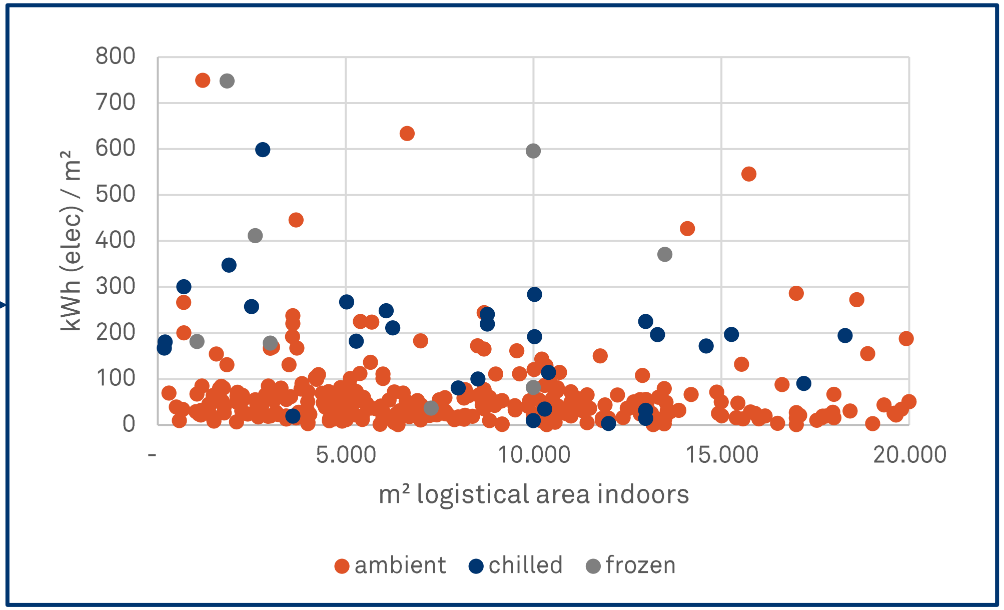
Electricity consumption per logistical area indoors or logistical real estates



- **Performance of (partial) sample shows pattern**
- **Segmentation based upon internal activity or automation level might be very useful**
  - **we need a larger sample !**



- ambient real estates, n=433
- chilled real estates, n=42
- frozen real estates, n=11

Which share do logistics sites contribute to the total of GHG emissions?

- Still difficult to say: Not addressed by national statistics
- Some assumptions published
  - 13% of logistics emissions related to logistics buildings (global) WEF 2009
  - 11 - 20% of transport emissions related to warehouses (UK, US) McKinnon 2018
  - 15% of logistics emissions related to logistics nodes (Germany) Rüdiger et al. 2017

Use of initial KPIs elaborated in GILA for new estimates

Work in progress!!	ambient		mixed	
Transhipment	16.7 kg CO_2e / m²	n=61	19.5 kg CO_2e / m²	n=7
Storage + transhipment	28.0 kg CO_2e / m²	n=124	64.4 kg CO_2e / m²	n=43
Warehouse	23.6 kg CO_2e / m²	n=138	22.8 kg CO_2e / m²	n=21

on average ~ 25 kg CO_2e/m^2

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Decarbonising logistics hubs

GERMANY

- A very rough estimate…

Footprint of logistics sites [m²]	x	Average GHG-KPI [kg CO_2e/m²]
~ 300 Mio m²	x	~ 25 kg CO_2e/m²
	=	~ 7.4 Mio t CO_2e

…
Der Footprint an Logistikflächen in Deutschlan
300 Mio. m², wovon aber aufgrund von Bausub
Eigentumsverhältnissen ein Großteil dem Nutze
dürfte. Der auch unter immobilienwirtschaftlichen Aspekten interessante
…

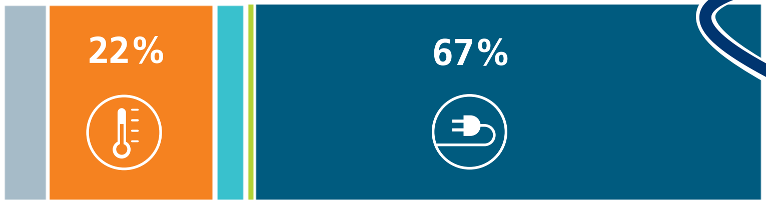
DVZ Deutsche Verkehrs-Zeitung

[dvz 2019]

GILA average value for all logistics real estates

in comparison German road transport:
145 Mio t CO_2e (2022) [UBA 2023]
→ 40% ≅ 60 Mio t CO_2e in freight transport

~ 11% of logistics emissions



GILA sample size: 439 sites offering storage and/or transshipment

- 90% of the operational carbon footprint(1) of logistics sites result from energy use; **67% from electricity**
- The **transfer towards** electricity basing on **renewable energy sources** will impact carbon footprint decisively.

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(1) location based approach

Decarbonising logistics hubs

ITALY

- A second, very rough estimate...

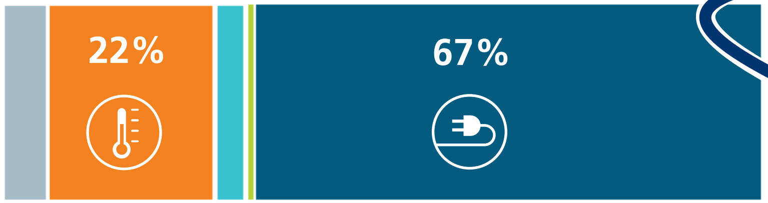
Footprint of logistics sites [m²]	x	Average GHG-KPI [kg CO_2e/m^2]
~ 60+ Mio m²	x	~ 25 kg CO_2e/m^2
	=	~ 1.5 Mio t CO_2e

Source: World Capital/OSIL, Guizzo.eu

GILA average value for all logistics real estates

in comparison Italian road transport:
109 Mio t CO_2e [2022 ISPRA]
→ 27% road freight ≅ 30 Mio t CO_2e

~ 4,8% of logistics emissions



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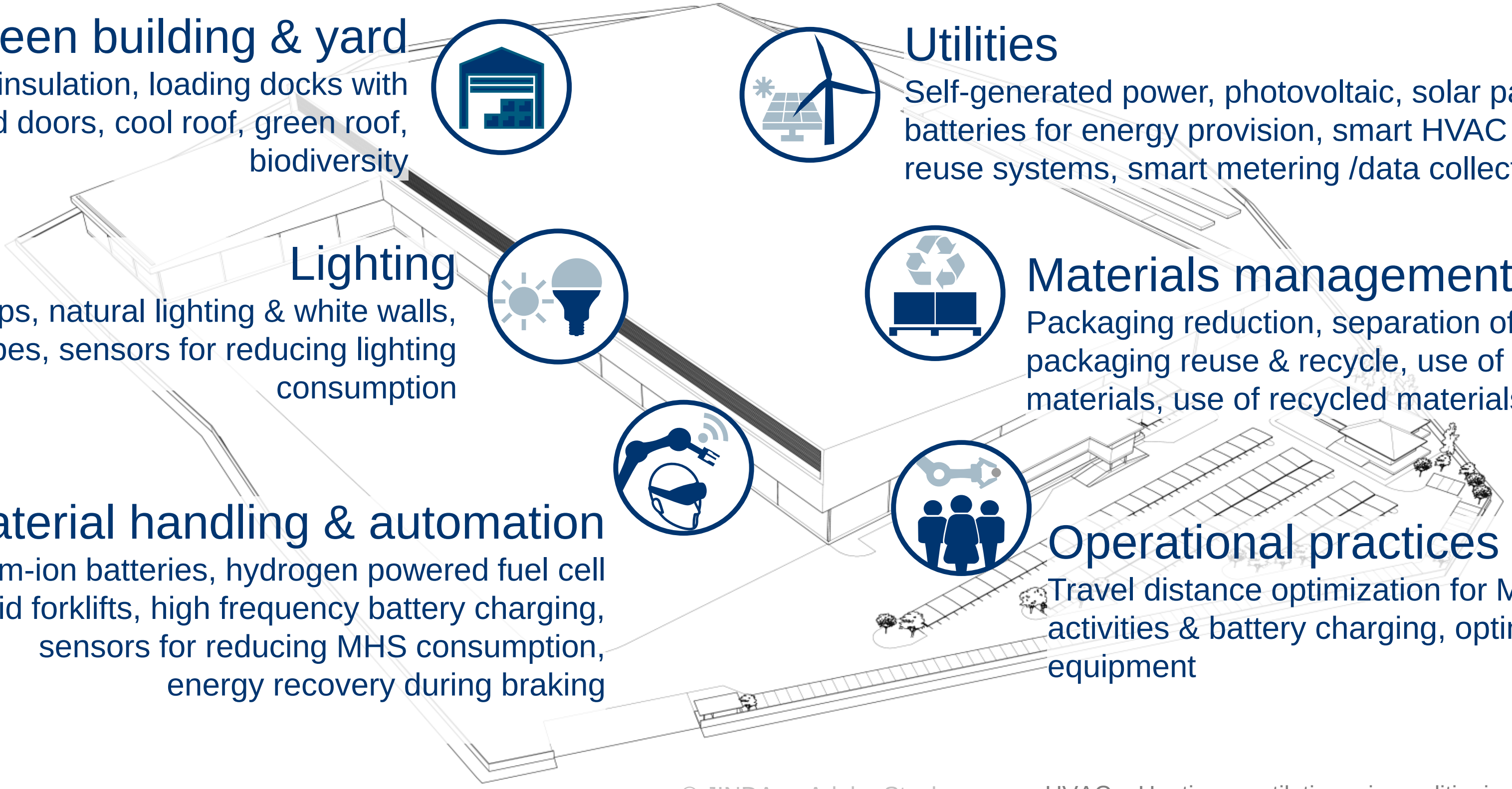
Decarbonisation measures

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, biodiversity

Lighting

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

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

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

Materials management

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

Operational practices

Travel distance optimization for MHS, optimal planning for MH activities & battery charging, optimized location of charging equipment

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

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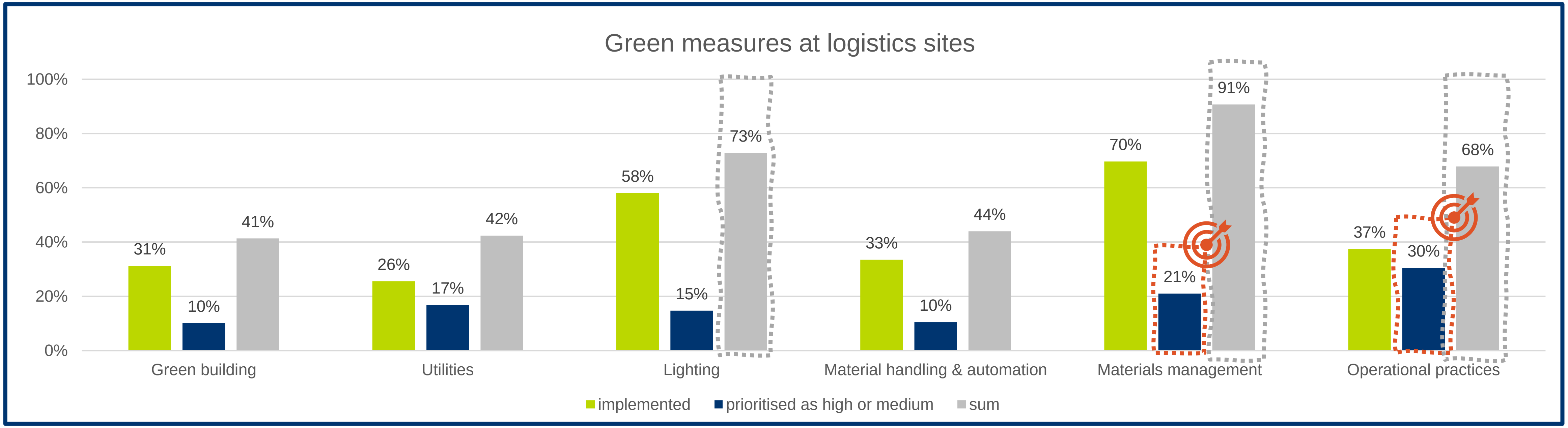
see also Perotti et al. (2023)

Decarbonisation measures

Current adoption vs. prospective scenario: an overview

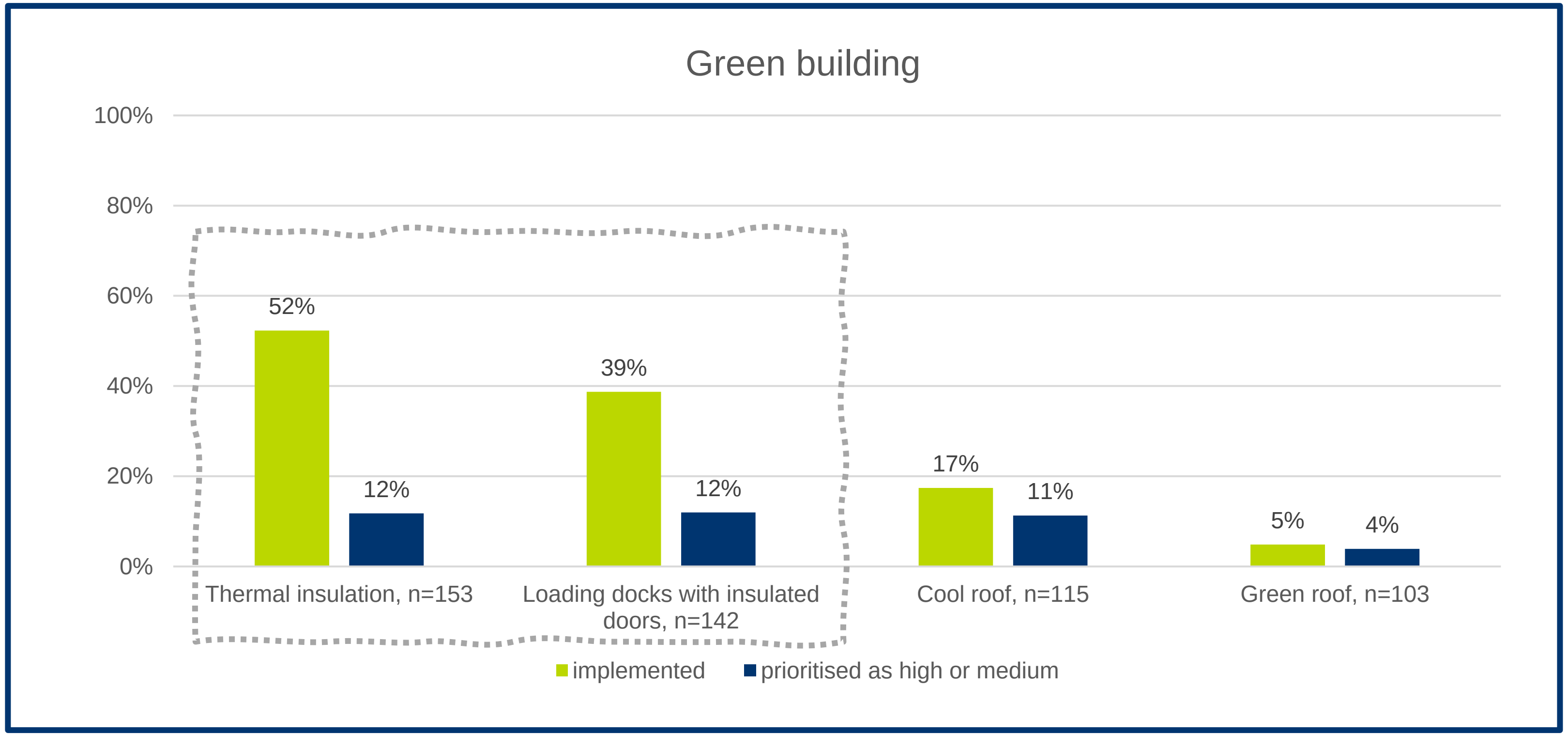
- **Materials management** (91%), **lighting** (73%), and **operational practices** (68%) appear the major areas of intervention in terms of current adoption and priority for future interventions.



Green building

Current adoption vs. prospective scenario

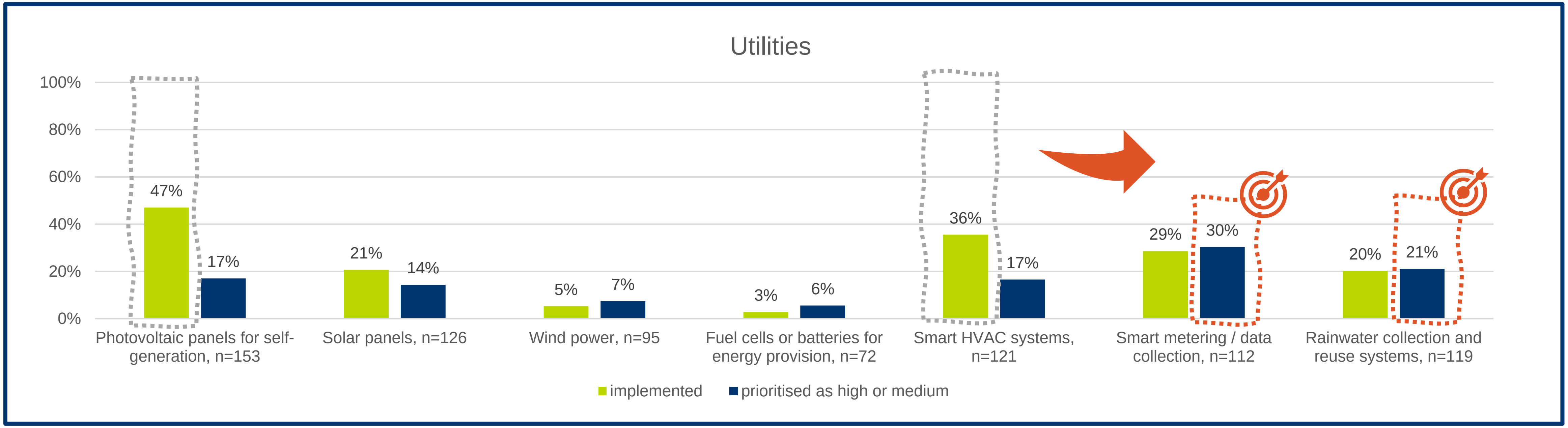
- ▶ 153 sites provided answers on the measure "**Thermal insulation**", half of which have implemented it.
- ▶ **Loading docks with insulated doors** is another widespread solution (55 sites).
- ▶ Innovative solutions such as **cool roof** and **green roof** are still scarcely adopted.



Utilities

Current adoption vs. prospective scenario

- **Photovoltaic panels** (72 sites) for own use and **smart HVAC systems** (44 sites) are particularly widespread.
- Priorities for **future** interventions seem to highlight a market interest in **smart metering** (34 sites), followed by rainwater collection and reuse systems (25).

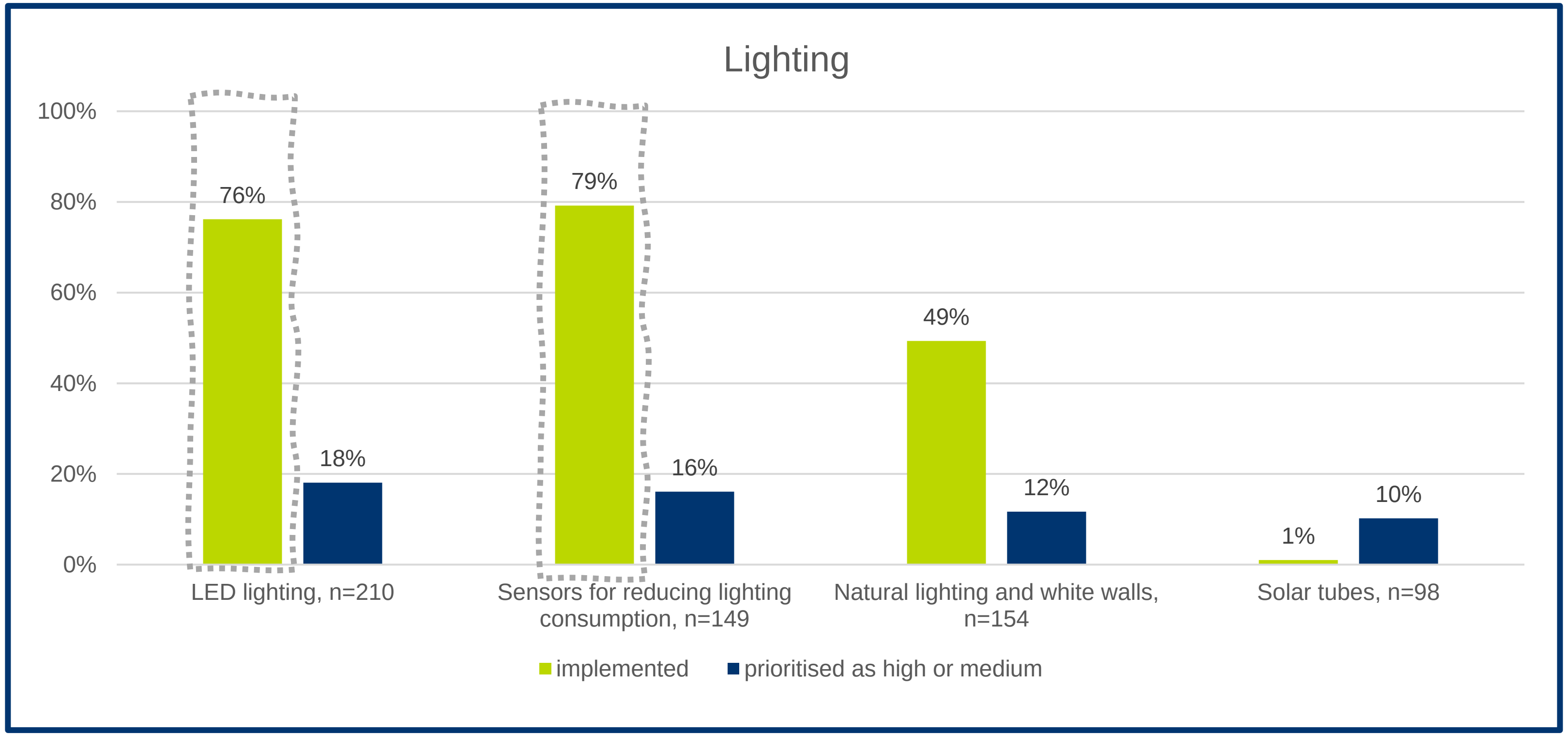


HVAC – Heating, ventilation, air conditioning

Lighting

Current adoption vs. prospective scenario

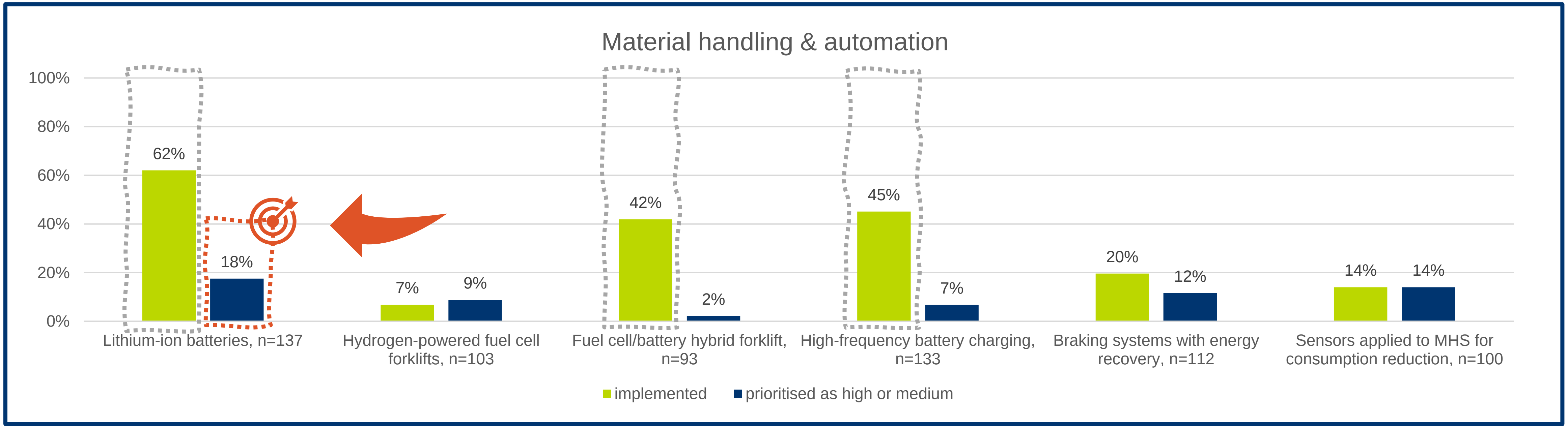
- **LED lighting** (160 sites) together with **sensors for reducing consumption** (118 sites) are the most implemented solution by far.
- A relevant share also uses natural lighting and white walls (49%) for energy efficient working conditions.



Material handling and automation

Current adoption vs. prospective scenario

- Current adoption is mainly concentrated on **forklifts**, especially on the implementation of lithium-ion batteries (85 sites), **high-frequency battery charging** (60 sites) or **fuel cell/battery hybrid forklift** (39 sites).
- Lithium-ion batteries are **also prioritised** as high or medium for future implementation in 25 sites (18%).



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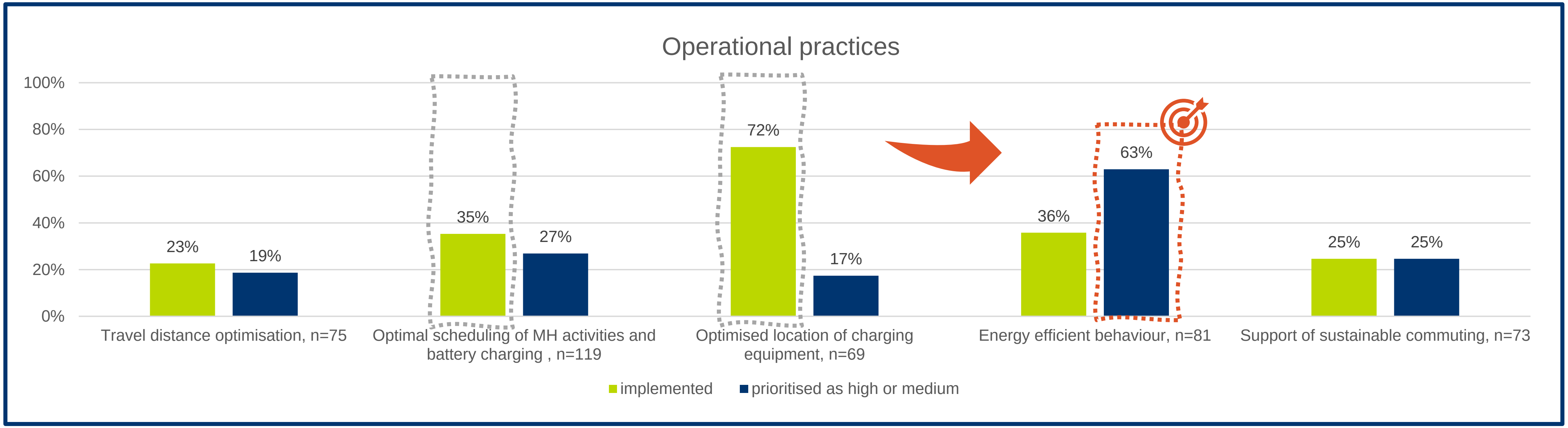
Operational practices

Current adoption vs. prospective scenario

- Improvement by **optimising the location of charging equipment** of material handling system has been adopted by 50 sites, followed by **optimal scheduling of MH activities and battery charging** (42 sites)
- **Energy efficient behaviour** is also quite common (30 sites) and has emerged as a clear focus for future implementation (63%).

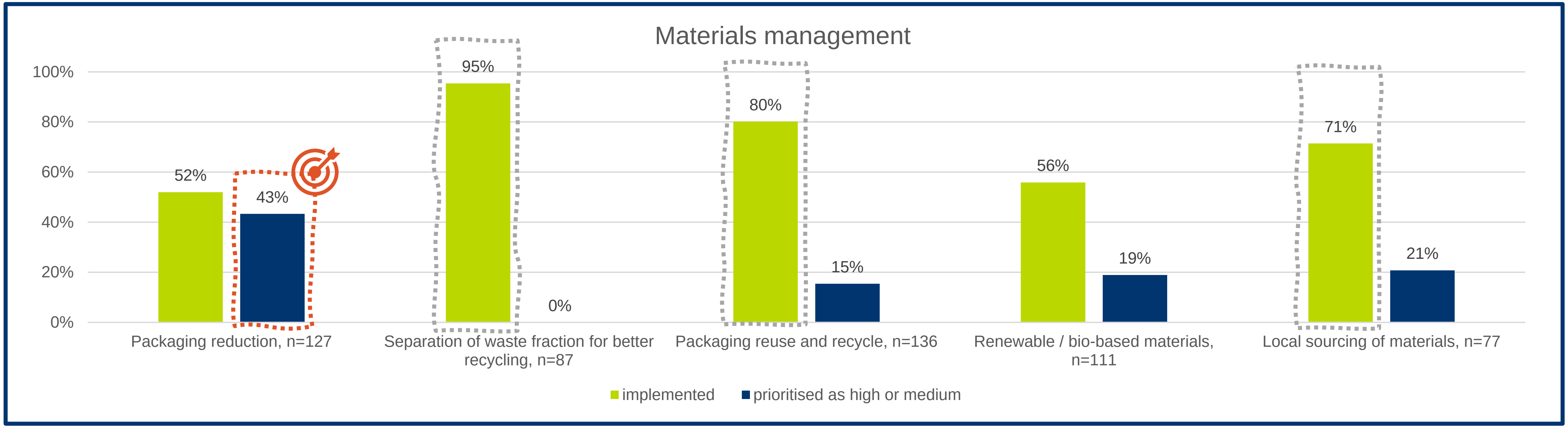


MH – Material handling

Material management

Current adoption vs. prospective scenario

- High adoption: the main levers for companies involve **actions on the 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 decarbonisation measures

- Main focus on **lighting**, **materials management**, and **operational practices** with these latter two being the major areas in terms of **priority** for future interventions.
- **LED lighting** often coupled with **sensors for reducing consumption** are confirmed as particularly widespread.
- As per materials management, improved **materials** and more **efficient processes** appear as the key actions.
- Operational practices often entail both a focus on **MH optimisation** (charging location and scheduling) and an overall commitment towards **energy efficient behaviour**.

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

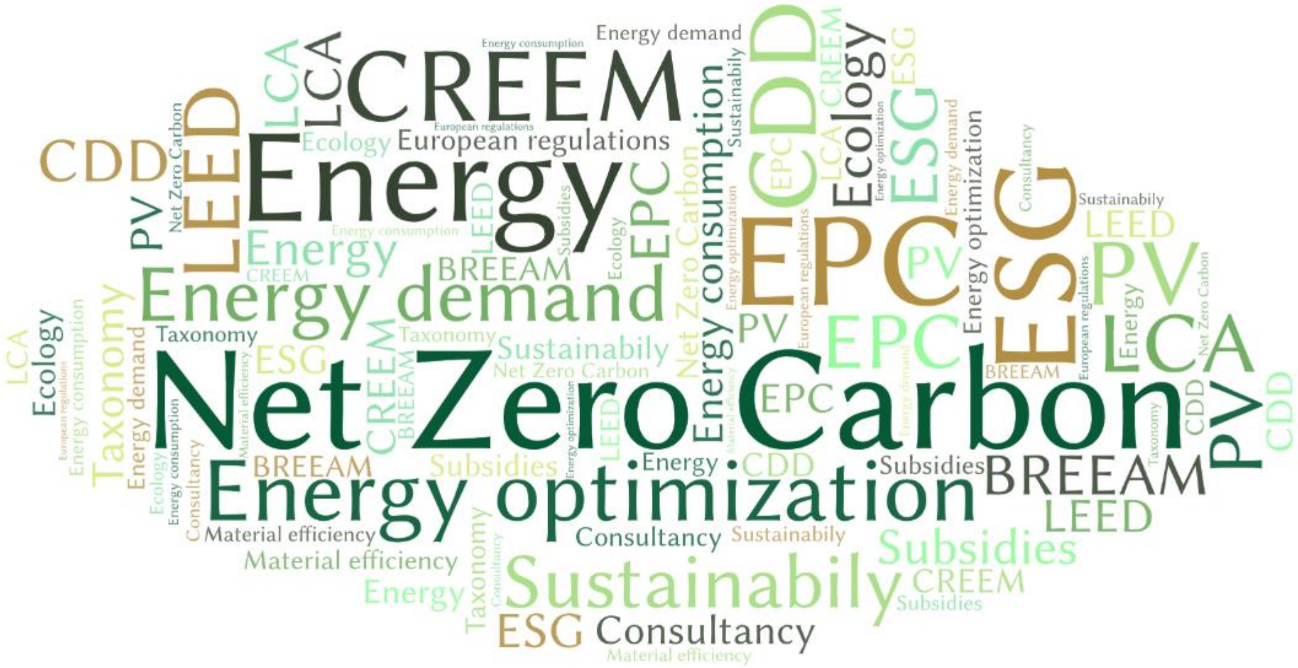
Alliance for Logistics Innovation through Collaboration in Europe

SUSTAINABILITY AND GHG PERFORMANCE AT LOGISTICS HUBS

Joint webinar of the GILA project and ETP ALICE

- GHG emissions quantification of logistics sites aligned with ISO 14083
  Jan-Philipp Jarmer, Fraunhofer IML
- Annual market studies & overall GHG performance indicators for logistics hubs
  Andrea Fossa, GreenRouter & Kerstin Dobers, Fraunhofer IML
- Possible solutions for decarbonising logistics hubs
  Sara Perotti, Politecnico di Milano
- Sustainability of hubs: a key driver for maintaining value over time
  Scarlet Romano, Arcadis Germany

Trend Study and Development Paths



- In achieving a climate-neutral building sector (85-95 % of the building stock will exist in 2050), the existing buildings must be strongly considered and renovated.

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Master model for sustainable prototype

- Assessment and Benchmarking of existing Construction types

Data Collection via site visits & experience		Organization and Grouping of Information		Benchmarks
STEP 1	+	STEP 2	=	STEP 3
18 Halls* were inspected in Germany in 2021 - 2022		Type of use Asset type Size Year of construction / modifications Energy certificate		**3a** Capex **3b** Carbex

Capex = Capital Expenditure
Carbex = Carbon Expenditure

Master model for sustainable prototype

- Assessment of existing Construction Types
- Capex = Capital Expenditure

1. The benchmarks were separated into three tables based on the condition of the buildings at the time of assessment (good = markup of 1, fair = markup of 1,1, poor = markup of 1,2).
2. The life cycle costs of different building equipment to determine the required investment for maintenance were considered

Condition	Factor
good	1

Benchmarks Capex per building age (€/sqm) // Office			
	Capex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	6,40	25,60	32,00
20	15,10	60,40	75,50
30	18,40	73,60	92,00
40	14,30	57,20	71,50
50	18,40	73,60	92,00

Benchmarks Capex per building age (€/sqm) // Warehouse			
	Capex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	5,40	21,60	27,00
20	13,10	52,40	65,50
30	16,40	65,60	82,00
40	12,90	51,60	64,50
50	17,10	68,40	85,50

Condition	Factor
Fair	1,1

Benchmarks Capex per building age xx // Office			
	Capex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	7,04	28,16	35,20
20	16,61	66,44	83,05
30	20,24	80,96	101,20
40	15,73	62,92	78,65
50	20,24	80,96	101,20

Benchmarks Capex per building age xx // Warehouse			
	Capex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	5,94	23,76	29,70
20	14,41	57,64	72,05
30	18,04	72,16	90,20
40	14,19	56,76	70,95
50	18,81	75,24	94,05

Condition	Factor
Poor	1,2

Benchmarks Capex per building age xxx // Office			
	Capex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	7,68	30,72	38,40
20	18,12	72,48	90,60
30	22,08	88,32	110,40
40	17,16	68,64	85,80
50	22,08	88,32	110,40

Benchmarks Capex per building age xxx // Warehouse			
	Capex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	6,48	25,92	32,40
20	15,72	62,88	78,60
30	19,68	78,72	98,40
40	15,48	61,92	77,40
50	20,52	82,08	102,60

Example: An office building constructed in 1990 (age ca. 30 years) and a fair condition has the following Capex (€/sqm) for the next 10 years (2023 – 2032, depending on date of assessment):

Year 1	Years 2-5	Years 6-10
20,24	80,96	101,20

Master model for sustainable prototype

- Assessment of existing Construction Types
- Carbex = Carbon Expenditure

1. The benchmarks were separated into three tables based on the condition of the buildings at the time of assessment (good = markup of 1, fair = markup of 1,1, poor = markup of 1,2).
2. The required investment to transform the existing buildings towards zero carbon buildings, were considered.

Condition	Factor
good	1

Benchmarks Capex per building age (€/sqm) // Office			
	Carex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	1,70	6,80	8,50
20	5,60	22,40	28,00
30	7,70	30,80	38,50
40	9,30	37,20	46,50
50	11,30	45,20	56,50

Benchmarks Capex per building age (€/sqm) // Warehouse			
	Carex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	1,30	5,20	6,50
20	4,40	17,60	22,00
30	6,50	26,00	32,50
40	7,80	31,20	39,00
50	9,70	38,80	48,50

Condition	Factor
Fair	1,1

Benchmarks Capex per building age xx // Office			
	Carex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	1,87	7,48	9,35
20	6,16	24,64	30,80
30	8,47	33,88	42,35
40	10,23	40,92	51,15
50	12,43	49,72	62,15

Benchmarks Capex per building age xx // Warehouse			
	Carex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	1,43	5,72	7,15
20	4,84	19,36	24,20
30	7,15	28,60	35,75
40	8,58	34,32	42,90
50	10,67	42,68	53,35

Condition	Factor
Poor	1,2

Benchmarks Capex per building age xxx // Office			
	Carex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	2,04	8,16	10,20
20	6,72	26,88	33,60
30	9,24	36,96	46,20
40	11,16	44,64	55,80
50	13,56	54,24	67,80

Benchmarks Capex per building age xxx // Warehouse			
	Carex*		
Age	Year 1 (€)	Year 2 - 5 (€)	Year 6 - 10 (€)
10	1,56	6,24	7,80
20	5,28	21,12	26,40
30	7,80	31,20	39,00
40	9,36	37,44	46,80
50	11,64	46,56	58,20

Example: An office building constructed in 1990 (age ca. 30 years) and a fair condition has the following Carbex (€/sqm) for the next 10 years (2023 – 2032, depending on date of assessment):

Year 1	Years 2-5	Years 6-10
8,47	33,88	42,35

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Master model for sustainable prototype

- Assessment of existing Construction Types
- Capex + Carbex

By considering Capex + Carbex, the following values per time span should be considered:

Invest	Year 1	Years 2-5	Years 6-10
Capex	20,24	80,96	101,20
Carbex	8,47	33,88	42,35
Sum	**28,71**	**114,84**	**143,55**

Results:

- Initial benchmarks for the respective clusters were produced. These benchmarks referred to similar asset classes on similar construction years, whereby the energy consumption, maintenance and repair costs, as well as CO_2 emissions were determined and compared.

- From this evaluation, it was possible to see how legal changes to energy-saving measures (respective amendment of the EnEV and GEG) reduced the energy consumption including the respective emissions of the individual logistics halls.

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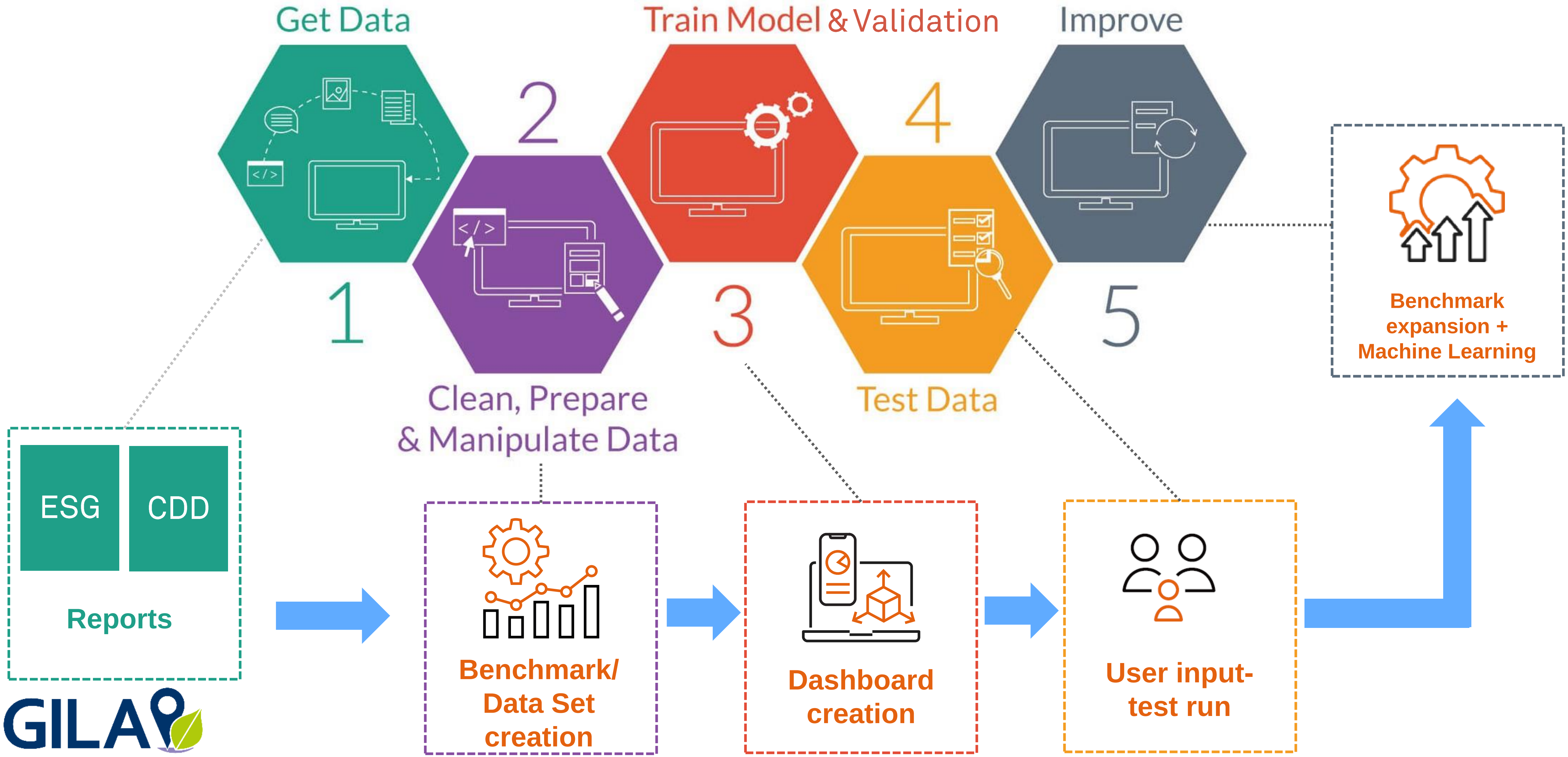
Developing a Sustainable Asset Tool

- The model/sustainable asset tool is developed as a dashboard with the objective to be:
  - Easy to use and understand.
  - Show numerous data visualizations side by side.
  - Provide a general transparent summary information (quality related to the amount of information available) .

- The objective of this tool is to provide a platform for owners, FM, researchers, etc., to make better, more informed and data-driven decisions regarding actions that can be used as roadmap towards sustainable logistics sites.

- The outcomes are:
  - Embodied carbon benchmark
  - Summary Report on Capex (Maintenance Technical Expenditures) and CarbEx (Carbon Expenditures)
  - Summary Report on inflation rates

Dashboard - How our solution works?



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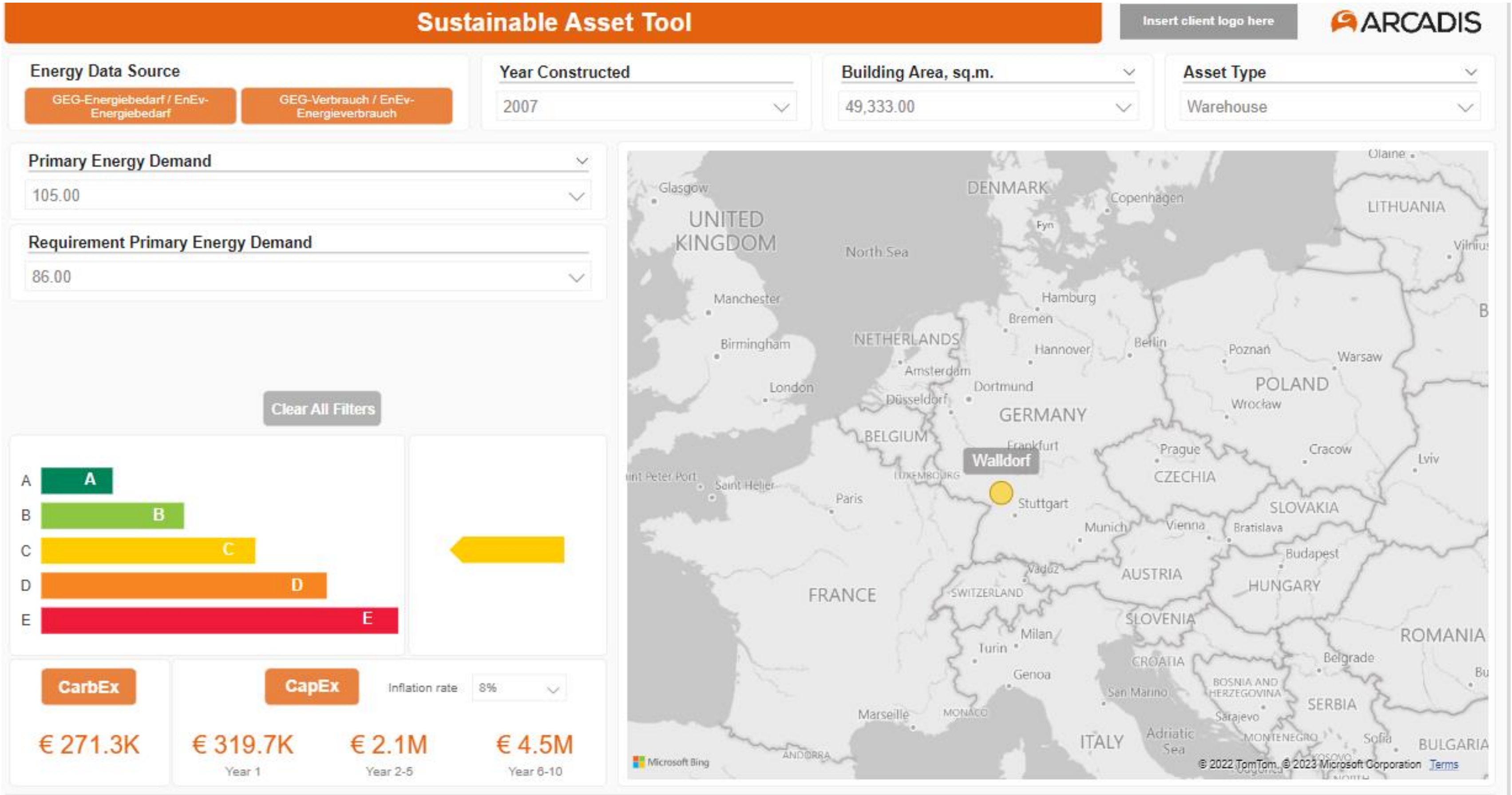
Dashboard visualization



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SUSTAINABILITY AND GHG PERFORMANCE AT LOGISTICS HUBS

Thank you for your participation!

Slides of the webinar are provided on https://reff.iml.fhg.de.

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Arcadis Deutschland

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

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