CARBON RISK REAL ESTATE MONITOR

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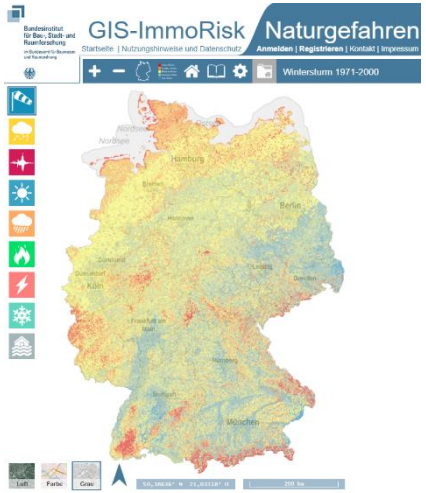
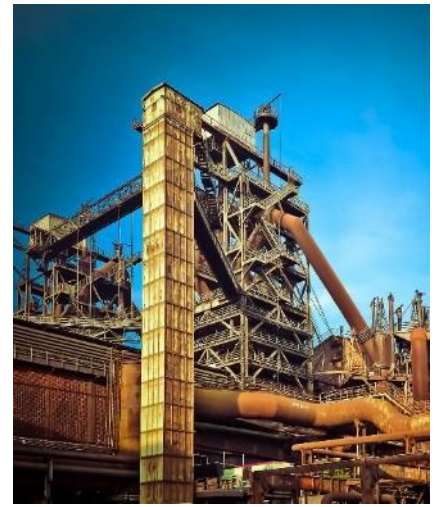
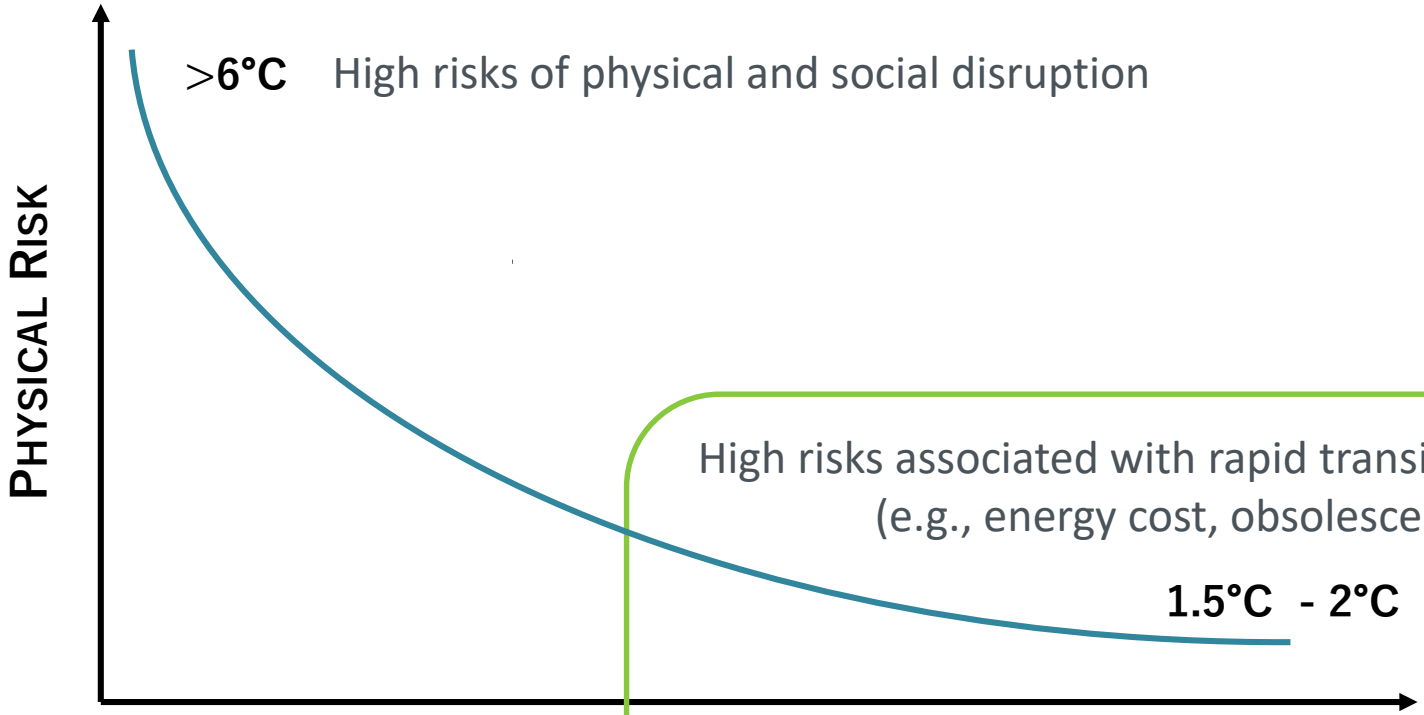


PHYSICAL RISK + TRANSITION RISK





"**STRANDED ASSETS** are properties that will be exposed to the risk of early economic obsolescence due to climate change because they will not meet future regulatory efficiency standards or market expectations." *(CRREM, 2019)*

Source: TCFD Technical Supplement, 2017

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Climate science: Climate impact and carbon emission budgets/pathways compatible with limiting global warming to x.x°C

↓

Politics: Commitment to limit global warming to 2°C or better 1.5°C

↓

New mandatory and voluntary requirements to (sustainable) finance & carbon risk

↓

CARBON RISK REAL ESTATE MONITOR

CRREM pathways

- Paris-aligned decarbonisation & energy reduction pathways
- Per country and building type

CRREM Tool

- Assess the carbon and energy performance of buildings and portfolios
- Benchmark against CRREM pathways and peers
- Derive indicators for risk management, reporting, disclosure

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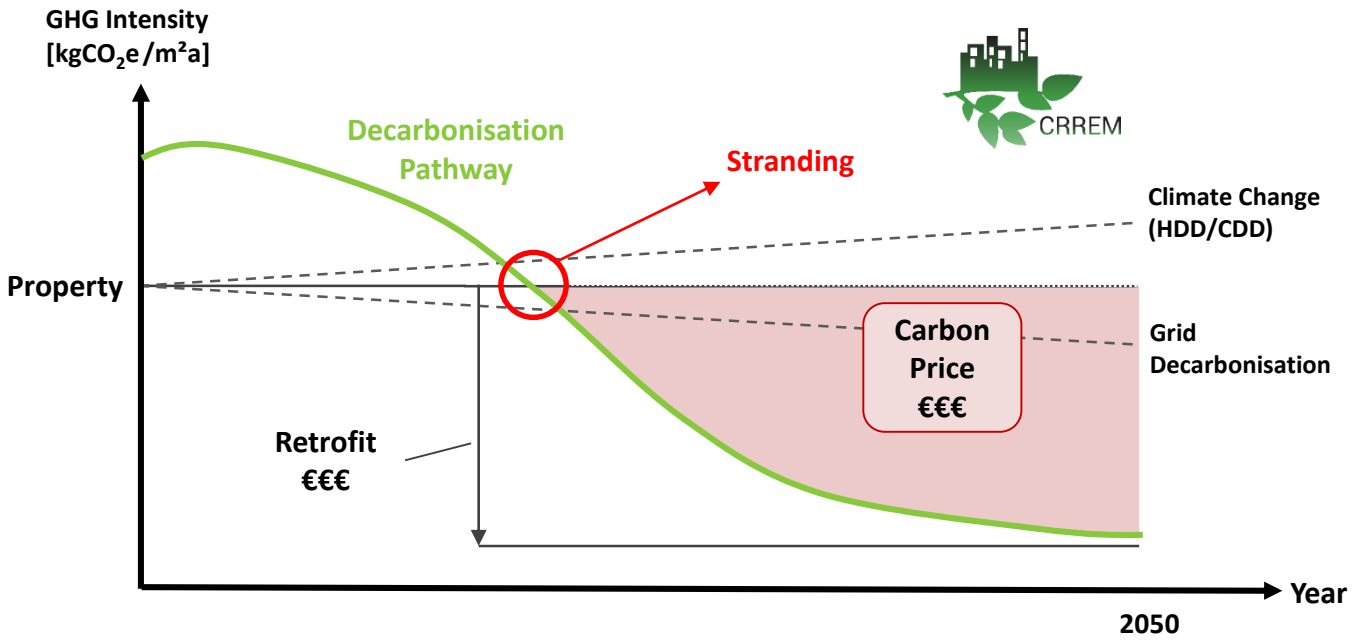
Carbon Risk Assessment & Management based on quantitative performance data and target setting



DECARBONISATION PATHWAYS

Aligned with 1.5°C and 2°C global warming, country- and building type specific

+

BUILDING'S CARBON PERFORMANCE

Energy consumption, carbon emission factors, grid decarbonsation), changed heating and cooling demand, normalisation

=

CARBON RISK ANALYSIS

Year of stranding, excess emissions, carbon costs, energy costs, benchmarking

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CRREM DOWNSCALING: FROM GLOBAL EMISSIONS TO CARBON INTENSITY PATHWAYS

DOWNSCALING

Global GHG budget and emissions pathway (consistent with a certain amount of global warming)

↓

Global buildings GHG emission pathway

↓

Global buildings GHG intensity pathway

↓

EU buildings GHG intensity pathway

↓

EU commercial real estate (CRE) GHG intensity pathway

↓

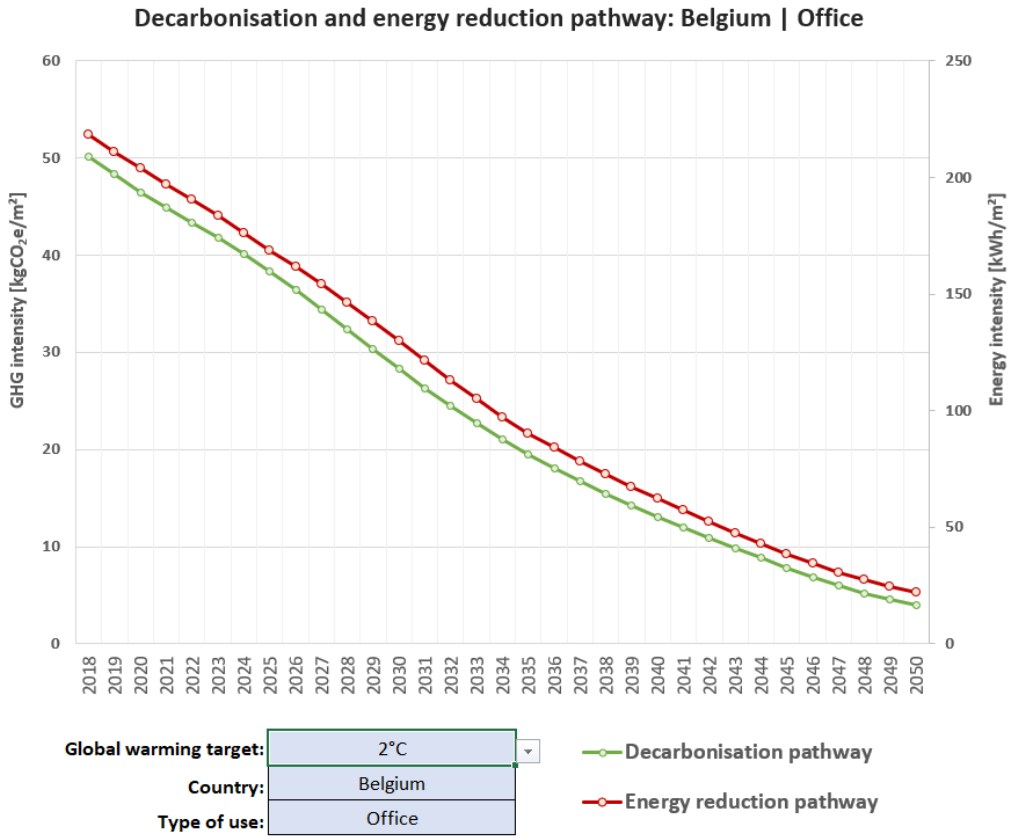
Country-specific CRE GHG intensity pathways

↓

Country-specific CRE-subsector GHG intensity pathways

↓

Country-specific CRE-subsector energy intensity pathways



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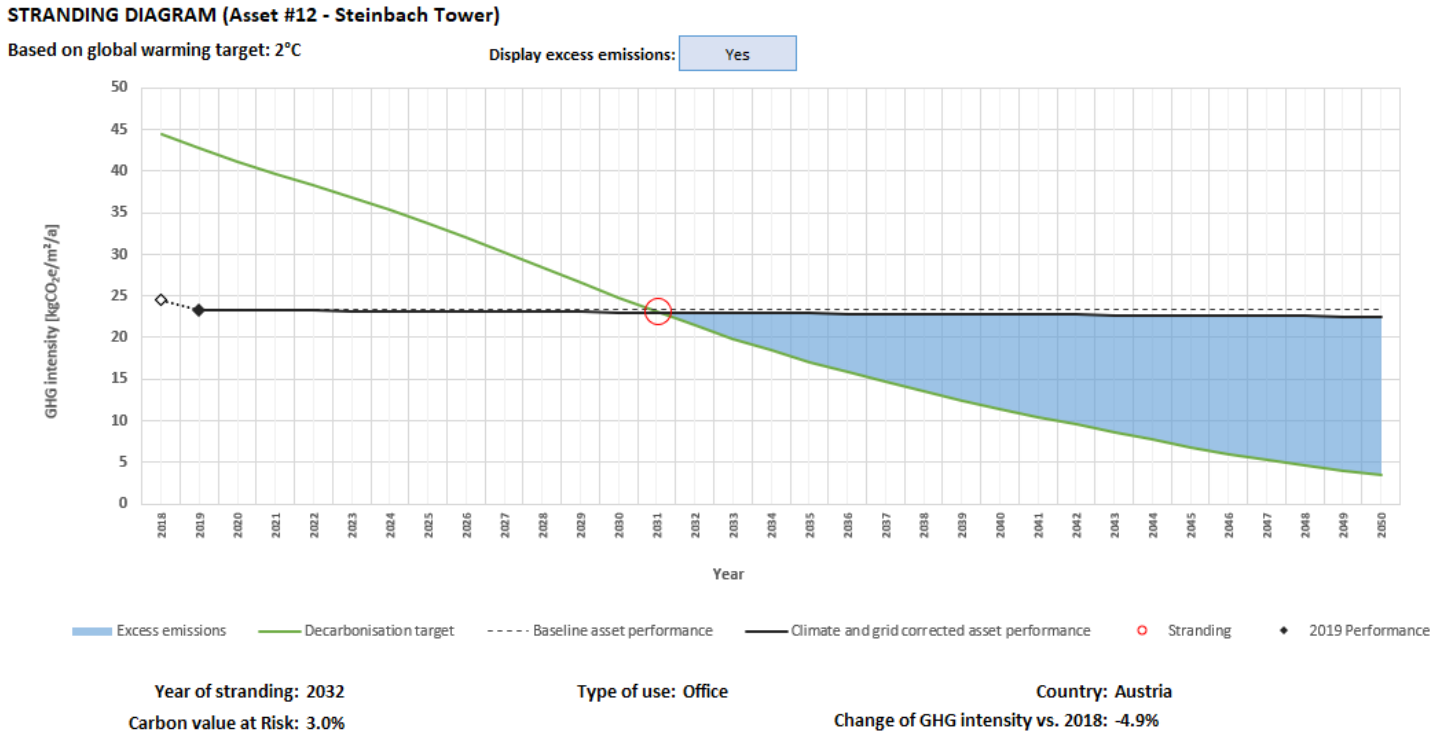
Carbon Risk Assessment & Management based on quantitative performance data and target setting

CRREM TOOL STRANDING DIAGRAM



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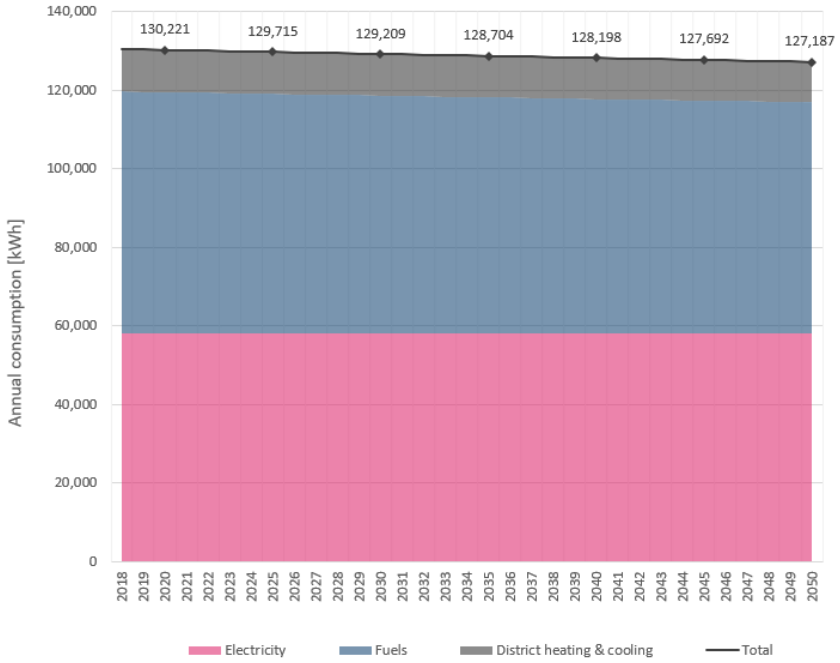
QUANTITATIVE CARBON PERFORMANCE AND RISK INDICATORS

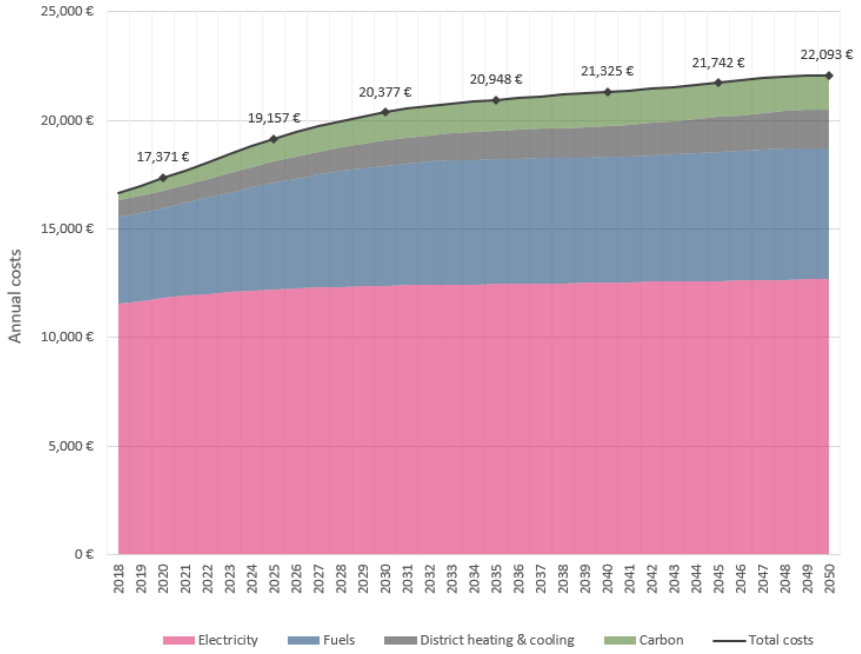
Year of Stranding, Carbon Value at Risk, Year-to-Year Improvement, Costs of Carbon...

ENERGY CONSUMPTION



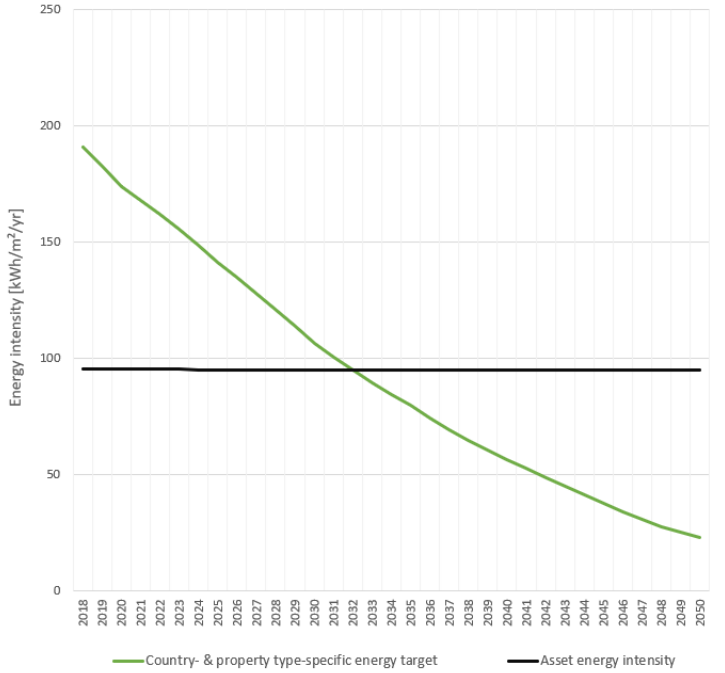
Based on (optionally) normalised baseline consumption and projected data considering changed heating and cooling demand

COSTS OF ENERGY AND CARBON



Based on energy and carbon price projections (IEA, EU etc.)

ENERGY REDUCTION PATHWAYS



Energy targets based on country-specific sector-wide emission factor reflecting energy mix and evolving grid decarbonisation

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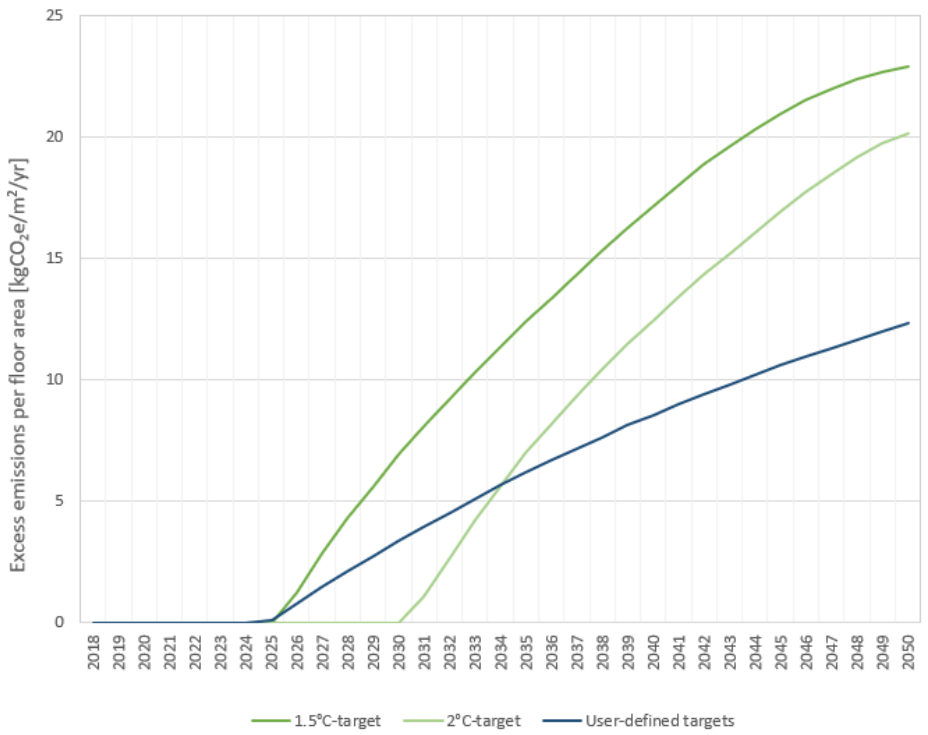
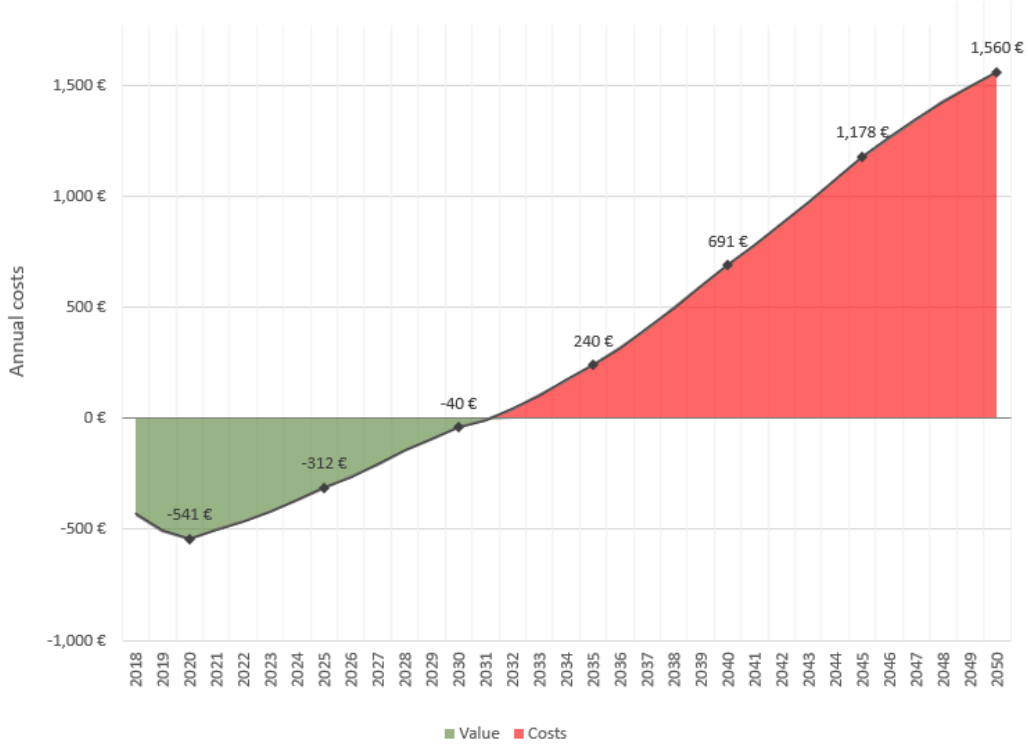
Quantitative Carbon Performance and Risk Indicators

EXCESS EMISSIONS PER FLOOR AREA



Cumulative excess emissions until 2050 [$kgCO_2e$]:	1.5°C-target	2°C-target	User-defined
	2,149,875	1,463,488	1,088,809

COSTS OF EXCESS EMISSIONS ABOVE TARGET



Analoguous to the NY City model with penalties for each ton of emission above emission limit (and possibility of trading emission credits)

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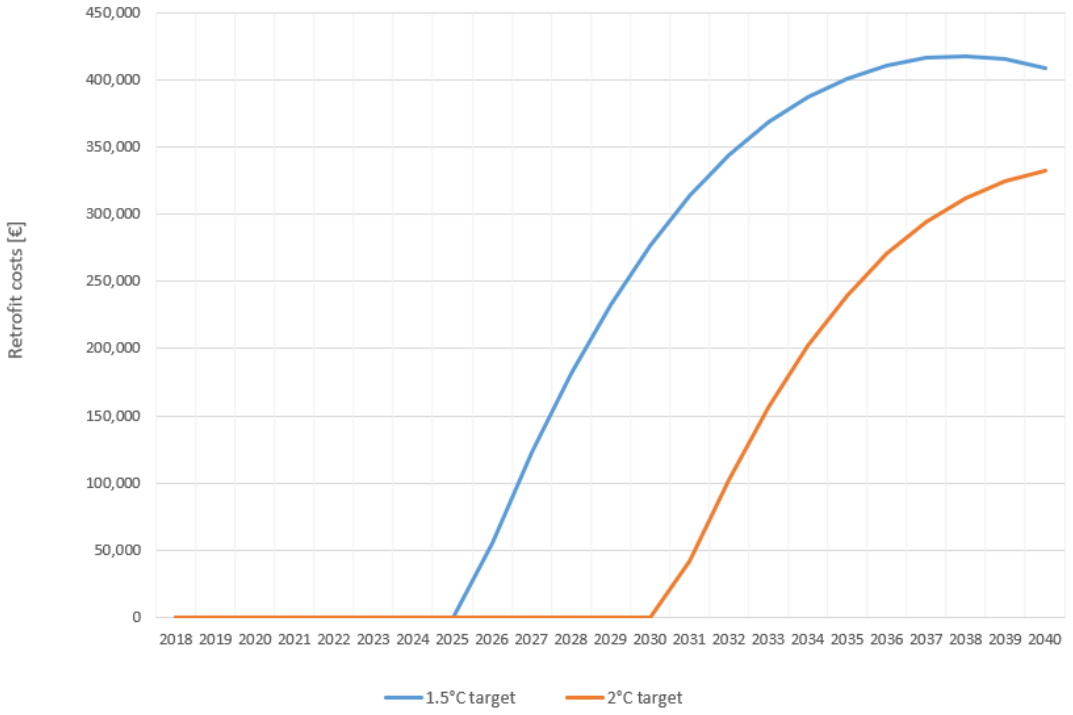
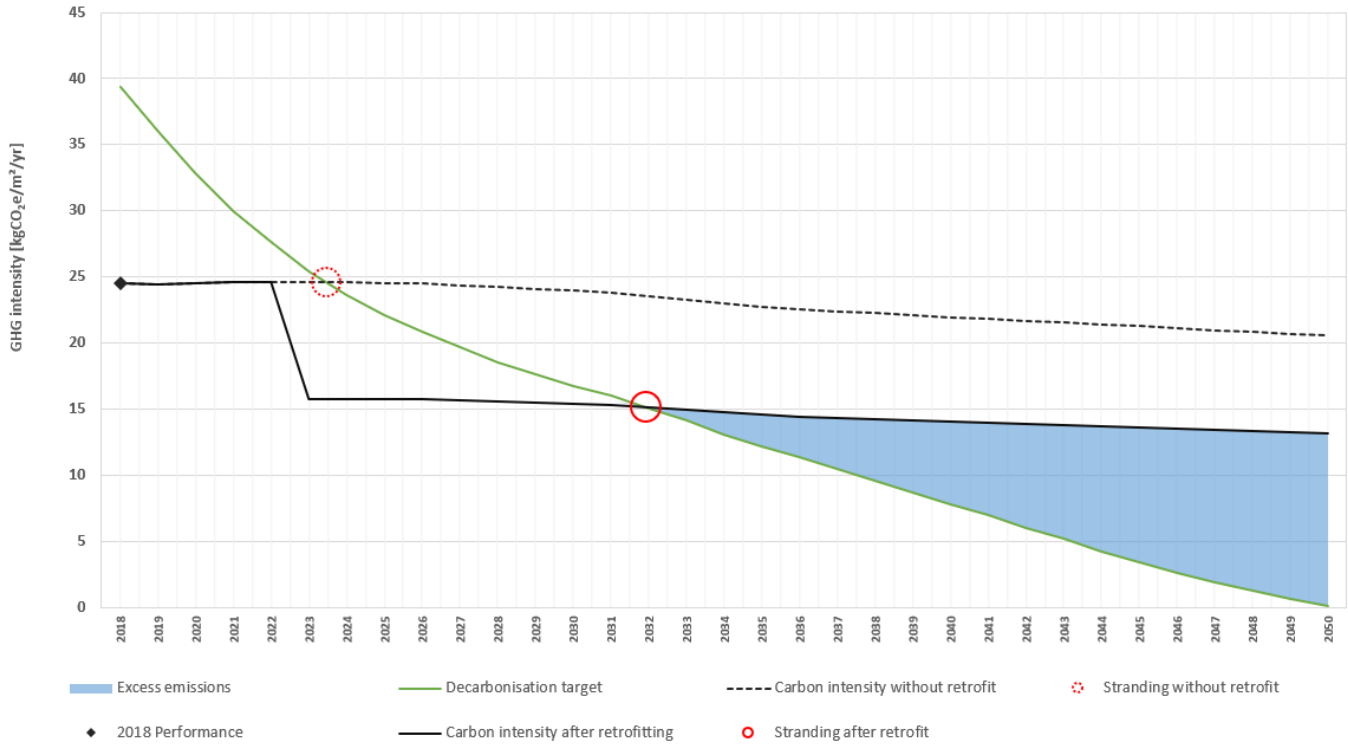
QUANTITATIVE CARBON PERFORMANCE AND RISK INDICATORS

COSTS OF RETROFITTING TO COMPLY WITH CARBON TARGETS



RETROFIT MODEL: STRANDING DIAGRAM WITH & WITHOUT RETROFIT



Simulation of investment in energetic retrofit and its effect on carbon risk indicators (based an marginal abatement costs)

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Carbon Risk in Real Estate Portfolios

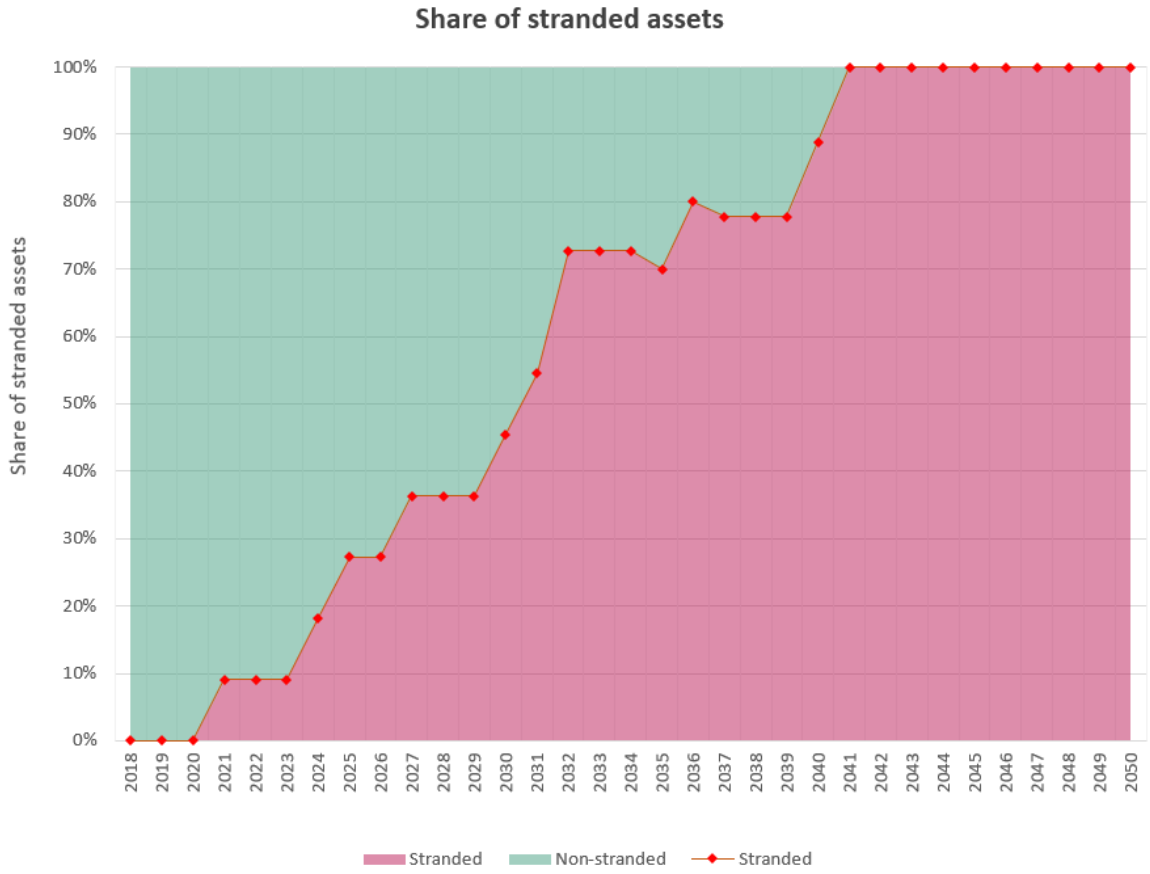
EVOLUTION OF STRANDING WITHIN PORTFOLIO

Diagrams on the right display the evolution of stranding within your portfolio. Upper graph: Relative share of stranded assets. Lower graph: Absolute figures. Choose whether to display data based on the number of buildings, gross floor area (GFA) or gross asset value (GAV). Choose whether to exclude individual assets or exclude them from a certain year on.

Asset ID	Include	Sell in year
1	Yes	Don't sell
2	Yes	Don't sell
3	Yes	Don't sell
4	Yes	Don't sell
5	Yes	Don't sell
6	Yes	Don't sell
7	Yes	2035
8	Yes	Don't sell
9	Yes	Don't sell
10	Yes	2037
11	Yes	Don't sell

Show shares based on: Number of buildings

Climate target: 2°C



Set filter:

Country: All

Property type: All

Entity/Fund: All

Assessment year: 2018

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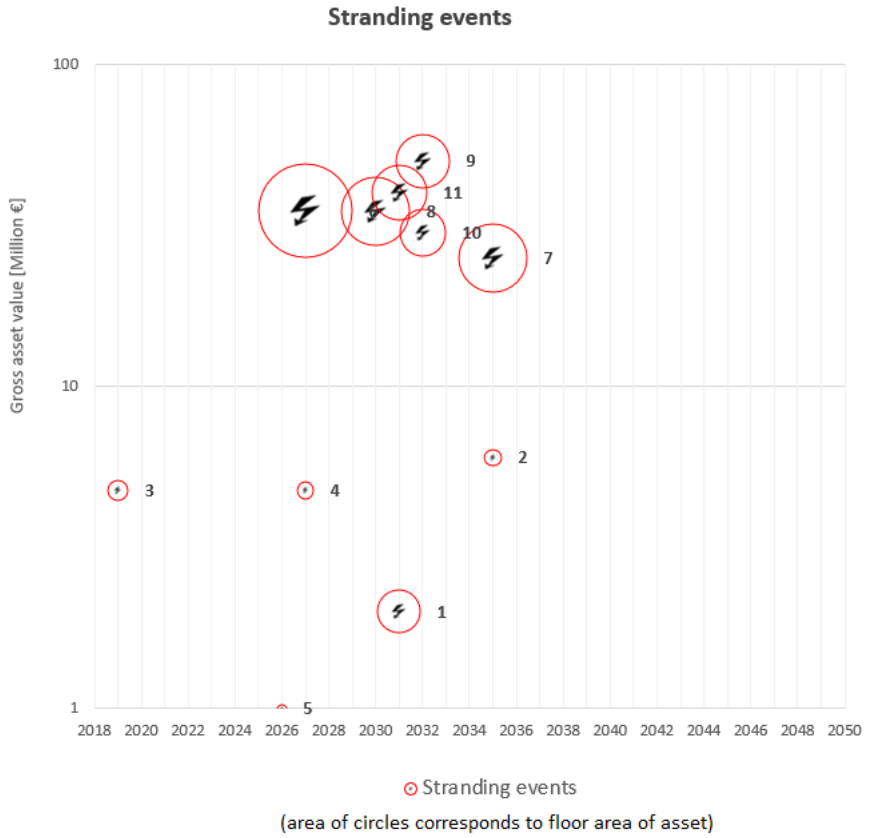
CARBON RISK IN REAL ESTATE PORTFOLIOS

STRANDING EVENTS: NEED FOR ACTION?

The graph on the right provides a summary of stranding events in the course of time. Each circle corresponds to one asset not complying with its decarbonisation pthways for the first time. Circle size (floor area) and y-axis (gross asset value) indicate the importance of an asset within the portfolio.

The area of the circles corresponds to the Gross floor area of the stranded asset. Choose below which global warming target to apply. The numbers next to the circles depict the asset ID.

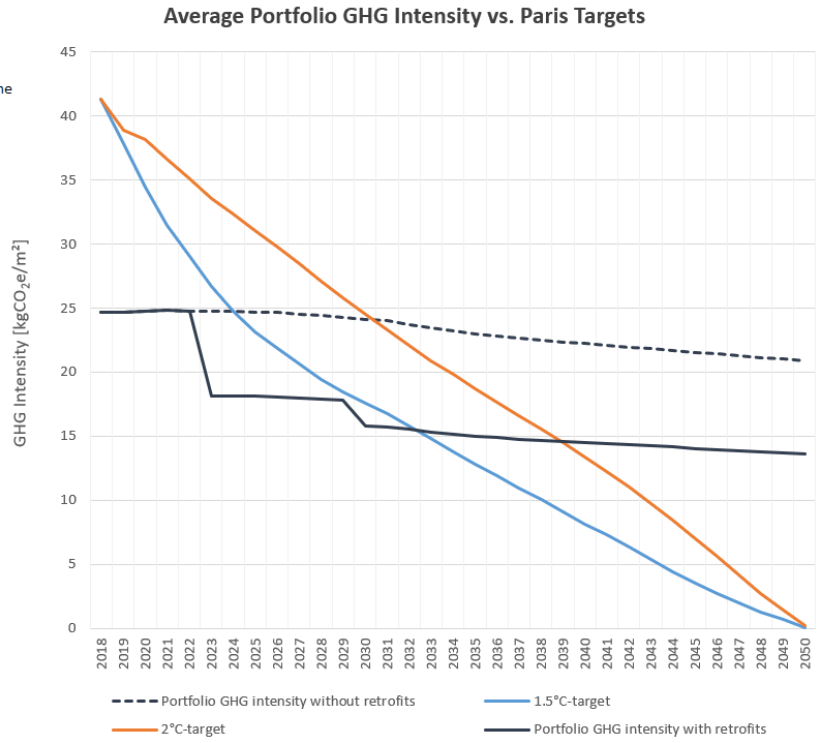
Climate target: 2°C



GHG INTENSITY OF PORTFOLIO vs. 1.5°C- & 2°C-TARGETS

The graph on the right presents the GHG intensity of the selected portfolio (black line), benchmarking it against the floor-area-weighted decarbonisation pathway (orange: 2°C, blue: 1.5°C).
Exclude individual assets by means of the table below.

Asset ID	Include
1	Yes
2	Yes
4	Yes



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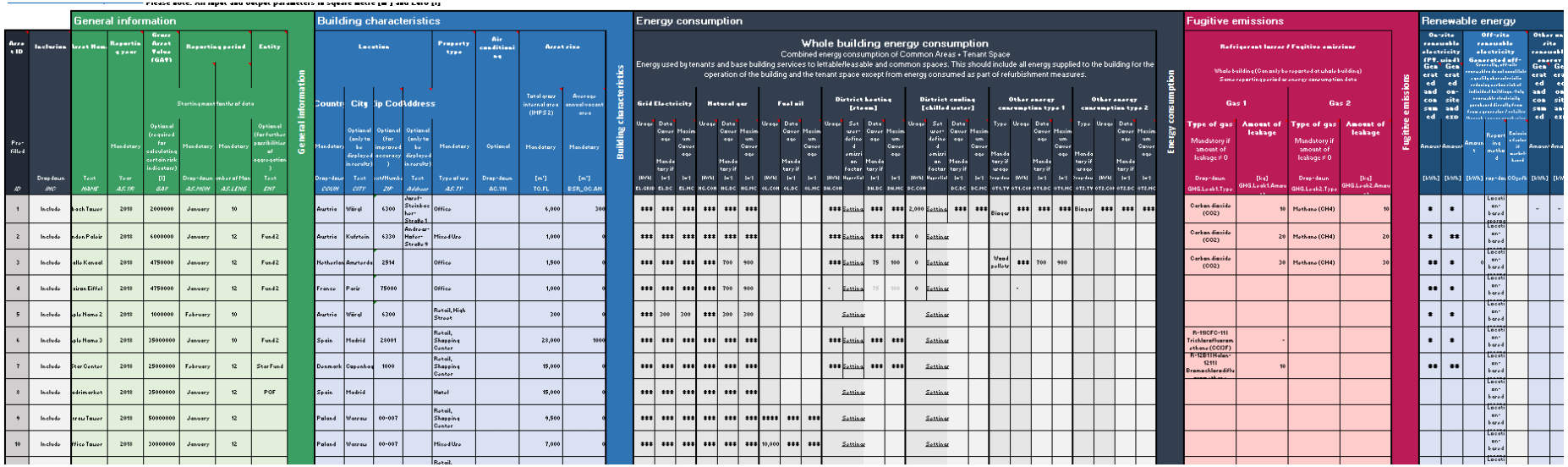
Stepwise integration of CRREM Risk Analysis and GRESB

(1) Download CRREM Risk Assessment Tool pre-filled with data company's GRESB participation

(2) GRESB participants to receive results of CRREM Risk Analysis within GRESB Portal

GRESB & CRREM

Property types and input parameters are aligned with GRESB ESG Benchmark:



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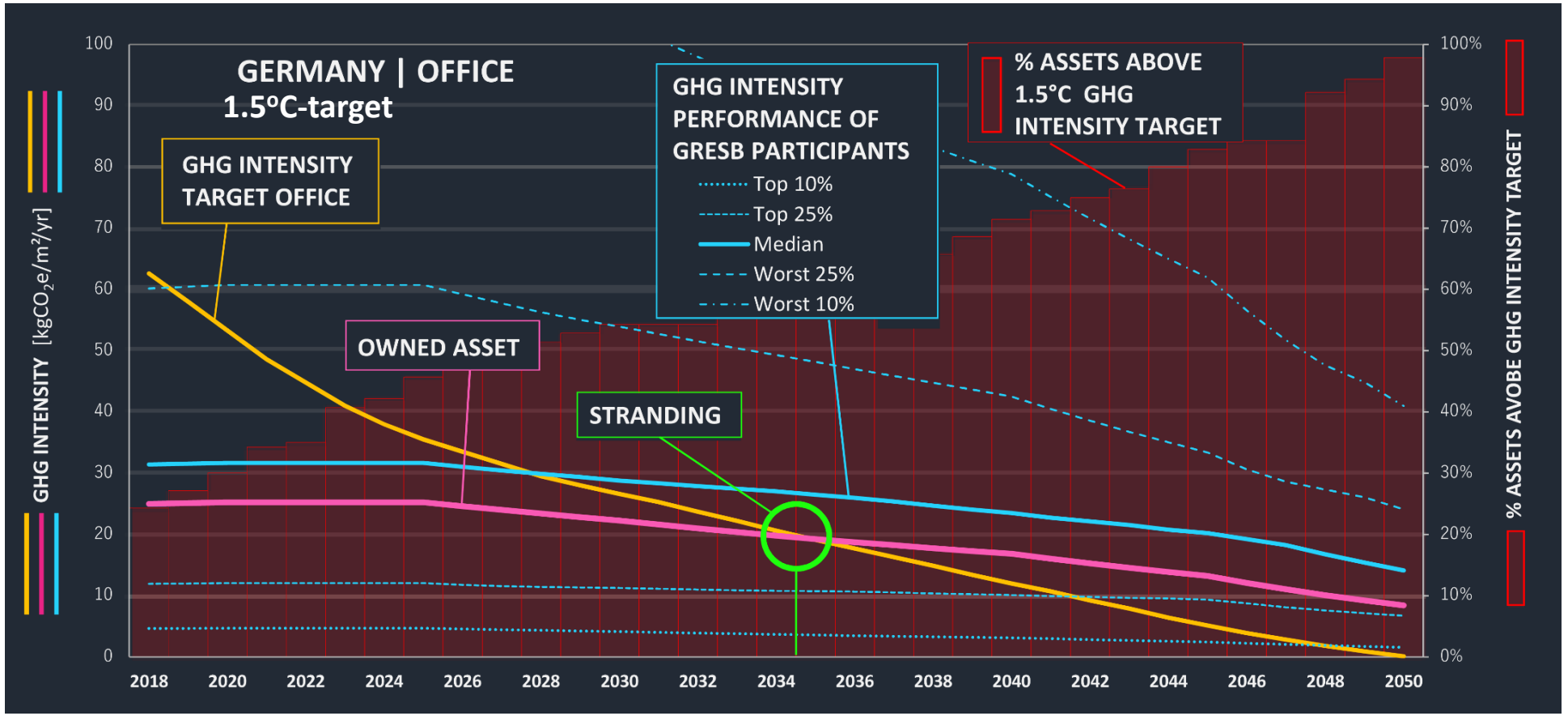
Benchmarking of individual assets or aggregated entities against peers from annual GRESB Benchmarking

- Share of stranded assets in peer group
- Benchmark against average, over- and under-performer



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STRANDING RISKS & CARBON

available on
www.CRREM.eu

Science-based decarbonising of the EU commercial real estate sector

available on
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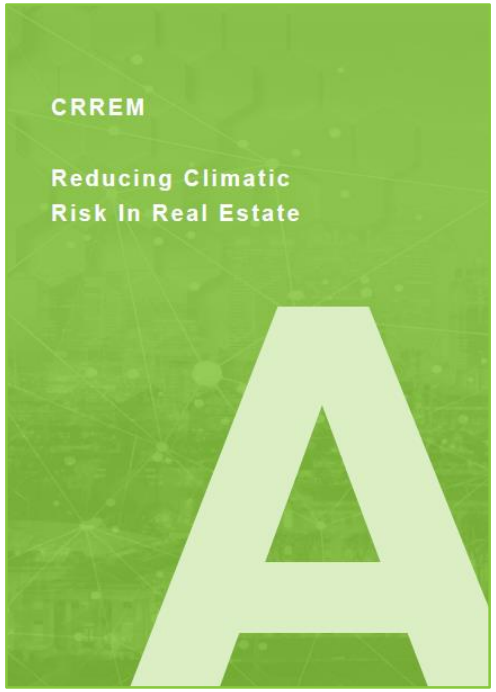

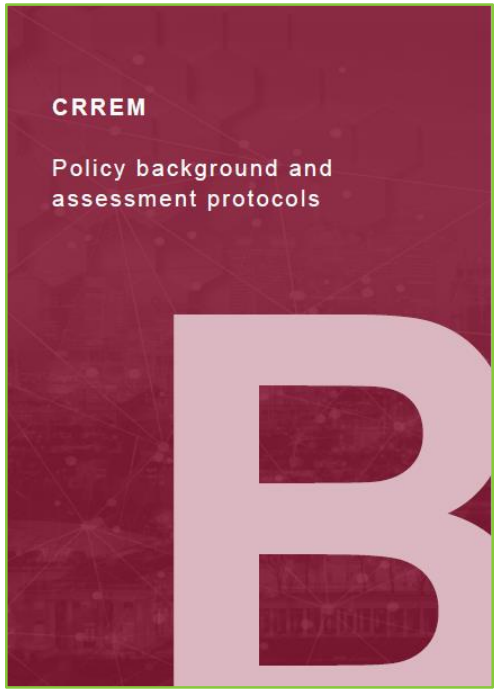

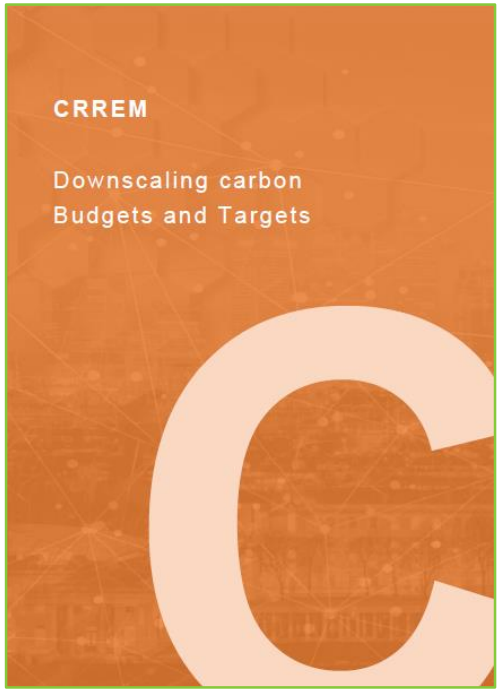

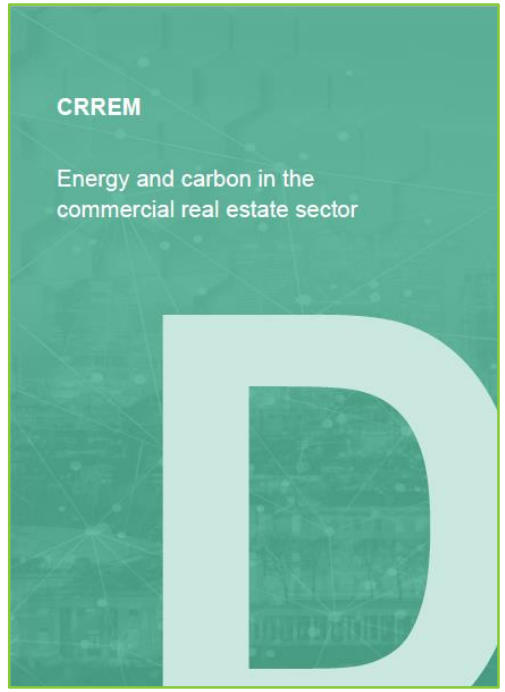

Ulster University

TIAS
SCHOOL FOR BUSINESS AND SOCIETY

IIÖ
INSTITUTE FOR REAL ESTATE ECONOMICS

GRESB

Universitat d'Alacant
Universidad de Alicante

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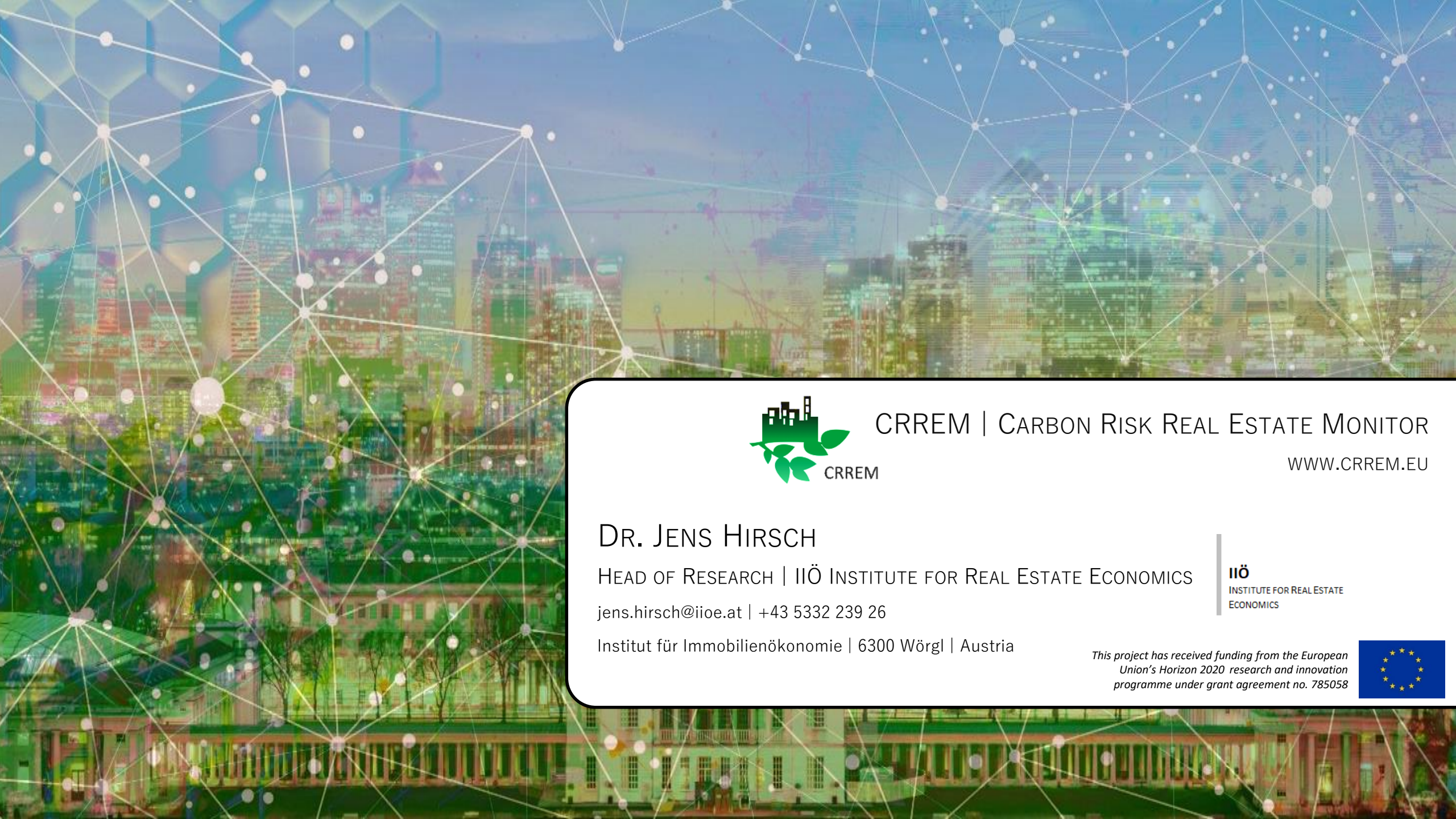

CRREM | Carbon Risk Real Estate Monitor

WWW.CRREM.EU

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Institute for Real Estate Economics

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ENERGY REDUCTION PATHWAYS: BASED ON NET-ENERGY DEMAND

Net-energy demand

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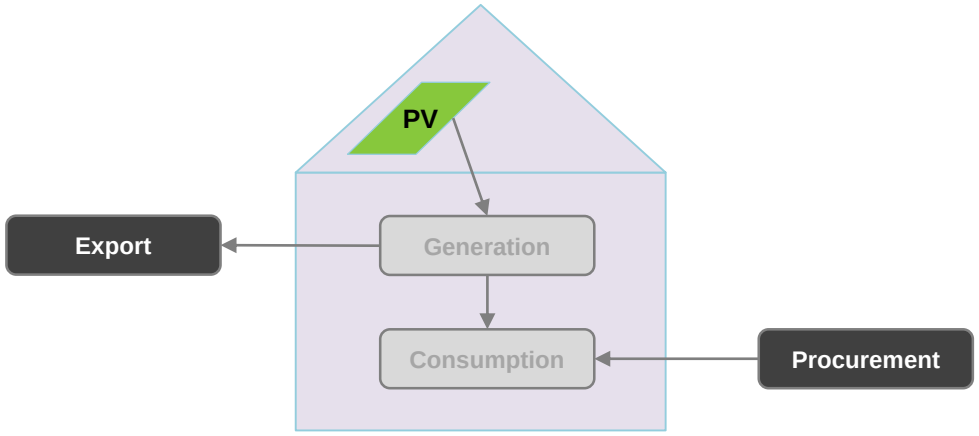
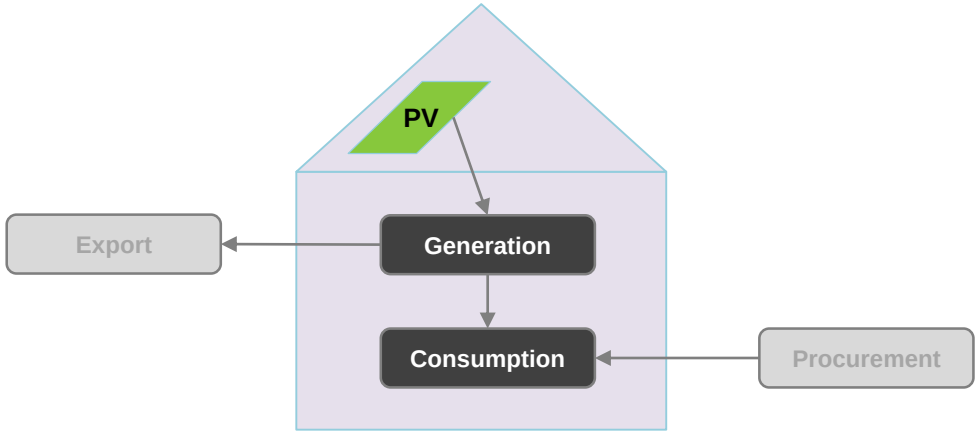
Procured energy – Exported energy



Consumed energy – (On-site) Generated energy



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