Carbon Risk Real Estate Monitor

CRREM Risk Assessment Reference Guide

- User manual for the CRREM Risk Assessment Tool

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

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Please note: Users will fill in the tool offline, therefore no private user data will be saved by the CRREM consortium.

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1 ABOUT CRREM

The *Carbon Risk Real Estate Monitor (CRREM)* is a European Horizon 2020 research and innovation project. The objective of *CRREM* is to accelerate the decarbonisation and climate change resilience of the EU real estate sector by providing appropriate science-based carbon reduction pathways at property, portfolio and company level ("2-degree-readiness"). *CRREM* aims to integrate carbon efficiency and retrofit requirements into investment decisions by evaluating and clearly communicating the downside financial risks associated with a low energy performance and quantifying the financial implications of stricter regulatory environment regarding carbon intensity on the building stock. *CRREM* therefore focusses on the transition risks which are part of the wider climate risks properties might be exposed to. The developed software derives carbon emission intensities as well as energy consumption intensities and demonstrates the 2-degree-readiness of each analysed property. Besides identifying carbon risks the tool also helps to identify and visualise strategies for improvement.

CARBON RISK ASSESSMENT TOOL FOR COMMERCIAL REAL ESTATE

The *CRREM Risk Assessment Tool* to identify stranded assets is designed for asset owners and investors to understand the carbon risks inherent in their real estate portfolio.

CRREM has derived decarbonisation pathways by breaking down the global anthropogenic GHG emissions budget that is consistent with the *Paris Climate Agreement* towards individual countries, the commercial real estate sector, property types and individual assets. The *CRREM* tool offers the possibility to evaluate the progress of a portfolio's carbon reduction performance against reduction targets (the developed "pathways") in line with the Paris Agreement (i.e., limiting global warming to 2°C / 1.5°C). The *CRREM* software is XLS based and helps to identify which properties will be at risk of stranding due to the expected increase in stringent building codes, regulation, and carbon prices. It also enables an analysis of the effects of refurbishing single properties on the total carbon performance of a company, including by assessing emissions related to the embodied carbon of the energetic retrofit itself.

The *CRREM* tool and pathways were originally developed for commercial real estate in Europe only. Over time the project scope evolved: to date also global pathways for residential and commercial real estate have been developed. Besides www.crrem.eu please also visit www.crrem.org for the global decarbonisation pathways developed for the real state sector.

Your feedback is welcome: Please do not hesitate to contact us if you have any questions or wish consultation regarding the *CRREM* tool. The project consortium appreciates industry feedback from user application (info@crrem.eu).

INTRODUCTION TO THE FUNDAMENTAL RATIONALE

This Reference Guide accompanies the *CRREM Carbon Risk Assessment Tool* for the European Commercial Real Estate Industry. The guide provides an overall instruction on how the *CRREM* tool should be applied, as well as in-depth guidance into the user input variables for the tool, user adjustable variables, default data underlying the tool and resulting output figures on property and portfolio level.

CRREM defines decarbonisation targets, so-called pathways in line with the EU commitment to limit global warming to well below 2°C or even 1.5 °C for individual EU countries and property types. These pathways and targets provide investors in European Commercial Real Estate with a roadmap for individual properties and portfolios on how to reduce

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carbon footprints over the next decades until 2050. Pathways are twofold: user can focus on energy intensity and carbon intensity likewise.

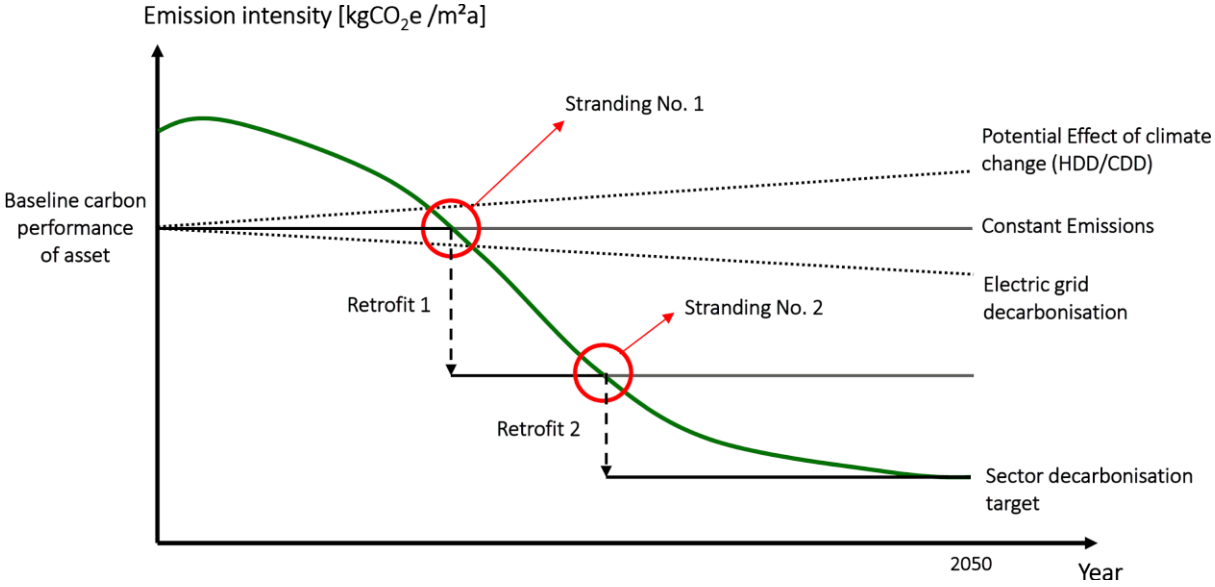

Figure 1: Stranding Diagram

'Stranding diagram': The figure above provides a summary of the fundamental principle of *CRREM's* stranding risk analysis approach for single properties:

- **Black line:** The black line represents a building's baseline and future carbon performance in terms of the so-called greenhouse gas (GHG) intensity, which is calculated as the amount of annual greenhouse gas emissions per building floor area. Emission figures include those directly generated by the on-site combustion of fossil fuels for heating and indirect emissions (caused by the use of district heating and/or electricity consumption).
- **Green curve:** The green curve represents the target decarbonisation pathway of a specific building type in a specific country that aligns with a certain climate target (1.5°C/2°C) and must not be exceeded if a property intends to be "Paris-proof". If the emission intensity is above the target value, "stranding" occurs. In that case the asset would have a carbon-footprint that is above the fair-share derived by downscaling the carbon budget to property level.

In the illustration above, the exemplary building fulfils the requirements only at the very beginning and faces stranding far before the end of the observation period (in 2050). Only appropriate retrofit measures reducing the GHG emissions can ensure that the building will meet the future emission ceilings. This might include changing the energy source (to renewables), decarbonization of the electricity grid and/or simply reducing consumption due to lower demand or due to higher insulation.

Climate Impact and Grid Decarbonisation: *CRREM* also considers the influence of two additional effects on the GHG performance of a property, which are per se independent of any retrofit measures:

- **Potential effects of climate change:** A certain building's future carbon performance will be affected by the impact of climate change on the heating and cooling demand. While global warming is expected to reduce the demand for heating across Europe, the energy required for air conditioning systems are increasing correspondingly. *CRREM* uses scientific modelling of the future development of so-called heating and cooling degree days (HDD/CDD) to consider this effect.
- **Electricity grid decarbonisation:** The second effect that *CRREM* takes into account when determining the future stranding risk of a property, is the influence of the electricity grid decarbonisation on the indirect emissions of a property. The increasing share of electricity that is generated from renewable sources implies

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that the average amount of GHG emitted per consumed kWh (also called GHG intensity of power generation or emission factor) will continue to decrease over time.

SCOPE OF THE CRREM RISK ASSESSMENT TOOL

The scope of the *CRREM* tool and research project is to assess the carbon risks associated with operational emissions from standing investments and retrofit actions on European commercial real estate properties. At this stage, the project does not cover residential properties, or countries outside of the EU (except for the global pathways available on www.crrem.org).

Alignment with major initiatives

Data input for the tool was aligned with the *GRESB* asset level, further input variables for the software are also largely based upon existing frameworks, such as the *EPRA sBPRs, GRI* and the *GHG Protocol Corporate Standard.* The output figures produced by the *CRREM* tool are intended to assist with reporting in accordance with the *Task Force on Climate-related Financial Disclosure (TCFD), GRI and other* recommendations.

CRREM integration into GRESB

To enable *GRESB* participant members to quickly begin to assess their assets and portfolios against the *CRREM* pathways, *GRESB* has automated the process of filling in the *CRREM* tool with the asset data uploaded into the *GRESB* Asset Portal. This document provides information on the mapping of *GRESB* asset-level performance data onto the *CRREM* tool parameters in its input tab. The download can be processed via www.gresb.com/carbon-risk-real-estate-monitor.

STRUCTURE OF THE CARBON RISK ASSESSMENT TOOL

The tool can be accessed via www.crrem.eu, the user has the option to download an empty version or a pre-filled version as an exemplary purpose. Once downloaded, the tool will open on the start/summary page and users have the option to navigate to different stages e.g. input sheet, asset-level or portfolio-level analysis. The tool consists of eight different pages, with the use of the starting/summary tab the user can easily access and enter the desired functionality.

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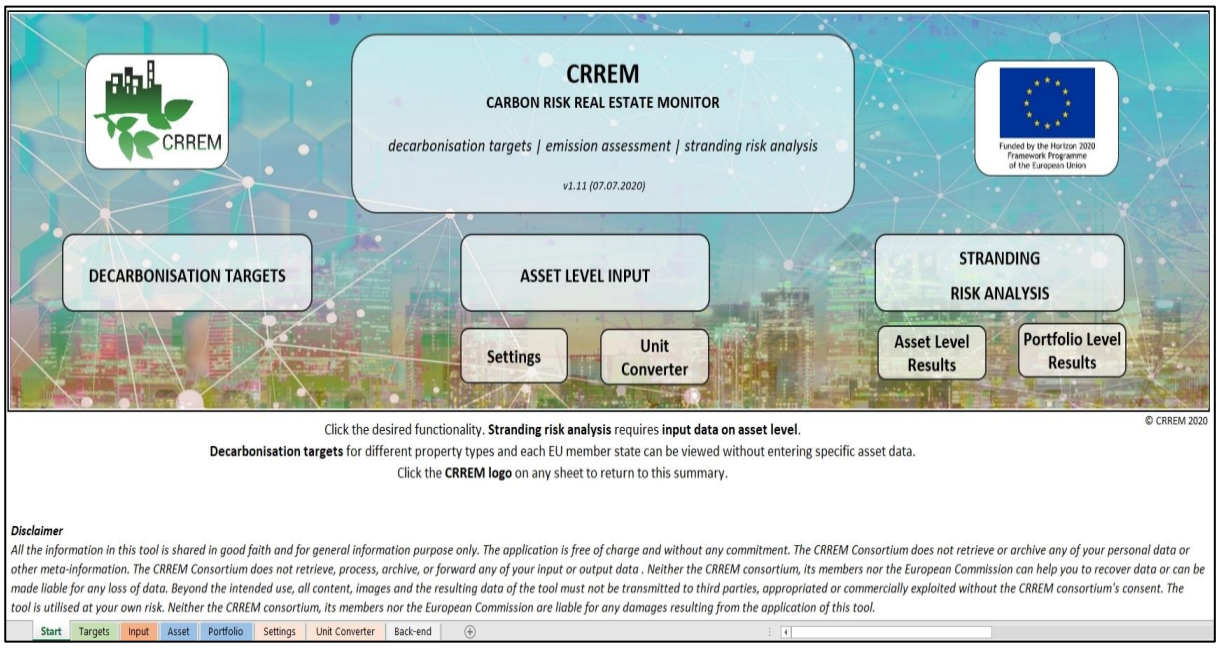

Figure 2: CRREM Tool Summary/Preface Tab

The CRREM Risk Assessment Tool consists of the following tabs:

Summary/Preface
Enables user to enter desired functionality of the tool. By clicking on the *CRREM* logo on any sheet, the user is taken back to this summary. Short explanations of the variables and graphs are included in the *CRREM Risk Assessment Tool*. General introductory information and specific instructions on how the *CRREM Risk Assessment Tool* should be used is provided on each sheet. Further specific detail/instruction on data input is available and blended in as a comment on each cell when required.
Decarbonisation target tool
This sheet provides the possibility to identify decarbonisation pathways without entering data for individual buildings. Pathways depend on selected country, building type and global warming target (1.5°C/2°C) and are presented in the form of a line chart and tabulated data. User can select country, asset type and global warming target by dropdown option. Data and graphs can in this way also be used for company target setting without using the tool itself. Users can use the tabs to directly access the different sections (e.g. data input, output, settings) of the tool or use the hyperlinks to navigate via the homepage.
Asset data input
Primary sheet where the user inputs the building data. This part covers the following categories: • **General information:** Covers basic information on the reported data, such as asset name, Gross Asset Value (GAV), reporting year, entity allocation and the period for which data is reported.

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- **Building characteristics:** Covers basic building characteristics such as asset location, size, property type, and primary floor areas, use of air conditioning and average annual vacant area.
- **Energy consumption data:** Covers the main input field which enables users to enter whole building energy consumption data, in turn used for calculating carbon emissions.
- **Refrigerant losses:** Covers an additional input field for calculating fugitive emissions for the whole building using refrigerant losses. Type of gas and amount of leakage can be reported.
- **Renewable energy:** Covers on-site and off-site generated renewable energy, with the differentiation of consumed on-site and export.
- **Retrofit action:** Enables the user to enter one future retrofit scenario for each asset. Year of investment, value and embodied carbon related to retrofit can be entered.
- **Building-use:** Covers additional building-use characteristics option of user defined settings that will enable to change the *CRREM* default assumptions for a specific asset.

The individual input sections are separated by different colors (e.g. green for the general information, dark blue for the energy consumption, etc.). Please note: data in certain areas can only be filled if all other mandatory sections are completed (e.g. energy consumption data can only be supplied once the asset size has been defined). All fields mandatory are indicated and further descriptions/explanations for data input are supplied via comments. Individual assets can be chosen to be included or excluded (column D), this will enable the user to exclude certain assets in the evaluation.

Results: Asset Level

This sheet shows the results of the *CRREM* stranding risk analysis for each property entered in the asset input sheet. The individual assets can be selected via the ID or can be viewed in a tabular format from row 35 onwards. The level of ambition (1.5°C or 2°C) against which the individual asset is to be benchmarked can also be selected here. The upper part shows diagrams and specific risk analysis results for selected individual properties and global warming target.

This section covers the following analysis and diagrams per asset starting at the very left and extends to:

- **Stranding diagram:** Interactive diagram that enables users to view the point of stranding, performance and excess emissions against the selected decarbonisation target ("pathway"). The asset carbon intensity performance per year is analysed. Further the Carbon Value at Risk (CVaR) is also provided below the graph as figure.
- **Energy reduction pathway:** Shows the energy intensity per year of the individual asset against the country and property type-specific energy target. Year of exceedance is given.
- **Excess emission:** Provides an overview of the excess emissions per floor area for the climate reduction targets as well as providing the user-defined targets if provided.
- **Costs of energy and carbon emissions:** Shows the annual energy costs distinguishing between the type of emission.
- **Total net energy per floor area:** Shows the produced energy as a percentage of consumed energy and the share of renewables on energy consumption.
- **Carbon costs of excess emissions:** Shows emissions above or below the decarbonisation target and the corresponding annual costs. Carbon Value at Risk is provided as a percentage for the given discount rate.
- **Costs of retrofitting to comply with decarbonisation pathway:** Provides costs of retrofitting per target (1.5°C/2°C) over the time horizon up to year 2040 for the individual retrofit scenarios entered in the input sheet.
- **Individual retrofit scenarios & payback:** Shows the energy intensity with retrofit measures and provides a payback diagram illustrating the break-even point.

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- **Economic payback:** Shows the retrofit investment against the cumulated discounted energy savings from retrofit actions. Point of break-even is given at the applied discount rate.
- **Energy and carbon intensity with and without retrofit measures:** Shows individual retrofit scenarios including payback and stranding point after retrofit. This enables users to assess the retrofits costs necessary to comply with decarbonisation targets.

In the lower part of the sheet the information is presented in a tabular format as an overview on all assets entered.

Results: Portfolio Level

The portfolio level results include specific graphs and metrics useful for reporting between investors and their fiduciaries in accordance with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations. Analysis can be conducted for the entire portfolio or filtered by country, property type and individual entities (e.g. funds) as defined in the Asset input sheet. Covers the following diagrams:

- **Evolution of stranding within the portfolio:** Display choice between relative share of stranded assets and absolute figures. A Filter can be applied to set a specific county, property type and fund. Results are displayed in the form of the Gross Asset Value (GAV), gross floor area or number of buildings against the selected climate target. Furthermore, the user can select scenarios of individual assets of the portfolio being sold and view its implications of stranding events over the course of time.
- **Stranding events:** Summary of stranding events over the course of time. Illustrated in GAV and floor area.
- **Emissions of portfolio vs 1.5°C & 2°C scenario emissions:** Provides illustration of annual emissions with and without retrofit measures against the decarbonisation targets.
- GHG intensity of portfolio: Shows the GHG intensity for the selected portfolio against the Paris targets.
- **Costs of excess emissions of portfolio:** Shows the annual costs of excess emissions for the two target scenarios. Further the CVaR is also provided as a percentage.
- **Evolution of stranding within the portfolio:** Shows the share of carbon stranded assets within the portfolio.

Default asset data (settings)

Sheet specifically for advanced users that want to overwrite default data points. Enables tailoring of the risk assessment to user-specific scenarios. Covers the following categories:

- **Normalisation:** Enables the user to adjust *CRREM* defined normalisation factors.
- **Electricity emission factor:** Enables the user to apply user-defined electricity emission factors.
- **District heating and cooling emission factor:** Enables the user to apply user-defined emission factors.
- **Energy prices:** Covers default energy prices that can be overwritten by the user.
- **Carbon prices:** Covers default carbon prices that can be overwritten by the user.
- **Discount rate:** Enables user to set own discount rate for valuing future spending and savings.
- **User-defined decarbonisation pathways:** Enables the user to enter individual decarbonisation pathways for each asset.

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Unit conversion tool
This sheet allows users to convert different units of energy consumption, weight/mass and volume, enabling the calculation of required values directly within the *CRREM* tool.
(Backend)
The *CRREM* tool is xls based and therefore very transparent regarding the applied calculation, (default) input data and sources used for both. Users who wish to look at more details might or view the formulas used can view the different sections in this tab. Users can also use the backend to view default asset data and average values used for specific countries. Default values include for example emission factors, energy prices and carbon prices (see Section 6 for a detailed list).

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2 OVERARCHING RECOMMENDATIONS

ORGANISATIONAL BOUNDARIES

Participating real estate portfolios are expected to be standing commercial real estate investment portfolios. The tool does not cover new construction projects or residential holdings. The *CRREM tool* covers EU Member States including the UK, further global pathways are available for download at www.crrem.org. The current version of the tool covers the following property types: *Retail High Street, Retail Shopping Center, Retail Warehouse, Office, Hotel, Healthcare, Mixed use, Industrial Distribution Warehouse, Other*.

CRREM uses a "Whole Building Approach", indicating that scope 1 and 2 emissions as well as scope 3 emissions in reference to tenant electricity and embodied carbon in reference to retrofits are included. Further, it is important to mention that both regulated and unregulated emissions are considered. The approach "polluter-pays principle" is taken, considering the net energy demand of the asset for the assessment. The *CRREM* tool is specifically intended for assessing risk of equity portfolios, and facilitates structured communication on climate change transition risks between real estate equity investors and their fiduciaries. As such, it is not intended to assess the risk associated with assets that are not owned by the portfolio (but might be occupied or operated by the manager), or fixed income holdings. *CRREM* will apply a sectoral decarbonisation approach to downscale EU's carbon reduction commitments (INDCs) to the Paris Agreement to sector and building level, these can be inputted individually in the settings sheet of the tool. Please note that European Real Estate is part of the non-ETS, therefore a whole building approach is taken (direct and indirect emissions).

DATA QUALITY AND ASSURANCE

It is important to ensure that the data inputted into the *CRREM* tool is of significant quality and that a company is aware of certain data gaps. This is especially relevant, as underreporting of, for instance, energy consumption data, can lead to an underassessment of a portfolio's carbon risk. To avoid underreporting risks, *CRREM* encourages users to conduct rigorous data quality checks and conduct third-party verification on energy and carbon data inputted into the tool.

EXTRAPOLATION

The tool extrapolates data for **"Reporting Period"**, **"Occupancy"** and **"Data coverage". Please note:** The extrapolation for months of reported data to 12 months **does not occur linear** due to the corresponding relevance in which months of the year cooling or heating is effectively carried out.

The *CRREM* tool has been specifically designed to enable risk assessment calculations with limited information. For example, if a company is unable to collect the energy consumption data from a single tenant, the user report upon this data gap arrears a "*maximum potential coverage area*" that covers all tenant areas, and a "*data coverage area*" for areas he has collected data for. Based on building-type-specific typical default values, the *CRREM* tool estimates missing data and provides the user with information on the resulting degree of uncertainty: The higher the data coverage, the lower the uncertainty and risk. Should there be vacancy in the asset, the tool extrapolates the information and normalises to full occupancy (this can also be changed in the settings sheet). The portfolio-level and asset-level results enable data comparison against the set climate targets of 1.5°C and 2°C, in addition the tool enables a comparison of the results against user-defined values.

DATA AVAILABILITY AND GAPS

The *CRREM* tool enables users to enter reporting data for 2018 and 2019. Asset data can be entered for 2019 and compared to the reference year 2018 at the portfolio level.

Should mandatory information required not be reported/inputted, then the tool will not calculate and display output data for this specific asset. This asset will not be listed in the asset- and portfolio-level results. Please return to the input sheet and input further required data.

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3 CRREM DECARBONISATION MODEL

CRREM has completed the decarbonisation model to calculate the pathways and carbon reduction targets required for the *EU* commercial real estate sector to comply with the Paris Conference (COP21) climate targets of limiting global warming to 1.5°C or 2°C. Recently, the *CRREM* project has been expanded beyond the European Union, providing long-term decarbonisation pathways for the global sector, including countries in North America and Asia-Pacific for the different asset classes. In the course of expanding the regional focus, residential decarbonisation pathways were also derived for all 28 *EU* member states as well as expanded on the global level. The Tool is available for all *EU* member states including the UK, the global pathways are available at www.crrem.org.

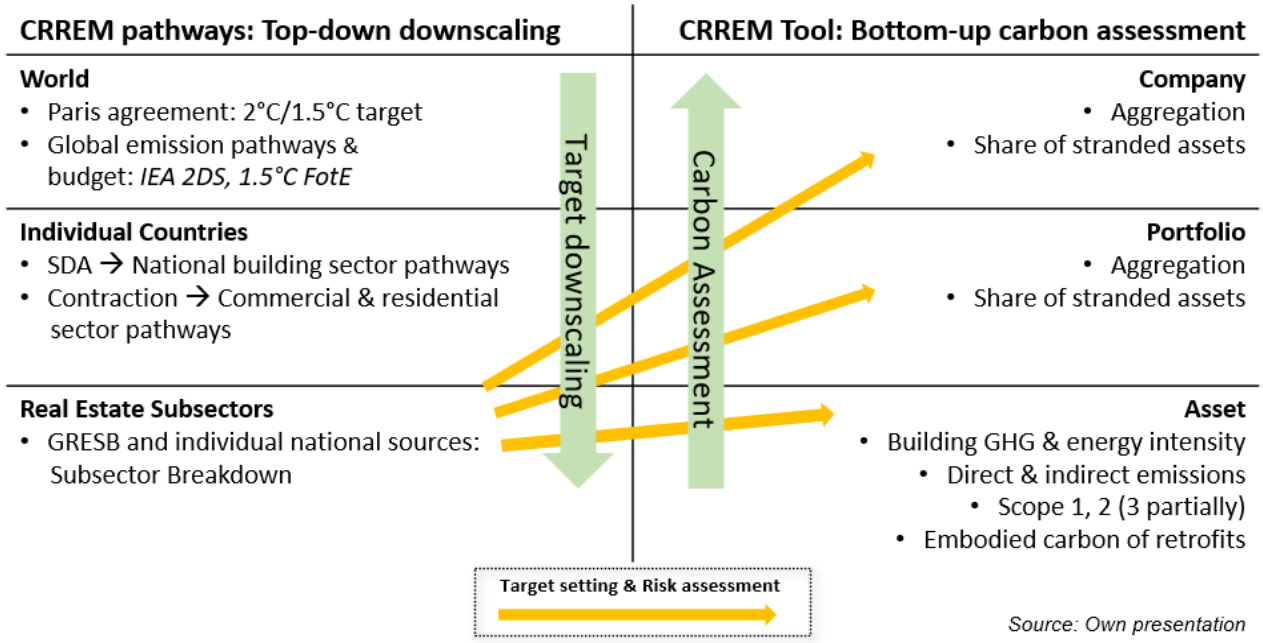

Figure 3: Downscaling approach to carbon & risk assessment via the CRREM Tool

The following paragraphs briefly describe the main steps to develop the required pathways and targets. This model constitutes the core of the decarbonisation target tool. The full description and references for this process can be found in the methodology document or in Section C of the document 'Stranding Risk & Carbon', available on the CRREM website.

Step 1. **Global carbon budgets and pathways.** The model adopts two warming scenarios to comply with COP21: 2°C and 1.5°C maximum warming by 2100, as well as the associated carbon budgets and emission pathways, calculated by the IEA 2DS, 1.5°C FotE amongst others. Budgets define the amount of carbon that can be emitted before 2050 in order not to exceed these warming limits.

Step 2. **Budget and pathways per country.** The next step is to allocate the global carbon budget to the global real estate sector in the form of **CO_2 emissions per square meter (kgCO2e/m²).** From the global emission budget, the model uses the SDA approach to derive to national building sector pathways for the residential and commercial property stock - again also taking into account different growth rates of the national building inventory. Each national pathway represents the "fair share" of carbon that each country could emit until 2050. This allocates the responsibilities and efforts required from the real estate sector to country and use-

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type level. Two sets of required decarbonisation pathways according to both warming scenarios are available for residential and commercial use types for 44 countries globally. All these trajectories start at the actual emission intensity of each country's building stock and converge to the same decarbonisation target.

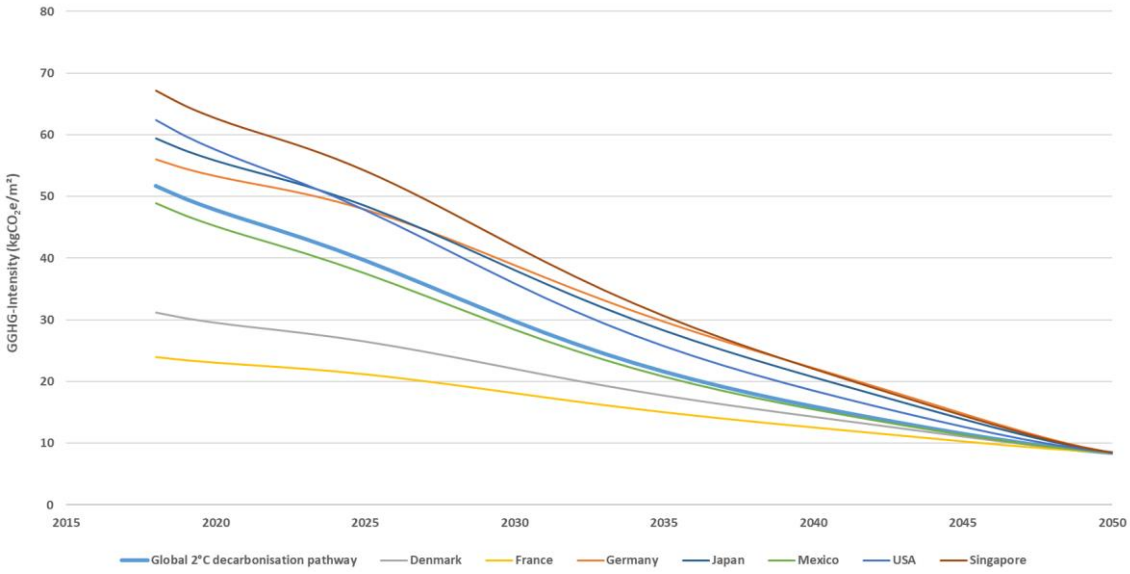

Figure 4: CRREM 2°C GHG-Intensity pathways for selected countries

Step 3. **Downscaling to building types.** The final step collects data from *GRESB* as well as individual national sources to calculate the decarbonisation pathways and targets for different non-domestic building types, including Office, Retail High Street, Retail Shopping Centre, Retail Warehouse, Hotel, Healthcare, Mixed use amongst others. The carbon emission rate and the saving capacity of each building type is intrinsically different due to the energy profiles of the activities that these buildings host. Therefore, these pathways do not converge on the same target. The calculation takes into consideration the size, expected growth and current emission rate of each sub-sector per country and assumes constant relative differences between each subsector.

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4 DECARBONISATION TARGET TOOL

This sheet of the *CRREM* tool provides the possibility to directly assess decarbonisation and energy reduction pathways (in terms of GHG intensity) without entering data for individual buildings. After selecting country, building type and global warming target (1.5°C/2°C) the *CRREM* decarbonisation target tool presents GHG intensity targets on an annual basis in the form of a line chart and tabulated data.

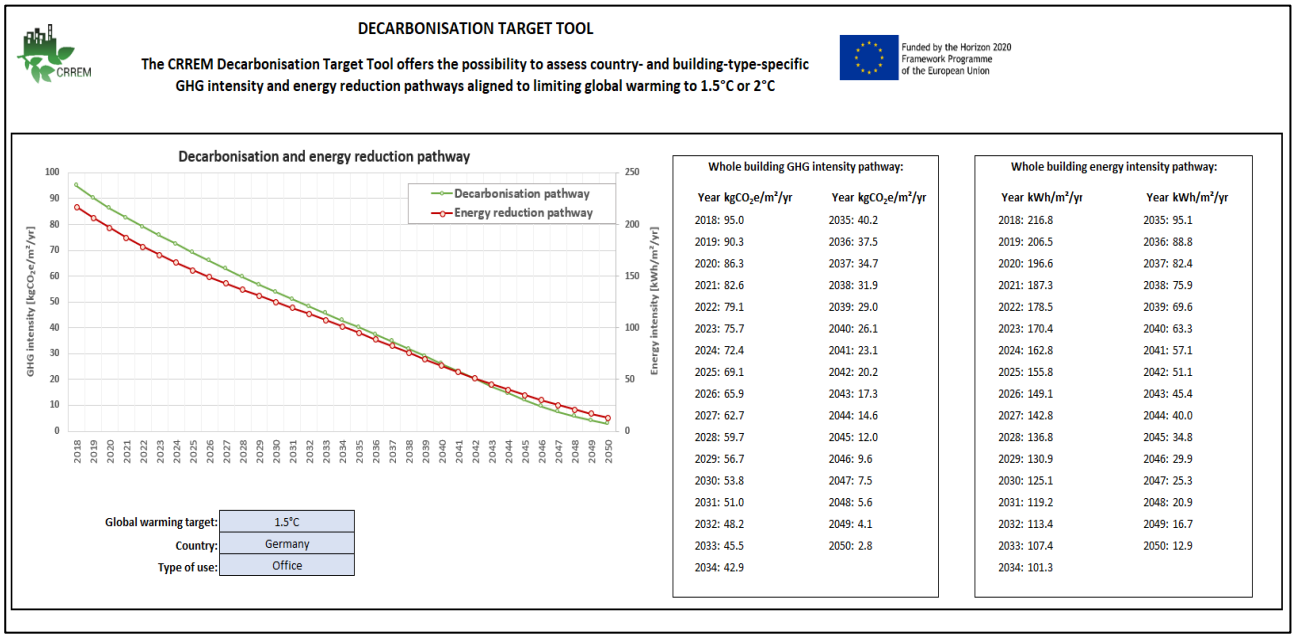

Figure 5: CRREM Tool Decarbonisation Target Tab

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5 ASSET DATA INPUT

This sheet of the *CRREM* tool provides the possibility to directly assess decarbonisation and energy reduction pathways (in terms of GHG intensity) without entering data for individual buildings. After selecting country, building type and global warming target (1.5°C/2°C)

In the asset data input sheet users enter information on individual assets that is necessary to assess stranding risks within the *CRREM* tool. The tool calculates with certain default values (e.g. country specific average energy prices), user-defined values can be entered in the settings sheet. Not all fields are mandatory and used for risk calculation but will still be included in the final reporting summary for each asset. The sheet is structure in the following six sub-sections:

General Information This part of the asset input sheet is to provide data on the asset, such as the name, period for which data is reported, Gross Asset Value (GAV) and entity name for later aggregation:

ID	**Asset ID**	*Text*

Description: Unique Asset ID that enables data consistency checks and enables the user to match asset level information with Data Management Systems (DMS) or GRESB using the GRESB Asset ID.

Requirements: Pre-filled unique asset identifier that enables the user to identify assets throughout the *CRREM* risk analysis on various tabs.

Rationale: Facilitates easy transfer of relevant variables across data platforms such as GRESB.

NAME	**Asset Name**	*Text*

Description: Name of the asset. This can also be the address of the asset.

Requirements: Mandatory. Provide the name of the asset, so that it can be identified in different tabs of the *CRREM* Risk Assessment Tool.

Rationale: Enables asset identification by the user.

AS.YR	**Reporting year**	Drop-down

Description: The year on which the user wants to report data for an asset.

Requirements: Mandatory. The *CRREM* Risk Assessment tool is intended to only allow users to report data from 2018.

Rationale: The *CRREM* Risk Assessment tool enables users to report on multiple years as to track year-over-year progress and identify outliers. Either business year 2018 or 2019 can be selected. In order to enable an automatic comparison of two assets over time, create a separate entry for both years and use the same *Asset Name (NAME).*

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GAV	Gross Asset Value (GAV)	*[€]*

Description: The total value of the asset at the end of the reporting year. GAV includes both debt and equity value.

Requirements: Optional. Report the figure at the end of the last reporting period.

Rationale: GAV is a key part for estimating the portfolio value at risk of becoming stranded due to future policy regulation. The GAV is also required to calculated the carbon value at risk (CVaR).

AS.MON	Reporting period: Starting month	*Drop-down*

Description: The first month for which data is reported in the *CRREM* Risk Assessment Tool. Dropdown consists of the months in the year.

Requirements: If left blank, *CRREM* will assumes this is January (e.g., aligned with the calendar year).

Rationale: The covered time period of the data is used for normalising non-full-year to a full year period considering different heating and cooling requirements in the course of the year.

AS.LENG	Reporting period: Months of data	[1-12]

Description: The number of months for which data is reported in the tool during the reporting year. Values entered can range from 1 to 12.

Requirements: If left blank, *CRREM* will assumes there was data for a full 12 months during the reporting year.

Rationale: *CRREM* aspires to normalise for missing months, but strongly encourages users to provide as much data as possible. The **extrapolation to 12 months does not occur linear** due to the corresponding relevance in which months of the year cooling or heating is effectively carried out.

ENT	Entity	*Text*

Description: This field can be used to categorise the analysis of assets amongst property managers, funds, separate accounts, or other entities.

Requirements: Ensure that the entity name is used consistently and mirrored across assets or reporting years.

Rationale: Provides advanced analytics for users that want to understand how a sub-part of their portfolio is performing and enables further possibilities of aggregation

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GENERAL INFORMATION INPUT:

		General information						
Asset ID	Inclusion	Asset Name	Reporting year	Gross Asset Value (GAV)	Reporting period		Entity	General information
					Starting month	Months of data		
Pre-filled			Mandatory	Optional (required for calculating certain risk indicators)	Mandatory	Mandatory	Optional (for further possibilities of aggregation)	
	Dropdown	Text	Year	[€]	Drop-down	Number of Months	Text	
ID	*INC*	*NAME*	*AS.YR*	*GAV*	*AS.MON*	*AS.LENG*	*ENT*	
1	Exclude							

Figure 6: CRREM Tool Input Tab, General information input

BUILDING CHARACTERISTICS

Building characteristics provide basic information associated with the asset such as asset location, size, property type, as well as primary areas. Generally, building characteristics remain the same over time and can thus be copied over across assessment years.

COUN.	**Location: Country**	*Drop-down*

Description: The country in which the asset is located.

Requirements: Mandatory. Dropdown of all EU countries including the United Kingdom.

Rationale: Understanding the country the asset is located in enables the tool to link the asset to the relevant Sectoral Decarbonisation Pathway, as well as convert energy consumption values to relevant electricity grid intensity metrics.

CITY.	**Location: City**	*Text*

Description: The city in which the asset is located.

Requirements: Optional. Free text entry.

Rationale: Identification of the asset.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

ZIP	**Location: Zip Code**	*Text*

Description: The Zip Code of the asset.

Requirements: Report using Zip Code. The *CRREM* automatically detects whether an entered Zip Code is valid for the selected country. Guidance regarding the correct format is available in an embedded comment in the tool.

Rationale: Geo-location of the asset (used to determine the local effects of climate change on future heating and cooling demand and local weather normalisation). If no or an invalid Zip Code is provided, the tool does the corresponding calculations on a country-level.

Address	**Location: Address**	*Text*

Description: The street address of the asset.

Requirements: Optional.

Rationale: Identification of the asset.

AS.TY	**Property type**	*Drop-down*

Description: The property type that the asset falls under.

Requirements: Mandatory. *CRREM* covers the following property types, which were originally adapted from the 2019 GRESB Real Estate Assessment:

- **Health Care:** Buildings used for the purpose of primary health care. Examples may include, but are not limited to: hospitals, clinics, physical therapy centres and mental health centres.
- **Hotel:** Includes hotels, motels, youth hostels, lodging, and resorts.
- **Mixed-use:** Assets that lack data availability by individual property type components but encompass several of the other property types in this list.
- **Office:** Includes free-standing offices, office terraces, unattributed office buildings and office parks.
- **Retail – High Street:** Retail buildings located on the high street in a particular area, usually terraced buildings located in the city centre or other high-traffic pedestrian zones.
- **Retail – Shopping Centre:** Enclosed centres for retail purposes. Examples may include, but are not limited to: regional malls and shopping malls.
- **Retail – Warehouse:** Refers to buildings in an unenclosed retail space, otherwise known as a strip centre or strip mall, whereby buildings are usually stand-alone and situated side-by-side with their entrance facing a main street or carpark.
- **Industrial – Distribution Warehouse:** Refers to a building in an unenclosed space, usually these are stand-alone buildings situated by a car park or truck loading areas as they act as a shipping hub, receiving shipments and holding items until they are loaded onto trucks and distributed elsewhere. Often the warehouses are in the form of large halls and are located around the outskirts of cities.
- **Lodging, Leisure & Recreation**: Includes lodging, sports club houses, gyms, sports stadia, indoor sports arenas, halls, swimming pools, theatre and auditoria.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

If **Mixed Use** is selected it is mandatory to state the floor area share of each building type, stated as a percentage. Given percentages must sum to one-hundred percent.

Rationale: *CRREM* has calculated decarbonisation pathways for individual property types. Entering this information enables *CRREM* to link the asset to a relevant decarbonisation target.

AC.YN	**Air conditioning**	Drop-down

Description: Selection of "yes" or "no" if air conditioning is used and available in the property.

Requirements: Optional.

Rationale: Air conditioning usage is an indicator for *CRREM* to understand the energy usage.

TO.FL	**Asset size: Total gross internal area**	*Area [m²]*

Description: The total gross internal area of the asset, measured in IPMS 2.

Requirements: Mandatory. Users should report the gross internal area of the asset, aligned with the International Property Measurement Standards (IPMS 2).

Please note: Any outdoor/exterior areas as well as indoor parking (heated as well as non-heated) should be excluded.

Rationale: Floor area is the key denominator to calculate carbon and energy intensity metrics in real estate, which is an important determinant for assessing carbon risk in the Sectoral Decarbonisation Model. The tool calculates with whole building energy consumptions, therefore requires whole building energy data (tenant space & common area energy use). All energy reported should be energy used for the operation, energy consumed as part of refurbishment measures should be included. If the user will input a user-defined pathway (e.g. for residential buildings), then the tenant space as well as common area energy consumption still applies.

BSR_OC.AN	**Asset size: Average annual vacant area**	Area [m²]

Description: The average annual vacant floor area in m².

Requirements: Mandatory. Report upon the vacancy rate during the reporting year. If part of the building was vacant for only a part of the year, include this in your calculation. If left blank, the tool assumes no vacancy during the reporting period.

Rationale: Vacant floor area is the key indicator to calculate carbon and energy intensity metrics in the property. Vacant assets generally consume significantly less energy compared to non-vacant assets. Assuming decreasing vacancy rates over time, energy consumption and GHG emissions will increase. Should there be vacancy in the asset, the tool extrapolates the information and normalises to full occupancy (this can also be changed in the settings sheet).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

BUILDING CHARACTERISTICS INPUT:

Building characteristics																			
Location				Property type	Floor area share of different property types in mixed use buildings										Air conditioning	Asset size		Building characteristics
Country	City	Zip Code	Address		Office	Retail, High Street	Retail, Shopping Center	Retail, Warehouse	Industrial, Distribution Warehouse	Hotel	Healthcare	Lodging, Leisure & Recreation	Data Centers	Check if floor area shares sum up to 100%		Total gross internal area (IPMS 2)	Average annual vacant area	
Mandatory	Optional (only to be displayed in results)	Optional (for improved accuracy)	Optional (only to be displayed in results)	Mandatory	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use	Mandatory if Property type = Mixed Use		Optional	Mandatory	Mandatory	
Drop-down COUN	Text CITY	Text/Numbers ZIP	Text Address	Type of use AS.TY	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	MX.100	Drop-down AC.YN	[m²] TO.FL	[m²] BSR_OC.AN	

Figure 7: Tool Input Tab, Building characteristics input

ENERGY CONSUMPTION DATA

This section covers the main input fields which enables users to enter energy consumption data. The *CRREM* tool in turn converts energy consumption data into GHG Emissions. If no data coverage is available for certain areas, *CRREM* intends to develop an estimation model that would still provide insights into potential carbon risks.

Whole building energy consumption is entered in this section (the combined energy consumptions of common areas and tenant space). This includes energy used by tenants and base building services to lettable/leasable and common spaces. This should include all energy supplied to the building for the operation of the building and the tenant space except from energy consumed as part of refurbishment measures. Please note: the tool calculates with country specific emission factors. The default emission factors evolve dynamically over time, with the district heating emission factor being coupled to the development of the electricity emission factor of the selected country. User-defined emission factors and the development can be entered in the settings sheet.

An important distinction is made between data coverage and maximum potential coverage:

- **Data Coverage (m^2):** The part of the asset or portfolio for which data is available, per space and fuel type. The floor area reported in these fields should reflect the floor area of the asset/portfolio for which energy consumption data is collected and reported upon.
- **Maximum Coverage (m^2):** The floor area reported in these fields should reflect the total floor area of the asset/portfolio of the area for which there is energy supply in the building.

EL.GRID	**Grid Electricity**	*Consumption [kWh]*
EL.DC/EL.MC		

Description: The annual electricity consumption [kWh] of a building area. Electricity consumption can be either purchased by the tenant or landlord.

Requirements (**Electricity Consumption (kWh)):** Report upon the electricity consumption of the building area in kilowatt hour (kWh) for the duration of the reporting period.

Rationale: Electricity consumption is a key indicator for building efficiency, covering both appliances and increasingly building heating. The *CRREM Risk Assessment* links electricity to country grid carbon intensity factors, to assess a building's current and future carbon risk profile.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

NG.CON	Natural Gas	*Consumption [kWh/m³]*

Description: Natural gas consumption of a building area. Natural gas can either purchased by the tenant or landlord, and is typically consumed for building heating.

Requirements: Report upon the natural gas consumption of the building area in kilowatt hour (kWh) or cubic meter (*m³)* for the duration of the reporting period.

Rationale: Natural gas is a key energy consumption type for building heating. The *CRREM Risk Assessment* converts natural gas consumption to carbon emissions using emission factors provided by the UK Government / BEIS 2018 Standard Set.

References: Gov.uk - Government emission conversion factors for greenhouse gas company reporting [online]

OL.CON	Fuel oil	*Consumption [kWh/m³]*

Description: Fuel oil consumption of a building area used for furnaces or boilers in buildings. Also known as heating oil. Fuel oil can either purchased by the tenant or landlord, and is typically used in remote premises without a natural gas connection for residential home heating.

Requirements: Report upon the fuel oil consumption of the building area in kilowatt hour (kWh) or cubic meter (*m³)* for the duration of the reporting period.

Rationale: The *CRREM Risk Assessment* converts fuel oil consumption to carbon emissions using emission factors provided by the UK Government / BEIS 2018 Standard Set.

References: Gov.uk: Government emission conversion factors for greenhouse gas company reporting [online]

DH.CON	District heating [steam]	*Consumption [kWh/m³]*

Description: System for distributing hot steam generated in a centralised location for residential and commercial heating requirements such as space and water heating.

Requirements: Report upon the steam consumption in kilowatt hour (kWh) for the duration of the reporting period. If the district heating consists of hot water instead of steam, you can report upon this in the “Other” energy consumption category.

Rationale: District heating [steam] is commonly regarded as an efficient heating source. *CRREM* aspires to convert district heating into emissions using localised emission factors. The district heating EF is coupled to the electricity EF and develops analogously to the electricity EF. This method is used as the heat production/distribution is often dependent on electricity. For accuracy please use local heating EF from your power provider and insert to the respective part in the settings sheet.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 785058.

DC.CON	District cooling [chilled water]	*Consumption [kWh/m³]*

Description: System for distributing chilled water generated in a centralised location for residential and commercial cooling requirements.

Requirements: Report upon the chilled water consumption in kilowatt hour (kWh) for the duration of the reporting period.

Rationale: District cooling [chilled water] is commonly regarded as an efficient cooling source. *CRREM* aspires to convert district cooling into emissions using localised emission factors.

OT1.TY	Other energy consumption type	*Consumption [kWh/m³]*

Description: Enables users to report upon other energy consumption types.

Requirements: Select the other energy consumption type from the drop-down, and report upon the other consumption type in kilowatt hour (kWh).

Rationale: Buildings can consume a wide range of energy sources in the form of fuels, gasses and solids, each corresponding to different carbon intensity values. *CRREM* aspires to measure a building's carbon performance as completely as possible, hence this other option is included for flexible reporting purposes. The following fuels and gases have been predefined:

- **Biogas:** Biogas consumption of a building area. Biogas can either purchased by the tenant or landlord, and it typically consumed for building heating. Some infrastructures produce it on site from anaerobic digestion of waste.
- **Wood chips:** Wood chips consumption of a building area. It is typically consumed for building heating.
- **Wood pellets:** Wood pellets consumption of a building area. It is typically consumed for building heating.
- **Coal:** Coal consumption of a building area. Coal can either purchased by the tenant or landlord, and it typically consumed for building heating.
- **Landfill gas:** Landfill gas consumption of a building area. Landfill gas can either purchased by the tenant or landlord, and it typically consumed for building heating.
- **LPGs:** Liquified Petroleum Gases (LPGs) consumption of a building area. LPGs can either be purchased by the tenant or landlord, and are typically consumed for cooking or building heating, normally in remote areas.

The *CRREM Risk Assessment* converts fuel oil consumption to carbon emissions using emission factors provided by the UK Government / BEIS 2018 Standard Set.

References: Gov.uk - Government emission conversion factors for greenhouse gas company reporting [online]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

ENERGY CONSUMPTION INPUT:

Energy consumption																												
Whole building energy consumption Combined energy consumption of Common Areas + Tenant Space Energy used by tenants and base building services to lettable/leasable and common spaces. This should include all energy supplied to the building for the operation of the building and the tenant space except from energy consumed as part of refurbishment measures.																												Energy consumption
Grid Electricity			Natural gas			Fuel oil			District heating [steam]				District cooling [chilled water]				Other energy consumption type 1				Other energy consumption type 2							
Usage	Data Coverage	Maximum Coverage	Usage	Data Coverage	Maximum Coverage	Usage	Data Coverage	Maximum Coverage	Usage	Set user-defined emission factor	Data Coverage	Maximum Coverage	Usage	Set user-defined emission factor	Data Coverage	Maximum Coverage	Type	Usage	Data Coverage	Maximum Coverage	Type	Usage	Data Coverage	Maximum Coverage				
	Mandatory if usage ≠ 0	Mandatory if usage ≠ 0		Mandatory if usage ≠ 0	Mandatory if usage ≠ 0		Mandatory if usage ≠ 0	Mandatory if usage ≠ 0			Mandatory if usage ≠ 0	Mandatory if usage ≠ 0			Mandatory if usage ≠ 0	Mandatory if usage ≠ 0	Mandatory if usage ≠ 0		Mandatory if usage ≠ 0	Mandatory if usage ≠ 0	Mandatory if usage ≠ 0		Mandatory if usage ≠ 0	Mandatory if usage ≠ 0				
[kWh]	[m²]	[m²]	[kWh]	[m²]	[m²]	[kWh]	[m²]	[m²]	[kWh]	Hyperlink	[m²]	[m²]	[kWh]	Hyperlink	[m²]	[m²]	Drop-down	[kWh]	[m²]	[m²]	Drop-down	[kWh]	[m²]	[m²]				
EL.GRID	EL.DC	EL.MC	NG.CON	NG.DC	NG.MC	OL.CON	OL.DC	OL.MC	DH.CON		DH.DC	DH.MC	DC.CON		DC.DC	DC.MC	OT1.TY	OT1.CON	OT1.DC	OT1.MC	OT2.TY	OT2.CON	OT2.DC	OT2.MC				
										Settings				Settings														

Figure 8: Tool Input Tab, Energy consumption input

FUGITIVE EMISSIONS / REFRIGERANT LOSSES

This section of the *CRREM Risk Assessment Tool* covers additional input fields for energy related Scope 1 and 2 GHG emissions including calculating Scope 1 GHG emissions associated with refrigerant losses or fugitive emissions. Refrigerant losses can be an important emission factor related to cooling. This section allows users to provide self-calculated GHG emissions, as an alternative to the *CRREM* GHG conversion system based on entering data.

GHG.Leak1,Type	**Fugitive Emissions / Refrigerant losses**	*[kg]*
GHG.Leak1.Amount		

Description: Report upon refrigerant losses associated with fugitive emissions due to air conditioning, refrigeration or industrial processes. Fugitive emissions contribute to both climate change and local air pollution. Amount of emissions reported will apply to all years (from reporting year up until 2050).

Requirements: Report upon the type of gas as well as the leakage in kilograms (kg). Users have the option to report upon two types of refrigerant gases per asset. The *CRREM Risk Assessment* converts refrigerant losses to carbon emissions using official emission factors.

Rationale: Fugitive emissions can be an important source of Scope 1 emissions especially for retail assets or assets with (older) air conditioning systems.

References: [Gov.uk - Government emission conversion factors for greenhouse gas company reporting [online]]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

FUGITIVE EMISSIONS INPUT:

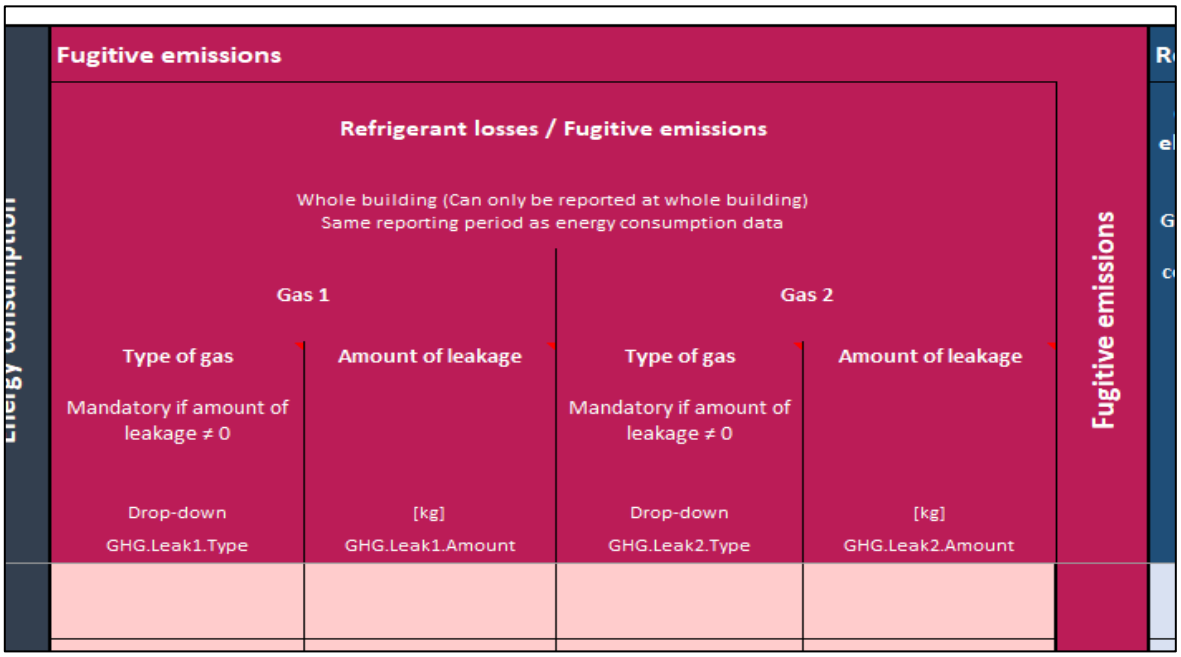

Figure 9: Tool Input Tab, Fugitive emissions input

RENEWABLE ENERGY GENERATION

This section of the *CRREM Risk Assessment Tool* covers renewable energy generated and purchased by the portfolio. The use of renewable energy reduces negative environmental impacts associated with fossil fuel use.

The *CRREM Risk Assessment Tool* has a designated field to report upon renewable electricity from solar PV or wind:

- **Solar PV:** Energy generated from solar heat and/or radiant light. Photovoltaic systems generate electrical power from sunlight by using solar cells or semiconductors. Solar water heating systems capture the heat from sunlight using solar thermal collectors to produce hot water.
- **Wind energy:** Energy generated by using wind turbines.

Additionally, users can report upon an "other" renewable energy source, if these can be reported upon using kWh. Participants have the option to report upon one of the following renewable energy options:

- **Geothermal energy:** Energy from heat generated by the earth's matter (e.g. ground pump heating systems). This includes geothermal storage.
- **Hydro energy:** Energy generated by the gravitational force of falling or flowing water.

The CRREM targets do not reflect energy consumption, however net energy demand. The net energy demand can be calculated by deducting the energy generated from the energy drawn/purchased from the grid, but the energy consumption would be both generated and consumed from the grid. An example of "low net energy" would be heat-pumps as these consume small amounts of energy from the grid, however generate a larger amount of energy through the heat from the earth on site.

Users can also report off-site renewable electricity. This comprises renewable energy that is generated off-site but consumed on-site and select a reporting method of either a location-based approach or a market-based approach.

Biofuels, which can also be considered renewables, need to be reported upon in the "other energy consumption type field". Please note: The asset and portfolio level output display net procured intensities, minus the exported energy.

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Generated and consumed on-site	*[kWh]*

Description: Report upon the renewable energy that was generated on-site, as well as consumed on-site.

Requirements: Report upon the renewable energy in terms of kilowatt hour (kWh). Users have the option to report renewable electricity generated through solar or wind and other renewable energy sources generated through heat-pumps or solar thermal.

Rationale: Renewable energy generated and consumed on-site makes electricity costs less dependent upon energy price fluctuations.

Please note: Input will **NOT** be included in the net energy display as this does not count into the Net Energy Demand. NED can be described as "procured (from the grid) minus exported" or "consumed minus generated".

Generated on-site and exported	*[kWh]*

Description: Report upon the renewable energy that was generated on-site but exported.

Requirements: Report upon the renewable energy in terms of kilowatt hour (kWh). Users have the option to report renewable electricity generated through solar or wind and other renewable energy sources generated through heat-pumps or solar thermal.

Rationale: Renewable energy generated on-site and exported can serve as a hedge against energy price fluctuations.

Generated off-site and purchased	*[kWh] / Drop-down*

Description: Report upon renewable energy that was generated off-site, consumed on-site and purchased by the landlord or the tenant.

Requirements: Report upon the renewable energy in terms of kilowatt hour (kWh). Users have the option of selecting a reporting method. A location-based approach can be selected or a market-based approach including the emission factor in kgCO2 or kWh.

Rationale: Renewable energy generated off-site and purchased by the landlord reduces a portfolio's carbon emissions. Off-site renewable energy contracts with a longer duration lock in an asset's energy price.

MARKET VS. LOCATION BASED DATA

Location based emission factors are based on the average emission intensities of the electricity grid (national grid-averages), whereas the marked-based approach reflects the GHG emissions based on emissions by the generators from which the entity purchases electricity.

- Market or location-based data can be selected in the input sheet for renewable energy or entered in the settings sheet.

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RENEWABLE ENERGY INPUT:

Renewable energy							
On-site renewable electricity (PV, wind)		Off-site renewable electricity Generated off-site and consumed on-site			Other on-site renewable energy source (heatpump, solar thermal)		Renewable energy
Generated and consumed on-site	Generated on-site and exported	Generally, off-site renewables do not constitute a quality characteristic reducing carbon risk of individual buildings. Only renewable electricity purchased directly from a generator / retailer through a power purchasing agreement or contract can be acknowledged under strict conditions.			Generated and consumed on-site	Generated on-site and exported	
Amount	Amount	Amount	Reporting method	Emission factor if market-based	Amount	Amount	
[kWh]	[kWh]	[kWh]	Drop-down	[$kgCO_2e/kWh$]	[kWh]	[kWh]	
			Location-based approach				

Figure 10: Tool Input Tab, Renewable energy input

Please note: If reporting method is set to **'market-based approach'**, please enter your electricity emission factor here (mandatory). If market-based is selected, the Emission Factor is only for the starting year (2018 or 2019). The EF development will then follow (rate of change) the market projections/market development for the selected country (in form of the relative change). Please use the settings sheet to input a user-defined EF development until 2050.

RETROFIT ACTION

This section of the *CRREM Risk Assessment Tool* enables the user to define generalised retrofit actions by setting year and investment amount intending to improve the energy and carbon performance of the building. Retrofit costs are specific to country and property type.

RF1.YR	Year of retrofit	[Year]
RF1.EUR	Expenses	[€]
RF1.PC	Achieved energy reduction of energy consumption	[%]
RF1.EC	Embodied carbon related to retrofit action	[kgCO2e]

Description: The year in which the asset will undertake a planned capital-intensive retrofit.

Requirements: Define budget to the selected year of which retrofit action is planned. One future retrofit action can be reported.

Rationale: The calculation of the energy and carbon reduction achievable with a certain amount of investment is based on a very general calculation, considering property type and location (country) of a building. Users can enter their own

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estimation of reduced energy consumption. Further an automatic estimation of embodied carbon related to a retrofit measure is available. Users can provide their own estimation of embodied carbon that will be used to assess the ecological balance of a retrofit measure (comparing embodied carbon and operational savings).

RETROFIT ACTION INPUT:

Retrofit actions							
Retrofit action					Retrofit actions	Click on 'User-defined settings' to change CRREM default assumptions for a specific asset	Click on 'results' to see results of CRREM stranding risk analysis on asset level. (you will have to manually select the desired asset (ID) in the asset results sheet)
Year	Investment	Achieved reduction of energy consumption [%] - Leave blank to apply default values	Embodied carbon related to retrofit action				
[yyyy]	[€]	[%]	[kg]				
RF1.YR	RF1.EUR	RF1.PC	RF1.EC	DatCent			
						User-defined settings	Results

Figure 11: Tool Input Tab, Retrofit action input

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6 DEFAULT ASSET DATA (SETTINGS)

This sheet is specific for advanced users and allows them to overwrite default data points to tailor the *CRREM Risk Assessment Tool* for each analysed asset regarding a wide range of parameters. *CRREM* assumes default scenarios that impact energy and carbon emissions normalisation, energy prices, climate transition pathway, and retrofit and abatement costs.

NORMALISATION

This section contains several options allowing users to change asset-level settings to normalise for occupancy and weather.

Normalise consumption data to 100% occupancy rate *[Yes/No]*

Description: Enables the user to specify whether to normalise for 100% occupancy.

Requirements: Select Yes or No. By default, this is set to Yes.

Rationale: Vacancy can be an important factor impacting the carbon emissions of an asset.

References: Normalisation is based upon “average vacant area” as reported in the asset input sheet.

Normalise current heating & cooling degree days *[Yes/No]*

Description: Enables the user to normalise the reporting year for heating & cooling degree days

Requirements: Select Yes or No. By default, this is set to Yes.

Rationale: Climatic differences can impact an asset’s energy consumption through heating or cooling requirements.

References: Normalisation is based upon a climatic model derived from the European Environmental Agency.

Climate change projection *[RCP4.5/RCP8.5]*

Description: The Representative Concentration Pathway (RCP) is a GHG concentration trajectory adopted by the *Intergovernmental Panel on Climate Change* (*IPCC*). The RCP8.5 projects a steep incline in GHG concentration of over 1200 ppm of CO2-equivalents, while the RCP4.5 estimates a moderate inclusion of 650 ppm CO2-equivalents until 2100.

Requirements: Default is RCP4.5. RCP8.5 can also be selected.

Rationale: The climate change projections affect the future heating and cooling demand.

References: RCP4.5 is an intermediate scenario, while RCP8.5 is the worst-case scenario.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 785058.

NORMALISATION SETTINGS:

Default:	Yes	Yes	RCP4.5
Asset ID	Normalise consumption data to 100% occupancy rate [yes/no]	Normalise heating and cooling consumption to weather in year of consumption [yes/no]	Climate change projection (affects future heating and cooling demand)
1	Yes	Yes	RCP4.5

Figure 12: Tool Settings tab, normalisation settings

ELECTRICITY EMISSION FACTORS

CBK_EC.EN ***GHG emission factor for electricity consumption*** *[kgCO2/kWh]*

Description: Enables the user to apply default or user-defined emission factor for electricity consumption with an option to either set the value for each year manually or to set to 2018 value and annual rate of change.

Requirements: Provide the alternative electricity grid carbon intensity factors or an annual rate of change. Values can also be entered for each year up to 2050. Please note that for all assets with entered emission factors of zero (user-defined), there is no corresponding consumption calculated.

Rationale: Buildings can have unique electricity grid intensity factors.

GHG emission factor for district heating or cooling *[kgCO2/kWh]*

Description: Alternative emission factor for district heating. Heating always follows the selected development of the EF for electricity. The emission factor develops analogously along the decarbonisation of electricity, the EF is linked to the ratio to electricity from an EU/UK average.

Requirements: Provide the alternative district heating intensity factors. In order to input the EF development until 2050, the users can overwrite the values in the back-end sheet.

Rationale: The carbon intensity of district heating system can differ strongly across regions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

EMISSION FACTOR SETTINGS:

Default					Default		Default		Emission factors	U
Electricity emission factor					District heating emission factor		District cooling emission factor			
Apply default or user-defined emission factor for electricity consumption	Choose method for setting user-defined electricity emission factors	Set baseline emission factor [kgCO2/kWh]	Set annual rate of change [%]	Set value for each year manually	Apply default or user-defined emission factor for district heating	Set baseline emission factor [$kgCO_2e/kWh$]	Apply default or user-defined emission factor for district cooling	Set baseline emission factor [$kgCO_2e/kWh$]		
Default					Default		Default			

Figure 13: Tool Settings tab, user-defined emission factor settings

USER-DEFINED ENERGY PRICES

Enables users to overwrite asset-level energy price assumptions. Larger portfolios generally have more market power to set prices, and could thus face lower energy prices. Please note that all energy prices are market averages, including VAT. Elements covered:

- Price per kWh gas consumption [€]
- Annual price increase per kWh gas consumption [%]
- Initial price per kWh district heating/cooling consumption [€]
- Annual price increase per kWh district heating/cooling consumption [%]
- Initial price per kWh electricity consumption [€]
- Annual price increase per kWh electricity consumption [%]
- Initial price per kWh “other source” consumption [€]
- Annual price increase per kWh “other source” consumption [%]

ENERGY PRICE SETTINGS:

User-defined energy prices																			
Electricity price					Gas price					District heating price					District cooling price				
Apply default or user-defined electricity price	Choose method for setting user-defined electricity price	Set baseline electricity price [€/kWh]	Set annual rate of change [%]	Set value for each year manually	Apply default or user-defined gas price	Choose method for setting user-defined gas price	Set baseline gas price [€/kWh]	Set annual rate of change [%]	Set value for each year manually	Apply default or user-defined district heating price	Choose method for setting user-defined district heating price	Set baseline district heating price [€/kWh]	Set annual rate of change [%]	Set value for each year manually	Apply default or user-defined district cooling price	Choose method for setting user-defined district cooling price	Set baseline district cooling price [€/kWh]	Set annual rate of change [%]	Set value for each year manually
Default					Default					Default					Default				

Figure 14: Tool Settings tab, user-defined energy price settings

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 785058.

CARBON PRICES

Enables users to overwrite asset-level carbon price assumptions. Elements covered:

- Default or own assumptions on carbon pricing
- Method for defining own carbon price development
- Year for beginning of carbon pricing
- Carbon price in initial year [€/tCO2]
- Climax carbon price in target year [€/tCO2]
- Type of growth path ('Linear' / 'Constant growth factor')
- Annual growth of carbon price [%]

DISCOUNT RATES

Enables users to choose default or user defined rate for valuing future spending and savings. Including:

- Discount rate for valuing future spending and savings (default: 3%)

CARBON PRICES & DR SETTINGS:

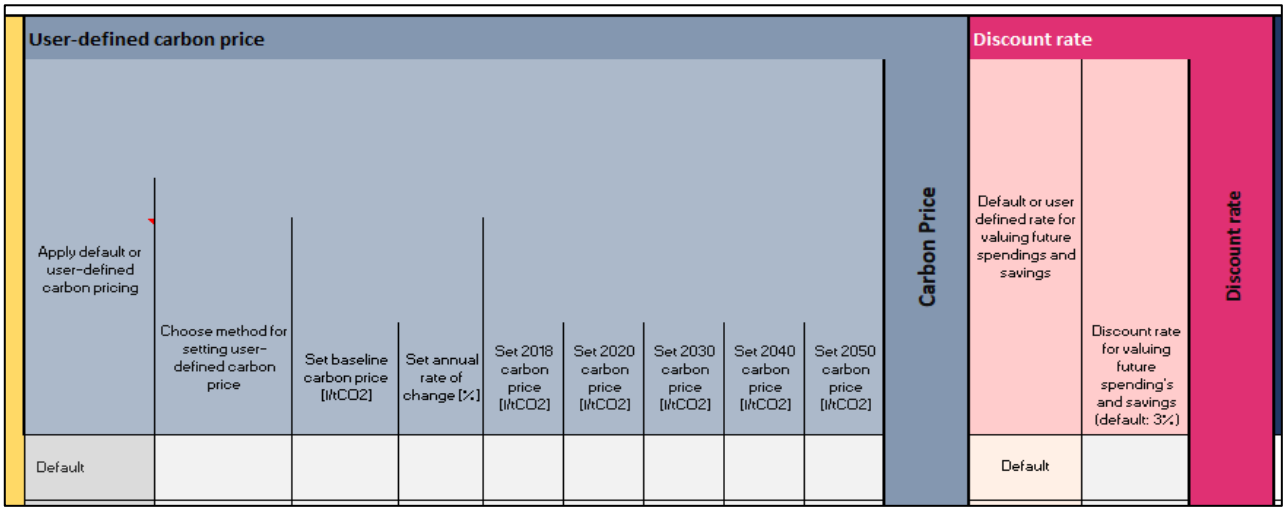

Figure 15: Tool Settings tab, user-defined carbon price and discount rate settings

MARKET VS. LOCATION BASED DATA

Location based emission factors are based on the average emission intensities of the electricity grid (national grid-averages), whereas the marked-based approach reflects the GHG emissions based on emissions by the generators from which the entity purchases electricity.

- Market or location-based data can be selected in the input sheet for renewable energy or entered in the settings sheet.

USER-DEFINED DECARBONISATION PATHWAYS

Enables users to enter individual decarbonisation pathways for each asset. This enables the user to make own assumptions and benchmark individual assets or the portfolio against own targets instead of the given *CRREM* 1.5°C/2°C pathways.

- User-defined decarbonisation pathway from 2018-2050 in terms of $kgCO_2e/m^2$.

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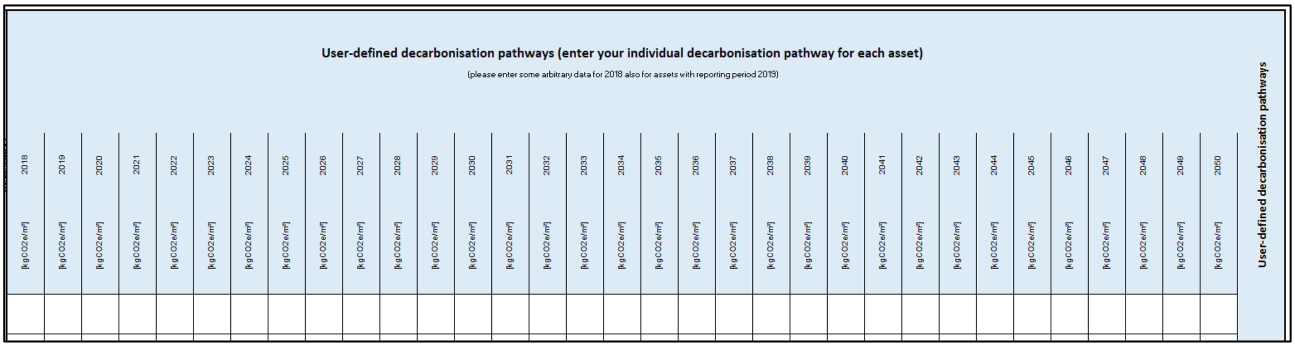
USER DEFINED DECARBONISATION PATHWAY SETTINGS:



User-defined decarbonisation pathways (enter your individual decarbonisation pathway for each asset)

(please enter some arbitrary data for 2018 also for assets with reporting period 2019)

2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	**User-defined decarbonisation pathways**
[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	[kgCO2e/m²]	

Figure 16: Tool Settings tab, user-defined decarbonisation settings

COUNTRY SPECIFIC DEFAULT VALUES

Following the idea of a transparent tool, all calculations are carried out in the back-end sheet, enabling users to easily understand the structure. Country specific default values can be viewed in the back-end sheet of the tool. These can then be **adjusted to user-specific values in the settings sheet of the tool.**

Default values used include:

Electricity EF	Back-end A 22-A 51
District Heating EF	Back-end ratio J 123 to Electricity EF UK
Electricity Price	Back-end AVH 33
Gas Price	Back-end AVH 96
Oil Price	Back-end AVH 127
Coal Price	Back-end AVH 344
Wood Chip Price	Back-end AVH 187
Pellets Price	Back-end AVH 253
District Heating Price	Back-end AVH 344
Carbon Price (€/Kg)	Back-end AVH 439
Carbon Price Development	Back-end CVQ

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research and innovation programme under grant agreement no. 785058.

7 UNIT CONVERSION TOOL

The *CRREM Unit conversion tool* is located in a separate sheet of the *CRREM* tool and allows users to convert different units of energy consumption, weight/mass and volume, enabling the calculation of required values.

Energy consumption by burning natural gas can be entered either in kilowatt hour (kWh) or square meters (m^2) directly in the Asset input data sheet. All other energy sources must be entered in kWh.

Floor area input data can be entered in square meter (m^2). Data on energy consumption or floor area based on other units must be converted.

The *CRREM Unit conversion tool* enables users to do this conversion directly in the *CRREM* tool for a wide range of the most common units including the possibility to take account of common unit prefixes like *kilo* or *mega. The following values can be converted:*

Energy				
Kilowatt hour (kWh)	Gigajoule (GJ)	British thermal unit (therm)	Tonne oil equivalent (toe)	Kilocalorie (kcal)

Weight / Mass				
Kilogram (Kg)	tonne (t)	ton (UK, long ton)	ton (US, short ton)	Pound (lb)

Volume					
Cubic metre (m^3)	Litre (L)	Cubic feet (cu ft)	Imperial gallon (Imp.gal)	American gallon (US.liq.gall)	American barrel (bbl)

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UNIT CONVERTER TAB:

UNIT CONVERTER

Funded by the Horizon 2020 programme of the European Union

The Unit Converter Sheet allows you to convert your data into one of the supported units that are used to enter data in the CRREM Asset Input Sheet. The Unit Converter Sheet may also support you to convert any results of the CRREM Risk Analysis into your favoured unit. Tables are adopted from the publication 'UK Government GHG Conversion Factors for Company Reporting'.

Decimal separator: "."
Thousand separator: "," (output only; don't use thousand separators in your input)

		GJ	kWh	therm	toe	kcal	OUTPUT	
Energy	Gigajoule, GJ		277.78	9.47817	0.02388	238,903	20.2000	Gigajoule, GJ
	Kilowatt-hour, kWh	0.0036		0.03412	0.00009	860.05	5,611.1111	Kilowatt-hour, kWh
	Therm	0.10551	29.307		0.00252	25,206	191.4590	therm
	Tonne oil equivalent, toe	41.868	11,630	396.83		10,002,389	0.48247	Tonne oil equivalent, toe
	Kilocalorie, kcal	0.000004186	0.0011627	0.000039674	0.000000100		4,825,839.74	Kilocalorie, kcal
	Amount	20.20						
	Select input unit	GJ						

CHOOSE THE UNIT OF YOUR INPUT DATA AND ENTER YOUR DATA IN THE YELLOW CELLS
TO SEE CONVERSION RESULST IN THE GREEN CELLS ON THE RIGHT

		kg	tonne	ton (UK)	ton (US)	lb	OUTPUT	
Weight/mass	Kilogram, kg		0.001	0.00098	0.00110	2.20462	-	Kilogram, kg
	tonne, t (metric ton)	1000		0.98421	1.10231	2204.62368	-	tonne, t (metric ton)
	ton (UK, long ton)	1016.04642	1.01605		1.12000	2240	-	ton (UK, long ton)
	ton (US, short ton)	907.18	0.90718	0.89286		2000	-	ton (US, short ton)
	Pound, lb	0.45359	0.00045359	0.00044643	0.00050		-	Pound, lb
	Amount							
	Select input unit	kg						

CHOOSE THE UNIT OF YOUR INPUT DATA AND ENTER YOUR DATA IN THE YELLOW CELLS
TO SEE CONVERSION RESULST IN THE GREEN CELLS ON THE RIGHT

		Litre	m^3	Cubic feet	Imp. gallon	US gallon	bbl (US pet.)	OUTPUT	
Volume	Litres, L		0.001	0.03531	0.21997	0.26417	0.0062898	158,987.2891	Litres, L
	Cubic metres, m^3	1000		35.315	219.97	264.17	6.2898	158.9873	Cubic metres, m^3
	Cubic feet, cu ft	28.317	0.02832		6.2288	7.48052	0.17811	5,614.5832	Cubic feet, cu ft
	Imperial gallon	4.5461	0.00455	0.16054		1.20095	0.028594	34,972.3144	Imperial gallon
	US gallon	3.7854	0.0037854	0.13368	0.83267		0.023810	41,999.9983	US gallon
	Barrel (US, petroleum), bbl	158.99	0.15899	5.6146	34.972	42		1,000.0000	Barrel (US, petroleum), bbl
	Amount						1000		
	Select input unit	bbl (US pet.)							

CHOOSE THE UNIT OF YOUR INPUT DATA AND ENTER YOUR DATA IN THE YELLOW CELLS
TO SEE CONVERSION RESULST IN THE GREEN CELLS ON THE RIGHT

Start | Targets | Input | Asset | Portfolio | Settings | Unit Converter | Back-end

Figure 17: Tool Unit Converter Tab

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8 RESULTS: ASSET LEVEL

This sheet contains all relevant analysis results on the individual asset level based on entered asset data input and the selected default or user-defined values and assumptions. The sheet is structured in two sections:

The upper part of the asset level results sheet shows a summary of the most important analysis results for a selected individual asset. After selecting an individual asset, the tool displays the stranding diagram (see graph below) with the decarbonisation target pathway based on the assets building type and location (country). The user can choose which global warming target (1.5°C or 2°C) the decarbonisation pathway shall be based on or whether to apply user-defined target values. The diagram further contains the baseline and estimated future GHG intensity of the selected asset considering country-specific grid decarbonisation and location-specific (Zip code) effects of climate change (based on default or user-defined values). The diagram displays the potential year of stranding (red circle) when the asset's GHG intensity is higher than the decarbonisation target. Any subsequent emission above the permissible values of the selected pathway (so called 'excess emissions') are used as one of the risk indicators. The economic obsolescence is associated with the stranding date; the higher the excess emissions, the greater the probability of economic obsolescence occurring. A further risk-indicator is also the Value at Risk (CVaR) calculated from the GAV, however, please note that the CVaR is only the risk associated with the negative value and hence not a simulation (as such terms often indicate).

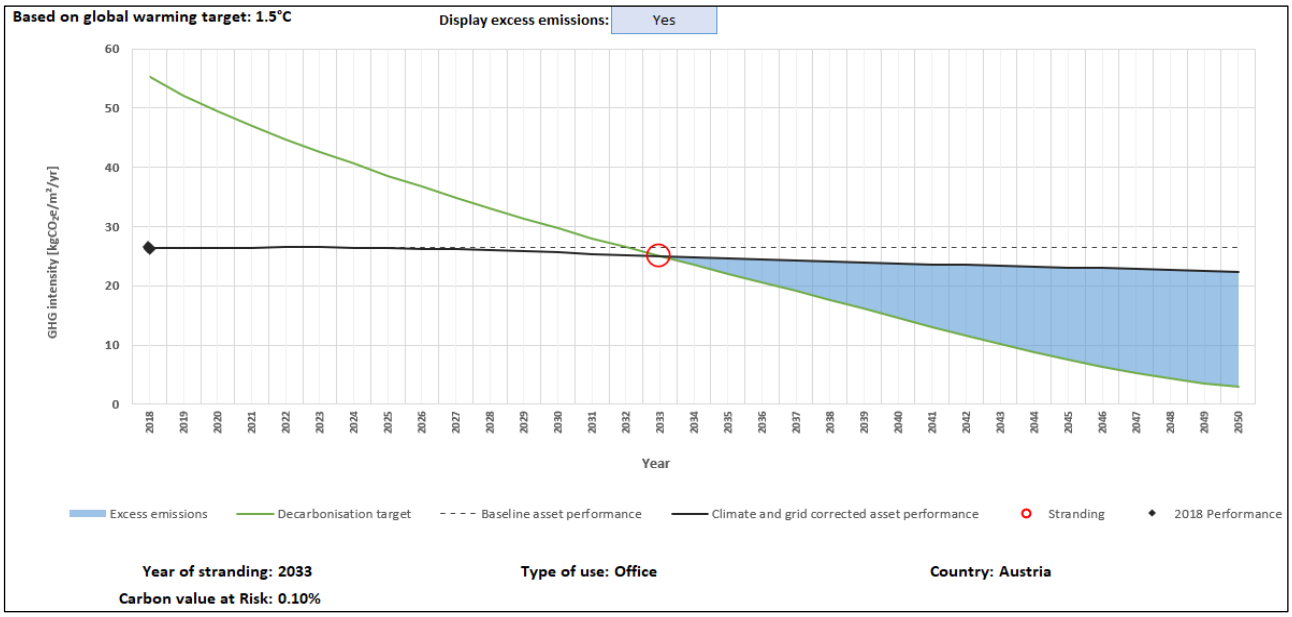

Figure 18: Asset-level output - Stranding diagram

Also, in the upper part of the asset level results sheet, besides the stranding diagram, the tool provides a table with decarbonisation targets for the chosen asset on an annual basis (based on the selected global warming target). Further key findings are presented, such as:

- estimated baseline annual energy costs,
- baseline whole building GHG emissions and intensity,
- cumulative emissions until 2050,
- the remaining emissions budget according to decarbonisation targets,
- the accumulated amount of GHG emissions surpassing the decarbonisation target (these "excess emissions" can optionally be visualised on the stranding diagram),
- excess emissions per floor area,

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- costs of retrofitting to comply with decarbonisation pathway,
- payback and point of break-even after retrofit investments,
- the monetary costs of these emissions assuming a certain carbon price.

Figure 19: Asse-level output – Stranding diagram with retrofit scenario

The graph above shows a further output generated on the asset level. The dashed line represents the asset GHG intensity up until 2050 without any planned retrofit measures, whereas in comparison the black line shows the GHG intensity pathway with retrofit measures. The new (later) point of stranding is indicated (red circle) and excess emissions displayed for the case of retrofit actions planned. If the excess emissions are multiplied by a carbon price (€/kgCO_2e), this results in increasing costs due the growing decarbonisation requirements, enabling estimates of imminent financial damage. Higher excess emissions lead to higher energy and carbon costs and therefore require higher retrofitting costs. Besides asset underperformance, the strategic timing of retrofit actions should also be subject to the refurbishment cycle (exploitation of possible synergy effects), availability and the timing of future sales (if intended).

The graph below (figure 20) illustrates the energy reduction pathway in contrast to the country and property-type specific energy target. This graph is a further important indicator in regards to asset performance in addition to the stranding diagram as building GHG intensity may be low, however, still have a high energy intensity.

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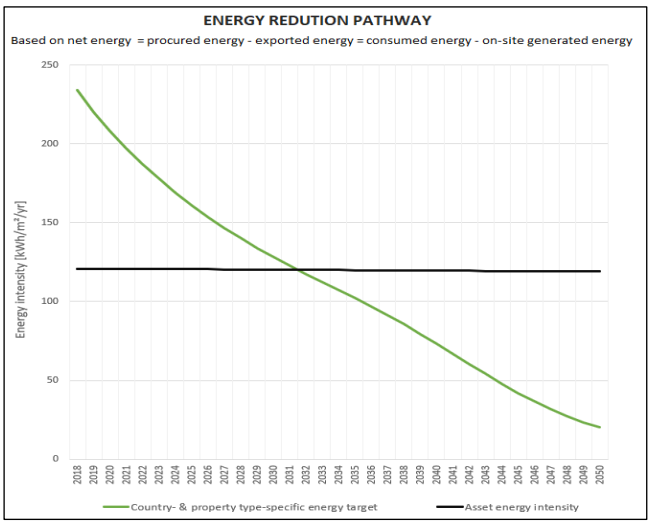

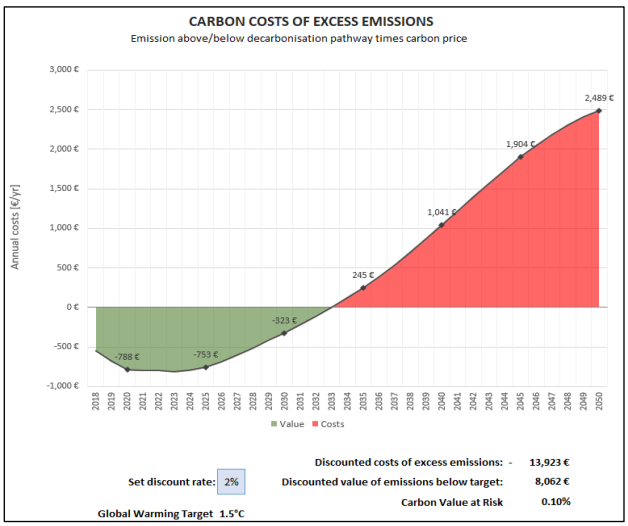

Figure 20 (left): Asset-level output - Energy reduction pathway
Figure 21 (right): Asset-level output - Carbon costs of excess emissions

Further results on the asset level include the representation of the carbon costs of excess emissions per year (see figure 21). Analogous to the NY City model with penalties applied for each ton of emissions above the limit (and possibly of trading emission credits). The carbon costs of excess emissions are also available on an aggregated level in the portfolio analysis. Below the graphical and tabulated results for individual selected assets, the tool contains a table of all entered assets, some key user input data (location, building type) and numerous derived data on stranding risk, energy consumption, GHG emissions and intensity, decarbonisation target and derived cost data (energy, carbon and retrofits) for each individual asset. The data is presented starting with the year of assessment until 2050 based on an annual basis, or in the form of cumulated figures where appropriate.

Aspects for data quality & accuracy improvement:

- Information regarding current vacancy
- Availability of the electricity usage for the entire building (tenant consumption)
- Input of individual Emission factors
- Prioritization regarding GAV (Gross Asset Value)
- Building retrofit scenarios / current state of retrofit-status
- Default values, e.g. company internal carbon shadow prices

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9 RESULTS: PORTFOLIO LEVEL

This sheet provides specific graphs and metrics that can be used for structured carbon risk reporting between real estate investors and their fiduciaries. The insights in this tab are specifically aligned with the *Task Force on Climate-related Financial Disclosures (TCFD)* recommendations as well as *EPRA*'s Sustainability Best Practice Recommendations (SBPRs). All relevant asset level output figures can be aggregated for an entire entered portfolio or as belonging to specific funds, entities, building types, reporting year or territorial units (countries or sub-national level).

The *CRREM* tool provides result figures for the selected type of aggregation comparable to those for individual assets applying weighted decarbonisation targets and pathways. It is also possible to compare individual assets and/or specified aggregations with each other and to assess the share of stranded assets for example within a specified fund or selected countries including the development over time of this share (based on the number of assets, GAV or floor area).

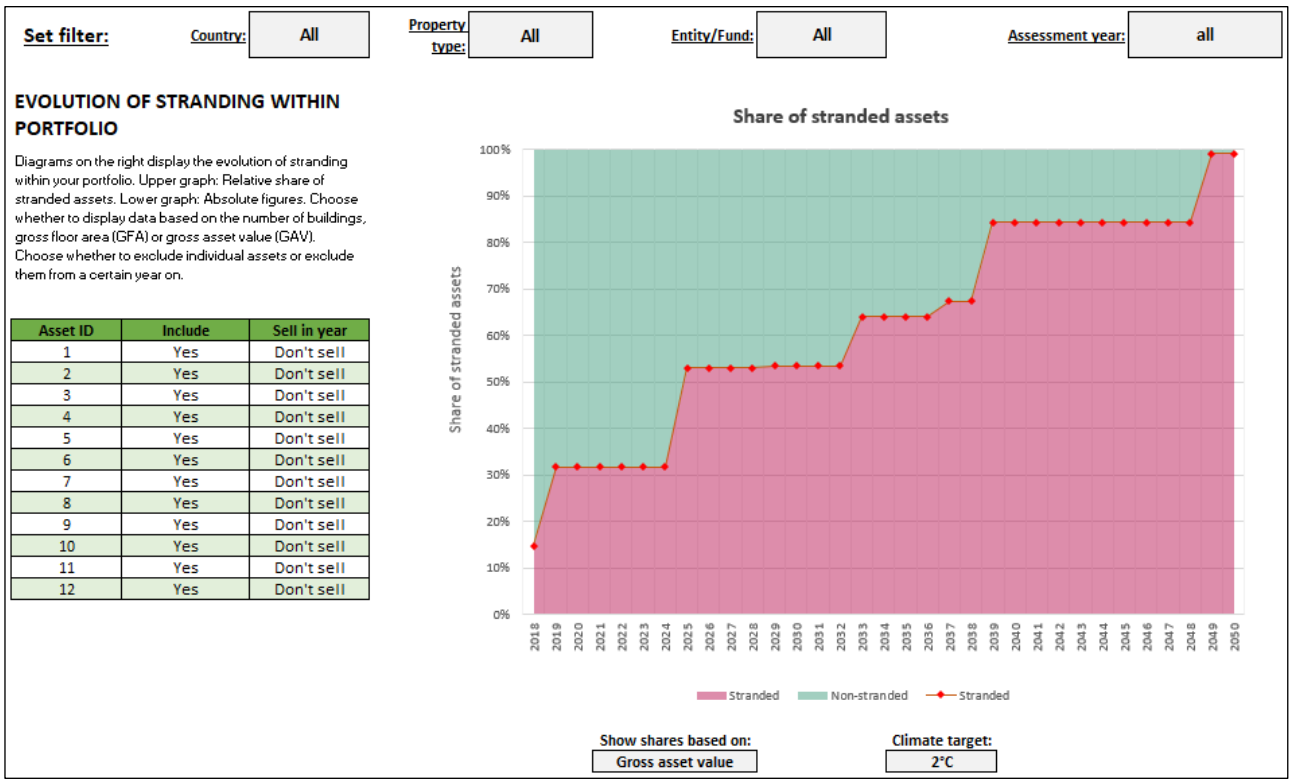

Figure 22: Portfolio-level output – Evolution of stranding within portfolio

On an optional basis, the effect of a sale of individual properties at a certain point in time can also be analysed. The *CRREM* tool portfolio assessment accounts for this fact by providing users with the option to select the year in which they want to sell the asset. Subsequently, the selected assets will not be taken into further consideration. Further analysis includes the presentation of the GHG intensity (see graph below) of the selected portfolio (black line), benchmarking it against the floor-weighted decarbonisation pathways (orange line: 2°C, blue: 1.5°C). Planned retrofit measures will be visible as the GHG intensity improves in that given year. The dashed line shows the portfolio pathway without any planned future retrofit measures.

CRREM calculations for abatement costs aim to provide a reference for investors to assess the potential risk and possible investment requirements for specific assets. The aggregated value at portfolio level also provides *CRREM* users with a valid reference to help them assess their exposure and expected level of investment. In relation to abatement costs,

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CRREM follows the approach that properties with low energy efficiency and correspondingly high carbon emissions will also face decreased marketability. Please note: in the graph below, the total emissions are displayed against the total floor area, a weighting for GAV is not accounted for.

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

The graphs on the right present the GHG intensity (above) and energy intensity (bellow) 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
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes
9	Yes
10	Yes
11	Yes
12	Yes

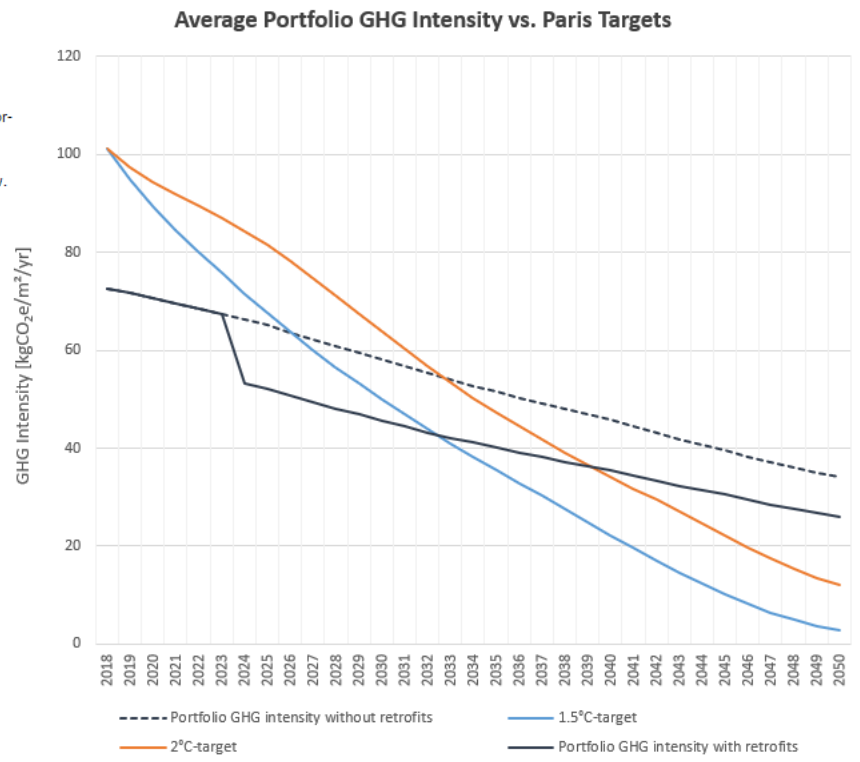

Figure 23: Portfolio-level output – Average GHG & Energy intensity of portfolio against the Paris Targets

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10 ADDITIONAL RESOURCES

The development of the *CRREM* tool has been underpinned by significant academic research. For this, *CRREM* has identified a wide range of academic articles and other resources, relevant for understanding carbon risk in real estate. A selection of these readings can be found on the *CRREM* website (available here).

CRREM specifically recommends real estate investment sustainability practitioners that use the *Risk Assessment tool* to have a comprehensive understanding of the following frameworks, as these have formed the basis in the development of the *CRREM Risk Assessment tool*, and represent overall industry best practices:

Stranding Risk & Carbon: Science-based decarbonising of the EU commercial real estate sector

This report forms the theoretical basis of the *CRREM Risk Assessment Tool*. In the report, *CRREM* explains how it defines science-based decarbonisation targets and pathways specifically for the commercial real estate industry. Additionally, the report covers corporate strategies for reducing carbon risk.

CRREM Retrofit Harmonisation Roadmap

This report synthesises and analyses existing policy initiatives in order to devise a set of policy recommendations for altering, developing and introducing energy efficiency policies for European regulation which support the upscaling of retrofit actions and seek to mobilise more proactive interventions–particularly targeting the mitigation of carbon intensive assets.

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CRREM Retrofit Harmonisation Roadmap

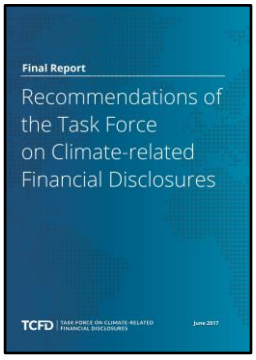
This report concludes the successful Pilot Testing Phase of the *CRREM* project and outlines the main benefits of the tool as demonstrated by the participants during testing. Due to larger investors participating, assets and portfolios covered a wider geographical range and asset-mix. All feedback was implemented on an ongoing basis and continuously updated throughout the testing phase. The version history is stated on the first page of the tool, the latest version was consistently updated online.

2019 GRESB Real Estate Assessment Reference Guide

The GRESB Real Estate Assessment is the global standard for ESG benchmarking and reporting for listed property companies, private property funds, developers and investors that invest directly in real estate. The Assessment evaluates performance against 7 sustainability aspects, including information on performance indicators, such as energy, GHG emissions, water and waste, or tenant and community engagement.

Recommendations of the Task Force on Climate-related Financial Disclosures

The TCFD recommendations are designed to disclose forward looking information on the material financial impacts of climate-related risks and opportunities. This includes risks related to the global transition to a lower-carbon economy. The recommendations are expected to form a key part of corporate communications on climate-related risks.



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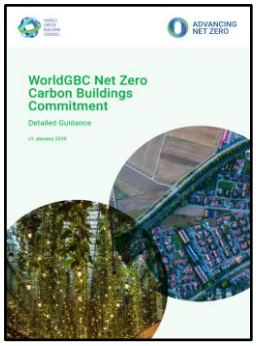
TEG Final Report on the EU Taxonomy

The EU Taxonomy for sustainable activities, developed by the Technical expert group on sustainable finance, is a classification system to define what economic activities can be labelled as environmentally sustainable. The EU Taxonomy is one of the main keystones in the development of the EU guidance for sustainable growth and reporting of climate-related topics and will have wide ranging implications for investors, as it will determine whether or not an economic activity is environmentally sustainable. Sustainable activities will have easier, preferential or exclusive access to future funding opportunities. The taxonomy sets performance thresholds for different economic activities (including buildings and real estate) that make a substantial contribution to climate change mitigation or adaptation. Complying with the thresholds will label an activity as 'Sustainable'.

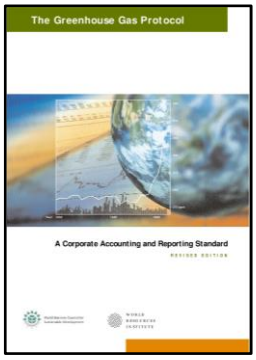
WorldGBC Net Zero Carbon Buildings Commitment Detailed Guidance

The WorldGBC launched The Net Zero Carbon Buildings Commitment, challenging companies, cities, states and regions to reach Net Zero operating emissions in their portfolios by 2030, and to advocate for all buildings to be Net Zero in operation by 2050. The commitment sets ambitious absolute targets aiming to maximise the chances of limiting global warming.



The GHG Protocol Corporate Accounting and Reporting Standard

The GHG Protocol Corporate Standard provides requirements and guidance for companies in preparing a corporate GHG emissions inventory. It is the most important global standard for corporate GHG accounting, and its principles form the basis of most other GHG reporting regimes.



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EPRA Sustainability Best Practices Recommendations Guidelines

The EPRA Sustainability Best Practices Recommendations (sBPR) consist of guidelines on how listed real estate companies and REITs should disclose their sustainability information. The guidelines have been developed by the EPRA Sustainability Reporting Committee in consultation with other EPRA members. These measures are largely based on the GRI Standards and the Construction and Real Estate Sector Supplement Disclosure.

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APPENDIX A: ACRONYMS AND ABBREVIATIONS

BEIS	Business, Energy and Industrial Strategy
CDD	Cooling Degree Day
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COP21	Conference of Parties
CRE	Commercial Real Estate
CRREM	Carbon Risk Real Estate Monitor
CVaR	Carbon Value at Risk
DMS	Data Management System
EF	Emission Factor
EPC	Energy Performance Certificate
EPRA	European Public Real Estate Association
EU	European Union
EUR	Euro
ft^2	Square feet
GAV	Gross Asset Value
GHG	Greenhouse gas
GRESB	Global Real Estate Sustainability Benchmark
GRI	Global Reporting Initiative
GWP	Global Warming Potential
HDD	Heating Degree Day
HFC	Hydrofluorocarbons
HVAC	Heating, Ventilation and Air Conditioning
ID	Identification
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
INREV	European Investors in Non-Listed Real Estate
IPCC	Intergovernmental Panel on Climate Change
IPMS	International Property Measurement Standards
JV	Joint Venture
Kg	Kilogramm

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kWh	Kilowatt hour
m^2	Square metre
m^3	Cubic metre
NPV	Net Present Value
NUTS	Nomenclature of Territorial Units for Statistics
LP	Limited Partner (in private equity)
PV	Photovoltaics
PPA	Power Purchase Agreement
sBPR	Sustainability Best Practice Recommendations
SBT	Science Based Targets
SDA	Sectoral Decarbonisation Approach
TCFD	Task Force on Climate-related Financial Disclosures
UK	United Kingdom
YR	Year

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APPENDIX B: FREQUENTLY ASKED QUESTIONS

Who should use the CRREM Risk Assessment Tool?

The *CRREM Risk Assessment tool* helps asset owners and managers to understand the long-term transition risks of their real estate investment portfolios. Climate change might endanger the business portfolios of real estate companies if no measures to transform the property stock under management are taken. Therefore, a stronger focus on climate change risk management is essential. A company strategy and risk management must ensure that individual efforts to mitigate CO2 within their portfolio must be sufficient to fulfil EU targets – otherwise the market participant might face a situation where properties do not meet future market expectations and therefore will be exposed to write-downs (we call this the risk of "Stranded assets"). The *CRREM Risk Assessment tool* will help users to assess the carbon risks of commercial real estate equity investments based on property specific decarbonisation pathways ensuring that assets are aligned with the Paris climate targets. Should you have any questions regarding data input or asset/portfolio-level output, please do not hesitate to contact us at info@crrem.eu.

Will the CRREM Risk Assessment Tool also cover non-EU countries or residential assets?

The current scope of the *CRREM* project only covers EU countries and commercial real estate properties. The Risk Assessment tool and methodological foundations might also be applicable for non-EU countries and residential properties.

How is the CRREM Consortium funded?

The *CRREM* Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 785058.

Is the CRREM Risk Assessment tool free?

The *CRREM Risk Assessment tool* can freely be used for non-commercial use and can be used in corporate reporting if correctly referenced. If you are interested in using the *CRREM Risk Assessment tool* for commercial purposes, please contact info@crrem.eu.

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APPENDIX C: GRESB DOWNLOAD – ADDITIONAL OPTIONAL DATA INPUT

The CRREM tool offers additional asset-level and portfolio-level evaluations and output calculations to those that use only the data that GRESB collects and supports. In order to take advantage of such calculations, users have the option to input additional information into the CRREM Tool or edit the information that GRESB pre-fills into the Tool. Appendix C lists all additional input that users can enter after using the automated CRREM Tool download function from GRESB in order to increase the types of data output available.

Entity

An optional field that can be used to categorize the analysis of assets amongst property managers, funds, separate accounts, or other entities. This is optional field can be filled in subsequent to the GRESB download function to enable further aggregation.

Air Conditioning

The users can additionally define if air conditioning is used in a specific asset. This field is optional, however, providing information on the existence of an air conditioning system enables the Tool to provide better estimations on the future effect of increasing cooling demand in buildings.

Energy Consumption

GRESB does not collect data on the type of fuels used, and in its pre-fill function, all fuel use is assumed to be natural gas. If a user knows that a particular asset uses a different type of fuel (such as fuel oil), he or she may then edit the pre-filled areas to reflect this.

GRESB imports all district heating and cooling into CRREM District Heating input, as GRESB does not delineate between district heating and district cooling. If users know the split between their district heating and cooling, they should edit the pre-filled areas to reflect this.

Fugitive Emissions

After the GRESB download, users can additionally enter fugitive emissions. The CRREM Tool allows users to report on the type of gas and the amount of the leakage in terms of kg. Amount reported will apply for each year, from the reporting year through 2050.

Renewable Energy

GRESB does not differentiate between different types of renewable energy sources. Therefore, all renewable energy collected from GRESB is assumed to fall under the “PV, wind” inputs of the CRREM Tool. Users may adjust this subsequent to the Tool download from the GRESB Portal.

Location-Based vs. Market-based

CRREM additionally allows the option to select location-based as the reporting method. If the market-based method is selected individual emission factors should be entered as disclosed by your energy provider.

Retrofit Actions

GRESB allows participants to report on the implementation of a variety of energy efficiency measures in the last three years. GRESB does not translate these into Retrofit Action inputs in the CRREM Tool because the effects on energy consumption should already be accounted for in the reported data, which is then used to fill in the CRREM Tool. The CRREM Tool allows users to define retrofit measures in the future. GRESB members may add a future retrofit action following the Tool download.

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