

Carbon Risk Real Estate Monitor



CRREM Risk Assessment Reference Guide

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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. *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.

CARBON RISK ASSESSMENT TOOL FOR COMMERCIAL REAL ESTATE

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

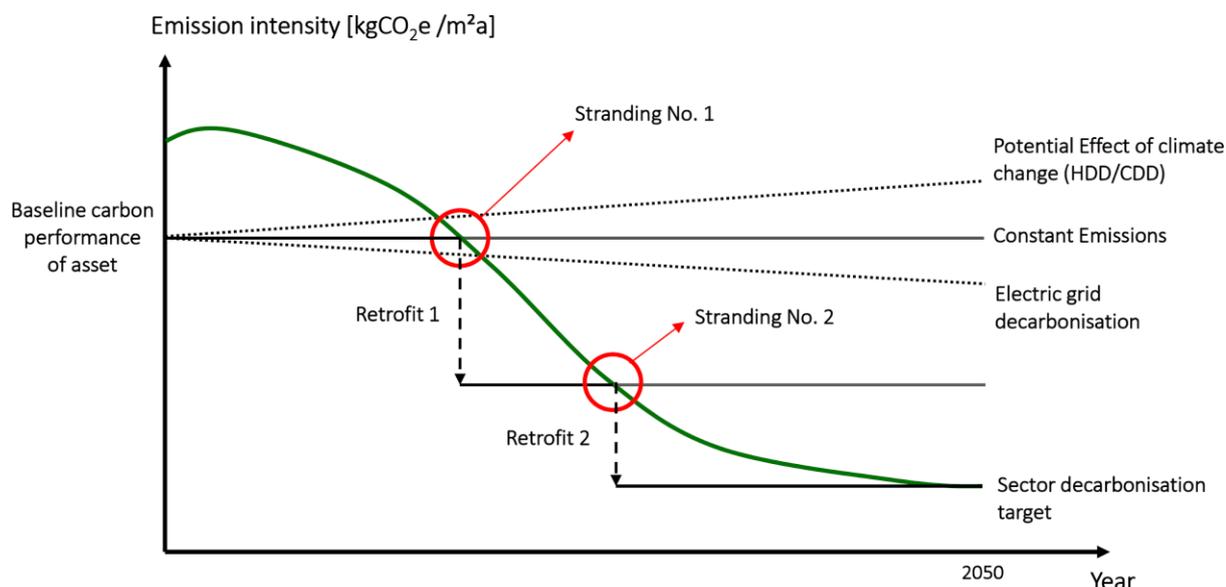
CRREM has derived decarbonisation pathways by breaking down the global GHG emissions budget that is consistent with the *Paris Climate Agreement* towards individual countries, the commercial real estate sector, property types and individual assets. The *CRREM* tool offers the possibility to evaluate the progress of a portfolio's carbon reduction performance against reduction targets in line with the Paris Agreement (i.e., limiting global warming to 2°C / 1.5°C). The *CRREM* tool 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 embodied carbon.

Consultation and Feedback 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

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 and 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 carbon footprints over the next decades.



‘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 that aligns with a certain climate target (1.5°C/2°C) and must not be exceeded. If the emission intensity is above the target value, “stranding” occurs.

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 (2050). Only appropriate retrofit measures reducing the GHG emissions can ensure that the building will meet the future emission ceilings.

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

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 assets 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.

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

STRUCTURE OF THE CARBON RISK ASSESSMENT TOOL

The *CRREM Risk Assessment Tool* consists of the following tabs:

Summary/Preface
<p>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.</p> <p>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.</p>
Decarbonisation target tool
<p>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.</p>
Asset data input
<p>Primary sheet where the user inputs the building data. Covers the following categories:</p> <ul style="list-style-type: none"> ● General information: Covers basic information on the reported data, such as asset name, Gross Asset Value (GAV), percentage of ownership and the period for which data is reported. ● Building characteristics: Covers basic building characteristics such as asset location, size, property type, and primary floor areas. ● 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 actions: Covers an overview of retrofit actions including investment value and corresponding year. ● 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.

Results: Asset Level

This sheet shows the results of the CRREM stranding risk analysis for each property entered in the asset input sheet. The upper part shows diagrams and specific risk analysis results for selected individual properties and global warming target.

Covers the following analysis and diagrams per asset:

- Stranding diagram: Interactive diagram that enables users to view the point of stranding, performance and excess emissions against the decarbonisation target. The baseline asset performance is compared against year 2018 performance. Further the Carbon Value at Risk (CVaR) is also provided.
- **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.
- **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 spendings and savings.

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.

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 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.*

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.

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.

DATA AVAILABILITY AND GAPS

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. The portfolio-level results enable data comparison against the set climate targets of 1.5°C and 2°C, whereas the asset-level results enable a comparison against user-defined values.

The *CRREM* tool enables data input from 2018 onwards, enabling 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.

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. This model constitutes the core of the decarbonisation target tool. The following paragraphs briefly describe the main steps to develop the required pathways and targets. The full description and references for this process can be found 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 amongst others. Budgets define the amount of carbon that can be emitted before 2050 in order not to exceed these warming limits.
- Step 2. EU carbon budget and pathways.** From this global emission pathway, the model extracts the share of carbon that the EU could emit before 2050, establishing annual reduction targets of **CO₂ emissions per capita**. Global and EU pathways converge in the target year 2050.
- Step 3. EU commercial real estate.** Using data from the EU Reference Scenario 2016, the EU carbon budgets and pathways are further broken down into economic sectors, with focus on commercial real estate. This process takes into account the expected growth of the sector. The resulting converging pathways and annual targets are defined in **CO₂ emissions per square meter**.
- Step 4. Budget and pathways per country.** The next step is to allocate the responsibilities and efforts required from the real estate sector in each EU Member State. Two sets of expected decarbonisation pathways according to both warming scenarios are defined. All pathways start at the current emission intensity of each country’s building stock and converge on the same decarbonisation target, common for the whole EU. The following graphs illustrate the pathways calculated for 8 of the 28 member states, although the pathways are calculated and available for all 28 countries.
- Step 5. Downscaling to building types.** The final step collects data from different EU 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 and Other. 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:

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.

5 ASSET DATA INPUT

In the asset data input sheet users enter information on individual assets that is necessary to assess stranding risks within the *CRREM* tool. 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) along with information on ownership:

ID	Asset ID	Text
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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
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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
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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)*

GAV	Gross Asset Value (GAV)	[€]
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Description: The total value of the asset at the end of the reporting year. GAV includes both debt and equity value.

Requirements: Mandatory. 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.

OWN	Percentage of ownership	[%]
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Description: The percentage of equity invested in the asset.

Requirements: Only to be filled in for Joint Ventures (JVs). CRREM assumes percentages are provided using a 0% to 100% scale. If left blank, the tool assumes 100% ownership of the asset.

Rationale: Enables the Risk Assessment Tool to correctly aggregate stranding risk in terms of value to a portfolio level.

AS.MON	Reporting period: Starting month	Drop-down
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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 assume 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]
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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 assume 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.

ENT	Entity	<i>Text</i>
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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

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	<i>Drop-down</i>
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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	<i>Text</i>
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Description: The city in which the asset is located.

Requirements: **Optional**. Free text entry.

Rationale: Identification of the asset.

ZIP	Location: Zip Code	<i>Text</i>
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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	<i>Text</i>
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Description: The street address of the asset.

Requirements: Optional.

Rationale: Identification of the asset.

AS.TY	Property type	<i>Drop-down</i>
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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 centers and mental health centers.
- **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.
- **Other:** Any other property type that does not have similar energy use or data collection ability characteristics, as the other property types listed. Examples include, but are not limited to: kindergarten, community halls. This option should only be used if the investment does not fit into any of the options given.
- **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 centers 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 center 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.
- Data Centers: Enclosed properties used to house computer systems and associated components such as storage systems for backup purposes, security, telecommunications among others.

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
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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	<i>Area [m²]</i>
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Description: The total gross internal area of the asset, measured in IMPS 2.

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

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.

BSR_OC.AN	Asset size: Average annual vacant area	Area [m ²]
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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.

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.

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

- **Data Coverage (m2):** 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 (m2):** 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	<i>Consumption [kWh]</i>
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.

NG.CON	Natural Gas	<i>Consumption [kWh/m³]</i>
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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 \[online\]](https://www.gov.uk/government/emission-conversion-factors-for-greenhouse-gas-company-reporting)

OL.CON	Fuel oil	<i>Consumption [kWh/m³]</i>
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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 \[online\]](https://www.gov.uk/government/publications/government-emission-conversion-factors-for-greenhouse-gas-company-reporting)

DH.CON	District heating [steam]	<i>Consumption [kWh/m³]</i>
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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.

DC.CON	District cooling [chilled water]	<i>Consumption [kWh/m³]</i>
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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	<i>Consumption [kWh/m³]</i>
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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:** Liquefied 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 \[online\]](http://gov.uk)

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 regriferent 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

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 \[online\]](http://gov.uk)

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.

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”.

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.

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.

RETROFIT ACTIONS

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	[%]
RF1.EC	Embodied carbon	[kgCO ₂ e]

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

Requirements: Define budget to the selected year of which retrofit actions are planned. Up to three retrofit actions 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 estimation of reduced energy consumption. An automatic estimation of embodied carbon related to a retrofit measure will be available in the final version of the CRREM tool. In the latest version for public testing, 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).

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 to 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.

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.

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.

Requirements: Provide the alternative district heating intensity factors.

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

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. 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 [%]

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: 2%)

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 (m²) 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 (m²). 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)	

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 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-defines values). The diagram displays the potential year of stranding (red circle) when the asset's GHG intensity is higher than the decarbonisation target.

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,

- 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.

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.

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).

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:

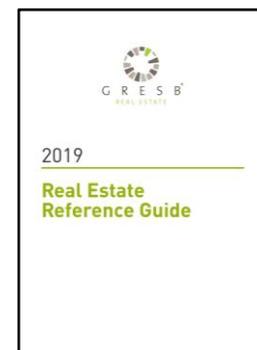
[Stranding Risk & Carbon: Science-based decarbonising of the EU commercial real estate sector](#)

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.



[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.



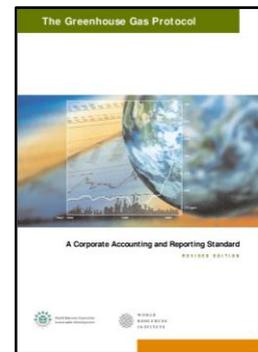
[EPRA Sustainability Best Practices Recommendations Guidelines](#)

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.



[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.



[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.



APPENDIX A: ACRONYMS AND ABBREVIATIONS

CDD	Cooling Degree Day
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
CRE	Commercial Real Estate
CRREM	Carbon Risk Real Estate Monitor
DMS	Data Management System
EPC	Energy Performance Certificate
EPRA	European Public Real Estate Association
EU	European Union
EUR	Euro
ft ²	Square feet
GHG	Greenhouse gas
GRI	Global Reporting Initiative
GWP	Global Warming Potential
HDD	Heating Degree Day
HFC	Hydrofluorocarbons
HVAC	Heating, Ventilation and Air Conditioning
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
kWh	Kilowatt hour
m ²	Square metre
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

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.

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 can I be involved in the development of the CRREM Risk Assessment tool?

Parties that are interested in providing feedback or pilot testing the *CRREM* tool can contact info@crrem.eu.

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.