TECHNICAL GUIDE | REAL ESTATE TRANSITION RISK

CRREM Assessment Guide

A technical reference for assessing real estate energy and carbon performance against the CRREM Pathways

MAY 2026 | v1.03

CRREM
CARBON RISK REAL ESTATE MONITOR

CRREM Assessment Guide

Introduction

The CRREM Assessment Guide explains how to assess the carbon and energy performance of real estate assets and portfolios against the CRREM Pathways.

This guide explains the calculation logic behind a CRREM assessment and sets out the steps for determining the CRREM Misalignment Year consistently across assets and portfolios. It covers data inputs, energy and emissions calculations, projection methods, and pathway comparison. Supporting open-access documents are listed below.

Supporting documents can be found in the CRREM Library for open-access public use:

1) **CRREM Global Pathways:**
    - CRREM_Pathways_V2.05 (.xlsx)
    - CRREM_Pathways_V2.05 (F-Gas Pathways) (.xlsx)
2) **Datasets**
    - Emission Factors (year 2020-2050) (.xlsx)
    - Postal Code Lookup table for countries with sub-national pathways
    - HDD/CDD projections for climate-adjusted energy projections
3) **Reference Implementations**
4) **Technical Blueprint**
    - CRREM Asset & Portfolio Assessment – Technical Blueprint (.xlsx)
    - CRREM Asset & Portfolio – Worked Examples (.xlsx)

Optional:

5) CRREM Assumption & Input Disclosure (.xlsx)
6) CRREM ZIP Code Lookup (.xlsx)
7) CRREM HDD CDD Zip Code Lookup (EU) (.xlsx)

This guidance reflects the calculation logic used in the CRREM Risk Assessment Tool v2.07. The tool will be retired on 1 July 2026, but the calculation approach described in this guide remains in place.

The CRREM Foundation's independent Technical Council is reviewing several elements of this methodology. These areas are flagged throughout the guide where future revisions may occur.

Best Practice Recommendation: From Measurement to Management

While the CRREM Assessment Guide ends at the Misalignment Year calculation, CRREM should not be treated as a simple climate scorecard where an asset is either aligned with the Pathway or it is not. Users are encouraged to compare forward-looking capex plans against the CRREM Pathways to map the transition impact of planned interventions over time. Used this way, CRREM becomes not just a measurement tool, but a guide for managing transition risk in real estate portfolios.

The *CRREM Asset & Portfolio – Worked Examples* **(.xlsx)** includes an illustrative function that lets users enter a percentage reduction in energy or carbon intensity and see the resulting impact on the CRREM Misalignment Year. For more background on the application and interpretation of CRREM, explore the guidance materials available on CRREM.org.

Glossary

DATA & NORMALIZATION	
Reported Energy	Measured energy consumption for the reporting period, prior to any adjustments.
Adjusted Energy	Energy consumption after applying normalization factors (e.g. vacancy, data coverage, weather adjustments).
Vacancy Rate	The share of the total floor area that is unoccupied (e.g. unleased) during the reporting period.
Data Coverage	The proportion of total floor area for which energy data is available.
Data Coverage Adjustment	Extrapolation of reported energy to account for missing data across parts of the asset.
Floor Area Definition	Asset floor area is measured in Gross Internal Area (GIA).
Total Energy	Total Energy is the sum of all energy types consumed on-site: grid electricity, gas, oil, district heating, district cooling, biomass, other fuels, and renewable energy generated and consumed on-site. Critically, any exported renewable energy is NOT included in Total energy, because energy exported to the grid is not consumed by the building.
Total Carbon Emissions	For each energy type, the annual energy consumption is multiplied by the corresponding emissions factor. The sum of all energy type emissions is the resulting total carbon emissions for the asset.
Net Carbon Emissions	Net carbon emissions are calculated by subtracting the grid export credit from total gross carbon emissions (from electricity). Note: Where an asset exports on-site renewable energy to the grid, a carbon credit is applied to offset emissions from electricity consumption. This credit is capped: it cannot exceed the emissions from grid electricity consumption itself. On-site gas, oil, or district heating emissions cannot be offset using the surplus solar export credit.
Energy Type	Refers to the source or form of energy used to supply a building. Examples include grid electricity, natural gas, oil, district heating, district cooling, biomass, other fuels, and renewable energy that is generated on-site (such as solar).

KEY INDICATOR	
Carbon Intensity ($kgCO_2/m^2/year$	Carbon Emissions per unit of Floor Area over time. Operational greenhouse gas emissions per unit of floor area, used to assess alignment with decarbonization pathways.
Energy Intensity (EUI) ($kWh/m^2/year$)	Total Energy consumption per unit of Floor Area, indicating the asset's operational energy performance.
CRREM Misalignment Year	The first year in which the building's projected carbon or energy intensity exceeds the CRREM Pathway. This marks when an asset's trajectory diverges from the science-based decarbonization pathways, signaling the onset of material transition risk across regulatory, financial, and/or reputational impacts.
Asset baseline performance	Represents a building's baseline and linear future carbon performance in terms of greenhouse gas (GHG) intensity. 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).
Climate and grid adjusted asset performance	Asset performance adjusted to reflect forward-looking changes in energy demand and emission factors. This includes the impact of climate change on heating and cooling demand, based on projected heating and cooling degree days (HDD/CDD), as well as reductions in electricity-related emissions due to grid decarbonization. These effects are applied independently of any retrofit measures to derive a forward-looking performance trajectory.

CLIMATE & PROJECTION TEMPLATES	
Heating Degree Days (HDD) & Cooling Degree Days (CDD)	A measure of heating / cooling days based on how much and how long outside temperatures are below / above a base temperature.
Emission Factor (EF)	A coefficient that converts energy consumption into greenhouse gas emissions. It represents the amount of carbon emissions released per unit of energy consumed.
Grid Decarbonization	Refers to the projected reduction in electricity emission factors over time as the energy mix shifts toward lower-carbon sources. As the share of electricity generated from renewable energy increases, the average amount of greenhouse gas (GHG) emissions per unit of electricity consumed—also known as the emission factor (EF) or GHG intensity of power generation—declines accordingly.

CRREM Global Pathways

CRREM's science-based decarbonization and EUI pathways reflect the emissions and energy intensity levels buildings must meet to stay aligned with a 1.5°C warming scenario. The CRREM Pathways cover a wide range of property types across 44 countries and are publicly available for open-access use.

The CRREM Pathways freely available for open-access public use.

Supporting documents: **CRREM Global Pathways:**

- CRREM_Pathways-V2.05 (.xlsx)
- CRREM_Pathways_V2.05 (F-Gas Pathways) (.xlsx)

Contents: Year-by-year energy and carbon budgets by country/region and property type (2020–2050). Available in six unit/area variants.

Underlying Assumptions

The CRREM Risk Assessment and Misalignment Year methodology relies on a common set of assumptions to support consistency and comparability across assets and portfolios. These assumptions apply unless stated otherwise.

- **Building Energy Use Coverage:** CRREM uses a whole-building approach. All in-use operational energy within the building boundary should be included, regardless of whether it falls under Scope 1, 2 or 3 for the lessor or investor. Use whole-building energy data covering all energy consumed within the building boundary, regardless of operational control. This includes energy from all sources, including landlord procured electricity and fuels (typically reported under Scopes 1 and 2), as well as tenant procured energy (typically reported under Scope 3 downstream leased assets).

  Exclude non-heated outdoor areas, indoor parking, and electricity used for electrical vehicle charging.
- **Reporting Period Coverage**: 12-month period of energy consumption data for the reporting year.
- **Occupancy:** The default assumption is full occupancy with no material vacancy.
- **Floor Area:** Floor area measurement methodologies vary across geographies. The key requirement is that the floor area measure used reflects the area that contributes

to the actual energy demand of the building.* Where Gross Internal Area (GIA) is not available, an alternative measure may be used, provided it captures the conditioned space that drives energy consumption and is not biased by areas such as balconies, underground parking, or other unconditioned zones.

- **Asset Characteristics:** Building attributes such as floor area, use type, and location are held constant over the projection period unless explicitly adjusted.
- **Grid Emission Factor:** Electricity-related emissions are calculated using the location-based approach per the GHG Protocol.
- **District Heating Emissions Factor Projections:** As a proxy, district heating is assumed to decarbonize at the same rate as the respective country's grid. This reflects the fact that heat production and distribution is often linked to electricity generation. Where available, use the local emission factor from the provider.
- **Refrigerant Losses:** Report the refrigerant type and leakage volume in kilograms (kg). CRREM risk assessment calculations convert refrigerant losses to carbon emissions using official emission factors. Users should benchmark an asset against the 1.5°C all-GHG pathway only when F-gas emissions are reported. If refrigerant-loss data is unavailable, use the standard pathway that excludes F-gases.
- **CRREM Pathway Scenario:** Only the 1.5°C scenario pathways are currently recognized for official CRREM Risk Assessments. No other temperature change scenario may be used. If CRREM publishes additional pathway scenarios in the future, the selected scenario must be disclosed.

Best Practice Recommendation: Disclose Key Assumptions

Supporting document: CRREM Assumption & Input Disclosure (.xlsx)

An Assumption & Input Disclosure (.xlsx) is provided by CRREM to promote comparability and transparency of CRREM risk assessments across assets, portfolios, and reporting periods. The table serves as a structured framework for users to document the key methodological choices and data inputs underlying their CRREM assessments.

In market practice, CRREM Assessments rarely use entirely standardized inputs. Estimated data, partial coverage, and methodological choices around boundaries, normalization, and emission factors vary across portfolios and reporting cycles. Users are therefore encouraged to disclose their assumptions and data inputs transparently using the CRREM Assumption & Input Disclosure file so that results can be interpreted in context and compared fairly. CRREM provides this disclosure framework as an optional support tool.

Technical Council Review Topics

At the time this Assessment Guide is published, several underlying assumptions remain under review by the Technical Council. These topics are still being refined and are noted here to ensure transparency for users of the guide.

The following topics are currently under development by CRREM's Technical Council:

- **Normalizations:** The Technical Council will set baselines for key normalizations, standardize their methodology, consider expanding them, and assess uniform application across CRREM Pathways and global benchmarks.
- **Building Energy Use Coverage:** CRREM uses a whole-building approach but lacks formal definitions for included end uses and process load exclusions. Definitions, exclusion criteria, and a property-type classification framework will be developed.
- **Energy Data Quality:** Metered data is preferred but modelled data is accepted without formal disclosure; a decision will be made on adopting an existing data quality table or creating a CRREM-specific framework for disclosing data quality.
- **Floor Area Definition:** to provide greater consistency in how floor area is defined.
- **District Heating and Cooling:** Current district thermal energy inputs do not enable accurate EUI assessment, and informal guidance on plant efficiency is inconsistently applied. This will be formalized and revised, along with consideration of emission factors and forward-looking projections for district thermal systems.

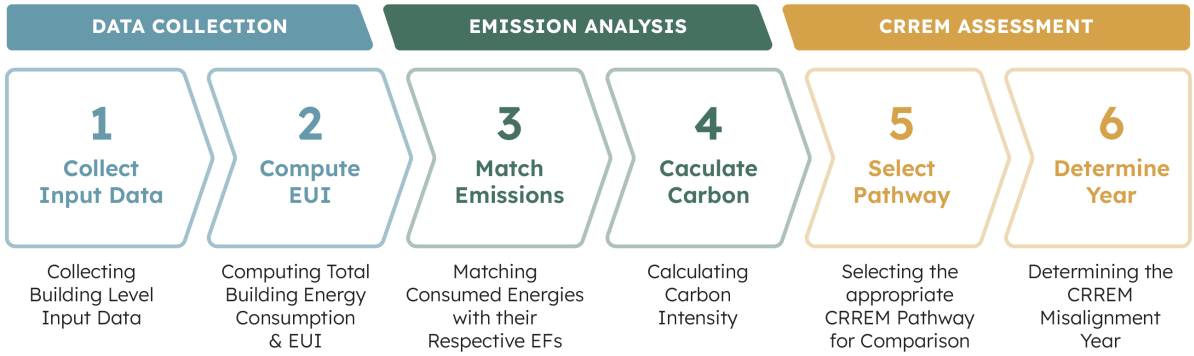
CRREM Asset Level Assessment Guide

This section explains how individual buildings are assessed against the CRREM Pathways. It covers data inputs, carbon and energy intensity calculations, pathway selection, and the calculation of the CRREM Misalignment Year.

Introduction

Asset-level assessment is the foundation of portfolio-level aggregation. The asset-level CRREM risk assessment uses energy consumption data to calculate two outputs: carbon intensity and energy-use intensity (EUI). These metrics are then compared with the relevant CRREM Pathway values to determine separate Misalignment Years for carbon and EUI.

The methodology follows six steps: (1) collect asset-level input data, (2) calculate total energy consumption and EUI, (3) match each energy type to its emission factor, (4) calculate carbon intensity, (5) select the appropriate CRREM Pathway, and (6) determine the CRREM Misalignment Year.



CRREM Asset & Portfolio Assessment – Technical Blueprint

Supporting documents:

- CRREM Asset & Portfolio Assessment – Technical Blueprint (.xlsx)
- CRREM Asset & Portfolio Assessment – Worked Examples (.xlsx)

For a step-by-step technical specification of the CRREM calculation logic, including formulas, validation rules, and worked examples, refer to the CRREM Technical Blueprint. This supporting document is intended for users who want to replicate the CRREM Assessment Guide steps programmatically.

Step 1: Collecting Building Level Input Data

The following list includes all the data points that are needed for a CRREM Risk Assessment and to calculate the CRREM Misalignment Year:

- **Property Type:** The property type that best describes the asset's primary use. Must match a property type for which a CRREM Pathway is available. Details and property type definitions are available in the **CRREM Property types & definitions** document.
- **Country:** The country in which the building is located. This is used to identify the correct CRREM Pathway.
- **Postal Code:** Required only for countries with sub-national CRREM regions (USA, Canada, Australia).
- **Reporting year:** Year the consumption data refers to (e.g. 2024).
- **Gross Internal Area (GIA):** Measured in square meters or local equivalent.
- **Energy Types:** Enter each energy source used in the building with annual consumption above 0 kWh, such as grid, electricity, gas, or district heating. Use whole-building consumption, combining landlord- and tenant-controlled energy. Record each energy type in kWh/year. Depending on the metrics and regional conventions used, intensities may also be expressed in alternative units such as square feet or kBtu.
- **Renewable energy produced and consumed on-site:** If applicable, record all on-site renewable energy generated and consumed on-site, such as rooftop PV, in kWh/year.
- **Renewable energy produced and exported to grid or other:** On-site renewable energy exported to grid or other, measured in kWh per year.

Best Practice Recommendation: Data quality

The quality of a CRREM Risk Assessment directly depends on the quality of the underlying energy consumption data. Transparent disclosure of data quality is therefore essential to properly contextualize the results, particularly for use in financial analysis. Metered and verified data, for example through utility invoices or automated meter readings covering the full reporting year, provides the best input data. In practice, however, estimated data is also commonly used for CRREM Risk Assessments, as full metered coverage is not always available. Users are therefore encouraged to disclose for each asset if consumption is based on measured or estimated data, using the CRREM Assumption & Input Disclosure (.xlsx).

Mixed-use Property Inputs

For mixed-use properties, additional input fields are required. For each CRREM property type present in the building, the floor area share as a percentage of total GIA must be entered. All shares must sum to 100%. These inputs are used in Step 5 to construct a mixed-use pathway that reflects the building's specific profile.

CRREM does not set minimum thresholds for applying mixed-use shares. Even small secondary use types can be reflected in the blended pathway, provided the floor area share is known. The decision whether to apply a single-use or mixed-use pathway is at the user's discretion and should reflect the actual use profile of the building as closely as possible.

Note: Where a property type is not covered by CRREM Pathways, or where energy data for individual floor areas or use types is not available separately, users may apply the main property type of the building as a single-use pathway instead. This choice must be disclosed.

Data Extrapolation for Incomplete Data

CRREM does not currently provide official guidance on filling data gaps caused by vacancy, partial-year reporting, or missing energy data. The legacy CRREM EU-Project Excel tool addressed missing monthly data through linear extrapolation. In current practice, any gap-filling should be performed outside the CRREM calculation (prior to the assessment) and the approach should be documented transparently in the relevant fields of the **CRREM Assumption & Input Disclosure (.xlsx),** such as Energy Data Boundary, Reporting Period Coverage, and Vacancy.

Data Normalization:

There might be cases in which further normalization is useful for contextualizing and benchmarking use-intensity or running hours (e.g., 24/7 operations) in comparison with the average property of this use-type. Users may apply appropriate normalization techniques for these situations and must clearly state the reason and applied methods. No official recommendation has been issued to date; the topic is currently under Technical Council review and will be addressed in due course.

Step 2: Computing Total Building Energy Consumption & EUI

Calculate total whole-building energy consumption and EUI.

Energy Use Intensity (EUI)

EUI is calculated as Total Energy divided by Floor Area. The result is expressed in kWh/m²/yr. This is the first key output of a CRREM assessment and is used to compare a building against the CRREM EUI Pathway in Step 6.

Note: CRREM treats energy intensity and carbon intensity separately. Renewable energy generated and consumed on-site is included in Total Energy because it meets the building's energy demand. Because its emission factor is zero, it improves carbon intensity. Renewable energy exported to the grid is excluded from Total Energy and treated separately as a grid export credit in Step 4 (carbon calculation only).

Step 3: Matching Consumed Energies with their Respective Emission Factors

Each energy type is assigned an emission factor expressed in $kgCO_2e$ per kWh or local equivalent. CRREM matches emission factors by energy type and region. Grid electricity factors are projected annually from the reporting year to 2050 to reflect grid decarbonization. This makes it easier to identify retrofit needs, explore energy alternatives, and plan interventions that keep buildings aligned with long-term climate goals.

Note: For countries with sub-national CRREM regions (United States, Canada, Australia), emission factors must be matched at the same sub-national level as the Pathway, not at country level. Use the **CRREM ZIP Code Lookup (.xlsx)** file for postal code matching to appropriate grid zones.

Best Practice Recommendation: Location-based Emission Factor

CRREM recommends the use of location-based emission factors (grid average). The location-based method is particularly useful in transition risk assessment, as it provides a more consistent basis for comparing buildings' energy mix and efficiency across a portfolio.

The legacy CRREM EU-Project Excel Tool allowed the use of market-based emission factors (e.g. from renewable energy certificates). In either case, users must disclose whether location-based or market-based emission factors were applied.

Emission Factor Dataset:

Supporting documents: Emission Factor Dataset (.xlsx)

Emission factors per type, per country/region, per year. This includes grid electricity as well as other fuel types, including natural gas, oil, biomass, coal, and LPGs. Grid electricity emission factors decline annually, while combustion-related emission factors for other fuels are held constant over time.

Best Practice Recommendation: District Heating/Cooling

Please note: CRREM does not provide emission factors for district heating and cooling systems. When calculating emissions from these sources, users must request the district heating /cooling emission factor directly from the energy provider.

Trajectory: Under the current methodology, CRREM couples district heating system decarbonization to the electricity grid decarbonization trajectory for the specific country. This is a proxy and we expect further development under CRREM's Technical Council in the coming period.

Step 4: Calculating Carbon Intensity

Carbon emissions are calculated by multiplying each energy type's consumption by its corresponding emission factor.

Carbon Emissions per Energy Type

For each energy type, multiply annual energy consumption by the corresponding emission factor. Sum the results to calculate the asset's total carbon emissions. Please refer to the CRREM Library for the emission factor datasets.

Grid Export Credit

Where an asset exports on-site renewable energy to the grid, a carbon credit is applied to offset emissions from electricity consumption. This credit is capped: it cannot exceed the emissions from grid electricity consumption itself. On-site gas, oil, or district heating emissions cannot be offset using the surplus solar export credit.

Net carbon emissions are calculated by subtracting the grid export credit from total gross carbon emissions. For example, in 2025 an asset consumes 200,000 kWh of electricity from the grid and, in the same year, produces 150,000 kWh of on-site renewable electricity that is exported to the grid. Because the exported volume (150,000 kWh) is lower than the grid consumption (200,000 kWh), the full export credit applies. The remaining 50,000 kWh of grid consumption is priced at the location-based grid emission factor and represents the asset's net carbon emissions for the year.

Carbon Intensity

Divide net carbon emissions by the asset's floor area to calculate carbon intensity, expressed in $kgCO_2/m^2/yr$. This is a key output that is used directly in the CRREM Assessment. It is compared against the CRREM Carbon Pathway in Step 6 to determine the CRREM Misalignment Year.

$$Net\ CO_2 = Total\ CO_2 - Grid\ Export\ Credit$$

$$Carbon\ Intensity = Net\ CO_2 / Floor\ Area$$

Step 5: Selecting the Appropriate CRREM Pathway for Comparison

CRREM Pathways are specific to property type and region, whether national or sub-national. Selecting the appropriate pathway is therefore a critical step in conducting a CRREM Risk Assessment.

Supporting documents:

1. **CRREM Global Pathways:**
   - CRREM_Pathways-V2.05 (.xlsx)
   - CRREM_Pathways_V2.05 (F-Gas Pathways) (.xlsx)

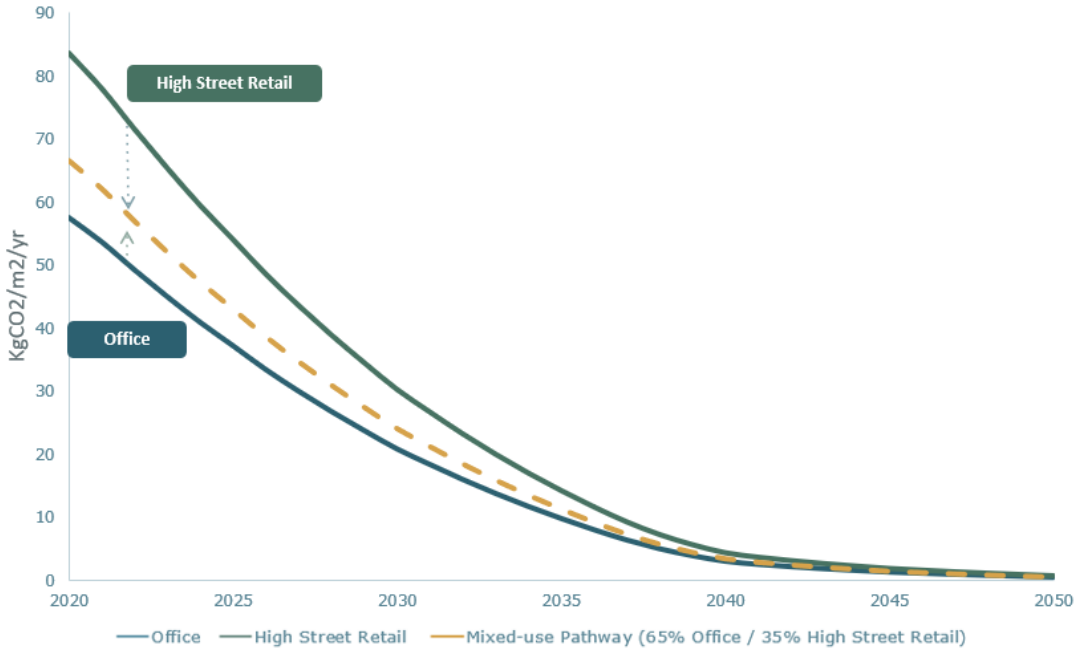
2. **Postal Code Lookup Table:**
   - CRREM ZIP Code Lookup (.xlsx) Maps postal codes to the CRREM region identifier. Required only for USA, Canada, and Australia.

Mixed-Use Buildings

For mixed-use buildings, CRREM uses a floor-area-weighted blended pathway. Users should generate a composite pathway based on the asset's property-type mix. This blending is performed separately for each year from 2020 to 2050 because the component pathways decline at different rates.

For example, Asset A is 65% Office and 35% Retail High Street by floor area. Its mixed-use CO_2 Pathway for 2024 is: 0.65 × 57 (Office CO_2 Pathway) + 0.35 × 84 (Retail High Street CO_2 Pathway) = 66 $kgCO_2e/m^2/yr$.

The resulting mixed-use pathway is then treated exactly like any single-use pathway for the misalignment comparison.



All GHG Pathway Selection

The "all GHG" pathway variant should only be selected where F-gas emissions are both comprehensively captured in the asset's emissions data and account for a material share of the asset's total emissions. Where F-gas data is not available, or where F-gases account for only a marginal share of total emissions, the standard CRREM Pathway (all CO_2 excl. F-gases) should be applied and F-gases excluded from the assessment.

This matters because the all-GHG pathway provides a larger emissions budget to account for both CO_2 and F-gases. Applying it to an asset with negligible F-gas emissions would make the assessment appear more favorable than it should. The choice of pathway variant must be disclosed.

Step 6: Determining the CRREM Misalignment Year

The final step is to project the asset's energy and carbon intensity from the reporting year to 2050 and compare those projections with the relevant CRREM Pathways.

6.1 Forward Projection with Grid Decarbonization

The forward projection from the reporting year to 2050 is a required component of the CRREM Risk Assessment and CRREM Misalignment Year calculation. It applies the following assumptions:

Energy Consumption: Held constant. The EUI remains flat from the reporting year to 2050, reflecting a "do-nothing" scenario in terms of capex improvements.

Grid Electricity Emission Factor: The forward projection of grid decarbonization is a required input to the forward carbon projection. CRREM provides annual grid emission factor projections to 2050 in the Emission Factors dataset. When these are applied, the asset's carbon intensity declines in line with the projected grid mix, even if building energy demand does not change.

Alternative Grid Emission Factor Projections:

When conducting a CRREM Risk Assessment or calculating the CRREM Misalignment Year one may use alternative grid emission factor projections. Where alternative projections are used, the source and any underlying assumptions must be disclosed transparently. The standard disclosure table is the optimal place for such footnoting.

All Other Emission Factors: Emission factors for fuels and other single-source energy types remain constant through 2050. District heating emission factors are assumed to decrease at a rate that is coupled to grid decarbonization. As noted above, this is subject to change.

In the formula below, for each year (t) from the reporting year to 2050, the carbon intensity is calculated using the same formula as Step 4, with the grid electricity emission factor replaced by the value applicable to that specific year. The grid electricity emission factor varies by year in accordance with the Emission Factors dataset. Energy consumption stays flat; only the grid emission factor changes.

$$\textit{Carbon Intensity}(t) = [\,\Sigma(\textit{type} \times \textit{EF type}(t)) - \textit{Grid Export Credit}(t)\,] \,/\, \textit{GIA}$$

The grid export credit also recalculates annually, since EF Electricity(t) changes.

Projected EUI for Year t

Under the default flat-demand assumption, EUI stays constant: Total Energy / GIA for every year from the reporting year to 2050. Grid decarbonization does not affect energy demand.

6.1a Optional: Climate-Scenario-Adjusted EUI Projection

Climate change is expected to change heating and cooling loads of buildings. Rising temperatures reduce Heating Degree Days (HDD) and increase Cooling Degree Days (CDD).

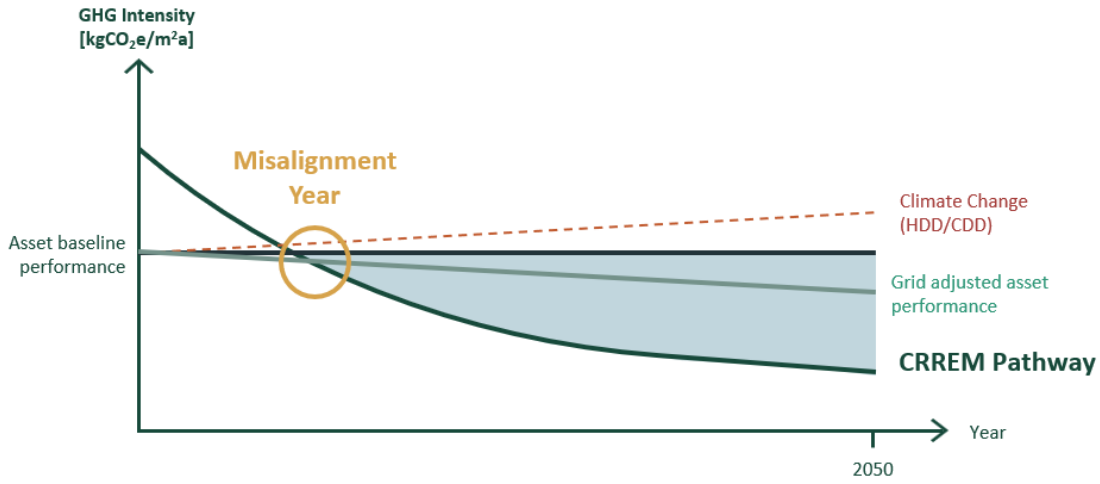
This optional extension of the CRREM Risk Assessment and CRREM Misalignment Year calculation requires a separate HDD/CDD Projection dataset. Energy consumption is split into a heating component (adjusted according to HDD), a cooling component (adjusted according to CDD), and a weather-insensitive baseload. Each component is then projected independently:

Total Energy = [Energy Heating × HDD Ratio] + [Energy Cooling × CDD Ratio] + Energy Baseload

When HDD/CDD data is available, a climate-adjusted EUI can be offered as an optional add-on to account for weather impacts and enhance the analysis.

6.2 Identifying the CRREM Misalignment Year

With the forward projections for both carbon intensity and EUI established, the final step is to identify the CRREM Misalignment Year. This is the first year in which the asset's projected intensity trajectory exceeds the respective CRREM Pathway intensity values.



CRREM Portfolio-level Aggregation Guide

Portfolio-level calculations provide an aggregated view of energy and carbon performance across multiple assets, including portfolios spanning different property types and regions. The following section explains how to calculate EUI and carbon intensities for a portfolio-level CRREM Risk Assessment and CRREM Misalignment Year.

Introduction

After asset-level assessments are complete, the next step is portfolio-level aggregation. This section explains the aggregation logic used in the legacy CRREM EU-Project Excel Tool and highlights what practitioners should pay attention to. In addition, it provides emerging Best Practice Recommendations observed in the market for the application of CRREM portfolio-level aggregation.

Each asset in a portfolio has a carbon intensity, an EUI, and associated CRREM Pathways. These individual results can be aggregated to portfolio-level and compared against a portfolio-level composite CRREM Pathway.

The process follows four steps: (1) assemble the asset-level inputs, (2) calculate weighted portfolio metrics, (3) build the weighted portfolio CRREM Pathway, and (4) compare performance against the Pathway to determine the portfolio's Misalignment Year.

Step 1: Assembling the Asset-level Inputs

For each asset, the following data points are needed:

- **Gross Internal Area (GIA)** in square meters (or local equivalent; see Floor Area Definitions in asset-level section)
- **Carbon intensity** in $kgCO_2e/m^2/year$, the net carbon intensity output from the asset-level assessment (Step 4 of the CRREM asset assessment calculations)
- **Energy use intensity (EUI)** in $kWh/m^2/year$, the output from Step 3 of the CRREM asset assessment calculations
- **CRREM Pathway** intensity values from 2020 to 2050 (full time series) for both carbon and energy, for the relevant property types and regions as found in the underlying portfolio

Optional Inputs

Optional fields such as Gross Asset Value (GAV) or Net Operating Income (NOI) can support alternative weighting approaches. The standard weighting factor is floor area, however GAV or NOI enable a money-weighted analysis that can reveal complementary perspectives on portfolio-level transition risk (see Best Practice Recommendations below). These are often preferred by investors for financial analysis or even regulatory application.

[illegible]

In market practice, assets with incomplete data are either included in the aggregation using estimates or excluded entirely. Both approaches are observed in the market and are acceptable, as long as the treatment is disclosed transparently (see below for disclosure recommendations).

Step 2: Floor-area-weighted Portfolio Aggregation

The goal is to produce CRREM outputs at the portfolio-level:

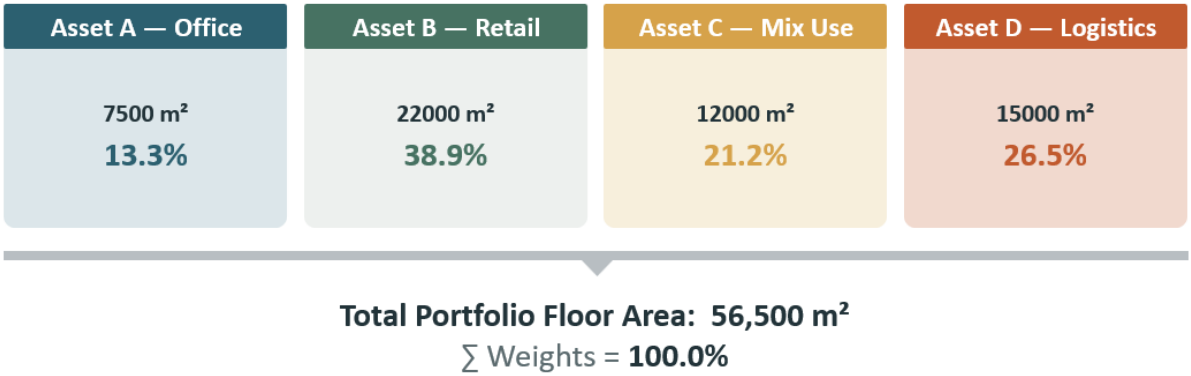
- Carbon intensity
- EUI
- CRREM Pathways (full time series for both carbon and EUI)
- CRREM Misalignment Year (for both carbon and EUI)

All outputs use floor-area weighting unless stated otherwise.

Computing Floor Area Weights

Calculate each asset's share of total portfolio floor area as a percentage. Sum all asset gross internal areas to obtain the total floor area, then divide each asset's GIA by the total. Assets excluded from the aggregation (e.g. because no suitable CRREM Pathway is available) are not part of the denominator; the weights of the remaining included assets always sum to exactly 100%.

For example, in a portfolio of four buildings where the assets have floor area of 7,500, 22,000, 12,000, and 15,000 m^2 respectively, the total floor area is 56,500 m^2. The largest asset (22,000 m^2) commands roughly 39% of the portfolio weight, meaning it will dominate the aggregated metrics.



Aggregating Carbon Intensity and EUI

Portfolio carbon intensity is calculated as the floor-area-weighted average of asset carbon intensities. Multiply each asset's carbon intensity by its floor area weight, then sum the results. The same approach applies to EUI.

In the worked example, a portfolio of four buildings produces a portfolio carbon intensity of approximately 54.6 $kgCO_2e/m^2$/year and a portfolio EUI of approximately 156.7 kWh/m^2/year. The high intensity retail asset in Hong Kong (106.6 $kgCO_2e/m^2$/year) has the largest single influence on the portfolio figure because it combines high intensity with the largest floor area.

Portfolio CI = Σ (Asset CI × Weight%) ≡ Total Emissions ÷ Total GIA

Asset	Weight	CI ($kgCO_2e/m^2$)	Weighted CI	EUI (kWh/m^2)	Weighted EUI
Asset A - Office	13.3%	45.39	6.02	204.04	27.08
Asset B - Retail	38.9%	106.62	41.52	232.73	90.63
Asset C - Mix Use	21.2%	20.20	4.29	141.67	30.09
Asset D - Logistics	26.5%	15.59	4.14	56.07	14.89
Portfolio Total	100.0%	—	54.58	—	156.65

Portfolio Carbon Intensity
54.6 $kgCO_2e/m^2/yr$

Portfolio EUI
156.7 $kWh/m^2/yr$

Asset B (Shopping Center, Hong Kong) dominates the portfolio — highest carbon intensity (106.62 $kgCO_2e/m^2$) paired with the largest floor area (38.9% weight)

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This distinction is particularly relevant in portfolios with diverse asset classes that differ significantly in floor area. A purely floor area-weighted approach may overweight asset types with large physical footprints, even where a smaller asset class carries higher capital values and therefore greater financial risk exposure. A parallel money-weighted view can help surface these dynamics.

In current market practice, money-weighted aggregation is predominantly observed for the aggregation of the CRREM Misalignment Year at portfolio or fund of funds level. A money-weighted aggregation of energy and carbon intensities expressed relative to a financial metric is less common, as intensity metrics are by convention expressed per unit of floor area.

To provide meaningful context beyond a single CRREM Misalignment Year figure, the share of aligned and misaligned assets by milestone year can also be reported, specifically the proportion of assets misaligning by 2030, 2040, and 2050. This distribution offers a more granular picture of the portfolio's transition risk profile over time and can be presented on both a floor-area-weighted and a money-weighted basis.

Regardless of the weighting approach chosen, market participants are encouraged to report transparently which underlying metric the portfolio-level CRREM assessment is based on and how results were weighted.

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Portfolio Performance Forward Projections

This step extends the reporting-year energy and carbon intensities into a full portfolio-level performance trajectory from the reporting year to 2050. For each year, the asset-level forward projections are aggregated using the same floor area weights established above.

In this projection, energy demand is held constant under a do-nothing scenario with no retrofit assumed, while grid electricity emission factors decline annually. The floor-area-weighted sum of asset-level carbon intensities produces a year-by-year portfolio carbon intensity trajectory.

If the optional climate-scenario adjustment (HDD/CDD-based) is utilized, the EUI trajectory will be adjusted to reflect changing heating and cooling loads.

These portfolio performance projections are compared against the floor-area-weighted Portfolio CRREM Pathway (Step 3) in Step 4 to determine the portfolio's CRREM Misalignment Year.

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Where granular asset-level energy consumption and carbon emissions data are not available, but the CRREM Misalignment Year for each asset or underlying fund is reported by a manager or estimated by a data provider, some market participants choose to aggregate these CRREM Misalignment Years directly at the portfolio or fund of funds level. This approach is often used be indirect investors.

Such an aggregation follows the same weighting logic as the aggregation of energy and carbon intensities described in Step 2: each asset's or underlying fund's CRREM Misalignment Year is multiplied by its respective weight (based on Floor Area or a money-weighted metric), and the weighted values are summed to produce a single weighted average CRREM Misalignment Year at the portfolio-level.

Step 3: Building the Weighted Portfolio CRREM Pathway

The portfolio-level CRREM Pathway is constructed by applying the same floor-area weights to the individual asset pathways for each year from 2020 to 2050. The result is a unique composite CRREM Pathway generated to reflect the portfolio's specific mix of assets across the full time series until 2050.

Concretely: for the year 2026, take each asset's 2026 CRREM Pathway value, multiply it by the asset's floor area weight, and sum the results. Then do the same for 2027, 2028, and so on through 2050. The result is a complete year-by-year CRREM Pathway against which the portfolio's performance can be compared.

The portfolio-level CRREM Pathway reflects the specific composition of the portfolio. If the portfolio is 80% office and 20% retail by floor area, the pathway will be dominated by CRREM

office pathways. If the regional or property type allocation of a portfolio changes, the portfolio CRREM Pathway should also change.

Mixed-use Assets

Mixed-use properties should generate asset-level mixed-use CRREM Pathways, and those pathways should be used in the portfolio-level aggregation.

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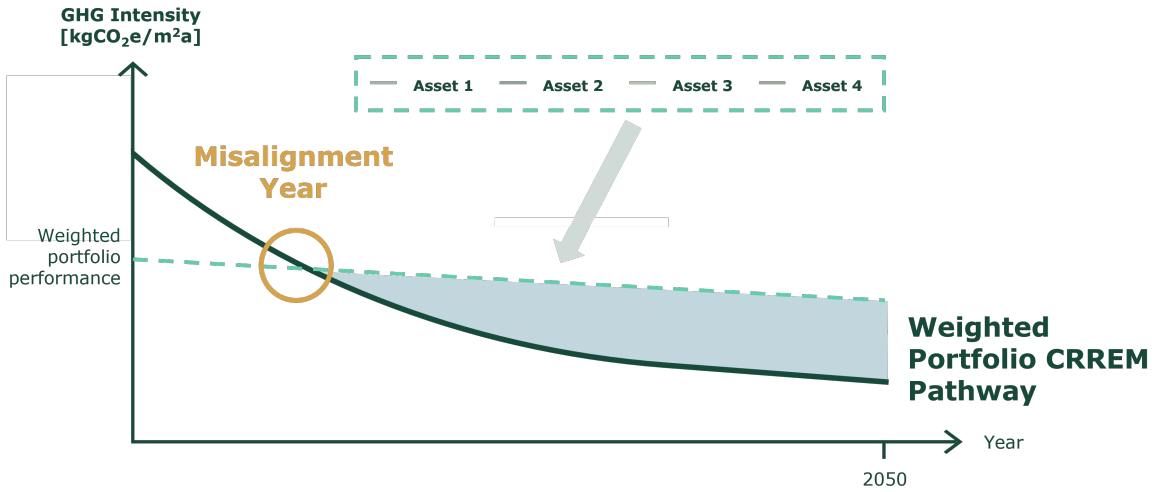
Market participants may consider excluding assets from the CRREM aggregation if no CRREM Pathway is available and no suitable proxy pathway can be applied (including assets in countries or regions not yet covered by CRREM Pathways). In such cases, no standard fallback methodology is prescribed by CRREM. Any alternative approach should be explicitly defined, documented, and justified on a case-by-case basis.

Step 4: Comparing Performance Against the Pathway

Portfolio-level carbon intensity and EUI are compared with the portfolio-level CRREM Pathway to determine whether, and when, the portfolio exceeds the pathway thresholds (see illustrative figure below).



Finding the CRREM Misalignment Year

The portfolio-level CRREM Misalignment Year is the first year in which the portfolio's projected carbon or energy intensity exceeds the constructed portfolio-weighted CRREM Pathway.

In the worked example provided in the **CRREM Asset & Portfolio Assessment – Technical Blueprint (.xlsx)**, the portfolio's carbon intensity of 54.6 $kgCO_2e/m^2$/year in 2024 declines in line with grid projections and remains below the portfolio CRREM Pathway through 2034. At that point, the portfolio's intensity is projected to be at 25.7 $kgCO_2e/m^2$/year, still below the pathway target of 27.13 $kgCO_2e/m^2$/year. However, in 2035, the pathway level declines to 24.9 $kgCO_2e/m^2$/year, falling below the portfolio's intensity for that year. This marks the point of misalignment: the CRREM Misalignment Year is 2035. For EUI, the crossover occurs one year earlier, in 2030.

Edge cases: If the portfolio's projected intensity already exceeds the CRREM Pathway before 2020, report 2020 as the CRREM Misalignment Year. If it never crosses the pathway by 2050, report 2050.

Best practice recommendation: Disclosures

Market participants are encouraged to disclose the following as a share of portfolio, calculated on the same weighting basis (floor area-weighted or money-weighted) used for the underlying aggregation. This supports readers in assessing the robustness and completeness of the reported average CRREM Misalignment Year:

- The share of assets or underlying portfolios excluded from the aggregation entirely
- The share of assets or underlying portfolios included based on estimated data

Where floor area or money-weighted metrics are not available for an individual asset, the portfolio average of the respective metric may be applied as a proxy for that asset when calculating data coverage. This allows the share of excluded or estimated-data assets to be reported even where building-level metrics are incomplete.


CRREM