CRREM EUI Methodology Explainer

A Summary of CRREM's Energy Pathway Methodology

MARKET SOUNDING | 2026

CRREM
CARBON RISK REAL ESTATE MONITOR

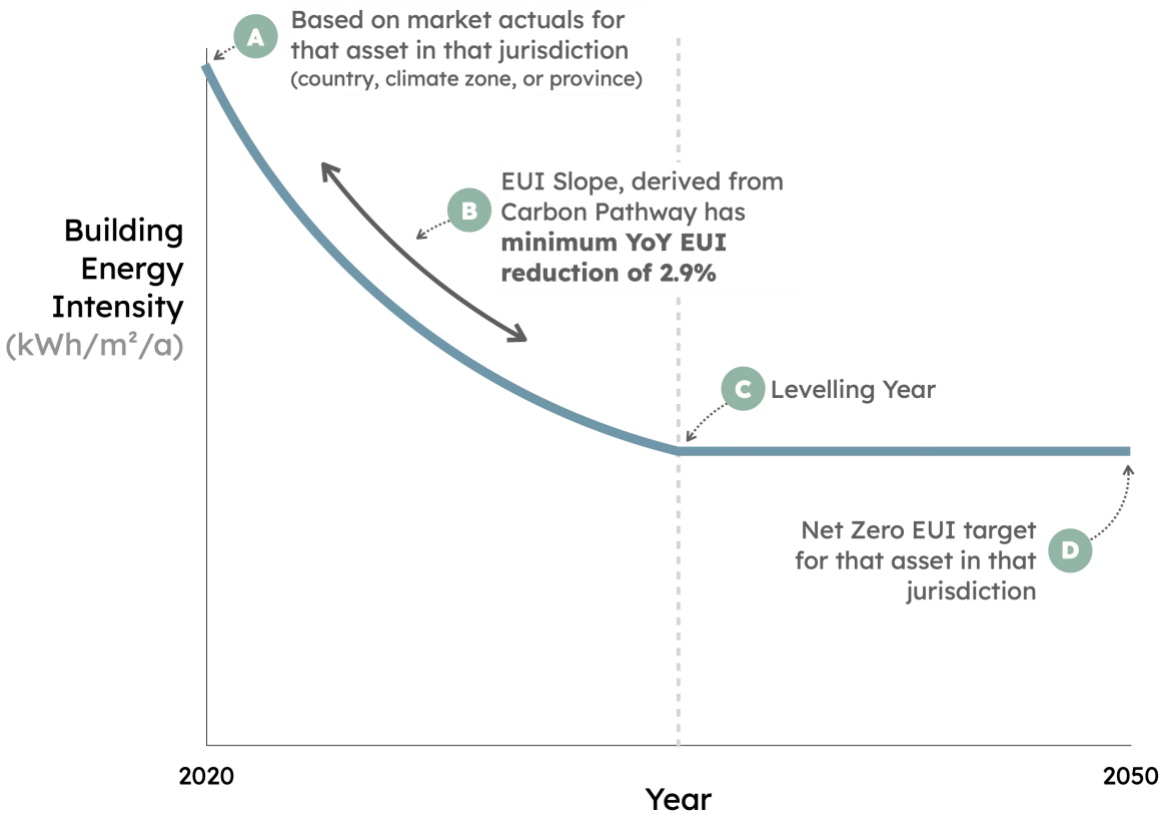
Contents

Introduction

This document explains the rationale underpinning the CRREM Energy Use Intensity (EUI) Pathway and provides a high-level overview of how it is constructed. A detailed technical description is provided in *From Global Emission Budgets to Decarbonization Pathways at Property Level*, available on the CRREM website.

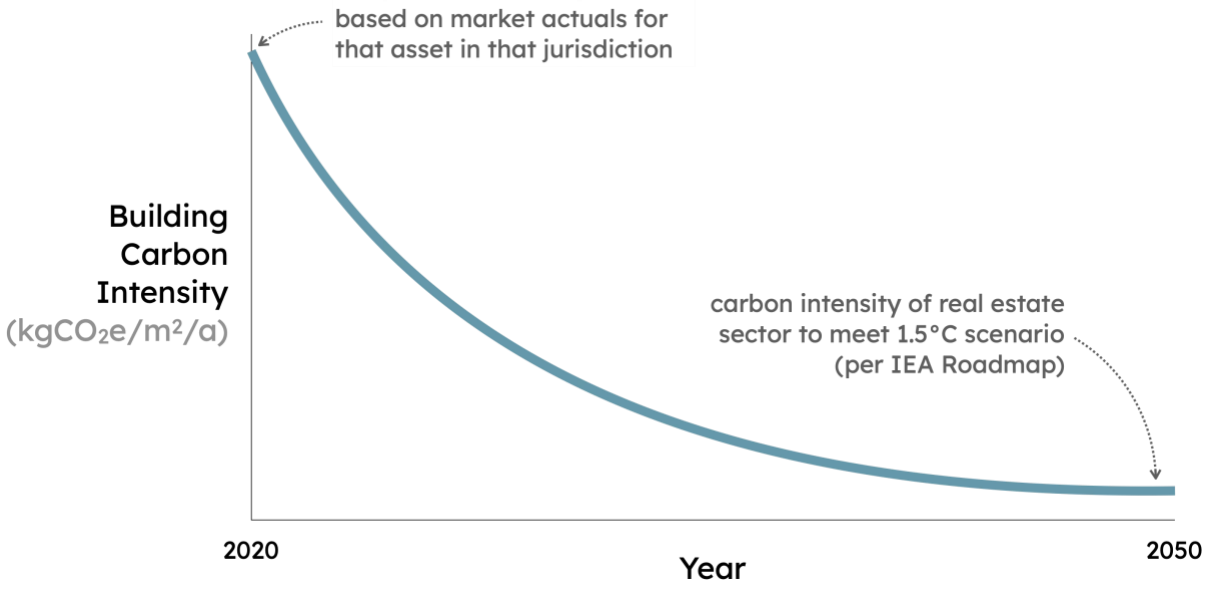
Each CRREM EUI Pathway is defined by four core elements or building blocks:

A. **2020 Baseline EUI**, representing the starting energy intensity for the property type and jurisdiction
B. **Pathway EUI Slope**, representing the year-over-year allowable energy-intensity budget and visualised as a downward-sloping trajectory
C. **Levelling Year**, the point at which the Net Zero EUI target is reached in order to remain aligned with the 1.5°C Global Warming scenario, after which the EUI Pathway remains constant or flat
D. **Net Zero EUI target**, representing the minimum residual operational energy intensity that can be fully supplied by zero-carbon energy sources in 2050 for the given property type and jurisdiction



Current Rationale

The CRREM EUI Pathways are derived from, and designed to complement, the CRREM Carbon Pathways.



A CRREM Carbon Pathway defines the maximum allowable operational greenhouse gas emissions[1], expressed as CO_2-equivalents (CO_2e), per unit of building floor area, for a given property type and jurisdiction[2], consistent with a 1.5°C Global Warming scenario.[3] The Carbon Pathway is expressed as an annual carbon intensity budget (i.e., CO_2e emitted per unit of floor area per year) from 2020 to 2050.[4]

The complementary CRREM EUI Pathway translates this carbon budget into an allowable level of operational energy use, based on the projected carbon intensity of the energy supply available to that property type in that jurisdiction over the 2020-2050 period. The annual projected carbon intensity of the energy supply is represented by an Emissions Factor, which reflects projected changes in energy supply driven by national and regional decarbonization

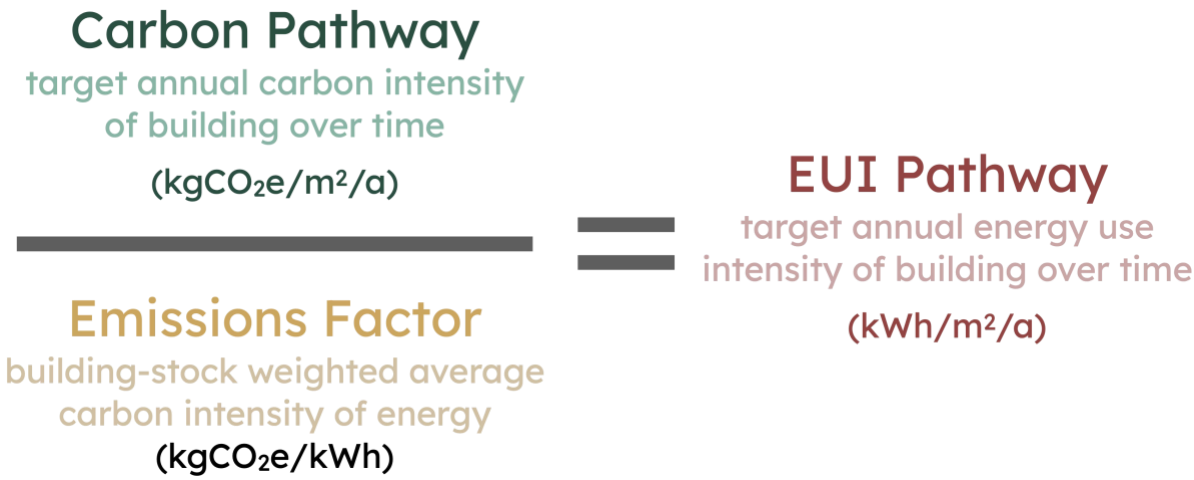
[1] In the context of CRREM Pathways, "carbon" refers to operational greenhouse gas emissions expressed as CO_2e, excluding F-gases.

[2] "Jurisdiction" refers to the geographic unit for which CRREM publishes Pathways. This may be a country or a sub-national jurisdiction (e.g. sub-country climate zones as used in Australia, or blended climate and electricity/grid regions as used in the United States). CRREM covers 44 countries, plus additional sub-national jurisdictions in selected markets.

[3] Operational energy = energy that a building uses to operate; does not include embodied energy.

[4] Carbon intensity = units of carbon dioxide-equivalent (CO_2e) greenhouse gases (GHG) emitted per unit of floor area. Units of measurement are: $kgCO_2e/m^2$ (metric) and $kgCO_2e/SF$ (imperial)

policies. This defines the maximum operational energy use permitted each year for a property to remain aligned with its Carbon Pathway.



While the CRREM Carbon Pathways decline continuously through to 2050, EUI Pathways reach a flattening point before 2050, often during the 2030s. This point is referred to as the *Levelling Year*: the year in which the CRREM EUI Pathway reaches the energy-use level corresponding to the projected Net Zero energy supply available to the building sector in 2050. Methodologically, once this Net Zero aligned level is reached, the CRREM EUI Pathway remains constant thereafter. Because buildings cannot operate without consuming energy, residual energy use beyond the Levelling Year is assumed to be supplied entirely by zero-carbon energy sources consistent with the projected 2050 energy mix for the sector.

The CRREM EUI Pathways' Net Zero aligned energy levels (i.e., EUI after the Levelling Year) vary by property type and jurisdiction. Some property types are inherently more energy intensive than others and the variation by jurisdiction is based on the heating degree days (HDD) and cooling degree days (CDD) typical of that jurisdiction.

Implications of Emissions Factors

Emissions Factors are projected based on national and regional energy-system decarbonization policies. In the Global EUI Methodology, CRREM builds what is called a Building-Stock Weighted Emissions Factor. This starts with a local building stock's energy type mix (i.e. a jurisdiction-level average breakdown of electricity, fuels, and district heating/cooling), and projects how that breakdown will evolve over time. The result is then combined with projected Emissions Factors of the respective underlying energy types to arrive at one overall projected Emissions Factor for a local building stock. This is done by property type. As a result, buildings located in jurisdictions with carbon-intensive electricity grids or district heating and/or cooling systems—and weak policies to decarbonize them—are assigned more aggressive EUI Pathways than otherwise equivalent buildings in jurisdictions with cleaner energy systems. Procuring 100% clean energy at the individual

building level does not alter performance against the EUI Pathway, because the Pathway is constructed using jurisdiction-level average energy supply characteristics rather than property-specific procurement choices.

Methodology: Step-by-Step

The following section provides a high-level overview of how CRREM EUI Pathways are constructed. Because the initial portion of the EUI Pathway (up to the Levelling Year) is derived directly from the Carbon Pathway, the construction of a CRREM EUI Pathway begins with the development of a CRREM Carbon Pathway for the relevant property type and jurisdiction.

Step 1: Constructing the Carbon Pathway

Every CRREM Carbon Pathway is anchored in the 2020-2050 decarbonization trajectory for residential and commercial buildings set out in the International Energy Agency (IEA) *Net Zero by 2050: A Roadmap for the Global Energy Sector* report, which defines a global decarbonization pathway consistent with limiting warming to 1.5°C, the highest ambition set out in the Paris Agreement.[5] The roadmap allocates carbon budgets for the 2020-2050 period across energy-using sectors, including residential and commercial buildings, and incorporates assumptions about technical feasibility. The report also defines a global 2050 Net Zero EUI benchmark for residential and commercial buildings, representing an energy-use level that can be reasonably supplied by zero-carbon energy sources worldwide.

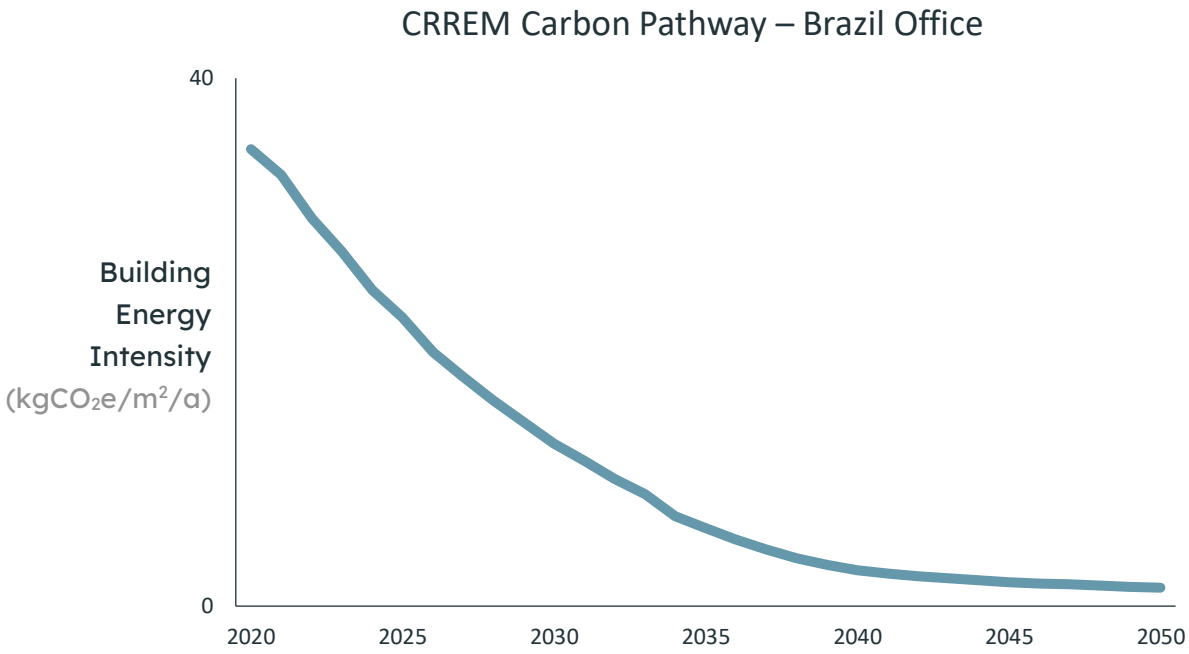
Constructing Jurisdiction Decarbonization Pathways

CRREM applies the Sectoral Decarbonization Approach (SDA), developed by CDP, WRI, and WWF under the Science Based Targets initiative (SBTi), to downscale global carbon budgets into jurisdiction-level decarbonization pathways for each property type that converge to Net Zero. The starting point of each CRREM Carbon Pathway, the 2020 carbon intensity, is derived from observed real-world data, including:

- existing floor area of buildings in each jurisdiction
- energy intensity of that floor area; and
- emissions factor for the energy used within that jurisdiction

The figure below illustrates an example Carbon Pathway for an office building in Brazil.

[5] CRREM intends to update Carbon Pathways in line with the most recent IEA carbon budgets as part of its ongoing research and development program. Update timelines will be communicated in due course.



Implications for Downscaling on Technical Feasibility

While the IEA *Net Zero by 2050* Roadmap incorporates assumptions about technical feasibility at a global level, the CRREM downscaling approach does not guarantee that the resulting EUI Pathway or its Levelling Year is technically feasible for individual buildings. At present, no bottom-up analysis is undertaken to validate market acceptance or technical feasibility at the building level.

Step 2: Deriving the CRREM EUI Pathway Slope (year-over-year change) from the Carbon Pathway

Once the CRREM Carbon Pathway has been established for a given property type and jurisdiction, the corresponding EUI Slope, representing the year-over-year allowable energy-intensity budget, can be derived. As described above, the EUI Pathway is calculated by backing out the amount of operational energy use permitted each year under the Carbon Pathway. This is achieved by dividing the annual carbon-intensity values of the Carbon Pathway by the corresponding Building-Stock Weighted Emissions Factors for the relevant property type and jurisdiction (national or sub-national, as defined by CRREM) for each year from 2020 to 2050.

Deriving Building-Stock Weighted Emissions Factors

To derive the slope of the EUI Pathway, CRREM applies Building-Stock Weighted Emissions Factors. These factors represent a jurisdiction-level weighted average of Emissions Factors

across the local building stock's energy sources (e.g. electricity, fuels, district heating/cooling) in a given year. Changes in the composition of building energy sources/types over time are explicitly accounted for in the calculation of the EUI Slope, using projections of building stock electrification, gas use, and district heating/cooling into the future. Building-Stock Weighted Emissions Factors are derived from the following four inputs, each of which is influenced by local policy conditions:

- projected building stock energy source/type mix (i.e. the relative shares of electricity, fuels, and district heating used by buildings) over time
- projected carbon intensity of grid-supplied electricity over time
- projected carbon intensity of district heating systems over time
- emissions factors associated with on-site fuels

It is important to note that the Building-Stock Weighted Emissions Factors are projections rather than observed values. The table below illustrates an example of how Building-Stock Weighted Emissions Factors are derived for a representative jurisdiction. In this example, district heating and cooling systems are not present, and natural gas is the only fuel used in addition to electricity; as a result, other fuels are not included in the weighted emissions factor calculation.

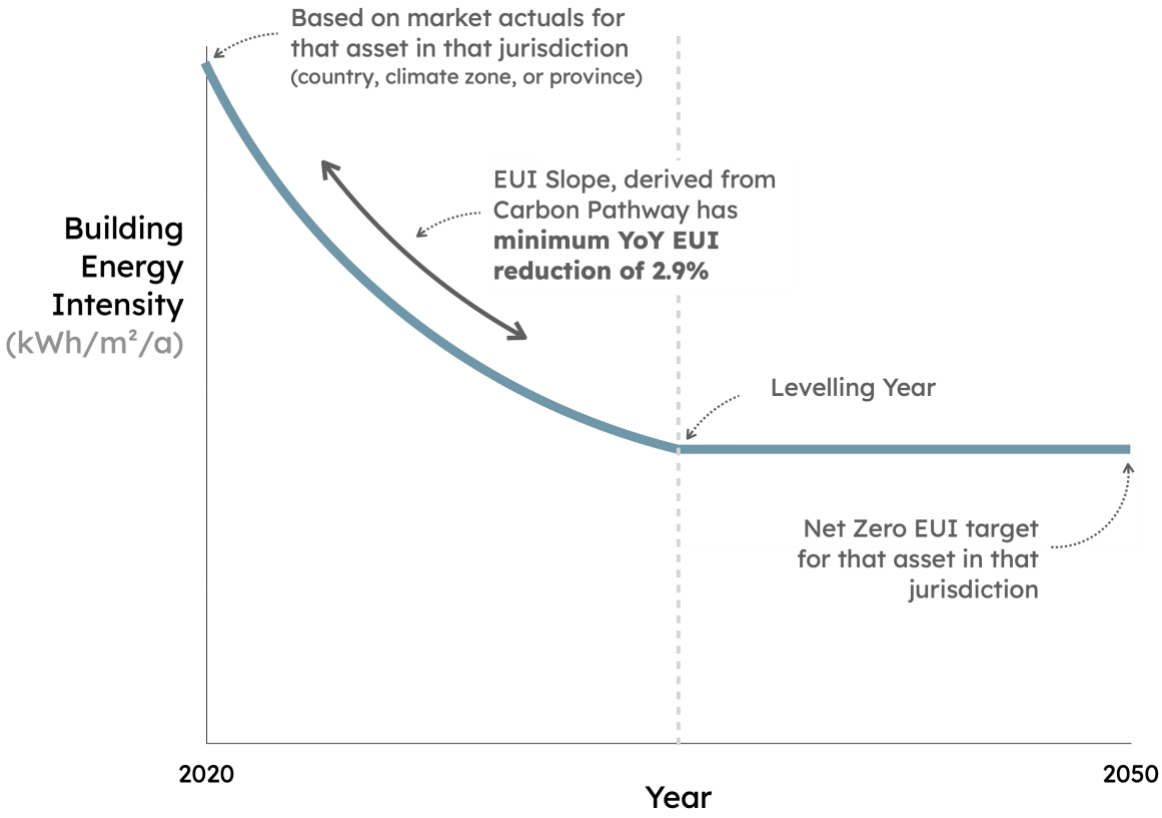
Year	**Electricity Emissions Factor** ($kgCO_2e/kWh$)	**Buildings' average electricity share %**	**Natural Gas Emissions Factor** ($kgCO_2e/kWh$)	**Buildings' average gas share %**	**Building-Stock Weighted Emissions Factors**[6] (kg CO_2e/kWh)
2020	0.385	0.808	0.181	0.192	0.346
2021	0.373	0.814	0.181	0.186	0.337
2022	0.346	0.820	0.181	0.180	0.316
2023	0.319	0.825	0.181	0.175	0.295
…	…	…	…	…	…
2047	0.033	0.929	0.181	0.071	0.044
2048	0.033	0.934	0.181	0.066	0.043

[6] This example is taken from the CRREM North America project and represents the Arizona–New Mexico (combined) grid-region jurisdiction.

2049	0.034	0.938	0.181	0.062	0.043
2050	0.034	0.942	0.181	0.058	0.043

Charting the EUI Slope Corresponding to the CRREM Carbon Pathway

Dividing the annual carbon-intensity values defined in a CRREM Carbon Pathway by the corresponding Building-Stock Weighted Emissions Factors for each year yields EUI levels that represent the maximum amount of operational energy use permitted per unit of floor area while remaining aligned with the 1.5°C Global Warming scenario. However, if the implied year-over-year reduction in EUI falls below 3% at any point along the Pathway (prior to the Levelling Year), the EUI slope is adjusted to continue thereafter at a minimum annual reduction rate of 2.9%. This reflects the global energy efficiency improvement target set under UN Sustainable Development Goal 7.3, which calls for doubling the global rate of improvement in energy efficiency by 2030.



Flattening the EUI Slope at the Levelling Year

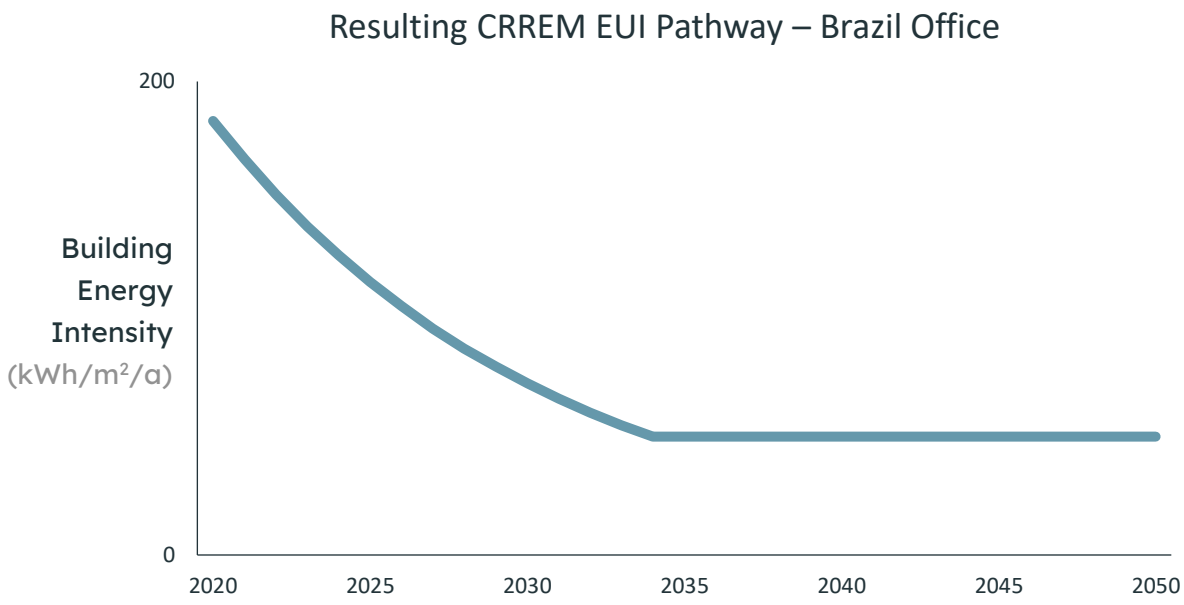
The CRREM EUI Pathway Slope flattens when it reaches the 2050 Net Zero EUI target for that property type and jurisdiction. The EUI Pathway flattens at this point because, beyond the Levelling Year, further alignment with the CRREM Carbon Pathway is assumed to be

achieved through continued decarbonization of the energy supply rather than further reductions in operational energy demand.

CRREM establishes the 2050 Net Zero EUI target for each covered property type and jurisdiction by allocating the IEA's projected 2050 zero-carbon energy supply available to buildings across property types and jurisdictions, based on the following three inputs:

1. 2020 population of the jurisdiction
2. Average heating degree days (HDD) and cooling degree days (CDD) for the jurisdiction
3. Relative energy-intensity requirements of each property type compared to other property types

The following figure illustrates an example EUI Pathway for an office building in Brazil.



Conclusion

In summary, CRREM EUI Pathways translate the CRREM Carbon Pathways into a year-over-year operational energy-intensity budget for buildings, using projected, jurisdiction-level emissions factors and energy-supply decarbonization assumptions consistent with a 1.5°C Global Warming scenario. The resulting Pathways define both the rate at which operational energy use must decline and the minimum residual energy intensity that can be sustained once a Net Zero aligned energy supply is reached, providing a consistent and transparent framework for assessing alignment over time.