

Bernardette Soust-Vedaguer^{1*}, Daniel Cagigas¹, Isidro Cortés¹, Rocío Quiñones¹, Alicia Vázquez-Cabrera¹, José Antonio Gutierrez Moreno¹, María Victoria Montes¹, Luis Angel Castro¹, María Dolores Fernández Galvéz¹, Xabat Oregi², Elisabetta Palumbo³, Encarnación Abajo¹, Francisco Espasandín¹, Teresa Rojo¹, Carmen Llatas¹

¹ University of Seville, Spain; ² University of the Basque Country, Spain; ³ University of Bergamo, Italy

Contact information:

Reina Mercedes 2,
Seville, Spain.
+34954556591
bsoust@us.es

Construction floor area a key driver of decarbonisation in Spain's residential building stock

- **Multiple future scenarios for building growth.** Six scenarios model the possible tendencies of new residential floor area in Spain up to 2075.
- **GHG emissions are assessed across scenarios and different climate zones in Spain.** The model covers both operational and embodied emissions over a 50-year life cycle.

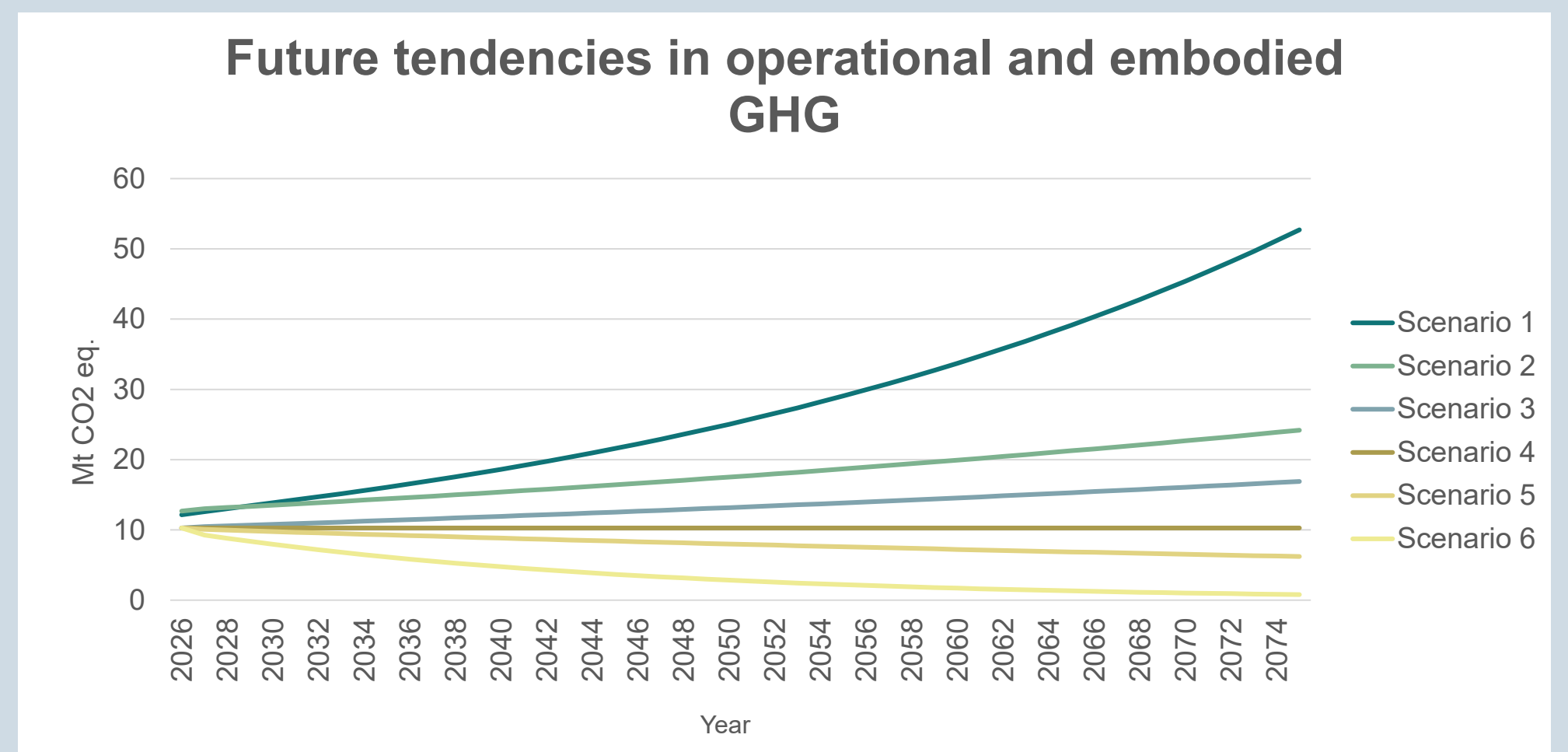


Fig. 1. Modelling of operational and embodied GHG emissions derivate from residential news building stock future scenarios*.

- **Construction activity**—particularly GFA growth—is a relevant driver of residential GHG emissions, outweighing the impact of grid decarbonisation.
- **Limiting new construction and prioritizing renovation and reuse** are relevant for effective decarbonisation.

Introduction

The building sector is a great contributor to global energy use and greenhouse gas emissions (GHG), with growing residential construction in Spain posing a challenge for decarbonisation. While operational emissions have traditionally been prioritized, embodied carbon is becoming increasingly significant.

Addressing these impacts requires forward-looking approaches integrating Life Cycle Assessment (LCA) and scenario-based analysis. This study explores future scenarios for residential construction in Spain, combining prospective LCA, statistical data, and BIM-based modelling to assess whole life carbon emissions.

The aim is to identify effective strategies to reduce emissions while supporting sustainable sectoral development and evidence-based decision-making.

Methods

The study uses a scenario-based framework combining prospective LCA, mathematical modelling, and BIM to assess embodied and operational carbon emissions in future residential construction in Spain, structured in four methodological stages.

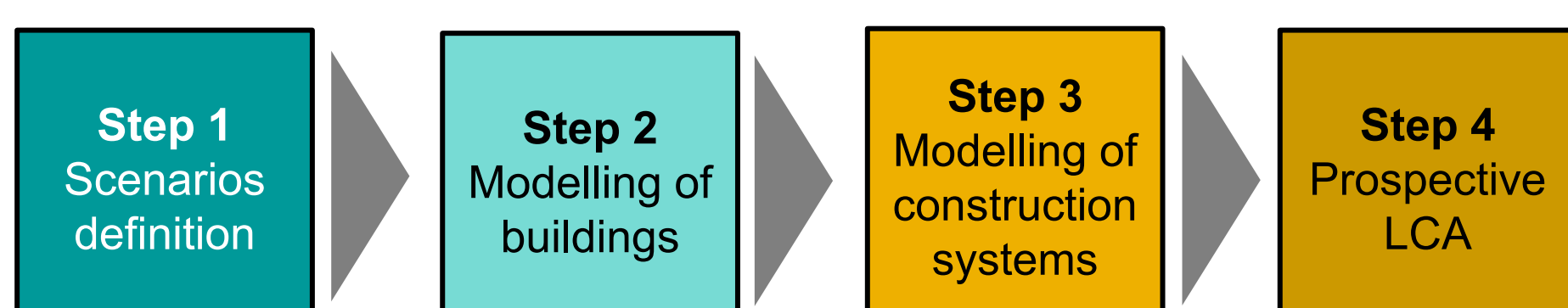


Fig. 2. Scheme of the methods*.

Results

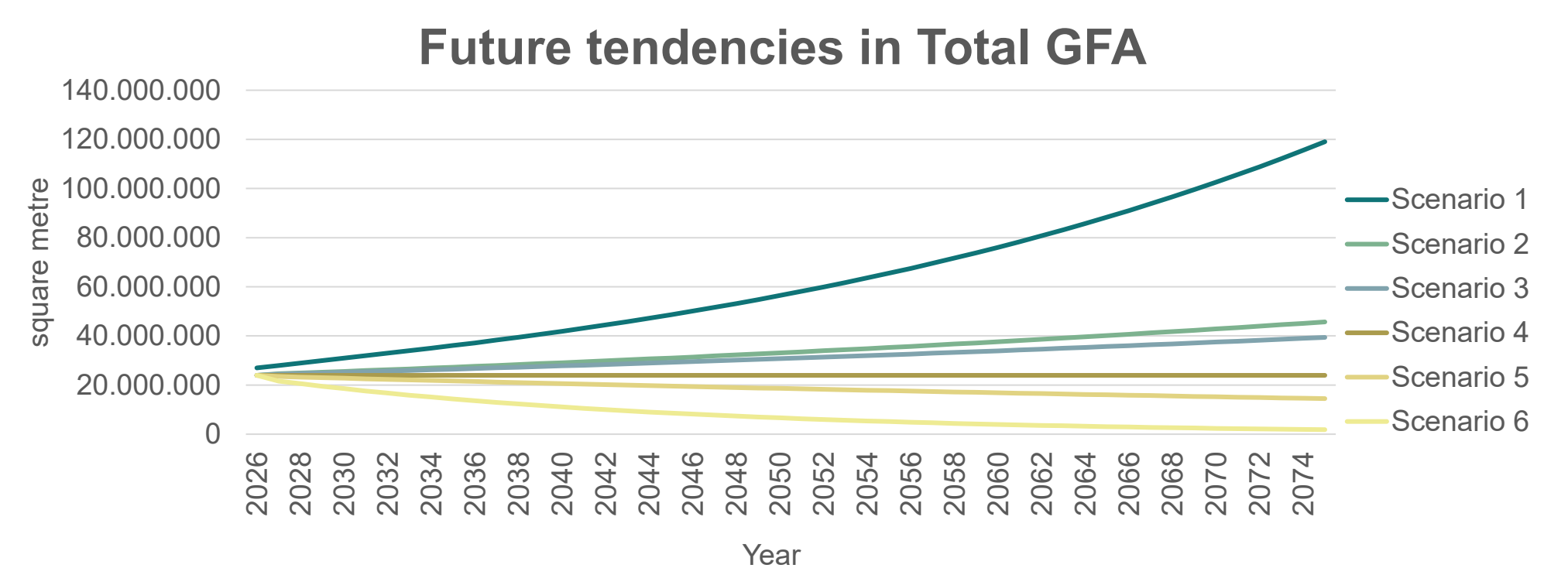


Fig. 3. Modelling of residential news building stock future scenarios*.

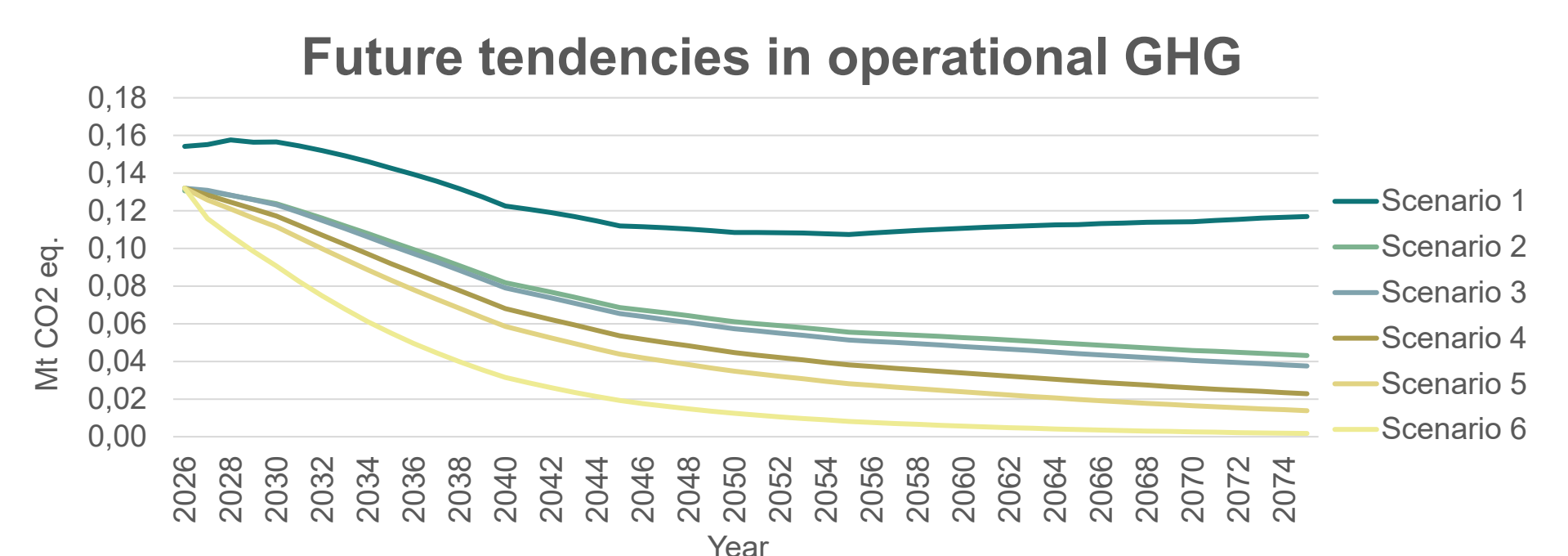


Fig. 4. Modelling of operational GHG emissions derivate from residential news building stock future scenarios*.

*Source: Authors owns elaboration.

Conclusions

This study highlights a critical opportunity to assess environmental performance and accelerate decarbonisation, particularly when supported by Whole Life Carbon (WLC) assessment methods (including operational and embodied impacts) and prospective LCA.

Acknowledgement

The authors thank the funding organisation MCIN/AEI/10.13039/501100011033, the European Union "NextGenerationEU"/PRTR, FEDER, EU and the Consejería de Fomento, Articulación del Territorio y Vivienda, Junta de Andalucía for supporting the following projects: Grant US.24-04 (GeoRecicla) and Grant PID2022-137650OB-I00 (DECIDE). The authors gratefully acknowledge the fruitful international collaboration of the participating countries and the strong engagement of the experts involved in the International Energy Agency's (IEA) Technology Collaboration Programme (TCP) on Energy in Buildings and Communities (EBC), project Annex 89: Ways to Implement Net Zero Whole Life Carbon Buildings (<http://annex89.iea-ebc.org>).